Volume 3
Part 1

Court Decision

U.S. Army Corps of Engineers
Memphis District

UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF COLUMBIA

ENVIRONMENTAL DEFENSE, *et al.*,	:	
Plaintiffs,	:	
v.	:	Civil Action No. 04-1575 (JR)
U.S. ARMY CORPS OF ENGINEERS, *et al.*,	:	
Defendants.	:	

MEMORANDUM

Plaintiffs Environmental Defense and National Wildlife Federation challenge the U.S. Army Corps of Engineers' authorization of a flood control project in the St. Johns Bayou and New Madrid Floodway on the west bank of the Mississippi River in the "bootheel" of southeastern Missouri. Plaintiffs ask the court to declare that the Corps, as well as the Secretary of the Army, Pete Geren, have violated the Water Resources Development Act of 1986 ("1986 WRDA"), the Water Resources Development Act of 1974 ("1974 WRDA"), the federal Clean Water Act ("CWA"), the National Environmental Policy Act of 1969 ("NEPA"), the Rivers and Harbor Appropriation Act of 1899 ("RHAA"), and the Administrative Procedure Act ("APA"); to declare that the USDA is violating the Swampbuster provisions of the Food Security Act of 1985 ("FSA") and the APA; and to enjoin these violations.[1]

---

[1]Although raised in the Second Amended Complaint, the claim against the USDA for violation of the Swampbuster provisions of the FSA were not addressed by either party in the motions for

In plaintiffs submission, the St. Johns Bayou-New Madrid Floodway Project is a terrible idea: It will not accomplish the flood control benefits claimed for it; its cost estimate relies on a discount rate last seen during the Eisenhower Administration; it violates statutory requirements for cost-sharing by local districts; and the Corps has improperly manipulated its habitat models to make it seem that the project's environmental impacts will be fully mitigated, when they will not. It is not for this court to determine whether the project is a good idea or a bad one, or to pass judgment on the policy implications of public works. On their last point, however, the plaintiffs are correct. As discussed below, the Corps of Engineers has resorted to arbitrary and capricious reasoning - manipulating models and changing definitions where necessary - to make this project seem compliant with the Clean Water Act and the National Environmental Policy Act when it is not. Because it is not, and because the government's arbitrary and capricious actions violate the Administrative Procedure Act, the plaintiffs' motion for summary judgment [87] must be granted. The defendants' cross-motion [92] will be denied. Further construction work on the project will be enjoined, and the Corps

---

summary judgment nor discussed during oral argument. That claim is therefore consider considered to have been abandoned and is not addressed in this memorandum.

will be required to restore the disturbances created by the preliminary construction work that has already been completed.

Background[2]

> "The Mississippi will always have its own way; no engineering skill can persuade it to do otherwise; it has always torn down the petty basketwork of the engineers and poured its giant floods whithersoever it chose, and it will continue to do this." - *Mark Twain*

This case presents the latest chapter in the story of the complicated relationship between the Army Corps of Engineers and the mighty Mississippi River. The flood control project in question (originally two projects, now treated as one) would transform two major drainage basins in a 400,000 acre project area: the New Madrid Floodway, and the St. Johns Bayou Basin immediately to its west. The New Madrid Floodway piece of the project would close a 1500 foot gap in the Mississippi River Levee ("MRL"), construct a concrete box culvert with gates to control water flow between the river and the floodplain, and install a large pump to remove water from behind the closed gates. The St. Johns Basin piece involves construction of a second pump, to remove water that collects in the lower part of the St. Johns Basin, and the widening and straightening of three separate channels to speed water removal from the area.

---

[2]The facts have been laid out in previous rulings and will not be repeated in detail in this memorandum. See, e.g., Envtl. Def. v. Army Corps of Eng'rs, 2006 U.S. Dist. LEXIS 47969 (D.D.C. 2006), [74].

The New Madrid Floodway is the last sizable section of the lower Mississippi River floodplain that remains connected to the river: 90 percent of the floodplain has been transformed - mostly into cropland - by the Corps and by the private developers it regulates. 2002 RSEIS, attached to Plaintiffs' MSJ [87] as Ex. 1 at E-53, E-73 (hereinafter "2002 RSEIS"). The construction of approximately 1600 miles of levees and supporting structures along the lower Mississippi began in a coordinated fashion in 1882. When the Corps completed the MRL in 1933, it left a quarter-mile gap along the New Madrid Floodway - the gap the Corps now proposes to close - so that the floodway could serve as a release valve for high water on the river. Id. at 100-01. When inundated, the floodplain provides invaluable habitat for fish and wildlife - half of the river's fish species follow the river as it spills into the floodway during flood conditions, to reproduce away from the river's punishing currents.

Seasonal flooding in the New Madrid Floodway interferes with farming and economic development, however, and the Corps has sought for many years to close the levee gap and drain the floodplain. It received congressional authorization to do so in 1954, and it has spent decades shoring up local support, developing complementary projects, and maneuvering around financial and environmental hurdles, in order to complete what it considers the final component of the Mississippi River Levee system. Especially cumbersome and time-consuming have been the

Corps' efforts to satisfy environmental requirements. In the last eight years alone, in response to numerous concerns and objections from government agencies and environmental groups, the Corps has prepared a Draft Supplemental Environmental Impact Statement (1999), a Final Supplemental Environmental Impact Statement (2000), a Revised Supplemental EIS (2002), and a second Revised Supplemental EIS (2006), prompting a biologist studying the project to fret that the agency may run out of abbreviations.

Plaintiffs filed this lawsuit in September 2004 challenging the 2002 RSEIS and subsequent Record of Decision ("ROD"). They moved for summary judgment on their many claims in March 2005 [23]. Defendants cross-moved for summary judgment in May 2005 [31]. In June 2005, three days before the date set for oral argument on the cross-motions, defendants acknowledged a major math error in the 2002 RSEIS, withdrew their challenged ROD and their cross-motion for summary judgment, and moved for a remand so that the Corps could prepare another Revised Supplemental Environmental Impact Statement [40]. I allowed the remand on condition that an appropriate attorneys' fee award be negotiated [48]. When the parties reported their inability to agree on a fee award, I stayed the case anyway, to await the issuance of a revised project plan [51].

In May 2006, plaintiffs moved to compel the filing of an administrative record [53], and in June 2006, plaintiffs moved for a preliminary injunction [58] and filed a second amended

complaint [105]. I denied the preliminary injunction in July 2006, finding that, although plaintiffs had demonstrated a substantial likelihood of success on the merits of one of their claims, the first phase of construction was unlikely to inflict irreversible injury [74]. I conditioned that ruling on the Corps' agreement to undo any project construction in the event of plaintiffs' ultimate success on the merits of their case. In August 2006, the Corps announced that it would shortly issue a Notice of Intent to Proceed with the first phase of construction: site preparation for the pumping plant, involving the creation of a cofferdam [80]. Plaintiffs objected to the plan, claiming that it violated the terms of my earlier ruling [81]. After considering the arguments of the parties at a hearing on an emergency motion for a preliminary injunction, again warning the Corps of my intent to order deconstruction if plaintiffs ultimately prevailed, and receiving assurances that defendants would not contest the court's authority to order such a remedy, I found that the first phase of construction would not result in irreparable injury, and I denied the renewed motion for a preliminary injunction.

At a hearing on subsequent cross-motions for summary judgment in February 2007, the Corps reported that the cofferdam construction permitted under my ruling in August 2006 would be

complete by May or June 2007.[3] The summary judgment motions were taken under advisement and are considered below.

Analysis

Legal Standard

A federal agency's compliance with its statutory and regulatory obligations is subject to review under the APA. The APA creates a cause of action for challenges to final agency actions, findings, or conclusions alleged to be "arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with the law." 5 U.S.C. § 702(2)(A). While the court's review must be "searching and careful, the ultimate standard of review is a narrow one[;] [t]he court is not empowered to substitute its judgment for that of the agency." Citizens to Preserve Overton Park v. Volpe, 401 U.S. 402, 416 (1971), *overruled on other grounds*. This deferential standard guards against "undue judicial interference with [agencies' exercise of] lawful discretion, and [prevents] judicial entanglement in abstract policy disagreements which courts lack both the expertise and information to resolve." Norton v. Utah Wilderness Alliance, 542 U.S. 55, 66 (2004). In applying this standard, the court must engage deeply with the administrative record in order to "determine whether the agency decision was rational and based on consideration of the relevant factors."

[3]A more recent construction report indicated that this phase of project construction would be completed no earlier than August 2007 [110].

Ethyl Corp. v. EPA, 541 F.2d 1, 36 (D.C. Cir. 1976). Action will be set aside under the APA if the agency identified no "rational connection between the facts found and the choice made," if the "explanation for its decision [ran] counter to the evidence before the agency, or is so implausible that it could not be ascribed to a difference in view or the product of agency expertise." Motor Vehicle Mfrs. Ass'n v. State Farm Mut. Auto. Ins. Co., 463 U.S. 29, 43 (1983) (internal quotations omitted). The Corps' 2002 RSEIS, 2006 RSEIS, and findings of compliance with statutory and regulatory requirements are all reviewable under the APA.

Plaintiffs' Challenges

Plaintiffs' challenges to the St. Johns Bayou-New Madrid Floodway Project fall into three broad categories. First, plaintiffs argue that the Corps' proposed mitigation will not fully offset the project's environmental impacts on fish and waterfowl. Second, they argue that the Corps conducted a deficient analysis of alternative projects and selected a project that insufficiently addresses a primary project purpose. Third, plaintiffs argue that the Corps' project is built upon a severely flawed economic analysis.

Distortions in the Agency's Fish Mitigation Analysis

It is undisputed that the largest environmental impact of the combined project will be on fisheries resources. Absent mitigation, the flood control project would have a devastating

impact on fisheries resources in the project area. In its environmental impact statements, the Corps has consistently acknowledged its intent to mitigate fully unavoidable adverse impacts on the fisheries resource. In its 2006 Record of Decision, the Corps again declared its "belie[f] that the fisheries resource will be fully mitigated." 2006 ROD, attached to Plaintiffs' MSJ [87] as Ex. 121 at 1632. Plaintiffs challenge this finding for several reasons, which will be addressed below.

The Corps' mitigation analysis is a major component of the project's compliance with the Clean Water Act. The CWA requires that all projects, such as this one, involving the discharge of dredged material into the waters of the United States, satisfy § 404(b) guidelines promulgated by the Environmental Protection Agency, 33 U.S.C. § 1344(b)(1), as incorporated in the Corps' regulations. The CWA prohibits the Corps from issuing permits to projects that will have a significant adverse impact on the environment,[4] and the Corps is

[4]The Corps is charged with issuing § 404(b) permits to private parties and with authorizing "its own discharges of dredged or fill material by applying all substantive legal requirements, including public notice, opportunity for public hearing, and application of the section 404(b)(1) guidelines." 33 C.F.R. § 336.1(a). The "Corps does not process and issue permits for its own activities," id., but it "shall be subject to, and comply with, all . . . requirements . . . respecting the control and abatement of water pollution in the same manner, and to the same extent as any nongovernmental entity." 33 U.S.C. § 1323(a)(2). The Corps' EIS and ROD for projects such as this one serve the same purpose as §404(b) permits for private parties - they are the enabling documents that certify compliance with the regulations and allow the project to go forward.

required to calculate adverse impacts by analyzing the short and long term consequences of discharges on the "physical, chemical, and biological components of the aquatic environment." 40 C.F.R. § 230.11. The Corps may approve a project only if it is the least damaging practicable alternative, if its discharges do not cause or contribute to significant degradation of the waters of the United States (including, in relevant part, loss of fish and wildlife habitat), and if potential adverse impacts to aquatic ecosystems are minimized to the extent practicable. 40 C.F.R. § 230.10.

In its 2006 RSEIS, the Corps certified the project's full compliance with the Clean Water Act and the Section 404(b)(1) guidelines, and declared that "impacts to significant fish and wildlife resources are fully compensated." 2006 RSEIS, attached to Plaintiffs' MSJ [87] as Ex. 104 at x, table S.2 (hereinafter "2006 RSEIS"). As explained below, however, this certification of compliance "runs counter to the evidence before the agency [and] is so implausible that it [cannot] be ascribed to a difference in view or the product of agency expertise." State Farm, 463 U.S. at 43 (1983).

Environmental impact statements are also reviewed for compliance with the National Environmental Policy Act, which was designed to "prevent or eliminate damage to the environment." 42 U.S.C. § 4321. NEPA is a procedurally-oriented statute intended to prevent uninformed agency action. Agencies must prepare

environmental impact statements under NEPA for all projects "significantly affecting the quality of the human environment," 42 U.S.C. § 4332(2)(C), identifying "any adverse environmental effects which cannot be avoided should the proposal be implemented," 42 U.S.C. § 4332(C)(ii). A "reasonably complete discussion of possible mitigation measures" is implicitly required. Robertson v. Methow Valley Citizens Council, 490 U.S. 332, 351 (1989).

"Accurate scientific analysis, expert agency comments, and public scrutiny are essential to implementing NEPA." 40 C.F.R. § 1500.1. For this reason, agencies are under an affirmative mandate to "insure the professional integrity, including scientific integrity, of the discussions and analyses in environmental impact statements[,] identify any methodologies used and . . . make explicit reference by footnote to the scientific and other sources relied upon for conclusions[.]" 40 C.F.R. § 1502.24.

Courts reviewing agency action for compliance with NEPA must confirm "that the agency has adequately considered and disclosed the environmental impact of its actions and that its decision is not arbitrary or capricious." Nevada v. Dept. of Energy, 457 F.3d 78, 87-88 (D.C. Cir. 2006). Under NEPA, if "the administrative record contains evidence that supports the positions of both the agency and the party seeking relief, the agency is entitled to rely on its experts' tests and

observations," Central South Dakota Coop. Grazing Dist. v. U.S. Dept. of Agric., 266 F.3d 889, 899 (8th Cir. 2001), "even if . . . a court . . . find[s] contrary views more persuasive." Marsh v. Or. Natural Res. Council, 490 U.S. 360, 378 (1989). "So long as the record demonstrates that the agencies in question followed the NEPA procedures, which require agencies to take a 'hard look' at the environmental consequences of the proposed action, the court will not second-guess the wisdom of the ultimate decision." Utahns v. United States DOT, 305 F.3d 1152, 1163 (10th Cir. 2002), citing Robertson, 490 U.S. at 350.

NEPA review, however, is not toothless. Reviewing courts must independently evaluate the record to confirm that the agency made a reasoned decision based on its analysis of the evidence before it. See, Marsh, 490 U.S. at 378. If it did not, a court "may properly conclude that the agency has acted arbitrarily and capriciously." Earth Island Inst. v. United States Forest Serv., 442 F.3d 1147, 1160 (9th Cir. 2006). Here, although the agency complied with NEPA by identifying and responding to criticisms in its 2002 RSEIS and in its 2006 RSEIS, several of its fish mitigation determinations were unsupported by record evidence, and it did not consistently comply with NEPA's requirement that the agency insure the accuracy and scientific integrity of the analyses contained in its environmental impact statements. 40 C.F.R. § 1502.24.

The Corps calculated project impact and proposed mitigation with the aid of habitat evaluation procedure ("HEP") models developed by an interagency team of experts comprised of internal and external biologists (the "HEP team"). Under the model, full mitigation is achieved when habitat loss equals habitat mitigation, see Defendants' MSJ [92] at 12 ("[m]itigation is complete when the habitat values of Project impacts are replaced[]"). Habitat is measured, roughly, by multiplying quality times quantity. The value assigned for quality varies based on the type of land under consideration. Quantity is not simply the number of acres flooded, but the number of flooded acres, discounted by how frequently those acres flood on average, and, sometimes, by the average water depth during a flood.

In its 2002 RSEIS, the Corps used discounted habitat quantity values for habitat loss, but not for habitat mitigation. Accordingly, its calculations greatly exaggerated the extent of the proposed mitigation for fisheries impacts, claiming that 8,375 total mitigation acres - instead of 8,375 average daily flooded acres (or "ADFAs") - would suffice. See Plaintiffs' MSJ [87] at 3-4. That was the error, eventually acknowledged by the Corps, that led to the withdrawal of the 2002 ROD and of the government's original motion for summary judgment, and the remand to correct the miscalculation.[5] Since the Corps requires all

[5]Note that the 2002 RSEIS was not withdrawn; to the extent that it was not explicitly superseded by the 2006 RSEIS, it remains valid and is under review in this case.

adopted projects to pass a benefit-cost test, and since, even with the underestimated mitigation, project benefits only slightly outweighed project costs, the Corps had to come up with numbers that would allow its mitigation proposal to fit the benefit-cost model.

In order to achieve mitigation totaling 8,375 AFDAs using the mitigation strategy proposed in the 2002 RSEIS, the Corps would have had to obtain an additional 124,000 total mitigation acres. See Declaration of Dr. Curtis Bohlen, attached to Plaintiffs' MSJ [87] as Ex. 111 at 1483 fn.1. That would cost approximately $200 million, Ex. 20 to Plaintiffs' MSJ [87] at 289, but the Corps could afford to add only slightly more than $3 million to project costs before flipping the benefit-cost ratio - so, in order to stay within budget, the Corps made several changes to its mitigation plan. See memo of Shawn Phillips assessing additional mitigation opportunities, attached to Plaintiffs' MSJ [87] as Ex. 107 at 1470.

The Corps' new fish mitigation proposal entails reforesting 6,356 acres[6] - a reduction from its 2002 plan. 2006 RSEIS at table 5.12. Most of the mitigation sites will be surrounded by levees and pumps to maintain shallow flooding throughout the spring. One thousand eight hundred acres of

[6]Total acres, not average daily flooded acres.

reforestation near Big Oak Tree state park will be maintained by a natural flood regime.[7] 2006 RSEIS at 101-02.

Those basic mitigation proposals leave a 97 percent mitigation gap in the New Madrid Floodway project and an 83 percent mitigation gap in the St. Johns Basin project, 2006 RSEIS at 32. The Corps' solution to this seemingly confounding problem relies heavily upon two additions to its mitigation proposal: changing the configuration of the "borrow pits" dug in the St. Johns Basin, and extending the flooding in the sump area behind the levee closure in the New Madrid Floodway during the mid-season.

It is not my role to "'flyspeck' an agency's environmental analysis, looking for any deficiency" in the Corps' calculations, but it is my responsibility to look carefully at the Corps' findings, to make sure that they were not arbitrary and capricious, and that the record supports the agency's compliance with NEPA and the CWA. Nevada v. DOE, 457 F.3d at 93. After giving the Corps' findings the required scrutiny, I have concluded that the Corps' adjustments were done arbitrarily, to manipulate the HEP model and to squeeze the New Madrid Floodway-St. Johns Basin project until it fit the Procrustean bed that is the agency's benefit-cost test.

[7]The phrases, "natural flood regime" or "naturally variable hydrology" refer to hydrology that rises and falls along with the natural patterns of the Mississippi River.

1. Fish access

Plaintiffs' first objection to the Corps finding that its plan will achieve full fish mitigation is that it does not account for reduced fish access to the floodplain. Plaintiffs' MSJ [87] at 27-31. Obviously, if fish are to use floodplain for spawning, they must have access to the floodplain when they are ready to spawn, but, although the dominant fish spawn seasonally, the model created by the HEP team does not distinguish between flooded acres that will remain accessible to fish and those that will be frequently or entirely inaccessible. As the Fish and Wildlife Service noted, the project impact and mitigation assessments both fail to account for "areas that will [remain] flooded but unavailable to fish." Oct. 7, 2002 Letter from FWS to Corps, attached to Plaintiffs' MSJ [87] as Ex. 5 at 26. The proposed mitigation will eliminate accessible habitat and substitute in its place mitigation sites that are frequently inaccessible to spawning fish.

The Corps' plan to strategically manipulate the levee gates will not significantly alleviate the problem of reduced fish access. First, because the project's primary goal is to reduce flooding, the levee gates will of course be closed in times of significant flooding -- the very time when the floodplain access is most valuable for the fish. In the 2002 RSEIS, the Corps conceded that "during high-water years . . . fish passage would be reduced or even prevented," 2002 RSEIS at

76. The 2006 RSEIS reveals a plan to close the gates for an even longer portion of the year in order to trap water in the floodplain for longer periods and enhance the habitat mitigation score calculated by the HEP model. The Corps' primary mitigation focus in the new 2006 plan is on fish that breed during the mid-season, 2006 RSEIS at 375, but the Corps now plans to close the levee gates throughout almost the entire mid-season, when water levels are high and fish are most likely to seek access to the floodplain, see Dr. Bohlen's analysis of Corps data, attached to Plaintiffs' MSJ [87] as Ex. 112 at 1515. When will the gates be open? Under both old and new plans, they will be open when water levels are lower, providing no access for the fish that travel to the floodplain to spawn during high flood conditions. See Deposition of Corps' biologist Dr. Killgore, attached to Plaintiffs' MSJ [87] as Ex. 21 at 354-55. Plaintiffs' ecologist and mitigation expert Dr. Curtis Bohlen, after reviewing the newest Corps mitigation plan in the 2006 RSEIS, determined that the need to keep the gates closed when water levels reach certain heights essentially guarantees that in years with habitat, there will be little or no fish access to the sump area during the mid-season; and in years with access, there will be little or no habitat. Dr. Bohlen's analysis of Corps data, attached to Plaintiffs' MSJ [87] as Ex. 112 at 1516.

Even when the levee gates are open, the fish access will be through culverts, and the evidence in the record suggests

that fish will be less likely to navigate culverts than open floodplain. Defendants submit that the culverts are wider than those that are known to interfere with fish access, but the Corps acknowledges that "the extent of fish movement through the box culverts (especially in the New Madrid Floodway) is unknown," 2002 RSEIS at 74. The agency's inability to estimate the expected impact on fish access does not relieve it of its obligation to incorporate expected reductions in access to its mitigation calculations and insure the scientific integrity of its analysis. 40 C.F.R. § 1502.24.

The Corps' response to these concerns is that the floodplain is home to a diverse range of fish, not all of which travel to the floodplain during mid-season periods of high flooding, and that the reduction in fish access is therefore insignificant. 2006 RSEIS at 121, 360-62. The Corps does not quantify this assertion, however, nor does it dispute the proposition that it is precisely during the mid-season when most fish travel to the floodplain to reproduce. The agency's failure to incorporate known access issues into its mitigation calculation and to identify evidence supporting its determination that reduced access will be insignificant amounts to a failure to present a "complete analytic defense of its [habitat] model," Sierra Club v. Costle, 657 F.2d 298, 333 (D.C. Cir. 1981) (internal quotations omitted) *rev'd on other grounds*, 463 U.S. 680 (1983). This omission violates NEPA (requiring "scientific

integrity" in environmental impact statements, 40 C.F.R. 1502.24), and undermines the Corps' conclusion that the project complies with CWA (mandating "appropriate and practicable steps . . . [to] minimize potential adverse impacts . . . on the aquatic ecosystem," 40 C.F.R. 230.10(4)).

2. Habitat value assigned to the "sump area"

The Corps intends to make up for most of the environmental impacts caused by the levee closure by closing the levee gates for longer periods of time, in order to prolong flooding in the 2,000-plus acre "sump" of undrained wetlands. Under existing conditions, this area floods when the river rises. The agency has long planned to leave water in the sump area each spring. Under the old plan, however, the Corps would close the gates to prevent flooding beyond the sump area when river water levels were high, and open the gates to let water retreat from the floodplain when river levels were low. In its 2006 RSEIS, the Corps announces a plan to retain water in the sump area by keeping the gates closed during the middle of the spawning season until May 15, even if river levels drop, 2006 RSEIS at 120-125, table 5.7, allowing "fish that have accessed the floodplain [prior to high water levels]" to reproduce, id. at 121. The Corps claims that, simply by keeping the levee gates closed for longer periods of time, it can extend flooding and make up for the enormous mitigation gap that prompted the voluntary remand and the creation of the 2006 RSEIS. Id. at 120-25.

This extended flooding will increase fish habitat quantity, but the record reflects that the increase will be slight. The Corps does not seriously dispute this assessment: in its 2006 RSEIS, it confirms that the new plan will increase flooding in the sump area from an average of 20.5 average annual flooded days to a maximum of 32.9 average flooded days, depending on how the plan is executed. See 2006 RSEIS at 394, affirming data of Dr. Bohlen. During years in which the sump area would be flooded throughout the mid-season without the gate manipulation, the plan will not extend flooding in the sump area at all. Id. So, if the increase in flooding resulting from the extended closure is minimal, how does it account for 97 percent of the levee project mitigation (which could be achieved through reforestation only with the acquisition of an additional 124,000 acres at a cost of $200 million)? The answer is that, with of this modest extension in average flooding, the Corps has given itself permission to change the nomenclature of the "sump area," now calling it a "spawning and rearing pool," which, *mutatis mutandis*, now becomes a "permanent water body." 2006 RSEIS at 79. Permanent water bodies are assigned much greater habitat value under the HEP model.

This change is essentially word play. The HEP model does assign greater mitigation value to permanent water bodies, but the decision to call seasonally flooded land such as a sump area a permanent water body is unsupported in the record. The

2006 RSEIS lists several features that the sump area shares with PWBs, see 2006 RSEIS at 79-80, but it fails to explain how the sump area meets the primary qualifier for this class of waterbodies: that it be "permanent." One HEP team member, Dr. Jane Ledwin of the FWS, explained that the HEP team understood the PWB category as including only those areas that hold water permanently and have seasonal connectivity to the river. See email of Jane Ledwin, attached to Plaintiffs' MSJ [87] as Ex. 110 at 1478; see also, Declaration of Dr. Richard Sparks, attached to Plaintiffs' MSJ [87] as Ex. 116 at 1569-70 (discussing Ledwin's opinion). The HEP model developed by the interagency team did not even include the category of "spawning and rearing pools" -- a category that appears to have been created in the 2006 RSEIS for the specific purpose of increasing the mitigation numbers.

The agency's inflation of sump area value in the HEP model grossly overstates the total value of the proposed mitigation. This overstatement is not attributable "to a difference in view or the product of agency expertise," as the agency expressly relied upon the HEP team for expertise in this area but found no support from the team for this spike in the habitat value of the sump area, even in years when flooding is not extended and fish access is reduced. State Farm, 463 U.S. at 43; Am. Wetlands v Norton, 193 F. Supp. 2d 244, 248 (D.D.C. 2002) (reversing decision of FWS as "not supported by the best

available scientific data"); Defenders of Wildlife v. Babbitt, 958 F. Supp. 670, 685 (D.D.C. 1997) (declaring FWS action arbitrary and capricious when the analysis of its own experts). The distorted calculation – which supported 97 percent of the Corps' levee mitigation – reflects a "clear error of judgment" in violation of the APA. Volpe, 401 U.S. at 416.

3. Two-year floodplain

Another way in which the Corps arbitrarily manipulated the HEP model to achieve full mitigation within a fixed budget was by limiting its calculation of habitat loss to the two-year floodplain. The two-year floodplain - land that floods every two years, on average - accounts for 27,000 habitat acres within the project area, while the three-year floodplain constitutes approximately 50,000 habitat acres, and as many as 130,000 acres are flooded far less frequently. Joint Statement of Issues before the Missouri Clean Water Commission, attached to Plaintiffs' MSJ [87] as Ex. 8 at 108.

In considering impacts to the fisheries resource under the CWA, the Corps determined that the project life was 50 years and that long-term fish population trends were therefore the most appropriate focus of its mitigation efforts. The Corps further determined that the two-year floodplain was the most important habitat sustaining the long-term population trends of small fish with life spans of between 2 and 3 years. That reasoning is disputed, but the dispute presents a battle of experts -- a

battle conducted in an arena that is off limits to APA judicial review.

The experts are in agreement, however, that the three-year floodplain provides habitat that can boost the long-term population of larger fish with longer lives, and that the short-term population of smaller fish with shorter life spans can benefit from significant but less frequent flood events. Declaration of Dr. Sheehan, attached to Plaintiffs' MSJ [87] as Ex. 33 at 578; Killgore Dep., attached to Plaintiffs' MSJ [87] as Ex. 21 at 376-80; 2006 RSEIS at 70-73. Land that floods an average of once every three years, if included in the HEP team model, would be discounted to reflect its less frequent innundation. The decision to leave it out of the calculation entirely, despite its acknowledged role in boosting fish population and against the recommendations of FWS and Missouri Department of Conservation HEP team members, arbitrarily manipulates the model.

This omission enabled a reduction in the proposed mitigation and compromised the agency's finding of full mitigation. The agency cannot reliably conclude that the selected project has minimized adverse impacts on aquatic ecosystems to the extent practicable when its habitat mitigation calculations are infected with an underestimate of the floodplain habitat impacted. 40 C.F.R. § 230.10(d); see Ohio Valley Envtl. Coalition v. United States Army Corps of Eng'rs, 479 F. Supp. 2d

607, 627 (D. W. Va. 2007) ("[u]nless the effects of the activity are properly identified, the agency has not met its legal obligation and any proposed mitigation measures dependant upon an incomplete environmental impact analysis necessarily fail[;]") (appeal pending). The finding of full mitigation in spite of this omission was arbitrary and capricious.

4. Borrow pits and connectivity

The Corps has always planned to excavate 387 acres of "borrow pits" to collect levee material, but only recently did it decide to convert these borrow pits into floodplain ponds, to mitigate destruction of fish habitat. 2006 RSEIS at 37. These 387 acres of "permanent ponds," indeed, now make up the entire 83 percent mitigation gap in the St. Johns Basin. The Corps submits that borrow pits accessible to fish during the spawning and rearing season can appropriately compensate for the loss of seasonally-connected permanent water bodies in the floodplain. Defendants' MSJ [92] at 22.

Since floodplain ponds do hold water year-round, labeling the borrow pits "permanent water body habitat" is appropriate. The Corps misuses the HEP model, however, when it quantifies the mitigation value of borrow pit habitat more liberally than that of permanent water body habitat lost to the project. When it calculated project impacts on habitat provided by a permanent water body such as a backwater lake, the Corps discounted the result to account for the percentage of the mid-

season when the lake is flooded by - connected to - the river.[8] See Declaration of Dr. Bohlen, attached to Plaintiffs' MSJ [87] as Ex. 111 at 1490. When calculating the mitigating impact of the 387 acres of borrow pits, however, the Corps applied no discount for connectivity, even though backwater flooding occurs during an average of only 27 percent of the mid-season in the areas where the borrow pits will likely be located. 2006 RSEIS at 115.

The Corps justifies this apparent discrepancy by explaining that the project impact and the project mitigation in this instance require different treatment under the model. In both instances, the value assigned to the PWBs accounted for the fact that the PWBs provide some habitat year round, and connectivity was taken into consideration. In the case of project impact, the Corps argues, the only impact is the loss of the backwater flooding since the PWBs remain viable habitat, but, in the case of the borrow pits, not only are the pits viable habitat year round, but the occasional connection to the river enhances their habitat value.

There would be nothing artificial about this approach if the model actually assigned value to PWBs in the project area

[8]In other words, a 50 acre permanent water body would receive 50 acres under the model if it was typically flooded throughout the mid-season. However, if, on average, it was flooded by the river only 20 percent of the mid-season before project construction, the Corps' model would reduce its value by 80 percent, so, if the project disconnected the water body from the river altogether, the loss would be valued at 10 acres.

independent of their connection to the river. However, the Corps' model assigns no habitat value to PWBs when they are not connected to the river. The agency's discrepant treatment of project impact and project mitigation in this area was therefore unsupported by the record and "internally inconsistent," undermined the conclusion that project impacts are minimized to the extent practicable as required by the CWA, and violated NEPA's regulation mandating the scientific integrity of environmental impact statements. Air Transp. Assn. v. DOT, 119 F.3d 38, 43 (D.C. Cir. 1997).

5. Borrow pits and diversity

The HEP model reduces all habitat types to fungible "habitat units," but this approach has limits: different species of fish require different sorts of habitat. The Corps, resource agencies, and other interested parties agree that, for the sake of diversity, "borrow pits [are] appropriate only to mitigate for losses of permanent water bodies" and should not be used as a substitute for other types of water bodies, such as seasonal wetlands, that provide habitat for other species. 2006 RSEIS at 227. The Corps denies that it has relied exclusively on borrow pits for mitigating impacts to the St. Johns Basin fisheries, but it dodges the question of the extent of its reliance, and it does not challenge plaintiffs' contention that the borrow pits account for 83 percent of the mitigation in the St. Johns Basin project area. The Corps does not argue that 83 percent of the lost

habitat that requires mitigation is in the form of permanent water bodies, and it has identified no record evidence supporting its assertion that the borrow pits only mitigate the loss of PWBs. The result is a failure to produce a "complete analytic defense of its model," Costle, 657 F.3d at 333 (internal quotations removed). This failure further undermines the required finding of compliance with the Clean Water Act §404(b) regulations, which prohibit projects that substantially degrade the waters of the United States and mandate mitigation to the extent practicable, and it is in conflict with the NEPA mandate of scientific integrity in environmental impact statements.

6. The Corps' plan to modify mitigation as necessary

NEPA does not require "a complete mitigation plan [to] be actually formulated and adopted" in an agency's environmental impact statement. Robertson, 490 U.S. at 352. The public is nevertheless entitled to an accurate EIS that indicates whether a project's environmental impacts "can be fully remedied by, for example, an inconsequential public expenditure, [or whether they will be] only be modestly ameliorated through the commitment of vast public and private resources." Id. In defending its mitigation calculation, the Corps repeatedly assures the Court that its mitigation team will implement, monitor, and adjust mitigation techniques so as to balance the project's twin aims of flood control and environmental protection. If such assurances were allowed to paper over the flaws in the Corps' mitigation

analysis, however, they would effectively gut the environmental safeguards that Congress enacted in the CWA and NEPA.

7. Fish Mitigation: Conclusion

The Corps' manipulation of its habitat model in analyzing fish mitigation gives new meaning to the phrase "result-oriented decision-making." The Corps has obviously worked backwards from the mitigation dollars it could afford, tweaking several of its original, fundamental understandings of its mitigation obligations so as to make the project appear to return a positive benefit-cost ratio. Many mitigation decisions seem to have been based on cost alone, with a troubling disregard for the fundamental assumptions of the HEP team model and HEP team member judgment. Several elements discussed above lack factual support or substantial evidence, but, more disturbingly, the Corps has demonstrated its willingness to do whatever it takes to proceed with this project - change definitions, abandon core assumptions - even if it means ignoring serious environmental impacts. The Corps' conclusion that its proposal would fully mitigate adverse impacts on fisheries was neither "rational [nor] based on consideration of the relevant factors." Ethyl Corp., 541 F.2d at 36. Exclusions from and manipulations of the HEP model infected the 2002 RSEIS and 2006 RSEIS with scientifically unsound analyses in violation of NEPA and prevented a reliable conclusion that the project satisfies the

CWA. For these reasons, the agency's deficient fish mitigation proposal is arbitrary and capricious in violation of the APA.[9]

Plaintiffs' Waterfowl Mitigation Challenges Fail

Plaintiffs contend that the Corps had no expert support for its total reliance on the model designed for estimating environmental impacts on waterfowl ("the WAM model"). The Corps' waterfowl biologist Rumancik stated in a deposition that the Corps relied on FWS expertise in this area and admitted that he had no personal understanding of the model's intricacies. See Deposition of John Rumancik, attached to Plaintiffs' MSJ [87] as Ex. 22 at 410-433, 443. When asked if anyone in the Corps had a more extensive background in waterfowl mitigation, he responded in the negative, noting that "no one in the Corps has really [sic] waterfowl background." Id. at 443. The FWS explicitly told the Corps that it should not rely entirely on the WAM model, since it only looks at one element of waterfowl mitigation: ducks feeding in water no deeper than two feet, see Bruce Dugger's Assessment of Waterfowl Mitigation, attached to Plaintiffs' MSJ [87] as Ex. 109 at 1476; see also, 2002 RSEIS at E-139. The plaintiffs therefore submit that there is no battle of experts here, as all the experts relied upon agree that this model should not be used for mitigation.

[9]Plaintiffs' other arguments about the Corps' mitigation plan - that the Corps reneged on its earlier acceptance of responsibility for mitigating fish habitat beyond the mid-season; and that the Corps' mitigation plan violates the RHAA by falsely claiming full fish mitigation - are rejected.

Plaintiffs also identify a math error in defendants' application of the waterfowl model: the acreage needed for waterfowl mitigation was not discounted for the frequency and depth of flooding. Plaintiffs demonstrate that, while the Corps' calculation indicated that 891 total acres were needed for waterfowl mitigation, in fact, to mitigate for harms to waterfowl habitat, the Corps needs to reforest enough total acreage so that 891 acres are flooded an average of less than two-feet in February and March. Declaration of Bruce Dugger, attached to Plaintiffs' MSJ [87] as Ex. 94 ¶¶ 6-19; email from Jane Ledwin to Bruce Dugger, attached to Plaintiffs' MSJ [87] as Ex. 108. The Corps argues that, even if it committed this error, the error was harmless. Defendants' MSJ [92] at 32. Since 700 acres will be purchased for shorebirds to occupy in April and May, and since there will be continual flooding in February and March, the Corps argues that there will be more than enough waterfowl mitigation to offset impacts. Plaintiffs point out, however, that the waterfowl model doesn't work for continually flooded areas, because waterfowl quickly exhaust their food supply. If the area is flooded continually, the benefits will be lost.

The agency's defense of its waterfowl mitigation plan is complicated and unclear. The 2006 RSEIS, however, shows that the Corps consulted with two additional waterfowl experts in developing its waterfowl mitigation plan. These consultations undermine plaintiffs' argument that the agency relied entirely on

the FWS for wildlife expertise and therefore lacked any expert support for its waterfowl mitigation design. Since "agency determinations based upon highly complex and technical matters are entitled to great deference," the court will not disturb the Corps' waterfowl mitigation plan. Appalachian Power Co. v. EPA, 249 F.3d 1032, 1051-52 (D.C. Cir. 2001) (internal quotations omitted).

The Corps' Alternatives Analysis was Sufficient

A central declared purpose of the combined projects is to alleviate flooding, and, by doing so, to promote economic development in East Prairie. East Prairie is a small town located on the St. Johns side of the impacted project area; its economic development has been significantly stunted by the heavy flooding it experiences every ten years. See 2002 RSEIS at B-18.

In 1995, East Prairie became eligible for economic development aid from the United States Department of Agriculture, after the federal government designated it an "enterprise community." The enterprise community program was designed to "afford communities real opportunities for growth and revitalization." Enterprise Community Fact Sheet, attached to Plaintiffs' MSJ [87] as Ex. 43 at 641. In 1996, Congress authorized the use of East Prairie's enterprise funds to cover most of the local cost-share for the pump stations and channel work. Water Resources Development Act of 1996, Pub. L. No. 104-303, § 331, 110 Stat. 3658, 3718. This legislative action

was influenced by assurances from the Corps and from local officials that the project would reduce or eliminate flooding in East Prairie and clear the way for economic development. See Aug. 19, 1995 letter from John Ashcroft and Christopher Bond to President Clinton, attached to Plaintiffs' MSJ [87] as Ex. 17 at 274 (". . . East Prairie officials were told by the Corps the project could be trimmed to two elements, which would eliminate flooding in and around East Prairie").

In plaintiffs' submission, the projects will do very little to address the flooding problems plaguing East Prairie. At least one Corps economist admits that the project will not result in any significant economic development in East Prairie, presumably because, although the project will alleviate overflow from a local stream that infrequently floods a small eastern part of the town, it will do nothing to address the 10-year flood, which is caused by poor drainage and agricultural runoff from the north. See Plaintiffs' MSJ [87], citing the Deposition of Corps Economist Bobby Learned, attached as Ex. 15 at 179; 2002 RSEIS at B-18. During the 10-year flood, 19 miles of East Prairie's roads are under water, 2002 RSEIS at B-18, and these roads will remain under water during the 10-year flood, even after project completion.

Plaintiffs may well be right, that the Corps rejected alternative plans that really would have alleviated East Prairie's flooding problems. They may even be right, that a ring

levee system around East Prairie, combined with channel improvements to assist with drainage, would have been preferable in some respects. But plaintiffs have not demonstrated that the Corps' rejection of a ring levee system or of other alternatives "suggest[s] a lapse of rational decisionmaking," Achernar Broadcasting Co. v. FCC, 62 F.3d 1441, 1447 (D.C. Cir. 1995), nor have they demonstrated that the Corps' failed to conduct the public interest review mandated by § 404 of the CWA and § 10 of the Rivers and Harbor Act. The alternatives analysis was therefore legally sufficient.

Exclusions from the Benefit-Cost Analysis

If a benefit-cost test is used to evaluate a proposed project, NEPA requires the agency to include that test in its environmental impact statement. 40 C.F.R. § 1502.23. The benefit-cost test is therefore subject to the NEPA regulations regarding accuracy and scientific integrity. 40 C.F.R. § 1502.24. Plaintiffs challenge the scientific integrity of defendant's benefit-cost test. First, they contend that, in the benefit-cost analysis performed by defendants, the Corps improperly attributed agricultural benefits to crop production on land which, after project implementation, will be transformed into project mitigation acreage and will no longer yield crops. Second, they charge that the Corps omitted from its cost calculation the expense attributable to levee and earth-moving work in the reforested areas. Third, they argue that the Corps

failed to include the costs of wildlife corridor and buffer strips in its cost calculation.

The Corps, in its 2002 RSEIS, acknowledged that it cannot claim agricultural crop benefits on mitigation land. 2002 RSEIS at M-72. Nevertheless, in its 2002 RSEIS, it declined to subtract roughly 7,000 mitigation acres from its benefit computation on the grounds that the exact location of the mitigation acres was unknown. Id. In the 2006 RSEIS, however, the Corps indicated that this mitigation acreage will be located within the impacted project area: 1,293 cropland acres will be within the St. Johns Bayou Basin and 4,126 cropland acres will be within the New Madrid Floodway. 2006 RSEIS at vii. In addition, the transformation of borrow pits will remove an additional 387 acres of cropland from the St. Johns Basin, id. at viii, and at least an additional acreage from the sump areas, id. at 55-56.

The Corps explains this apparent omission from the benefit-cost analysis by noting its intent to seek mitigation acreage that will "receive significant flooding" even after project construction. Defendant's MSJ [92] at 66. The acquisition, they contend, will therefore have a "minimal effect" on the benefit-cost ratio, since most of the acreage obtained for mitigation will be frequently flooded land that is presently unavailable for farming much of the time and will not trigger a significant reduction in project benefits. Id. at 67. The Corps is entitled to deference on its claim that, because it intends to

obtain mitigation acreage in areas that will remain flooded after the project is constructed, the reduction in benefits will be slight and may be excluded from the benefit-cost test.

Additionally, plaintiffs note that the Corps omitted from its cost calculation the expense attributable to levee and earth-moving work in the reforested areas. The Corps acknowledges this omission, but rejects plaintiffs' assertion that these costs will be significant, since the Corps plans to focus "on more natural hydrology," while plaintiffs' cost estimates are based on projects involving complicated, expensive engineering structures. Defendants' MSJ [92] at 67. The cost issue is a disputed issue of fact, but the determination that the expense will be minimal appears reasonable in light of the Corps' plans and considerable experience designing such mitigation.

Lastly, the Corps' estimate of costs relating to the wildlife corridor and buffer strips appears to be conservative. However, the Corps submits that it may seek a permanent conservation easement for the associated land rather than purchasing the land outright. The Corps is under no obligation to include costs in its calculation that it may not incur, and the benefit-cost test cannot be invalidated on such speculative grounds.

Plaintiffs have not Demonstrated Standing to Raise WRDA Claims

The Corps argues that plaintiffs lack standing to challenge violations of the 1986 WRDA cost-sharing requirement because they are not within the "zone of interests" protected by the statutory provision they invoke and because their injury is not fairly traceable to the Corps' failure to require local cost-sharing. Defendants raise the same objections to plaintiffs' standing to challenge the adoption of the 1954 discount rate in the benefit-cost analysis under the 1974 WRDA.

In my earlier ruling on plaintiffs' motion for a preliminary injunction, I found that plaintiffs had demonstrated a substantial likelihood of success on their claim under the 1974 WRDA, but that was before the standing arguments were fully briefed. One may marvel at the Corps' reliance on an archaic discount rate to pass its benefit-cost test, and one is only somewhat less flummoxed by the Corps' tortured interpretation of the "separable element" provision in the 1986 WRDA, 33 U.S.C. § 2213, but plaintiffs have not succeeded in locating themselves with the "zone of interests" of either statutory provision. See National Wildlife Fed'n v. Westphal, 116 F. Supp. 2d 49, 54 (D.D.C. 2000). In any event, Congress was apparently neither surprised nor flummoxed by the Corps' legerdemain and authorized expenditures for this project.

Conclusion

The project at issue in this case has been controversial for many years. It is not the role of this court to determine whether the project is wise or worthwhile, but it is the court's responsibility to decide whether or not the agency's decisions, approving and justifying the project, were arbitrary and capricious in violation of applicable laws. For the reasons discussed above, I have determined that, at least with respect to the environmentally important issue of fish mitigation, they were. The agency acted arbitrarily and capriciously in violation of the APA, the CWA, and NEPA in finding that its plan would fully mitigate impacts to fisheries habitat.

Plaintiffs' motion for summary judgment will accordingly be **granted**, and defendant's 2002 RSEIS, 2006 RSEIS, and 2006 ROD will be set aside. The Corps will be enjoined from proceeding with the project, and it will be ordered to deconstruct that portion of the project which it has already built. An appropriate order accompanies this memorandum.

JAMES ROBERTSON
United States District Judge

Volume 3
Part 2

Phase I IEPR

U.S. Army Corps of Engineers
Memphis District

Final Independent External Peer Review Report

St. Johns Bayou and New Madrid Floodway, MO, Consolidated NEPA Document and Work Plan: Environmental, Economic, and Hydrologic and Hydraulic Review, Phase I

Prepared by

Battelle Memorial Institute
505 King Avenue
Columbus, OH 43201

for

U.S. Army Corps of Engineers
Flood Risk Management Planning Center of Expertise
Sacramento District

Delivery Order: 0666
Contract No. W911NF-07-D-0001
Task Control Number: 09-0150

October 23, 2009

SHORT-TERM ANALYSIS SERVICE (STAS)

on

St. Johns Bayou and New Madrid Floodway, MO, Consolidated NEPA Document and Work Plan Environmental, Economic, and Hydrologic and Hydraulic Review, Phase I

by

Battelle
505 King Avenue
Columbus, OH 43201

for

Mr. R. Fraser Gensler
U.S. Army Corps of Engineers
Flood Risk Management Planning Center of Expertise
Sacramento District
Attn: CESPK-PD-W
1325 J Street
Sacramento, CA 95814-2922

October 23, 2009

Contract Number: W911NF-07-D-0001
Task Control Number: 09-150
Delivery Order Number: 0666

Scientific Services Program

The views, opinions, and/or findings contained in this report are those of the author and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

This page intentionally left blank

FINAL
INDEPENDENT EXTERNAL PEER REVIEW REPORT
for the

St. Johns Bayou and New Madrid Floodway, MO, Consolidated NEPA Document and Work Plan Environmental, Economic, and Hydrologic and Hydraulic Review, Phase I

EXECUTIVE SUMMARY

The St. Johns Bayou and New Madrid Floodway, MO, Consolidated NEPA Document and Work Plan Environmental, Economic, and Hydrologic and Hydraulic Review (St. Johns Bayou) Project is a partially constructed authorized project. Following litigation based on environmental concerns, the U.S. District Court for the District of Columbia halted construction of the project and ordered work already constructed to be restored to pre-construction conditions. In response to this litigation, an additional National Environmental Policy Act (NEPA) document will likely be prepared to fully address the requirements of the NEPA. The purpose of this Independent External Peer Review (IEPR) is to determine the adequacy of past NEPA documentation and ensure that the scope of any future NEPA document is complete and scientifically accurate. In order to ensure that the panel members had the most current version of the project reports, USACE prepared a Consolidated NEPA Document that merged the past NEPA documents (2000 Supplemental EIS, the 2002 Revised Supplemental EIS, and the 2006 Revised Supplemental EIS 2) into one document.

The St. Johns Bayou Project area is located in Mississippi and New Madrid counties in southeastern Missouri along the right descending bank of the Mississippi River floodplain. The project area encompasses portions of two drainage basins separated by the Mississippi River and Tributaries Project's Birds Point-New Madrid Setback Levee.

The Consolidated NEPA Document focused on flood risk management within the St. Johns Bayou and the New Madrid Floodway. Agriculture is the primary economic resource within the project area. At the New Madrid gage, the flood of record was in 1937; since then, the most significant flood event occurred in 1973 when over 56,500 acres of agricultural land in the New Madrid Floodway were inundated. According to recent data, the two-year backwater flood occurrence in the New Madrid Floodway inundates 17,316 acres, of which 11,843 acres are agricultural lands. At high Mississippi River stages, the St. Johns Bayou control gates are closed to prevent backwater flooding. However, closing the gates prevents interior drainage and leads to headwater flooding. The two-year headwater flood event under these circumstances inundates approximately 10,056 acres, of which 6,312 acres are agricultural lands

USACE is conducting an independent external peer review (IEPR) of the St. Johns Bayou and New Madrid Floodway, MO, Consolidated NEPA Document and Work Plan, Environmental, Economic, and Hydrologic and Hydraulic Review ("St. Johns Bayou IEPR"). Battelle, as a 501(c)(3), non-profit science and technology organization with experience in establishing and administering peer review panels for USACE, was engaged to coordinate the IEPR of the St. Johns Bayou IEPR. Independent, objective peer review is regarded as a critical element in ensuring the reliability of scientific analyses. The IEPR will be external to the agency and

conducted following guidance described in the Department of the Army, USACE, guidance Peer Review of Decision Documents (EC 1105-2-410) dated August 22, 2008, CECW-CP Memorandum dated March 30, 2007, and the Office of Management and Budget's Final Information Quality Bulletin for Peer Review released December 16, 2004.

This final report details the IEPR process, describes the panel members and their selection, and summarizes final comments of the IEPR panel members on the existing environmental, economic, and hydrologic and hydraulic engineering of the St. Johns Bayou project as described in the Consolidated NEPA Document and related appendices. Review of the Consolidated NEPA Document was conducted as Phase I of the overall IEPR; only Phase I of the review is discussed in this report. The results of this IEPR report will be taken into consideration prior to USACE preparing the Project Work Plan outlining the additional analyses that will be required to complete the proposed NEPA document. Review of the Project Work Plan will be conducted as Phase II of the overall IEPR. This approach seeks to fully consider all analytical efforts within the Consolidated NEPA Document that contained significant deficiencies or erroneous conclusions as recognized by the panel members.

Eight panel members were selected for the IEPR from more than 100 identified candidates. Corresponding to the technical content of the St. Johns Bayou Project, the areas of technical expertise of the eight selected panel members included wetland ecology, waterfowl biology, fishery biology, water quality, hydrologic and hydraulic engineering, economics, the National Environmental Policy Act (NEPA), and shorebird ecology.

The panel members were provided electronic and CD versions of the St. Johns Bayou Consolidated NEPA Document, along with a charge that solicited their comments on specific sections of the documents that were to be reviewed. The panel members and Battelle were briefed by the St. Johns Bayou Project Delivery Team during a kick-off meeting held in Sikeston, MO prior to the start of the review; a second kick-off meeting was held for the shorebird ecologist panel member. More than 460 individual comments were received from the panel members in response to the charge questions. There was no direct communication between the panel members and USACE during the peer review process.

Following the individual reviews of the St. Johns Bayou Consolidated NEPA Document and related appendices by the panel members, a teleconference was conducted to review key technical comments, discuss charge questions for which there were conflicting responses, and reach agreement on the Final Panel Comments to be provided to USACE. The Final Panel Comments were documented according to a four-part format that included description of: (1) the comment statement (2) the basis for the comment; (3) significance of the comment (high, medium, and low); and (4) recommendations on how to resolve the comment. Overall, 28 Final Panel Comments were identified and documented. Of the 28 Final Panel Comments, 19 were identified as having high significance and 9 were identified as having medium significance. Note: as the Consolidated NEPA Document will not be revised as a result of the St. Johns Bayou IEPR, low-significance comments were not identified.

Table ES-1 summarizes the Final Panel Comments by level of significance. Detailed information on each comment is contained in Appendix A of this report.

The IEPR panel generally agreed on their "assessment of the adequacy and acceptability of the economic, engineering, and environmental methods, models, and analyses used" in the reports. However, the panel found the structure of the Consolidated NEPA Document difficult to follow, the presentation of analyses and conclusions uneven, and study references lacking or outdated, making it difficult to properly evaluate the report's findings and conclusions.

The following statements provide a summary of the panel's findings, which are described in more detail in the individual Final Panel Comments. Note that during the IEPR review process, several individual panel comments pertaining to multiple resources (fishery biology, waterfowl biology, shorebird ecology) were identified. These comments resulted in several Final Panel Comments being developed that appear to have the same justification, or Basis for Comment, however, each Final Panel Comment has subtle differences that are specific to each resource.

Economics: Key assumptions are missing from the economic analysis for a flood reduction project, such as injuries avoided and lives saved from flooding. In addition, the Consolidated NEPA Document states that current agricultural production is suboptimal and that the project will add benefits. However, there is inadequate evidence presented that current production is suboptimal. The agricultural benefits are almost the sole driver of the project, unless other types of benefits are brought into the analysis, so the agricultural benefits must be clearly calculated, convincing, and large for the project to have a benefit-cost ratio that is greater than one, especially as some analysts may question the use of a 2.5% discount rate.

Engineering: The hydrology and hydraulics portions of the report are covered well and appear to be well done. However, since economic feasibility and environmental assessments are very sensitive to the accuracy of the hydrologic and hydraulic modeling studies, extending the hydrologic period-of-analysis and adopting more detailed modeling methods are warranted. Modeling uncertainties should also be analyzed and presented in a more detailed format.

Environmental: The analysis of wetland, shorebird, fisheries, and waterfowl impacts is underestimated, not clearly described in the report, and most likely will result in losses that are not compensated for in the proposed mitigation plans. Likewise, there is inadequate analysis or discussion on cumulative loss in the Lower Mississippi River and on adaptive management related to the mitigation plans.

Table ES-1. Overview of 28 Final Panel Comments Identified by the St Johns Bayou IEPR Panel

Significance – High	
1	The cumulative impacts section lacks specific information on the incremental impacts of the proposed project.
2	Baseline agricultural economic conditions are not adequately supported with evidence, nor are the predicted future economic benefits associated with the project.
3	The economic analysis is confusing because it does not follow the standard practice of calculating the present value of future benefits and costs using a single discount rate for the project analysis, and for a well-defined and consistent period of analysis.
4	The assumption used to calculate mid-season fish spawning habitat to mitigate winter waterfowl habitat has not been properly evaluated.
5	The proposed basic mitigation features are unlikely to achieve the desired level of wetland compensation.
6	The Consolidated NEPA Document is inadequate in justifying the use of the two-year floodplain in calculating the environmental impact.
7	The operation and management costs associated with managed moist soil units and levees around bottomland hardwood flooding were not considered.
8	There is strong evidence that moist soil units managed for both shorebirds and waterfowl would not provide habitat at the levels assumed for mitigation of impacts to both shorebirds and waterfowl.
9	Mitigating floodplain average annual habitat unit (AAHU) loss with modified borrow pits overestimates compensation of mid-season fish rearing habitat.
10	Additional reforestation opportunities should be considered to fully compensate for mid-season fish-rearing habitat in the St. Johns Bayou and New Madrid Floodway since the floodway was historically a bottomland hardwood ecosystem.
11	The Consolidated NEPA Document does not appear to compensate for the amount of shorebird habitat impacted, and does not provide sufficient detail to determine if mitigation of shorebird impacts can be achieved.
12	It is unclear if a combination of flooding and soil maps were used to determine the extent of existing jurisdictional wetlands and what wetland delineation methodology was used.
13	Reclassification of habitat to permanent waterbody based upon 100% flooding during the mid-season fish rearing period inappropriately increases the cumulative habitat suitability index (HSI).
14	The proposed monitoring plans for fish passage, spawning, and rearing utilization lack critical study design and time-frame details.
15	The accuracy of the hydrologic and hydraulic analyses needs to be improved by extending the period-of-analysis and using more detailed modeling techniques.
16	Impacts to shorebird habitats cannot be determined based on the information provided in the Consolidated NEPA Document, but the impacts are probably much larger than the analysis indicates.
17	It is unclear if fish from the Mississippi River will have access to the St. Johns Bayou and New Madrid Floodway based solely on water stages, gate operations, and current fish species composition of the St. Johns Bayou.
18	Use of mid-season rearing habitat for mitigation is not fully justified and is only represented by 3 (New Madrid Floodway) to 5 (St Johns Bayou) evaluation species in the Habitat Suitability Index (HIS) model.

Table ES-1. Overview of 28 Final Panel Comments Identified by the St Johns Bayou IEPR Panel (continued)

19	The four mitigation alternatives presented in the Consolidated NEPA Document do not appear to compensate for loss of waterfowl habitat.
Significance – Medium	
20	The structure of the Consolidated NEPA Document is difficult to follow, the presentation of analyses and conclusions is uneven, and the study references are lacking or outdated, all of which make it difficult for the panel to properly evaluate the report's findings and conclusions.
21	The economic analysis is missing key assumptions used in flood reduction projects, such as injuries avoided and lives saved from flooding.
22	It is unclear how the proposed change in the condition of Big Oak Tree State Park will mitigate loss of wetlands and other habitat in the project.
23	The analysis of water quality impacts in the Consolidated NEPA Document did not meet the objectives of the study.
24	The planned project monitoring for water quality lack key elements and sufficient detail to satisfy U.S. EPA guidance.
25	Economic impacts that could be cancelled out in other regions should not be included in a Benefit-Cost (BC) analysis or economic analysis for a project that focuses on national economic development.
26	Uncertainties in the hydrologic, hydraulic, and economic studies could be analyzed and presented in a more detailed and meaningful manner using methodologies incorporated in the HEC-FDA Flood Damage Reduction Analysis modeling system.
27	Given the goals of the Gulf Hypoxia Action Plan 2008, Alternative 8 in the Consolidated NEPA Document should be reframed as a "nutrient farming" alternative
28	It is not clear from the Consolidated NEPA Document if adequate resources are available for adaptive management to be successfully applied at mitigation areas, and adaptive management plans are not described in sufficient detail.

TABLE OF CONTENTS

EXECUTIVE SUMMARY iii

1. INTRODUCTION 1

2. PURPOSE OF INDEPENDENT EXTERNAL PEER REVIEW 2

3. METHODS 2
   3.1 Planning and Schedule 2
   3.2 Identification and Selection of Independent External Peer Reviewers 6
   3.3 Preparation of the Charge and Conduct of the Peer Review 8
   3.4 Review of Individual Panel Comments 9
   3.5 Independent Peer Review Panel Teleconference 9
   3.6 Preparation of Final Panel Comments 9

4. PANEL DESCRIPTION 11

5. RESULTS — SUMMARY OF FINAL PANEL COMMENTS 19

6. FINAL PANEL COMMENT REFERENCES 22

LIST OF TABLES

Table ES-1. Overview of 28 Final Panel Comments Identified by the St Johns Bayou IEPR Panel Members vi
Table 1. St. Johns Bayou IEPR Phase I Schedule 4
Table 2. St. Johns Bayou and New Madrid Floodway, MO Phase 1 Independent Peer Review Panel: Technical Criteria and Areas of Expertise. 12
Table 3. Overview of 28 Final Panel Comments Identified by St Johns Bayou IEPR Panel. 23

Appendix A Final Panel Comments and List of Final Panel Comment References A-1
Appendix B Final Charge to the Independent External Peer Review Panel. B-1
.

This page intentionally left blank

1. INTRODUCTION

The St. Johns Bayou and New Madrid Floodway, MO, Consolidated NEPA Document and Work Plan Environmental, Economic, and Hydrologic and Hydraulic Review (St. Johns Bayou) Project is a partially constructed authorized project. Following litigation based on environmental concerns, the U.S. District Court for the District of Columbia halted construction of the project and ordered work already constructed restored to pre-construction conditions. In response to this litigation, an additional NEPA document will likely be prepared to fully address the requirements of the National Environmental Policy Act (NEPA). The purpose of this Independent External Peer Review (IEPR) is to determine the adequacy of past NEPA documentation and ensure that the scope of any future NEPA document is complete and scientifically accurate. In order to ensure that the IEPR panel members had the most current version of the project reports, USACE prepared a Consolidated NEPA Document that merged the past NEPA documents (the 2000 Supplemental EIS, the 2002 Revised Supplemental EIS, and the 2006 Revised Supplemental EIS 2) into one document.

The St. Johns Bayou Project area is located in Mississippi and New Madrid counties in southeastern Missouri along the right descending bank of the Mississippi River floodplain. The project area encompasses portions of two drainage basins separated by the Mississippi River and Tributaries Project's Birds Point-New Madrid Setback Levee.

The Consolidated NEPA Document focuses on flood risk management within the St. Johns Bayou and the New Madrid Floodway. Agriculture is the primary economic resource within the project area. At the New Madrid gage, the flood of record was in 1937; since then, the most significant flood event occurred in 1973 when over 56,500 acres of agricultural land in the New Madrid Floodway were inundated. According to recent data, the two-year backwater flood occurrence in the New Madrid Floodway inundates 17,316 acres, of which 11,843 acres are agricultural lands. At high Mississippi River stages, the St. Johns Bayou Basin control gates are closed to prevent backwater flooding. However, closing the gates prevents interior drainage and leads to headwater flooding. The two-year headwater flood event under these circumstances inundates approximately 10,056 acres, of which 6,312 acres are agricultural lands.

The objective of the work described here was to conduct an IEPR of the St. Johns Bayou and New Madrid Floodway Consolidated NEPA Document (Phase I) in accordance with procedures described in the Department of the Army, U.S. Army Corps of Engineers Engineer Circular (EC) No. 1105-2-410, Review of Decision Documents, dated August 22, 2008 and the Office of Management and Budget Final Information Quality Bulletin for Peer Review released December 16, 2004. Battelle, as a 501(c)(3) non-profit science and technology organization with experience in establishing and administering peer review panels for USACE, was engaged to coordinate the IEPR of the St. Johns Bayou and New Madrid Floodway Consolidated NEPA Document. Independent, objective peer review is regarded as a critical element in ensuring the reliability of scientific analyses.

This final report details the IEPR process, describes the panel members and their selection, and summarizes final comments of the IEPR panel members on the existing environmental, economic, and hydrologic and hydraulic engineering of the St. Johns Bayou project as described

in the Consolidated NEPA Document and related appendices. Review of the Consolidated NEPA Document was conducted as Phase I of the overall IEPR; only Phase I of the review is discussed in this report. The results of this IEPR report will be taken into consideration prior to USACE preparing the Project Work Plan outlining the additional analyses that will be required to complete the proposed NEPA document. Review of the Project Work Plan will be conducted as Phase II of the overall IEPR. This approach seeks to fully consider all analytical efforts within the Consolidated NEPA Document that contained significant deficiencies or erroneous conclusions as recognized by the panel members.
.

2. PURPOSE OF INDEPENDENT EXTERNAL PEER REVIEW

To ensure that USACE documents are supported by the best scientific and technical information, a peer review process has been implemented by USACE that utilizes Independent External Peer Review (IEPR) to complement the Agency Technical Review (ATR), as described in the Department of the Army, U.S. Army Corps of Engineers, guidance *Peer Review of Decision Documents* (EC 1105-2-410) dated August 22, 2008; and CECW-CP Memorandum dated March 30, 2007.

In general, the purpose of peer review is to strengthen the quality and credibility of the USACE decision documents in support of its Civil Works program. Independent external peer review provides an independent assessment of the economic, engineering, and environmental analysis of the project study. In particular, the IEPR addresses the technical soundness of the report's assumptions, methods, analyses, and calculations; and the need for additional data or analyses to make a good decision regarding implementation of alternatives and recommendations.

In this case, the IEPR of the St. Johns Bayou and New Madrid Floodway Consolidated NEPA Document was conducted and managed using contract support from Battelle, which is an Outside Eligible Organization (OEO) eligible under 501(c)(3). Battelle is an independent objective science and technology organization with experience conducting IEPRs.

3. METHODS

This section describes the methodology followed in selecting the IEPR panel members and in planning and conducting the IEPR. The IEPR was conducted following procedures described in USACE's guidance cited above (Section 1 of this report) and in accordance with the Office of Management and Budget's Final Information Quality Bulletin for Peer Review, released December 16, 2004. Supplemental guidance on evaluation for conflicts of interest used the National Academies' Policy on Committee Composition and Balance and Conflicts of Interest for Committees Used in the Development of Reports, dated May 12, 2003.

3.1 Planning and Schedule

In terms of planning, one of the first actions Battelle conducted after receiving the notice to proceed (NTP) was to hold a kick-off meeting between the USACE and Battelle. The purpose of

the meeting was to review the "*preliminary/suggested*" schedule, discuss the IEPR process, and address any questions regarding the scope (*e.g*., clarify expertise areas needed for panel members). Any revisions to the schedule were submitted as part of the final Work Plan. Due dates for milestones and deliverables in the table below are based on the NTP date of June 9, 2009. Table 1 defines the schedule followed in execution of the IEPR.

Table 1. St. Johns Bayou IEPR Phase I Schedule

TASK	ACTION	DUE DATE
1	NTP/ Review documents available	June 9, 2009
	Battelle submits Draft Work Plan	June 23, 2009
	Battelle submits Final Work Plan [a]	July 8, 2009
2	Battelle recruits and screens up to 16 candidate panel members; prepares summary information	June 30, 2009
	Battelle submits list of 8 selected panel members	July 2, 2009
	USACE comments on conflicts of interest (COI)	July 7, 2009
	Battelle completes subcontracts for 8 panel members	July 30, 2009
3	Battelle submits Draft Charge (combined with Draft Work Plan – Task 1)	June 23, 2009
	USACE provides comments on draft charge	June 30, 2009
	Battelle submits Final Charge (combined with Final Work Plan – Task 1)	July 8, 2009
	USACE approves Final Charge and Final Work Plan[a]	July 9, 2009
4	Battelle kick-off teleconference with USACE	July 22, 2009
	Battelle kick-off teleconference with panel members	July 30, 2009
	Battelle sends review documents and Final Charge to panel members	July 30, 2009
	USACE on-site kick-off meeting and site visit	August 4-5, 2009
	USACE second kick-off meeting and site visit (shorebird ecologist)	August 20-21, 2009
5	Battelle teleconference with panel members and USACE (agency Q&A session)	September 3, 2009
	Panel members submit individual comments to Battelle	September 16, 2009
	Shorebird ecologist submits comments to Battelle	September 18, 2009
	Battelle collates comments from panel members identifying key issues and distributes directive to panel	September 23, 2009
	Battelle convenes teleconference with IEPR panel to confirm key issues, and discuss final comments	September 25, 2009
	Panel members prepare Final Panel Comments on key issues using formatted structure and submit to Battelle	September 28-October 7, 2009
	Panel members review Final IEPR Report prior to submission to USACE	October 15-19, 2009
6	Submit Phase I IEPR Report	October 23, 2009
7[b]	Input Phase I Final comments to DrChecks	October 26, 2009
	USACE PDT provides draft Evaluator comments and clarifying questions to	November 2, 2009

TASK	ACTION	DUE DATE
	Contractor	
	Battelle/Panel Teleconference to discuss response to draft USACE comments	November 11, 2009
	Teleconference between Contractor, IEPR team, and PDT to clarify questions & concerns	November 12, 2009
	USACE input Evaluator comments in DrChecks	December 2, 2009
	Respond to USACE Evaluator comments in DrChecks (i.e. BackCheck)	January 5, 2010
	Submit pdf printout of DrChecks Phase I project file	January 6, 2010

[a] Deliverable

[b] Task occurs after the submission of this report.

Note that the work items listed in Task 7 occur after the submission of this report. The 28 Final Panel Comments will be entered in to DrChecks by Battelle for review by USACE the panel members. USACE will respond to the Final Panel Comments and the IEPR panel members will respond to the Evaluator's responses. All USACE and panel member responses will be documented by Battelle.

3.2 Identification and Selection of Independent External Peer Reviewers

Corresponding to the technical content of the Consolidated NEPA Document and the overall scope of the St. Johns Bayou project, the technical expertise areas for which the candidate panel members were evaluated focused on eight key areas: wetland ecology, waterfowl biology, fishery biology, water quality, hydrologic and hydraulic engineering, economics, NEPA, and shorebird ecology.

Battelle initially identified more than 100 candidate panel members, evaluated their technical expertise and inquired about potential conflicts of interest. Of those initially contacted, Battelle chose 16 of the most qualified candidates and confirmed their interest and availability. Of those 16 candidates, 8 were proposed as the final panel and 8 were proposed as backup reviewers. The 8 primary reviewers constituted the final panel. The remaining panel members were not chosen for a variety of reasons, including lack of availability, disclosed conflicts of interest, or because they did not possess the precise technical expertise required.

The candidates were screened for the following potential exclusion criteria or conflicts of interest.[a] Participation in previous USACE technical peer review committees and other technical review panel experience was also considered, as follows:

- Involvement by you or your firm in any part of the St. Johns Bayou and New Madrid Floodway Environmental Impact Statement process, including:
    - Final Environmental Impact Statement entitled Mississippi Rivers and Tributaries, Mississippi River Levees (MRL) and Channel Improvement (1976)
    - Final EIS entitled St. Johns Bayou/New Madrid Floodway Project Final EIS (1982)
    - Draft Supplemental EIS (1999)
    - Final Supplemental EIS (2000)
    - Revised Supplemental EIS (2002)
    - Second Revised Supplemental EIS (2006).
- Any involvement by you or your firm in the conceptual or actual design, construction or operation and maintenance of the St. Johns Bayou and New Madrid Floodway, MO Project or related projects.
- Involvement as an expert for or provided testimony for the civil action (04-1575) Environmental Defense, et al. v. U.S. Army Corps of Engineers, et al.
- Involvement as an expert or provided testimony for the Water Quality Certification for the St. Johns Bayou and New Madrid Floodway Project (06-0421) Missouri Coalition for the Environment, et al. v. Missouri Department of Natural Resources, et al.

[a]Note: Battelle evaluated whether scientists in universities and consulting firms that are receiving USACE-funding have sufficient independence from USACE to be appropriate peer reviewers. See the OMB memo p. 18, " ….when a scientist is awarded a government research grant through an investigator-initiated, peer-reviewed competition, there generally should be no question as to that scientist's ability to offer independent scientific advice to the agency on other projects. This contrasts, for example, to a situation in which a scientist has a consulting or contractual arrangement with the agency or office sponsoring a peer review. Likewise, when the agency and a researcher work together (e.g., through a cooperative agreement) to design or implement a study, there is less independence from the agency. Furthermore, if a scientist has repeatedly served as a reviewer for the same agency, some may question whether that scientist is sufficiently independent from the agency to be employed as a peer reviewer on agency-sponsored projects."

- Current USACE employee.
- Current or previous employee or affiliation with members of the interagency mitigation team or the local sponsor, including the U.S. Environmental Protection Agency (EPA), U.S. Fish and Wildlife Service (USFWS), Missouri Department of Natural Resources (MDNR), Missouri Department of Conservation (MDC), and the St. Johns Levee and Drainage District.
- Current or previous employment or affiliation with Environmental Defense, National Wildlife Federation, or Missouri Coalition for the Environment (for pay or pro bono).
- Current or future interests in the subject project or future benefits from the project.
- Current personal involvement with other USACE projects, including whether involvement was to author any manuals or guidance documents for USACE. If yes, provide titles of documents or description of project, dates, and location (USACE district, division, Headquarters, ERDC, etc.), and position/role. Please highlight and discuss in greater detail any projects that are *specifically* with the Memphis District.
- Current personal or firm involvement with other USACE projects, *specifically* those projects/contracts that are with the Memphis District. If yes, provide title/description, dates, and location (USACE district, division, Headquarters, ERDC, etc.), and position/role.
- Previous employment by the USACE as a direct employee or contractor (either as an individual or through expert's firm) within the last 10 years, notably if those projects/contracts are with the Memphis District. If yes, provide title/description, dates employed, and place of employment (district, division, Headquarters, ERDC, etc.), and position/role.
- Previous experience conducting technical peer reviews. If yes, please highlight and discuss any technical reviews concerning water resource development projects involving levees, channel modifications, and pumping stations, and include the client/agency and duration of review (approximate dates).
- A significant portion (i.e., greater than 50%) of personal or firm revenues within the last three years came from USACE contracts.
- Any publicly documented statement made by you or your firm advocating for or against the Mississippi River and Tributaries Project.
- Other possible perceived conflict of interest for consideration, e.g.,
    - Former USACE employee
    - Repeatedly served as USACE technical reviewer
    - Paid or unpaid participation in litigation related to the work of the USACE
    - Prior repeated service as a technical advisor, or expert witness for, Environmental Defense, National Wildlife Federation, and/or the Missouri Coalition for the Environment
    - Any other perceived COI not listed.

In selecting final panel members from the list of candidates, an effort was made to select experts who best fit the expertise areas and disclosed no conflicts of interest. Based on these considerations, eight panel members were selected (see Section 4 of this report for the names and biographical information of the panel members). The eight panel members selected were Ph.D.-holding experts from academic institutions or consulting companies. Battelle established

subcontracts with the panel members when they indicated their willingness to participate and confirmed the absence of conflicts of interest through a signed conflict of interest form.

Prior to beginning their review and within three days of their subcontracts being finalized, all members of the IEPR panel were required to attend a kick-off meeting teleconference planned and facilitated by Battelle in order to review the IEPR process, the schedule, communication, and other pertinent information for the IEPR panel; a second kick-off meeting was held for the shorebird ecologist panel member.

3.3 Preparation of the Charge and Conduct of the Peer Review

A charge document, including specific charge questions and discussion points, was developed by Battelle, reviewed and approved by USACE, and provided to the panel members to guide their review of the Consolidated NEPA Document. The charge was prepared with guidance provided in USACE's Peer Review of Decision Documents (EC 1105-2-410) and the Office of Management and Budget's Final Information Quality Bulletin for Peer Review, released December 16, 2004. A draft charge was submitted to the USACE for evaluation as part of the draft Work Plan. USACE provided a list of charge questions developed by their legal department that were incorporated, along with minor clarifications, to the final charge questions. In addition to a list of 194 charge questions/discussion points, the final charge included general guidance for the IEPR panel members on the conduct of peer review (as provided in Appendix B of this final report).

The final kick-off meeting included an on-site, 2-day meeting with USACE, the interagency team (i.e., EPA, Fish and Wildlife Service, Missouri Department of Natural Resources, and Missouri Department of Conservation), the St. Johns Levee and Drainage District (i.e., project sponsor), Battelle and the IEPR panel members. Before the kick-off meeting started, the IEPR panel members were provided an electronic version of the St. Johns Bayou Consolidated NEPA Document and related Appendices and the final charge. A full list of the documents that were reviewed by the IEPR panel is also provided in Appendix B of this report. The IEPR panel members were instructed to address the charge questions/discussion points within a comment-response form provided by Battelle.

As part of the planning for this meeting, Battelle provided each IEPR panel member with travel logistics and directions. The on-site kick-off meeting was held at a location close to the project site and included a tour of the project area in and around Sikeston, MO. The kick-off meeting and site tour took place on Day 1, and a follow-up meeting with USACE and Battelle was held the morning of Day 2. The purpose of the meeting was to familiarize the reviewers with the project and provide guidance to IEPR panel members concerning specific objectives of Phase I of the overall IEPR. The IEPR panel members also received a briefing by the St. Johns Bayou Project Delivery Team.

A second kick-off meeting was held for the shorebird ecologist panel member. There was no communication between the IEPR panel and the authors of the St. Johns Bayou Consolidated NEPA Document during the review process, but communication between Battelle and the reviewers, and among the reviewers, was conducted as needed.

3.4 Review of Individual Panel Comments

In response to the charge questions/discussion points, approximately 460 individual comments were received from the IEPR panel members. Battelle reviewed these comments to identify overall recurring themes, potential areas of conflict, and other overall impressions. As a result of this review, Battelle developed a preliminary list of 46 comments and discussion points that emerged from the IEPR panelists' individual comments. Each reviewer's individual comments were shared with the full IEPR panel in a merged individual comments table.

3.5 Independent Peer Review Panel Teleconference

Battelle facilitated a teleconference with the IEPR panel members to provide for the exchange of technical information among the panel experts, many of whom are from diverse scientific backgrounds. This information exchange ensured that this final IEPR report would accurately represent the panel's assessment of the project and would avoid isolated or conflicting opinions and analyses. The panel review teleconference consisted of a thorough discussion of the overall negative comments, positive comments, and comments that appeared to be conflicting among reviewers. In addition, Battelle used the teleconference to confirm each comment's level of significance to the panel, add any missing issues of high-level importance to the findings, resolve whether to "agree to disagree" on the conflicting comments, and to merge related individual comments into one "Final Panel Comment". The main goal of the teleconference was to identify which issues should be carried forward as Final Panel Comments and to decide which panel member would serve as the lead author for the development of each Final Panel Comment.

In addition to identifying which issues should be carried forward as Final Panel Comments, the IEPR panel discussed responses to 20 specific charge questions where there appeared to be disagreement among the reviewers. The conflicting comments were resolved based on professional judgment of the panel members; each comment was either incorporated into a Final Panel Comment or determined to be a non-significant issue (i.e., either a true disagreement did not exist, or the issue was not important enough to include as a final comment).

During the teleconference, the panel identified 27 comments and discussion points that should be brought forward as Final Panel Comments.

3.6 Preparation of Final Panel Comments

Following the teleconference, a summary memorandum documenting each Final Panel Comment (organized by level of significance) was prepared by Battelle and distributed to the panel members. The memorandum provided the following detailed guidance on the approach and format to be used in the development of the Final Panel Comments for the Consolidated NEPA Document:

- Lead Responsibility: For each Final Panel Comment, one panel member was identified as the lead author responsible for coordinating the development of the Final Panel Comment and submitting it to Battelle. Lead assignments were modified by Battelle at the direction of the IEPR panel. To assist each lead in the development of the Final Panel Comments, Battelle distributed merged individual comments in the comment-response form table, a summary detailing each draft final comment statement, an example Final Panel Comment following the four-part structure described below, and a template for the preparation of the Final Panel Comments.

- Directive to the Lead: Each lead was encouraged to communicate directly with other reviewers, as needed, to contribute to a particular Final Panel Comment. If a significant comment was identified that was not covered by one of the original Final Panel Comments, the appropriate lead was instructed to draft a new Final Panel Comment.

- Format for Final Comments: Each Final Panel Comment was presented as part of a four-part structure, including:
    1. Comment Statement (i.e., succinct summary statement of concern)
    2. Basis for comment (i.e., details regarding the concern)
    3. Significance (high, medium, low; see description below)
    4. Recommendation for resolution (see description below).

- Criteria for Significance: The following were used as criteria for assigning a significance level to each Final Panel Comment:
    1. *High:* Describes a fundamental problem with the project that could affect the recommendation or justification of the project
    2. *Medium:* Affects the completeness or understanding of the reports/project
    3. *Low:* Affects the technical quality of the reports but will not affect the recommendation of the project. Note: as the Consolidated NEPA Document will not be revised as a result of the St. Johns Bayou IEPR, low-significance comments were not identified.

- Guidance for Developing the Recommendation: The recommendation was to include specific actions that the USACE should consider to resolve the Final Panel Comment (e.g., suggestions on how and where to incorporate data into the analysis, how and where to address insufficiencies, areas where additional documentation is needed).

As a result of this process, 27 initial Final Panel Comments were prepared. However, after the peer review panel teleconference, the panel decided to merge two comments. In addition, based on the panel's discussions during the comment development period, the panel members determined that two new Final Panel Comments were necessary. A total of 28 Final Panel Comments were developed.

Battelle reviewed and edited the Final Panel Comments for clarity and adherence to the requested format. There was no direct communication between panel members and USACE during the preparation of the Final Panel Comments. The Final Panel Comments were assembled and are presented in Appendix A to this report.

4. PANEL DESCRIPTION

Panel member candidates were identified using Battelle's Peer Reviewer Database, targeted internet searches using key words (e.g., technical area, geographic region), search of websites of universities or other compiled expert sites, and through referrals. A draft list of primary and backup candidate panel members (which were screened for availability, technical background, and conflicts of interest) was prepared by Battelle and provided to USACE. The final list of panel members was determined by Battelle.

An overview of the credentials of the final eight IEPR panel members and their qualifications in relation to the technical evaluation criteria is presented in Table 2. More detailed biographical information regarding each panel member and their technical area of expertise is presented in the text that follows the table.

Table 2. St. Johns Bayou and New Madrid Floodway, MO Phase I IEPR Panel: Technical Criteria and Areas of Expertise

	Mitsch	Eichholz	Jackson	Brown	Bierman	Wurbs	Shaw	Southerland
Wetland Ecologist	✓							
Nationally recognized expert (e.g., authored books, invited speaker at national conferences/meetings, professional society memberships)	✓							
Experience performing wetland delineations (Years of experience)	✓(20)						✓ (10)	
Experience developing wetland mitigation plans (Years of experience)	✓(25)						✓ (10)	
Experience restoring wetlands/floodplains within the floodplain of large river systems (Years of experience)	✓(25)						✓ (10)	
Number of peer-reviewed publications related to wetlands	70							
Ph.D. (field of study)	✓(environ-mental engineering)							
Waterfowl Biologist		✓						
Nationally recognized expert (e.g., authored books, invited speaker at national conferences/meetings, professional society memberships)		✓						
Experience studying waterfowl biology of large river systems (Years of experience)		✓(11)						
Familiar with caloric models for determining waterfowl usage of various land uses within floodplains of large river systems (Years of experience)		✓(11)						
Number of peer-reviewed publications related to waterfowl		✓(12)						
Ph.D. (field of study)		✓(wildlife/ waterfowl ecology)						

Table 2. St. Johns Bayou and New Madrid Floodway, MO Phase I IEPR Panel: Technical Criteria and Areas of Expertise, continued

	Mitsch	Eichholz	Jackson	Brown	Bierman	Wurbs	Shaw	Southerland
Fishery Biologist			✓					
Nationally recognized expert (e.g., authored books, invited speaker at national conferences/meetings, professional society memberships)			✓					
Experience studying fisheries biology of large river systems (Years of experience)			✓(14)					
Familiar with issues relating to fish passage through culverts or similar structures (Years of experience)			See footnote[2]					
Number of peer-reviewed publications related to studying fishes of large river systems			8					
Ph.D. (field of study)			✓(fisheries management)					
Shorebird Biologist				✓				
Nationally recognized expert (e.g., authored books, invited speaker at national conferences/meetings, professional society memberships)				✓				
Experience studying shorebird ecology (Years of experience)				✓(15)				
Number of peer-reviewed publications related to studying shorebird ecology				16				
Ph.D. (field of study)				✓(natural resources)				

[2] No direct experience; experience with floodplain connectivity and fish use of floodplains

Table 2. St. Johns Bayou and New Madrid Floodway, MO Phase I IEPR Panel: Technical Criteria and Areas of Expertise (continued)

	Mitsch	Eichholz	Jackson	Brown	Bierman	Wurbs	Shaw	Southerland
Water Quality Expert	✓							
Nationally recognized expert (e.g., authored books, invited speaker at national conferences/meetings, professional society memberships)	✓				✓			
Experience studying water quality within large river systems (Years of experience)	✓(30)				✓(19)		✓(3)	
Experience studying Gulf of Mexico Hypoxia (Years of experience)	✓(10)				✓(18)			
Number of peer-reviewed publications related to studying water quality within large river systems	50				10		1	
Ph.D. (field of study)					✓(environ-mental engineering)			
Hydrologic and Hydraulic Engineer						✓		
Extensive experience in hydrology and hydraulics (minimum of 10 years requested)						✓(38)		
Experience in hydraulic engineering with an emphasis on large public works projects on large river systems (registered professional engineer)						✓(38)		
Extensive background in hydraulic theory and practice (professor from academia)						✓(29)		
Familiar with standard USACE hydrologic and hydraulic computer models						✓		
Registered professional engineer						✓		
Ph.D. (field of study)						✓(civil engineering – water resources)		

Table 2. St. Johns Bayou and New Madrid Floodway, MO Phase I IEPR Panel: Technical Criteria and Areas of Expertise (continued)

	Mitsch	Eichholz	Jackson	Brown	Bierman	Wurbs	Shaw	Southerland
Economist							✓	
Experience in agricultural-economics (Years of experience)							✓(14)	
Experience in water resource economic evaluation or review (Years of experience)							✓(29)	
Ph.D. (field of study)							✓ (economics)	
NEPA Expert								✓
Experience in evaluating and conducting controversial water resource development Environmental Impact Statements (minimum of 10 years requested)								✓(20)
Familiar with research and theories relating to adaptive management of wetlands mitigation (Years of experience)								✓(10)
Ph.D. (field of study)								✓ (biology – ecology)

William Mitsch, Ph.D., PWS

Role: This reviewer was chosen primarily for his expertise in wetland ecology and experience involving wetland delineation, mitigation, and restoration within the floodplains of large river systems.
Affiliation: The Ohio State University

Dr. William Mitsch is a Professional Wetland Scientist and a Certified Senior Ecologist with 34 years of diverse experience in wetland ecology. His areas of expertise include wetland ecosystems, ecological engineering, and ecosystem restoration. He holds a Ph.D. in environmental engineering sciences (systems ecology) from the University of Florida. He is currently a Distinguished Professor of Environment and Natural Resources, Professor of Evolution, Ecology, and Organismal Biology, and Professor of Civil and Environmental Engineering at The Ohio State University. Dr. Mitsch is also Director of the Wilma H. Schiermeier Olentangy River Wetland Research Park in Columbus, Ohio. He has 70 combined years of experience in performing wetland delineations, mitigation plans, and restoring wetlands/floodplains within large rivers systems. Additionally, he is a nationally recognized water quality expert with 30 years of experience studying large river system water quality and 10 years of experience studying hypoxia in the Gulf of Mexico. Dr. Mitsch served on the National Technical Review Committee and the Post-Hurricane Katrina Review Committee for the restoration of the Louisiana coastal area. He has served on several National Research Council Committees providing expertise related to river basins and coastal systems, wetland mitigation, and wetland characterization. He also has provided oral and written testimony to Congress on wetlands. Dr. Mitsch has provided consulting services related to water quality and wetland monitoring, modeling, restoration, conservation, mitigation, delineation, and creation for the past 33 years to numerous agencies and companies.

Michael Eichholz, Ph.D.

Role: This reviewer was chosen primarily for his expertise in waterfowl biology of large river systems.
Affiliation: Southern Illinois University Carbondale

Dr. Michael Eichholz has a Ph.D. in wildlife/waterfowl ecology from the University of Alaska-Fairbanks. He is a nationally recognized expert in waterfowl biology and has 11 years of experience in waterfowl biology of large river systems and caloric modeling for determining waterfowl usage of various land uses within floodplains of large river systems. He is currently an Associate Professor of zoology at Southern Illinois University Carbondale, and also holds a position as a Waterfowl/Wetland Ecologist at the University's Cooperative Wildlife Research Laboratory. His research interests include investigating the influence of resource availability during the spring on productivity and population dynamics of waterfowl and the influence of waterfowl density on reproductive and survival rates. In addition, Dr. Eichholz has conducted research on macroinvertebrate response to floodplain wetland habitat rehabilitation and the impact to migrating waterfowl.

John Jackson, Ph.D.

Role: This reviewer was chosen primarily for his expertise in fisheries biology of large river systems.
Affiliation: Arkansas Tech University

Dr. John Jackson is an Associate Professor of Fisheries Biology at Arkansas Tech University's Department of Biological Sciences and holds a Ph.D. in fisheries management from Mississippi State University. He teaches a variety of biology and ecology courses, including population dynamics, stream ecology, limnology, and ichthyology. Dr. Jackson is a nationally recognized expert in fisheries biology and has 14 years of experience in studying fisheries biology of large river systems. He also has several years of experience dealing with issues of floodplain connectivity and fish use of floodplains. He has authored numerous technical reports relating to fish biology in streams and rivers, including a report for the USACE characterizing floodplain fish assemblages in a large river system. In addition, Dr. Jackson has researched the relationship between fish and environmental variables in large river-floodplain ecosystems, microhabitat partitioning by multiple fish species, and urban fisheries management.

Victor J. Bierman, Jr., Ph.D.

Role: This reviewer was chosen primarily for his expertise in water quality in large river systems and Gulf of Mexico Hypoxia.
Affiliation: LimnoTech

Dr. Victor J. Bierman is a Senior Scientist with LimnoTech in Oak Ridge, NC, and holds a Ph.D. in environmental engineering from the University of Notre Dame. He is a nationally recognized expert in water quality with 19 years of experience studying water quality in large river systems and 18 years of experience studying hypoxia in the Gulf of Mexico. Projects of note include the Gulf of Mexico Hypoxia Assessment completed for the White House Committee on Environment and Natural Resources in which Dr. Bierman developed a water quality model to assess hypoxia responses to reductions in nutrient loadings from the Mississippi River Basin. He also directed transport and fate modeling studies for PCB-contaminated sediments to investigate the impacts of continued No Action and various remedial scenarios in the Hudson River. Dr. Bierman has 36 years of experience in the development and application of water quality models for eutrophication and the transport and fate of toxic chemicals, which has led to his publication of more than 100 technical papers and reports. He is a leading expert in the assessment and solution of problems related to nutrients, nuisance algal blooms, nitrogen fixation, hypoxia, exotic species, and ecosystem processes. He has conducted studies in watersheds, lakes, rivers, estuaries, and coastal marine systems. This experience has included data synthesis, expert review, and development and application of mass balance models.
Dr. Bierman is also a leading expert in toxic chemical transport, fate, partitioning, and bioaccumulation. He has conducted assessment studies in major river systems, estuaries, and the Great Lakes, and remedial investigations at U.S. EPA Superfund sites. These studies have included organic chemicals, heavy metals, sediment processes, and mass balance modeling.

Ralph Wurbs, Ph.D., P.E.

Role: This reviewer was chosen primarily for his expertise in hydrologic and hydraulic engineering and his extensive background in hydraulic theory.
Affiliation: Texas A&M University

Dr. Ralph Wurbs is a Registered Professional Engineer in Texas and a Diplomate of the American Academy of Water Resources Engineers. He has a Ph.D. in civil engineering-water resources from Colorado State University. Dr. Wurbs has 38 years of extensive experience in hydrology and hydraulics, including experience in hydraulic engineering working on large public works projects on large river systems. Additionally, he has 29 years of experience in hydraulic theory and practice and is familiar with standard USACE hydrologic and hydraulic computer models. He has authored numerous technical reports involving simulation studies, water availability monitoring, flood control, river/reservoir system modeling, water resource planning and management, and other topics related to hydrology and/or hydraulics, including several reports for the USACE. Dr. Wurbs has held positions as Professor, Associate Professor, and Assistant Professor since 1980 in the Civil Engineering Department at Texas A&M University. He also is the Associate Director for Engineering at the Texas Water Resources Institute. Dr. Wurbs has been the principal investigator for university research contracts and grants funded by numerous agencies, including the USACE.

W. Douglass Shaw, Ph.D.

Role: This reviewer was chosen primarily for his expertise in water resource economic evaluation or review.
Affiliation: Texas A&M University

Dr. W. Douglass Shaw is a tenured Full Professor in the Department of Agricultural Economics at Texas A&M University. He has a Ph.D. in economics from the University of Colorado. Dr. Shaw has 29 years of experience in water resource economic evaluation or review and 3 years of experience in studying water quality within large river systems. He regularly teaches environmental and natural resource economics at the undergraduate and graduate levels at Texas A&M University and is a member of the University's interdisciplinary program in Hydrologic Science and Policy. He also developed and taught new coursework for the Hydrologic Science Program at University of Nevada-Reno in water resource economics. Dr. Shaw is the author of "Water Resource Economics and Policy: an Introduction" published by Edward Elgar Press, and is the former associate editor for the journal Water Resources Research. He has published several peer-reviewed articles on water quality topics such as drinking water and arsenic, and dissolved oxygen, turbidity, and their role in recreational fishing demand. Dr. Shaw recently served as independent expert reviewer for the Mississippi Coastal Improvement Project of the USACE (as subcontractor to Battelle Memorial Institute). His role as a reviewer was to evaluate the economics, i.e., benefits and costs, of programs, relocation plans, and potential facilities to enhance safety and improve coastal response to future hurricanes. He also evaluated the risk analysis for the programs and projects. His research specialties are environmental and water resource economics, with emphasis on valuing environmental amenities and changes in health risks associated with contamination of resources and human health effects.

Mark T. Southerland, Ph.D.

Role: This reviewer was chosen primarily for his NEPA-related experience and expertise.
Affiliation: Versar, Inc.

Dr. Mark T. Southerland is a Principal Ecologist and NEPA Director with Versar, Inc. in Columbia, MD. His current position with Versar, Inc. also involves directing major programs in the monitoring, assessment, and restoration of freshwater and terrestrial ecosystems. He is a Certified Senior Ecologist and Project Management Professional. He holds a Ph.D. in biology (ecology) from the University of North Carolina-Chapel Hill. Dr. Southerland has 10 years of experience each performing wetland delineations, developing wetland mitigation plans, and restoring wetlands/floodplains within the floodplains of large river systems. Additionally, he has 20 years of experience in evaluating and conducting controversial water resource development Environmental Impact Statements and 10 years of familiarity/experience with research and theories relating to adaptive management of wetlands mitigation. His areas of expertise include NEPA guidance and compliance and he is considered a national expert on NEPA analysis, representing the Council on Environmental Quality throughout the U.S. Since 1993, Dr. Southerland has been involved with USACE reconnaissance and feasibility studies for environmental restoration of the Susquehanna River, Delaware River, Anacostia River, and Barnegat Bay watersheds.

Stephen Brown, Ph.D.

Role: This reviewer was chosen primarily for his expertise in shorebird ecology.
Affiliation: Manomet Center for Conservation Sciences

Dr. Stephen Brown is the Director of Shorebird Science at the Manomet Center for Conservation Sciences in Manomet, MA. He has a Ph.D. in natural resources from Cornell University. He is a recognized national expert on shorebird biology/ecology and has 15 years of experience in shorebird ecology. Dr. Brown has authored numerous publications on topics related to shorebird abundance, distribution, and population trends. His current role at the Manomet Center involves designing, funding, and managing a research program on shorebird ecology and conservation. He previously held the position of U.S. Shorebird Conservation Plan Coordinator at the Manomet Center, which involved developing a national conservation plan for all U.S. shorebird species among all 50 states, Federal agencies, non-governmental organizations, and academic institutions, including research priorities, population trend monitoring program, habitat management recommendations, and public education and outreach.

5. RESULTS — SUMMARY OF FINAL PANEL COMMENTS

The IEPR panel generally agreed on their "assessment of the adequacy and acceptability of the economic, engineering, and environmental methods, models, and analyses used" in the reports. However, the panel found the structure of the Consolidated NEPA Document difficult to follow, the presentation of analyses and conclusions uneven, and study references lacking or outdated, making it difficult to properly evaluate the report's findings and conclusions.

The following statements provide a summary of the panel's findings, which are described in more detail in the individual Final Panel Comments. Note that during the IEPR review process,

several individual panel comments pertaining to multiple resources (fishery biology, waterfowl biology, shorebird ecology) were identified. These comments resulted in several Final Panel Comments being developed that appear to have the same justification, or Basis for Comment, however, each Final Panel Comment has subtle differences that are specific to each resource.

Economics: Key assumptions are missing from the economic analysis for a flood reduction project, such as injuries avoided and lives saved from flooding. In addition, the Consolidated NEPA Document states that current agricultural production is suboptimal and that the project will add benefits. However, there is inadequate evidence presented that current production is suboptimal. The agricultural benefits are almost the sole driver of the project, unless other types of benefits are brought into the analysis, so the agricultural benefits must be clearly calculated, convincing, and large for the project to have a benefit-cost ratio that is greater than one, especially as some analysts may question the use of a 2.5% discount rate.

Engineering: The hydrology and hydraulics portions of the report are covered well and appear to be well done. However, since economic feasibility and environmental assessments are very sensitive to the accuracy of the hydrologic and hydraulic modeling studies, extending the hydrologic period-of-analysis and adopting more detailed modeling methods are warranted. Modeling uncertainties should also be analyzed and presented in a more detailed format.

Environmental: The analysis of wetland, shorebird, fisheries, and waterfowl impacts is underestimated, not clearly described in the report, and most likely will result in losses that are not compensated for in the proposed mitigation plans. Likewise, there is inadequate analysis or discussion on cumulative loss in the Lower Mississippi River and on adaptive management related to the mitigation plans.

As a result of the comment/review process, the IEPR panel members identified 28 Final Panel Comments, segmented into rankings of high and medium significance. In total, as shown in Table 3, 19 were identified as having high significance and 9 were identified as having medium significance. The Final Panel Comments in their entirety are included in Appendix A.

Table 3. Overview of 28 Final Panel Comments Identified by St Johns Bayou IEPR Panel

Significance – High	
1	The cumulative impacts section lacks specific information on the incremental impacts of the proposed project.
2	Baseline agricultural economic conditions are not adequately supported with evidence, nor are the predicted future economic benefits associated with the project.
3	The economic analysis is confusing because it does not follow the standard practice of calculating the present value of future benefits and costs using a single discount rate for the project analysis, and for a well-defined and consistent period of analysis.
4	The assumption used to calculate mid-season fish spawning habitat to mitigate winter waterfowl habitat has not been properly evaluated.
5	The proposed basic mitigation features are unlikely to achieve the desired level of wetland compensation.
6	The Consolidated NEPA Document is inadequate in justifying the use of the two-year floodplain in calculating the environmental impact.
7	The operation and management costs associated with managed moist soil units and levees around bottomland hardwood flooding were not considered.
8	There is strong evidence that moist soil units managed for both shorebirds and waterfowl would not provide habitat at the levels assumed for mitigation of impacts to both shorebirds and waterfowl.
9	Mitigating floodplain average annual habitat unit (AAHU) loss with modified borrow pits overestimates compensation of mid-season fish rearing habitat.
10	Additional reforestation opportunities should be considered to fully compensate for mid-season fish-rearing habitat in the St. Johns Bayou and New Madrid Floodway since the floodway was historically a bottomland hardwood ecosystem.
11	The Consolidated NEPA Document does not appear to compensate for the amount of shorebird habitat impacted, and does not provide sufficient detail to determine if mitigation of shorebird impacts can be achieved.
12	It is unclear if a combination of flooding and soil maps were used to determine the extent of existing jurisdictional wetlands and what wetland delineation methodology was used.
13	Reclassification of habitat to permanent waterbody based upon 100% flooding during the mid-season fish rearing period inappropriately increases the cumulative habitat suitability index (HSI).
14	The proposed monitoring plans for fish passage, spawning, and rearing utilization lacks critical study design and time-frame details.
15	The accuracy of the hydrologic and hydraulic analyses needs to be improved by extending the period-of-analysis and using more detailed modeling techniques.
16	Impacts to shorebird habitats cannot be determined based on the information provided in the Consolidated NEPA Document, but the impacts are probably much larger than the analysis indicates.
17	It is unclear if fish from the Mississippi River will have access to the St. Johns Bayou and New Madrid Floodway based solely on water stages, gate operations, and current fish species composition of the St. Johns Bayou.

Table 3. Overview of 28 Final Panel Comments Identified by St Johns Bayou IEPR Panel, continued

18	Use of mid-season rearing habitat for mitigation is not fully justified and is only represented by 3 (New Madrid Floodway) to 5 (St Johns Bayou) evaluation species in the Habitat Suitability Index (HIS) model.
19	The four mitigation alternatives presented in the Consolidated NEPA Document do not appear to compensate for loss of waterfowl habitat.
Significance – Medium	
20	The structure of the Consolidated NEPA Document is difficult to follow, the presentation of analyses and conclusions is uneven, and the study references are lacking or outdated, all of which make it difficult for the panel to properly evaluate the report's findings and conclusions.
21	The economic analysis is missing key assumptions used in flood reduction projects, such as injuries avoided and lives saved from flooding.
22	It is unclear how the proposed change in the condition of Big Oak Tree State Park will mitigate loss of wetlands and other habitat in the project.
23	The analysis of water quality impacts in the Consolidated NEPA Document did not meet the objectives of the study.
24	The planned project monitoring for water quality lack key elements and sufficient detail to satisfy U.S. EPA guidance.
25	Economic impacts that could be cancelled out in other regions should not be included in a Benefit-Cost (BC) analysis or economic analysis for a project that focuses on national economic development.
26	Uncertainties in the hydrologic, hydraulic, and economic studies could be analyzed and presented in a more detailed and meaningful manner using methodologies incorporated in the HEC-FDA Flood Damage Reduction Analysis modeling system.
27	Given the goals of the Gulf Hypoxia Action Plan 2008, Alternative 8 in the Consolidated NEPA Document should be reframed as a "nutrient farming" alternative
28	It is not clear from the Consolidated NEPA Document if adequate resources are available for adaptive management to be successfully applied at mitigation areas, and adaptive management plans are not described in sufficient detail.

6. LIST OF FINAL PANEL COMMENT REFERENCES

Altor, A.E. and W.J. Mitsch. 2008. Pulsing hydrology, methane emissions, and carbon dioxide fluxes in created marshes: A 2-year ecosystem study. *Wetlands* 28:423-438.

Anderson, C.J. and W.J. Mitsch. 2008. The influence of flood connectivity on bottomland forest productivity in central Ohio, USA. *Ohio J. Science* 108 (2): 2-8.

Bingswanger, H.P. 1981. Attitudes toward risk: Theoretical implications of an experiment in rural India. *The Economic Journal* 91 (364):867-90.

Council on Environmental Quality. 1997. Considering Cumulative Effects under the National Environmental Policy Act. Washington, D.C. January 1997.

Cross, D., and P. Vohs, (eds). 1988. Waterfowl Management Handbook. Fort Collins, CO: U.S. Fish and Wildlife Service.

Farmer, A. and F. Durbian. 2006. Estimating Shorebird Numbers at Migration Stopover Sites. *The Condor* 108:792-807.

Farmer, A. H. and J. A. Wiens. 1999. Models and reality: Time-energy trade-offs in Pectoral Sandpiper (Calidris melanotos) migration. *Ecology* 80:2566-2580.

Fink, D.F. and W.J. Mitsch. 2007. Hydrology and biogeochemistry in a created river diversion oxbow wetland. *Ecological Engineering* 30:93-102.

Frederick, S., G. Loewenstein and T. O'Donoghue. 2002. Time Discounting and Time Preference: A Critical Review. *J. of Econ. Literature* Vol. XL, June:351-401.

Greenhalgh, S. and P. Faeth. 2001. A water quality strategy for the Mississippi River Basin and the Gulf of Mexico. *American Agricultural Economics Association Meeting* 2001.

Hands, H.M., M. R. Ryan, and J.W. Smith. 1991. Migrant shorebird use of marsh, moist-soil, and flooded agricultural habitats. *Wildlife Society Bulletin* 19:457-464.

Helmers, D. 1992. Shorebird Management Manual. Western Hemisphere Shorebird Reserve Network Manomet, MA. 58p.

Hernandez, M.E. and W.J. Mitsch. 2006. Influence of hydrologic pulses, flooding frequency, and vegetation on nitrous oxide emissions from created riparian marshes. *Wetlands* 26:862-877.

Hernandez, M.E. and W.J. Mitsch. 2007. Denitrification in created riverine wetlands: Influence of hydrology and season. *Ecological Engineering* 30:78-88.

Laubhan, M.K., and L.H. Fredrickson. 1993. Integrated Wetland Management: Concepts and Opportunities. Special Session 6 of Wetland Management for Shorebirds and Other Species. *In* G.H. Finney and G. Castro. (eds.) *Transactions of the 58th North American Wildlife and Natural Resources Conferences,* Wildlife Management Institute.

Laubhan, M. K. 1995. Effects of prescribed fire on moist-soil vegetation and soil macronutrients. *Wetlands* 15:159-166.

Lehnen, S. E., and D. G. Krementz. 2005. Turnover Rates of Fall-Migrating Pectoral Sandpipers in the Lower Mississippi Alluvial Valley. *Journal of Wildlife Management* 69:671-680.

Loesch, C.R., D. J. T., K. Tripp, W.C. Hunter, and M.S. Woodrey. 2000. Development of Management Objectives for Waterfowl and Shorebirds in the Mississippi Alluvial Valley, Pages 8-11. *In* D. P. R. Bonney, R.J. Cooper and L. Niles, (eds.), Strategies for Bird Conservation: The Partners in Flight Planning Process*, Proceedings of the 3rd Partners in Flight Workshop*, 1995 October 1-5, Cape May, NJ. U.S. Department of Agriculture, Forest Service, Rocky Mountain Experiment Station, Ogden UT.

Mitsch, W.J. and R.F. Wilson. 1996. Improving the success of wetland creation and restoration with know-how, time, and self-design. *Ecological Applications* 6:77-83.

Mitsch, W.J., L. Zhang, C.J. Anderson, A. Altor, and M. Hernandez. 2005. Creating riverine wetlands: Ecological succession, nutrient retention, and pulsing effects. *Ecological Engineering* 25:510-527.

Mitsch, W.J., L. Zhang, D.F. Fink, M.E. Hernandez, A.E. Altor, C.L. Tuttle and A.M. Nahlik. 2008. Ecological engineering of floodplains. *Ecohydrology & Hydrobiology* 8:139-147.

Ochs, C.A. and S.A. Milburn. 2003. Effects of simulated wintertime flooding to control erosion on selected chemical and microbial properties of agricultural soils in the Mississippi Delta. *Journal of the Mississippi Academy of Sciences* 48:102-114.

Ochs, C.A. 2006. Corrections to denitrification measurements. *In* C.A. Ochs and S.A. Milburn (eds.), With a revised view of the importance of denitrification to N-loss from agricultural soils of the Mississippi Delta. *Journal of the Mississippi Academy of Sciences* 51:177-179.

Pankau, A. K. 2008. Examining cost effectiveness of actively and passively managed wetlands for migrating and wintering waterfowl in Southern Illinois. M.S. Thesis. Southern Illinois University Carbondale.

Peterson, S.B., J.M. Teal, and W.J. Mitsch (eds.) 2005. Delaware Bay Salt Marsh Restoration. Special Issue of *Ecological Engineering* 25: 199-314.

Skagen, S. K., D. A. Granfors, and C. P. Melcher. 2008. On Determining the Significance of Ephemeral Continental Wetlands to North American Migratory Shorebirds. *The Auk* 125:20-29.

Tuttle, C.L., L. Zhang, and W.J. Mitsch. 2008. Aquatic metabolism as an indicator of the ecological effects of hydrologic pulsing in flow-through wetlands. *Ecological Indicators* 8: 795-806.

Twedt, D. J., C. O. Nelms, V. E. Rettig, and S. R. Aycock. 1998. Shorebird Use of Managed Wetlands in the Mississippi Alluvial Valley. *The American Midland Naturalist* 140:140-152.

U.S. Environmental Protection Agency (USEPA). 2003. Elements of a State Water Monitoring and Assessment Program. Assessment and Watershed Protection Division, Office of Wetlands, Oceans and Watersheds. EPA 841-B-03-003. Washington, DC.

APPENDIX A

Final Panel Comments

on the
Final Independent External Peer Review Report
St. Johns Bayou and New Madrid Floodway, MO,
Consolidated NEPA Document and Work Plan
Environmental, Economic, and Hydrologic and Hydraulic Review

This page intentionally left blank

Comment 1:
The cumulative impacts section lacks specific information on the incremental impacts of the proposed project.
Basis for Comment:
Cumulative impact is defined as the impact on the environment that results from the incremental impact of the proposed project when added to other past, present, and reasonably foreseeable future actions. In assessing cumulative impact, there are two factors that should be considered: (1) the unique characteristics of the geographic area and (2) whether the action is related to other actions with individually insignificant but cumulatively significant impacts on the environment. The project area is considered to be unique because only approximately 50,000 acres remains of an original 2.5 million acres of forested wetlands in southeast Missouri (Page 232). Also, according to the U.S. Fish and Wildlife Service (Page 260), the New Madrid Floodway is the last remaining connection of the Mississippi River with its historic floodplain in Missouri. In the opinion of the panel, these unique aspects, and the importance of annual flooding in maintaining the remaining natural refugia, increase the probability that additional incremental losses will be cumulatively significant. The Consolidated NEPA Document provides a descriptive historical account of the St. Johns Bayou and New Madrid Floodway, along with statistics on acres of present land uses, but does not provide analysis of the incremental impacts of the proposed project within the context of the cumulative loss of wetlands and river-floodplain connections in the lower Mississippi River Basin. According to the Council on Environmental Quality (1997), the unique requirements of cumulative effects analysis (i.e., the focus on resource sustainability and the expanded geographic and time boundaries) must be addressed by developing an appropriate conceptual model. This conceptual framework should constitute a general causal model of cumulative effects that incorporates information on the causes, processes and effects involved. The cumulative impacts section of the Consolidated NEPA Document lacks such an overall conceptual framework. References Council on Environmental Quality. 1997. Considering Cumulative Effects under the National Environmental Policy Act. Washington, D.C. January 1997.
Significance – High:
An accurate assessment of cumulative effects is essential to avoiding and minimizing adverse consequences, and developing an adequate compensatory mitigation strategy.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Develop an overall conceptual framework that incorporates information on causes, processes and effects. ▪ Identify cause-effect relationships relevant to the proposed project. ▪ Utilize available information on biotic indices (e.g., habitat suitability, diversity, etc.) and landscape conditions (e.g., habitat fragmentation) as benchmarks of accumulated change over time. ▪ Utilize remote sensing and GIS methods to quantitatively assess historical changes in land uses and habitats.

Comment 2:
Baseline agricultural economic conditions are not adequately supported with evidence, nor are the predicted future economic benefits associated with the project.
Basis for Comment:
The Consolidated NEPA Document maintains that current agricultural production is suboptimal and that the project will add benefits. There is no evidence provided in the reports that current production is suboptimal. Optimal production occurs either when profits are maximized given current conditions, or at least that costs are minimized given current conditions. Farmers who live in regions that experience frequent floods have very likely already fully adapted to flooding conditions. There are also a host of federal assistance or relief packages and insurance that they might be taking advantage of, which help offset any losses due to flooding. The report does not document whether or not farmers in the area have already taken flooding risks into account and are already optimizing their production activities, thus it does not include sufficient evidence that the project will add agricultural benefits. The main assumption made that underlies the claim that the project will contribute benefits to agriculture is that farmers plant low valued crops when there is a probability of flooding, but would switch to higher valued crops when flood risks are reduced (see Appendix B, p. B5, B6). There is mention of crop budgets (p. B6), but no documentation of the costs involved with planting and harvesting different crops, and the assumption is not supported with evidence. The regression results at p. B6 are not adequately explained, nor defined. The usual reported statistic is the goodness of fit, or R^2, but this is not reported on that page, although simple correlation coefficients are. Many studies have suggested that farmers behave in a fashion consistent with them being risk averse (e.g. Bingswanger, H.P. (1981)). While aversion to risk is one possible risk attitude, other people are risk neutral (i.e. they are indifferent between choosing to play a 50-50 gamble that pays either $1.00 or nothing, versus being offered $0.50 with certainty), and still others are risk lovers (people who like to gamble: they could be offered more than $0.50 with certainty and still choose the gamble). Risk attitudes for any particular farmer are an empirical issue and thus, risk attitudes for farmers in this region need to be documented before future decisions they might make in response to risk changes can be predicted. This is because farmers with any of the three types of risk attitudes each would behave differently in response to risk changes than farmers of another type. For example, some farmers might already factor in the risk and try to get the profits from high-valued crops under current (before project) conditions, especially if they can get federal disaster or other assistance. Other types of farmers might be unwilling to gamble on planting high valued crops that might be destroyed by a flood, assuming that the cost of planting and harvesting is higher. The economic analysis in the report makes strong assumptions about how cropping patterns will change (switching to crops of different values) with reduced risk. Again here, there is no evidence provided about how farmers would change cropping patterns, in response to risk changes.

Third, there is no detailed analysis of what use producers would make of any additional acreage for agricultural production. The report needs to document that farmers would, for example, plant more rice than they do now, including rice that might be planted on lands acquired in association with mitigation strategies such as those associated with offsetting impacts to shorebirds.

Fourth, future benefits depend on how different future crop prices will be from ones used for an analysis, and this cannot be known either. Subsidies for crops and price support programs may be absent, lower or in fact much higher or stronger in future years. As another example, consider what happened to the price of corn and other crops recently, with severe droughts in some areas of the world, coupled with ethanol subsidies that led corn producers to take advantage of them. Global warming in the future may exacerbate the drought problem, and no one knows with certainty what energy supplies will be and how they will relate to bio-fuel production.

The panel's literature search in economics and agricultural economics did not locate any convincing studies to link flood risks to agricultural production, so whether farmers would switch from current crops to other ones cannot be known at this juncture, introducing a great deal of uncertainty in the analysis.

References

Bingswanger, H.P. 1981. Attitudes toward risk: Theoretical implications of an experiment in rural India. *The Economic Journal* 91 (364):867-90.

Significance – High:

The agricultural benefits are almost the sole driver of the project, unless other types of benefits are brought into the analysis, so the agricultural benefits must be clearly calculated, convincing, and large for the project to have a BC ratio that is greater than one.

Recommendations for Resolution:

To resolve these concerns, the project needs to consider the following:

- Provide data and evidence that baseline production (current production today), is "suboptimal", i.e. that farmers are not already optimizing in response to flooding conditions. To do so might require reporting of farm profits in the region for lower flooding and higher flooding years.
- Document the costs of planting and harvesting different crops that would be profitable in the region.
- Provide evidence that crop prices used in the analysis are reasonable in projection of future benefits.
- Provide evidence and documentation that farmers will change existing cropping patterns.
- Revise the risk analysis to include possible scenarios for future crop prices that prices that depend on world-demand and supply conditions that in turn depend on subsidies, global warming, and energy supply and demand.

Comment 3:

The economic analysis is confusing because it does not follow the standard practice of calculating the present value of future benefits and costs using a single discount rate for the project analysis, and for a well-defined and consistent period of analysis.

Basis for Comment:

Conventional benefit-cost analysis uses one single discount rate (r) to calculate the present value of all future benefits and costs, for a well defined time period (t = 1,…T) associated with the life of the project, ending in the Tth year. The discounting procedure is done such that there is no discounting in the very first period, and the discount factor ($=[1/(1+r)]^t$) is then less than one as each future year is contemplated, thus making benefits or costs smaller, from the point of view of the present.

Sensitivity analysis is often performed as a way of accounting for the presence of risk or uncertainty by redoing the entire analysis after it has been done for one discount rate, consistently using a single alternative (lower or higher) discount rate. The Office of Management and Budget (OMB) is the authority that issues a memorandum on the discount rate to be used in analysis of federal projects in the United States. Currently, the OMB recommends a 3% and a 7% rate be used, even though private market decisions often imply much higher rates of discounting. {The economics literature often shows that private decision making is often consistent with individual rates of discount well above 10% (see the summary review paper Frederick et al. (2002).}

The Consolidated NEPA Document claims that the project, or at parts of it such as the New Madrid closure levee see page xx – note that "xx" refers to the Roman numeral set of pages that precede the table of contents, section S.9.10.2), are "grandfathered" with respect to the discount rate that could be used. The report suggests that a 2.5% rate of discount can be used (see p. xx), but it is not clear whether the 2.5% could only be used for the New Madrid closure levee, or the entire project. Page B-1 (bottom) and B-2 of Appendix B make it sound like two rates are used.

In addition, the use of 2.5% instead of 3% or 7% is a legal issue, and not an economic one, but different discount rates {the report also features some calculations for a rate of about 5.125% (see page 211 of the Consolidated NEPA Document) and at 6.125% - see page 211, and also see B41, Appendix B, for example} cannot be used for some years versus others, or used for some impacts or alternatives, but not others. The report is confusing about which rates are used for which alternatives and parts of the project.

The alternative discount rates such as 6.125% are used for sensitivity analysis in connection with the revision to the report (RSEIS 2), but this is not very clear to the reader. Discounting the alternatives at 3 or 7%, but discounting the favored at 2.5% of course gives the favored project the advantage, however, it is not clear whether the levee closure is always incorporated using a 2.5% discount rate, even when it is a feature of the one of the alternatives (p. B-24 of Appendix B suggests this is true).

The period of analysis sometimes appears in the report to be 2002 to 2052 (implying a fifty year project life – see page B20, Appendix B, for example) and at other times in the report the initial period seems to be 1997 to some unknown future date (page B-1, Appendix B is not clear about this). The analysis for the report needs to adopt one consistent time period, from the start of

construction, through to a well-defended end to the project. It is not standard practice to compound (inflate) benefits or costs that precede the start date of the project (see page B-1, Appendix B), thus, the start date needs to be consistent with the initial construction phase of the project to provide clarity for the analysis.

Finally, it would be best to use the most available, up to date, and relevant information on prices and costs, and inflation rates available at the time of the analysis. Discount rates should reflect society's real rate of time preference, not confounded with inflationary trends, and the report is not clear regarding treatment of inflation rates.

References

Frederick, S., G. Loewenstein and T. O'Donoghue. 2002. Time Discounting and Time Preference: A Critical Review. *J. of Econ. Literature* Vol. XL, June:351-401.

Significance – High:

The project is close to the point where it would not be considered economical, even when using a low discount rate of 2.5%, as in Table 19 (Appendix B, p. B-25), thus the methods and procedures must be clear, and sound.

Recommendations for Resolution:

To resolve these concerns, the project needs to consider the following:

- Provide an analysis using a well-defined period for the project that is consistent for all of the impacts considered, and this should carefully define the actual starting date for construction of the project, its completion, and the end of the project life.
- Conduct an analysis of all of the costs and benefits for the project in present value terms using a 3% discount rate, then completely re-estimated using a 7% discount rate. Sections of any future report should be very clear as to which single rate is being used for the analysis that is presented within that section of the report. Separate tables, or at least clearly indicated separate columns or rows of any single table, should label the discount rate used to arrive at this present value.
- Conduct a sensitivity analysis for the 2.5% rate, again using only this rate for all benefits and costs, starting from a clear starting date and discounting all future benefits and costs, without compounding any benefits or costs that precede the start date.

Comment 4:
The assumption used to calculate mid-season fish spawning habitat to mitigate winter waterfowl habitat has not been properly evaluated.
Basis for Comment:
Even if winter habitat is emphasized for mitigation of waterfowl, which is an assertion, is not clear how this is possible under the basic mitigation plan. According to Table 2.4 (Page 35, Consolidated NEPA Document), 1,293 acres will be reforested for duck use in the St. Johns Bayou (SJB), 2,326 acres of habitat will be reforested in the New Madrid Floodway (NMF) in addition to the 671 acquired for vegetative buffer and 266 acres acquired for a wildlife corridor. All of these acres are intended to, in part, be used to provide adequate mitigation Duck Use Days (DUDs) by maintaining water at 285 feet during the winter in the St. James Bayou and 284.4 feet in the new Madrid Floodway (tables 2.1 and 2.2). Thus, the basic mitigation plan will require the acquisition of 4,556 acres (summation of the above acreages) of crop and fallow fields (Table 2.4, Page 35, Consolidated NEPA Document), with water being maintained on this habitat during December and January by maintaining water levels at 285 feet and the SJB flood gate and 284.4 feet at the NMF flood gate. The problem is, according to Tables 3.3 and 3.4, Table 2.4 (Pages 58 and 59, Consolidated NEPA Document) there are only 3,174 acres of crop or fallow fields (1,382 acres less than needed) that would be flooded when water is maintained at 285 feet in the SJB and 284.4 in the NMF. Furthermore, flooded is only useful when water levels are ≤ 30 cm; any habitat deeper than 30 cm will not be providing DUDs for waterfowl. Therefore, when water is held in SJB at 285 feet, the only acres available for ducks are the acres that fall between the elevations of 284 and 285, which total 1,472 acres. The only acres available for ducks in the NMF when gates are holding water at 284.4 feet are the acres between elevation 283 and 284 (assumes 0.4 feet is needed for ducks to use it and simplifies the example), which is only 437 acres of crop and fallow fields. This analysis indicates only 1,909 acres of crop and fallow fields are available at the appropriate elevation for potential mitigation. This analysis also assumes the 387 acres for borrow pits will come from acres above or below these elevations. Thus, the basic mitigation plan calls for 4,556 mitigation acres of habitat for waterfowl when only 1,909 acres of crop and fallow fields are available for mitigation (assuming all owners of the 1,909 acres are willing participants). More of these acres could be made available by fluctuating the water levels during winter so different acres were at the appropriate depth at different times, but this would require regular monitoring and regulation of water levels; at considerable additional expense. Even if the much more expensive approach was taken, an additional 1,382 acres that don't exist would be required.
Significance – High:
Mitigation adequate to replace wetlands lost to migratory birds is required for this project to move forward; it is unclear how adequate mitigation could be achieved under current plan.

Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Develop a new mitigation plan needs that will allow flooding at a depth < 30 cm on adequate acreage to mitigate for lost DUDs (at least 4,556 acres according to the Consolidated NEPA Document) due to the altered hydrology produced by the project.

Comment 5:
The proposed basic mitigation features are unlikely to achieve the desired level of wetland compensation.
Basis for Comment:
Federal law (Section 404 Clean Water Act) requires that wetland loss be avoided, minimized or mitigated to achieve no net loss of wetlands. While some of the first two options were incorporated into this project, wetlands will be lost due to direct construction (~170 acres) while considerably more wetlands (up to 13,200 acres) will be affected due to the water control project that, by design, will lessen the amount of flooding that occurs in the study sites (Appendix D, p. D-9). So significant mitigation for wetland loss and particularly loss in wetland function should be required for this project and the mitigation is being done in an area that will have less water flux than before. The Panel believes that, despite the fact that a hydrogeomorphic (HGM) analysis was completed after the 2002 Revised Supplemental Environmental Impact Statement (RSEIS), there remain three issues with the proposed mitigation for wetland loss described for the alternatives in the Consolidated NEPA Document. First the amount of wetland function impacted by the project is probably understated. Second, a description of the mitigation of wetland loss, as described in Appendices D and E and other parts of the Consolidated NEPA Document as reforstation of 8,400 acres of frequently flooded cropland, purchasing of flood easements, development of moist soil units, and wetland restoration/river reconnections in Big Oak Tree State Park, is not provided in sufficient detail nor in a comprehensive manner to allow a determination if the mitigation is sufficient. There does not appear to be a mitigation ratio approaching 1:1 based on wetland area (acreage); if functional attributes of the wetlands are used, there is even less chance that the ratio will be at 1:1 or higher. Third, there is no clearly stated adaptive management plan in the report that would be subject to use after the standard 5-year monitoring. <u>Understated impact</u> The Consolidated NEPA Document states that even though there is a reduction in hydrology as a result of this project, it "does not mean that these lands will lose their wetland character." The panel believes that floodplain wetlands without river pulses are not the same as wetlands with flood pulsing (see, e.g., Mitsch et al. 2005, 2008; Fink and Mitsch 2007; Hernandez and Mitsch 2006, 2007; Altor and Mitsch 2008; Anderson and Mitsch 2008; Tuttle et al. 2008) even if groundwater and local rainfall cause water level fluctuations. It is not sufficient to have water level; water flux with accompanying nutrients and export capacity are important for many functions. The panel is also concerned about the potential indirect impact of dredging in the St. Johns on the hydrology and subsequent function and value of riparian wetlands. While this may be minor compared to the large-scale impact of indirect effects of the project, the issue appears to be ignored in the Consolidated NEPA Document. The panel knows from other systems that when you reduce the elevation of the main channel, adjacent riparian wetlands are also dried out. <u>Mitigation description</u> The proposed mitigation for wetland loss is not clearly described in the report. To simply state

that agricultural lands will be reforested according to "commonly accepted practices for wetland mitigation projects in the Corps' Memphis District" (Appendix E) is not sufficient, given the importance of this on project success. There are also few details of monitoring beyond required 5 years, there are not any projections of hydroperiods, plant communities, or soils for the mitigation sites at 20 50, and 100 years into this project. The panel believes that the mitigation plan appears to be theoretical more than real.

Reforestation is a reasonable alternative, although the panel suspects that these forests will mostly be on the dry side, given the large-scale drainage that is occurring. They will be expensive to maintain and it is unlikely that trees can be kept out of these sites without constant management.

The panel believes that the mitigation that has the most chance of success is the Big Oak Tree State Park hydrologic restoration. Here, USACE is adding water, not draining. Unfortunately, there are no specifications given (p. 118) on how much water, when, etc. Relying on gravity would of course be optimum, but to ensure success, pumps might have to be installed too. There is more detail given about purchasing the property and the zones of bottomland that are desired (essentially all 4 types of bottomland forest) than about the expected hydrologic regime, which is crucial to the project's success.

Borrow pits may have the most potential of becoming and staying as wetlands for a very long duration as they fill with sediments and organic matter. If half of them are 3 ft deep or less, they can be designed with littoral zones for vegetation and contribute significantly to biodiversity. Ecological engineering help to design these ponds appropriately is needed.

Adaptive management

While it is stated that the mitigation sites will be monitored in the short-term (usually 5 years), there is no adaptive management plan in place should the wetland mitigation fail or prove to be marginal either in this short term or in a much longer term (15 – 50 years). There are several successful adaptive management plans related to wetland restoration that have been used in wetland mitigation cases, particularly refer to the Delaware Bay Marsh Restoration Project (see Peterson et al., 2005).

References

Altor, A.E. and W.J. Mitsch. 2008. Pulsing hydrology, methane emissions, and carbon dioxide fluxes in created marshes: A 2-year ecosystem study. *Wetlands* 28:423-438.

Anderson, C.J. and W.J. Mitsch. 2008. The influence of flood connectivity on bottomland forest productivity in central Ohio, USA. *Ohio J. Science* 108 (2): 2-8.

Fink, D.F. and W.J. Mitsch. 2007. Hydrology and biogeochemistry in a created river diversion oxbow wetland. *Ecological Engineering* 30:93-102.

Hernandez, M.E. and W.J. Mitsch. 2006. Influence of hydrologic pulses, flooding frequency, and vegetation on nitrous oxide emissions from created riparian marshes. *Wetlands* 26:862-877.

Hernandez, M.E. and W.J. Mitsch. 2007. Denitrification in created riverine wetlands: Influence of hydrology and season. *Ecological Engineering* 30:78-88.

Mitsch, W.J., L. Zhang, C.J. Anderson, A. Altor, and M. Hernandez. 2005. Creating riverine wetlands: Ecological succession, nutrient retention, and pulsing effects. *Ecological Engineering* 25:510-527.

Mitsch, W.J., L. Zhang, D.F. Fink, M.E. Hernandez, A.E. Altor, C.L. Tuttle and A.M. Nahlik. 2008. Ecological engineering of floodplains. *Ecohydrology & Hydrobiology* 8:139-147.

Peterson, S.B., J.M. Teal, and W.J. Mitsch (eds.) 2005. Delaware Bay Salt Marsh Restoration. Special Issue of *Ecological Engineering* 25: 199-314.

Tuttle, C.L., L. Zhang, and W.J. Mitsch. 2008. Aquatic metabolism as an indicator of the ecological effects of hydrologic pulsing in flow-through wetlands. *Ecological Indicators* 8: 795-806.

Significance – High:

With up to 13,000 acres of wetlands lost or affected by the reduced flooding due to this project, the Consolidated NEPA Document does not provide convincing evidence that the loss in wetland function can be mitigated to achieve no net loss of wetlands.

Recommendations for Resolution:

To resolve these concerns, the report would need to be expanded to include:

- Reassess the mitigation plan to include both more detail on the mitigation locations and monitoring and incorporate more wetlands that are open to Mississippi River flooding.
- Determine the loss in function of wetlands that are indirectly affected by the project with the realization that wetlands are distinctly different when flooded by river water as opposed to groundwater and local seepage/runoff.
- Simplify the discussion of wetland mitigation so it is clear how many acres of each wetland type is affected by the project and how many acres of each type of wetland is created, restored, or enhanced as a result of the mitigation.
- Provide an explicit adaptive management plan for wetland mitigation in the report. It should be sequenced to review the mitigation sites at least on an every-other-year cycle after the 5-year monitoring is completed, no matter who is in charge of the sites.
- Provide information about the potential indirect impact of dredging in the St. Johns Bayou on hydrology (function and value) of riparian wetlands.

Comment 6:
The Consolidated NEPA Document is inadequate in justifying the use of the two-year floodplain in calculating the environmental impact.
Basis for Comment:
The Consolidated NEPA Document uses the two-year flood elevation to calculate the extent of the impacts to fish and wildlife. The mean two-year flood elevations are likely to be insensitive to more extreme events that are of importance to species using shallowly flooded areas, and some measure of variance among years that accounts for less frequent events is required to determine the likely impacts overall to these species. The primary concern for fish is whether two-year flood events provide conditions for needed habitat (spawning, rearing, juvenile, and adult) for fishes and how reduced annual variability in flooding (hydrology) will impact fish populations and fish assemblages. Fish have evolved to natural variation that provides a diversity of environmental conditions ultimately leading to diversity of the fish community as expressed, in part, in the high species richness found in the St. Johns Bayou and New Madrid Floodway. The annual flooding variation not only helps determine available fish habitat but also has a role in the creation, maintenance, and changes in the functional role of the floodplain habitats for fishes. Less frequent flood events can significantly influence year-class strength of a population through increased spawning success and juvenile survival for many species. These flood events, however, have less influence on the long-term population for most species. Flood frequency has a much greater impact on fish communities; reducing flooding that isolates habitat within the floodplain can have localized population influences and thus communities adjust to a different set of environmental characteristics. In this respect, longer and greater flood events do have a beneficial role for fish populations. The model does estimate lost AAHUs on the floodplain that corresponds to the two-year frequency flood. This area of the floodplain receives more frequent and thus less variable annual flooding than the 3-year plus floodplain. Habitat that floods less frequently can have different environmental characteristics than areas that flood more often and this is expressed in differences in the fish assemblage across the floodplain. The Consolidated NEPA Document discusses these expected community changes but does not quantify or address them in mitigation. As with fish, varying flood frequencies maintain variation in wetland plant communities and diversity. Reducing or controlling these frequencies will likely reduce plant diversity, thus value and function of wetlands within the project area. While “a regular, recurrent flooding regime of the two-year floodplain”, is not likely to maintain fish community diversity, it is likely to maintain fish base populations; this is not the case for waterfowl and shorebirds. The 2-year floodplain doesn’t consider the loss of habitat for shorebirds and waterfowl due to loss of less frequent flood events. Shorebirds and waterfowl (waterbirds) are very mobile and have adapted to opportunistically exploit resources whenever and wherever they become available, especially during migratory periods. The mobility of waterbirds allows them to survive long fall migrations and survive and actually acquire nutrient reserves for reproduction during spring migration, while migrating over extremely patchy environments. They accomplish this by exploiting these patchy resources to the fullest extent whenever possible during migrations. Thus, for migratory waterbirds, just because a habitat in a

specific region isn't regularly available does not mean it is not critical habitat when it is available. Not all potential wetland habitat is available during migration every year. This is especially true for ephemeral wetlands most often exploited by migratory waterbirds. In fact, annually variable precipitation patters tend to cause surface flooding in one region in one year then in a different region the next. The exploitative nature of migratory waterbirds allows them to utilize these variable habitats even though they may be very unpredictable. Thus, an area does not need to be flooded in a frequent and dependable manner for it to be critically important at supporting migratory waterbirds. Areas that are inundated as infrequently as every 10 to 20 years will likely be exploited and may prove to be critical in supporting the successful migration of waterbird populations by providing habitat during years when little habitat is available at other latitudes.

Waterbird habitat will be reduced to some degree on any suitable habitat that no longer floods in any year as a result of the project, and the total amount of suitable habitat that no longer floods must be calculated in order to determine the loss of foraging habitat that would occur post-project. Further justification is needed regarding the use of the two year flooding elevation rather than the total area on which flooding would be reduced as an acceptable approach to calculating loss of habitat for waterbirds and other wildlife. This loss of less frequently inundated habitat needs to be considered when determining mitigation needs for migratory waterbirds.

Significance – High:

The Consolidated NEPA Document underestimates the environmental impact of the loss of greater than 2 year flood events, underestimating necessary mitigation.

Recommendations for Resolution:

To resolve these concerns, the project needs to consider the following:

- Conduct an analysis of flood frequency variations, while maintaining a minimum base of habitat. Alternative 3-1.C recognizes the importance of variability. The flood frequency that is most appropriate is best determined through monitoring and adaptive management as the project progresses. The plan should have the flexibility to allow larger flood event (3-10) as a possible alternative if determined necessary to maintain fish and wetland diversity and resources for migratory waterbirds across the floodplain. It should be noted however, that mitigation alternatives proposed actually may reduce flood variation. In the long-term this will change community structure and may reduce diversity on the floodplain.
- Include the total area currently subject to flooding in calculations of required mitigation for waterbirds.

Comment 7:
The operation and management costs associated with managed moist soil units and levees around bottomland hardwood flooding were not considered.
Basis for Comment:
The panel was not able to locate a calculation of the substantial ongoing costs for managing the moist soil units intended to provide mitigation for waterfowl and shorebird habitat impacts. In particular, intensively managing an area for waterfowl and shorebird habitat requires annual management of both the water level and the vegetation on the site, including such intensive activities as burning or discing (disturbing the soil with a disc) to control invasive vegetation. Annual costs of managing moist soil units at production levels such as those proposed in this mitigation were approximately $885/ha in 2006 (Pankau 2008). This equates to a cost of > $13,000,000 over the 50 year project period, not accounting for inflation. In the panel's opinion, without dedicated funds to support these activities, it is unlikely that ongoing management will persist, and without ongoing management, the high values applied in the shorebird Habitat Evaluation Procedure (HEP) and Duck Usage Days (DUDs) to managed moist soil units will not be achievable. In addition, there does not appear to be an agency specified to take on this significant management responsibility. Carrying out appropriate management for shorebirds and waterfowl will require the efforts of a trained wildlife biologist skilled in moist soil management. These costs do not appear to be calculated as part of the cost assessment, and should be estimated and included in the Consolidated NEPA Document. Furthermore, similar to moist soil units, any levees placed around bottomland hardwood forests will require annual operation and maintenance costs. These costs should also be estimated and included NEPA document. References Pankau, A. K. 2008. Examining cost effectiveness of actively and passively managed wetlands for migrating and wintering waterfowl in Southern Illinois. M.S. Thesis. Southern Illinois University Carbondale.
Significance – High:
Mitigating the impacts of wetland loss is required for this project to proceed, including this information will be critical in ensuring appropriate mitigation and cost benefit analyses are achieved.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Provide assurance that appropriate resources (money and expertise) for operation and management of moist soil units and levies around bottomland hardwood forests are available.

Comment 8:
There is strong evidence that moist soil units managed for both shorebirds and waterfowl would not provide habitat at the levels assumed for mitigation of impacts to both shorebirds and waterfowl.
Basis for Comment:
The ability of moist soil units to produce resources for shorebirds and waterfowl at a level presumed under the current Consolidated NEPA Document will require hydrology and vegetation to be managed in a way that maximizes the production of moist soil seeds for waterfowl and the production and availability of aquatic invertebrates for shorebirds. As described below, while managing hydrology and vegetation in a way that provides resources for both waterfowl and shorebirds is possible, such a management approach would dramatically reduce productivity and resource availability for both waterfowl and shorebirds, thus, productivity levels (Duck Usage Days {DUDs} and Habitat Evaluation Procedure {HEP}) for both waterfowl and shorebirds are drastically over estimated in the current mitigation plan. For example, maximizing productivity for waterfowl would require a slow draw down from approximately 1 April to 15 May (Cross and Vohs 1988). This time period coincides nicely with the spring migration of shorebirds, thus, as long as residual vegetation has decomposed adequately, which is often unlikely to be the case, moist soil units could produce both waterfowl and shorebird habitat. The most important limiting factor for shorebirds in the Mississippi Alluvial Valley, however, is fall foraging habitat during southbound migration (Twedt et al. 1998), as documented by the Lower Mississippi Valley Joint Venture management plan for shorebirds in the region (Loesch et al. 2000). Managing moist soil units for the maximum benefit of shorebirds would require fall drawdowns to expose shallowly flooded areas, which virtually eliminates the productivity of moist soil seeds, and thus, DUDs. Additionally, even if it is deemed appropriate to mitigate for shorebird habitat loss with spring migratory habitat, manipulations to control vegetation encroachment has very different effects depending on the season when the activity occurs, and while spring manipulation is optimal for waterfowl, summer manipulation has been shown to be more beneficial for shorebird habitat (Laubhan 1995). Some benefits to waterfowl of moist soil management for shorebirds have been documented in the literature (Laubhan and Fredrickson 1993), including wintering habitat if units are kept flooded at appropriate depths for waterfowl during the winter season. There are important limitations, however, to the use of managed lands for both shorebirds and waterfowl. Currently all shorebird mitigation and the majority of waterfowl mitigation is based on the successful management of moist soil units. References Cross, D., and P. Vohs, (eds). 1988. Waterfowl Management Handbook. Fort Collins, CO: U.S. Fish and Wildlife Service. Laubhan, M.K., and L.H. Fredrickson. 1993. Integrated Wetland Management: Concepts and Opportunities. Special Session 6 of Wetland Management for Shorebirds and Other Species. *In* G.H. Finney and G. Castro. (eds.) *Transactions of the 58th North American Wildlife and Natural Resources Conferences,* Wildlife Management Institute. Laubhan, M. K. 1995. Effects of prescribed fire on moist-soil vegetation and soil macronutrients.

Wetlands 15:159-166.
Loesch, C.R., D. J. T., K. Tripp, W.C. Hunter, and M.S. Woodrey. 2000. Development of Management Objectives for Waterfowl and Shorebirds in the Mississippi Alluvial Valley, Pages 8-11. *In* D. P. R. Bonney, R.J. Cooper and L. Niles, (eds.), Strategies for Bird Conservation: The Partners in Flight Planning Process*, Proceedings of the 3rd Partners in Flight Workshop*, 1995 October 1-5, Cape May, NJ. U.S. Department of Agriculture, Forest Service, Rocky Mountain Experiment Station, Ogden UT.
Twedt, D. J., C. O. Nelms, V. E. Rettig, and S. R. Aycock. 1998. Shorebird Use of Managed Wetlands in the Mississippi Alluvial Valley. *The American Midland Naturalist* 140:140-152.
Loesch, C.R., D. J. T., K. Tripp, W.C. Hunter, and M.S. Woodrey. 2000. Development of Management Objectives for Waterfowl and Shorebirds in the Mississippi Alluvial Valley, Pages 8-11. *In* D. P. R. Bonney, R.J. Cooper and L. Niles, (eds.), Strategies for Bird Conservation: The Partners in Flight Planning Process*, Proceedings of the 3rd Partners in Flight Workshop*, 1995 October 1-5, Cape May, NJ. U.S. Department of Agriculture, Forest Service, Rocky Mountain Experiment Station, Ogden UT.
Twedt, D. J., C. O. Nelms, V. E. Rettig, and S. R. Aycock. 1998. Shorebird Use of Managed Wetlands in the Mississippi Alluvial Valley. *The American Midland Naturalist* 140:140-152.

Significance – High:

Estimates of current benefits of moist soil units for proposed mitigation are based on values achieved when habitat is either managed specifically for shorebirds or specifically for waterfowl. These benefits are thus over estimates when habitat is to be managed simultaneously for both.

Recommendations for Resolution:

To resolve these concerns, project needs to consider the following:

- Decrease the value of moist soil units for both shorebirds and waterfowl based on more recent values from studies on wetlands being managed for multi uses and either (a) recalculate the acreage needed for mitigation or (b) provide moist soil waterfowl and shorebirds separately.

Comment 9:
Mitigating floodplain average annual habitat unit (AAHU) loss with modified borrow pits overestimates compensation of mid-season fish rearing habitat.
Basis for Comment:
Modified barrow pits as described for the St. Johns Bayou can provide habitat for fishes. Modifications in shape, size, depth (greater amounts of shallow areas), and bottom contour will increase habitat heterogeneity for fishes and improve the quality of the habitat. The fish model as applied calculates maximum value for fish rearing habitat for the 5 mid-season rearing evaluation species used in the model. These maximum values are a result of a higher Habitat Suitability Index (HSI) for oxbow lakes than other habitats and the fact that each acre of the lake receives 100% weighted value in the calculation of Average Daily Flooded Acres (ADFAs). The ecological function of oxbow lakes and fish community composition are influenced by lake characteristics, surrounding riparian habitat in the floodplain, and connectivity to the river. These details should to be considered in the design of modified barrow pits to provide the highest possible habitat quality (max HSI score for this habitat). The panel did not see any information that indicates the Habitat Evaluation Procedure (HEP) team approved HSI values assigned to oxbow lakes be used for borrow pits or that borrow pits were considered in HSI valuation. In the panel's opinion, not all borrow pit acres are suitable rearing habitat for the 5 evaluation species. This assumption leads to an over representation of the value of the compensation acres. For example, pirate perch is a shallow water floodplain lake species associated with abundant cover in the littoral zone. Much of the borrow pit acreage does not fit this description and will be of less value for this species. Therefore, the HSI score as applied to calculate the AAHUs is too high. A final consideration is that no transition period was applied to borrow pit habitat. Since its function is dependent, in part, on the surrounding riparian area (bottomland hardwoods with a 10 to 20 year transition) that should seasonally flood and connect to the borrow pits a transition period is warranted.
Significance – High:
The Consolidated NEPA Document overestimates the value of modified borrow pit acres used for mitigation of mid-season fish rearing habitat, thereby under compensating for lost AAHUs.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Determine and apply specific discount criteria to the HSI value for borrow pit mid-season rearing habitat. This could include river connectivity (time and duration), location within the floodway, surrounding riparian habitat, lake morphometrics, and water quality. ▪ Determine acreage of mid-season rearing habitat as a subset of water surface area of borrow pits and apply to determination of ADFAs and AAHUs. ▪ Incorporate a transition period for the establishment of functional bottomland hardwoods into the calculation of AAHUs for borrow pit habitat.

Comment 10:
Additional reforestation opportunities should be considered to fully compensate for mid-season fish-rearing habitat in the St. Johns Bayou and New Madrid Floodway since the floodway was historically a bottomland hardwood ecosystem.
Basis for Comment:
Project impacts on mid-season fish rearing habitat are estimated to be 1,884 and 2,329 Average Annual Habitat Units (AAHUs) in the St. Johns Bayou and New Madrid Floodway, respectively. The Basic Mitigation Feature estimates 1,884 AAHUs (313 with reforestation and 1,571 with barrow pits) and 51 AAHUs (38 with reforestation, 9 with vegetated buffers, and 4 with wildlife corridor easement) in the Bayou and Floodway, respectively. The Basic Mitigation Feature (Basic Feature) for the New Madrid Floodway provides only 2% of the mid-season fish rearing habitat AAHUs needed for mitigation. Although additional techniques that supplement the Basic Feature are proposed, they depend too much on non-reforestation. Reforestation should be the primary technique used since the Bayou/floodway was historically a bottomland hardwood ecosystem and the dominant habitat type. However, within the bottomland hardwood floodplain other important fish habitats exist that include permanent floodplain lakes, ephemeral floodplain pools, sloughs, and bayous that are all seasonally connected to the Mississippi River. This habitat diversity and the connection to the Mississippi River provide the foundation for the fish species richness and diversity found in the floodways. Therefore, a diversity of habitat mitigation techniques should be the goal of the Basic Mitigation Feature.
Significance – High:
Mitigation techniques that gain AAHUs by focusing on limited types of floodplain habitats (primarily permanent water bodies) and not reforestation may reduce species richness and diversity in the floodways.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Revise the Basic Mitigation Feature to include a much greater percentage of the AAHUs through reforestation. ▪ Ensure the mitigation team agrees on the appropriate AHHU amounts provided by each of the main habitat types in the Basic Mitigation Feature and in the Additional Techniques that supplement the Basic Feature. The panel suggests that no single mitigation approach dominate as currently proposed.

Comment 11:
The Consolidated NEPA Document does not appear to compensate for the amount of shorebird habitat impacted, and does not provide sufficient detail to determine if mitigation of shorebird impacts can be achieved.
Basis for Comment:
The mitigation plan for shorebird habitat impacts cannot be adequately evaluated from the information provided in the Consolidated NEPA Document. The Consolidated NEPA Document itself, and the information provided in Appendix L relative to shorebird habitats, provide only the results of the calculations on Average Annual Habitat Units (AAHUs) lost due to the project, but provide no information about how the calculations were made. The supporting materials provided in the Revised New Madrid Floodway Terrestrial Habitat Evaluation Procedures dated September 4, 2001, also provide only the acreage inputs and the final amount of mitigation acres proposed, with no indication of how the results were calculated. Without this information, it is impossible to determine if the mitigation plan is adequate. The input values for suitable habitats are dramatically larger than the resulting values for impacted areas. For example, Table 4 in the Revised New Madrid Floodway Terrestrial Habitat Evaluation Procedures dated September 4, 2001, lists inputs of 1,632.6 acres of existing cropland in the New Madrid Floodway within 1 foot of the 50% exceedence level, and 36,968.3 acres greater than 1 foot above the same level, but Table 5 provides a result of only 605.53 AAHU's lost under Alternative 3, with no information about how the calculation was completed. Because no detail was provided about what calculations were actually conducted, it is impossible to determine how the total acreage needed to mitigate for shorebird impacts was determined. However, the total acreage appears to be substantially lower than what would be expected from the large reductions in flooding on suitable shorebird habitat under current conditions that would result from implementation of the project. The project aims to reduce seasonal flooding during the shorebird migration season over very large areas of cropland. All shallowly flooded and sparsely vegetated areas that are subsequently exposed during the shorebird migration period will provide suitable shorebird habitat. The panel believes it is likely that the impacted acreage of shorebird habitat is much greater than the estimates provided in the report. In addition, the Consolidated NEPA Document does not adequately justify the projected post-project increase in rice acreage. The Consolidated NEPA Document states on page 125 that "At the time the shorebird model was developed, the HEP team assumed that cropping patterns under future with-project conditions would include increased rice acreage. That assumption accounts for most of the shorebird habitat value under both project alternatives." It is not clear why the assumption was made that the project would result in an increase in rice acreage, and this assumption is critical to determining likely project impacts. An explicit mitigation plan is needed to address impacts if this assumption of increased rice acreage turns out to be incorrect. In addition, some literature suggests that shorebirds use other agricultural field types more extensively when they are flooded, including soybeans (Twedt et al. 1998), so the assumption that rice acreage would be the most valuable requires further justification. The Consolidated NEPA Document also incorrectly states that spring migration habitat for shorebirds are the most critical timeframe: "The shorebird HEP addresses only spring migration habitat, since that timeframe was considered most critical throughout the year" (page 124).

Spring migration habitat is not the most critical habitat for shorebirds in this region, where shorebird species are most likely to be limited by fall migration habitat (Loesch et al. 2000; Skagen 2006).

References

Loesch, C.R., D. J. T., K. Tripp, W.C. Hunter, and M.S. Woodrey. 2000. Development of Management Objectives for Waterfowl and Shorebirds in the Mississippi Alluvial Valley, Pages 8-11. *In* D. P. R. Bonney, R.J. Cooper and L. Niles, (eds.), Strategies for Bird Conservation: The Partners in Flight Planning Process*, Proceedings of the 3rd Partners in Flight Workshop*, 1995 October 1-5, Cape May, NJ. U.S. Department of Agriculture, Forest Service, Rocky Mountain Experiment Station, Ogden UT.

Skagen, S. K., D. A. Granfors, and C. P. Melcher. 2008. On Determining the Significance of Ephemeral Continental Wetlands to North American Migratory Shorebirds. *The Auk* 125:20-29.

Twedt, D. J., C. O. Nelms, V. E. Rettig, and S. R. Aycock. 1998. Shorebird Use of Managed Wetlands in the Mississippi Alluvial Valley. The American Midland Naturalist 140:140-152

Significance – High:

An accurate and fully documented assessment of impacts to shorebird habitats is essential to avoiding and minimizing adverse consequences, and developing an adequate compensatory mitigation plan.

Recommendations for Resolution:

To resolve these concerns, the project needs to consider the following:

- Calculate the amount of shorebird habitat to be impacted, describing in detail the application of the HEP model and the assumptions made about the extent of shallowly flooded area in each project year;
- Develop a mitigation plan that demonstrably replaces the total amount of shallowly flooded and subsequently exposed habitat that currently occurs under existing conditions in the project area.

Comment 12:
It is unclear if a combination of flooding and soil maps were used to determine the extent of existing jurisdictional wetlands and what wetland delineation methodology was used.
Basis for Comment:
The National Resource Conservation Service (NRCS) classified only 520 acres in the project area as farmed jurisdictional wetlands on the total project area while the USACE determined that backwater flooding would be reduced on 1,296 and 5,417 acres (total = 6,713) of agricultural lands in the St. Johns Bayou and New Madrid Floodway, respectively. Wetland delineation to determine the extent of jurisdictional wetlands usually requires independent identification of water, soils, and vegetation. In this case, floodwater mapping was used with some ground truthing by the USACE while the NRCS depended primarily on the USDA hydric soils maps and color slides from 1984-89 for summer conditions, not spring. The panel agrees with the Consolidated NEPA Document that the methodology described by the USACE is more defensible. At a minimum, the USACE figure should be used. However, it is not clear how much total area currently meets the hydrological criteria for wetlands. This is important because the project will result in less river flooding on additional agricultural habitat, and these acres may or may not fall within the criteria of jurisdictional wetlands, but they do provide habitat that is used by spring migratory waterfowl and shorebirds. Thus, the project will lead to a decrease in the function of those habitats as well as those in the jurisdictional wetlands category. The panel would like to know if there was any attempt to determine if all the areas designated as hydric soils by the USDA on this site were included in the wetland areas identified by the USACE in this report. Finally, it is not clear what methodology the NRCS used to calculate the amount of acres that would experience reduced inundation in Appendix D, Table 2, and how this relates to their methodology for measuring farmed wetlands. The methodology that resulted in the NRCS numbers in Table 2 of Appendix D should be more fully explained, and the reasons for the differences between the NRCS and USACE calculations should be explained. The panel also believes that the calculations for wetland area lost, both agricultural and natural are difficult to interpret, both in the report and in Appendix D.
Significance –High:
Accurately determining jurisdictional wetlands is critical to measuring the impacts of the project, and to the design of appropriate mitigation for project impacts.
Recommendations for Resolution:
To resolve these concerns, the projects need to be expanded to include the following: ▪ Describe the extent to which soils and soil maps were used to validate the estimated jurisdictional wetlands determined primarily by hydrology by USACE. ▪ Use scientific names for dominant trees and other vegetation and an indication of their wetland classification (OBL, FACW etc.). ▪ Provide a clear, succinct, and quantitative tabulation and ecological description of the jurisdictional wetlands lost or impacted due to the entire project.

Comment 13:

Reclassification of habitat to permanent waterbody based upon 100% flooding during the mid-season fish rearing period inappropriately increases the cumulative habitat suitability index (HSI).

Basis for Comment:

The basic mitigation feature for the New Madrid Floodway provides only 52 of the impacted 2,329 Average Annual Habitat Units AAHUs. The vast majority of the remaining AAHUs are mitigated through four possible alternative scenarios that depend primarily on reclassification of habitat to permanent waterbody through modified gate operations (Table 5.26). Increasing flood duration during the 45 day mid-season fish rearing period would increase the Average Daily Flooded Acres ADFAs proportionately up to 100%. However, the reclassification of habitat to permanent water that increases the cumulative Habitat Suitability Index (HSI) value is inappropriate with this duration of flooding.

Characteristics that define aquatic habitat as permanent waterbody are not restricted to fish spawning and rearing periods, but are based, in part, on year-round water. This is supported by the original land-use classification/quantification in the floodways using GIS (5.6.1.1 pages 145-147) and in the seven classification criteria listed for permanent waterbodies found in the Consolidated NEPA Document as shown below (5.6.15.25 pages 175-178).

1. Waterbodies form or are replenished during rising water levels but retain water on the floodplain after floods recede as river stages fall.
2. Portions of the waterbodies remain sufficiently deep to retain significant volumes of water for a prolonged period.
3. Reduced occurrence of water level fluctuations so that stranding of eggs and displacement of larvae are less likely.
4. Warmer water temperatures that result in higher primary productivity (biomass produced per unit area) than the river (due to isolation and shallow littoral zone) thus providing an abundant food supply (phytoplankton and zooplankton) for fishes.
5. Periodic connection to the mainstem river either prior to or during the rearing period to provide access by spawning adults.
6. Depositional material forming the nutrient rich substrate that leads to higher chlorophyll content and rapid biochemical cycling.
7. Structural diversity of the littoral zone.

Modified criteria (also provided in the Consolidated NEPA Document) that reclassifies habitat to permanent water by retaining water during 100% of the mid-season rearing period (only 12% of the year) fails to meet the above classification criteria (5.6.15.25 pages 175-178). In addition, reclassification was proposed without specific guidance or criteria for water temperature and other water quality considerations, productivity, structural diversity of littoral zones, reduced water level fluctuations, depth, and river connectivity (all in the original permanent waterbody criteria listed above).

Significance – High:

Nearly all (1,309 to 2,505 AAHUs; Table 5.26) of the fish mitigation in the New Madrid Floodway is based on increased cumulative HSI values due to reclassification of habitat to permanent water. However, habitat criteria (listed above) were not met and reclassification was

only based on increased flooding during the mid-season rearing period.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Ensure the HEP and Mitigation Teams develops specific criteria that would allow habitat reclassification to permanent waterbody. This should be based on the assumption that this habitat is available all year and not just during the mid-season fish spawning period. Reclassification consideration should be based, in part, on all seven criteria listed above. ▪ If criteria for reclassification are not met, then holding water back and flooding during the mid-season rearing period should only increase ADFAs up to 100% and not result in a change in HSI due to habitat reclassification to permanent water.

Comment 14:
The proposed monitoring plans for fish passage, spawning, and rearing utilization lack critical study design and time-frame details.
Basis for Comment:
Fish passage into and out of the floodways from the Mississippi River is a primary assumption in the fish model (5.6.14.4 pages 162-163) and has not been tested. In the Consolidated NEPA Document, proposed monitoring is based solely on a mark/recapture study. The panel believes that other methods and approaches should be considered to monitor fish passage including hydroacoustics, telemetry, directional trapping, pre- and post project evaluations, and St Johns Bayou and New Madrid Floodway comparisons. Relations of passage to the time of year, water temperature, river stage, fish species, life history stage and other environmental characteristics that may influence passage should also be evaluated as part of this new study. This project can provide an opportunity to gain much needed information on fish passage through culverts for a large river ecosystem and is needed to support the assumption that fish passage occurs and is not impacted by gate operations. However, the details of monitoring are missing from the Consolidated NEPA Document. A second feature of proposed monitoring was assessment of spawning and rearing utilization of mitigation tracts. Mitigation for this project depends on improved habitat for fishes. Mitigation features of the plan include raising mid-season rearing habitat HSI values by changing habitat types (agriculture to bottomland hardwood or permanent water), and increased inundation time during the mid-season period (up to 100%) that increases ADFAs (5.6.15.2 pages 170-180). However, the mitigation plan does not discuss detailed monitoring of these changes as they pertain to fish spawning or rearing. Monitoring is critical for mitigation evaluation and the adaptive management proposed in the Consolidated NEPA Document.
Significance – High:
An evaluation/comparison of current fish passage between the Mississippi River and SJB/NMF for the pre- and post- construction conditions is critical. In addition, monitoring spawning and rearing habitats is critical to proposed fish mitigation.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Evaluate fish movement into and out of the floodways, both prior to and after project construction. ▪ Monitor spawning success and juvenile fishes to determine if access changes and mitigation of floodplain habitats influenced fish populations pre- and post project construction. These studies can also be used to evaluate increased changes in HSI values assigned to different habitats and the transition times associated with habitat changes.

Comment 15:
The accuracy of the hydrologic and hydraulic analyses needs to be improved by extending the period-of-analysis and using more detailed modeling techniques.
Basis for Comment:
Changes in the results of the hydrologic and hydraulic analyses can directly affect the economic feasibility of the project as well as formulation of environmental mitigation plans, especially where the benefit-to-cost ratio is near one. Economic and environmental assessments are based on hydrologic and hydraulic analyses. The economic benefit-to-cost ratio for the proposed plan is slightly above one. The benefit-to-cost ratio is below one for many of the alternatives considered. The marginal economic feasibility of the project means that the accuracy of the hydrologic and hydraulic analyses upon which the economic evaluations are based is particularly important. A 32-year 1943-1974 hydrologic period-of-analysis was adopted for the Consolidated NEPA Document. The accuracy and credibility of the hydrologic analyses presented in Appendix C as well as various other environmental and economic studies that utilize the results of these hydrologic analyses would be improved by changing to a 67-year 1943-2009 period-of-analysis. Gauged rainfall and stream flow data for 1975-2009 are likely available at most of the sites having data for 1943-1974. Staying with the 1943-1974 period-of-analysis has the advantages of allowing studies completed years ago to continue to be used and allowing consistency in comparing studies performed over the past number of years. Updating to 1943-2009 would require redoing a significant amount of work and would affect various aspects of the overall study. However, updating the hydrologic period-of-analysis in future studies would improve the accuracy and credibility of the analyses and thus probably would be worth the effort. The accuracy of the water surface profiles for flows in the channels could also be improved with more in depth hydraulic modeling techniques. With the very flat floodplains, a small change in flood stage will translate to a relatively large change in land area inundated. Channel stages discussed in Appendix C of the Consolidated NEPA Document were estimated based on the Manning equation assuming uniform flow, which does not properly capture backwater effects. The USACE Hydrologic Engineering Center (HEC) River Analysis System (RAS) computer model facilitates developing water surface profiles based on gradually varied flow energy equation computations or even unsteady flow dynamic routing. Improvements in accuracy of stage estimates that are possible using HEC-RAS will probably justify the additional effort. The hydrologic simulation study presented in Appendix C was performed using the HUXRAIN model developed by the USACE Memphis District. The model uses a daily time step and 1943-1974 simulation period. The continuous watershed (rainfall-runoff) modeling component of HUXRAIN computes daily flows for inputted daily rainfall from the several rain gages located in the basins using API methodology. More recently developed watershed models such as the USDA Agricultural Research Service (ARS) Soil and Water Assessment Tool (SWAT) and the latest expanded version of the UASCE Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS) probably provide more detailed rainfall-runoff modeling capabilities. However, HUXRAIN also provides hydraulic analysis capabilities for simulating the levee sump operations. The HUXRAIN simulations generated 1943-1974 sequences of daily water surface

elevations in the sump areas for existing conditions, the authorized project, and proposed alternatives to the authorized project which are presented in Appendix C of the Consolidated NEPA Document. If the simulations are updated from the 1943-1974 period-of-analysis to 1943-2009, a comparative assessment of currently available alternative generalized hydrologic simulation models could also be made along with the input data update to decide whether to continue to apply HUXRAIN or switch to another model such as SWAT or HEC-HMS.
Significance – High:
The significance is classified as high because changes in the results of the hydrology and hydraulics studies can directly impact the economic feasibility of the project as well as environmental assessments and plan formulation. Improvements in the accuracy of the hydrologic and hydraulic analysis could significantly affect the final recommendations.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Extend the hydrologic period-of-analysis from 1943-1974 to 1943-2009. This would require a new hydrologic and hydraulic analysis be conducted as well as revisions to the economic and environmental analyses that build upon the hydrology and hydraulics information. ▪ Re-compute water surface profiles for the channels should using HEC-RAS assuming either steady gradually varied flow or unsteady flow rather than applying the Manning equation assuming uniform flow. ▪ Revaluate the HUXRAIN simulation studies to determine whether other enhancements to the methodologies adopted for the watershed modeling and hydraulic modeling of facility operations are warranted.

Comment 16:
Impacts to shorebird habitats cannot be determined based on the information provided in the Consolidated NEPA Document, but the impacts are probably much larger than the analysis indicates.
Basis for Comment:
The Consolidated NEPA Document does not include sufficient detail to determine the methodology used or the accuracy of the resulting estimate of impacts to shorebirds. The supporting document referenced in the Consolidated NEPA Document, The Habitat Evaluation Procedure (HEP) model presented in the Revised New Madrid Floodway Terrestrial Habitat Evaluation Procedures dated September 4, 2001, describes some aspects of the analysis used. However, the application of the model appears to be seriously flawed and cannot be evaluated with the information provided, so the impacts to shorebird habitats cannot be determined. There are two important but related issues to address: The total amount of currently existing shallowly flooded and sparsely vegetated habitat appears to be substantially larger than the amount of habitat loss to be mitigated, but the extent of the impacts cannot be determined from the Consolidated NEPA Document or the supporting documents. For shorebirds, the amount of habitat that occurs in each season includes all areas of sparsely vegetated habitat that are shallowly flooded or exposed as flooding recedes, and the total area available will depend on the maximum extent of flooding in each year. When calculating inundation under current conditions, the panel believes that USACE used a median value for flooding levels, and based shorebird habitat calculations on conditions during the 2-year flood (Tables 5.2 and 5.3, pages 94-5). The text accompanying Tables 5.2 and 5.3 of the Final Consolidated NEPA Document (pages 93-95) indicates that the project would "reduce flooding on 44,545 acres" in St. Johns Bayou, and "on up to 61,800 acres" in the New Madrid Floodway, but only by 2,717 acres and 10,319 acres respectively for the mean two year flood event. The larger figures are presumably measured for less frequent flooding events such as the 30-year flood (although Table S.1 provides different numbers for maximum acreage not flooded under the 30-year flood with post-project conditions, of 55,000 acres in St. Johns Bayou, and 75,078 in the New Madrid Floodway, Page iv). There is a large difference between the calculations of impacted shorebird habitat and acreage with reduced flooding, and any reduction in flooding of suitable habitat would be expected to have some impact on potential use of the area by shorebirds. Using the mean two-year flood frequency, without accounting for the much larger impacts that occur less frequently, will not adequately assess the impacts to shorebird habitat as a result of the project. The application of the HEP model cannot be evaluated from the information provided, but it is the panel's opinion that it substantially underestimates the amount of shorebird habitat by using static water levels for each month. The Revised New Madrid Floodway Terrestrial Habitat Evaluation Procedure dated September 4, 2001 does not provide enough detail to determine how the results in Table 5 showing total shorebird AAHU's were calculated. The result of approximately 600 AAHU's for Alternative 3 suggests that the calculations of impacted habitat included approximately 1200 acres, given the HSI value of 0.5 for low elevation croplands.

The panel believes that the amount of currently available shorebird habitat has been calculated from the three static flood elevations for March, April, and May, as given in Table 2 of the Revised New Madrid Floodway Terrestrial Habitat Evaluation Procedures dated September 4, 2001 (Habitat Evaluation Procedures), rather than by estimating the total area first flooded and then exposed at some point during the entire migration period. The metric of importance for shorebird habitat is the total amount of area that will no longer be flooded and then exposed under post-project conditions in each year during which the project is operational. This includes all sparsely vegetated areas that are first flooded and then exposed as flood waters recede, since shorebirds can opportunistically respond to newly exposed habitat, virtually wherever it occurs on their migration route (Helmers 1992; Lehnen and Krementz 2005), and since wetter seasons with more ephemeral flooding have been shown to provide greater weight gain for foraging shorebirds during migration (Farmer and Weins 1999).

Table 2 of the Habitat Evaluation Procedures provides one single elevation during each month for water levels used to determine the amounts of acreage suitable for shorebird habitat. It is the panel's understanding that the GIS analysis used these static water levels to calculate the amount of area within 1 foot of this elevation, and the resulting areas were then used as input for the habitat model. However, the panel believes that the report significantly underestimates the total number of acres of suitable habitat that would be available to shorebirds during the course of each migration season. During each of these months, water levels will be changing over time and either flooding or receding and exposing different areas. Shorebirds can use any shallowly flooded or recently exposed area for foraging, so the input values appear to significantly underestimate the total number of acres of suitable habitat that would be available to shorebirds during the course of each migration season. In addition to the likely underestimate described above under point 1, using static water levels will also likely significantly underestimate the amount of area actually available to shorebirds under current conditions.

One additional detail is also important in assessing the application of the HEP model. The HEP model references Hands (1991) as the basis for assuming that flooded agricultural fields will have approximately 0.1 times the value of managed moist soil units, but it is unclear what values were actually used in the analysis. Figure 1 (Habitat Evaluation Procedures) indicates a value of 0.5 for low elevation cropland, and 0.1 for high elevation cropland. However, the agricultural areas described in Hands (1991) are drainage ditches with shallow margins exposed by drawdowns, not open agricultural fields (p. 458). The relative value of agricultural fields is probably better represented by data from Twedt et al. (1998), which reports that previously dry and then flooded agricultural land has approximately 0.5 times the density of shorebirds found on managed moist soil units with a gradual drawdown. The HEP model should be corrected to use 0.5 rather than 0.1 as an approximate HSI value for all shallowly flooded and gradually exposed croplands, and the calculations used to apply the model should be clearly described, accounting for all cropland that is shallowly flooded and then exposed during the migration window.

References

Farmer, A. H. and J. A. Wiens. 1999. Models and reality: Time-energy trade-offs in Pectoral Sandpiper (Calidris melanotos) migration. *Ecology* 80:2566-2580.

Hands, H.M., M. R. Ryan, and J.W. Smith. 1991. Migrant shorebird use of marsh, moist-soil, and flooded agricultural habitats. *Wildlife Society Bulletin* 19:457-464.

Helmers, D. 1992. Shorebird Management Manual. Western Hemisphere Shorebird Reserve Network Manomet, MA. 58p.
Lehnen, S. E., and D. G. Krementz. 2005. Turnover Rates of Fall-Migrating Pectoral Sandpipers in the Lower Mississippi Alluvial Valley. *Journal of Wildlife Management* 69:671-680.
Twedt, D. J., C. O. Nelms, V. E. Rettig, and S. R. Aycock. 1998. Shorebird Use of Managed Wetlands in the Mississippi Alluvial Valley. *The American Midland Naturalist* 140:140-152.

Significance – High:

The Consolidated NEPA Document underestimates the impacts to shorebird habitats, and therefore underestimates the amount of mitigation necessary to compensate for those impacts.

Recommendations for Resolution:

To resolve these concerns, the project needs to consider the following:

- Conduct a detailed GIS analysis of the amount of shallowly flooded sparsely vegetated habitat, such as cropped fields or herbaceous areas that would be reduced in each year by implementation of the project.
- Ensure the detailed GIS analysis includes a measure of the impacts expected from less frequent but large scale flooding events, and the total area that would be first flooded and then gradually exposed during the shorebird migration period, and should also account for gradual lowering of flood elevations that exposes new habitat areas as flooding recedes during each migration season.

Comment 17:
It is unclear if fish from the Mississippi River will have access to the St. Johns Bayou and New Madrid Floodway based solely on water stages, gate operations, and current fish species composition of the St. Johns Bayou.
Basis for Comment:
The information presented in the Consolidated NEPA Document supports the assumption that riverine fish species exist in the St. Johns Bayou. However, fish access studies through the St. Johns Bayou culverts were not cited. It is unclear if fish from the Mississippi River pass through the existing St. Johns Bayou culverts as operated or if access is restricted in any way. In addition, species, timing, water temperature, and river stage of floodplain access are unknown for both the St. Johns Bayou and the New Madrid Floodway. Once current access is quantified (restricted in the St. Johns Bayou and open in the New Madrid Floodway) fish project impacts can be assessed. In addition, proposed operating rule curves can be developed and evaluated based on fish access during critical life-history periods. If access is restricted and spawning and rearing success impacted the fish model mitigation should be modified to account for the impact.
Significance – High:
The assumption of fish access through the culverts of the St. Johns Bayou has not been tested and is based solely on floodway species lists. Gate operating rule curves and fish impacts cannot be fully assessed until additional information is collected.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Support the indirect evidence by quantification of Pre- construction fish access in the St. Johns Bayou (culvert/gate operation access) and compared to open access in the New Madrid Floodway. ▪ Conduct post construction access studies to evaluate impacts including monitoring by mark/recapture, hydroacoustics, telemetry, and directional trapping. Evaluate the relationship of fish passage to the time of year, temperature, river stage, fish species, life history stage, and other environmental characteristics. ▪ Potential modifications to operating rule curves may be warranted based on results from fish passage monitoring studies.

Comment 18:
Use of mid-season rearing habitat for mitigation is not fully justified and is only represented by 3 (New Madrid Floodway) to 5 (St Johns Bayou) evaluation species in the Habitat Suitability Index (HSI) model.
Basis for Comment:
In the Consolidated NEPA Document, mid-season rearing habitat is defined based on flooded acres with no depth requirement, discounted proportionately to flooding over a 45 day period from May 1 through April 15. This method assesses mitigation acreage needed based on the amount of time during the mid-season rearing period when water is present. Spawning habitat is defined as acres flooded at least 1 foot deep for 8 consecutive days. By definition, all spawning habitat is considered rearing habitat. The decision to use mid-season rearing habitat for mitigation appears to be based on the highest measure of impacts (acreage). The Consolidated NEPA Document suggests that mid-season rearing may not be the most biologically justified life history period for mitigation with the statement "The Corps maintains spawning is the most appropriate habitat impact to measure" (5.6.1.1 pages 145-147). In addition, while the panel believes that the early and late season spawning/rearing habitat is the most important time period for some species, a complete evaluation of how many and which species in the floodway/Bayou fall into each of the rearing/spawning time periods was not provided. If impacts and mitigation are based only on mid-season rearing, then these fish must rely on carryover compensation. Early and late season rearing and spawning habitat, mid-season spawning habitat, and adult habitat loss has either not been quantified or compensated in the mitigation. To fully understand and determine the best mitigation approach an evaluation should be conducted that compares impacts and mitigation for all life history stages and time periods since evaluation species utilize all rearing periods (2 early-season, 5 mid-season, and 4 late-season). Species were assigned a spawning guild (13 types possible with representative species in both Floodways that cover 11 spawning types) and rearing habitat (2 types: floodplain or channel). Six of the 11 spawning guilds were represented by evaluation species. Eight evaluation species were classified rearing in the floodplain and 4 evaluation species were classified rearing in channel habitat. The 12 evaluation species were said to represent over 91% of the species in the project area. The panel can only assume which species of fish were represented by the spawning guild and rearing habitat combinations that included over 91% of the species in the project area as this was not described specifically in the Consolidated NEPA Document. It would be of more interest to know the percentage of species represented for each floodways independently since the floodways do not contain the same species. In the final analysis, only 5 and 3 evaluation species are used in the calculation of cumulative (Habitat Suitability Indexes) HSIs for mid-season rearing habitats in St. Johns Bayou and New Madrid Floodway. The other species either used another time period for spawning and rearing and/or were not collected in a Floodway. This number represents a much smaller percentage of species in the combinations of spawning guilds and rearing habitats.

Significance – High:
Fish impacts and mitigation is based on a single life history period (mid-season rearing) and on a small number of evaluation species, resulting in an incomplete evaluation of project impacts and mitigation needs.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Determine impacts (annual daily flooded acres (ADFAs) and cumulative habitat units (HUs) for each life history stage/habitat as part of the evaluation process and evaluate the impacts of only mitigating a single life history stage/time period on the fish community (especially on those species that use other habitat or time periods that are impacted but not mitigated) ▪ Evaluate expected fish species use of each rearing/spawning period and habitat prior to selecting life history stage(s)/time period(s) for measuring impacts and mitigation. ▪ Represent the HSI model with a larger number of species and multiple species for each guild designation. This is especially true for the selected life history stage(s)/time period(s) selected to measure impacts and mitigation.

Comment 19:
The four mitigation alternatives presented in the Consolidated NEPA Document do not appear to compensate for loss of waterfowl habitat.
Basis for Comment:
The panel believes that estimating mitigation needs for waterfowl based on Duck Usage Days (DUDs) is the appropriate approach. For the following reasons we do not believe that the loss of waterfowl habitat will be mitigated appropriately under any of the 4 mitigation alternatives. (i) Dabbling duck populations are driven primarily by factors that influence productivity. Thus, duck populations are much more likely to be influenced by spring migratory habitat, a period when ducks are acquiring nutrient reserves for egg production and incubation, than wintering habitat. Mitigation emphasis, therefore, should be on mitigating spring migratory habitat to ensure impacts to duck populations are minimized. Only secondary consideration should be given to providing winter habitat for maintaining the recreational value and economic benefits (duck sport hunting) in this region. Because providing wintering habitat (DUDs) beyond those that were available prior to the implementation of this project will not influence the ability of dabbling ducks to acquire nutrient reserves for reproduction, overcompensating loss of DUDs during the wintering period does not adequately mitigate lost DUDs for ducks during spring. (ii) After a brief review of the WHAM model used to estimate mitigation requirements in the Consolidated NEPA Document, it appears values of energetic carrying capacity are outdated and not appropriate for modeling DUDs for spring migratory habitat. Furthermore, in addition to having greater energetic costs, unlike winter, spring migratory ducks are acquiring endogenous nutrient reserves, thus, the energetic demand of ducks is much greater in spring than winter, which are the values used in the model. (iii) Although there is detailed reference to reforestation to mitigate waterfowl habitat loss, there is little detail on how, when, and to what level these forested tracts will be flooded. Reforestation will only mitigate waterfowl habitat loss if forested habitat is inundated with standing water at or below a level of 30 cm during the spring migration. (iv) It is highly unlikely that the moist soil units will be able to meet the productivity levels indicated if they are operated to provide both waterfowl and shorebird habitat. Shorebirds are likely most limited by fall migration habitat, thus this period should be emphasized for mitigation. Managing the moist soil units for fall migratory shorebirds severely limit the production of waterfowl foods. (v) A tremendous number of DUDs mitigation in dependent on the moist soil units. Productivity of these units will only be maintained at the level proposed if proper operation and maintenance is applied at a cost of over 13 million dollars during the 50 years of this project. Furthermore, moist soil units only produce foods at the level indicated in the model when they are appropriately managed by an individual properly trained in wetland management. There is no indication who will finance or provide the manpower for this O&M. (vi) There is no indication the Corps is considering decreases in the value and function of jurisdictional wetlands. As mentioned above, waterfowl require a minimum and maximum water level for habitat to be of beneficial. This project will undoubtedly

reduce flooding on agricultural habitats that do not meet the criteria as being cropped wetlands, thus, there will be a considerable amount of lost waterfowl habitat that will not be mitigated. Additionally, hydrology will be reduced in jurisdictional wetlands to a level that may not cause them to lose their jurisdictional status, but will certainly decrease their function and value at providing waterfowl habitat. Again, there is no indication this loss of habitat will be mitigated.

(vii) Habitat diversity must be considered when mitigating habitat for waterfowl. Habitat requirements vary considerably even among dabbling ducks. Some species require more open habitat (e.g., northern shovelers and northern pintails), while others prefer wooded habitats (e.g., mallards and wood ducks), while still other prefer and intermediate type habitat such as moist soil units (e.g., blue and green winged teal) during spring migration. While the panel believes food resources depicted as DUDs is the most appropriate metric to measure habitat impacts, these DUDs need to be spread over a diversity of habitats to properly mitigate for all species.

Significance – High:

It appears none of the 4 mitigation alternatives will properly mitigate wetland loss for waterfowl; lack of appropriate mitigation will prevent the project from moving forward.

Recommendations for Resolution:

To resolve these concerns, project needs to consider the following:

- Base waterfowl mitigation criteria on mitigating for not only lost wetlands but the loss of wetland and value function for waterfowl during the spring migratory period.
- Ensure forested mitigation wetlands are inundated by water at the appropriate level for use by ducks.
- Include estimates of loss of value and function of wetlands when estimating mitigation requirements.
- Base mitigation plan on loss of spring migratory not winter habitat.
- Update WAHM model with more recent parameter estimates and incorporate the greater energetic cost of migration as well as the need for waterfowl to acquire nutrient reserves during spring migration.
- Provide a long term (50 year) plan for managing moist soil units.
- Provide multiple habitat types in the mitigation plan.

Comment 20:
The structure of the Consolidated NEPA Document is difficult to follow, the presentation of analyses and conclusions is uneven, and the study references are lacking or outdated, all of which make it difficult for the panel to properly evaluate the report's findings and conclusions.
Basis for Comment:
The panel found the Consolidated NEPA Document difficult to read and evaluate because of its complicated structure, uneven level of analysis, and inconsistent numbering of alternatives. The complicated structure derives from the fact that the report is a revision of a supplement and therefore frequently references previous analyses rather than describing them clearly. The panel believes the document would be improved by (1) including a narrative comparison of the impacts to supplement Table 2.3 Comparative Impacts of Alternatives on p. 26, (2) ensuring that the numbering of the alternatives reflects the relationships among alternatives and is consistent throughout all the appendices, and (3) adding relevant citations and updating those that are 20-30 years old. A specific example of the confusing numbering of alternatives is as follows: the list of alternatives mentioned in the footnote on Appendix C, p. C-3, notes that "Options 1, 2, and 3 are denoted on Appendix A, Figure 2, as alternatives 3-1, 3-2, and 3-3, respectively. Also, Options 4 and 5 are denoted as alternatives 7-2 and 7-3, respectively." There is no clear reason for the different numbering systems, and standardizing the list of alternatives throughout the project, including the Revised New Madrid Floodway Terrestrial Habitat Evaluation Procedures, would substantially improve the clarity of the documents.
Significance – Medium:
The complexity of the document, its uneven treatment of different issues, and its lack of recent citations adversely affect the ability of readers to understand the analysis and evaluate the conclusions.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ The panel assumes that the document under review will not be revisited, but recommends that any future document be written in a way that does not include the complicated structure and redundant material in this document. ▪ The panel recommends that the alternatives be named and numbered in a way that clearly shows their relationship with each other, making it easier to follow subsequent analyses. ▪ The panel recommends that each resource of concern receive the level of analysis commensurate with the anticipated impacts (e.g., information on the dominant species and the different types of floodplain habitat should be included since they are important to the life-history stages and communities of fishes that will be significantly affected by the alternatives) and include the most recent and relevant citations.

Comment 21:
The economic analysis is missing key assumptions used in flood reduction projects, such as injuries avoided and lives saved from flooding.
Basis for Comment:
The current Consolidated NEPA Document states the possibility of flood reduction in communities where people live; however, it provides no quantitative analysis of the economic benefits that pertain to flood risk reduction in those communities other than for some of the alternatives (e.g. for Alternative 4, street and road benefits, p. B-18, Appendix B). A range of economic and quantifiable benefits have been associated with risk reductions for low to high flooding conditions in other studies and for other contexts (regions) that pertain to lives saved, injuries avoided, commuting delays avoided. The report needs to clarify whether such benefits as avoided commuting delays are included in the "damage rate per mile" (p. B-18 of Appendix B), and if not, why an analysis like this is absent for this region and project. Flooding causes delays, at the very least, in commuting to work, school, or for emergency trips, etc. The literature in economics suggests that time savings can be substantial and a common approach in the transportation economics literature {e.g., Brownstone and Small. (2005)} is to calculate the amount of time saved and multiply this by some fraction of the wage rate. At worst, flooding could lead to deaths from drowning or from blocked roads that make emergency trips to hospitals impossible. References Brownstone, D., Small, K.A. (2005). Valuing time and reliability: assessing the evidence from road pricing demonstrations, *Transportation Research A*, 39(4), 279-293..
Significance – Medium:
As economic benefits associated with community flood-related losses are absent in the report, this lowers the benefit-cost ratio for the project.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Clarify why the benefits associated with reduced flooding and flood risk is not calculated as they relate to the project. If they simply do not arise because of the project, make clear why they do not. ▪ If these benefits exist, but simply have not been calculated, then a future report should make an effort to estimate the economic benefits associated with lives saved, or injuries avoided, and/or the time saved due to increased reliability of regional transportation and less need to manage minor flooding events at homes in the communities.

Comment 22:
It is unclear how the proposed change in the condition of Big Oak Tree State Park will mitigate loss of wetlands and other habitat in the project.
Basis for Comment:
Big Oak Tree State Park (BOTSP) provides habitat for some of the nation's champion bottomland trees (Appendix L, page 15) and thus, this is potentially an important resource for not only the state, but for the nation. The Consolidated NEPA Document does not clearly indicate how the project will change ecological conditions at BOSP, and the panel is unsure if the proposed mitigation plan is possible to implement. The Consolidated NEPA Document references potential re-flooding of BOTSP for mitigation (p. 39 and Appendix L), but does not document the impacts of the original project goals that are designed to reduced flooding. The exact changes at BSOTP due to managing hydrological conditions might help mitigate losses of wetlands at other areas, but the current report does not document the current ecological trends at the BSOTP carefully nor does the report predict future conditions after the river flooding mitigation of BOTSP (p. 38-39). Economic benefits are among the potential positive impacts from the proposed mitigation, as there is anticipated to be an increase in park attendance. Visitation to BSOTP is a form of recreation, and non-visitors might also have some willingness to pay for protection of the species there even when they do not go. There is no detailed discussion of either of these potential benefits in the current Consolidated NEPA Document. The economics literature that provides estimates of the values and increases in recreation at forests, as well as estimates of willingness to pay for protection of forest stands that might be unique, is relatively large. No mention of that literature appears in the current report/revisions.
Significance – Medium:
Big Oak Tree State Park is potentially an important resource for not only the state, but for the nation, and benefits of improvements there could change the estimated BC ratio, possibly increasing the benefits.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Evaluate existing ecological conditions and trends at Big Oak Tree State Park, to support the claim that there is drying, and that this indeed may harm current species and habitat if the trend continues. ▪ If the above evaluation of the project's mitigation strategy determines that habitat will be improved, then a long-term (15-50 year) monitoring program should be designed to track those changes. ▪ Revise the economic analysis to include estimates of future visitation increases that might accompany positive resource changes, as well as possible economic benefits that are simply associated with protection of the species. This additional analysis could be prepared by using the method of unit day values for recreation, or benefits transfer for forest protection (using estimates for another similar site).

Comment 23:
The analysis of water quality impacts in the Consolidated NEPA Document did not meet the objectives of the study.
Basis for Comment:
A stated objective of the water quality analysis in the Consolidated NEPA Document is to quantify the effects of hydrologic changes on water quality for both the area impacted by the proposed project and in relationship to the overall water quality of the Mississippi River. The methods used to meet this objective (Appendix I) were based on the relative transport/retention of nutrients, organic carbon and sediments associated with various hydrologic events based on selected surface water elevations. Hydrologic data and land cover data were used in conjunction with water quality data to conduct mass balances for various scenarios associated with the project. The water quality analysis in the document fails to meet either part of the stated objective for two reasons. First, the mass balances conducted do not represent water quality conditions in any of the waterbodies in the project area (St. Johns Bayou and New Madrid Floodway) under current conditions or with the proposed project, but only the total amounts of mass transported or retained. Second, these mass balances did not compare nutrient loads from the project area to the Mississippi River under current conditions to those under the proposed project. These balances compared nitrogen removal efficiencies at an assumed water surface elevation of 290 feet NGVD between current conditions and with mitigation associated with restored acreage. None of the five hydrologic scenarios in the report was the actual project because each of them involved the same flooded acres at 290 feet NGVD, whereas the proposed project involves blocking the water level beyond 284.2 feet NGVD in the New Madrid Floodway. The water quality analysis in the report tends to diminish the potential impacts of the proposed project. The nutrient loads from the project area, however they are determined, will always be a small fraction of the total nutrient loads in the mainstem of the Mississippi River, hence none of the project alternatives will substantially change current water quality conditions on the basis of this metric alone. What have not been adequately addressed in the water quality analysis are potential impacts of the proposed project on local water quality within the St. Johns Bayou and New Madrid Floodway. The water quality analysis in the report did not consider the potential impacts of the proposed project on suspended sediment in Spillway Ditch, St. Johns Bayou. This system is listed as impaired by the State of Missouri under Section 303(d) of the Clean Water Act because the water quality standards were exceeded due to sediment. The primary cause of the sediment impairment was identified as pollution caused by agricultural non-point sources. A total maximum daily load (TMDL) was approved by U.S. EPA on November 22, 2006, that established the maximum allowable amount of sediment load to Spillway Ditch from non-point sources. The impacts of the proposed project on suspended sediment loads to Spillway Ditch were not investigated to determine whether they will exceed this maximum allowable load. Another issue is that the report's estimate of denitrification rates on farmed wetlands was based on values from the literature (Ochs and Milburn 2003) that were later discovered to be erroneous

and that were subsequently corrected by the senior author (Ochs 2006). The corrected rates are three orders of magnitude higher than those in Ochs and Milburn (2003). The report did not use these erroneous denitrification rates in the mass balance analysis in Appendix I, but used them in Appendix M, Page 461, to support the assertion that this analysis does not likely underestimate the nitrogen removal on flooded crop fields. When the corrected rates are used, it appears likely that the mass balance analysis is underestimating the nitrogen removal on flooded crop fields. The significance of this apparent underestimation is that greater compensatory mitigation might be required to offset the lost nitrogen removal capacity on these fields because they would no longer be regularly flooded with the proposed project.

References

Ochs, C.A. and S.A. Milburn. 2003. Effects of simulated wintertime flooding to control erosion on selected chemical and microbial properties of agricultural soils in the Mississippi Delta. *Journal of the Mississippi Academy of Sciences* 48:102-114.

Ochs, C.A. 2006. Corrections to denitrification measurements. *In* C.A. Ochs and S.A. Milburn (eds.), With a revised view of the importance of denitrification to N-loss from agricultural soils of the Mississippi Delta. *Journal of the Mississippi Academy of Sciences* 51:177-179.

Significance – Medium:

The Consolidated NEPA Document's conclusion that water quality in both basins (St. Johns Bayou and New Madrid Floodway) is expected to remain unchanged is not supported by the analysis in the report because this analysis did not include investigations of local water quality in either basin under the actual proposed project.

Recommendations for Resolution:

To resolve these concerns, the project needs to consider the following:

- Conduct a quantitative assessment of the impacts of the actual proposed project on waterbodies in the St. Johns Bayou and New Madrid Floodway.
- Investigate the impacts of the proposed project on suspended sediment load to Spillway Ditch and on the sediment TMDL.
- Re-investigate the nitrogen removal on flooded crop fields in the mass balance analysis and re-consider the compensatory mitigation that might be required to offset the lost nitrogen removal capacity on these fields with the proposed project

Comment 24:
The planned project monitoring for water quality lack key elements and sufficient detail to satisfy U.S. EPA guidance.
Basis for Comment:
The planned project monitoring for water quality is described in only two short paragraphs (Sections 7.2 and 6.5) in the Consolidated NEPA Document. Missing from the document are key elements including strategy, objectives, design, quality assurance, data management, data analysis and assessment, and reporting. These are all basic elements of state water monitoring and assessment programs and are contained in published U.S. EPA guidance (EPA 2003). These elements are all relevant to the planned project monitoring goals for water quality for the proposed project. References U.S. Environmental Protection Agency (USEPA). 2003. Elements of a State Water Monitoring and Assessment Program. Assessment and Watershed Protection Division, Office of Wetlands, Oceans and Watersheds. EPA 841-B-03-003. Washington, DC.
Significance – Medium:
Without a well-formulated water quality monitoring plan, it will not be possible to determine whether water quality in the St. Johns Bayou and New Madrid Floodway is adversely impacted by the proposed project.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Develop a water quality monitoring plan for the proposed project that includes an overall strategy, objectives, design, quality assurance, data management, data analysis and assessment, and reporting, consistent with the U.S. EPA (2003) technical guidance.

Comment 25:
Economic impacts that could be cancelled out in other regions should not be included in a Benefit-Cost (BC) analysis or economic analysis for a project that focuses on national economic development.
Basis for Comment:
Several parts of the Consolidated NEPA document and parts of Appendix B (starting at p. B43 and through p. B.53-B56) deal with economic impacts on the local communities in the project area. These impacts include descriptions of how local economic conditions might improve with the project, focusing on regional income and employment, and describing these as benefits of a national/federal project. A federal project is typically evaluated from the perspective of the nation, leading to "net national economic value." From the national accounting stance, only those benefits that do not arise at the expense of benefits in other regions of the country would pertain to a Benefit-Cost (BC) analysis. It is not clear whether local, rather than national benefits, have been included in the calculations of the BC ratios in Table 19 (Appendix B, p. B-25). For example, projects such as this one produce jobs in building the project facilities and infrastructure, and create jobs for support of the workers, all leading to multiplier impacts on regional economies. The multiplier concept describes how a single dollar of income or spending can generate more than one dollar of spending. By example, if Worker A earns $1 in income and then spends it on food at a restaurant, this means the cook gets another dollar in income, and can then turn around and spend it on something else, etc. Income and wages to the workers are often seen as a local economic benefit, especially when there are new jobs. The multiplier impacts are deemed "secondary" impacts and arise from such things as expenditures that the workers make on local food, housing, transportation, etc. Some jobs vanish when construction is completed, but others are created over the life of the project, tied to ongoing operations and management. However, all of these jobs might be filled by workers that are imported from other regions. If Region A, the project region, gains jobs and income, but Region B loses jobs, and therefore also suffers economically, then the two impacts cancel each other out, and a national accounting of the impacts would show no net gain. In contrast, an area that has high unemployment, and which is regionally unique in this regard, might staff or fill the jobs with unemployed workers within the region, adding income for those workers and some secondary impacts. Whether the unemployed can fill jobs is often a case of whether there is a match in the skills needed, and those skills that existing unemployed workers can provide. Analysis must show this is the case, or all local and regional economic impacts cannot be included in the national benefit-cost analysis.
Significance – Medium:
All benefits categories must clearly be shown to be only national impacts for the benefits used in calculating the BC ratios that appear in Table 19 of the Consolidated NEPA Document and other similar tables.

Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Evidence that local and regional economic impacts do not come at the expense of losses in other parts of the state, or region, or another state, and if so, analysis of these clear economic benefits. Documentation would include a detailed assessment of employment in the region and outside of it, including skills that unemployed people have, and would need to have in the future. In addition, migration patterns should be well documented, showing demographic changes expected for the region. ▪ If the evidence cannot be demonstrated that benefits are national in scope and not offset by losses in other regions, then a new report might add a separate appendix, including "local" or "regional" primary and secondary economic impacts, but these benefits cannot be included in the analysis of national economic impacts.

Comment 26:
Uncertainties in the hydrologic, hydraulic, and economic studies could be analyzed and presented in a more detailed and meaningful manner using methodologies incorporated in the HEC-FDA Flood Damage Reduction Analysis modeling system.
Basis for Comment:
USACE policy requires incorporation of relatively new uncertainty analysis methods in flood risk reduction analysis procedures that explicitly consider uncertainty by expressing various inputs with probability descriptors. In flood hydrology studies, probability descriptors represent the uncertainties in estimating flow rates and durations associated with specified exceedance frequencies. In hydraulic studies, probability descriptors model the uncertainties involved in estimating flow depths resulting from specified flow rates. In economic evaluations, probability descriptors are formulated to describe uncertainties in estimating economic damages to result from specified flood stages and durations. Methods for dealing with uncertainties were developed at the USACE Hydrologic Engineering Center (HEC) and elsewhere during the 1990's and have been implemented Corps-wide. The uncertainty analysis methods expand on and are incorporated within the older conventional evaluation procedures. Methods for explicitly considering uncertainties in hydrologic, hydraulic, and economic analyses are incorporated in the latest (1998) version of the HEC-FDA Flood Damage Reduction Analysis software. Both conventional and the newer uncertainty-based analysis methodologies were adopted in the hydrologic, hydraulic, and economic evaluations presented in Appendices B and C of the Consolidated NEPA Document. However, the capabilities afforded by the newer uncertainty-based methodologies for presenting analysis results are not fully utilized. A basic reason for explicitly incorporating uncertainty in an analysis is to be able to express the results probabilistically. For example, the ratio of economic benefits to costs are presented in the Consolidated NEPA Document in the traditional format of a single number such as 1.10, meaning the benefit-to-cost ratio (BCR) is estimated to be 1.10 for a particular plan. Alternatively, a BCR could be viewed probabilistically. A report could state that, due to many complexities, the BCR is not known with certainty. However, there is an estimated "x" percent probability that the BCR is above 1.0 and a "y" percent probability that the BC ratio is below 1.0. Likewise, the report could present the estimated likelihoods that the BC ratio exceeds 1.10 and other levels. The effects of uncertainties on the component estimates of flows, stages, and damages upon which the economic benefits are based can be displayed using HEC-FDA tools. Strategies for expanding the use of uncertainty analysis methods in the various assessments presented in the Consolidated NEPA Document should be developed and applied.
Significance – Medium:
More detailed analyses and display of uncertainties will enhance the completeness of the report and facilitate a more thorough understanding of study results.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Apply the uncertainty modeling capabilities incorporated in HEC-FDA and organize the results of the hydrologic, hydraulic, and economic analyses to more meaningfully display modeling/data uncertainties and their effects on the study results and conclusions.

Comment 27:
Given the goals of the Gulf Hypoxia Action Plan 2008, Alternative 8 in the Consolidated NEPA Document should be reframed as a "nutrient farming" alternative.
Basis for Comment:
The Gulf Hypoxia Action Plan 2008 calls for a 45 percent reduction in nitrogen and phosphorus loads delivered to the Gulf of Mexico to achieve the coastal goal for reduction in the size of the hypoxic zone ("dead zone") in the Gulf, and to improve water quality within the Mississippi River Basin. The Consolidated NEPA Document acknowledges that removal of cropland from production and reforesting will reduce nitrogen available to the Gulf of Mexico by: (1) reducing fertilizer applications; (2) improving nitrogen removal from runoff in the project area; and (3) improving removal of nitrogen from the Mississippi River during periods of backwater flooding on the mitigation sites when flooded. The report also acknowledges that bottomland hardwoods have higher habitat value for fish than cropland. Under Alternative 8, frequently flooded agricultural land in the St. Johns Bayou and New Madrid Floodway would be converted to silviculture and would require changing several thousand acres from agricultural production to forest through the Wetland Reserve Program (WRP) or other similar mechanisms. The Consolidated NEPA Document stated that while the WRP has been available to landowners for many years, few have chosen to participate, thus apparently ruling out this alternative for detailed analysis. The apparent rationale for ruling out Alternative 8 was flawed because it did not include economic incentives based on nutrient trading but only those based on the Wetland Reserve Program and other, unspecified mechanisms. Nutrient trading is a market-based approach for improving water quality that involves two basic steps: (1) a goal (or percent reduction) for the total amount of nutrients that can be delivered to a waterbody; and (2) allowing sources to trade in ways that meet local and watershed-wide water quality goals. Once nutrient sources are allocated, sources with low-cost pollution reduction options have an incentive to reduce nutrient loadings beyond what is required of them and to sell the excess credits to sources with higher control costs. Greenhalgh and Faeth (2001) conducted an economic and environmental policy analysis to assess how the agricultural community could better reduce its contribution to the Gulf of Mexico "dead zone." Using a sectoral model of U.S. agriculture, they compared policies including untargeted conservation subsidies, nutrient trading, Conservation Reserve Program extension, agricultural sales of carbon and greenhouse gas credits, and fertilizer reduction. They concluded that nutrient trading strategies produce greater all round benefits for the environment and for farm returns than traditional policy approaches. The Consolidated NEPA Document used a traditional land valuation approach to assess the possible benefits of land use changes such as converting agricultural lands to silviculture. The report also considered the use of incentives provided for under the WRP and other, unspecified

incentives, but did not contain any analysis of incentives based on nutrient trading. References Greenhalgh, S. and P. Faeth. 2001. A water quality strategy for the Mississippi River Basin and the Gulf of Mexico. *American Agricultural Economics Association Meeting* 2001.
Significance – Medium
The investigation of Alternative 8 is incomplete because it did not include consideration of relevant economic factors that would have provided a more complete understanding of its environmental and economic benefits, hence resulting in retention of Alternative 8 for more detailed analysis.
Recommendations for Resolution:
To resolve these concerns, the project needs to consider the following: ▪ Re-frame Alternative 8 as a "nutrient farming" alternative and re-evaluate the economic incentives based on nutrient trading. ▪ Evaluate potential nutrient trading options with both point source dischargers and other nonpoint sources in the Mississippi River Basin. ▪ Coordinate this investigation of nutrient trading with the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force.

Comment 28:
It is not clear from the Consolidated NEPA Document if adequate resources are available for adaptive management to be successfully applied at mitigation areas, and adaptive management plans are not described in sufficient detail.
Basis for Comment:
Adaptive management is a useful approach to managing uncertainty when significant resources are available for monitoring post project environmental conditions, and when resources are also available to conduct substantial mid course corrections in project design and implementation. The monitoring necessary to determine if the wetlands and other habitats proposed as mitigation for project impacts on shorebirds, waterfowl, and fish are adequately replacing lost habitat functions is considerable, and it is not clear if adequate resources are available for adaptive management to be successfully applied. Impacts from the project on shorebirds are likely to be significant, and will occur in a region that is critical for maintaining shorebird populations during annual migration (Skagen et al. 2008). Monitoring of shorebird impacts for at least 15 years is a critical aspect of determining whether mitigation planning and implementation was successful. Table 6.1 in the Consolidated NEPA Document does not mention monitoring for shorebird use, other than the general phrase "other biological monitoring" (p. 240). The most reliable metric of shorebird use is direct counts through the migration season, and the collection of detailed data requires careful project design (Farmer and Durbian 2006). The monitoring plan should be designed to provide the data necessary to determine whether mitigation areas are providing the required level of function. In addition, the plan should specify the resources that will be available for correcting any problems that arise, and the commitment to carry them out. Direct counts of shorebird numbers, following modern techniques that include measures of detection rates, should be included, and funding for carrying out these counts should be included in the overall cost estimates of the mitigation plan. Mitigation for waterfowl is based on creating or restoring wetlands that produce an appropriate level of invertebrates and moist soil seeds. Thus, the adaptive management approach to monitoring the success of mitigation for waterfowl should emphasize the monitoring of moist soil seed and invertebrate production and biomass in mitigation wetlands. Monitoring should continue for a minimum of 15 years to ensure wetlands are being maintained at the appropriate successional stage. For fishes, no detailed monitoring parameters or end point levels for measuring progress/success are provided in the Consolidated NEPA Document. The HEP and mitigation teams need to develop a specific adaptive approach that incorporates monitoring fish access and use (spawning and rearing) in each of the mitigation habitats. Specific monitoring considerations should include HSI values, habitat transition times, optimum water inundation conditions for spawning and rearing, reference species, fish access, species richness and diversity, river connectivity, and monitoring time-frame. For wetlands, the normal monitoring period is often 5 years after mitigation sites have been created or restored, but this has been considered too short (see e.g., Mitsch and Wilson 1996), and the panel recommends an adaptive management monitoring period of at least 15 years for

marshes or mudflat wetlands and for the entire project duration of 50 years for bottomland hardwood forest mitigation sites. There is little description in the Consolidated NEPA Document on any triggers that might put an adaptive management plan into effect during the monitoring period. There is no description of the adaptive management plan or which agency would be responsible for it after the monitoring period ends.

The Consolidated NEPA Document also suggests that mitigation areas may be turned over to state agencies for long term management. However, it is the panel's opinion that most state agencies are critically short of funds to manage existing state lands. It is questionable whether the state would have the resources to manage these additional areas in perpetuity. In particular, management of the moist soil units requires ongoing input of human resources for monitoring, determining management techniques, and implementing management efforts, along with substantial direct costs in materials and equipment. In particular, the mitigation plan will fail to adequately compensate for project impacts if the moist soil units are not managed extensively in perpetuity, which represents a substantial cost of the project. The costs of adaptive management should be included in calculations of the total cost of the project, on an ongoing basis as part of the operation of the project itself, or the planned management of the mitigation areas will likely be inadequately implemented due to resource constraints.

References

Farmer, A. and F. Durbian. 2006. Estimating Shorebird Numbers at Migration Stopover Sites. *The Condor* 108:792-807.

Mitsch, W.J. and R.F. Wilson. 1996. Improving the success of wetland creation and restoration with know-how, time, and self-design. *Ecological Applications* 6:77-83.

Skagen, S. K., D. A. Granfors, and C. P. Melcher. 2008. On Determining the Significance of Ephemeral Continental Wetlands to North American Migratory Shorebirds. *The Auk* 125:20-29.

Significance – Medium:

Providing adequate resources to implement ongoing adaptive management and monitoring are critical to successful execution of the mitigation plan.

Recommendations for Resolution:

To resolve these concerns, the project needs to consider the following:

- Conduct an adaptive management study, including a field-based monitoring system for fish and wildlife use of mitigation areas, and a source of support for monitoring over at least 15 years and management in perpetuity to ensure that mitigation areas continue to provide suitable habitat.
- The adaptive management plan for shorebirds should include ongoing direct counts of shorebirds at mitigation sites for at least 15 years, including measurements of detection rates, the source of support for monitoring, and plans for mid-course corrections if adequate habitat is not being provided.
- The adaptive management plan for waterfowl should include monitoring of moist soil seed and invertebrate production and biomass in mitigation wetlands for a minimum of 15 years.
- The adaptive management plan for fish should include monitoring fish access and use for both spawning and rearing in each of the mitigation areas for 15 years, and measurement of HSI values, habitat transition times, optimum water inundation conditions for spawning and rearing, reference species, species richness and diversity, and river connectivity.

- The adaptive management plan for wetland mitigation sites should include a 15 year timeframe for marshes and the full project duration of 50 years for the bottomland hardwood forests, specify the measures of ecological function that will be monitored, and specify the conditions that would trigger implementation of adaptive management to meet plan objectives if conditions are below target thresholds.

List of Comment References

Altor, A.E. and W.J. Mitsch. 2008. Pulsing hydrology, methane emissions, and carbon dioxide fluxes in created marshes: A 2-year ecosystem study. *Wetlands* 28:423-438.

Anderson, C.J. and W.J. Mitsch. 2008. The influence of flood connectivity on bottomland forest productivity in central Ohio, USA. *Ohio J. Science* 108 (2): 2-8.

Bingswanger, H.P. 1981. Attitudes toward risk: Theoretical implications of an experiment in rural India. *The Economic Journal* 91 (364):867-90.

Council on Environmental Quality. 1997. Considering Cumulative Effects under the National Environmental Policy Act. Washington, D.C. January 1997.

Cross, D., and P. Vohs, (eds). 1988. Waterfowl Management Handbook. Fort Collins, CO: U.S. Fish and Wildlife Service.

Farmer, A. and F. Durbian. 2006. Estimating Shorebird Numbers at Migration Stopover Sites. *The Condor* 108:792-807.

Farmer, A. H. and J. A. Wiens. 1999. Models and reality: Time-energy trade-offs in Pectoral Sandpiper (Calidris melanotos) migration. *Ecology* 80:2566-2580.

Fink, D.F. and W.J. Mitsch. 2007. Hydrology and biogeochemistry in a created river diversion oxbow wetland. *Ecological Engineering* 30:93-102.

Frederick, S., G. Loewenstein and T. O'Donoghue. 2002. Time Discounting and Time Preference: A Critical Review. *J. of Econ. Literature* Vol. XL, June:351-401.

Greenhalgh, S. and P. Faeth. 2001. A water quality strategy for the Mississippi River Basin and the Gulf of Mexico. *American Agricultural Economics Association Meeting* 2001.

Hands, H.M., M. R. Ryan, and J.W. Smith. 1991. Migrant shorebird use of marsh, moist-soil, and flooded agricultural habitats. *Wildlife Society Bulletin* 19:457-464.

Helmers, D. 1992. Shorebird Management Manual. Western Hemisphere Shorebird Reserve Network Manomet, MA. 58p.

Hernandez, M.E. and W.J. Mitsch. 2006. Influence of hydrologic pulses, flooding frequency, and vegetation on nitrous oxide emissions from created riparian marshes. *Wetlands* 26:862-877.

Hernandez, M.E. and W.J. Mitsch. 2007. Denitrification in created riverine wetlands: Influence of hydrology and season. *Ecological Engineering* 30:78-88.

Laubhan, M.K., and L.H. Fredrickson. 1993. Integrated Wetland Management: Concepts and Opportunities. Special Session 6 of Wetland Management for Shorebirds and Other Species. *In* G.H. Finney and G. Castro. (eds.) *Transactions of the 58th North American Wildlife and Natural Resources Conferences,* Wildlife Management Institute.

Laubhan, M. K. 1995. Effects of prescribed fire on moist-soil vegetation and soil macronutrients. *Wetlands* 15:159-166.

Lehnen, S. E., and D. G. Krementz. 2005. Turnover Rates of Fall-Migrating Pectoral Sandpipers in the Lower Mississippi Alluvial Valley. *Journal of Wildlife Management* 69:671-680.

Loesch, C.R., D. J. T., K. Tripp, W.C. Hunter, and M.S. Woodrey. 2000. Development of Management Objectives for Waterfowl and Shorebirds in the Mississippi Alluvial Valley, Pages 8-11. *In* D. P. R. Bonney, R.J. Cooper and L. Niles, (eds.), Strategies for Bird Conservation: The Partners in Flight Planning Process*, Proceedings of the 3rd Partners in Flight Workshop*, 1995 October 1-5, Cape May, NJ. U.S. Department of Agriculture, Forest Service, Rocky Mountain Experiment Station, Ogden UT.

Mitsch, W.J. and R.F. Wilson. 1996. Improving the success of wetland creation and restoration with know-how, time, and self-design. *Ecological Applications* 6:77-83.

Mitsch, W.J., L. Zhang, C.J. Anderson, A. Altor, and M. Hernandez. 2005. Creating riverine wetlands: Ecological succession, nutrient retention, and pulsing effects. *Ecological Engineering* 25:510-527.

Mitsch, W.J., L. Zhang, D.F. Fink, M.E. Hernandez, A.E. Altor, C.L. Tuttle and A.M. Nahlik. 2008. Ecological engineering of floodplains. *Ecohydrology & Hydrobiology* 8:139-147.

Ochs, C.A. and S.A. Milburn. 2003. Effects of simulated wintertime flooding to control erosion on selected chemical and microbial properties of agricultural soils in the Mississippi Delta. *Journal of the Mississippi Academy of Sciences* 48:102-114.

Ochs, C.A. 2006. Corrections to denitrification measurements. *In* C.A. Ochs and S.A. Milburn (eds.), With a revised view of the importance of denitrification to N-loss from agricultural soils of the Mississippi Delta. *Journal of the Mississippi Academy of Sciences* 51:177-179.

Pankau, A. K. 2008. Examining cost effectiveness of actively and passively managed wetlands for migrating and wintering waterfowl in Southern Illinois. M.S. Thesis. Southern Illinois University Carbondale.

Peterson, S.B., J.M. Teal, and W.J. Mitsch (eds.) 2005. Delaware Bay Salt Marsh Restoration. Special Issue of *Ecological Engineering* 25: 199-314.

Skagen, S. K., D. A. Granfors, and C. P. Melcher. 2008. On Determining the Significance of Ephemeral Continental Wetlands to North American Migratory Shorebirds. *The Auk* 125:20-29.

Tuttle, C.L., L. Zhang, and W.J. Mitsch. 2008. Aquatic metabolism as an indicator of the ecological effects of hydrologic pulsing in flow-through wetlands. *Ecological Indicators* 8: 795-806.

Twedt, D. J., C. O. Nelms, V. E. Rettig, and S. R. Aycock. 1998. Shorebird Use of Managed Wetlands in the Mississippi Alluvial Valley. *The American Midland Naturalist* 140:140-152.

U.S. Environmental Protection Agency (USEPA). 2003. Elements of a State Water Monitoring and Assessment Program. Assessment and Watershed Protection Division, Office of Wetlands, Oceans and Watersheds. EPA 841-B-03-003. Washington, DC.

APPENDIX B

Final Charge to the IEPR Panel

on the
Final Independent External Peer Review Report
St. Johns Bayou and New Madrid Floodway, MO,
Consolidated NEPA Document and Work Plan
Environmental, Economic, and Hydrologic and Hydraulic Review

This page intentionally left blank

APPENDIX B

Final Charge to the IEPR Panel

on the
Final Independent External Peer Review Report
St. Johns Bayou and New Madrid Floodway, MO,
Consolidated NEPA Document and Work Plan
Environmental, Economic, and Hydrologic and Hydraulic Review

BACKGROUND

The St. Johns Bayou and New Madrid Floodway, MO, Consolidated NEPA Document and Work Plan Environmental, Economic, and Hydrologic and Hydraulic Review Project is an authorized project with a portion already constructed. Due to environmentally based litigation, the U.S. District Court for the District of Columbia halted construction and ordered constructed work restored to pre-construction conditions. In response to this litigation, an additional NEPA document will likely be prepared to fully address the requirements of the National Environmental Policy Act. The purpose of this Independent External Peer Review (IEPR) is to determine the adequacy of past NEPA documentation and ensure that the scope of any future NEPA document is complete and scientifically accurate.

The St. Johns Bayou Basin and New Madrid Floodway Project area is located in Mississippi and New Madrid counties in southeastern Missouri along the right descending bank of the Mississippi River floodplain. The project area encompasses portions of two drainage basins separated by the Mississippi River and Tributaries Project's Birds Point-New Madrid Setback Levee.

The Environmental Impact Statement will focus on Flood Risk Management (FRM) within the St. Johns Bayou Basin and the New Madrid Floodway. Agriculture is the primary economic resource within the project area. The flood of record at the New Madrid gage occurred in 1937. The most significant flood event since 1937 occurred in 1973, when over 56,500 acres of agricultural land in the New Madrid Floodway were inundated. According to recent data, the two-year backwater flood occurrence in the New Madrid Floodway inundates 17,316 acres, of which 11,843 acres are agricultural lands. At high Mississippi River stages, the St. Johns Bayou Basin control gates are closed to prevent backwater flooding. However, closing the gates prevents interior drainage and leads to headwater flooding. The two-year headwater flood event under these circumstances inundates approximately 10,056 acres, of which 6,312 are agricultural lands.

OBJECTIVES

The objective of work described in this statement of work is to conduct an Independent External Peer Review (IEPR) of the St. Johns Bayou and New Madrid Floodway EIS in accordance with procedures described in the Department of the Army, U.S. Army Corps of Engineers Engineer Circular (EC) No. 1105-2-410, Review of Decision Documents, dated August 22, 2008 and the Office of Management and Budget Final Information Quality Bulletin for Peer Review released December 16, 2004.

Peer review is one of the important procedures used to ensure that the quality of published information meets the standards of the scientific and technical community. Peer review typically evaluates the clarity of hypotheses, the validity of the research design, the quality of data collection procedures, the robustness of the methods employed, the appropriateness of the methods for the hypotheses being tested, the extent to which the conclusions follow from the analysis, and the strengths and limitations of the overall product.

This task involves conducting an independent technical peer review to analyze the adequacy and acceptability of economic, engineering, and environmental methods, models, data, and analyses. The independent review will be limited to technical review and will not be involved in policy review. The peer review will be conducted by subject matter experts with extensive experience in engineering, economics, and environmental issues associated with flood risk management. The subject matter experts will be "charged" with responding to specific technical questions, as well as providing a broad technical (engineering, economic, and environmental) evaluation of the overall project.

The subject matter experts (i.e., reviewers) will identify, recommend, and comment upon assumptions that underlie the analyses, as well as evaluate the soundness of models and planning methods. The reviewers should be able to evaluate whether the interpretations of analyses and conclusions are technically sound and reasonable, provide effective review in terms of both usefulness of results and of credibility, and have the flexibility to bring important issues to the attention of decision makers. The reviewers may offer opinions as to whether there are sufficient technical analyses upon which to base the ability to implement the project. The independent reviewers will address factual inputs, data, the use geotechnical, hydrologic, and hydraulic models, analyses, assumptions, and other scientific and engineering tools/methodologies to inform decision-making.

This review will be conducted in two phases. The first phase will review previous technical analyses and documentation and recommend additional analytical procedures. Those recommendations will be the basis for preparing a Project Work Plan to accomplish those procedures. The second phase of review will address the technical adequacy of that Project Work Plan. The goal of these two phases is to guide and support future critical investigations that will be incorporated into a future Environmental Impact Statement for the project. This review seeks to determine the applicability of past work and minimize the risk of having to repeat substantial EIS analytical efforts.

Phase I: Relevant Environmental Document Review. The expert panel will review past NEPA documentation and assess the adequacy and acceptability of the economic and environmental assumptions and projections, project evaluation data, economic analyses, environmental analyses, engineering analyses, formulation of alternative plans, methods for integrating risk and uncertainty, applicable legal documents, models used in evaluation of economic or environmental impacts of the proposed project, and any biological opinions of the project.

As a 501(c)(3) nonprofit science and technology organization with experience in establishing and administering peer review panels for USACE, Battelle was engaged to conduct the Independent External Peer Review (IEPR) of the St. Johns Bayou and New Madrid Floodway, MO, Consolidated NEPA Document. Independent, objective peer review is regarded as a critical element in ensuring technical quality, system quality, and usability of the models. The IEPR will follow the procedures described in the Department of the Army, U.S. Army Corps of Engineers, guidance Peer Review of Decision Documents (EC 1105-2-410) dated August 22, 2008; CECW-CP Memorandum dated March 30, 2007; and the Office of Management and Budget's Final Information Quality Bulletin for Peer Review released December 16, 2004. To accomplish the IEPR, subject matter experts will be recruited to participate in the peer review panel. Potential candidates for the peer review panel will be screened for availability, interest, and technical experience in defined areas of expertise and any actual or perceived conflicts of interest will be determined. Ultimately, no more than eight experts will be selected for the final IEPR panel using predetermined criteria related to technical expertise and credentials in the subject matters related to the documents and materials to be reviewed.

One of the initial steps in the process is to prepare a detailed work plan (this document) under Task A1. Additional tasks are detailed in the Technical Approach described in the following sections. These tasks are based on the USACE Statement of Work (SOW).

DOCUMENTS PROVIDED

The following is a list of documents and reference materials that will be provided for the review and the cross-referenced USACE files (in parentheses). **The documents and files presented in bold font are those which are to be reviewed.** All other documents are provided for reference.

1. **St. Johns Bayou and New Madrid Floodway, MO, Consolidated NEPA Document**
    a. **Main Environmental Impact Statement ("final_consolidated_nepa_5_8 (350 pgs. Also, cover sheet separate doc with review instructions).pdf")**
    b. **Appendix A: Figures ("app-a-figures (Part 1- 2002 RSEIS Figures_33pgs).pdf")**
    c. **Appendix B: Economics and Social Analysis ("app-b-socioeconomic (Economic and Social Analysis_ Part 1_ 2002 RSEIS_73pgs).pdf")**
    d. **Appendix C: Hydraulics and Hydrology ("app-c-h_h (Hydraulics and Hydrology_153pgs).pdf")**
    e. **Appendix D: Wetlands ("app-d-wetlands (Rev SEIS_First Phase_Wetland Delineation and Analysis_ 29pgs).pdf")**
    f. Appendix E: USFWS Coordination Act Report ("app-e-fwcar.pdf")
    g. **Appendix F: Section 404(b)1 Evaluation Report ("app-f-404b1 (Section 404(b1) Eval Report_33 pgs).pdf")**

h. **Appendix G: Fisheries ("app-g-fishes (Fisheries_Part 1_Project Impacts_see VIP note on content_49pgs).pdf")**
i. Appendix H: Biological Assessment ("app-h-ba (Rev SEIS Endangered Species Biological Assessment_35pgs).pdf")
j. **Appendix I: Water Quality ("app-i-wq (Water Quality_100pgs).pdf")**
k. Appendix J: Hazardous, Toxic, and Radioactive Waste (HTRW) ("app-j-htrw.pdf")
l. Appendix K: Floodway Operations ("app-k-flwy_op (Exec Summary_Birds Pt-NEw Madrid Floodway Operations_29pgs).pdf")
m. **Appendix L: Mitigation and Environmental Plan ("app-L.pdf")**
n. **Appendix M: Public Comments ("app-m-public-comments (Part 1 2002 RSEIS_356pgs).pdf")**
o. U.S. District Court for the District of Columbia Decision dated 13 September 2007.

The highlighted dates below emphasize those dates that directly pertain to the reviewers.

Task	Activity	Deliverable (D) or Milestone (M)	Projected Date
PHASE I			
A1/A3	Notice to Proceed/review documents available	M	June 9, 2009
	Submit Phase I draft work plan to USACE, including draft charge	D	June 23, 2009
	Receive comments from USACE on Phase I draft work plan and draft charge	M	June 30, 2009
	Conference call with USACE to discuss comments on Phase I draft work plan and draft charge	M	July 2, 2009
	Submit Phase I final work plan and final charge to USACE with comments addressed	D	July 9, 2009
A2	Submit list of up to 16 potential IEPR reviewers and their credentials to USACE	D	July 2, 2009
	Receive comments from USACE on proposed experts, including input on Conflicts of Interest	M	July 7, 2009
	Identify final 8 experts and complete subcontracts	M	July 28, 2009
A4	Phase I IEPR Battelle kick-off meeting with reviewers	M	July 31, 2009
	Phase I IEPR kick-off meeting with USACE (travel required)	M	August 4, 2009
A5	Phase I Review documents and final charge sent to the IEPR panel	M	July 29, 2009
	IEPR panel completes review and sends comments to Battelle	M	September 16, 2009

Task	Activity	Deliverable (D) or Milestone (M)	Projected Date
	Conduct panel review teleconference to discuss review findings and assign writing responsibilities	M	September 25, 2009
A6	Submit Final Phase I IEPR Report	D	October 23, 2009
A7	Input Phase I Final comments into DrChecks	M	October 26, 2009
	USACE PDT provides draft Evaluator comments and clarifying questions to Battelle	M	November 4, 2009
	Convene teleconference between Battelle, panel, and USACE to clarify questions and concerns	M	November 11, 2009
	USACE input Evaluator comments in DrChecks	M	December 2, 2009
	Respond to USACE Evaluator comments in DrChecks (i.e., BackCheck)	M	December 23, 2009
	Submit pdf printout of DrChecks Phase I project file.	M	December 24, 2009
PHASE II			
B1	USACE provides Battelle with Project Work Plan (Phase II IEPR Document)	M	February 1, 2010
	Revise and submit Task A1 work plan (including draft charge)	D	February 15, 2010
	USACE provides comments on draft work plan and charge	M	February 22, 2010
	Submit final work plan and final charge	D	March 1, 2010
	USACE approves final work plan and final charge	M	March 3, 2010
B2	Modify reviewers' subcontracts to include Phase II (if necessary)	M	March 10, 2010
B3	Phase II Kick-off Meeting teleconference	M	March 15, 2010
B4	Phase II Review documents and final charge sent to the IEPR panel	M	March 17, 2010
	IEPR panel completes review and sends comments to Battelle	M	April 14, 2010
	Conduct panel review teleconference to discuss review findings and assign writing responsibilities	M	April 23, 2010
B5	Submit Final Phase II IEPR Report	D	May 14, 2010
B6	Input Phase II Final comments into DrChecks	M	May 18, 2010
	USACE provides draft Evaluator comments and clarifying questions to Battelle	M	May 28, 2010

Task	Activity	Deliverable (D) or Milestone (M)	Projected Date
	Convene teleconference between Battelle, panel, and USACE to clarify questions and concerns	M	June 7, 2010
	USACE inputs Evaluator comments in DrChecks	M	June 28, 2010
	Respond to USACE Evaluator comments in DrChecks (i.e., BackCheck)	M	July 20, 2010
	Submit pdf printout of DrChecks Phase II project file.	M	July 21, 2010

Final Charge Guidance and Questions to the Peer Reviewers
for
St. Johns Bayou and New Madrid Floodway, MO,
Consolidated NEPA Document and Work Plan
Environmental, Economic, and Hydrologic and Hydraulic Review, Phase I

Overall

1. Based on your opinion, please comment on whether you believe this consolidated NEPA document contains all the information, analyses, and discussions required under NEPA.

2. Are the assumptions that underlie the economic, engineering, and environmental analyses sound?

3. Comment on the adequacy and acceptability of the economic, engineering, and environmental methods, models, and analyses used.

4. In general terms, are the models and planning methods sound?

5. Are the interpretations of analysis and conclusions based on the analysis reasonable?

6. Are there sufficient analyses upon which to base a recommendation for construction?

7. Please comment on the clarity of the consolidated NEPA document.

8. Based on your expertise, please provide a conclusion comment on the overall adequacy of the consolidated NEPA document with regard to the requirements of NEPA.

1.0 Purpose and Need

1. Please comment overall on whether you believe that Section 1.0: Purpose and Need has clearly and completely described both the *purpose of* and the *need for* the project.

   a. Please share what additional information, if any, should have been included in this section.

2.0 Plan Formulation

2.1 Alternative 1: Without-Project

1. Please comment on the significance of the "without project" consequences.

2.2 Alternative 2: Authorized Project

1. Please comment on whether, based on your experience, the design specifications and engineering methods of the authorized project are sufficient to meet the project objectives.

2. Please comment on the assessment that the proposed changes in the authorized project are not likely to affect headwater flooding.

2.3 Alternative 3: Avoid and Minimize

1. Please comment on whether all the possible "avoid and minimize" variations have been included and discussed in this section.

2. Please comment on whether the proposed schedule and structural modifications designed to minimize the ecological impact to invertebrates and fishes in St. Johns Bayou Basin appears sufficient to ensure their protection.

3. Discuss whether additional variations are required for Alternative 3-3 to provide additional feasible options for flood gate management.

4. Do you believe USACE has analyzed a full range of alternatives that addresses the flood problems in the area including reasonable alternatives outside USACE's jurisdiction and why? If not, what additional alternatives would you recommend?

2.4 Alternatives Considered but Eliminated from Detailed Study

1. Please comment on whether this section clearly and completely discussed the reasoning behind the elimination of specific alternatives.

2. Explain whether you agree with the rationale in eliminating Alternatives 4-9 from detailed study and comment on whether any of them should have been retained.

3. Discuss the practicality of the rationale behind eliminating the additional floodway levee locations in Alternative 7.

4. Please comment on the consideration of land use changes as an alternative.

2.5 Comparative Impacts of Alternatives

1. Based on your expertise, is the overall analysis of the alternatives analysis appropriate and correct?

a. Why or why not?

2. Comment on the completeness of the evaluation of comparative impacts presented in Table 2-3.

2.6 Preferred Plan

1. Please comment on the size and quality of the Eagle's Nest habitat to be inundated during annual springtime flooding.

2. Please comment on whether the information presented in Table 2-3 and subsequent sections justify the selection of Alternative 3-1.B.

2.7 Compensatory Mitigation for the Preferred Plan

1. Please comment on whether the stated planning objectives meet the goal of compensating for unavoidable impacts to significant fisheries.

2. The NRCS classified only 520 acres in the project area as farmed wetlands. USACE used an inundation analysis, rather than NRCS' estimate to identify potential wetlands. USACE determined backwater flooding would be reduced on 1,296 and 5,417 acres (total = 6,713) of agricultural lands in the St. Johns Bayou and New Madrid Floodway, respectively. Based on your expertise and for the purposes of the Clean Water Act and Swampbuster, should compensatory mitigation be based on NRCS' analysis of 520 acres, USACE's analysis of 6,713 acres, or some other figure? If another figure, please give your rationale, and methodology to show impact analysis and supporting data.

3. Please comment on the planning objectives for compensating for unavoidable impacts to significant fish and wildlife resources from project construction and whether they are appropriate to the task at hand.

4. Discuss the viability and cost-effectiveness of mitigation measures to increase flood durations.

2.8 Compensatory Mitigation Options Considered in Detail

1. USACE intends to construct 765 acres of moist soil units to compensate impacts to shorebird habitat from reduced flooding. In addition to compensating for shorebird habitat losses, USACE intends to quantify the benefits of constructing 765 acres of moist soil units for waterfowl. Based on your expertise, can moist soil units be managed to benefit both shorebird and waterfowl populations? If yes, please provide any management recommendations. If not, please explain why both populations would not benefit concurrently.

2. The construction of modified borrow pits is proposed to compensate for a large percentage of impacts to mid-season fish rearing habitat. This is based upon the model's dual assumptions that a) flooded farmland (the pre-project condition) provides less value (according to the model) for rearing habitat and b) permanent water bodies, such as the proposed borrow pits, provide the maximum value (according to the model) for rearing habitat. USACE has received comments that modified borrow pits cannot compensate for the impacts associated with the reduction of flooding on the floodplain, even though these borrow pits will be located in flooded areas adjacent to the river channels. Based on your expertise, can modified borrow pits, such as those proposed for this project, be used to compensate for impacted floodplain habitat (e.g., flooded farmland, bottomland hardwoods, etc.) and why?

   b. If your answer to the question above was negative, what habitat value should be used for borrow pits? Explain your response.

   c. Would some other form of compensatory mitigation be preferable? Explain your response.

3. USACE has received comments that it did not consistently calculate the value of existing permanent water bodies and the proposed borrow pits. Impacted habitat was based on the number of days over the period of record that a particular habitat type was inundated by the Mississippi River (i.e., average daily flooded acres). However, USACE did not base benefits of mitigation based on Mississippi River inundation because the proposed borrow pits would be inundated 100% of the time regardless of Mississippi River elevation. Based on your expertise, do you believe that habitat provided by permanent water bodies should be quantified 100% of the time or do you believe it should be discounted by the number of days the Mississippi River is at or above the elevation of the borrow pit even though borrow pits retain water after floods recede? Explain your response.

4. Compensatory mitigation for fish is based on rearing habitat only, with the premise that impacts on spawning habitat are not the limiting factor. The decision to base compensatory mitigation on rearing impacts was made because it resulted in the greatest quantity of required compensatory mitigation acres. Based on your expertise, is spawning or rearing habitat the limiting factor?

5. The interagency team decided to base mitigation for fish on impacts to mid-season habitat, because, in the team's assessment, this was the time period when the greatest impacts occurred. Based on your expertise, do you believe that basing mitigation solely on mid-season habitat, or in other words the period with the greatest impacts, adequately compensates for impacts across the entire reproduction season and why? Explain your response.

a. Do you believe that impacts in the early or late reproductive seasons are different in kind or quantity from those in mid-season? Are those impacts biologically significant to the fisheries resource? Explain your response.

b. If you disagree with the interagency team plan for fish mitigation, what revisions to the impact/mitigation formulation would you recommend for this project? Explain your response.

6. Please comment on the viability of the described techniques for the Basic Mitigation Feature to fully compensate all significant resource categories, except habitat within the New Madrid Floodway, for loss due to project implementation.

7. Please comment on the adequacy of the proposed Additional Techniques to compensate, individually or in aggregate, for impacts to the New Madrid Floodway mid-season fish rearing habitat due to project implementation.

8. Please comment on the summary of expected benefits (Table 2.4) and its relationship to the detailed findings analyses.

2.9 Mitigation Scenarios

1. Please comment on whether the four mitigation scenarios presented suitably mitigate impacts to all significant resource categories.

2. Please comment on whether the estimated costs associated with each mitigation scenario are realistic and economically justifiable.

3. Please comment on the clarity and the accuracy of the real estate requirements for these mitigation scenarios.

2.10 Mitigation Summary

No questions.

2.11 Mitigation Contingencies

1. Please comment on the likelihood that fish would utilize areas managed primarily for shorebirds.

2. Please comment on whether the approach used to quantify mitigation credits for lost wetland habitat fully considered all lost wetlands functions and values.

3. Please comment on the statement that the basic mitigation feature overcompensates for impacts to waterfowl and terrestrial wildlife.

4. Please comment on the additional mitigation opportunities that may be considered outside the New Madrid Floodway.

3.0 Affected Environment

3.1 Location

No questions.

3.2 Climate

No questions.

3.3 Land Use

1. Please comment on completeness and accuracy of the land use discussion. Is additional information needed? If so, what?

3.4 Topography

1. Please comment on whether the topography discussion is complete and accurate and whether additional information would be beneficial.

3.5 Hydrology

1. Is the hydrology discussion complete and accurate? If not, what additional information would be beneficial?

3.6 Floodplain Ecology

1. Please comment on whether the floodplain ecology discussion is complete and accurate and whether additional information would be beneficial.

2. Please comment on whether the significance of the potentially affected floodplain to the broader ecosystem is fully and accurately characterized so that all potentially lost functions can be considered as part of mitigation planning.

3.7 Geology

1. Please comment on whether the geology discussion is complete and accurate and whether additional information would be beneficial.

3.8 Minerals

1. Please comment on whether the minerals discussion is complete and accurate and whether additional information would be beneficial.

3.9 Soils

1. Please comment on whether the discussion on soils is complete and accurate and whether additional information would be beneficial.

3.10 Water Quality

1. Please comment on whether the water quality discussion is complete and accurate and whether additional information would be beneficial.

2. Please comment on the findings that there have been no substantive changes in crops, cropping patterns, and agrochemical use and very minimal changes in water quality in both basins and the Mississippi River between the two water quality analysis activities.

3. Please comment on the conclusion that Section 303(d) is not applicable in this situation.

4. Please comment on the accuracy and relevance of the hypoxia discussion.

3.11 Socioeconomic Profile

1. Please comment on whether the socioeconomic discussion is complete and accurate and whether additional information would be beneficial.

4.0 Significant Resources

1. Please comment on whether any other significant resource categories that were not analyzed in the past NEPA documents need to be analyzed.

4.1 Agricultural Land

1. Please comment on the methodology used for determining crop distribution acreage in the St Johns Bayou Basin and the New Madrid Floodway.

2. Please comment on whether the description of the agricultural land in the St. Johns Bayou Basin and New Madrid Floodway is accurate and complete.

4.2 Woodlands

1. Please comment on whether the description of the remaining woodlands in the St. Johns Bayou Basin and New Madrid Floodway is accurate, clear, relevant, and complete.

4.3 Wetlands

1. Is the methodology used to determine the quantity of existing wetlands in the project area appropriate? If not, please recommend an alternative method.

   a. Do you agree that the result is accurate? If you disagree, please recommend an alternative method and explain why it is superior to the method used.

2. Please comment on the accuracy and completeness of the wetland delineation methodology described and whether it complies with all regulatory requirements.

3. Please comment on the re-analysis of National Resource Conservation Service (NRCS) wetland classifications.

4.4 Wildlife

1. Please comment on the completeness, relevance, accuracy, and clarity of the description of wildlife present in the St. Johns Bayou Basin and New Madrid Floodway.

4.5 Waterfowl

1. Please comment on whether the waterfowl discussion is complete and accurate and whether additional information would be beneficial.

2. Please comment on whether the descriptions of waterfowl migration and seasons are complete and accurate.

4.6 Fisheries

1. Please comment on whether the fisheries discussion is complete and accurate and whether additional information would be beneficial.

4.7 Mussels

1. Please comment on whether the mussel discussion is complete and accurate and whether additional information would be beneficial.

4.8 Endangered Species

1. Please comment on whether the three Federally listed endangered species and one Federally listed threatened species are described accurately and completely in this section.

a. To the best of your knowledge, have any federally listed threatened or endangered species been omitted from this section? If so, which ones?

2. Please comment on Table 4.3 and whether the information provided in it is complete and accurate.

4.9 Big Oak Tree State Park and Other State Conservation Areas

1. Please comment on whether the description of Big Oak Tree State Park is accurate and complete.

4.10 Water Quality

1. Please comment on the assertion that post-project water quality conditions will be similar to existing conditions.

4.11 Recreation

1. Please comment on the accuracy, completeness, and relevance of the description of recreational amenities and their use.

4.12 Cultural Resources

1. Please comment on the accuracy, completeness, and relevance of the cultural resource discussion, the impact of the alternative actions on these resources, and the mitigation approach that will be followed.

5.0 Environmental Consequences

1. A 32-year period of record (1943-1974) was used to quantify impacts to environmental resources and economic benefits of the project. Based on your expertise, do you believe that the 32-year period of record used is a representative sample of data? If not, what changes should be made to the calculations (e.g., longer period of record, more recent period of record)?

2. Please comment on whether the information provided in this section justifies the selection of Alternative 3-1.B as the recommended plan.

3. Please comment on whether Section 5.0 fully considers the impacts to important resources due to both project construction and project operation.

4. Please comment whether the impacts identified as unavoidable are unavoidable.

5. Please comment on whether the mitigation scenarios outlined in this section can fully compensate for all unavoidable impacts to significant resources.

5.1 Agricultural Land

1. Please comment on whether the environmental consequences of the various alternatives on agricultural land are accurately and completely described.

5.2 Woodlands

1. Please comment on whether the environmental consequences of the various alternatives on woodlands are accurately and completely described.

2. Please comment on the description of Big Oak Tree State Park's without-project hydrological problems.

5.3 Wetlands

1. Is the methodology that was used to determine the impacts to wetlands in the project area appropriate? If not, explain why.

   a. Do you agree that the impact of the Project as indicated is accurate? If you disagree, please recommend an alternative method and explain why it is superior to the method used.

2. USACE used the HGM approach to quantify direct impacts of the project on forested wetlands and indirect impacts from the reduction of flooding on areas identified by the NRCS as farmed wetlands. Do you agree or disagree with the HGM methodology, the way the Corps employed it, and the accuracy of the result obtained and why? If you do not agree with HGM methodology or its application in this case, please recommend alternative methodologies or techniques.

3. Please comment on whether the concerns that the project would result in a substantial loss of forested wetlands have been addressed.

   a. Please comment on the reasonableness of the wetland impact estimates for the various alternatives.

4. Please comment on whether the proposed basic mitigation features are appropriate and likely to achieve the desired level of wetland compensation.

5. Please comment on the accuracy and comprehensiveness of the analysis of additional wetland mitigation techniques.

6. Please comment on how likely it is that the implementation of one or more of these additional techniques would result in a significant shift in the project benefit/cost profile.

5.4 Wildlife

1. The USFWS used the Habitat Evaluation Procedures to quantify impacts to shorebird habitat from the reduction of flooding. The model recommended that 765 acres of moist soil units be constructed to compensate for impacted habitat. Based on your expertise, do you agree with the impact analysis and its conclusion that constructing 765 acres of moist soil units compensates for impacted shorebird habitat and why?

   a. If not, how would you change the analysis?

2. Please comment on the decision to not include separate reptile and amphibian species evaluations.

3. Please comment on the decision to use HEP to evaluate the impacts of the project on wildlife.

   a. Would another method have been more appropriate?

4. Please comment on the estimated impacts to wildlife from each alternative scenario.

   a. Based on your expertise, are the estimated impacts appropriate?

5. Please comment on whether the proposed basic mitigation features are appropriate and likely to achieve the desired level of wildlife compensation.

6. Please comment on the accuracy and comprehensiveness of the analysis of additional wildlife mitigation techniques.

5.5 Waterfowl

1. The Waterfowl Assessment Methodology was used to quantify impacts of the flood damage reduction project and quantify compensatory mitigation. The model quantifies impacts to dabbling ("puddle") ducks. Accordingly, the model only looks at habitat that is flooded at depths no greater than two feet deep. USACE has received comment that impacts to diving ducks should also be quantified. Although diving ducks are found within the project area, USACE has concluded that dabbling ducks are the significant waterfowl resource found within the project area, and therefore would be representative of the broader extent of impact. Based on your expertise, do you believe USACE's decision to assess impacts to dabbling ducks only is correct? Explain your response.

2. USACE has received comments that the FWS made a "math error" in the preparation of the Waterfowl Assessment Methodology. USACE believes that there was no error; it was the result of the methodology. Impacts are expressed in median monthly flooding (50% or greater frequency per month) during February and March

at depths less than two feet deep. Therefore, waterfowl benefits from mitigation sites should also be expressed in median monthly flooding. Do you believe that waterfowl impacts and benefits of mitigation were calculated correctly? Explain your response.

3. The closure structures will have the capability to pool water in both basins during waterfowl season. Based on your expertise, do you believe that flooding approximately 6,000 acres in both basins by means of the closure structures would provide the stated benefit to waterfowl? Explain your response.

4. Is it your opinion that the benefits of the waterfowl ponding feature, impacts of the reduction in flooding, and benefits of the proposed waterfowl mitigation were calculated correctly? If not, please explain how the impact/mitigation calculations should be revised.

5. Please comment on whether the proposed basic mitigation features are appropriate and likely to achieve the desired level of waterfowl compensation.

6. Please comment on the accuracy and comprehensiveness of the analysis of additional waterfowl mitigation techniques.

5.6 Fisheries

1. USACE received comments that it should have included impacts on fish access as a factor in its predictive models for two reasons: (1) because the levee gates between the river and the mitigation sites will be closed during certain high water stages which may coincide with the spawning season in some years, and (2) because fish will be less likely to navigate culverts3 than open floodplain.

   a. On the first point, USACE intends to develop an operating rule curve for the structure that will maximize periods when fish can access the floodplain from the Mississippi River without jeopardizing the economic benefits of the project. USACE has stated that fish do not need access to the floodplain 100% of the time. Rather, a pulsed hydrograph in the winter and spring provides numerous opportunities for fish (different individuals and species at multiple times of the year) to access floodplain habitat where they may reside for extended periods to feed and reproduce, and later have opportunities to move back to the river when the structure is open. Based on your expertise, do you believe that USACE can develop an operating rule curve that takes advantage of pulsed hydrographs that maximize fish access opportunities? Explain your response.

   b. On the second point, USACE believes that there is enough ancillary evidence (e.g., species composition comprised of riverine fishes) in the St. Johns Bayou Basin to suggest that fish can and do pass from the Mississippi River through the

[3] The proposed closure of the New Madrid Floodway consists of four 10-foot by 10-foot box culverts that will be placed in Mud Ditch with a levee comprising the remainder of the 1,500 foot-gap.

existing box culverts and access the floodplain. The St. Johns Basin, as will be the case for the New Madrid Basin if the project is constructed, is already closed off with levees and box culverts that are closed during Mississippi River flood events. However, the culverts are open during the remainder of the year includingperiods of minor flooding that do not threaten land use practices. There is not at present an operating rule curve such as described above to maximize the time during which fish can access the floodplain. USACE has assumed that although individual fish will not be able to access the floodplain when the flood gates are closed, enough fish (individuals and species) will be able to pass through the culverts during other portions of the year when the gates are open and access spawning and rearing sites including mitigation sites. Therefore, USACE concluded that closing off the Floodway would not significantly impact the diversity and population of fishes in the New Madrid Floodway and the Mississippi River. Based on your expertise, is this assumption correct? Explain your answer.

c. If your answer to either (a) or (b) is negative, what is an adequate methodology to quantify benefits of fish mitigation in the New Madrid Floodway during periods that the gates are closed to flooding?

2. Please comment on whether the reference species chosen to quantify impacts of the project adequately represents all guilds of fishes found within the project area? If not, what species would you remove and what species would you add? Explain your responses.

3. USACE has received comment that it overstated the value of the sump area as fish habitat by classifying it as a permanent water body and assigning it an equivalent habitat value. Based on your expertise and for the purpose of this analysis, what are the important characteristics of a permanent water body as it relates to fish spawning and rearing? Please comment on whether the USACE used the proper HSI value for the proposed spawning and rearing pool? Explain your response.

a. If not, what is the appropriate classification (i.e., HSI value)? Explain your response.

b. USACE also quantified cypress swamps and herbaceous wetlands that usually go dry during the summer and fall as small permanent water bodies. Is it correct to classify these areas as small permanent water bodies considering that we were evaluating the spawning and rearing season during floods and not the entire year after reproduction has occurred?

4. USACE has received comments that it “arbitrarily manipulated the HEP model” by excluding impacts from floods that occur less frequently than the two-year event. The premise to this comment is that fish living longer than two to three years derive some benefit from less frequent flood events. Further, the comment states that USACE could have conceivably included discounted impacts to the three year

floodplain in its predictive model. USACE has stated that all species, including the longer-lived fish, depend on the regular, recurrent flooding regime of the two-year floodplain to maintain baseline populations. Therefore, only the two-year floodplain was assessed. Based on your expertise, please comment on whether the model accurately describes the impacts of the project by only analyzing impacts of the two-year floodplain.

a. Please comment on whether less frequent floods (three year and less) contribute significantly to the long-term population of the fishery. Explain your response.

b. If your response to the preceding question is negative, what flood frequency is appropriate for the evaluation?

c. Should the Corps consider the distance that fish have to travel from the river to the floodplain (e.g., how far a fish will travel from the channel through the flooded floodplain to spawn)?

5. USACE has received comments that providing mitigation (e.g., reforesting farmland, restoring/enhancing floodplain lakes, etc.) in the batture lands does not provide in-kind replacement for impacted habitat in the Floodway because these are two separate areas and two different kinds of fishery habitat. USACE disagrees because batture areas have physicochemical characteristics similar to the Floodway, are frequently flooded, and have the same species composition of fishes. Based on your expertise, please comment on whether fishery mitigation measures in the batture area can compensate for fishery impacts in the Floodway.

a. Do you believe that impacts in the New Madrid Floodway can be compensated by conducting mitigation in the St. Johns Bayou Basin and vice versa? Explain your response.

b. If mitigation occurs outside of the impacted watershed, should different reference species be selected to quantify benefits of mitigation? Explain your response. How should reference species be selected?

6. Please comment on the use of a two-year flood event frequency to estimate fish habitat in the floodplain.

7. Please comment on the methodology, assumptions, and use of EnviroFish to estimate project impacts to the fishery.

8. Please comment on the robustness and relevance of the evaluation of fish species in the project area.

9. Please comment on the assumptions and conclusions associated with each project alternative.

10. Please comment on the findings of the 2006 REIS 2 of using selected reforestation of frequently flooded agricultural lands to mitigate for impacts to mid-season fish rearing habitat.

11. Please comment on the modifications to the Habitat Evaluation Procedure (HEP) methodologies developed during the 2002 REIS.

12. Please comment on the rationale for calculating and accounting for transition periods of habitat type from agricultural lands to bottomland hardwoods.

13. Please comment on the rationale of expressing mitigation lands for mid-season fish rearing habitat in terms of Average Daily Flooded Acres.

14. Please comment on the techniques used (in addition to reforestation) to compensate for impacts to mid-season fish rearing habitat.

15. Please comment on the components, methodology, and assumptions used to determine mitigation benefits to mid-season fish rearing habitat.

16. Please comment on the calculation and potential of constructed moist soil units to provide mid-season fish rearing habitat.

17. Please comment on the feasibility of increasing mid-season fish rearing Average Annual Habitat Units (AAHUs) over the calculated 20-year transition period using vegetated buffer strips.

18. Please comment on the feasibility of creating four mid-season fish AAHUs by converting 266 acres of agricultural lands to bottomland hardwoods for the purpose of a wildlife corridor.

19. Please comment on the feasibility of the designed Big Oak Tree State Park hydrologic restoration feature to create 442 mid-season fish AAHUs.

20. Please comment on the hydrologic criteria required to establish adequate fish passage.

21. Please comment on the feasibility of the proposed borrow pits to create 1,571 mid-season fish rearing AAHUs.

22. Please comment on the suitability and viability of each proposed mitigation technique to create the stated respective supplemental fish spawning and rearing AAHUs.

23. Please comment on the suitability of each mitigation scenario listed in Table 5.26.

5.7 Mussels

1. Please comment on the components and estimated outcomes of proposed alternatives 1, 2, and 3.1A.

2. Please comment on the robustness and effectiveness of the proposed monitoring and relocation measures.

5.8 Endangered Species

1. Please comment on the estimated impacts to endangered species from each alternative scenario.

   a. Based on your expertise, are the estimated impacts appropriate?

5.9 Big Oak Tree State Park and Other State Conservation Areas

1. Please comment on the potential impacts to Big Oak Tree State Park and other conservation areas from each alternative scenario.

   a. Based on your expertise, are the estimated impacts appropriate?

5.10 Water Quality

1. USACE has been criticized that closing off the Floodway would contribute to Gulf of Mexico hypoxia and poor water quality in the Mississippi River. USACE has stated that the Floodway contributes more nutrients to the Mississippi River than are absorbed during floods because of the large agricultural area. USACE presumes that with compensatory mitigation (reforestation of agricultural areas and buffer strips), the overall amount of nutrients exported to the Mississippi River would be less than what is exported under current conditions. Based on your expertise, please comment on USACE's water quality analysis. How, if at all, would you change the analysis? Explain your responses.

2. Please comment on the extent to which the data support the conclusion that water quality in both basins is expected to remain unchanged.

3. Please comment on the appropriateness of the methodologies and the adequacy of the results of the mass balance exercise.

4. Please comment on whether you concur with the conclusions that the project alternatives would not change water quality conditions from current conditions.

5. Please comment on the approach used to address the impacts of wetland loss on water quality.

5.11 Recreation

1. Please comment on the extent to which this section accurately describes and appropriately addresses the impact of the alternatives on recreational amenities.

5.12 Cultural Resources

1. Please comment on the extent to which this section accurately describes and appropriately addresses the impact of the alternatives on cultural resources.

2. Please comment on the mitigation approach proposed for limiting impacts to cultural resources.

5.13 Section 122 Items

1. Please comment on the extent to which this section accurately describes and appropriately addresses the impact of the alternatives on Section 122 issues (including noise; air quality; aesthetic value; displacement of people; community cohesion; local government finance, tax revenues, and property values; displacement of businesses and farms; public services and facilities; community and regional growth; and employment).

5.14 Socioeconomics

1. Please comment on the adequacy of the interpretation of the economic analysis and the extent to which the selection of the Recommended Plan is justified by this analysis.

5.15 Hazardous, Toxic, and Radioactive Waste

1. Please comment on the extent to which this section accurately describes and appropriately addresses the impact of the alternatives on hazardous, toxic, and radioactive waste issues.

5.16 Mississippi River Stage Impacts and New Madrid Floodway Operations

1. Please comment on whether the information provided in this section was consistent with earlier sections.

2. Please comment on the extent to which this section accurately describes and appropriately addresses the impact of the alternatives on Mississippi River stage and New Madrid Floodway Operations.

5.17 Cumulative Impacts

1. Please comment on whether this section provides the appropriate level of detail to determine cumulative impacts to the relevant resources, when considered with other

actions from the past, present, and reasonably foreseeable future, regardless of whom undertakes those actions.

6.0 Recommended Mitigation

6.1 Introduction

No questions.

6.2 Land Acquisition

No questions.

6.3 Detailed Mitigation Plans

No questions.

6.4 Mitigation Construction

1. Please comment on the completeness of the information provided on mitigation construction.

   a. What, if anything, should be included in this section?

6.5 Monitoring

1. The RSEIS 2 recommended an adaptive approach that would utilize monitoring to ensure that mitigation performs as designed. USACE was criticized in its adaptive management approach. Based on your expertise, is adaptive management appropriate for this project? Can you please provide specific examples of successful mitigation that utilized adaptive management on other large water resource development projects?

   a. Based on your expertise, how can adaptive management be used for this specific project?

2. Please comment on whether the text and Table 6.1 provide a comprehensive listing of monitoring parameters.
3. Please comment on whether the additional discussion of potential corrective actions is required.

6.6 Long Term Management

1. Please comment on whether the long-term management plan for the mitigation projects is accurately and completely described.

7.0 Project Monitoring

7.1 Jurisdictional Wetlands

1. USACE has classified all post-project forested wetlands as jurisdictional, even though some are no longer flooded by Mississippi backwater. This is due to the high groundwater table, precipitation, and interior flooding. Based on the data presented in the Corps' NEPA documents and your expertise, do you agree with this classification? Explain your response.

2. Please comment on the assertion that the reduced flooding in St. Johns Bayou and the New Madrid Floodway would not result in some areas losing their jurisdictional wetland classification.

7.2 Water Quality

1. Please comment on the adequacy of the planned project monitoring goals and measures presented for the mitigation plan.

7.3 Aquatic Biological Populations

1. Please comment on the post-construction monitoring timeline criteria that will trigger remedial mitigation.

7.4 Freshwater Mussels

1. Please comment on the robustness and effectiveness of the proposed monitoring plans for freshwater mussels.

7.5 Fish Passage

1. Please comment on the robustness and effectiveness of the proposed monitoring plans for fish passage.

8.0 2002 REIS Public Involvement

8.1 Public Involvement Program

1. Please comment on whether the USACE has allowed adequate opportunities for public involvement and agency coordination as required by NEPA.

8.2 Coordination

1. Please comment on whether USACE adequately justified their responses to USFWS comments.

8.3 Distribution

No questions.

9.0 2006 REIS2 Coordination

9.1 Scoping Process

No questions.

9.2 Distribution

No questions.

9.3 Comments

No questions.

9.4 Coordination

No questions.

9.5 U.S. Fish and Wildlife Planning Aid Letter

No questions.

9.6 U.S. Fish and Wildlife Service Coordination Act Report

No questions.

10.0 Conclusion

10.1 Relationship of Plan to Environmental Laws and Regulations

No questions.

Appendix A: Figures

1. Please comment on whether the figures were helpful in conceptualizing and understanding the project.

Appendix B: Economics and Social Analysis

1. Based on your expertise, did USACE perform an appropriate economic analysis of this project? Explain your response.

2. Are there other socioeconomic factors that you would suggest the Corps consider?

   a. How would you improve this analysis/section?

3. Please comment on the assumptions used, and the justification provided for them, in the economic analysis (i.e., multiple interest rates, discount rate, price levels and use data, expected changes in crops planted).

   a. Please comment on whether the assumptions included in the analysis are comprehensive and up-to-date.

4. Please comment on the risk and sensitivity analysis approach used for the project.

5. Please comment on the analysis and evaluation of non-market values (e.g., externalities) and social costs and benefits.

6. Please comment on the assumptions used, and the justification provided for them, in the socioeconomic analysis and Section 122 items.

Appendix C: Hydraulics and Hydrology

1. Based on your expertise, do you believe the H&H analysis was calculated properly? Explain your response.

   a. If not, what changes should be made?

2. Please comment on the applicability of the five types of hydrologic evaluation used for statistical analysis of daily sump elevations.

3. Please comment on the results of the statistical analyses and how they support the design of the preferred plan.

Appendix D: Wetlands

1. Please comment on the reasonableness of the key assumptions (page D-2) employed in identifying jurisdictional wetlands within the area potentially impacted by the proposed project.

2. Please comment on whether the jurisdictional wetlands within the project area were accurately identified, with consideration to the delineation techniques and data inputs.

3. Please comment on the accuracy and comprehensiveness of the wetland delineation review process.

4. Please comment on the accuracy and comprehensiveness of the analyses used to estimate the acreage of and types of impacts to wetlands.

5. Please comment on the likelihood that project implementation would result in induced clearing of woodlands and whether recommended mitigation measures would fully mitigate these losses if they were to occur.

6. Please comment on the accuracy and comprehensiveness of the analyses of other wetland functions that could potentially be affected by project implementation.

7. Please comment on the reasonableness of the key assumptions (pages 244-245) that were used in the HGM analysis, including an assessment of the applicability of the Arkansas Delta regional guidebook to the project area.

8. Please comment on whether the HGM adequately estimated the Functional Capacity Indices (FCIs) associated with all functions provided by wetlands within the project area with regard to planning purposes.

9. Please comment on the reasonableness of the FCI trajectories presented in Figure 3.

10. Please comment on the reasonableness of the mitigation ratios presented in Table 2, based on the stated assumptions and pre-project condition assessment.

11. Please comment on the sensitivity of the mitigation ratios to assumptions regarding the success of re-established forested wetlands in the mitigation areas.

Appendix F: Section 404(b)1 Evaluation Report

1. Please comment on the anticipated re-growth/recovery in the conservation easements.

2. Please comment on the anticipated recovery times of potentially disturbed benthic communities.

3. Please comment on the cumulative impact considerations described in Section 2.7.

4. Please comment on whether the findings of compliance are consistent with the supporting information provided.

Appendix G: Fisheries

1. Please comment on the methods used to quantify the impacts of the proposed projects on fish habitat.

2. Please comment on the assumptions used to parameterize the EnviroFish model.

3. Please comment on the suitability of the equations used to quantify mid-season fish rearing habitat.

Appendix I: Water Quality

1. Please comment on whether the data as collected can be used to meet project objectives.

2. Please comment on whether the methods can be used to meet project objectives.

3. Please comment on the wetland function factor approach, the values selected for the analysis, and any uncertainties associated with the approach.

Appendix L: Mitigation and Environmental Plan

1. Please comment on whether the impacts described in Appendix L are consistent with those described in the main body of the Consolidated NEPA document.

2. Please comment on whether the mitigation feature is appropriate given the project and its estimated impacts.

3. Please comment on the mitigation alternatives screening process.

4. Please comment on the discussion of mitigation needs.

5. Please comment on the description and screening process of mitigation sites.

6. Please comment on the cost effective analysis of the mitigation options.

7. Please comment on Attachment 1: Avoid and Minimized Features. Are the descriptions accurate and complete?

8. Please comment on Attachment 2: Big Oak Tree State Park Water Balance Analysis. Is the information contained therein accurate and complete?

Appendix M: Public Comments

No questions.

Volume 3
Part 3

Phase II IEPR

U.S. Army Corps of Engineers
Memphis District

Battelle
The Business of Innovation

Addendum to Final Independent External Peer Review Report

St. Johns Bayou and New Madrid Floodway, Missouri Project Work Plan, Phase 2 Environmental, Economic, and Hydrologic and Hydraulic Review

Prepared by
Battelle Memorial Institute

Prepared for
Department of the Army
U.S. Army Corps of Engineers
Flood Risk Management Planning Center of Expertise
Sacramento District

Contract No. W911NF-07-D-0001
Task Control Number: 09150
Delivery Order: 0666

November 5, 2010

SHORT-TERM ANALYSIS SERVICE (STAS)

on

Addendum to Final Independent External Peer Review Report

St. Johns Bayou and New Madrid Floodway, Missouri
Project Work Plan, Phase 2
Environmental, Economic, and Hydrologic and Hydraulic Review

by

Battelle
505 King Avenue
Columbus, OH 43201

for

Department of the Army
U.S. Army Corps of Engineers
Flood Risk Management Planning Center of Expertise
Sacramento District

November 5, 2010

Contract Number: W911NF-07-D-0001
Task Control Number: 09150
Delivery Order Number: 0666

Scientific Services Program

The views, opinions, and/or findings contained in this report are those of the author and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

TABLE OF CONTENTS

1. INTRODUCTION 1
2. METHODS 2
   2.1. Round 1: Draft Comment/Response 2
   2.2. Round 2: Final Preliminary Evaluator Response and Focus Groups 2
   2.3. Round 3: Final Comment/Response 3

Appendix A: IEPR Final Panel Comments on the SJNM Final IEPR Report: Project Work Plan, Phase 2
Appendix B: Draft Evaluator Questions/Responses and Draft BackCheck Responses
Appendix C: Final Preliminary Evaluator Responses
Appendix D: Final Evaluator Responses and Final BackCheck Responses

LIST OF TABLES

Table 1. SJNM IEPR: Project Work Plan Comment/Response Schedule 5
Table 2. Final Panel Comments Identified by the SJNM IEPR Panel for the Final IEPR Report: Project Work Plan, Phase 2 6
Table 3. Draft Comment/Response - Round 1: IEPR Final Panel Comment Status 8
Table 4. Final Preliminary Comment/Response and Focus Group - Round 2: IEPR Final Panel Comment Status 10
Table 5. Final Comment/Response - Round 3: IEPR Final Panel Comment Status 11

This page intentionally left blank

LIST OF ACRONYMS

AAHU	Average Annual Habitat Unit
ADFA	Average Daily Flooded Area
ATR	Agency Technical Review
BLH	Bottomland Hardwood Forest
CA	Conservation Area
CEA	Council of Economic Advisors
CE/ICA	Cost Effectiveness Incremental Cost Analysis
CECW	Corps of Engineers Directorate of Civil Works
CEQ	Council on Environmental Quality
cm	Centimeter
CNP	Current Normalized Price
COI	Conflict of Interest
CRP	Conservation Reserve Program
CWA	Clean Water Act
DEE	Daily Existence Energy
DTM	Digital Terrain Model
DrChecks	Design Review and Checking System
DSS	Data Storage System
DUD	Duck Use Days
EC	Engineering Circular
ECO-PCX	USACE Ecosystem Restoration Planning Center of Expertise
EIS	Environmental Impact Statement
EMAP	Environmental Monitoring and Assessment Program
ER	Engineering Report
EROS	Earth Resources Observation and Science Center (USGS)
ERDC	Engineer Research and Development Center
FCA	Flood Control Act
FCI	Functional Capacity Index
FCU	Functional Capacity Unit
FORTRAN	Formula Translation
FRM-PCX	Flood Risk Management Planning Center of Expertise
ft.	Foot/Feet
HEP	Habitat Evaluation Procedure
HGM	Hydrogeomorphic (or Hydrogeomorphic Method)
HSI	Habitat Suitability Index
HU	Habitat Unit
GIS	Geographic Information System
IEPR	Independent External Peer Review
in.	Inch
Lansat TM	Land Satellite Thermatic Mapper
LIDAR	Light Detection and Ranging
LMAV	Lower Mississippi Alluvial Valley

MAV	Mississippi Alluvial Valley
MDNR	Missouri Department of Natural Resources
MDOC	Missouri Department of Conservation
MRL	Mississippi River Levees
MoDOT	Missouri Department of Transportation
NRCS	Natural Resources Conservation Service
NEPA	National Environmental Policy Act
NED	National Economic Development
NGVD	National Geodetic Vertical Datum
NTP	Notice to Proceed
OEO	Outside Eligible Organization
OMB	Office of Management and Budget
PCX	Planning Center of Expertise
PDT	Project Delivery Team
POP	Period of Performance
PMIP	Planning Models Improvement Program
RMR	Resting Metabolic Rate
SI	Suitability Index
SJNM	St. Johns Bayou and New Madrid Floodway
SOW	Statement of Work
STAS	Short Term Analysis Service
TMDL	Total Maximum Daily Load
TME	True Metabolizable Energy
UMAV	Upper Mississippi Alluvial Valley
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
WAA	Wetland Assessment Area
WAM	Waterfowl Assessment Method
WET	Wetland Evaluation Technique
WRDA	Water Resources Development Act
WRP	Wetlands Reserve Program

1. INTRODUCTION

This addendum is a supplement to the *Final Independent External Peer Review Report, St. Johns Bayou and New Madrid Floodway, Missouri, Consolidated NEPA Document and Project Work Plan: Phase 2 Environmental, Economic, and Hydrologic and Hydraulic Review* (hereinafter referred to as the SJNM Final IEPR Report) submitted on April 28, 2010, by Battelle. The activities associated with this addendum to the SJNM Final IEPR Report were conducted under Contract No. W911NF-07-D-0001, Delivery Order: 09150, Delivery Order Number: 0666.

The addendum was prepared to document activities related to the independent external peer review (IEPR) comment/response process associated with the IEPR Final Panel Comments contained in the SJNM Final IEPR Report (Appendix A). The comment/response process is conducted after the Final IEPR Report is submitted to ensure that the IEPR Panel's (the Panel's) opinion and objectivity are not influenced by the U.S. Army Corps of Engineers (USACE). It is a critical part of the IEPR process because it allows the USACE Project Delivery Team (PDT) to understand the concerns of the Panel and also allows both the PDT and the Panel to discuss and agree to (if appropriate) actions to address the concerns. The comment/response process (the last step in the IEPR process following submission of the Final IEPR Report) usually involves a draft and final response from the PDT and a final response from the IEPR Panel. However, the PDT's draft Evaluator Responses included a list of detailed clarifying questions (instead of the typical Concur or Non-Concur responses), necessitating that the comment/response process be conducted over several iterations (defined as "rounds") for the IEPR Panel to respond to PDT questions. The results of the comment/response process are documented in this addendum report. For this IEPR, the comment/response process was coordinated by the Flood Risk Management Planning Center of Expertise (FRM-PCX) and Battelle. The comment/response process involved the Memphis District PDT responding to the IEPR Final Panel Comments (Evaluator Responses), and the IEPR Panel responding to the PDT Responses to the comments (BackCheck Responses). The details of this comment/response process are described in Section 2.

2. METHODS

The section provides a detailed description of the activities associated with each comment/response round conducted for this project. The schedule associated with these activities is shown in Table 1.

2.1. Round 1: Draft Comment/Response

Battelle posted 20 IEPR Final Panel Comments developed as part of the SJNM Final IEPR Report in USACE's Design Review and Checking System (DrChecks) on May 4, 2010. Table 1 shows the comment/response schedule, and Table 2 lists the Final Panel Comment statements (full IEPR Final Panel Comments, including the basis for comments, level of significance, and recommendations for resolution, are shown in Appendix A). Battelle received the draft Evaluator Questions/Responses from USACE on May 5, 2010. The draft Evaluator Questions/Responses consisted of a series of questions, clarifications, and responses to the IEPR Final Panel Comments. Following the receipt of the draft Evaluator Responses, Battelle instructed the Panel to prepare draft BackCheck Responses to the draft Evaluator Questions/Responses. Specifically, the lead panel member (i.e., author) for each IEPR Final Panel Comment was instructed to develop a draft BackCheck Response and circulate the response to the Panel for review. Once the draft BackCheck Responses were reviewed by the entire IEPR Panel, they were compiled and submitted to the FRM-PCX and PDT to facilitate discussion during the Draft Response teleconferences.

Due to the length of the questions and responses prepared by both USACE and the IEPR Panel, two Draft Response teleconferences were held on May 13, 2010, and May 17, 2010. Participants in these two teleconferences included the FRM-PCX, PDT, IEPR Panel, project sponsor, and review agencies to discuss the Panel's draft BackCheck Responses to the draft Evaluator Responses. At the close of the two teleconferences, 6 IEPR Final Panel Comments (Final Panel Comments 9, 10, 15, 16, 17, and 19) were resolved (i.e., USACE and the IEPR Panel both concurred with the Final Panel Comment and the questions/responses) and 14 IEPR Final Panel Comments required further discussion. The unresolved IEPR comments included the broad topic areas of Shorebirds, Hydrogeomorphic Method (HGM)/Wetland Mitigation, Fisheries, and Economics (Table 3) (full Draft Responses are shown in Appendix B).

2.2. Round 2: Final Preliminary Evaluator Response and Focus Groups

At the close of the two Draft Response teleconferences, USACE prepared a May 21, 2010, Final Preliminary Evaluator Response memorandum describing the unresolved issues relating to 10 of the 14 unresolved IEPR Final Panel Comments and providing further comment and clarification on primary areas of concern (Appendix C). Based on this memorandum, Battelle formed individual Focus Groups, each consisting of two to three subject matter experts from the IEPR Panel, to facilitate further discussion on the four topic areas. It was determined that the IEPR panel members with subject matter expertise on those topics would attend their respective Focus Group meetings and report the findings back to the IEPR Panel.

- Focus Group A (Shorebirds): IEPR Final Panel Comment 1 (Note: IEPR Final Panel Comment 2 is considered a subtopic of this Focus Group topic)
- Focus Group B (HGM/Wetland Mitigation): IEPR Final Panel Comments 7, 8, and 18 (Note: IEPR Final Panel Comment 6 is considered a subtopic of this Focus Group topic)
- Focus Group C (Fisheries): IEPR Final Panel Comments 3, 4, and 5
- Focus Group D (Economics): IEPR Final Panel Comments 11, 12, and 13

As noted above, IEPR Final Panel Comment 6 was determined to be a subtopic of IEPR Final Panel Comment 7 (Focus Group B: HGM/Wetland Mitigation) and was removed from further discussion as a separate comment. In addition, IEPR Final Panel Comment 2 was determined to be a subtopic of IEPR Final Panel Comment 1 (Focus Group A: Shorebirds) and was removed from further discussion as a separate comment. A portion of IEPR Final Panel Comment 14 (Subtopic: Cumulative Effects) and a portion of IEPR Final Panel Comment 20 (Subtopics: Gate and Pump Operation/Alternatives) were not resolved; however, the remaining concerns were considered minor and tabled until the Final Response process.

Battelle convened a teleconference on May 24, 2010, with the IEPR Panel to discuss the expertise necessary to respond to the four topic areas and to develop a Focus Group meeting schedule. The four Focus Group teleconferences were held with the PDT counterparts to the IEPR Panel subject matter experts. The PDT also invited the project sponsor and review agencies to participate in each Focus Group discussion.

The Focus Groups meetings were held over a two-week period starting May 28, 2010, and ending June 9, 2010. Subsequent to the close of the last Focus Group discussion, USACE determined that there was sufficient information for development of its final Evaluator Responses. This action concluded the activities associated with the draft comment/response process. The results of the Focus Group teleconferences are shown in Table 4.

2.3. Round 3: Final Comment/Response

The goal of the final round in the comment/response process was for the PDT and the IEPR Panel to reach "concurrence" on the 12 IEPR Final Panel Comments discussed in the Focus Group meetings. Battelle received the USACE final Evaluator Responses on July 14, 2010. The period of performance (POP) for the St. Johns Bayou Project Work Plan IEPR expired on July 31, 2010. Following the receipt of the final Evaluator Responses on July 14, 2010, no activities were conducted until Battelle received a contract modification revising the scope of work and extending the POP (authorization was received on August 17, 2010).

Once the panel members were under subcontract, a kick-off meeting was held on August 25, 2010, to provide the IEPR Panel with the July 14, 2010, USACE final Evaluator Responses and to discuss the overall Final Response schedule. The IEPR Panel was instructed to review the final USACE Evaluator Responses and prepare final BackCheck Responses. The lead panel member for each IEPR Final Panel Comment was instructed to develop a "draft" of the final BackCheck Response and circulate the draft Final Response to the Panel for review. A second Final Response teleconference was held with the IEPR Panel on August 31, 2010, to determine the panel members' preliminary review of their final BackCheck Responses. Battelle moderated

a third Final Response teleconference on September 15, 2010, for the panel members to review the compiled final BackCheck Responses. Once the final BackCheck Responses were reviewed by the entire IEPR Panel, Battelle submitted them to the FRM-PCX.

The PDT and the FRM-PCX requested a Final Response teleconference with the IEPR Panel to discuss a subset of the final BackChecks Responses − specifically, those responses indicating that the IEPR Panel did not concur with the USACE final Evaluator Response. This Final Response teleconference was held on September 8, 2010, with the FRM-PCX, PDT, IEPR Panel, and review agencies in attendance. At the close of this Final Response teleconference, 19 of the 20 IEPR Final Panel Comments were determined to be resolved as "Concur with Comment"(15) or "Concur" (4), with one IEPR Final Panel Comment unresolved. A second Final Response teleconference was held on September 15, 2010, to discuss the concerns relating to the unresolved IEPR Final Panel Comment 1 (Topic: Shorebirds).

At the close of this Final Response teleconference, the PDT and the IEPR Panel reached partial concurrence on the response to this remaining IEPR Final Panel Comment (Table 5) (full Final Responses are shown in Appendix D). The final BackCheck Responses were entered into DrChecks on November 4, 2010. A pdf printout of DrChecks and the addendum to the SJNM Final IEPR Report was submitted to USACE on November 5, 2010.

Table 1. SJNM IEPR: Project Work Plan Comment/Response Schedule

Activity	Due Date
Battelle submits Final IEPR Report	April 28, 2010
Draft Question/Comment/Response: Round 1	
Battelle inputs IEPR Final Panel Comments into DrChecks	May 4, 2010
USACE provides draft Evaluator Questions/Responses to Battelle	May 5, 2010
Draft Response Teleconferences between Battelle, IEPR Panel, and USACE to clarify questions and concerns on draft Evaluator Questions/Responses and draft BackCheck Responses	May 13, 2010, and May 17, 2010
Final Preliminary Evaluator Question/Response and Focus Groups: Round 2	
USACE prepares Final Preliminary Draft Evaluator Questions/Response memorandum in response to IEPR Panel concerns raised during May 13 and May 17 Draft Response teleconferences	May 21, 2010
Teleconference between Battelle and IEPR Panel to assign Focus Group (i.e., subject matter expert topic) responsibilities	May 24, 2010
Focus Group A(Shorebirds) Teleconference between Battelle, IEPR Panel, and USACE:	May 28, 2010
Focus Group B (HGM/Wetland Mitigation) Teleconference between Battelle, IEPR Panel, and USACE	June 4, 2010
Focus Group C (Fisheries) Teleconference between Battelle, IEPR Panel, and USACE	June 8, 2010
Focus Group D (Economics) Teleconference between Battelle, IEPR Panel, and USACE	June 9, 2010
USACE inputs final Evaluator Responses into DrChecks	July 14, 2010
St. Johns Bayou Project Work Plan IEPR: POP expires	July 31, 2010
Final Comment/Response: Round 3	
Contract modification received on St. Johns Bayou Project Work Plan IEPR	August 17, 2010
Teleconference between Battelle and IEPR Panel: Kick-Off for St. Johns Bayou Project Work Plan IEPR revised scope	August 25, 2010
Teleconference between Battelle and IEPR Panel to discuss BackCheck Responses to final Evaluator Responses	August 31, 2010
Final Response Teleconference between Battelle, IEPR Panel, and USACE to discuss the final Evaluator Responses and clarify questions	September 8, 2010
Final Response Teleconference between Battelle, IEPR Panel, and USACE to discuss the final Evaluator Response regarding the IEPR Panel Response on Final Panel Comment 1:Shorebirds	September 15, 2010
IEPR Panel submits final BackCheck Responses to final USACE Evaluator Responses in DrChecks	September 22 - October 5, 2010
Battelle enters final BackCheck Responses into DrChecks	November 4, 2010
Battelle submits Addendum to Final IEPR Report	November 5, 2010
Battelle submits pdf printout of DrChecks project file to USACE	November 5, 2010

Table 2. Final Panel Comments Identified by the SJNM IEPR Panel for the Final IEPR Report: Project Work Plan, Phase 2

IEPR Final Panel Comment	Significance – High
1	There are significant gaps regarding the application of the Shorebird Model, and the major concerns raised in the Phase 1 IEPR of the Consolidated NEPA Document have not been addressed.
2	The Project Work Plan does not respond to the concerns raised during the Phase 1 IEPR regarding the method to analyze the project's impact on shorebird habitat.
3	Information is not provided to support the importance of flood pulses (different from 2-year frequencies) in wetland ecosystems and for wetland-dependent organisms.
4	A more complete discussion of fish access in St. Johns Bayou and New Madrid Floodway is needed, and the potential quantification of losses and potential mitigation due to access restrictions must be addressed.
5	The fisheries methodology is not adequate to quantify actual spawning and rearing habitat based on Habitat Suitability Index (HSI) values.
6	The Waterfowl Assessment Method (WAM) appears to be appropriate; however, the parameter estimates for the model are based on fall migratory and wintering ducks and do not appear to consider spring migrants.
7	It is unclear if the application of the Hydrogeomorphic (HGM) approach to evaluate project impacts and develop proposed mitigation will yield scientifically credible results.
8	There is an insufficient level of detail in the Project Work Plan to evaluate the validity of the proposed compensatory mitigation plan.
9	The adaptive management plan requires a detailed analysis of the ongoing mitigation management costs and a clear funding source adequate to support those activities.
10	The methodology to determine the extent of the wetlands in the project area requires further detail to determine if it is valid.
11	The assessment of economic impacts of the proposed project may not be valid because the method used to document the future with and without project conditions, does not consider trends in real prices and costs.
12	The use of two discount rates for the same analysis is confusing and is not warranted in any conventional economic analysis.
13	The farming survey may not be credible unless a large enough sample size is used, producing a smaller statistical error for the analysis and avoiding many possible sources of bias.
14	The cumulative impact approach lacks specific information on how the conceptual matrix will be used to evaluate the incremental impacts of the proposed project or address the unique aspects of the study area.
15	More precise contour data (i.e., greater than a 1-foot contour interval) are required to estimate wetland availability and mitigation for waterfowl and shorebirds.

Table 2. Final Panel Comments Identified by the SJNM IEPR Panel for the Final IEPR Report: Project Work Plan, Phase 2, continued

IEPR Final Panel Comment	Significance – Medium
16	The list of significant resources is not complete because it does not include a discussion of the quality of the wetland resource, which is dependent upon the dynamic nature of the ecosystem's function and its connection to the river.
17	The water quality analysis in the Project Work Plan does not address water quality conditions in any of the study area water bodies and does not compare nutrient loads to the Mississippi River with and without project conditions.
18	The validities of several assumptions for the future without project alternatives are questionable.
19	The potential impact of global climate change on the proposed project and the conceptual mitigation plan should be acknowledged.
Significance – Low	
20	The gate closure and pump operation management alternatives proposed for St. Johns Bayou and New Madrid Floodway require further clarification.

Table 3. Draft Comment/Response[a] - Round 1: IEPR Final Panel Comment Status

IEPR Final Panel Comment	Draft Evaluator Response/Questions (Q)	Status at End of Round 1[b]	Path to Resolution/Remarks
1	17 questions (Q1a - Q1q)	**Unresolved**	**Focus Group A**
2	3 questions (Q2a - Q2c)	Unresolved subtopic: Additional comments noted during meeting	Subtopic of Final Panel Comment 1
3	2 questions (Q3a, Q3b)	Resolved: Q3b **Unresolved: Q3a**	**Focus Group C**
4	3 questions Q4a - Q4c	Resolved: Q4b **Unresolved: Q4a, Q4c**	**Focus Group C**
5	7 questions Q5a - Q5g	**Unresolved**	**Focus Group C**
6	6 questions Q6a - Q6f	Unresolved subtopic	Subtopic of Final Panel Comment 7
7	5 questions Q7a - Q7e	Resolved/No comment: Q7d, Q7e **Unresolved: Q7a – Q7c**	**Focus Group B**
8	4 questions Q8a - Q8d	Resolved/No comment: 8c **Unresolved: Q8a, Q8b, Q8d**	**Focus Group B**
9	2 questions Q9a, Q9b	Resolved/Comments noted	None required
10	Response only - no questions	Resolved/Comment noted	None required
11	1 question Q11	**Unresolved**	**Focus Group D**
12	1 question Q12	**Unresolved**	**Focus Group D**
13	1 question Q13	**Unresolved**	**Focus Group D**
14	Questions/Responses Q14a - Q14e	Resolved/Comments noted: Q14a, Q14e Unresolved: Q14b, Q14c, Q14d	Focus Group not required to resolve Q14b, Q14c, Q14d

Table 3. Draft Comment/Response - Round 1: IEPR Final Panel Comment Status, continued

IEPR Final Panel Comment	Draft Evaluator Response/Questions (Q)	Status at End of Round 1[a]	Path to Resolution/Remarks
15	Response only - no questions	Resolved/Comments noted	None required
16	6 questions/responses Q16a - Q16f	Resolved/Comments noted	None required
17	2 questions/responses Q17a, Q17b	Resolved/Comments noted	None required
18	3 questions/responses Q18a - Q18c	**Unresolved**	**Focus Group B**
19	Response only - no questions	No response required/Comment noted	None required
20	1 question Q20	Resolved/Comments noted	None required

[a.] Full draft Evaluator Responses and draft Panel BackChecks are shown in Appendix B.
[b.] Color-coded cells indicate unresolved questions sent to Focus Group.

Key:
= Focus Group A (Shorebirds)
= Focus Group B (HGM/Wetland Mitigation)
= Focus Group C (Fisheries)
= Focus Group D (Economics)

Table 4. Final Preliminary Comment/Response and Focus Group - Round 2: IEPR Final Panel Comment Status

IEPR Final Panel Comment	Final Preliminary Evaluator Question/Response[a] and Focus Groups			
	Status at End of Round 2		Focus Group Discussion	Potential Revisions to Response
	Resolved	Unresolved		
1	--	all	**A: Shorebirds**	**x**
2	--	N/A Subtopic of Final Panel Comment 1	N/A	N/A
3	Q3b	Q3a/R3-2	**C: Fisheries**	**x**
4	Q4b	Q4a, Q4c/R4-1, 4-2	**C: Fisheries**	**x**
5	--	x	**C: Fisheries**	**x**
6	--	N/A Subtopic of Final Panel Comment 7	N/A	N/A
7	Q7d, Q7e	Q7a – Q7c	**B: HGM/Wetland Mitigation**	**x**
8	RQ8c	Q8a, Q8b,Q8d R8-1, R8-2	**B: HGM/Wetland Mitigation**	**x**
9	all	--	N/A	N/A
10	all	--	N/A	N/A
11	--	x	**D: Economics**	**x**
12	--	x	**D: Economics**	**x**
13	--	x	**D: Economics**	**x**
14	Q14a, Q14e	--		N/A
15	all	--	N/A	N/A
16	all	--	N/A	N/A
17	all	--	N/A	N/A
18	--	x	**B: HGM/Wetland Mitigation**	**x**
19	No response required	--	N/A	N/A
20	all	--	N/A	N/A

[a]Full final Preliminary Evaluator Comment/Responses are shown in Appendix C.

Key:
= Focus Group A (Shorebirds)
= Focus Group B (HGM/Wetland Mitigation)
= Focus Group C (Fisheries)
= Focus Group D (Economics)

Table 5. Final Comment/Response[a] - Round 3: IEPR Final Panel Comment Status

IEPR Final Panel Comment	Final Comment/Response Status at End of Round 3			
	Final Evaluator Response	Final BackCheck Response		
		Resolved		Unresolved
		Concur	Concur with Comment	
1	Comment/Response Q1a - Q1q	Q1m - Q1q [b]		Q1a-Q1k
2	Recommendation 1-3 revised response		x	
3	Questions / Recommendation Q3a, Q3b/R3-1, R3-2		x	
4	Recommendations 1 and 2 revised response		x	
5	Recommendations 1 and 2 revised response		x	
6	Recommendation revised response		x	
7	Recommendation revised response		x	
8	Recommendation revised response		x	
9	Recommendation revised response		x	
10	Recommendation revised response	x		
11	Recommendation revised response		x	
12	Recommendation revised response		x	
13	Recommendation revised response		x	
14	Recommendation revised response		x	
15	Recommendation revised response	x		
16	Recommendation revised response		x	
17	Recommendation revised response		x	
18	Recommendation revised response		x	
19	Recommendation revised response	x		
20	Recommendation revised response	x		

[a.] Full final Evaluator Responses and final Panel BackChecks are shown in Appendix D.
[b.] An additional teleconference was held on Final Panel Comment 1, resulting in a split of "concur" and "unresolved" responses to the Q1a – Q1q.

This page intentionally left blank

Appendix A
IEPR Final Panel Comments

on the

St. Johns Bayou and New Madrid Floodway, Missouri
Final IEPR Report: Project Work Plan, Phase 2
Environmental, Economic, and Hydrologic and Hydraulic Review

This page is intentionally left blank.

Comment 1:
There are significant gaps regarding the application of the Shorebird Model, and the major concerns raised in the Phase 1 IEPR of the Consolidated NEPA Document have not been addressed.
Basis for Comment:
The Phase 1 IEPR of the Consolidated NEPA Document (Phase 1 IEPR) raised significant concerns regarding the application of the Habitat Model of Mitigating Shorebirds in the Upper Mississippi Alluvial Valley (Shorebird Model). The Project Work Plan does not include adequate detail to address how the analyses of impacts on shorebird habitat will be carried out, and therefore does not respond to the concerns raised in the Phase 1 IEPR Final Panel Comments. The future NEPA document will require the development of new techniques for estimating impacts on shorebird habitat that are not currently specified or described. Neither the Phase 1 IEPR nor the Shorebird Model Certification Review were able to address these issues, because the information supplied to the IEPR Panel was inadequate to base a review of the application of the Shorebird Model. Major issues raised in the IEPR that are not addressed in the Project Work Plan include the following: • The use of total sparsely vegetated area that is flooded and then exposed, rather than average or median area is recommended, because all sparsely vegetated and flooded areas become suitable habitat when exposed by receding flood waters. The Project Work Plan does not incorporate the key recommendation from the Phase 1 IEPR, that the <u>total</u> flooded area should be used to calculate shorebird habitat, rather than average habitat available by month. There are large differences between the amount of area where flooding is proposed to be reduced by the project, and the relatively much smaller area where shorebird habitat was calculated to be lost. This concern will not be addressed by the application of mean flood elevations as proposed in the Project Work Plan. As discussed in the mid-review conference call with USACE, the IEPR panel, and Battelle (March 17, 2010), the total sparsely vegetated area which is flooded and then exposed should be estimated and used as the input for the Shorebird Model. • The actual habitat value of moist soil units for shorebirds will be substantially less than calculated because the same units are being managed for waterfowl as well. The Project Work Plan does not include a response to this issue, which will require calculating reduced values for both species groups if the same area is to provide habitat for shorebird and waterfowl simultaneously. • 3. The long-term maintenance of the moist soil units will require extensive management in perpetuity. The Project Work Plan does not indicate that a permanent management plan will be included in the future NEPA document.
Significance – High:
The major concerns raised in the Phase 1 IEPR must be addressed prior to developing a detailed proposal to mitigate for shorebird habitat impacts.

Recommendations for Resolution:
To resolve these concerns, the future NEPA document should address the following: 1. Develop methods for calculating the total area of sparsely vegetated habitat that floods and is then exposed; these methods should be subjected to peer review. 2. Reduce the value of moist soil units for both shorebirds and waterfowl to reflect the difficulties of managing the same area for both species groups. 3. Develop a permanent management plan to ensure that the dynamic nature of the area to be impacted, and the high level of function that results, is replaced in perpetuity once natural function is lost.

Comment 2:

The Project Work Plan does not respond to the concerns raised during the Phase 1 IEPR regarding the method to analyze the project's impact on shorebird habitat.

Basis for Comment:

The Shorebird Model is a simple Habitat Suitability Index (HSI) model that discounts various habitat types by their relative value for migrating shorebirds, and employs commonly used approaches. The correct application of the Shorebird Model is critical because the acreage values used as inputs have the largest effect of any variable on the output of the model. Although the application of the model has not been adequately reviewed by the IEPR panel, the panel believes that the methods used in the future NEPA document were seriously flawed. Insufficient information was provided to the panel to review the model application, as detailed in the Phase 1 IEPR. The application of the model was specifically excluded from the Shorebird Model Certification Review (Battelle, 2010), which focused only on the technical quality and usability of the model and not on its application. Presumably, a new analysis and a new application of the model, potentially with modifications, is proposed, but this is not specified clearly in the Project Work Plan. A detailed review of the calculations of shallowly flooded areas used as inputs for the Shorebird Model, and the application of the shorebird Habitat Evaluation Procedures (HEP) models to those input values, still needs to be completed to determine if the methodology follows standard scientific procedures. It would be prudent to include this review during the early stages of the development of the future NEPA document, rather than after the future NEPA document is completed.

In addition, the Project Work Plan does not respond to several of the major concerns raised in the Shorebird Model Certification Review, because the Project Work Plan was written before the Model Certification Review had been completed. As a result, the Project Work Plan does not explain how these concerns will be addressed in the future NEPA document. Major issues that were not addressed include the following:

1. The use of more detailed elevation data to determine impact area. The Project Work Plan states that more detailed data are not available, but does not provide a plan for overcoming this limitation. During the mid-review conference call with USACE, the IEPR panel, and Battelle (March 17, 2010), the IEPR panel discussed the possibility of using total flooded area as an approach to resolving this issue. The total area flooded to any depth but subsequently exposed, plus the addition of the one-foot contour above the maximum flood extent, will likely include all water depths and all mudflats accessible to shorebirds.
2. The use of other variables known to be important for determining shorebird habitat value, including percent cover, proximity to other wetlands, and the amounts of mudflat habitat.
3. A description of how the HSI values were developed, and a justification for the values chosen.

- A description of how the Shorebird Model was developed, how it should be interpreted, the assumptions made, and the limitations of the model.

• Testing and validation of the Shorebird Model.
Significance – High:
The impacts of the proposed project on shorebird habitat cannot be determined without a thorough review of the methods to be applied in estimating those impacts.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should address the following: 1. Conduct a review of the application of the shorebird model; such a review did not occur either during the Phase 1 IEPR or during the Shorebird Model Certification Review. 2. Clearly outline the methods for carrying out the analysis of impacts on shorebird habitat before they are applied during the development of the future NEPA document. 3. Address all of the concerns raised in the Phase 1 IEPR and the Shorebird Model Certification Review.

Literature Cited:

Battelle Memorial Institute. 2010. Model Certification Review of the Habitat Model for Migratory Shorebirds in the Upper Mississippi Alluvial Valley Prepared for Department of the Army U.S. Army Corps of Engineers Ecosystem Restoration Planning Center of Expertise, Rock Island District, Battelle, Columbus, OH

Comment 3:
Information is not provided to support the importance of flood pulses (different from 2-year frequencies) in wetland ecosystems and for wetland-dependent organisms.
Basis for Comment:
Bottomland hardwood forests and backwater swamps are characteristic wetland ecosystems of the St. Johns Bayou and New Madrid Floodway. These ecosystems are adapted to, and nourished by, the flood-pulsing Mississippi and Ohio Rivers. Floodplain ecosystems depend on a pulsing hydrology of various amplitudes and frequencies (Junk et al., 1989; Odum et al., 1995), and when their hydrology is not altered they are generally most productive (Conner and Day, 1976; Mitsch and Ewel, 1979; Megonigal et al., 1997). Any changes in that pulsing can lead to suboptimal conditions. The Project Work Plan does not present adequate information regarding the impact of flooding frequency on ecosystem or community function, except for the assumption that 2-year frequency flood events will be used to determine the impacts on fish and shorebirds. Floodplain ecosystems and their biological communities are formed not only by annual and 2-year frequency floods, but also by dramatic floods of longer recurrence interval such as 25-year and 100-year flood events. Fluvial processes such as sediment deposition and erosion are often dramatic during these less frequent flood events. Fish and wildlife are influenced by these rare events, which generate new habitats, different hydrology, and major inputs of nutrients and sediments. The Consolidated NEPA Document and the Project Work Plan mostly ignore recurrence intervals above two years for fish. Pulsing hydrology is also an important consideration for shorebirds because of rare but important hydrologic processes such as development of new mudflats, yet only 2-year floods are described for their habitat as well.
Significance – High:
Changing either the frequency or amplitude of flooding on the project site has great implications on how well the impacts can be mitigated on site and on the ability of the site biota, especially fish and shorebirds, to adapt to that change in flooding.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should address the following: 1. Understand and recognize the importance of flood pulses to the remaining natural ecosystems on the site. 2. Consider impacts of these important seasonal pulses by evaluating the effects of floods with other than a 2-year recurrence interval.

Literature cited:

Conner, W. H., and J. W. Day, Jr. 1976. Productivity and composition of a bald cypress-water tupelo site and a bottomland hardwood site in a Louisiana swamp. *American Journal of Botany* 63:1354–1364.

Junk, W. J., P. B. Bayley, and R. E. Sparks. 1989. The flood pulse concept in river-floodplain systems. *In* D. P. Dodge, ed. *Proceedings of the International Large River*

Symposium. Special Issue of the Journal of Canadian Fisheries and Aquatic Sciences 106: 11–127.

Megonigal, J. P., W. H. Conner, S. Kroeger, and R. R. Sharitz. 1997. Aboveground production in Southeastern floodplain forests: A test of the subsidy-stress hypothesis. *Ecology* 78: 370–384.

Mitsch, W. J., and K. C. Ewel. 1979. Comparative biomass and growth of cypress in Florida wetlands. *American Midland Naturalist* 101:417–426.

Odum, W. E., E. P. Odum, and Odum, H.T. 1995. Nature's pulsing paradigm. *Estuaries* 18: 547–555.

Comment 4:
A more complete discussion of fish access in St. Johns Bayou and New Madrid Floodway is needed, and the potential quantification of losses and potential mitigation due to access restrictions must be addressed.
Basis for Comment:
Mississippi River fish access to spawning and rearing habitat is a critical component of this project. An evaluation of fish access, comparing the open New Madrid Floodway with the existing culvert access of the St. Johns Floodway, would quantify any access restriction due to the culverts. The fish access studies outlined in the Project Work Plan will provide data needed to assess fish movement into and out of the St. Johns Floodway in relation to river stage and water temperature. However, the Project Work Plan does not include a comparison between the gated St. John's Floodway and the currently open New Madrid Floodway. This information would allow a comparison of the scenarios needed to evaluate access restriction due to the culverts. In addition, monitoring fish access in the floodways during and after project construction and under varying gate operations is not mentioned in the Project Work Plan. Finally, the Project Work Plan does not identify a methodology that may be used to quantify the impact of restricted access on fish rearing and spawning or mitigation for the potential loss due to restricted access by the culverts or gate operations.
Significance – High:
River connectivity to the floodways allowing fish access for spawning and rearing is a significant ecological feature of floodplain river ecosystems and any potential impact should be quantified for the proposed project.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should address the following: 1. Expand current fish access studies in the St. Johns Floodway to include the New Madrid Floodway. This would allow a comparison of fish access between a culvert access floodway and an open access floodway. Noted fish access restrictions due to the proposed culverts or gates should be subject to a detailed compensation plan as part of the overall mitigation program. 2. Use existing gate operations to conduct a study to quantify fish access restrictions for each spawning period, including stage and water temperatures. Any impact or loss should then be compensated in the mitigation plan. If fish access is restricted, then nearby batcher land mitigation should be considered to offset spawning and rearing loss attributed to access loss.

Comment 5:
The fisheries methodology is not adequate to quantify actual spawning and rearing habitat based on Habitat Suitability Index (HSI) values.
Basis for Comment:
HSI values used for each of five spawning and rearing habitats represent a community-level perspective. However, the HSI values have not been empirically developed or evaluated within habitats of either floodway. Although the relative ranking of HSI values among habitats is supported in the Project Work Plan, quantitative HSI differences need to be determined since these differences will influence mitigation choices. In turn, mitigation choices may increase HSI values due to habitat classification changes and adaptive management scenarios. For example, changing from fallow habitat (HSI = 0.5) to bottomland hardwood (HSI = 1.0) suggests a doubling of habitat suitability for spawning and rearing for all periods. This is not supported in the Project Work Plan. This comment was also included in the Model Certification Review for Enviro Fish (Battelle, 2010). The Project Work Plan indicates that HSI values may change due to holding water during the entire spawning and rearing period even though the habitat complexity does not change. The Delphi Process will be employed to determine a new HSI value for these scenarios. Even without an HSI change, the habitat units (HUs) may increase appropriately if the number of days of suitable habitat within the spawning and rearing period increases due to holding water and increasing the average daily flooded acres (ADFAs) within the spawning and rearing periods.
Significance – High:
The HSI values are critical in calculating existing and lost HUs for project alternatives, as well as for evaluating mitigation alternatives.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should address the following: 1. Evaluate and compare existing spawning and rearing habitat types within the St. Johns and New Madrid floodways that will allow the development of quantitative HSI values for each habitat during each of the three spawning/rearing periods. 2. Evaluate any positive effects on spawning and rearing success in habitat types that may occur by holding water during the entire spawning and rearing period beyond any ADFA increase. 3. Monitor mitigation areas to determine if HSI values initially assigned are appropriate, or if adaptive management changes need to be considered to achieve the desired HUs.

Comment 6:
The Waterfowl Assessment Method (WAM) appears to be appropriate; however, the parameter estimates for the model are based on fall migratory and wintering ducks and do not appear to consider spring migrants.
Basis for Comment:
The current Waterfowl Assessment Method (WAM) is parameterized based on data collected from waterfowl wintering locations and adjusted for spring when data allow. Recent studies (see below) now provide estimates for these same parameters during the spring migratory period. For example, Hitchcock (2009) provides estimates of diets for five species of duck during spring migration. These data indicate aquatic invertebrates are a more important component of the diet in four of the five species than previously expected; thus the WAM should rely more on aquatic inverts during spring. Data from Eichholz and Yerkes (in prep.) indicate that spring migratory ducks are acquiring nutrient reserves during spring migration, thus the estimate of daily energy expenditure (DEE) used in WAM is likely an underestimate of true DEE during spring (this concern was also recognized during the Model Certification review for the Waterfowl Assessment Method, [Battelle, 2010]). Finally, aquatic invertebrate and moist soil seed availability estimated directly from samples collected during the spring migratory period differ considerably from estimates derived using the WAM model, especially for agricultural habitat.
Significance – High:
Use of the parameters outlined in the Project Work Plan may result in underestimating the required waterfowl habitat mitigation.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should use parameter estimates from data collected during the spring migratory period for parameterization of the model.

Literature Cited:

Battelle Memorial Institute. 2010. *Model Certification Review of the Waterfowl Assessment Method*. Prepared for Department of the Army, U.S. Army Corps of Engineers, Ecosystem Restoration Planning Center of Expertise, Rock Island District, under Contract Number W911NF-07-D-0001,Battelle, Columbus, OH.

Eichholz, M. W. and T. Yerkes *in prep*. Body condition of spring migratory ducks.

Hitchcock, A. N. 2009. Diet of spring-migrating waterfowl in the upper Mississippi River Great Lakes Region. M.S. Thesis. Southern Illinois University Carbondale, Carbondale, IL.

Straub, J. N. 2008. Energetic carrying capacity of habitats used by spring-migrating waterfowl in the Upper Mississippi River and Great Lakes Region. M.S. Thesis. The Ohio State University, Columbus, OH.

Comment 7:
It is unclear if the application of the Hydrogeomorphic (HGM) approach to evaluate project impacts and develop proposed mitigation will yield scientifically credible results.
Basis for Comment:
The Project Work Plan calls for the use of HGM (described in Klimas et al., 2009) to estimate wetland function lost and compare it to wetland function gained in mitigation. The procedure has been in development for over 20 years and has been used by USACE on many occasions. The IEPR panel recognizes that the HGM approach, even with its shortcomings, is one of the few methods available to compare wetland functions. Furthermore, the panel recognizes the need for a quantitative assessment of wetland functions to be used in impact evaluation and mitigation development. However, giving HGM "model" status implies that it has a dynamic modeling capability similar to the hydrologic models used by USACE. In ecology, and certainly in wetland ecology, data are generally ±20%. Such field data are used to estimate and calibrate functional capacity indices (FCIs, usually ranging from 0.0 to 1.0) in the HGM. In turn, these data are used to determine mitigation and impacts with the HGM approach. Given that the site is divided into many wetland types, it is obvious there are large data requirements to split the functions among these types with any degree of certainty. The panel does not believe that there is sufficient wetland science to support the detail required in the report for different wetland types. Therefore it is the IEPR panel's opinion that the method may not produce defensible data. The amount and type of mitigation for the proposed project are greatly dependent on the results obtained from the HGM model Furthermore, the Draft Model Certification Review Report for the HGM Guidebook (Battelle, 2010) stated that there "were some issues identified with the models' documentation, application, and variables, and some potentially serious errors were noted in the spreadsheet calculations and formulas." This HGM Model certification review did not provide assurance to the Phase 2 IEPR panel that this method will provide a scientifically defensible method for estimating impacts and mitigation. It also appears that all of the wetlands in this bottomland area should be categorized as "riverine" (see Table 9.2), with only a few categorized as lacustrine. To call some depressional and some fringe is not looking at the main forcing function of this system–the river–and it adds unwanted detail. Depressional or basin wetlands were originally meant to describe isolated wetlands, whereas fringe wetlands were mostly used for bidirectional coastal wetlands or lacustrine wetlands. Neither is usually associated with floodplain landscapes.

Significance – High:
The HGM model results may be of key significance in estimating the impacts of the entire project.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should address the following: 1. Use a safety factor as high as 4x (there are ample precedents for this) when estimating the amount and type of mitigation that this project should propose; this will resolve the uncertainty in the HGM method and its parameters. 2. Continue to evaluate other models that are more related to the function and structure of wetlands to assess comparison of wetland functions for mitigation. This of course will not be possible in the short term of this investigation.

Literature Cited:

Battelle Memorial Institute. 2010. *Draft Model Certification Review Report for the Delta Region of Arkansas Hydrogeomorphic Methodology (HGM) Guidebook*. Prepared for Department of the Army, U.S. Army Corps of Engineers, Ecosystem Restoration Planning Center of Expertise, Rock Island District, by Battelle, Columbus, OH.

Klimas, C.V., E.O. Murray, J. Pagan, H. Langston, and T. Foti. 2009. *Revision to the 2005 - A regional guidebook for applying the hydrogeomorphic approach to assessing wetland functions of forested wetlands in the Delta Region of Arkansas, Lower Mississippi River Alluvial Valley*. U.S. Army Corps of Engineers: Engineer Research and Development Center Publication ERDC/EL TR-04016

Comment 8:

There is an insufficient level of detail in the Project Work Plan to evaluate the validity of the proposed compensatory mitigation plan.

Basis for Comment:

There is insufficient detail on the method used to estimate wetland habitat loss and function. For example, the IEPR panel is concerned that the method to estimate changes of wetland functional condition among and within subclasses is not adequate. This concern is also emphasized in the Draft Model Certification Review Report for the HGM Guidebook (Battelle, 2010), which was provided to the panel during the review of the Project Work Plan. Furthermore, it is impossible to form an opinion as to whether mitigation will offset loss without greater detail in the proposed mitigation plan, For example:

- The plan does not describe how USACE will determine the environmental value of managed moist soil habitat when being managed to simultaneously support waterfowl, shorebirds, and fish. In addition, the Project Work Plan needs to state how management of moist soil units and levies for other inundated habitat will be funded in perpetuity to ensure that the habitat value of the units is adequate to replace lost wetland function.
- In Section 8.5.1 of the Project Work Plan, the discussion on reforestation is brief and lacks the necessary detail, considering the importance of this mitigation measure. The panel agrees that reforestation may need to include, in addition to planting appropriate tree species, restoration of topography and hydrology to be considered a successful mitigation measure.
- More detail is needed when identifying specifics of types of ecosystems that would be expected from this mitigation and time over which they will reach maturity or at least stability.
- There is too little detail in the methodology of the restoration of Big Oak Tree State Park to determine the feasibility of restoring Big Oak Tree State Park, given its importance to successful mitigation.

Significance – High:

The project success is dependent on determining the appropriate level of mitigation.

Recommendations for Resolution:

To resolve these concerns, the future NEPA document should address the following:

1. Provide more detail as to how wetland habitat loss and function will be estimated.
2. Provide more detail on how estimated wetland loss and function will be mitigated.

Comment 9:
The adaptive management plan requires a detailed analysis of the ongoing mitigation management costs and a clear funding source adequate to support those activities.
Basis for Comment:
Comparing the costs and benefits of the proposed project requires a complete accounting of the costs. One major cost associated with the mitigation plans proposed in the Consolidated NEPA Document, and discussed in detail in the Phase 1 IEPR, is the monitoring and management required to successfully implement an adaptive management program. The mitigation sites cannot be managed adaptively without both an ongoing monitoring program sufficient to detect areas where actual function falls short of proposed goals, and a management program designed to correct those inadequacies. In addition, general ongoing management is required for moist soil management impoundments in perpetuity for them to function effectively and provide high levels of wildlife habitat for waterfowl and shorebirds. The Phase 1 IEPR pointed out the lack of a designated funding source for these ongoing activities, and the Project Work Plan does not include a proposal to address this issue. In addition, the adaptive management discussion leaves most details to be addressed during the development of the future NEPA document. The IEPR panel suggests that the Project Work Plan would be significantly improved by a discussion of possible monitoring results that would trigger management changes for each of the significant resources.
Significance – High:
Without a demonstrated source of funding, adaptive management cannot be applied to the mitigation sites, and therefore full mitigation for project impacts cannot be achieved.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document must include a source of funding for adaptive management activities, including ongoing monitoring and management as part of the mitigation plan.

Comment 10:

The methodology to determine the extent of the wetlands in the project area requires further detail to determine if it is valid.

Basis for Comment:

An accurate measure of wetland types in the project area is one of the important pieces of information needed to make a fair assessment of wetland impacts and mitigation. The IEPR panel notes that the Project Work Plan calls for a generally appropriate approach to estimating wetland area. Areas that meet the definition of wetlands based on hydrology and soils will be considered wetlands. Given the extensive agriculture and other management on the site over the years, this appears to be an acceptable definition.

The panel is also pleased to see that an interagency team is being used to assess the overall effect of the project on wetlands. The team properly includes state agencies, USEPA, and USACE. It is not clear why USFWS is not included.

The panel is concerned that the level of detail in the methodology presented is not sufficient to determine how well that inventory will meet the needs of this Project Work Plan:

- The description of a wetland "scene" includes identification of soils from hydric soils and hydric soil inclusions on USDA soil maps, identification of wetland hydrology in the growing season from site hydrology data, estimates of growing season, and a model WETSORT. The panel was provided with little detail on what the model WETSORT does. It is a key component to this estimate of wetland area.
- For field sampling, the Project Work Plan suggests that random set of plots/samples will be used. It is not clear how many will be taken; the panel needs this information to determine the precision of the wetland area estimates.
- Agricultural land is one of the important variables in estimating the extent of wetlands. How much of the site will be exempted because it is agricultural land? Will it always be exempted or can it convert to jurisdictional wetland some day? There are also agricultural wetlands (agricultural fields that seasonally flood) that have major implications for shore birds.

Significance – High:

An accurate determination of the area of wetlands is needed to estimate the impact of this project.

Recommendations for Resolution:

To resolve these concerns, the future NEPA document should address the following:

1. Provide a more detailed description of the methods needed for estimating the area of wetlands, especially on the field sampling, to determine the total area of wetlands on the site.
2. Provide details of the WETSORT program.

Comment 11:
The assessment of economic impacts of the proposed project may not be valid because the method used to document the future with and without project conditions does not consider trends in real prices and costs.
Basis for Comment:
The project's projected net benefits largely pertain to agricultural profits in the future; therefore, a good understanding of potential future costs and revenues is essential. A complete stream of net benefits to agricultural producers fundamentally depends on real trends in prices and costs. The issue is not about inflationary trends in general (all prices for all commodities in the country or region moving up or down), as price indexes typically are used to examine inflationary trends. The primary concern is about future changes in real prices and costs because of possible changes in the importance of agriculture. It is impossible to know the future with certainty, but a regular part of economic analysis under uncertainty considers various possible scenarios. For instance, future real (inflation-adjusted) agricultural prices may rise because of increasing relative scarcity of agricultural land and water. Agricultural land has declined in the United States because of conversion to other uses. In addition, water scarcity may be a future issue due to global warming. Energy prices may also rise as society converts to alternatives to fossil fuels. Thus, real price and cost changes may be a reality for agricultural producers in this and other regions of the United States.
Significance – High:
Nearly all project benefits relate to agricultural profits for the life of the project, and fundamentally depend on future prices and costs.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should address the following: 1. The agricultural crop price indexes from the Economic Research Service should first be carefully evaluated for signals of trends in real (inflation adjusted) crop prices. 2. The economic analysis (the benefit-cost analysis) should be conducted under various scenarios pertaining to future price and cost changes, considering for example, a constant real rate of growth in prices, a zero rate of growth, and perhaps a decline in the real rate of change in prices. Similarly, such scenarios might be done as well, for key agricultural input costs, such as energy.

Literature Cited:

Cline, William R. 2007. *Global Warming and Agriculture: Impact Estimates by Country*. Washington D.C.: The Peterson Institute.

Hertel, Thomas W. et al. 2010. *The poverty implications of climate-induced crop yield changes by 2030*. GTAP Working Paper No. 59, Center for Global Trade Analysis.

Comment 12:
The use of two discount rates for the same analysis is confusing and is not warranted in any conventional economic analysis.
Basis for Comment:
Multiple discount rates are used in the economic analysis: the first discount rate is grandfathered in and this rate is used for selected parts of the project and selected years of the project. The second rate used in the analysis is a more current rate that is applied to other parts and years pertaining to project impacts. The standard procedure for benefit-cost analysis dictates that an analysis be prepared using a single discount rate for all benefits and costs, including all years of construction and operation of the project. The primary reason for this rationale is that the use of a single rate provides consistency in decision-making: once society commits to a project, it would be inconsistent to stop half-way through and decide a different discount rate should be used from then on, because this may suggest the project never should have been undertaken in the first place (Heal, 2009). Federal projects are evaluated using guidelines for a single discount rate provided by the Office of Management and Budget, but because of controversy over exactly what this rate should be, the current recommendation is to evaluate projects at 3% and 7%, conducting separate analysis with each rate. The project's grandfathered rate of 2.5% is lower than either current rate; therefore, evaluating all impacts at this rate results in a different benefit-cost ratio than would result from using 3% or 7%. In response to new theoretical economic analysis pertaining to the discount rate, the current procedure for calculating the benefit-cost analysis using a single discount rate for the entire period is under debate. The new findings suggest that society's true discount rate may actually fall over long periods of time, not rise. Therefore, using one single discount rate for the entire period may not be consistent with society's preferences. Laibson (1997) and Weitzman (1998) suggest that it is appropriate to use a higher discount rate at the beginning of the project, and a lower one much later in the profile of analysis, such as 40 or 50 years out. The project's use of the grandfathered rate and a second, higher discount rate for later years implies the opposite of what the literature finds. Since dictated and federally mandated procedures have not yet changed in response to this emerging literature, the current analysis needs to use the single discount rate approach.
Significance – High:
The project's benefit-cost ratio fundamentally depends on the chosen discount rate.

Recommendations for Resolution:
To resolve these concerns, the future NEPA document should address the following: 1. First, the benefit-cost-analysis should first be conducted in its entirety for a well-defined period beginning with the very first project construction (for which only costs, and no benefits would be expected in the profile), and extending through the life of the project, using a single discount rate of 2.5%. 2. Second, the benefit-cost analysis (i.e., entire accounting exercise) should then be repeated at the single discount rate of 3%, and then repeated again at the single discount rate of 7%, resulting in three benefit-cost ratios, one for each discount rate assumed. 3. Results from each analysis, i.e. for each discount rate, should be clearly presented and contrasted to show the effect of using the range from lower to higher discount rates. This is consistent with doing sensitivity analysis for a long-term project.

Literature Cited:

Heal, Geoffrey, 2009. Climate economics: A meta-review and some suggestions for future research. *Review of Environ. Econ. and Policy* 3(1/Winter):4-21.

Laibson, D. 1997. Golden eggs and hyperbolic discounting. *Quarterly J. of Economics* 112:443-477.

Weitzman, M.L. 1998. Why the far-distant future should be discounted at its lowest possible rate. *J. of Environ. Econ. and Manage*. 36:201-208.

Comment 13:
The farming survey may not be credible unless a large enough sample size is used, producing a smaller statistical error for the analysis and avoiding many possible sources of bias.
Basis for Comment:
Most, if not all, of the project's benefits relate to agricultural net benefits, which in turn, relate to before- and after- production decisions. These decisions cannot be determined without conducting a survey, which USACE acknowledged in the Project Work Plan. This survey will be a very difficult task, as credible survey results relate to large, unbiased samples of the population of interest, which in this case, will be the population of affected farmers. The opportunity for strategic bias is strong because the farmers have a vested interest in the project. Therefore, a careful survey design must ensure responses that are incentive compatible (consistent with true underlying preferences and beliefs). Sample selection bias may also be an issue as often only those most interested in the project will respond to a survey. The results will then pertain to biased samples, not the general population. Strategic bias may also be a factor in influencing the outcome of the analysis. Strategic bias occurs when individuals do not respond truthfully to questions, and are smart enough to see that by over or under-stating responses to the survey. The IEPR panel notes that experimental procedures used by psychologists and increasingly, by experimental economists, might be used to design laboratory experiments that will identify several types of bias, provide incentive compatibility and meaningful results for small samples of subjects. Using a laboratory setting provides controls that survey-settings (mail, telephone, or even in-person), do not.
Significance – High:
Agricultural production decisions and behaviors after flood risks have been reduced must be convincingly identified or the project's main economic benefits cannot be calculated. Because this must be done before actual flood risk reductions are realized, a survey of farmers must be implemented to provide a convincing and credible analysis of these decisions and behaviors.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should address the following: 1. Mention the above details in the scoping the future NEPA document. 2. State that state-of-the-art survey or experimental design will be conducted when the time comes to research behaviors of farmers in the region.

Comment 14:
The cumulative impact approach lacks specific information on how the conceptual matrix will be used to evaluate the incremental impacts of the proposed project or address the unique aspects of the study area.
Basis for Comment:
The Consolidated NEPA Document provided a descriptive historical account of the St. Johns Bayou and New Madrid Floodway, along with statistics on acres of present land uses, but did not provide an analysis of the incremental impacts of the proposed project within the context of the cumulative loss of wetlands and river-floodplain connections in the lower Mississippi River Basin. The Project Work Plan proposes a conceptual matrix that will incorporate information on causes, processes, and effects of all project alternatives. This conceptual approach will include historic habitat condition, past impacts that have contributed to the overall decline of habitat in the project area, future impacts that will continue the decline of the habitat, and potential future benefits. In addition to the project area, the cumulative effects assessment will include applicable areas within the lower Mississippi River Basin, such as the remaining batture areas and backwater areas located within adjacent states. The proposed conceptual matrix is a necessary first step, but it is not considered a detailed methodology. According to the Council on Environmental Quality (1997), after developing a conceptual framework, the analyst must choose a methodology to determine and evaluate the cumulative effects of the proposed project. While a matrix is one of 11 generic methods summarized in the CEQ guidance, it does not constitute a methodology with specific spatial and temporal boundaries, as well as thresholds of significance (e.g., capacity of the resources to accommodate stress). In particular, the Project Work Plan lacks specific information on how the proposed conceptual matrix will address the unique aspects of the study area. The Project Work Plan should describe how the methodology will weigh each factor in determining whether the cumulative effects are significant.
Significance – High:
An accurate assessment of cumulative effects is essential to avoiding and minimizing adverse consequences, and to developing an adequate compensatory mitigation strategy.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should address the following: 1. Identify the specific methodology for using the proposed conceptual matrix to address the incremental impacts of the proposed project and the unique aspects of the study area. 2. Identify how the results and findings from this methodology will be used in the decision process for the proposed project.

Literature cited:

Council on Environmental Quality. 1997. *Considering Cumulative Effects under the National Environmental Policy Act*. January.

Comment 15:
More precise contour data (i.e. greater than a 1-foot contour interval) are required to estimate wetland availability and mitigation for waterfowl and shorebirds.
Basis for Comment:
The IEPR panel is concerned that the 1-foot contour interval outlined in the Project Work Plan will not provide adequate precision to estimate wetland loss and to determine shallow water wetlands necessary for mitigation of shorebird and waterfowl habitat. For example, the Shorebird Model Certification Review (Battelle, 2010) requests using survey data taken from 0.1 ft contour intervals. Furthermore, waterfowl require water depths less than 12-15 inches for foraging.
Significance – High:
The use of a 1-foot contour interval to determine the availability of shallow water wetlands may lead to underestimating the existing resources and the requirements to replace habitat impacted by the proposed project.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should consider using mapping with a contour interval of 0.25 - 0.50 feet to estimate wetland loss and function and to mitigate estimated habitat losses.

Literature cited:

Battelle Memorial Institute. 2010. *Model Certification Review of the Habitat Model for Migratory Shorebirds in the Upper Mississippi Alluvial Valley*. Prepared for Department of the Army, U.S. Army Corps of Engineers, Ecosystem Restoration Planning Center of Expertise, Rock Island District, by Battelle, Columbus, OH.

Comment 16:
The list of significant resources is not complete because it does not include a discussion of the quality of the wetland resource, which is dependent upon the dynamic nature of the ecosystem's function and its connection to the river.
Basis for Comment:
The river-floodplain connection has significant impacts on the maintenance of wetlands and on the flooded areas providing shorebird habitat, even if these areas do not meet the wetland requirements for duration of saturation. Removing the connection will change the ecological function of the remaining wetlands significantly, and, in turn, affect wildlife habitat. The impact of removing this connection on wetland function and value should be analyzed fully, so that its effect on wetlands and their wildlife habitat values is completely documented, and mitigation for all impacts can be carried out. As noted in the Project Work Plan, the list of significant resources should include all of the types of habitats within the project area. In addition, the list should also include the characteristics of the habitats that affect their function and make them unique. The project area includes the only significant remaining section of floodplain where Mississippi River backwater flooding still occurs. The dynamic nature of the hydroperiod is a significant aspect of the wetland resources in the project area. This is a critical characteristic of the wetlands that would be affected by the project. Dynamic hydroperiods significantly affect the function of wetlands in many ways, including their ability to process nutrients and to provide wildlife habitat. The river connection allows the exchange of nutrients between the wetland systems and the river, which is a unique aspect of riverine wetland function. Mitigation for the loss of wetland function will be more difficult to achieve because of the loss of this dynamic hydroperiod. Planning a mitigation proposal that replaces all of the lost wetland functions will require that the dynamic nature of the wetlands that occur in the project area be replaced, so this aspect of the existing resources should be stressed in the significant resources list.
Significance – Medium:
Mitigation of proposed project impacts requires a complete list of site resources. To be complete, the list of resources should include the unique nature of the wetland ecosystem.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should add a discussion to the list of resources that clearly describes the unique nature of the wetlands in the project area, including the features that result from a dynamic water level and periodic flooding by the river.

Comment 17:
The water quality analysis in the Project Work Plan does not address water quality conditions in any of the study area water bodies and does not compare nutrient loads to the Mississippi River with and without project conditions.
Basis for Comment:
The Project Work Plan states that the water quality analysis completed in the Consolidated NEPA Document will be re-analyzed utilizing updated land cover data, period of record, and corrected denitrification rates from inundated farm fields. Although these re-analyses are appropriate and will improve the water quality analysis, they will still not meet the stated water quality objectives of the study for the same reasons the analysis in Consolidated NEPA Document failed to do so. First, the mass balances to be conducted do not represent water quality conditions in any of the waterbodies in the project area (St. Johns Bayou and New Madrid Floodway) under current conditions (without project) or with the proposed project, but only the total amounts of mass transported or retained. Second, these mass balances did not compare nutrient loads from the project area to the Mississippi River under current conditions (without project) to those with the proposed project. They compared nitrogen removal efficiencies at an assumed water surface elevation of 290 feet NGVD between current conditions (without project) and with mitigation associated with restored acreage. None of the hydrologic scenarios in the Consolidated NEPA Document accurately represented the actual project because each considered the same flooded acres at 290 feet NGVD, whereas the proposed project involves blocking the water level beyond 284.2 feet NGVD in the New Madrid Floodway.
Significance – Medium:
It will not be possible to draw any conclusions about whether water quality in both basins (St. Johns Bayou and New Madrid Floodway) will remain unchanged because the proposed analysis does not include investigations of local water quality in either basin under actual project conditions.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should address the following: 1. Conduct quantitative assessments of the impacts of the actual proposed project on waterbodies in the St. Johns Bayou and New Madrid Floodway. 2. Conduct a quantitative assessment of the nutrient loads from the project area to the Mississippi River under the actual proposed project.

Comment 18:
The validities of several assumptions for the future without project alternatives are questionable.
Basis for Comment:
The Project Work Plan makes a number of assumptions regarding the future without project conditions. While the IEPR panel recognizes that it is impossible to predict the future, the panel believes there is ample evidence to indicate that three of these assumptions are invalid. • The panel questions the validity of the assumption "There will be no change in overall land use" (Project Work Plan 8.3). Flood-prone agricultural habitat in areas near but outside the project area have been enrolled in the Natural Resources Conservation Service (NRCS) Wetlands Reserve Program (WRP). Based on this activity, the panel believes the potential for this project has prevented farmers within the project area from doing the same. If this project were abandoned, the panel believes a number of the frequently flooded fields would be enrolled in WRP. The USACE appears to recognize the potential for wetland restoration through WRP with a footnote and suggests this statement may change with the development of the future NEPA document. The panel suggests it would be more appropriate to recognize the potential influence of the WRP. • The panel questions the validity of the assumption "Existing drainage ditches and infrastructure will be maintained" (Project Work Plan 8.3). While the panel agrees that drainage structures will be maintained on farmed lands, we believe a substantial component of the frequently flooded areas will be enrollment in WRP, thus likely leading to a modification of some of the ditches and drainage structures. This is not considered in the Project Work Plan. • The panel questions the validity of the assumption "No plans with funding mechanism have been identified to restore Big Oak Tree State Park. Therefore, the observed progression from hydric vegetation to drier species will continue to occur" (Project Work Plan 8.3). It is the panel's understanding that the State of Missouri appropriated $1.5 million in 1996 to restore hydrology to the park but abandoned the project when it became part of the planning for St. Johns Bayou. Thus, the panel believes that if the St. Johns Bayou project is abandoned, resources from the State of Missouri to restore hydrology to the park would likely again become available.
Significance – Medium:
The validity of the assumptions used to determine impacts for the without project alternative affects the completeness and understanding of the Project Work Plan and the justification of the project.

Recommendations for Resolution:
To resolve these concerns, the future NEPA document should address the potential for the Wetlands Reserve Program and the likelihood that the State of Missouri will restore hydrology to Big Oak Tree State Park.

Comment 19:
The potential impact of global climate change on the proposed project and the conceptual mitigation plan should be acknowledged.
Basis for Comment:
The IEPR panel generally agrees with the strategy outlined in the Project Work Plan (Section 8.3.1, Global Climate Change [pages 36-37]), but also must emphasize the need to qualitatively assess the potential effects of climate change, recognizing the additional uncertainty imposed on planning and decision-making processes by these effects. Use of historical hydrology in the studies is necessary; however, a qualitative consideration of possible impacts on proposed flood control and environmental mitigation plans by potential future changes in hydrology resulting from global warming or other factors is appropriate. The need to consider how climate change can affect the environment of a proposed action is included in the February 18, 2010 memoranda from the Council on Environmental Quality (CEQ). The online Water and Climate Bibliography (http://biblio.pacinst.org/biblio/) maintained by the Pacific Institute contains more than 4,300 publications dealing with the impacts of climate change on hydrology. Numerous studies are reported in the literature in which global circulation models (GCMs) are combined with watershed precipitation-runoff models to assess the impacts of global warming on hydrology. The capabilities of GCMs to predict future climate are generally recognized as approximate, strongest in predicting temperature changes, and weak in predicting precipitation changes. Climate change modeling capabilities are strongest in predicting changes over large regions of the world and weak in downscaling to watersheds. Thus, the panel agrees that accurate quantitative predictions of future changes in stream flow characteristics at the project site would be extremely difficult, if not impossible. Hydrology is highly variable and uncertain even without consideration of future long-term climate change owing to global warming, which adds to the uncertainties. Key questions to be acknowledged and discussed in the studies are as follows: • What is the effect on proposed flood control and environmental mitigation plans if stream flow characteristics are different in the future than indicated by historical hydrology? • How robust are recommended plans to variations in hydrology?
Significance – Medium:
Although highly uncertain, the potential effects of climate change have important consequences for the project and mitigation plans, and therefore an assessment of these effects is needed to support a complete evaluation as required by NEPA.

Recommendations for Resolution:
To resolve these concerns, the future NEPA document should, at a minimum, address the impacts of potential future climate impacts on the project and proposed mitigation plan on a qualitative basis.

Literature cited:

Council on Environmental Quality. 1997. *Considering Cumulative Effects under the National Environmental Policy Act*. January.

Comment 20:
The gate closure and pump operation management alternatives proposed for St. Johns Bayou and New Madrid Floodway require further clarification.
Basis for Comment:
The Project Work Plan states that a variety of adaptive management scenarios would be explored (Section 8.4.2.1 and 8.4.2.2, subheading Gate and Pump Management). The list includes gate closings for falling river stages during fish spawning and rearing seasons to create a spawning and rearing pool. This action could prolong an existing spawning and rearing pool created by backwater flooding from the river and watershed runoff. However, if the gates are closed, the pool would not be created by river backwater flooding as implied in the Project Work Plan, since the river is disconnected from the floodways. During gate closure and falling river stages, the pool would be maintained only through watershed runoff and site-specific floodway water control structures. However, this scenario assumes that fish have already entered the floodways from the river prior to gate closure. Overall, the timing and environmental conditions during this scenario are critical and bring into question fish floodway access opportunities during periods of gate closure.
Significance – Low:
For a successful project, it is important to maintain existing fish access and to create and maintain a spawning and rearing habitat in the floodways.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should include a more detailed description of how gate and pump management will: 1. Achieve project objectives for each of the alternatives (flood frequency elevations and/or inundated acres). 2. Provide fish access during appropriate river stage and water temperature periods.

This page intentionally left blank

Appendix B
Draft Evaluator Questions/Responses and Draft BackCheck Responses

for the

St. Johns Bayou and New Madrid Floodway, Missouri
Project Work Plan, Phase 2
Environmental, Economic, and Hydrologic and Hydraulic Review

This page intentionally left blank

Comment 1:
There are significant gaps regarding the application of the Shorebird Model, and the major concerns raised in the Phase 1 IEPR of the Consolidated NEPA Document have not been addressed.
Significance – High:
The major concerns raised in the Phase 1 IEPR must be addressed prior to developing a detailed proposal to mitigate for shorebird habitat impacts.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should address the following: 1. Develop methods for calculating the total area of sparsely vegetated habitat that floods and is then exposed; these methods should be subjected to peer review. 2. Reduce the value of moist soil units for both shorebirds and waterfowl to reflect the difficulties of managing the same area for both species groups. 3. Develop a permanent management plan to ensure that the dynamic nature of the area to be impacted, and the high level of function that results, is replaced in perpetuity once natural function is lost.
Draft Evaluator Response in bold ***Draft Panel BackCheck in italics***
Question 1a: Given that the project area was historically a bottomland hardwood that provided minimal shorebird habitat (due to vegetation), is existing shorebird habitat due to a manipulated (*i.e.,* farmland) condition or something else? *The Panel's understanding is that the goal of the mitigation plan as proposed by USACE is to compensate for any difference in with-project conditions relative to current without-project conditions. Current shorebird habitat includes all areas of shallowly flooded and sparsely vegetated area exposed by natural drawdowns, which include both wetlands and farmed flooded areas.* **Question1b:** Are shorebird numbers greater than or less than historic population levels and if so, why? *Many species of shorebirds have experienced dramatic population declines since historical levels (Brown et al. 2001). In addition, many species continue to experience significant declines in the recent past (Morrison et al. 2006, Bart et al. 2007). The causes for these declines are not well understood, but are thought to include habitat loss, increases in predation pressures, historical hunting impacts, climate change, and a variety of other factors. Habitat losses on migration may be an important factor (Skagen 2006) , which makes mitigation for loss of foraging habitat on migration important.* **Question 1c:** What is the limiting factor (number of acres of habitat) that maintains shorebird population (*e.g.,* If the project area reduces inundated habitat by 50%, will this impact overall shorebird numbers) in regards to the project area?

Currently available data are sufficient to determine population limiting factors for only a small number of shorebird species. Skagen (2006) argues that migration habitat may be limiting for some small shorebirds common in the project area.

Question 1d:
Since shorebirds are opportunistic and since there will likely be available habitat throughout the LMAV during the spring, will reducing inundated habitat in the project area significantly impact shorebird populations and why? For example, available habitat will remain immediately adjacent to the project area.

As stated above, it is impossible with current data to determine the population level impact of the loss of a particular amount of habitat. However, it is the Panel's understanding that the goal of the mitigation plan is to replace all lost habitat functions of current without-project conditions that would occur with implementation of the project.

Question 1e:
Regarding the statement develop "methods for calculating the total area of sparsely vegetated habitat that floods and is then exposed; these methods should be subjected to peer review."

The Panel supports the development of a new methodology for calculating impacts of the proposed project to shorebirds, but maintains that the procedures should be fully developed, justified with a literature review, and then subjected to a model certification review.

(1) First issue discussed
Question 1f:
The following Shorebird Methodology (Twedt, personal communication) is proposed:

1. Discussion of elevation contours is required during the teleconference, specifically interpolation of elevations <1-foot.
2. Most shorebirds use suitable habitat within the St. Johns and New Madrid Basins as foraging habitat during spring (northbound) and fall (southbound) migration with few species and individuals breeding or over-wintering within these Basins.
3. Migration periods will be restricted to 15 April – 15 May during spring and 15 July – 15 October during fall.

Selection of the migration period is a critical factor in designing an adequate mitigation plan, and these dates should be given further review. One major document on the timing of migration in the region suggests that these windows would contain the peaks of migration, but are too narrow to include the full migration period (Skagen et al. 1999). For the latitude band of the project, 35-40 degrees North in spring, Skagen et al. show the migration window as including approximately March 15th through June 15th for all shorebirds (Skagen et al. 1999, p. 17). Particularly for small sandpipers, the distribution indicated on p. 27 includes substantial numbers throughout most of that period in spring. For fall migration for small sandpipers, the period includes July 1 through October 30 (p. 27). Additional review of available data should be conducted to ensure that the full migration period is considered

USACE Response/Question 1g:

4. Small and medium sized shorebirds that forage primarily in water depths from 0 – 9 cm
5. (0-4 inches) represent the preponderance of shorebirds likely to use the St. Johns and New Madrid Basins.
6. These shorebirds, and other less abundant shorebirds, may also forage in exposed mudflat habitat and in floodwater of depth from 9-18 cm (4-8 inches).Sparsely vegetated areas (e.g., cropland, bare soil, grasslands) that are exposed or shallowly (<8") flooded within the previous 2 days will be counted as suitable shorebird habitat (*i.e.,* mudflats).
7. Shorebird habitat will be separated into optimal (< 4 inches) and sub-optimal (4-8 inches including areas of exposed mudflats).

Recently exposed mudflats are likely to be valuable shorebird habitat. The Panel agrees that water deeper than 4 inches is likely to have less use than shallow water, but lumping mudflats with deep water does not seem appropriate. The panel recommends that the final categories chosen for use in the EIS analysis be developed based on a thorough review of available scientific information and a peer review process.

Question 1h:

7. These categories will be summed on each day during the spring and the fall migration periods over the period-of-record. These estimates will quantify the total, temporally available, shorebird habitat during spring and fall migration periods as a total "ha-days" of shorebird habitat. Separate estimates will be made for each migration period and separate yearly estimates will be possible for each year from which Mississippi River stage data are available (entire period of record).

The Panel is pleased to see the use of total area, as recommended in the Phase 1 IEPR process, and believes this approach will provide a much more reliable estimate of habitat value across the project area.

[Note that 1 ha-day of shorebird habitat represents 1 ha of sparsely vegetated habitat under suitable flood conditions for a period of 1 day.]

Question 1i:

Sub-optimal areas will have a HSI value of 0.5.

The choice of value has a significant impact on the calculation of mitigation area required, so should be fully justified when the mitigation plan is developed, and should be subjected to peer review. The literature cited below documents less use of shorebirds in deeper water, but does not unambiguously support this value as being the most appropriate.

USACE response continued:

Optimal areas will have a HSI value of 1.0. Justification for optimizing shallowly flooded areas is based on observed shorebird abundances as reported within the Lower Mississippi Valley Joint Venture Shorebird Monitoring Program (http://www.lmvjv.org/shorebird/default.asp), Loesch et al. (1999), and Elliott and McKnight (2000). As further confirmation, Davis (1996), in his assessment of shorebird use of Playa Lake wetlands, reported between 39% and 46% of shorebird flocks (weighted for abundance) used areas with water depth < 4 cm (<2 inches), circa 30% of shorebird flocks used areas

with water depth of 4 – 16 cm (circa 2-6 inches), whereas only 19% of shorebird flocks used mudflats, and <8% used areas within water depth >16 cm (>6 inches).

Project impacts will be calculated for each alternative and is defined as the difference between future without project conditions and future with project conditions.

USACE response/Question 1j:
Moist soil management remains a practical mitigation method. Regarding the statement, "The actual habitat value of moist-soil units for shorebirds will be substantially less than calculated because the same units are being managed for waterfowl as well." And, it is recommended that the future NEPA document should "Reduce the value of moist soil units for both shorebirds and waterfowl to reflect the difficulties of managing the same area for both species groups." These statements have no foundation and misrepresent the actual seasonal and long-term vegetation/water composition and management of moist-soil impoundments.

Management of seasonally flooded impoundments (i.e., moist-soil units) involves purposeful manipulation of soil, water, and vegetation that seeks to emulate natural dynamics of seasonal herbaceous plant communities, at least in the MAV (Fredrickson and Taylor 1982, Fredrickson 1996, Strader and Stinson 2005). Management of these impoundments is not exclusive to either waterfowl or shorebirds, and in fact, managing the seasonal dynamics of water levels required to support herbaceous wetland vegetation provides a seasonal and inter-annual continuum of dry to flooded, and mud flat to densely vegetated, conditions. These habitats then provide resources to, and are used by, over 150 species of birds and numerous mammals, amphibians, reptiles, and fish that regularly use these impoundments (e.g., Fredrickson and Taylor 1982, Reid 1989, Sargent 1996). Long term management of seasonally flooded impoundments also uses regular disturbances to soil and vegetation that periodically increase the time of mud flat or shallowly flooded, sparsely flooded habitats. In effect, the proper management of seasonally flooded impoundments will provide a diversity of water, soil, and vegetation conditions through time similar to natural dynamics of herbaceous communities in the MAV (see again Fredrickson and Taylor 1982, Fredrickson 1996, Strader and Stinson 2005).

This section provides a good description of the application of moist soil management techniques for maximizing diversity of wildlife habitat values in managed areas. However, it is important to distinguish the use of these techniques for managing wildlife areas from their application in a mitigation context. The Panel believes that USACE did not understand the concerns being raised, and that it's concerns do have a foundation in wetland management science and do not misrepresent moist soil management in practice. We will attempt to clarify the important points here.

The project area currently includes habitats subjected to natural variation in hydroperiod. Replacing these naturally dynamic areas with managed areas is a difficult undertaking. While the Panel supports the application of moist soil management to increase diverse wildlife habitat benefits of managed areas, there is still an important issue regarding HOW MUCH habitat it takes to replace lost functions. Habitats managed to maximize value to one group of species generally have reduced value for other groups, which was the point of the moist soil management literature cited above, and Dr. Fredrickson's work to support an increase in integrated management.

It has been difficult for the Panel to determine whether USACE intends to manage moist soil units for multiple species groups, and appreciates the clarification included in this response that they will be targeted at providing shorebird habitat. The Panel raised this issue because it appeared that there were multiple mitigation goals for the managed areas, including both shorebird and waterfowl habitat, that would have impacts on how much habitat was required to replace lost functions for both groups. The former wetland model assigned an HSI of 1 to moist soil units for shorebirds, which would be appropriate if all of the managed area is available, and managed for shallow water levels during migration. If, for example, the management plan included deeper water levels for waterfowl during the shorebird migration period, some of the area would be inaccessible to shorebirds, and additional area would be required. Overall, sites managed for diversity of wildlife include some areas that are optimal for some species at particular times, and other areas that are not optimal for the same species. This is important in a mitigation context.

Question 1k:
*USACE wrote above that "*Management of these impoundments is not exclusive to either waterfowl or shorebirds, and in fact, managing the seasonal dynamics of water levels required to support herbaceous wetland vegetation provides a seasonal and inter-annual continuum of dry to flooded, and mud flat to densely vegetated, conditions."

*This is true, and it emphasizes the major point the Panel was trying to make. When there is a continuum of habitat conditions being maintained in the same area, some parts of that area will be optimal for particular species, while others will not be optimal at any given time. This means that the entire area of the mitigation habitat parcel cannot be considered to be providing optimal habitat for each species group at any one point in time. In a context of managing wildlife habitat at publicly managed sites, this is often an appropriate management goal. In a mitigation context, the total amount of habitat area lost must be compensated for by the total appropriate habitat area provided. A managed area with dry or deeply flooded conditions in part of the management unit during shorebird migration would not mitigate for the loss of shorebird habitat equal to the entire area of the unit. A portion of the managed area that has been drawn down to provide habitat for shorebirds and is now dry or in a mudflat state cannot provide optimal habitat for waterfowl. In a mitigation context, a larger managed area is necessary to provide the amount of optimal habitat that replaces the habitat functions lost in the habitat areas impacted by the project. In fact, this point is made explicitly by Dr. Fredrickson (1982) on p. 7, where he states : "*Ideally, several moist soil impoundments should be available on each management area. Each impoundment can then be managed individually for different types of wildlife. A master plan involving a group of impoundments can provide a maximum diversity of wildlife continuously by rotating management options among the different units.*" In addition, Fredrickson and Taylor (1982) provide specific recommendations of water depths appropriate for different species groups. The critical point is that applying moist soil management effectively involves rotating through different habitat types and water levels, and therefore requires greater amounts of area to provide habitat targeted at one species group such as shorebirds during migration so as to replace lost functions from the impacted areas.*

The Panel recommends that in development of the mitigation plan in the EIS, the total habitat area lost for each species group be completely replaced by available habitat of equal or

greater value, as USACE has stated is its goal. To accomplish this, moist soil units must have a specific management plan that includes how long areas will be in shallow water or mudflat, and will likely require greater area to make up for the times when management requires water levels not appropriate for shorebirds during migration. Even if managed primarily for shorebirds, as indicated in the USACE comments above, the fact that these are mitigation areas where a specific total amount of shallowly flooded and sparsely vegetated area is required to replace lost functions will require more area than can likely be achieved in practice with 1:1 replacement of acreage. The exact amount of additional area will depend on the specific management plan put in place to maintain conditions over time, and cannot be determined in advance of the development of that plan.

The response to this comment suggests that moist soil units will be managed primarily for shorebirds, with waterfowl benefits being a secondary goal. This approach simplifies the issue the Panel has raised in the past. If the moist soil units are managed for shorebird habitat, a greater percentage of the managed area can provide shorebird habitat at any one time. However, consideration must still be given to the fact that only a portion of the mitigation area will be providing optimal habitat at any one time, depending on the topography of the site and the management plan being implemented. The goal should be to provide at least the same number of hectare-days of shallowly flooded habitat as occur on the project area under existing conditions.

USACE response/Question 1l:
The recommendation that estimates of food availability in seasonally flooded impoundments be reduced because they may be used by both waterfowl and shorebirds (and also other species – see above) is not appropriate and this recommendation should not be adopted. The purpose of carrying capacity models, such as the WAM, is to estimate **potential** carrying capacity of habitats and sites for a species group and not to speculate on the proportionate use of a site by multiple species. No data exist that indicate that waterfowl and shorebird use of seasonal herbaceous impoundments are exclusionary or competitive. In fact, shorebird use of SJNM sites is predominantly in July-August and April (while waterfowl use is greatest from November through February (Heitmeyer, aerial survey data 2000-2004). And, seasonally flooded impoundments consistently support large numbers of both shorebirds and waterfowl on the Ten Mile Pond CA. The WAM does account for some non-availability of foods (of all types) to waterfowl from consumption by other species, such as shorebirds, decomposition, disturbance, etc. and some further speculated estimate of reduced availability because of shorebird use ,as suggested by the reviewer, is not supported.

The Panel's comment did not recommend that estimates of food availability in seasonally flooded impoundments be reduced because of <u>use</u> by both shorebirds and waterfowl, but rather because it appeared that they may be <u>managed</u> with provision of habitat for one or the other as the primary goal. The panel is suggesting that if the hydrologic conditions are managed, for example, to maximize resources for shorebirds, the resources produced by the moist soil wetlands will not be as high as the expectations in the WAM.

Question 1m:
Regardless, moist soil units will be proposed and managed to maximize shorebird habitat. However, waterfowl benefits will be quantified if appropriate as well as any benefits to wetlands, fish, and water quality.

The panel agrees that moist soil units managed for shorebirds will produce resources for waterfowl; the panel does not believe, however, that the level of these resources will be at the level assumed in the current WAM.

Question 1n:
Since moist soil units will be managed for shorebirds, what type of reduction to waterfowl DEE does the panel recommend?

The panel assumes the USACE meant reduction in DUD to waterfowl not DEE sine DEE will not be impacted by habitat management. It is impossible to answer this question without first knowing how the USACE intends to manage the moist soil areas. Moist soil units produce anywhere from 50 to 2000 kg/ha of food depending on how the hydrology and vegetation is managed. There is no way to provide an estimate of the resources for waterfowl produced by the moist soil units without first knowing the hydrologic management of the wetlands.

Question 1o:
How would you manage the moist soil units to maximize both shorebirds and waterfowl?

As discussed above, maximizing the habitat value of the moist soil units for shorebirds provides an efficient approach to replacing lost shorebird habitat. The Panel recommends this approach, with drawdowns timed to coincide with shorebird migration, and the overall goal of providing the same number of hectare-days of habitat as existed in the without project conditions. As USACE states above, some waterfowl use can be expected where water remains during drawdowns, and documented waterfowl use of these moist soil units can contribute to waterfowl mitigation goals, but should be measured in the field and quantified in the mitigation areas once they are constructed.

Question 1p:
Should USACE consider providing fall shorebird habitat to compensate for spring shorebird impacts (borrow pits, moist soil units, etc.) and if so, how much more valuable is fall habitat than spring habitat?

The Panel recommends that the mitigation goal should be to replace all of the habitat losses that would occur from implementation of the project. If the analysis indicates an impact on fall habitat, then mitigation should be provided for this impact. Because shorebirds are likely to be most limited by fall habitat, ensuring complete mitigation for any fall impacts should be an important goal of the mitigation plan, and anything that can be done to provide fall shorebird habitat would be valuable in addition to fully compensating for spring habitat losses. There is insufficient information about shorebird populations and ecology to precisely determine the relative values of spring and fall habitat in regulating shorebird population dynamics, but the Lower Mississippi Valley Joint Venture Shorebird Monitoring Program suggests fall habitat is likely limiting for shorebird populations in this region (http://www.lmvjv.org/shorebird/default.asp).

USACE response/Question 1q: A conceptual management plan will be developed in the EIS once impacts are determined. A permanent management plan will be developed during the completion of the site specific mitigation plan. *Comment noted.*

Comment 2:
The Project Work Plan does not respond to the concerns raised during the Phase 1 IEPR regarding the method to analyze the project's impact on shorebird habitat.
Significance – High:
The impacts of the proposed project on shorebird habitat cannot be determined without a thorough review of the methods to be applied in estimating those impacts.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should address the following: 1. Conduct a review of the application of the shorebird model; such a review did not occur either during the Phase 1 IEPR or during the Shorebird Model Certification Review. 2. Clearly outline the methods for carrying out the analysis of impacts on shorebird habitat before they are applied during the development of the future NEPA document. 3. Address all of the concerns raised in the Phase 1 IEPR and the Shorebird Model Certification Review.
Draft Evaluator Response in bold ***Draft Panel BackCheck in italics***
USACE response: The shorebird model that was developed by the Fish and Wildlife Service for past NEPA analyses underwent an independent model certification review. That review did not recommend its use. Comments received during the Phase 1 IEPR also found problems with the model. Therefore, USACE has abandoned the Fish and Wildlife Service model. The revised methodology that is planned for subsequent project analysis is found in Response 1. **Question 2a:** Does this alternate methodology address the IEPR concerns? Specifically what changes are necessary and why? *In general this methodology appears to be an improvement over the past methodology with respect to shorebird habitat impacts. Some notes were provided by the Panel in response to the methodology above under Comment 1.* *In past discussions, USACE has indicated that finer discrimination of water depths was not feasible. The Panel is interested to learn how USACE will accomplish the finer discrimination proposed here.* **Question 2b:** The Project Delivery Team (USACE and its private contractors) have reservations that require discussion during the teleconference concerning the comment to expand the model to include other variables. *The Panel's comment simply noted that the Model Certification Review suggested expansion of the past model to incorporate these factors. Whether they are relevant to the proposed new model will depend on how that model is constructed, and is one reason that the Panel*

recommends that whatever model is developed be subjected to peer review.

USACE response/Question 2c:
Migrating shorebirds only use certain land cover in the MAV (Loesch et al. 2006). All of the farmland in spring will be the same (barren earth). Therefore, it should all "count" the same. We will not count any vegetated areas (fallow, BLH, etc.).

It is important to remember that some shorebirds, particularly plovers, use vegetated areas on migration. Depending on how the term is defined, some "fallow" areas, such as grasslands, may provide important shorebird habitat. However, there may be relatively little impact of the proposed project in these areas.

USACE response continued:
In the early fall, the majority of the farmland will still be vegetated. The primary use within the project area will be from Mud and Wading Shorebirds. Most of these shorebirds do not prefer vegetation that limits their view. Therefore, there will be little available habitat in the fall. Furthermore, this is the period that coincides with low river conditions. By late fall, when the crops are harvested and the river tends to rise, most of the shorebirds will have left the project area.

USACE response continued:
PERCENT COVER: In the revised shorebird analysis, the basic assumption is that all crops, bare soil, and grasslands constitute suitable shorebird habitat when appropriately flooded. Heavily vegetated habitats (e.g., forest and shrub) will be excluded from consideration as shorebird habitat.

TEMPERATURE: Although incorporation of temperature will not be feasible, it may be possible to include correlated surrogates such as day of year or duration of flooding.

PROXIMITY TO OTHER WETLANDS: Indeed, the proximity among wetland has been deemed important for "resident" shorebirds (i.e., birds spending extended periods within a local landscape during breeding or while over-wintering). However, the importance of wetland proximity during migration has not been established. The total area of available habitat may be an important attractant for increasing the likelihood of migratory stop-over at a site, with larger areas having increased likelihood of occupancy. However, specific area requirements with regard to patch size or proportion of landscape in shorebird habitat are unknown. Therefore, any attempt to include these parameters within models assessing suitable shorebird habitat would be without justifiable foundation.
Regarding the development of HSI values for different shorebird guilds comment and development of HSI values. Twedt, personal communication, Loesch, 2006 and other cites.

The revised shorebird analysis will quantify sparsely vegetated habitat conditions under 3 flooding regimes that are associated with different shorebird feeding guilds: (1) shallowly flooded with water depth <4 inches, (2) more deeply flooded with water depth between 4 and 8 inches, and (3) mudflat habitats which are not flooded but which had been flooded to any depth within the previous 2 days.

Because the preponderance of shorebirds migrating through the St. John's and New Madrid

Basins are likely small and medium-sized shorebirds that predominately forage in water <4 inches deep, the shallowly flooded area have maximum suitability for shorebirds (i.e., HSI value = 1.0).

Conversely, more deeply flooded areas provide access for few species and individual shorebirds: thus the suitability of areas with water depth form 4 – 8 inches is less than optimal. Similarly, mudflat habitats are less than optimal because fewer species and individuals may use these areas. In addition, the longevity of mudflat suitability is likely variable, being highly dependent on evapo-transpiration, thus increasing variability in area estimates of mudflat habitat.

Regarding the testing and validation comment. Verification and validation of the revised shorebird analysis is beyond the scope of the development of the revised shorebird assessment. However, a methodology for verification and validation of the assessment is outlined below for the specific application to the St. Johns Bayou and New Madrid Floodway Project. The procedures verify potential shorebird habitat in relation to depth and inundation, they do not necessarily equate to actual shorebird usage. Therefore, no quantitative shorebird counts and or population estimates will be necessary

VERIFICATION - We will verify the predictive ability of the assessment using remotely sensed data (*e.g.,*Landsat TM imagery, aerial photography, etc.). Imagery with known date of origin that includes the study area will be obtained (ideally from in-hand images within archives of USACE, USFWS, and Ducks Unlimited). These images will be classified into a binary depiction of water versus non-water (dry). We will compare the geographical depiction of shorebird habitat (as determined based on the revised shorebird assessment using the river stage associated with the date of the imagery) with the water-dry interface. Areas of estimated shorebird habitat that coincide within or are in reasonable proximity (distance yet to be determined) to the water-dry interface on the images will be assumed to be verified. The proportion of estimated shorebird habitat that is verified versus the proportion that is unverified will provide an estimate of overall verification. Model verification will be repeated using up to 10 images from different dates; ideally each date would be associated with a different river stage reading.

VALIDATION – We propose that validating the predictive ability of the shorebird analysis will require an on the ground assessment of water depths and soil saturation. During flood events, transects will be established in both basins that transition from dry to mudflat to wet conditions. The locations will be selected a priori and entered into a database or global positioning unit. Thereafter, upon obtaining the river stage at New Madrid and the interior staff gage on St. Johns Bayou, field personnel would visit each transect and assess shorebird habitat at that location (e.g., measure water depth, presence of soil saturation, distance to nearest water edge, etc.). This process would be repeated at various river stages during flood events. The proportion of locations where the estimated shorebird habitat that was validated as present (at or near the evaluation point) versus the proportion of locations that were not validated will provide an estimate of overall validation of the revised shorebird assessment.

USACE Literature Cited:

Elliott, L. and K. McKnight. 2000. U.S. Shorebird Conservation Plan: Lower Mississippi Valley/Western Gulf Coastal Plain. Mississippi Alluvial Valley/West Gulf Coastal Plain

Working Group, Lower Mississippi Valley Joint Venture. 29 pp. <http://www.lmvjv.org/library/USSP_LMVWGCP.doc >

Davis, C.A. 1996. Ecology of Spring and Fall Migrant Shorebirds in the Playa Lakes Region of Texas. PhD Dissertation. Texas Tech University, Lubbock, Texas. 224 pp.

Loesch, C.R., D.J. Twedt, K. Tripp, W C. Hunter, and M.S. Woodrey. 2006. Development of Management Objectives for Waterfowl and Shorebirds in the Mississippi Alluvial Valley. http://www.birds.cornell.edu/pifcapemay/loesch.htm

Comment 3:
Information is not provided to support the importance of flood pulses (different from 2-year frequencies) in wetland ecosystems and for wetland-dependent organisms.
Significance – High:
Changing either the frequency or amplitude of flooding on the project site has great implications on how well the impacts can be mitigated on site and on the ability of the site biota, especially fish and shorebirds, to adapt to that change in flooding.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should address the following: 1. Understand and recognize the importance of flood pulses to the remaining natural ecosystems on the site. 2. Consider impacts of these important seasonal pulses by evaluating the effects of floods with other than a 2-year recurrence interval.
Draft Evaluator Response in bold ***Draft Panel BackCheck in italics***
Recommendation 1 *The panel is pleased to know that the Corps recognizes the importance of concepts such as flood pulses such as the theories of Junk et al. We are also pleased to see that these will be brought up as important issues in the future NEPA documents. We also were aware that there would be some attempt to connect Big Oak Tree State Park to the river in a limited way. Our comment was based on the management of the entire site and the importance that flood pulsing once had on the integrity of the bottomland forests that once were there and which still remain in remnants.* **Recommendation 2** The Phase 1 IEPR stated that the 2-year floodplain was acceptable to determine fish impacts. The EnivroFish Model Certification also validated the use of the 2-year floodplain as the upper limit to quantify spawning and rearing habitat. **Question 3a: Please clarify the panel position, and why?** *This comment is not only based on fish use of the floodplain (which is the basis of EnviroFish model) but also the general ecosystem health of bottomland ecosystems, which depend on a wide frequency of flood pulses. The panel would like the Corps to consider the importance of a wide variety of flooding frequencies for waterfowl and bird use, for fish habitat and spawning, for introduction of plant and animal propagules, for movement of large-scale detritus (thereby forming new habitat structures for example), for scouring effects and export of large woody debris to the river, and so on. An ecosystem that is only flooded, on average, once every other year and with a similar flood intensity each time, will not mimic the natural world. As we already stated in our support for these recommendations "Fluvial processes such as sediment deposition and erosion are often dramatic during these less frequent flood events. Fish and wildlife are influenced by these rare events, which generate new habitats, different hydrology, and major inputs of nutrients and sediments." Thus the*

Corps should consider floods with a longer recurrence interval as well in their analysis for reasons other than fish spawning and rearing.

Question 3b:
Please provide rational and documentation for the statement about 25-year and 100-year events having a significant impacts to the wetlands within the project area.

The panel is aware that this is a dramatically drained site and that "no natural habitat that remains in either the St. Johns Basin or the New Madrid Floodway." It is no longer subjected to natural flooding from the Mississippi-Ohio complex as it once was. But we also believe that there could be much more imaginative solutions to restoration and/or mitigation at the site, in addition to the effort at Big Oak Tree State Park, to use the complex and widely varying frequencies of current Mississippi-Ohio flooding to provide both mitigation and adaptive management opportunities to allow small areas to recover to something approximating pre-drainage conditions. The newly forming batture land, as recognized by the Corps as possible mitigation and compensation areas is one area (see Comment 4).

The panel also recognizes that the site is not entirely isolated from the river as groundwater connections remain. High river stage means high groundwater and backwater effects, if only due to local runoff and precipitation, in the sites themselves. Floodplains can never be totally isolated from the rivers and streams that used to nourish them, even if the nourishment has been replaced by more subtle backwater and groundwater effects.

Comment 4:
A more complete discussion of fish access in St. Johns Bayou and New Madrid Floodway is needed, and the potential quantification of losses and potential mitigation due to access restrictions must be addressed.
Significance – High:
River connectivity to the floodways allowing fish access for spawning and rearing is a significant ecological feature of floodplain river ecosystems and any potential impact should be quantified for the proposed project.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should address the following: 1. Expand current fish access studies in the St. Johns Floodway to include the New Madrid Floodway. This would allow a comparison of fish access between a culvert access floodway and an open access floodway. Noted fish access restrictions due to the proposed culverts or gates should be subject to a detailed compensation plan as part of the overall mitigation program. 2. Use existing gate operations to conduct a study to quantify fish access restrictions for each spawning period, including stage and water temperatures. Any impact or loss should then be compensated in the mitigation plan. If fish access is restricted, then nearby batcher land mitigation should be considered to offset spawning and rearing loss attributed to access loss.
Draft Evaluator Response in bold ***Draft Panel BackCheck in italics***
USACE response/Recommendation 1: The studies outlined in the USACE Evaluator Response above addresses recommendations by the panel to evaluate fish access prior to project construction. These studies should be continued after construction to provide a better evaluation of fish access and potential access restrictions for early, mid, and late spawning season species across several years of hydrologic variation and gate operations. The USACE Evaluator Response did not address the lack of methodology in the Work plan needed to evaluate potential loss of spawning access and mitigation alternatives for early, mid, or late spawning species. **Recommendation 2.** **Question4a**: Are ancillary and telemetry studies sufficient to document that fish are passing through the St. Johns Bayou structure and does the Panel feel other studies are warranted, and if so, what type of studies? *The telemetry studies outlined in the above USACE Evaluator Response should provide a comparison of access prior to project construction for early, mid, and late spawning season species. However, coupling fish movement studies with spawning/rearing habitat use and successful reproduction (spawning adults, larval, and juvenile sampling in each of the main habitat types) is needed to fully evaluate habitat use and spawning/rearing habitat value (HSI scores). This is further supported given the poor recapture rate of marked fish in the floodways.*

Question 4b:
What specific data is needed to trigger additional mitigation due to changes in access?

A general principle of adaptive management is that adjustments should be made when the level of function falls below expected levels, as described by USACE above. The Panel's intent was to request that USACE include a specific statement that mitigation would be increased if ongoing monitoring shows that expected levels of function have not been achieved. This was missing from the Work Plan, but has been adequately addressed in the response to comments in this review. USACE notes that the specifics of the mitigation plan are to be developed in the EIS, and therefore cannot provide a specific list of adaptive management triggers. The same limitation applies to the Panel, which recommends simply that the EIS include a clear statement that mitigation shortfalls will be addressed for each resource. In general, the approach should include both the quantity of habitat and the quality of habitat created for each resource category.

USACE response/Question4c:
The Fish and Wildlife Service has repeatedly indicated that batture land mitigation is not suitable to mitigate for project impacts because it does not provide habitat (in-kind) that is similar to that found in the Floodway. USACE is of the opinion that batture land habitat is appropriate to compensate for project impacts. Although the Phase 1 IEPR review stated that batture land is appropriate and this comment suggests it is appropriate, please confirm the panel's position on batture land mitigation for fish.

The Panel agrees with the USACE opinion that batture land habitat may be an appropriate compensation alternative for project impacts if floodway compensation is not achievable. For example, if fish access studies indicate a reduction of fish spawning use of the floodways due to culverts and/or gate operations then compensating this loss through nearby batture land mitigation is appropriate.

Comment 5:

The fisheries methodology is not adequate to quantify actual spawning and rearing habitat based on Habitat Suitability Index (HSI) values.

Significance – High:

The HSI values are critical in calculating existing and lost HUs for project alternatives, as well as for evaluating mitigation alternatives.

Recommendations for Resolution:

To resolve these concerns, the future NEPA document should address the following:

1. Evaluate and compare existing spawning and rearing habitat types within the St. Johns and New Madrid floodways that will allow the development of quantitative HSI values for each habitat during each of the three spawning/rearing periods.
2. Evaluate any positive effects on spawning and rearing success in habitat types that may occur by holding water during the entire spawning and rearing period beyond any ADFA increase.
3. Monitor mitigation areas to determine if HSI values initially assigned are appropriate, or if adaptive management changes need to be considered to achieve the desired HUs.

Draft Evaluator Response in bold

Draft Panel BackCheck in italics

Recommendation 1.
Question 5a:
What is the basis for the statement regarding HSI values not supported in the project work plan?

The Work Plan does not provide details of a scientifically based approach that was used to assign HSI values for each habitat type. For example, the Work Plan assumes that all habitat types have equal value for the early, mid, and late season spawning fish community without supporting information. In addition, the detailed bases for HSI score differences among agriculture fields (0.1), fallow fields (0.5), bottomland hardwoods (1.0), and waterbodies (1.0) is not provided in the Work Plan.

Question 5b:
Do the similarity of delta streams and their associated floodplains in the Lower Mississippi River basin indicate that HSI values are transferable from one project area to another? If not, are there any unique differences in landuse categories or species utilization curves in the St. Johns Bayou and New Madrid basins that require a separate field study?

The Panel would support initial use of Lower Mississippi River basin HSI values for each of the habitat types if these values were developed based on sound scientific investigation with meaningful quantitative HSI differences among habitats. However, the Panel recommends that the HSI values be tested/validated for use in the St. Johns Bayou and New Madrid basins though field studies.

Question 5c:
Do you agree with the relative ranking of least valuable to most valuable habitats for spawning and rearing fishes: Agricultural land – Fallow land – Bottomland hardwoods - Floodplain waterbodies?

The Panel agrees with the relative ranking of the above habitats as indicated in the basis of this comment above.

Question 5d:
Does the panel agree that the stated fish HSI values are appropriate for use on this project?

The panel supports the community based approach for HSI values. However, as indicated above, the Work Plan does not provide detailed support of specific spawning period habitat HSI values.

Question 5e:
Does the panel recommend the Delphi process or something else to establish the HSI values for the project?

The Panel supports the Delphi process using scientifically based information that would provide qualitative and quantitative habitat and season specific fish community HSI values.

Question 5f:
What qualifications are necessary to serve on the Delphi Panel?

A main purpose of the Delphi process is to develop agreement/consensus among panel members. Therefore, the panel should have representatives of important basin stakeholders. Specific expertise should be based on the questions the panel will answer. In this case fisheries scientists/managers with a background in floodplain fisheries habitat in the lower Mississippi River basin should be part of the panel that assigns HSI scores.

Question 5g:
The model certification report noted that less valuable habitat (farmland) may need to be excluded because fish may choose to use optimum habitat (bottomland hardwoods or borrow pits) instead of sub-optimum habitat (farmland). Although not proposed in the work plan, should USACE exclude all sub-optimal habitat (farmland) from its fishery impact assessment and only assess optimal habitat (BLH and waterbodies)?

The Work Plan HSI values indicate that farmland and fallow fields do provide spawning and rearing habitat. Although HSI values are community based, these "sub-optimal" habitats may provide species specific spawning and rearing habitat across a changing temporal and spatial scale as water inundates and recedes from the floodplain. The Panel recommends inclusion of these habitats in the context of HSI values discussed above.

Recommendation 2: (need clarification)
By pooling water with the control structure, acres of habitat remain relatively constant. The primary purpose of managing water levels is to maximize duration and habitat quality of the

waterbody. Therefore, we assume that the habitat value remains constant during the time the pool is maintained. The panel comments suggest that habitat value is constantly changing during this period. If this is the case, how should the HSI values be adjusted to reflect changes, if any, that occur in the spawning pool or other semi-permanent waterbodies?

The Panel did not suggest that HSI values should change due to the number of days the spawning/rearing pool is maintained. This HSI change was outlined on page 76 of the Work Plan. The Panel supports a scientifically based approach to determine if (and how) quality of flooded habitat increases (HSI value) due to maintaining a pool through the spawning/rearing period. If a HSI value change is not supported, habitat units will still increase due to a longer pool duration that is reflected in increased ADFAs.

Recommendation 3:
Monitoring of mitigation sites and adaptive management will be discussed in the EIS after impacts are quantified.

USACE response noted by the Panel.

Comment 6:
The Waterfowl Assessment Method (WAM) appears to be appropriate; however, the parameter estimates for the model are based on fall migratory and wintering ducks and do not appear to consider spring migrants.
Significance – High:
Use of the parameters outlined in the Project Work Plan may result in underestimating the required waterfowl habitat mitigation.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should use parameter estimates from data collected during the spring migratory period for parameterization of the model.
Draft Evaluator Response in bold ***Draft Panel BackCheck in italics***

USACE response/Question 6a:

Nonbreeding migrant waterfowl are present in the SJNM from September through March. This is the time frame used in the WAM. Numbers of waterfowl in the SJNM gradually increase through fall to peaks in December and January and then decline through March (Bellrose 1980, www.mdc.mo.gov). This chronology of occurrence includes the sequential annual cycle events of waterfowl of fall migration, prealternate molt, pair formation, prebasic molt, reserve deposition, and spring migration (Heitmeyer 1988, 2002). Consequently, a continuum of annual cycle events is occurring among species and individuals within the SJNM and the SJNM is not a region or complex of habitats that is used solely or primarily for spring migration.

Weekly waterfowl counts in the SJNM have been made by the Missouri Department of Conservation from ca. October through January, and often through March since the early 1980s. U.S. Fish and Wildlife Service coordinated mid-winter inventories of the SJNM and surrounding Upper Mississippi Alluvial Valley (MAV) region have been made since the 1960s. Biweekly surveys throughout the year were made for 15 randomly selected four-square mile blocks in the SJNM region from 2000 through mid 2004 (Heitmeyer, unpublished data). All of these data indicate peak waterfowl presence in the SJNM is in December and January. Numbers of waterfowl in the SJNM regional area often are 70% less in March (when most waterfowl species are in spring migration in the Upper MAV – Bellrose 1980) than during mid-winter peaks. Peak numbers of waterfowl (combined ducks and geese) at the Ten Mile Pond Conservation Area (CA) in the SJNM are regularly > 100,000 birds in December and January. Surveys in 2009-10 indicated over 3 million waterfowl use days occurred from November through January. In 1997-2000 over 9 million waterfowl use days occurred each year from November through January at Ten Mile Pond CA. In addition to Ten Mile Pond CA, the SJNM region includes many other important public and private wetlands in western Kentucky (e.g., Ballard County CA), northwest Tennessee (e.g., Reelfoot Lake), and southeast Missouri and northeast Arkansas (e.g., Big Lake National Wildlife Refuge) that support large numbers of waterfowl from fall through spring. For example, waterfowl numbers at Reelfoot Lake alone often exceed 300,000 during

December and January and many of these birds move between the SJNM and the Reelfoot Lake area daily. Consequently, the SJNM provides resources to more birds than are present on Ten Mile Pond CA or other regional areas on any given day. Conservative average estimates of total waterfowl within a 30 mile radius of Ten Mile Pond in early January are > 500,000 birds (http://www.fws.gov/birddata/databases/mwi/mwidb.html). Clearly, the SJNM is heavily used by waterfowl from fall through spring periods, and is not primarily a spring migration region.

The panel does not disagree that waterfowl are used during all potions of the year and has never made that assertion. The panel is suggesting, however, that this region likely has the greatest influence on populations by providing spring migratory habitat, an assumption we thought the USACE agreed with at this point. This assumption is based on the annual life cycle and the need for waterfowl to acquire nutrients for reproduction at this time and not on the abundance of waterfowl in the region at any given time. Thus, although it is important for the project mitigation to replace habitat lost to waterfowl at all time of the annual cycle in which the region is used, it is most important to ensure loss of spring migratory habitat is appropriately mitigated.

USACE response/Question 6b:
Regarding the statement "… the parameter estimates for the (WAM) model are based on fall migratory and wintering ducks and do not appear to consider spring migrants." This statement is incorrect and appears to be based on the false assumption that the SJNM is most important for spring migration (see above) and does not understand the data, timeframe, energetic basis, and habitat and food production analyses in the WAM. First, the WAM includes estimates of food abundance and energetic requirements of all waterfowl species using the SJNM from September through March. As stated above, this timeframe accurately represents the entire suite of nonbreeding events, species, and times for the SJNM from September through March. Consequently, the WAM does provide quantitative methods to determine food abundance and energetic requirements for the late winter and spring period through March.

The panel agrees the WAM estimates the food availability during spring by estimating depletion and decomposition from fall estimates. The pane is suggesting, however, it would be more appropriately to use actual data collected during spring that is now available instead of using estimates from data collected during fall and winter then adjusting them with depletion and decomposition curves.

USACE response/Question 6c:
Annual food production, and subsequent availability to waterfowl species, is a function of when specific foods are produced and how the standing crop changes over time. For most plant foods (excepting some above-ground browse), the actual production is during the growing season and usually peaks in late summer or fall. Consequently, estimating potential food abundance must start with understanding the standing crop in summer or fall and then determine changes thereafter through spring. For invertebrates, the chronology of production and turnover rates vary by taxa and habitat. For some benthic crustaceans (e.g., *Cranonyx*) in the Upper MAV the peak production is in spring (e.g., White 1985). In contrast, many aquatic insects (e.g., Chironomidae) reach peak levels in late summer. Throughout the WAM, food production estimates are based on the life history characteristics of the

plants/invertebrates involved and state-of-the-art understanding of availability dynamics. Consequently, the parameter estimates are founded on basic plant/invertebrate ecology and reflect their potential abundance and use by waterfowl in the SJNM regardless of when, or which species, uses them. This includes all time periods and events from fall through spring migration.

Again, the panel is not suggesting the data used in the WAM is inappropriate, only that the model uses various methods to estimate abundance when data on actual abundance now exists.

USACE response/Question 6d:
The comments seem to imply that invertebrates are the primary food consumed by spring migrant waterfowl in the SJNM and that the WAM should be based primarily on invertebrates. First, the WAM does provide estimates of invertebrates in all habitats and times. It also provides estimates of all other foods potentially consumed by waterfowl species. Consequently, the WAM provides appropriate estimates of potential carrying capacity of a region (such as the SJNM) regardless of species, time, or annual cycle event the bird is engaged in.

The assertion that spring migrant waterfowl eat mostly invertebrates is not true for all species or areas. Knowledge that some duck species seek habitats that have, and eat, a higher proportion of invertebrates in late winter and spring compared to fall and early winter periods is well documented and not new (e.g., Heitmeyer and Vohs 1984, Heitmeyer 1985, LaGrange 1985, LaGrange and Dinsmore 1988, Heitmeyer and Fredrickson 1990, Gammonley and Heitmeyer 1990, Heitmeyer 2006 and many others). However, not all species consume large quantities of invertebrates in spring (e.g., wigeon, geese, etc., Heitmeyer and Raveling 1988, Heitmeyer 2002) nor do individuals of a species, such as mallards, always eat large amounts of invertebrates by sex (Combs and Fredrickson 1996) or location (Gruenhagen and Fredrickson 1990). In fact, few invertebrates may be eaten in some locations. Consequently, it is inappropriate for the WAM to speculate on which species will eat what amounts of specific food types by time period.

The panel never asserted WAM should speculate on which species should eat what amount of specific food types at any given time, only that recent data specific to spring migratory ducks is now available and invertebrates appear to be an important component of their diet, thus, invertebrate loss should also be mitigated.

USACE response/Question 6e:
The references used as the supporting evidence by the reviewer are not peer reviewed and/or available for analyses at this time. No doubt, the studies were well conducted, however the locations of the study sites used in these references are not stated, but appear to have been in central Wisconsin, Saginaw Bay in Michigan, Lake Erie, the Scotio River in central Ohio, the central Illinois River Valley in central Illinois, and the Cache River area in southern Illinois (Yerkes 2010). None of these study sites were within the SJNM and only the Cache River location may have had similar habitats as the SJNM. Using data from sites in the Great Lakes region, and even the central part of the Illinois River Valley, to indicate and project resource use, energetic requirements, habitat food type and abundance, and inclusion in WAM models is scientifically inappropriate.

The WAM clearly states that the model parameter estimates may be refined as new information becomes available from sites that represent the area of coverage, i.e. within the MAV. Consequently, if new studies can convincingly validate and suggest changes to the parameter estimates, based on equivalent MAV habitats and locations, then food estimate changes can easily be made in the WAM tables. New production information will not change the form of the DUD equations, however.

The citations are all theses or dissertations which are commonly used for management purposes. Most of the data from these documents are currently being submitted to peer reviewed journals. The panel does not believe the fact the data have not been published in peer reviewed journals is an adequate excuse to exclude it from use. The panel agrees the data from most of the sites in these citations are not appropriate for the use in this instance, however, the panel feels data from the cache river study site, which is only about 45 miles from and at similar latitude to the project area is more appropriate than data for most parameter estimates currently being used in the model The panel would be happy to provide copies of each of the cited theses to the USAE for their use..

The response further suggests that the DEE used in the WAM may underestimate "true" DEE during spring. The reviewer offers no data to support this assertion and the comments appear to have been based on non-MAV locations mostly from the Great Lakes region (see above).

USACE response/Question 6f:
The review comments imply that because waterfowl are storing reserves during spring migration a different DEE estimate should be used than during winter. Nutrient reserve deposition for many waterfowl begins in late winter including during flood events (e.g., Heitmeyer 1988, 2006) and is not confined to spring. The WAM clearly indicates how the DEE estimates for all waterfowl species using the Upper MAV were calculated. The actual estimate of 4x RMR is higher than earlier published estimates and it is acknowledged that the estimate may be conservative. However, until new validated information becomes available for DEE in the Upper MAV and SJNM, the WAM estimates represent the state-of-the-art understanding of DEE for the SJNM and are appropriate for the SJNM project analyses.

The data supporting this assertion are in a manuscript in preparation. The panel would be happy to provide this information. It is unclear to the panel why the USAE has chosen to belabor this point. The panel is not suggesting the WAM is inappropriate, only that there is more recent data that would be more appropriate to this specific project area.

Comment 7:
It is unclear if the application of the Hydrogeomorphic (HGM) approach to evaluate project impacts and develop proposed mitigation will yield scientifically credible results.
Significance – High:
The HGM model results may be of key significance in estimating the impacts of the entire project.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should address the following: 1. Use a safety factor as high as 4x (there are ample precedents for this) when estimating the amount and type of mitigation that this project should propose; this will resolve the uncertainty in the HGM method and its parameters. 2. Continue to evaluate other models that are more related to the function and structure of wetlands to assess comparison of wetland functions for mitigation. This of course will not be possible in the short term of this investigation.
Draft Evaluator Response in bold ***Draft Panel BackCheck in italics***
USACE Response We agree with the panel's assessment that HGM has a long record of development and application in the estimation of functional losses and gains of wetland resources for Corps planning projects. More importantly, the specific Guidebook in question has been used successfully in similar Corps projects in Arkansas, where multiple wetland types and proposed mitigation types were employed, and changes in flood frequency and duration were components in the wetland impact. HGM reviewers concluded that the guidebook has been in use for approximately five years and could potentially be used with the same level of accuracy under the condition that existing users will be the ones who continue to use the method. One or more members from team of experts who developed the regional HGM guidebook will perform the assessments for all wetland sites to ensure the models are used as intended and that there is consistency in the results. The minimum requirements of the review team will be met during the SJNM application of the Delta Region of Arkansas Hydrogeomorphic Methodology (HGM) Guidebook. The panel's assertion that calling an approach a "model" automatically implies that it is a specific type of model is not founded. There are many models that have been developed over the years for ecological assessment purposes; one of the most famous and oldest of these is the Habitat Evaluation Procedure, first developed in 1980. HEP models, as they are called, are clearly models: mathematical aggregations of factors to determine a single metric. They do not involve differential equations or other techniques that might be used in dynamic hydrologic modeling. HGM was originally conceived as a way of extrapolating the techniques and methods used in HEP to address the multiple functions that needed to be addressed for wetlands. The model development is quite comparable to that used in HEP. Unlike HEP, however, HGM models are calibrated using reference data specific to the

wetland subclass and a specific reference domain, such as an ecoregion. This makes it actually more scientifically defensible than many models, which are calibrated using literature review data that are aggregated across the entire country. The data collected for the Guidebook in question is from the same EPA Level III ecoregion as the project site, and the models are proven sound by previous use.

The panel is pleased to see this complete discussion of the pros and cons of the HGM technique for assessing ecosystem function of wetlands and the use of mitigation ratios. It provided us with much additional information that was not in the reports we reviewed.

The Corps states that the HGM has been used "successfully" in several previous projects. How does the Corps know that the use was "successful." In one sense if a model is used and results are obtained it could be called success. But there is no absolute criteria that can be used to determine if the results from these previous applications of HGM found results that were even close to estimating wetland function on a quantitative scale. So the panel does not concur with the use of the term "success" in previous applications. Perhaps "used with some quantification of wetland function" is what has been accomplished.

The panel is aware of models such as HEP and even the predecessor model to HGM which was called WET (Wetland Evaluation Technique). While the panel is pleased that HGM has, at its basis, the hydro and geological conditions of the wetlands, it complexity does not, by itself, convince us that it is better (or worse) than these previous models.

Question 7a:
Although the IEPR panel believes that the HGM does not provide a scientifically defensible method for estimating impacts, is the model appropriate to compare project alternatives for this project?

The panel found this to be a very interesting question. In other words, does the model, even though it does not provide any absolute measures of wetland function, provide relative scales that could be used at the same sites to determine relative impact? Perhaps, especially if the same person or persons carry out all of the studies. We do not know what the probability of that would be. Most importantly we believe that the Corps is too far along in using and reusing the HGM technique to abandon it now, and there is no other appropriate model out there, save for ecosystem simulation models, that could provide any resolution needed for mitigation ratios. That is why we called for a "generous" mitigation ratio or safety factor (see below)—to acknowledge that the science of providing indicators of ecosystem function is quite inexact as is the development of mitigation ratios from these indicators.

USACE response:
The HGM guidebook calibration process employed direct measurements of thousands of tree diameters, counts of shrub stems, snags, and logs, and similar specific data, and application of the guidebook uses similar direct measures. Variable values that are estimated (such as litter cover) should be consistent in the way that they are applied, as long as the field team is consistent. Since functional loss and gain are calculated as differences between before and after states, the absolute value isn't as important as the consistent application of the variable. An overestimate of 5% across all the sites will yield the same results once the difference between before and after states are compared.

HGM separates wetlands into classes and subclasses using hydrology and landscape position, which directly affect function. A riverine wetland functions differently than a wet flat or an unconnected lacustrine fringe. To lump these wetland types together and then try to determine changes in function is precisely the sort of illogical analysis that HGM was designed to avoid. It's true that splitting the project site into multiple types will increase the amount of data required for analysis, but that is justified if it is required to develop a defensible analysis. The keys provided in the Guidebook are sufficient for splitting out the types, and since the project will lead to changes in flood frequency and duration that will not only affect function within types, but also lead to type conversion, the idea that these functional changes can be assessed in any scientifically defensible way without splitting the wetlands into classes is not supportable.

Any errors in the calculators will be addressed, but as for the issues with the models, they were ultimately certified for use on this project. The form and component variables in the assessment models and the format of the guidebook were constructed to be consistent with previously published guidebooks (specifically, the Yazoo Basin guidebook) and were reviewed and approved by a team of regional experts and the USACE - ERDC. Calibrations were based on actual field data from within the same EPA Level III ecoregion as the project site, which makes them more scientifically defensible than calibrations used in many HEP models. They are the best available tools for use in this application, and have been extensively tested in the region, as noted by the panel in their opening comments above.
In order to be classified as riverine, a wetland must be within the 5-year floodplain of a river, according to HGM convention. If a site is not subject to flooding at least 1 year in 5, then the river is not the "main forcing function of the system," and is certainly not the principal hydrologic factor maintaining wetland character. The statement that fringe wetlands are not usually associated with floodplain landscapes is curious, as the cypress fringe communities associated with oxbow lakes are among the most iconic and widely occurring of the remaining wetlands in the Lower Mississippi Valley. Other non-riverine wetlands, such as hardwood flats, sand pond depressions, valley train ponds, and various other communities discussed in detail in the guidebook, have been seriously impacted by historic land use in the study area, and merit more, not less, attention.

It is not clear where the panel has obtained the number 4 as a multiplier for any mitigation ratio determined using HGM. HGM analyses in the region have previously tended to produce mitigation ratios in the range of 2:1 to 4:1, depending on the
condition of the impacted wetland, and the type of mitigation proposed. Preservation has been calculated as high as 10:1 due to the lack of functional lift over the course of the project lifetime. In all cases, the rationale and supporting data for calculating these ratios, including developmental trajectory analyses, are presented and discussed clearly, and can be specifically criticized as appropriate if logic or data errors are identified.

The Memphis District Regulatory Branch stated that the following ratios have been developed by the Missouri Department of Natural Resources (MDNR) with cooperation from the Missouri Department of Conservation (MDC), the U.S. Fish and Wildlife Service (USFWS), the U.S. Environmental Protection Agency (EPA), the U.S. Army Corps of Engineers (COE), the Natural Resources Conservation Service (NRCS) and the Missouri Department of Transportation (MoDOT) for wetland creation/restoration. The ratios are

intended for use by projects for which the sequencing requirements have been completed and it has been determined at that point that compensatory mitigation is appropriate. The ratios are not intended for enforcement purposes; however, the high end of the range may be an appropriate place to begin negotiations for enforcement cases.

Farmed Wetlands 1.0-1.5
Emergent 1.0-3.0
Shrub-Scrub Wetlands 1.5-3.0
Wooded Wetlands 2.0-4.0
Open Water 1.0

Question 7b:
What other models are readily available that is superior to HGM that have the possibility to compare alternatives, quantify likely impacts of the project, and determine appropriate mitigation?

Our criticism of HGM is based on absolute, not relative terms. But its methods are simply to prone to error and lack of repeatability. Wetland practitioners have not developed any other standardized and widely accepted approaches for estimating wetland function. It is unfortunate that standard dynamic and statistical models such as those used in hydrologic sciences, to predict ecosystem trajectory over 10 to 100 years, have not been developed and standardized. Among the reasons are that wetland functions are difficult to measure with any accuracy with repeated measurements and there are so many different types of wetlands and wetland functions.

To lump these wetland types together and then try to determine changes in function is precisely the sort of illogical analysis that HGM was designed to avoid. It's true that splitting the project site into multiple types will increase the amount of data required for analysis, but that is justified if it is required to develop a defensible analysis.

We could not agree more that a system was needed to divide the wetlands into hydrological categories and the HGM system does that part fairly well. We are only commenting that these systems, far and away, are systems that used to be and still are to some small degree, riverine. We are further commenting that there is little to be gained from splitting functions between, say a pond-edge cypress swamp, and one in a slow-flowing slough.

The fact that wetlands on the study sites can now be classified in other hydrological categories reflects the dramatic drainage impact that has occurred on these sites in the last 100 years. There would not have been anything approaching a basin or lacustrine wetland per se 100 years ago. While backwater swamps on these sites have lacustrine features when viewed at the small scale, they are really riverine in the landscape scale.

Question 7c:
Please expand and provide rational and documentation for use of a safety factor as high as 4x when estimating amount and type of mitigation. For example should a safety factor of 4x be used for wetlands that lose all wetland characteristics (i.e., jurisdictional wetlands that as a result of the project lose jurisdictional status)?

The table that you provided above shows mitigation ratios (which are sort of an engineering safety factors) up to 4:1 for forested wetlands so you have provided us with examples where the ratio could be that high. We are arguing for this case, just as has been the case in other aquatic resource impacts when the accuracy of measuring the impacts is imprecise and the probability of success of the mitigation is unclear, a mitigation ratio of 4:1 or even higher could certainly be warranted. The numbers provided in your table were undoubtedly a result of consensus by knowledgeable individuals than precise calculations based on analytical techniques. We are arguing that this site, because the large scale prevents both accuracy of methods and prediction of final results, high mitigation ratios are warranted. 4:1 is not uncommon in such situations. So we agree that "the high end of the range may be an appropriate place to begin negotiations for enforcement cases."

Question 7d:
Should this safety factor be reduced for partial impacts (i.e., jurisdictional wetlands will maintain jurisdictional status but may not be inundated as frequent as existing conditions).

That seems reasonable.

Question 7e:
Should benefits to existing wetlands that are not connected to the Mississippi River (e.g., Big Oak Tree State Park and the St. Johns Bayou Basin) be 4x greater than previously thought if river connections are re-established?

The panel believes that reestablishing true river connections to formerly isolated wetlands should be rewarded. If you are able to establish true surface water hydroperiods with some wetlands in the State Park or the Bayou due to river re-connections, it should receive lower mitigation ratio requirements than wetlands that are isolated or lacustrine in nature. The panel believes that these true "riverine" wetlands would provide many more functions for fish and wildlife and water quality improvement and establishing models of such wetlands at this site would provide useful benchmarks and models for future mitigation of wetland loss in riparian areas.

Comment 8:
There is an insufficient level of detail in the Project Work Plan to evaluate the validity of the proposed compensatory mitigation plan.
Significance – High:
The project success is dependent on determining the appropriate level of mitigation.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should address the following: 1. Provide more detail as to how wetland habitat loss and function will be estimated. 2. Provide more detail on how estimated wetland loss and function will be mitigated.
Draft Evaluator Response in bold ***Draft Panel BackCheck in italics***
USACE response: USACE agrees that project success is dependent on determining the appropriate level of mitigation. However, a specific sequence needs to be employed which first describes the impact, determines its significance, seeks to avoid and minimize the impact, and lastly compensates the impact. Obviously mitigation cannot be determined without first determining what the significant unavoidable impacts of the project are. Therefore, the project work plan only contains conceptual mitigation. Although USACE assumes impacts are likely, USACE does not know if impacts are greater or less than past project recommendations. Therefore, mitigation specifics would be discussed in detail in the EIS. If determined necessary, moist soil units will be primarily managed to compensate for impacts to spring shorebirds. Therefore, moist soil sites would likely have to be inundated prior to spring shorebird arrival for several months to maximize invertebrate productivity. This would likely coincide with spring waterfowl migration. Therefore, waterfowl will likely utilize the sites. Please refer to response to comment 1 for further discussion of waterfowl/shorebird use of moist soil habitats. **Question 8a:** If moist soil units will be managed primarily for spring shorebirds, how much should the value be "reduced" for waterfowl benefits? *As stated in # 1, without knowing the actual hydrologic conditions, there is no way to answer this question.* **USACE response/Question 8b:** USACE acknowledges that the discussion on reforestation is brief. This is primarily due to the fact that site specific location needs to be known (elevation, soils, topography, hydrologic regime, etc.) prior to determining the species of trees to be planted, spacing, direct seeding vs. seedlings, etc. The EIS will include a more thorough description of "typical" mitigation sites that would be found throughout the project area. At a minimum the following conceptual sites will be described:

• Lands adjacent to Big Oak Tree State Park
• Lands that are within the project's sump elevation
• Lands that are outside the project's sump elevation
• Adjacent batture sites
• Moist Soil Unit
• Lands within a spawning and rearing pool

The Project Work Plan includes transition periods that discount mitigation based on the amount of time necessary for mitigation sites to reach maturity or when they reach full habitat potential (*i.e.,* forested areas for fish).

There is little shorebird habitat provided in the project area due to Mississippi River flooding in the project area during the critical southward migration (15 July to 30 September, see Loesch et al., 2000). Is it appropriate to compensate for spring shorebird habitat by providing habitat to shorebirds via moist soil units, borrow pits, etc. in the summer/fall and if so, how much more valuable is summer/fall habitat than spring habitat?

Question 8c:
The term "wetlands" - are you referring to lands that meet the definition of Section 404 of the Clean Water Act or other areas such as areas that are defined as functional floodplain habitat in the Project Work Plan?

The panel is referring to all "wetlands" that require mitigation for the loss of form and function.

Question 8d:
The project work plan describes the methodologies that will be used to determine habitat loss and function. What specific additional information is necessary?

The project work plan provides general methodology but is lacking detail adequate to determine if these methods will achieve their desired objectives.

Recommendation 2:
Panel Question: The project work plan describes conceptual methodologies that will be used to compensate likely project impacts, in the panel's opinion what additional information is necessary to satisfy the requirements of NEPA and the Clean Water Act?

Comment 9:
The adaptive management plan requires a detailed analysis of the ongoing mitigation management costs and a clear funding source adequate to support those activities.
Significance – High:
Without a demonstrated source of funding, adaptive management cannot be applied to the mitigation sites, and therefore full mitigation for project impacts cannot be achieved.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document must include a source of funding for adaptive management activities, including ongoing monitoring and management as part of the mitigation plan.
Draft Evaluator Response in bold ***Draft Panel BackCheck in italics***
USACE response/Question 9a*:* Recommendations regarding adaptive management were included in the Project Work Plan (see Section 8.6). The cost of this management and monitoring will be determined in the EIS. Applicable funding (Federal funds from the Mississippi River and Levees Program, Federal funds from the St. Johns Bayou and New Madrid Floodway project, and non-federal funds from the project sponsor) will be required to implement the plan. The amount of required funding from each source will be described in the EIS. *The Panel recommends that the full cost of developing, managing, and maintaining the mitigation areas over the entire life of the project be included in the EIS.* **USACE response continued:** Conditions that would "trigger" adaptive management have not been discussed with the interagency team to date because project impacts, and avoid and minimize measures have not been formulated. However, these conditions will be described in the EIS. Mitigation will increase and or site specific adjustments made in the event that they are not functioning as desired. Conversely, adaptive management may reveal that mitigation sites are functioning at greater rates than modeled, or impacts were not as significant as modeled. If this is the case, overall mitigation may be reduced. **USACE response/Question 9b:** Please provide specific examples that would trigger adaptive management in each of the significant resource categories (*i.e.,* fish, waterfowl, shorebirds, water quality, and wetlands). *A general principle of adaptive management is that adjustments should be made when the level of function falls below expected levels, as described by USACE above. The Panel's intent was to request that USACE include a specific statement that mitigation would be increased if ongoing monitoring shows that expected levels of function have not been achieved for any resource. This was missing from the Work Plan, but has been adequately*

addressed in the response to this comment. USACE notes that the specifics of the mitigation plan are to be developed in the EIS, and therefore cannot provide a specific list of adaptive management triggers. The same limitation applies to the Panel, which recommends simply that the EIS include the following: 1) an ongoing monitoring plan sufficient to detect insufficient levels of function for all resources, 2) a clear statement that mitigation shortfalls will be addressed for each resource, and 3) proposed responses to improve levels of function.. In general, the approach should include both the quantity of habitat or function and the quality of habitat or function created for each resource category.

The Panel recommends that for each resource, adaptive management be triggered when the ongoing monitoring plan shows that levels of function have fallen below those proposed for the specific mitigation plan for that resource. For example, for water quality, these should include:

1. Exceedance of any applicable water quality criteria or standards in streams, channels, or other surface waterbodies in the project area.

2. An increase in total nitrogen loads from the New Madrid Floodway to the Mississippi River.

Comment 10:
The methodology to determine the extent of the wetlands in the project area requires further detail to determine if it is valid.
Significance – High:
An accurate determination of the area of wetlands is needed to estimate the impact of this project.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should address the following: 1. Provide a more detailed description of the methods needed for estimating the area of wetlands, especially on the field sampling, to determine the total area of wetlands on the site. 2. Provide details of the WETSORT program.
Draft Evaluator Response in bold ***Draft Panel BackCheck in italics***
USACE response: Wetland ecosystems and their community functions will be analyzed utilizing HGM in accordance with the SJNM Interagency Wetland Team recommendations. USACE will utilize WETSORT, which is based on a 1997 USDA, NRCS method and uses daily water surface elevation readings to determine wetland elevations. The program can be used to determine the median elevation of specified flood durations during the period of record. The flood duration will be fourteen days (according to the supplement to the 1987 Wetlands Delineation Manual). Wetlands above the flooding elevation will also be classified. The team has reviewed available maps and discussed the different approaches (abundance, distribution, and qualitative condition of wetlands as well as FCU's and HGM analyses). The team agreed to use HGM to assess project related wetland impacts, while the probabilistic sampling based on EMAP will provide wetland acreage and a qualitative wetland condition. The team discussed using hydric soil and land use cover maps (and potentially WETSORT data) to help assess farm land (particularly if NRCS cannot provide FW/PC data). The team agreed to use the same proportion of agricultural land on hydric soils that meets wetland parameters (as determined by on-site wetland data collection) within the field- and remote-sampled portions of the project area. Hydric soils will be overlain on the identified agricultural project area landcover GIS layer within the project impact area. Members from the interagency team will assess these probabilistic determined sampling points. After sampling these ~50 points, the same individuals will derive remotely sensed assessments on 50 probabilistic sample points outside of the impact area. These sample points will be determined in the same fashion as the impact sites, except for these sites will be outside the impact zone. Aerial imagery will be used in making these assessments. Concerning lack of involvement by USFWS on the interagency wetland team, the Service was asked to participate; however, they decided they would not be a member on the wetland team. USFWS is free to attend any sub-team meeting and is advised of all sub-team meetings and decisions. The full interagency team (including wetland team participants and the Service) are kept apprised of decisions made at the sub-team level, including Memos for

Records and updates at interagency team meetings.

A detailed description of the WETSORT program was provided to the interagency team and is attached to these responses. Briefly, WETSORT is a utility program written in FORTRAN 77 that uses methods published by the USDA Natural Resources Conservation Service (1997) to determine wetland elevation using daily water surface elevation data and user supplied input. User supplied input to the computer program are: growing season length (begin and end dates) and a percent duration (typically a 5, 12.5 or 15-day duration). WETSORT does not evaluate moist soil conditions, does not evaluate conditions based on shallow groundwater, and does not identify wetlands. WETSORT does identify a median wetland elevation determined by multi-year analysis and requires field verification by experienced professionals.

The wetland team will determine the appropriate classification for agricultural areas (wetlands, farmed wetlands, prior converted cropland). Preliminary estimates suggest that the vast majority of lands in the project area are prior converted cropland. Although these areas may not be subject to Section 404 of the Clean Water Act, the functional floodplain (including agricultural land) value they provide will be assessed with the fish, waterfowl, wetland, and shorebird models. It is possible that areas that are currently in agricultural production could convert to wetlands if farm practices are abandoned and no channel maintenance is conducted on the vast network of drainage ditches. The vast majority of agricultural areas are expected to remain in agricultural production (see response to comment 18). Project mitigation will seek to purchase agricultural areas and restore wetland status to these areas.

Shallowly flooded agricultural land (regardless of wetland jurisdictional status) that provide shorebird habitat will be assessed in the Shorebird impact analysis (See response to comment 1).

See also (attached to FPC #10)
Determination of Wetland Elevation from Daily Water Surface Elevations
Using the Computer Program WETSORT
US Army Corps of Engineers, Memphis District
March 23, 2010

We appreciate the answers that the Corps provided to the panel on these recommendations and have no further questions on wetland area determination.

While it is beyond the charge of this panel to review the NRCS WETSORT program in detail, the description provide here helps us to understand its role and limitations.

We appreciate knowing the reason for the absence of the U.S. Fish & Wildlife Service in this wetland determination. While it is unfortunate, we are pleased to know that they can be at the table if they wish.

Comment 11:
The assessment of economic impacts of the proposed project may not be valid because the method used to document the future with and without project conditions does not consider trends in real prices and costs.
Significance – High:
Nearly all project benefits relate to agricultural profits for the life of the project, and fundamentally depend on future prices and costs.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should address the following: 1. The agricultural crop price indexes from the Economic Research Service should first be carefully evaluated for signals of trends in real (inflation adjusted) crop prices. 2. The economic analysis (the benefit-cost analysis) should be conducted under various scenarios pertaining to future price and cost changes, considering for example, a constant real rate of growth in prices, a zero rate of growth, and perhaps a decline in the real rate of change in prices. Similarly, such scenarios might be done as well, for key agricultural input costs, such as energy.
Draft Evaluator Response in bold ***Draft Panel BackCheck in italics***
USACE response: Current economic guidance ER 1105-2-100 states that only Current Normalized Prices can be used to assess the economic viability of Federal water resources development projects. Current Normalized Prices (CNP's) are the calculated by the USDA Economic Research Service and are the values that the Federal government places on the various agricultural commodities. They are calculated by State but they are "national" in scope in that the methodology used is consistent so that they can be used to compare projects in various locations throughout the United States. CNP's are adjusted for inflation and do in fact reflect trends in that they are 5-year lagged averages of actual market prices. *The panel definitely recommends doing a sensitivity analysis as suggested above, and as also suggested in key Federal guidelines for conducting benefit-cost analysis on Federal projects (see OMB, 1992), and in the USACE's own guidelines (see Appendix E of ER1105-2-100). Again, general nationwide or regional "inflation" and "real price" trends in agriculture are potentially two different things, and a sensitivity analysis should focus not on the general rate of inflation in the United States or within the region, but on possible real trends in agricultural prices and costs, so that all benefits and costs are in real, and not nominal terms.* *Note that guidelines within the OMB circular (1992, p. 7) states that "Future inflation is highly uncertain. Analysts should avoid having to make an assumption about the general rate of inflation whenever possible."* *The OMB circular (1992, p. 8) also states "For projects or programs that extend beyond the six-year budget horizon, the inflation assumption can be extended by using the inflation rate*

for the sixth year of the budget forecast." Therefore, the USACE needs to estimate the inflation rate in the sixth year of the project analysis, and use the inflation rate for that sixth year in adjusting all benefits and costs for inflation, for all impacts accruing after six years.

USACE response:
The recommendations contained in comment 11 seem to suggest estimating inflation adjusted trends or changes in commodity prices over the 50 year period of analysis. This type of change in prices could only be used in a type of sensitivity analysis to show the effect of these estimated trends. By regulation, they can not be used in the NED analysis of the proposed water resource improvements. Therefore, USACE can not adopt the recommendation.

Question 11:
Does the panel foresee any agricultural conversions to other land uses in the project area?

The panel does not know the future and USACE guidelines suggest that believing the future is uncertain and that it involves risky outcomes is a standard presumption in such analysis (see Appendix E, section E-4). Prudent analysis would allow for numerous possibilities for uncertainty or risk (again, see section E-4, Appendix E) relating to the future of land use over a 50 year period into the future. If the USACE disagrees, then the analysis of the future should provide clear evidence that the best prediction is for no conversion of agricultural land to another other use. Such evidence might be based on past trends using years that contain extreme weather (high and low precipitation) and flood events. However, if the USACE uses past trends to demonstrate that there have been no changes at all in land uses, including farming practices over the entire past period, then the project's agriculturally related benefits can assumed to be zero because one can expect there to be no changes in agricultural practices by farmers in the future, even when flood risks change.

Comment 12:
The use of two discount rates for the same analysis is confusing and is not warranted in any conventional economic analysis.
Significance – High:
The project's benefit-cost ratio fundamentally depends on the chosen discount rate.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should address the following: 1. First, the benefit-cost-analysis should first be conducted in its entirety for a well-defined period beginning with the very first project construction (for which only costs, and no benefits would be expected in the profile), and extending through the life of the project, using a single discount rate of 2.5%. 2. Second, the benefit-cost analysis (i.e., entire accounting exercise) should then be repeated at the single discount rate of 3%, and then repeated again at the single discount rate of 7%, resulting in three benefit-cost ratios, one for each discount rate assumed. 3. Results from each analysis, i.e. for each discount rate, should be clearly presented and contrasted to show the effect of using the range from lower to higher discount rates. This is consistent with doing sensitivity analysis for a long-term project.
Draft Evaluator Response in bold ***Draft Panel BackCheck in italics***
USACE response: The recommendation to resolve this comment is to present the results of the economic analysis using 3 different discount rates. This is contrary to established Corps of Engineers economic guidance. To minimize confusion in future studies, the Corps will better explain why more than one discount rate is used. Basically, there are two separate project authorizations, each of which requires different interest rates. The first is the New Madrid Floodway Levee Closure that was authorized as part of the Flood Control Act of 1954. Its authorized discount rate is 2.5%. This rate is confirmed by the Water Resources Development Act of 2007. The second project is the St. Johns Bayou-New Madrid Floodway Project that consists of the two pumping stations and channel improvements. This project was authorized by the Water Resources Development Act of 1986. Future studies will use two discount rates, the authorized rate for the Levee Closure of 2.5 percent and the current discount rate in effect at the time of analysis. All benefits and costs associated with the Levee Closure will be presented at 2.5%. Any recommendations for the Levee Closure will be based on 2.5%. The St. Johns Bayou-New Madrid Floodway Project will use the current discount rate in effect at the time of analysis. The benefits and costs and subsequent recommendations for this project will be based on the current rate. In addition, for sensitivity purposes only, both projects will be combined using the current rate. *A single discount rate is to be used for a single analysis, and using that for both the benefits, and the costs of a project (OMB Circular, 1992). That remains the convention in all economic analysis. The higher the discount rate, the less weight future benefits and costs*

receive in the economic analysis, and the less favorable the benefit-cost analysis for a project with a stream of impacts occurring as far into the future as 50 years.

The above comment recommends that the three above evaluations be done, which can perhaps be deemed as appropriate for sensitivity analysis. Using a single discount rate, and doing sensitivity analysis, are both definitely consistent with conventional economic guidance *(OMB Circular, 1992). No more than one discount rate may be used for a single evaluation under all conventional regulations for benefit-cost analysis. That is contrary to all economic guidance.*

Separate authorizations of a discount rate for the project are a legal issue, however, the use of more than one discount rate in a single evaluation of benefits and costs does not appear in any Federal guidance on benefit-cost analysis that the panel is familiar with.

The discount rate is currently a very controversial topic in economics. As noted above, some economists now believe that individuals have non-constant, declining discount rates over time. Many other economists currently recommend that a near- zero real discount rate be used for very long term projects, such as strategies to cope with climate change. The reason such economists offer for this is that society may indeed care about future generations as much as current ones. However, using a single discount rate equal to zero is still not federal policy (see OMB Circular, 1992). Any discount rate might be used in a sensitivity analysis (OMB Circular, 1992, p. 12).

Question 12:
Based on your opinion, what is the appropriate social discount rate that should be used to evaluate Federal projects, and why?

The panel's opinion on the appropriate social discount rate is to some extent irrelevant because the guidelines on the discount rate used to evaluate Federal projects remains clear. The key OMB Circular recommends that a different discount rate be used for real, versus nominal flows. Discount rates for analysis of a public investment differ from those used to evaluate a lease-purchase of cost-effectiveness analysis (Orszag, 2009).

Federal regulations recommend that the Office of Management and Budget provide the discount rate to be used for analysis (see Appendix B, OMB Circular, 1992). The OMB circular (p. 9) states that for public investments, "Constant-dollar benefit-cost analysis of proposed investments and regulations should report net present value and other outcomes determined using a real discount rate of 7 percent."

However, note that the OMB circular also recommends doing sensitivity analysis (p. 11). OMB states that "In general, sensitivity analysis should be considered for estimates of (i) benefits and costs; (ii) the discount rate…" (p. 12). If the legal team wishes to establish legally that the USACE is allowed to use 2.5% because of authorizations, then the panel recommends doing the entire analysis at the single alternative rate of 2.5%.

The USACE's own planning guidance document (Planning Guidance Notebook, ER 1105-2-100, April 22, 2000, page 2-11) states that "Present Values, at the base year of analysis, shall be calculated using the discount rate established annually for the formulation and

economic evaluation of plans for water and related land resources (published by HQUSACE as an Economic Guidance Memorandum)."

*Note that the USACE's document does not say discount rate**s** (plural), is says discount rate (singular), implying one be used. The USACE should make clear what the Economic Guidance memorandum published by HQUSACE currently states is the single rate to be used, and if this differs from the 7% rate recommended by OMB.*

The panel does not recommend mixing more than one discount rate within a single benefit-cost analysis. It the USACE wishes to do so, it needs to provide documented evidence of a regulation or authorized Federal principle or guideline that recommends this practice. The panel does not know of any.

Comment 13:
The farming survey may not be credible unless a large enough sample size is used, producing a smaller statistical error for the analysis and avoiding many possible sources of bias.
Significance – High:
Agricultural production decisions and behaviors after flood risks have been reduced must be convincingly identified or the project's main economic benefits cannot be calculated. Because this must be done before actual flood risk reductions are realized, a survey of farmers must be implemented to provide a convincing and credible analysis of these decisions and behaviors.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should address the following: 1. Mention the above details in the scoping the future NEPA document. 2. State that state-of-the-art survey or experimental design will be conducted when the time comes to research behaviors of farmers in the region.
Draft Evaluator Response in bold ***Draft Panel BackCheck in italics***
USACE response: The comment points out the shortcomings of relying on survey information. The Corps recognizes these shortcomings and plans to also employ other methods in addition to surveys. The main focus is to estimate how the area's farmers as a whole will respond to a reduction in flood risk. We currently plan to use GIS information of existing flood risk management practices and USDA Farm Services information to validate any survey information that is collected. However, due to the points brought out in this comment we may revisit the wisdom of using survey information. USACE is currently conducting public scoping in regards to NEPA. The above details will be discussed in the future NEPA document. **Question 13:** Should USACE utilize the survey or, given the IEPR comments, utilize secondary information sources? *Adequate funding certainly relates to obtaining credible experimental or survey information, and of course it is USACE's choice to pursue this. The key is to provide adequate evidence to support the key assumption of positive changes on profits from flood risk reduction. However, the panel has virtually little or no faith in the likelihood that secondary information can be used to validate the farmer's response to a reduction in flood risk. The best secondary information would come from exactly this scenario having happened already, perhaps somewhere else in the world. However, the panel is not familiar with any such situation that has occurred and where documentation of the behavior accompanying that situation has been established. Even if this has been done somewhere that the panel is not aware of, an additional requirement for sufficient evidence would be to demonstrate that such behavior in*

another area of the United States (or the world) will be exactly duplicated in the project region, by the local farmers. It would thus appear that the best approach would still be to plan for doing a very well-funded survey, or set of laboratory experiments to provide convincing evidence.

Comment 14:

The cumulative impact approach lacks specific information on how the conceptual matrix will be used to evaluate the incremental impacts of the proposed project or address the unique aspects of the study area.

Significance – High:

An accurate assessment of cumulative effects is essential to avoiding and minimizing adverse consequences, and to developing an adequate compensatory mitigation strategy.

Recommendations for Resolution:

To resolve these concerns, the future NEPA document should address the following:

1. Identify the specific methodology for using the proposed conceptual matrix to address the incremental impacts of the proposed project and the unique aspects of the study area.
2. Identify how the results and findings from this methodology will be used in the decision process for the proposed project.

Draft Evaluator Response in bold

Draft Panel BackCheck in italics

USACE response/Question 14a:

In the Handbook, "Considering Cumulative Effect under the National Environmental Policy Act" January 1997, the third method covered is matrices. We will have historical mapping of habitat and plan to develop a trend analysis (method 6). Other methods that will be investigated are Ecosystem Analysis (method 9) and Economic Impact Analysis (method 10).

It is true that matrices, trend analysis, ecosystem analysis, and economic impact analysis are all generic methods described in the 1997 CEQ handbook on CEA. As stated in our panel comment, these do not constitute methodologies with specific spatial and temporal boundaries, as well as thresholds of significance (e.g., capacity of the resources to accommodate stress).

Question 14b:

Please provide clarification if there is a preferred method that the panel recommends.

The panel prefers a method of ecosystem analysis since this method can best incorporate changes to ecosystem functioning that are critical to providing the ecological services and supporting the natural resources of concern. As stated above, this method needs to be developed in more detail by specifying the spatial and temporal boundaries, as well as thresholds of significance (e.g., capacity of the resources to accommodate stress). The panel recommends that spatial boundary include applicable areas within the lower Mississippi River Basin, such as the remaining batture areas and backwater areas located within adjacent states. The panel recommends that the temporal boundary include historical conditions when most of the floodplain in this region was connected to the Mississippi River.

Question 14c:
Even though the New Madrid Floodway is still connected to the Mississippi River floodplain what are the differences in areas resources (agriculture and other land cover) in terms of thresholds of significance-specifically differences between St. Johns Bayou Basin, the New Madrid Floodway, and other areas in the vicinity of Southeast Missouri?

The panel believes that the New Madrid Floodway is unique because, in context, it is the last remaining connection between the Mississippi River and its floodplain in the State of Missouri. Therefore, it plays a much larger role in providing natural floodplain services than the other areas. If the other originally connected areas had not been disconnected, the Floodway would be playing a proportionally smaller, and less important, role in maintaining the natural ecosystem. The loss of this last remaining connection and its ecosystem functioning would be the "straw that broke the camel's back" in terms of the total cumulative impact. That is, not all incremental impacts are equal and it is the impact that exceeds a threshold that is significant. In this case, the adverse impact of removing the last floodplain connection, once the other connections have already been removed, is disproportionally high.

Question 14d:
Are there any other unique aspects of the study area that have not been discussed during the Phase 2 IEPR process?

As stated above, the panel believes that this last remaining connection to the River is the unique aspect of the study area.

USACE response/Question 14e:
Results from the cumulative impact analysis as well as other project analysis will be used to document agency decisions.

Response noted.

Comment 15:
More precise contour data (i.e. greater than a 1-foot contour interval) are required to estimate wetland availability and mitigation for waterfowl and shorebirds.
Significance – High:
The use of a 1-foot contour interval to determine the availability of shallow water wetlands may lead to underestimating the existing resources and the requirements to replace habitat impacted by the proposed project.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should consider using mapping with a contour interval of 0.25 - 0.50 feet to estimate wetland loss and function and to mitigate estimated habitat losses.
Draft Evaluator Response in bold ***Draft Panel BackCheck in italics***
USACE response: Regarding the statement, "Furthermore, waterfowl require water depths less than 12-15 inches for foraging." This statement is incorrect. Optimal foraging depths vary considerably among waterfowl species. Obviously, species that are adapted to dive for food (i.e., Mergini, Aythyini, Oxyurini) can forage in water deeper than 12-15 inches (often up to 10+ feet deep) and some species, conversely, can forage on dry ground (e.g., *Anser, Branta*). Foraging depth also varies by type of food being consumed, habitat type, hydrological event, etc. For example, water depths (mean + SE) where mallards foraged during flood events in southeast Missouri were 48.6 + 6.3 cm during a February flood and 42.3 + 8.9 cm during a January flood (Heitmeyer 2006:105). Foraging depth also varied by habitat, for example water depth in shrub/scrub habitats was 42.6 + 9.4 cm compared to 31.2 + 4.6 in flooded bottomland hardwood forest. *It is the panel's understanding that the intent of the mitigation is to provide for habitat loss of dabbling ducks as stated in the Project Work Plan, thus water depth requirements for diving and sea ducks were not considered. Clearly dabbling ducks can utilize deeper habitat than the 30 cm historically recommended. But, if water levels are going to be greater the 30 cm in the mitigation wetlands, then again, the estimates of resources provided by those wetlands must be decreased because the benthic (where a large proportion of the resource are provided) will not be available. If the USAE now wishes to consider diving and seas ducks in their mitigation plan, more consideration to wetland diversity is needed.* **USACE response/Discussion Item**: During the shorebird model review, the model review panel stated that obtaining elevations less than 1-foot increments in a project area the size of the current project is impractical. Therefore, USACE proposes to interpolate elevations between one-foot contours. Further discussion regarding this recommendation is required during the teleconference.

Comment 16:
The list of significant resources is not complete because it does not include a discussion of the quality of the wetland resource, which is dependent upon the dynamic nature of the ecosystem's function and its connection to the river.
Significance – Medium:
Mitigation of proposed project impacts requires a complete list of site resources. To be complete, the list of resources should include the unique nature of the wetland ecosystem.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should add a discussion to the list of resources that clearly describes the unique nature of the wetlands in the project area, including the features that result from a dynamic water level and periodic flooding by the river.
Draft Evaluator Response in bold ***Draft Panel BackCheck in italics***
USACE response/Question 16a*:* Regarding the statement, "The project area includes the only significant remaining section of floodplain where Mississippi River backwater flooding still occurs." Concerning the Lower MAV, this is an incorrect statement. Furthermore, the project area connection is extremely altered. The area is entirely protected by levees with the exception of the 1,500-foot gap at the lower end of the Floodway. This gap has significantly changed the timing, depths, and durations of flood events from what could be considered normal/non-altered conditions. The entire Tennessee side of the Mississippi River floodplain from the confluence of the Old Bed of the Forked Deer and Mississippi rivers at the north Lauderdale County, Tennessee line south to Memphis does not have a mainstem, or frontline, levee and the Mississippi River overtops banks and floods portions of this over 40 mile stretch, covering several hundred thousand acres, annually. Additionally, there are ca. 64,000 acres of batture land are immediately adjacent to the 133,000 acre New Madrid Floodway. *The Panel's intent was to point out that connections with the Mississippi River are rare in the Project Area, not that there are no other areas with remaining connections in the entire River basin, and acknowledges that this was not sufficiently clear in the comment. Since similar areas are rare in the vicinity of the Project Area, their value is higher than if similar habitat was common, and the cumulative impact of loss of connected riverine wetlands is greater.* USACE acknowledges that river-floodplain connection provides wetland function. **Question 16b:** During the Phase 1 IEPR, the panel stated that shorebird habitat is provided by inundated habitat regardless to its source of water (backwater flooding, direct precipitation, groundwater, etc.). Is this still a true statement? *Shorebirds will use sparsely vegetated, shallowly flooded areas wherever the ecological conditions are sufficient to support populations of prey items. The Panel is not aware of any*

literature that would support a direct comparison between the shorebird habitat value of backwater flooded and direct precipitation flooded areas in the Mississippi Alluvial Valley, but would consider any information that USACE may be referring to here. In general, the Panel recommends that questions such as this be addressed with specific studies designed to compare existing conditions and potential with project conditions. General ecological principles suggest that areas subject to river flooding will have different nutrient dynamics and soil conditions than areas where such flooding does not occur, and these differences could result in differences between the resulting invertebrate communities when the areas are flooded.

Hydrologic connection alterations would be assessed by documenting impacts to fish spawning and rearing habitat (confined to the two year floodplain), waterfowl, shorebirds, and wetlands (river connected wetlands are defined as those that are within the five-year floodplain).

Question 16c:
Within the project area, which plays a greater role in providing habitat:
1) river connection or,
2) topography and local drainage?

As noted above, there are likely differences between the nutrient budgets and the resulting invertebrate communities between riverine wetlands and isolated wetlands which affect their value as habitat. It is not clear from the question what species are being referred to here, so the question is difficult to answer. Both types of wetlands could provide shorebird, fish, and waterfowl habitat if appropriate conditions exist, but the relative value depends on the specific conditions in each area, so a generalization about which type of wetland provides greater habitat is not possible without site specific data.

<u>USACE response continued:</u>
Although USACE concurs that the river connection is an important aspect to providing habitat on the floodplain, it appears that local drainage and topography may play a greater role. For example, areas that are frequently flooded (less than elevation 288-foot NGVD) are still mostly agricultural areas. These areas flood almost every year but water is quickly drained from these sites as the river elevation falls due to the extensive drainage system. However, areas that river connections are greatly altered or severed such as Big Oak Tree State Park and Bogle Woods are not farmed because they were likely too wet to clear and farm. These areas are found in the lowest elevations within historic Mississippi River meander belts. Hydrology in these areas is mostly influenced by local drainage and not the Mississippi River.

Question 16d:
What significant roles do wetlands that retain floodwaters after flood waters recede and or capture local rainfall/drainage provide to the floodplain?

Wetlands provide a wide range of functions within the floodplain. The Panel interprets this question as asking how riverine and isolated wetland functions differ. The flooding regime of wetlands is likely to affect nutrient budgets and vegetation patterns. Deeper and longer duration flooding is likely to reduce the amount of persistent vegetation, which can affect the

habitat value of the area for wildlife including shorebirds. In addition, the hydrology is likely to affect the nutrient budget, with riverine wetlands that have regular flooding likely to include additional nutrient inputs from river sedimentation.

USACE response/Question 16e:
The EIS will provide a discussion regarding river connection.

Comment noted.

Question 16f:
Specifically, what are the other resources that need to be discussed in the EIS.

The Panel recommends that USACE include a description of the dynamic nature of the hydroperiod of riverine wetlands as a resource of importance to the floodplain. Replacement of this habitat functions that result from this dynamic hydroperiod should be included in the mitigation plan.

Comment 17:
The water quality analysis in the Project Work Plan does not address water quality conditions in any of the study area water bodies and does not compare nutrient loads to the Mississippi River with and without project conditions.
Significance – Medium:
It will not be possible to draw any conclusions about whether water quality in both basins (St. Johns Bayou and New Madrid Floodway) will remain unchanged because the proposed analysis does not include investigations of local water quality in either basin under actual project conditions.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should address the following: 1. Conduct quantitative assessments of the impacts of the actual proposed project on waterbodies in the St. Johns Bayou and New Madrid Floodway. 2. Conduct a quantitative assessment of the nutrient loads from the project area to the Mississippi River under the actual proposed project.
Draft Evaluator Response in bold ***Draft Panel BackCheck in italics***
USACE response: <u>Recommendation 1</u>. Conduct quantitative assessments of the impacts of the actual proposed project on waterbodies in the St. Johns Bayou and New Madrid Floodway. **Question 17a:** Does this comment refer to lack of water quality data for waterbodies within the project area, if so, then a query will be conducted of agencies and academic institutions that would be sources of water quality data in the project area and the water quality assessment conducted in Ashby et al., 2000, will be updated with any new information. It is anticipated that information such as TMDLs in the project area will be identified and additional impact assessments can be made. *This comment does not refer to lack of water quality data for waterbodies within the project area, but to lack of analysis of the impacts of the actual proposed project on these waterbodies. The actual proposed project will change the hydrology of and nutrient mass loadings to these waterbodies and, in turn, these will impact water quality conditions within these waterbodies. This comment refers to the conduct of quantitative assessments of the relationships between altered hydrology and nutrient loadings, and water quality responses. The assessment conducted in Ashby et al. (2000) does not describe water quality responses within any waterbodies in the project area, but only the total amounts of nutrient mass transported or retained, nor does it include scenarios that represent the actual project.* <u>Recommendation 2</u>. Conduct a quantitative assessment of the nutrient loads from the project area to the Mississippi River under the actual proposed project. **USACE Response/Question17b**: Differences in relative load estimates will be used (similar to Ashby, et al, 2000) to compare project alternatives. Although these are not intended to represent actual loads since this

would require a long-term study outside the scope of this project. Mass balances will be calculated utilizing the values presented in the project Work Plan for all project alternatives to determine relative change to project alternatives, including mitigation.

As stated above, the panel believes that nutrient loads from the project area to the Mississippi River under current conditions (without project) should be compared to those with the actual proposed project. Differences in relative load estimates (similar to Ashby, et al. 2000) do not represent differences between current conditions and the actual proposed project.

Comment 18:

The validities of several assumptions for the future without project alternatives are questionable.

Significance – Medium:

The validity of the assumptions used to determine impacts for the without project alternative affects the completeness and understanding of the Project Work Plan and the justification of the project.

Recommendations for Resolution:

To resolve these concerns, the future NEPA document should address the potential for the Wetlands Reserve Program and the likelihood that the State of Missouri will restore hydrology to Big Oak Tree State Park.

Draft Evaluator Response in bold

Draft Panel BackCheck in italics

USACE response:
Since this project is authorized by Congress, abandonment of the project would require Congressional action to de-authorize it or the project would have to meet specific criteria that would automatically de-authorize it.

Based on preliminary numbers, there are a total of 4,526.8 acres of WRP easements in the project area (Kevin Dacey, NRCS, personal communication).

Year	# of easements	Acres
1995	2	2253.3
1998	5	338.6
2001	1	53.0
2003	2	606.1
2005	1	597.3
2006	1	95.1
2007	1	350.9
2010*	3	281.9

*applications not easements

These numbers will be confirmed in the EIS. Some of the existing WRP sites remain in agricultural production (see Phase 1 Consolidated EIS Appendix M page 341-343). Therefore, even if they have a WRP easement, it is appropriate to classify them as agricultural areas to determine appropriate value and function. Future WRP lands are difficult to estimate and likely have more to do with agricultural prices than whether or not the project is authorized. For example, there was not a dramatic increase in WRP enrollment after the Court decision. In fact, the greatest acreage enrolled occurred during the period when USACE was actively preparing for construction, including purchasing project related mitigation sites. Therefore, the panel's comment may not be correct. Regardless, the existing WRP lands found within the project area will be compared to areas outside the project area (including the batture area that remains subject to flooding) to determine if any changes to the future without project land use are necessary.

USACE response/Question18a:
Future WRP lands are difficult to estimate and likely have more to do with agricultural prices than whether or not the project is authorized. For example, there was not a dramatic increase in WRP enrollment after the Court decision. In fact, the greatest acreage enrolled occurred during the period when USACE was actively preparing for construction, including purchasing project related mitigation sites. Therefore, the panel's comment may not be correct. Regardless, the existing WRP lands found within the project area will be compared to areas outside the project area (including the batture area that remains subject to flooding) to determine if any changes to the future without project land use are necessary.

The panel agrees that agricultural prices might have the greatest influence on enrollment of WRP and that predicting the enrollment is difficult. The panel, however, also believes that lack of productivity on specific tracts of property due to an overabundance of soil moisture also plays a large role in determining WRP enrollment and still contends that the potential for this project has influenced WRP enrollment.

USACE response/Question18b:
It is appropriate to assume that existing drainage ditches will be maintained. As seen during the IEPR site visits made in August 2009, the St. Johns Levee and Drainage District has recently completed maintenance activities that involved channel cleanout on all of their ditches. The drainage district has easements to perform necessary channel maintenance regardless if the lands are enrolled in WRP or not.

The panel agrees that primary drainage ditches and channels will remain. If some of the properties were to be enrolled in WRP, however, hydrology would have to be restored so drainage ditches specific to those properties would have to be plugged.

USACE response/Question18c:
The State of Missouri's plan for Big Oak Tree State Park did not include a plan to restore the Mississippi River connection to the park, or increase the size of the park. It only provided funds to use an alternative to Mississippi River (ground water or a pump installed in St. James Bayou). As indicated in Phase 2 IEPR comment 16, "The river connection allows the exchange of nutrients between the wetland systems and the river, which is a unique aspect of riverine wetland function." Therefore, it is reasonable to assume that the connection of Big Oak Tree State Park to the Mississippi will not be restored without this project, or specific modification/authorization of the Mississippi River and Tributaries Project Nonetheless, the State of Missouri will be contacted to determine if they have a plan to restore the park independent of this project.

The assumption is "No plans with funding mechanism have been identified to restore Big Oak Tree State Park. Therefore, the observed progression from hydric vegetation to drier species will continue to occur." Although, the panel agrees that restoring hydrology by providing connectivity to the river would be the most appropriate approach, this is not what is specified in the assumption.

Comment 19:
The potential impact of global climate change on the proposed project and the conceptual mitigation plan should be acknowledged.
Significance – Medium:
Although highly uncertain, the potential effects of climate change have important consequences for the project and mitigation plans, and therefore an assessment of these effects is needed to support a complete evaluation as required by NEPA.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should, at a minimum, address the impacts of potential future climate impacts on the project and proposed mitigation plan on a qualitative basis.
Draft Evaluator Response in bold ***Draft Panel BackCheck in italics***
The comments provided will be used to expand the discussion of global climate change to the EIS. Preliminary analysis indicates that the authorized project would be extremely robust to any changes in future hydrology because pump operations and gate management can be modified as a result of any significant changes in precipitation/Mississippi River water levels. Moreover, the gate management/pump operation (i.e., operating rule curve) has the capability to be flexible and can be modified for environmental/habitat reasons as well.
Draft Panel Response #19
No response required.

Comment 20:
The gate closure and pump operation management alternatives proposed for St. Johns Bayou and New Madrid Floodway require further clarification.
Significance – Low:
For a successful project, it is important to maintain existing fish access and to create and maintain a spawning and rearing habitat in the floodways.
Recommendations for Resolution:
To resolve these concerns, the future NEPA document should include a more detailed description of how gate and pump management will: 1. Achieve project objectives for each of the alternatives (flood frequency elevations and/or inundated acres). 2. Provide fish access during appropriate river stage and water temperature periods.
Draft Evaluator Response in bold ***Draft Panel BackCheck in italics***
USACE response: Preliminary plans call for allowing the river to come up to a certain elevation and closing the gates to provide flood protection. Pumps would be used to evacuate interior drainage. Gates would normally be re-opened once the river recedes to allow for gravity drainage. A rapidly falling river in a highly drained project area will lead to the stranding and desiccation of eggs and larvae. Therefore, operating rules will consider multiple factors including flood damage reduction, maximizing periods when gates are open, and reduce ramping effects that could strand eggs and larvae. The EIS will analyze opportunities that would allow the river to come up to certain elevations but will hold water to create a spawning and rearing pool for fish as well as habitat for other resources (shorebirds, waterfowl, etc.). Although this action would prevent ingress of individual fish when gates are closed constant access is not required for successful spawning and rearing. The spawning and rearing pool will provide optimum habitat for those fish (individuals and species) that have already accessed the site during a rising hydrograph prior to gate closure. Re-opening the gates after successful spawning and rearing period and a gradual drawdown would allow adult fish that had previously accessed the site and young of the year to egress into the Mississippi River. The EIS will discuss the overall timing of gate operation and the events that would trigger holding water or releasing water such as time of the year, temperatures, dissolved oxygen concentrations, river forecasts, precipitation forecasts, etc. Opportunities will be explored that maximize the exchange of water (and fish) from the Mississippi River and the spawning and rearing pool. In addition to fish benefits, the EIS will analyze management opportunities for other significant resource categories provided by the spawning and rearing pool. **Question 20:** Please provide examples and operating criteria on how management of the spawning and rearing pool could be improved.

The Panel supports the integration of the listed environmental variables associated with fish access in the development of gate operations. In addition, the EIS should utilize the fish access studies being conducted to evaluate potential access restrictions for each of the spawning/rearing periods (early, mid, and late). For example, if late spawning species are unable to access the river due to gate closure then this component of the fish community would have different mitigation needs than early or mid season species that may involve gate operation changes and/or batture land mitigation.

Appendix C
Final Preliminary Evaluator Responses

for the

St. Johns Bayou and New Madrid Floodway, Missouri
Project Work Plan, Phase 2
Environmental, Economic, and Hydrologic and Hydraulic Review

Comment 1:
There are significant gaps regarding the application of the Shorebird Model, and the major concerns raised in the Phase 1 IEPR of the Consolidated NEPA Document have not been addressed.
USACE Final Preliminary Evaluator Response 1 **This comment is unresolved.**
Question 1a The project work plan states that the goal of mitigation is to compensate for unavoidable significant impact to the extent justified. Significance of impacts will be determined in the EIS. Although reforesting areas such as what is conducted in the WRP Program may show an impact to shorebirds according to the model because the area is no longer sparsely vegetated, restoring bottomland hardwoods will not be considered a significant impact that would require mitigation. Additionally, USACE does not consider a mitigation measure that restores bottomland hardwoods on farmland a significant impact to shorebird habitat because bottomland hardwoods better represent historical/unaltered conditions of the project area. Question 1b The comment and literature cited will be used to determine significance of project impacts in the EIS. Question 1c The comment and literature cited will be used to determine significance of project impacts in the EIS. Question 1d See response to Question 1a. Question 1e **This is unresolved**. What information would an additional round of peer review resolve that has not been resolved by this panel, or would not be resolved by subsequent IEPR review of this project (Phase 3 and Phase 4)?

Question 1f

Although the panel recommended expanding the period to 15 March to 15 June in the spring and 1 July to 30 October in the fall, after reviewing small and medium shorebird graphs for latitude 35-40 degree North, the recommended shorebird dates are 15 March to 30 May in spring and 1 July to 15 October in fall (Dan Twedt, personal communication).

Question 1g

This is unresolved. The alternate methodology provided the proposed HSI values. A separate HSI value will be proposed for Mud Flats. Please place a habitat value to the following sparsely vegetated shorebird habitat types found in the project area and provide justification:

1. Shallow Water (less than 4 inches)
2. Mud Flat (areas recently inundated during the preceding two days)
3. Deep Water (greater than 4 inches but less than 8 inches).

Question 1h

No response necessary.

Question 1i

This is unresolved. See Question 1g and 1e.

Response regarding moist soil management

Moist soil management remains one technique to compensate for potential impacts to shorebirds. Compensating for shorebird impacts by means of moist soil management may also provide additional benefits to other resource categories (wetlands, fish, waterfowl, etc.). Therefore, appropriate gains to these other resource categories will also be quantified. USACE understands the Panel's comments and will only take credit for other resource categories if it is appropriate.

Question 1k

The comment provides an accurate representation on likely mitigation. However, in a mitigation context, a smaller (acreage) managed area that provides optimal habitat could provide equal habitat to a larger (acreage) un-managed area that provides sub-optimal habitat.

See Question 1a regarding the goal of mitigation.

USACE will provide a conceptual management plan that describes duration of inundation, durations of exposed mudflats, and rotating management through all of the units. The site specific management plan would be developed as lands are purchased and site specific details are developed.

USACE does not agree with a 1:1 replacement of acreage. Conceptual mitigation will be based on unavoidable significant impacts to habitat, not on a certain number of acres. The number of acres needed will be determined during the EIS after impacts have been defined, and avoid and minimize measures explored.

The goal of mitigation is not to provide at least the same number of hectare-days of shallowly flooded habitat as occur on the project area under existing conditions. Mitigation is based on replacing significant impacted habitat that is defined as the difference between future with the recommended alternative and the future without the project, not existing hectare days that are flooded with no regard whether the flooded area is optimal or sub-optimal.

Question 1l

See response regarding moist soil management. Once conceptual management is determined during the EIS, benefits to waterfowl will be quantified by providing moist soil management to shorebirds if it is determined appropriate to do so.

For example, shorebird management will focus on providing shallowly flooded (less than 4 inches) and mud flat habitat during the spring migration. Portions of the shorebird migration coincide with the spring waterfowl migration. Obviously this management technique would provide habitat to both waterfowl and shorebirds. Additionally, management for shorebirds would likely entail flooding the sites prior to shorebird arrival. This pre-arrival time span also coincides with spring waterfowl migration. Therefore, it is appropriate to quantify benefits to waterfowl as well. Moreover, it may be practical to manage the sites in a similar fashion that MDC's Eagles Bluff Conservation Area manages their sites that would provide benefits to waterfowl, shorebirds, and fish. Mitigation benefits would be determined for each resource that management is intended to compensate.

Question 1m

This comment is unresolved. Please see response to Question 1l. The WAM has undergone a review by a panel of regional waterfowl experts as well as an independent panel during the model certification review. Please provide information that contradicts the existing peer review that the model has undergone that would support the panel's belief so USACE can make informed decisions.

Question 1n

Management of moist soil units is not known at this time because impacts have not been determined. **Therefore, this comment can not be resolved until the EIS is formulated**. The purpose of the Phase 2 IEPR is to ensure that the proposed USACE methodology is scientifically valid. Once formulated, the EIS will undergo additional reviews (*i.e.,* public, interagency, USACE review, IEPR)

Question 1o

Comment noted. However, the EIS needs to make an accurate prediction regarding waterfowl use of moist soil units to determine if the project is feasible. Therefore, expected

use of waterfowl in moist soil units will be quantified. Mitigation will be adjusted through adaptive management and monitoring.

Question 1p

See response to 1a regarding the mitigation goal. Although USACE believes that it would be a practical trade-off to replace spring habitat by providing fall habitat (that is the limiting factor regarding the overall shorebird population in the region), USACE acknowledges the panel's comment and will only intend to compensate for shorebird habitat by respective seasons.

Question 1q.

No response required.

Comment 2:
The Project Work Plan does not respond to the concerns raised during the Phase 1 IEPR regarding the method to analyze the project's impact on shorebird habitat.
USACE Final Preliminary Evaluator Response 2 **This comment is unresolved.**
Question 2a Based on the 13 and 17 May teleconferences, it is appropriate to interpolate elevations between the 1-foot increments. **The overall question still remains unresolved**: *Is the alternate methodology appropriate to use to determine the "value" of shorebird habitat, compare project alternatives, and determine appropriate mitigation?* Question 2b See response to Question 1e. How would an additional peer review be different from this peer review? USACE is interested in knowing the conclusions of this peer review prior to determining whether an additional review is warranted. Question 2c Comments noted. USACE will investigate the possible impacts to plovers on project area grasslands. Additional USACE Comments Based on the 13 and 17 May teleconference, proximity to other wetlands should not be an issue regarding suitable shorebird habitat nor should any incubation time for macroinvertebrates should be used. The assumption that any sparsely vegetated area that is inundated at appropriate depths provides shorebird habitat (optimal and sub-optimal).

Comment 3:

Information is not provided to support the importance of flood pulses (different from 2-year frequencies) in wetland ecosystems and for wetland-dependent organisms.

USACE Final Preliminary Evaluator Response 3

This comment remains unresolved

Recommendation 1

Flood pulses will be discussed in the EIS.

Question 3a

USACE concurs that an ecosystem that is only flooded, on average, once every other year and with a similar flood intensity each time, will not mimic the natural world. That is precisely one of the reasons why USACE is conducting a study to determine natural/historic conditions. The importance of a variety of flooding frequencies for waterfowl and bird use, for fish habitat and spawning, for introduction of plant and animal propagules, for movement of large-scale detritus (thereby forming new habitat structures for example), for scouring effects and export of large woody debris to the river, and so on played a critical role in the broad natural floodplain ecosystem. However, the role that these rarer flood events play on the existing floodplain may be largely absent or significantly reduced to what occurred historically due to the intense modifications for agricultural purposes.

Habitat provided for these less frequent floods are considered in the shorebird and waterfowl models. However, it was determined during the Phase 1 review that the two-year frequency was appropriate to limit fish habitat. Based on the 13 and 17 May teleconferences, this is no longer the case. **Therefore, this comment remains unresolved.**

> Please provide rational for the change of opinion regarding the concurrence of Phase 1 IEPR Comment/Response 6 and discussions during the 12 November teleconference related to distances fish will swim from the main channel to access spawning sites. In your response, consider the existing network of drainage ditches, many with flap gates that offer the primary means of dispersal for fish moving from the Mississippi River onto the floodplain and the predominance of agricultural lands at higher elevation on spawning preferences of fish.
>
> What flood frequency should be used as the upper limit to quantify habitat value to fish spawning and rearing habitat and why?

Question 3b

USACE will consider a wide variety of techniques including more imaginative solutions to restore ecosystems and welcomes any ideas that the panel, the interagency team, or the

public may formulate.

The comments regarding mitigation in the batture area is noted and the effects of groundwater connections are noted.

Comment 4:
A more complete discussion of fish access in St. Johns Bayou and New Madrid Floodway is needed, and the potential quantification of losses and potential mitigation due to access restrictions must be addressed.
USACE Final Preliminary Evaluator Response 4 **This comment remains unresolved**
<u>Recommendation 1</u> The telemetry study was designed to strategically monitor fish movement at all possible locations that a fish would travel in the two basins: one mile above St. Johns structure, immediately above St. Johns structure, immediately below St. Johns structure, approximately ¼ mile above the mouth of Mud Ditch as it flows into St. Johns Bayou, and at the mouth of St. Johns/Mud Ditch as it flows into the Mississippi River. <u>Question 4a</u> T**his comment is unresolved**. The goal of the telemetry study is to determine if fish can access the St. Johns Bayou basin through the gravity outlet culverts, not actively tracking fish to spawning and rearing habitat. Is the existing telemetry study suitable to make reasonable conclusions for the purpose of the EIS regarding fish access? For the purpose of the EIS, what additional data are required to make a determination on whether fish are moving through the St. Johns Bayou gravity outlet structure? For the purpose of the EIS, how can impacts to fish access be quantified? Although the additional study regarding tracking fish to spawning/rearing habitat sounds interesting and likely beyond the scope of this effort, it does not necessarily answer the question regarding fish access. See response to Question/Comment 5. <u>Question 4b</u> Comments noted, adaptive management and monitoring will be discussed in the EIS. <u>Question 4c</u> Comments noted, batture land is suitable for compensatory mitigation. In addition, based on the 13 and 17 May teleconferences, restoring hydrology to Big Oak Tree State Park as well as restoring a backwater connection to the St. Johns Bayou Basin is also suitable to compensate impacts to fish.

restricted.

In addition to batture land mitigation, restoring hydrology to Big Oak Tree State Park, as well as restoring a backwater connection to the St. Johns Bayou Basin, it is also suitable to compensate for impacts to fish on the floodplain by the methods discussed in the Project Work Plan (*e.g.,* borrow pits, floodplain lakes, reforestation, spawning and rearing pool, etc.).

Comment 5:

The fisheries methodology is not adequate to quantify actual spawning and rearing habitat based on Habitat Suitability Index (HSI) values.

USACE Final Preliminary Evaluator Response 5

This comment remains unresolved.

Question 5a

Based on the 13 and 17 May teleconferences, the panel agrees with the habitat ranking in the Project Work Plan. **This comment remains unresolved**. Please clarify why the panel does not support the habitat values provided in the Work Plan. USACE's justification for the habitat values are contained in the Work Plan.

> Based on discussions during the teleconference on 13 and 17 May, the panel is of the opinion that impacts should be assessed up to the five-year floodplain. However, habitat value (HSI value) above the two-year floodplain should be reduced for a variety of reasons such as distances fish will move away from the channel to find suitable mitigation sites, rising/falling hydrographs that strand fishes (both adults and larvae) making them susceptible to high predation rates, and the fact that over 90% of the land use in the 3-5 year floodplain is cultivated agricultural land. USACE is of the opinion that agricultural lands do not provide habitat value (HSI=0) beyond the two year floodplain and the HSI value of other habitats (e.g., BLH) would be sub-optimal for the reasons stated above compared to the two-year frequency.
>
> Do you agree with the opinion that agricultural lands do not provide habitat to fish above the two year floodplain, and how much should the value other habitat types (BLH and waterbodies) be reduced above the two year floodplain? Please keep in mind that EnviroFish already considers the frequency of flooding, so this question is directed towards HSI values.

Note: For clarification, the proposed HSI value for agricultural areas is 0.2 (see USACE Work Plan page 70), not 0.1 in the panel response.

Question 5b

Field studies to document differences among habitat types would be difficult and likely beyond the scope of this NEPA effort. Therefore, USACE proposes to utilize the HSI values found in the Work Plan. See Question 5a, please clarify why the panel does not support the habitat values provided in the Work Plan and would a Delphi Process be suitable in lieu of field investigations?

Question 5c

No comments required.

Question 5d

See Comment Response to Question 5a.

Question 5e

As stated in the Work Plan (page 71) HSI values have been developed that combine spawning and rearing into one life stage. These values evolved from numerous applications of the model in the lower Mississippi River Valley and were initially developed by consensus of an interagency team of biologists (e.g., Delphi technique, Crance 1987), supplemented by published field data on fish reproduction in floodplains (Baker et al., 1991; Hoover et al., 1995; Killgore and Baker, 1996; Hoover and Killgore, 1998), and best professional judgment.

USACE also proposes to conduct a Delphi process again with the interagency team, if determined necessary.

Based on the 13 and 17 May teleconferences, if the panel concurs that the Delphi Process is appropriate, why are the values presented in the work plan not acceptable?

> Please confirm the panel's position regarding the Delphi Process.
>
> Prior to the Delphi Process, what are the values the panel recommends tp the various land cover types (agriculture, fallow, bottomland hardwoods, and waterbodies) and why (see Question 5a)?
>
> Are the same values applicable to batture areas, or are different values recommended? If so, please provide recommended values and why?

Question 5f

No comments required.

Question 5g

As noted in the Work Plan, the HSI values are community based and not species specific. Regardless, USACE will quantify the benefits of agricultural areas to fish spawning and rearing habitat using Habitat Suitability Indices. In this regard, what is the appropriate HSI value for agricultural areas (see Question 5a)?

Recommendation 2

This comment remains unresolved. Please clarify - Should USACE utilize underlying land use HSI values for a spawning and rearing pool, or is a different HSI value

warranted and why? Please keep in mind that pooling water after the floods recede mimics a semi-permanent waterbody allowing larval fish to grow and survive at greater rates than if they were flushed back into the river prematurely. Consequently, the Corps considers this management action a justification to change the designation of underlying land use (e.g. agricultural land) to a semi-permanent waterbody.

Recommendation 3

No response required.

Comment 6:
The Waterfowl Assessment Method (WAM) appears to be appropriate; however, the parameter estimates for the model are based on fall migratory and wintering ducks and do not appear to consider spring migrants.
USACE Final Preliminary Evaluator Response 6 **This comment is not resolved.**
Based on discussions during the 13 and 17 May teleconference, the IEPR panel stated that they will provide additional documentation regarding the response so it can be forwarded to the WAM model developer. **Therefore, this comment is not resolved at this time**. However, the EIS will include a discussion whether or not the documentation submitted was used in any modifications, or if it was determined not to be applicable to the analysis. and Fredrickson 1996) or location (Gruenhagen and Fredrickson 1990). In fact, few deposition for many waterfowl begins in late winter including during flood events (e.g., Heitmeyer 1988, 2006) and is not confined to spring. The WAM clearly indicates how the DEE estimates for all waterfowl species using the Upper MAV were calculated. The actual estimate of 4x RMR is higher than earlier published estimates and it is acknowledged that the estimate may be conservative. However, until new validated information becomes available for DEE in the Upper MAV and SJNM, the WAM estimates represent the state-of-the-art understanding of DEE for the SJNM and are appropriate for the SJNM project analyses.

Comment 7:
It is unclear if the application of the Hydrogeomorphic (HGM) approach to evaluate project impacts and develop proposed mitigation will yield scientifically credible results.
USACE Final Preliminary Evaluator Response 7 **This comment remains unresolved.**
The panel's comments related to HGM "success" are noted. <u>Question 7a</u> USACE is not too far along in using the HGM technique on this project. This is one of the main objectives of the Phase 2 IPER process. USACE would like to know if the methodologies described in the Work Plan, including HGM, are a reasonable approach to support agency decisions. Although it sounds practical for USACE to take a "generous" mitigation ratio, the mitigation must be based on scientifically justified data. Likewise it would not be prudent for USACE to take a "generous" benefit regarding agricultural benefits of the project. <u>Question 7b</u> USACE is tasked with quantifying the existing wetland conditions, develop future without a project conditions, and compare a range of alternatives to determine potential impacts to wetlands. This requires a tool/mechanism that has the ability to classify wetlands in the project area, map wetland subclasses, and identify impacts. Based on past project analysis, USACE is of the opinion that the majority of wetland impacts will be partial in nature (i.e., wetlands will still retain jurisdictional status but due to hydrologic modifications will no longer be inundated as often or will change subclass). Therefore, an assessment tool needs the ability to capture these types of impacts. Based on the IEPR teleconference, there are no other readily available tools that have the ability to provide this information. **Therefore, to resolve this issue**, should USACE abandon the HGM approach for this project and base impacts/mitigation on the other resource categories (shorebirds, terrestrial wildlife, fisheries, and waterfowl)? <u>Question 7c</u> See response to 7a. <u>Question 7d</u> Comment noted.

Question 7e

Comment noted.

Comment 8:
There is an insufficient level of detail in the Project Work Plan to evaluate the validity of the proposed compensatory mitigation plan.
USACE Final Preliminary Evaluator Response 8 **This comment is unresolved.**
Question 8a See responses to comments 1 and 2. Question 8b The panel did not provide a response. However, based upon the response to Question 1p, it is not an appropriate trade off to provide fall habitat for spring impacts. Question 8c Comment noted. Question 8d The project work plan only describes the methodologies that will be used to describe impacts and formulate alternatives. Additional detail will be provided in the EIS. **This comment is unresolv**ed. USACE is not asking whether or not mitigation is adequate because this will be determined in the EIS. USACE is asking if the methodology described in the work plan is appropriate to base mitigation on to satisfy the requirements of NEPA and the Clean Water Act. Recommendation 2 See Question 8d.

Comment 9:
The adaptive management plan requires a detailed analysis of the ongoing mitigation management costs and a clear funding source adequate to support those activities.
USACE Final Preliminary Evaluator Response 9 <u>Question 9a</u> Comments noted. <u>Question 9b</u> Comments noted.

Comment 10:
The methodology to determine the extent of the wetlands in the project area requires further detail to determine if it is valid.
USACE Final Preliminary Evaluator Response 10 Comments noted.

Comment 11:
The assessment of economic impacts of the proposed project may not be valid because the method used to document the future with and without project conditions does not consider trends in real prices and costs.
USACE Final Preliminary Evaluator Response 11 **This comment is unresolved.** **This comment is not resolved**. During the 13 and 17 May teleconference the panel was asked to provide peer reviewed references addressing the panel's concern on increasing commodity prices. These articles have been received. Would using the agricultural prices in these articles in a sensitivity analysis address the panel's concerns outlined in the comment? It should be noted here that Current Normalized Prices will still be used in the project's sizing and optimization. However, the effects of the alternative prices will be shown in the sensitivity analysis to better inform the appropriate decision makers. Please clarify the last sentence in the Panel Response regarding changes in land use and economic benefits. The panel may have been referring to intensification benefits in this section since direct flood damage reduction benefits can still accrue on lands where the use does not change.

Comment 12:
The use of two discount rates for the same analysis is confusing and is not warranted in any conventional economic analysis.
Final USACE PRELIMINARY Response Comment 12 **This comment is unresolved.** During the 13 and 17 May teleconference, the panel noted that using more than one interest rate in the analysis can be confusing. Further the panel noted that the economic justification is highly dependent on the rate used. Corps guidelines are very specific regarding the interest rate used for project optimization. As discussed in the teleconference, there are two distinct authorizations for this project that warrant two distinct interest rates. It is currently planned to optimize the individual projects included in the overall EIS using their appropriate rate(s). It is also planned to present the selected alternatives using an array of interest rates in a sensitivity analysis as the panel suggests. Will utilizing three interest rates in the sensitivity analysis satisfy the panel's concern? The planned rates are 2.5%, current rate (4.375%), and 7%. If the above approach is not acceptable, does the panel recommend preparing two separate EIS documents for each of the two project authorizations (i.e., Mississippi River Levees Project and St. Johns Bayou and New Madrid Floodway Project) to satisfy the interest rate concern?

Comment 13:
The farming survey may not be credible unless a large enough sample size is used, producing a smaller statistical error for the analysis and avoiding many possible sources of bias.
Final USACE PRELIMINARY Response 13 **This comment is unresolved.**
Based on the 13 and 17 May teleconference, it appears that there was a basic miscommunication regarding the proposed process to estimate future with-project effects on farming practices and land use during the written comment/response process. During the teleconference the proposed process was discussed and clarified. The proposed process is to use present (existing) land use by flood zone as a proxy for with-project land use. For example, assume that present land use for the 5 year flood zone is 50% corn and 50% soybeans and the present 3 year flood zone land use is 100% soybeans. Under a potential scenario (with-project conditions) flooding will be reduced. Let's assume the existing 3 year flood zone now becomes the with-project 5 year flood zone. This will cause a change in land use from 100% soybeans to 50% corn and 50% soybeans for this particular flood frequency zone. This process can be further supported using surveys of the area's farmers regarding how they would react and change their farming practices in response to a reduction in flood risk if the panel feels that surveys will be valuable. Will the discussed changes satisfy the panel's concerns regarding future with-project farming practices and land use?

Comment 14:
The cumulative impact approach lacks specific information on how the conceptual matrix will be used to evaluate the incremental impacts of the proposed project or address the unique aspects of the study area.

USACE Final PRELIMINARY Response Comment 14

Question 14a:

Comments noted.

Question 14b:

Comments noted, USACE will further develop a method of ecosystem analysis as recommend by the panel including spatial and temporal boundaries. As previously stated, we currently have a contract to obtain historical mapping that will show pre-settlement conditions within the project area. Per conversations with our contactor, historic maps are being reviewed. The historical mapping will include the entire St. Johns Basin and the New Madrid Floodway as well as the adjacent batture areas.

Question 14c:

As pointed out in our draft response to comment #16, the project area connection is extremely altered. The area is entirely protected by levees with the exception of the 1,500-foot gap at the lower end of the Floodway. This gap has significantly changed the timing, depths, and durations of flood events from what could be considered normal/non-altered conditions. Simply stating that this is the last remaining connection between the Mississippi River and its floodplain in the State of Missouri does not provide an accurate assessment of current conditions.

The cumulative impact assessment will assess widescale drainage of the project area's historic bottomland hardwood ecosystem (previously occurred), the clearing of vast tracts of forested areas (previously occurred), leveling of farm fields (previously occurred), construction of private levees (previously occurred), closing off the St. Johns Bayou Basin (previously occurred), on-going Mississippi River Levee and Mississippi River and Tributaries construction (this project), and likely future projects. Previous work in the project area could have already "broken the camel's back". In fact, the panel stated that remaining wetlands in the project area were "sad". To reverse this trend, this project, with its conceptual mitigation, has the potential to restore significant habitat types that are no longer found in the project area and would likely never be replaced.

As discussed during the teleconference, we will look for opportunities to restore river connections and restore historic ecological communities. The cumulative assessment will include both the project's impacts as well as the benefits of compensatory mitigation to the entire floodplain ecosystem.

Question 14d:

Please see Panel Comment 16 regarding the "last remaining connection to the River". This is not the last remaining connection to the river.

Question 14e:

No response required.

Comment 15:
More precise contour data (i.e. greater than a 1-foot contour interval) are required to estimate wetland availability and mitigation for waterfowl and shorebirds.
USACE Final PRELIMINARY Response 15: Based on the 13and 17 May teleconferences, it is appropriate to interpolate elevations within the one-foot contours.

Comment 16:
The list of significant resources is not complete because it does not include a discussion of the quality of the wetland resource, which is dependent upon the dynamic nature of the ecosystem's function and its connection to the river.
USACE Final PRELIMINARY Response 16 <u>Question 16a</u> Comments noted. Likewise, cumulative benefits to Big Oak Tree State Park or other areas where river connections are restored would be greater. <u>Question 16b</u> Comments noted. <u>Question 16c</u> Comments noted. Based on discussions during the 13 and 17 May teleconferences, factors independent of backwater flooding appear to play a significant role in the remaining vegetated habitat found in the project area. <u>Question 16d</u> Comments noted. <u>Question 16e</u> No response required. <u>Question 16f</u> Comments noted.

Comment 17:
The water quality analysis in the Project Work Plan does not address water quality conditions in any of the study area water bodies and does not compare nutrient loads to the Mississippi River with and without project conditions.
USACE Final PRELIMINARY Response 17 <u>Question 17a</u> Based on discussions during the 13 and 17 May teleconference, USACE will conduct a qualitative water quality assessment to project area waterbodies for each project alternative and compensatory mitigation. <u>Question 17b</u> Comments noted. USACE will conduct the assessment with the future without project conditions and for each of the project alternatives including compensatory mitigation.

Comment 18:
The validities of several assumptions for the future without project alternatives are questionable.
USACE Final PRELIMINARY Response 18 **This comment remains unresolved.** <u>Question 18a</u> **Based on the 13 and 17 May teleconference a methodology that sufficiently predicts future without project conditions related to WRP is unresolved because the panel believes this project plays a role in WRP enrollment**. Please provide a methodology to estimate future WRP enrollment in the project area considering Comment 11 (Real price and cost changes may be a reality for agricultural producers in this and other regions of the United States). <u>Question 18b</u> Comments noted. Property specific drains may be modified under WRP; however, ditches that drain multiple fields would be maintained with routine maintenance. <u>Question 18c</u> Based on the 13 and 17 May teleconferences, USACE will defer to the State of Missouri regarding Big Oak Tree State Park. Additionally the assumption will be changed to clarify that restoration that involves the restoration of the Mississippi River connection as opposed to groundwater/surface water pumps.

Comment 19:
The potential impact of global climate change on the proposed project and the conceptual mitigation plan should be acknowledged.
USACE Final PRELIMINARY Response No response required.

Comment 20:
The gate closure and pump operation management alternatives proposed for St. Johns Bayou and New Madrid Floodway require further clarification.
USACE Final PRELIMINARY Response Comments noted.

This page intentionally left blank

Appendix D
Final Evaluator Responses and Final BackCheck Responses

for the

St. Johns Bayou and New Madrid Floodway, Missouri
Project Work Plan, Phase 2
Environmental, Economic, and Hydrologic and Hydraulic Review

Comment 1:
There are significant gaps regarding the application of the Shorebird Model, and the major concerns raised in the Phase 1 IEPR of the Consolidated NEPA Document have not been addressed.
USACE Final Evaluator Response

Recommendation 1

Although the project area historically did not provide suitable shorebird habitat because it was a bottomland hardwood forest, the significant anthropogenic alterations (large-scale drainage and canals, laser leveling, forest clearing, and intense agricultural production) that have occurred result in providing suitable habitat for shorebirds. Therefore, to determine significant unavoidable impacts to shorebirds the following methodology is proposed: follows:

Study Objectives:

1. Develop a methodology to quantify the area of potential shorebird habitat relative to Mississippi River stage within the New Madrid Basin and relative to a synthetic derivation of river stage (i.e., headwater flooding or pooling) within the St. Johns Basin.
2. Estimate the area of potential shorebird habitat within the St. Johns and New Madrid Basins that is associated with each relevant 0.1 foot increment of Mississippi River stage.
3. Quantify the historical availability of shorebird habitat within the St. Johns and New Madrid Basins (based on Period of Record data for Mississippi River stage, estimated areas of potential shorebird habitat, and duration of inundation) during periods of northward and southward migration of shorebirds.
4. Predict future availability of shorebird habitat during periods of northward and southward migration of shorebirds within the St. Johns and New Madrid Basins based on presumed post-project simulations of Mississippi River stages upon completion of the St. Johns-New Madrid project.

Approach:

Available Data **-** The Memphis District Office of the U.S. Army Corps of Engineers will provide USGS Patuxent Wildlife Research Center with:

1. Period of Record data for Mississippi River stage from the gauging station associated with the New Madrid floodway, and
2. Digital (GIS) data for the project area within the St. Johns and New Madrid Basins depicting:
    1. The area of inundation associated with 1-foot river stages (i.e., 1-ft contour lines).
    2. Land cover classes.
        a. National Land Cover classes as amended by USACE field evaluations.
    3. LIDAR based elevations.
        a. Available only for a portion of the study area (New Madrid Basin).
    4. Bare earth digital terrain model (DTM) derived from LIDAR data.

a. Available only for a portion of the study area (New Madrid Basin).

Assumptions and Rationale –

1. The contour lines developed by USACE, Memphis District that are associated with 1-foot increments in Mississippi River stage, as recorded at the New Madrid gauge, provide a reasonably accurate representation of the floodwater extent associated with each of these river stages.

2. Use Geographic Information System (GIS) to derive interpolated elevations between 1-foot contour lines at <1-foot intervals (e.g., at 2 inch [5 cm], 4 inch [10 cm], or 0.1 foot [3 cm] intervals) so as to depict the theoretical distribution of floodwater extent associated with Mississippi River stages between the 1 foot river stages.

    a. Where possible, interpolation will be aided by LIDAR and DTM data. Elsewhere, interpolations will be based only on distance between contour lines.

    b. Although distance interpolation may be imprecise, the assumption is that variation in flood area is averaged thereby providing a reasonable approximation of the flooded area. Thus, this representation may not depict the exact geographic distribution of flooding but the total area inundated is presumed accurate.

3. Few shorebird species breed within the study area (Missouri Breeding Bird Atlas 1986 – 1992 <http://mdc.mo.gov/nathis/birds/birdatlas/index.htm>): only Killdeer commonly breed in the study area. Similarly, few individuals and species of shorebirds are found within the study area during winter. For example, during the past 2 decades, Christmas Bird Counts conducted at Big Oak Tree State Park [MOBO; a 15-mile diameter circle within the study area] detected only 5 species of shorebird, with only Killdeer, Common Snipe, and Least Sandpiper detected in more than 1 year. The greatest abundance and species diversity of shorebirds within the study area occur during spring and fall, as en-route migrant shorebirds make "rest and refueling" stops during their northbound (spring) and southbound (fall) passages (Elliott and McKnight 2000). Therefore, the period of interest for this assessment of habitat will be limited to 15 March – 30 May during spring and 15 July – 30 October during fall (Skagen et al. 1999). These two time intervals encompass nearly the entirety of shorebird passage through the study area (Fig. 2).

4. Review of shorebird abundances within the Mississippi Alluvial Valley (Table 1), suggest that small and medium size shorebirds represent the preponderance of shorebirds likely found in the St. John's and New Madrid Basins during migration.

5. Most of these small and medium size shorebirds forage primarily in water depths from 0 – 6 cm (Table 1). Even so, some of these shorebirds, and other less abundant shorebirds, also forage in exposed mudflat habitats and in floodwater of depth from 6-12 cm, with a few species foraging at greater water depth (Fig. 3, Table 1). More than 70% of shorebirds species require water depths <10 cm and many are restricted to water depths of <5 cm (Helmers 1992, Skagen et al. 1998, Dinsmore et al. 1999). Indeed, water depth (shallow being better) was the most important predictor of shorebird abundance within the Rainwater Basin (Webb et al. 2010).

    a. Because of preferential habitat use by shorebirds, I will assume that shallow flooded habitats (circa 0-6 cm) provide optimal foraging conditions. Habitats flooded to moderate depth (circa 6-16 cm), and mudflat habitats, are assumed to be used by shorebirds but are less than optimal habitats.

    b. Justification for optimizing shallowly flooded areas is based on observed shorebird abundances as reported to Lower Mississippi Valley Joint Venture Shorebird

Monitoring Program (http://www.lmvjv.org/shorebird/default.asp), Loesch et al. (1999), and Elliott and McKnight (2000). As further confirmation, in an assessment of foraging habitat use by 8 species in the Playa Lakes Region of Texas during spring, Davis (1996; Table 2.3) reported shallow (<4 cm depth) flooded habitats were used by 46% of foraging flocks whereas moderately flooded (4-16 cm depth) habitats were used by 29% of foraging flocks. Mudflats were used by 19% of foraging flocks but only 5% of flocks used habitats flooded deeper that 16 cm. Based on habitat used reported by Davis (1996):

i. Suitability of shallowly flooded (≤6 cm depth) habitat will be considered optimal habitat (HSI score = 1.0)

ii. Suitability of moderately flooded (6 - 16 cm depth) habitat will be considered 60% of optimal (HSI score = 0.6).

iii. Suitability of mudflat habitat will be considered 40% of optimal (HSI score = 0.4). Reduce suitability of mudflat is based on fewer species and individuals using these areas and anticipated heterogeneity of conditions within areas of presumed mudflat habitat. That is, due to mircro-topography and temporal variation in rates of evapo-transpiration within areas of presumed mudflat habitat, not all predicted mudflat habitat will likely be suitable as foraging habitat for shorebirds.

6. Shorebirds forage within a variety of substrates that range from bare ground to >75% vegetative cover, but most species use sites with sparse (<25%) vegetative cover (Dinsmore et al. 1999). Additionally, many species exhibit a preference for sites with vegetation height less than half of their body height. Davis (1996) reported 95% of foraging flocks used sites with <33% vegetation. Therefore, all landcover types assumed to have tall or dense vegetation (e.g., forest or shrubs) will be considered unsuitable for shorebirds. Conversely, I will assume that agricultural fields and grasslands constitute suitable shorebird habitat when appropriately flooded.

   a. During spring, cropped fields subject to flooding will likely not have been planted or only recently emerged. Flooding during fall is far less likely than during spring, but if floods occur, crops nearing maturity may remain in field. Even so, prolonged flooding during fall will likely lead to "lodging" of crops, resulting in relatively sparse vegetation within at least portions of mature crop fields that are flooded.

   b. Grassland vegetation may range from very short to relatively tall and rank. Grazed or hayed grasslands likely have vegetation structure during fall or spring that when flooded constitutes suitable habitat for shorebird foraging. On the other hand, the dense vegetation structure associated with conservation grasslands (e.g., CRP, or "set-aside" lands) likely restricts their suitability for shorebirds even when flooded. If conservation grasslands can be identified, these areas will be assumed to be of reduced suitability for shorebirds.

7. Because prolonged duration of flooding stimulates production of aquatic invertebrates within artificial wetland (i.e., impoundments) being managed for shorebird habitat, water is often retained for long periods (weeks or months). However, natural wetlands and rivers harbor myriad aquatic invertebrates upon which shorebirds forage. In addition, terrestrial insects and other invertebrates found in cultivated fields in the Mississippi Alluvial Valley provide food for shorebirds when these fields are flooded. Thus, flooded lands with sparse or short vegetation (e.g., agricultural fields or grazed grasslands) provide productive foraging sites for migrating shorebirds regardless of flood duration.

Methods:

The area of sparsely vegetated landcover (discounted by landcover type if warranted) between each interpolated flood contour will be summed. Using these area estimates as potentially suitable habitat, Period of Record river stage data will be used to evaluate the status of flood extent on each day within the shorebird migration periods. Based on interpolated flood contours (Fig. 3), a maximum flood extent will be associated with each 0.1 foot increment of Mississippi River stage (Table 2) [rounded up to nearest interpolated contour if rising river or rounded down if falling river stage] . This maximum extent represents the presumed water-land interface (i.e. flood depth = 0). The area between this leading edge and the interpolated contour presumed to represent flooding at or near 6 cm will be the optimal flood zone. Thus, the area of potential habitat within these contours will be summed to provide an estimate of realized optimally flooded habitat for each day. Similarly, the area between the interpolated contour presumed to represent 6 cm flood depth and that representing a presumed 16 cm flood depth will be summed to represent the realized sub-optimally (moderately) flooded habitat for each day.

During each daily evaluation, the river stage for each of the previous 2 days will be examined (Table 2). If the river stage during either of the previous 2 days was greater than on the day under consideration, mudflat habitat will be presumed to be present between the current river stage water-land interface and the maximum flood extent during the previous 2 day period. The area between the current water-land interface contour (0 depth) and the contour representing the maximum 2-day flood extent will be summed to represent the realized mudflat habitat for each day.

To estimate total daily shorebird habitat within the St. Johns and New Madrid Basins, for those areas with suitable vegetation structure (i.e., grasslands and croplands), I will combine the area of realized optimally flooded (circa 0-6 cm depth) habitat with the realized areas of mudflat habitat and deeper, sub-optimally flooded (circa 6-16 cm depth) habitat, after appropriately discounting the areas of mudflats and moderate flooding by multiplying by their respective HSI score. These summed estimates will provide the total area (ha) of shorebird habitat present during each day of the spring and fall migration periods. The area of daily realized shorebird habitat will be summed over the spring and fall migration periods to provide estimates of seasonal availability of shorebird habitat expressed in terms of total "ha-days" of shorebird habitat. Each ha-day of shorebird habitat represents 1 ha of sparsely vegetated habitat under optimal flood conditions for a period of 1 day. [However, as noted above, because areas in mudflats and more deeply flooded areas are considered sub-optimal habitats, the area of these habitats will be appropriately reduced relative to optimally flooded areas. Thus, >1 ha of each of these habitats will be required to achieve 1 ha-day of shorebird habitat.] Separate estimates of shorebird habitat availability will be made for each migration period and each year for which Mississippi River stage data are available.

Landscape Considerations - Proximity among wetlands has been deemed important for "resident" shorebirds (i.e., birds spending extended periods within a local landscape during breeding or while over-wintering [Taft and Haig 2006]). Similarly, during migration shorebirds are more likely to occur in areas with higher density of wetlands (Jorgensen et al. 2007). Webb et al. (2010) found shorebird abundance was positively associated with both wetland area and the number of wetlands within a 10-km^2 landscape. Based on these findings, I assume that more shorebirds are attracted to landscapes with increased area of floodwater. I will assess the area of floodwater extent (i.e., total area of floodwater) within the study area associated with each 1-foot river stage. "Attraction to habitat" will be assumed to be maximized if >10 km^2 (1000 ha) of floodwater (regardless of depth) are present within the study area. When <1000 flooded ha exist

within the study area, the daily area (ha) of shorebird habitat will be proportionally reduced. The degree of reduction has not yet been established, but will be based partially on the proportion of days within the study area with maximum "attraction to habitat" condition.

Future Predictions:

To provide an estimate of post-project shorebird habitat, U.S. Army Corps of Engineers will provide an estimate(s) of daily river stages that are likely to occur (or deemed possible to occur) under post-project conditions. These projected estimates of river stage will be substituted for historical river stage data. Thus, via simple substitution of river stage data, I will quantify future shorebird habitat using an identical method to historical shorebird habitat predictions.

Verification and validation:

A methodology for verification and validation of this assessment of shorebird habitat is provided below but verification and validation are beyond the scope of this study plan. Additional time and funding will be required to undertake model verification and validation.

Verification – Verification of the predictive ability of this assessment of shorebird habitat within the St. Johns and New Madrid Basins will be based on comparison of the area of predicted shorebird habitat with the area associated with the water-land interface identified on binary classified Landsat TM imagery. Satellite imagery of the study area with known date of origin, will be obtained from in-hand images within the archives of USACE, USFWS, and Ducks Unlimited. These images will be classified into a binary depiction of water versus land (non-water or dry). A linear contour will be established at all water-land interfaces. Interior (water-side) buffer distances will be generated from these linear contours that represent optimal (shallow) flooding and sub-optimal (moderate) flooding. Similarly, an exterior (land-side) buffer will be established (if appropriate for the date of the imagery as indicated by a falling river stage) at a distance representative of the maximum 2-day previous floodwater extent. The areas of presumed shorebird habitat (sparsely vegetated landcover classes) within these buffers will be extracted and quantified (with HSI appropriate reduction for moderate flooding and mudflat habitats). Correlation between the area of predicted shorebird habitat (as determined from the shorebird habitat assessment procedure described above) and that derived from satellite imagery will provide a measure of the reliability of habitat predictions associated with river stage data. Model verification based on ≥10 satellite images from different dates will likely be needed to provide reliable verification of predictions associated with different river stages.

Validation – Stage 1: For each day a TM image of the study area is available, the spatial depictions of predicted shorebird habitat associated with the appropriate, day-specific, river stage will be generated. This spatial representation will be compared with the area of presumed shorebird habitat associated with the water-land interface on TM images. Areas of estimated shorebird habitat that coincide or are in reasonable proximity (distance yet to be determined) between these 2 depictions of shorebird habitat will be assumed to be validated. The proportion of estimated shorebird habitat that is validated versus the proportion that is not validated provides an estimate of overall confidence in the validation. Model validation using ≥10 satellite images from different dates will likely be needed to provide a reliable validation for different river stages.

Stage 2: Field validation of the predictive ability of the shorebird assessment will require on the ground assessment of water depths and soil saturation. This validation should be based on a random selection of evaluation units (e.g., fields, ha, geographic coordinates) that can be sampled within the areas associated with predicted shorebird habitat

associated within each river stage. These random locations should be selected a priori and entered into a database or a global positioning unit. Thereafter, upon obtaining the 8 am river stage reading, field personnel would visit each random location and assess shorebird habitat at that location (e.g., measure water depth, soil saturation, distance to nearest water edge, etc.). The proportion of random locations where the estimated shorebird habitat was validated as present at or near the evaluation point versus the proportion of random locations that were not validated (i.e., no shorebird habitat at or near the location) will provide an estimate of overall validation of predicted shorebird habitat based on river stage data.

Notably, although the presence of shorebirds can and should be concurrently recorded during field validation, the validation is NOT dependent upon the shorebird use of the habitat – only that suitable habitat is present at (or within close proximity to) the validation location.

The alternate methodology stated above will undergo peer review.

Note: USACE does not consider measures that restore vegetation to an area, including compensatory mitigation measures, as a significant impact to shorebirds and therefore, does not intend to mitigate for shorebird impacts that the model may show by restoring bottomland hardwoods.

Recommendation 2

Moist soil units are proposed to compensate for shorebird impacts. The vast majority of impacts are likely to occur during the spring because this is the period that coincides with Mississippi River flooding. Managing for spring shorebird habitat likely compliments spring waterfowl. Therefore, waterfowl are likely going to utilize the moist soil units and USACE intends to take the appropriate credit. Nonetheless, the panel's comments are noted regarding the reduction of habitat value for waterfowl. During the formulation of the EIS and once impacts and mitigation are determined including management, the appropriate value for shorebirds and waterfowl will be determined that moist soil units provide.

Additionally, although fall habitat is likely the limiting factor for many shorebird species in the project area, USACE intends to follow the panel's recommendations and only compensate for impacts during the specific period (*i.e.,* spring or fall). Therefore, USACE will not provide fall habitat for shorebirds to compensate for spring impacts.

Recommendation 3

A conceptual management plan will be developed in the EIS once impacts are determined. A permanent management plan will be developed during the completion of the site specific mitigation plan.

Final Panel BackCheck Response 1
Non-concur: 1a – 1l
Concur with Comment: 1m

Question 1a. The USACE response states: "The project work plan states that the goal of mitigation is to compensate for unavoidable significant impact to the extent justified. Significance of impacts will be determined in the EIS."

The Panel understands that the specific impacts of the project cannot be determined precisely until the proposed design is finalized in the upcoming EIS. However, the Panel believes that the loss of large areas of seasonally flooded, sparsely vegetated habitats for shorebirds are a significant impact of the proposed project, and that USACE should clearly state in the Work Plan its intention to fully mitigate for the specific impacts to shorebird habitats that will be determined during the EIS analyses. The Panel will concur if USACE states its intent to fully mitigate for impacts to shorebird habitats.

Question 1a, continued. The USACE response states: "Additionally, USACE does not consider a mitigation measure that restores bottomland hardwoods on farmland a significant impact to shorebird habitat because bottomland hardwoods better represent historical/unaltered conditions of the project area." The response reiterates this point on page 19 where it states that: "Note: USACE does not consider measures that restore vegetation to an area, including compensatory mitigation measures, as a significant impact to shorebirds and therefore, does not intend to mitigate for shorebird impacts that the model may show by restoring bottomland hardwoods."

The Panel understands that the project area is highly modified from its historic conditions. These conditions notwithstanding, the goal of the mitigation plan is to compensate for losses in ecological function measured by comparing current without- project conditions to future with-project conditions. Importantly, this mitigation becomes part of the project and, therefore, all wildlife habitat losses that would result from the project, including those directly attributable to mitigation activities for other resource types, should be mitigated. The Panel will concur if USACE states that all wildlife habitat impacts, including those resulting from mitigation of other project impacts, will be mitigated.

Question 1e. The USACE response states: "**This is unresolved**. What information would an additional round of peer review resolve that has not been resolved by this panel, or would not be resolved by subsequent IEPR review of this project (Phase 3 and Phase 4)?"

The Panel has explained its rationale for requesting peer review on all major models to be used to measure habitat impacts and determine mitigation requirements. USACE apparently accepted this rationale, and states in the second to last line under Recommendation 1, on p. 19, that "The alternate methodology stated above will undergo peer review." If USACE intends to conduct a peer review on the alternate methodology, then it is unclear to the panel why this issue is listed as unresolved. The Panel will concur if USACE states that the shorebird habitat model will undergo peer review.

Question 1f
The USACE response states: "Although the panel recommended expanding the period to 15 March to 15 June in the spring and 1 July to 30 October in the fall, after reviewing small and medium shorebird graphs for latitude 35-40 degree North, the recommended shorebird dates are

15 March to 30 May in spring and 1 July to 15 October in fall (Dan Twedt, personal communication)."

The Panel recommends using the entire period of shorebird migration to calculate impacts to shorebirds, as proposed earlier. Because the comment says only what dates USACE recommends, it is not clear what rationale was applied to remove portions of the migration window when shorebirds are present in the study area. The Panel recommends the conservative rationale of calculating impacts to shorebird habitats during the entire periods when migrating shorebirds are present in the study area. Skagen et al. (1999, p. 17, 31, 33) supports shorebirds being present during spring migration through June 15th for both small shorebirds and all shorebirds, and supports shorebirds being present during fall migration through October 30th for all small, all medium, and all shorebirds. Particularly because migration phenology may change in response to climate change on the arctic breeding grounds, the panel recommends using the entire migration window to calculate impacts to shorebird habitats. The panel will concur if USACE uses the recommended migration windows to calculate shorebird habitat impacts.

Question 1g. The USACE response states: "**This is unresolved**. The alternate methodology provided the proposed HSI values. A separate HSI value will be proposed for Mud Flats. Please place a habitat value to the following sparsely vegetated shorebird habitat types found in the project area and provide justification:"

The Panel believes that the development of HSI values and other specifics related to model parameterization are beyond the scope of its review. The Panel believes its role is to comment on the process used to generate models and their output, the results of the peer review of those models, and their application. The Panel will review the models, parameter values, and application of the models during the next phase of the project, but cannot generate the model or parameter values to be used in the limited time available for working on this process. The Panel believes that the recommended peer review will resolve this issue.

Question 1k. The USACE response states in the last line of the response to this question, on page 9, that "The goal of mitigation is not to provide at least the same number of hectare-days of shallowly flooded habitat as occur on the project area under existing conditions. Mitigation is based on replacing significant impacted habitat that is defined as the difference between future with the recommended alternative and the future without the project, not existing hectare days that are flooded with no regard whether the flooded area is optimal or sub-optimal."

The Panel agrees that it is appropriate to consider the relative value of habitat types in currently existing conditions, and discount acreage affected by the project according to its relative value. This is the basis of the HSI approach. However, the Panel also believes that it is appropriate to compensate for all of the impacts to existing habitats, using the appropriate HSI value as a discounting factor. The Panel has always supported measuring the relative value of different habitat types, and is unclear why this is being raised as an issue at this point, but also continues to believe that the total impacted area, with appropriate discounting for habitat value, should be compensated for in a mitigation plan that replaces lost ecological function.

One significant issue relates to the value of a slow drawdown over time for shorebird habitat. Although some areas may be flooded to a depth that shorebirds do not use when deeply flooded, over time as flood waters recede, those areas will be exposed, and will become optimal foraging habitat while they are shallowly flooded or recently exposed. This is important when assigning habitat values as proposed in the alternate methodology, for example under section 5b, where different water depths are given different HSI values. The calculation of impacts now appears to

include all areas of shallowly flooded and sparsely vegetated habitat that would be flooded under current conditions but then exposed during the migration window, as the panel recommended. The Panel concurs with the approach outlined in the alternate methodology (Methods, p. 16), where total daily hectares of habitat are rated with respect to their habitat value, and then summed across the migration window. If USACE intends to include all appropriate shorebird habitats in its calculation of impacts, and assign them appropriate habitat values when they are exposed by drawdown during the migration window as outlined in the alternate methodology, the panel concurs with this general approach. The Panel still recommends that the alternate methodology be fully developed in a model document with all equations and parameter values specified, and subjected to peer review.

Question 1m

Concur

In theory, productivity levels used in the parameters of the WAM model can be reached, however, in practice, this rarely happens across large spatially divers areas (e.g., Kross et al. 2008). Equipment fails, levies break or leak, water control structures get clogged, etc., delaying or preventing flooding and draw-downs. If these problems occur, they will no doubt impact the ability of the moist soil units to produce foods for waterfowl. USACE has indicated they will monitor waterfowl food productivity on mitigation wetlands with an adaptive management approach to ensure mitigation wetlands produce food at levels assumed by the model. This approach appears to be an appropriate way to ensure waterfowl are properly mitigated. The Panel is concerned, however, this approach of additional mitigation after the completion of the project, during the adaptive management phase will lead to an artificially decrease in the cost of the project. The Panel believes the estimate of 556 kg/ha of seed production suggested by Kross et al. (2008) as an estimate for planning purposes represents a more realistic value for managed moist soil habitat and would be more appropriate for estimating project costs. Based on the September 8, 2010 conference call, USACE has agreed to use 556kg/ha as an estimate of seed production for managed moist soil habitat for planning purposes.

Kross, J., R.M. Kaminski, K.J. Reinecke, E.J. Penny and A.T. Pearse. 2008. Moist-soil seed abundance in managed wetlands in the Mississippi Alluvial Valley. Journal of Wildlife Management 72:707-714.

Comment 2:
The Project Work Plan does not respond to the concerns raised during the Phase 1 IEPR regarding the method to analyze the project's impact on shorebird habitat.
USACE Final Evaluator Response 2
<u>Recommendation 1</u> The alternate methodology described in Comment 1 will undergo peer review. <u>Recommendation 2</u> See Comment 1 – Alternate Methodology <u>Recommendation 3</u> See Comment 1 – Alternate Methodology.
Final Panel BackCheck Response 2
Concur with comment. The Panel believes that the methodology outlined proposes appropriate scientifically defensible methods to describe existing shorebird habitats that may be impacted by proposed project alternatives. However, the Panel also believes that the methodology needs to be fully developed in a proposed model document as was done with all of the other models, including specification of parameter values and how calculations are to be carried out, and then subjected to peer review. If USACE plans to fully develop this model and conduct a peer review, the Panel concurs with this approach.

Comment 3:
Information is not provided to support the importance of flood pulses (different from 2-year frequencies) in wetland ecosystems and for wetland-dependent organisms.
USACE Final Evaluator Response 3
Recommendation 1 The Corps recognizes the importance of the flood pulse concept, originally proposed by Junk et al., and has incorporated the importance of pulsed hydrographs in the project. For example, Big Oak Tree State Park will be a critical component of the project. Daily stage elevations reflect pulses in the hydrograph. In fact the EnviroFish review (Battelle, 2010) stated: > "It is based on habitat suitability theory, which has a long history, and EnviroFish appropriately accommodates the systems theory ideas that evaluation of fish reproduction involves the explicit linkage between the river and its associated floodplain (I.e., the Flood Pulse Concept, Junk et al. 1989)." Additional information on the flood pulse concept will be included in future NEPA documentation. Recommendation 2 As stated in the project work plan, impacts to waterfowl and shorebirds are not dependent on a particular flood frequency. Although the definition of a riverine wetland is dependent on it being located within the 5-year floodplain, wetlands are being assessed within the entire project area. For wetland discussions, see response to comment 10. With the exception of the batture land, it is reasonable to state that there is no natural habitat that remains in either the St. Johns Basin or the New Madrid Floodway. The St. Johns Bayou Basin is no longer connected to the Mississippi River (management of the gates do not allow for Mississippi River water to back up into the basin). All hydrologic influences are due to the fact that closing the gates artificially traps rainwater in the basin. With the exception of the 1,500-foot gap the entire New Madrid Floodway is protected by levees. Hydrologic regimes are extremely modified as a result of travelling through an un-natural 1,500-foot gap. All natural watercourses have been replaced with unnatural channelized drainage ditches, new ditches have been dug in areas to drain natural depressions, and water control structures are found throughout the project area. Landscapes have been leveled and farm drains are prevalent in virtually every agricultural field. Even Big Oak Tree State Park, which is arguably the best remaining habitat found within the project area and possibly the region, no longer can be considered natural given the present trend in the park's vegetation due to its altered hydrologic regime. USACE concurs that an ecosystem that is only flooded, on average, once every other year and with a similar flood intensity each time, will not mimic the natural world. That is precisely one of the reasons why USACE is conducting a study to determine natural/historic conditions. The importance of a variety of flooding frequencies for waterfowl and bird use, for fish habitat and spawning, for introduction of plant and animal propagules, for movement of large-scale detritus (thereby forming new habitat structures for example), for scouring effects and export of large

woody debris to the river, and so on played a critical role in the broad natural floodplain ecosystem. However, the role that these rarer flood events play on the existing floodplain in the project area may be largely absent or significantly reduced to what occurred historically due to the intense modifications for agricultural purposes.

Habitat provided for these less frequent floods are considered in the shorebird and waterfowl models. Although the Phase 1 review concluded that the two-year frequency was appropriate to limit fish habitat to, this has been expanded to the 5-year frequency based on subsequent conference calls and the panel's recommendation. The independent panel stated that the five year flood frequency is the appropriate upper limit to for the fish model utilized to determine impacts and quantify mitigation. The following revisions have been made to the spawning and rearing assessment as it relates to fish and flood frequencies.

The boundaries for the functional floodplain available for spawning and rearing habitat will be confined to the 5-year flood frequency due the reasons previously stated regarding the use of the two-year floodplain. The EnviroFish Manual states the following in regard to the two year flood frequency.

- Most fish species reach sexual maturity by age 1 or 2 indicating that a 2-year flood is necessary to maintain reproductive populations. The life span of small-sized species is 2-3 years and some may only reproduce once. Thus, a flood frequency less than 2-years may result in successive reproductive failures in species with short life spans.[1] Larger-sized species can live up to 10 years, and in riverine floodplains, experience high and low stages on an annual basis. The more extreme hydrologic events may result in higher fish abundance, but do not represent flooding regimes that maintain baseline population levels of long-lived species over the life of most projects (i.e., 50 year project life).

- In agricultural landscapes, floods greater than a 2-year frequency typically inundates cleared lands mostly unsuitable as reproductive habitat for two reasons. First, the floodplain closest to the river provides immediate access to reproductive fishes undergoing spawning migrations. Fish may have to travel miles from the mainstem river to reach lands corresponding to a 3-year or greater flood frequency. Second, even if adults do move great distances to spawn, eggs deposited in cleared lands far removed from the mainstem river have a greater risk of becoming trapped in isolated pools during receding stage elevations.

Therefore, by expanding the analysis to the 5-year flood frequency results in a conservative estimate regarding fish spawning and rearing habitat.

Based on the panel recommendations, fishery analysis will be split into two different zones regarding flood frequencies. Zone 1 will be within the two-year flood frequency. Analysis will be conducted as previously described in the Project Work Plan for fallow, bottomland hardwoods, and waterbodies. Habitat value will be quantified in these particular land cover types as long as they are inundated (no depth requirement) for at least one day. Spawning criteria (*i.e.,* water depth is ≥1.0 ft with duration of at least 8 days) will be applied to agricultural areas in Zone 1 to

[1] Although this text is provided in the EnviroFish Manual the following is provided for further clarification. Many small-sized in the Mississippi River only live 2-3 years and may only reproduce once during their life cycle. Therefore floods with a greater magnitude than the 2-year event (*i.e.,* flood frequency less than two years) such as the 10-year flood may result in successive reproductive failures.

quantify spawning and rearing habitat. The justification for this is due to mortality and stranding factors on agricultural areas. Agricultural areas provide sub-optimal habitat and quickly drain as Mississippi River stages fall due to the vast network of drainage ditches and structures. Therefore, agricultural areas need to be inundated for 8-day duration to be suitable spawning and rearing habitat.

Zone 2 (*i.e.,* areas that fall between the two-year and five-year frequencies) analysis will only be confined to "optimal habitat" (*i.e.,* waterbodies and bottomland hardwoods). Sub-optimum habitat (*i.e.,* fallow and agricultural areas will be excluded from the analysis) will be excluded from the analysis. The justification for this is fish are less likely to use the sub-optimal areas at greater distances from the river due to mortality factors and stranding issues. However, this is not the case in "optimal" areas.

An additional independent review conducted by the EnviroFish Model developers also shared the same views regarding optimal and sub-optimal habitat. Battelle (2010) stated the following:

> …In reality, a small area of high-quality habitat is likely to outperform a large number of low-quality habitat areas, even if they both have equal HU values. This assumption allows the potential for rationally choosing a project alternative that provides a lot of corn field stubble and not bottomland hardwood forest over one where bottomland hardwood forest is present in moderate amounts. This assumption precludes the model from an organizing the output to maximize the highest quality habitat type.
>
> …EnviroFish should not allow the opportunity to increase lots of acreage of really poor habitat for an alternative or future situation without regard for the absolute acreage of very high quality habitat. It might be more appropriate to calculate total Hus using only habitats with HSIs greater than soime minimum value, for example 0.4. The planning decisions would be based on changes from what is known to be fair/good habitat to other fair/good habitat because the value of Hus would be much more comparable. Other avenues to correct for very poor or very good habitat (e.g., weighting) should also be considered.

Therefore, USACE is of the opinion that calculating HUs on optimal habitat only in Zone 2 is appropriate and sub-optimal habitat (*i.e.,* agricultural and fallow areas) would not be considered.

Final Panel BackChecks Response 3

Concur with comment.

Recommendation 1: No additional comment.

Recommendation 2: Although the Panel agrees that both the St. Johns Basin and New Madrid Floodway are altered ecosystems due to a variety of anthropogenic impacts, wetland ecosystem function still exists and provides habitat for diverse plant and animal communities. In addition, annual variability in flood events, although altered from "natural" conditions, helps maintain ecosystem function in the remaining wetlands of the St. Johns Basin and New Madrid Floodway.

Comment 4:
A more complete discussion of fish access in St. Johns Bayou and New Madrid Floodway is needed, and the potential quantification of losses and potential mitigation due to access restrictions must be addressed.
USACE Final Evaluator Response 4
Recommendation 1 The Corps has actively studied fish passage through the St. Johns structure for two years. During the first year, we tagged over 1500 fish encompassing 38 different species both upstream and downstream of the structure. Although we did re-capture multiple individuals, none that were captured were located on the opposite side of the structure from the tagged location. Therefore, in Year 2 of the study, we implemented a sonic telemetry study. Remote receivers were placed in the channel at five locations: one mile above the structure in St. Johns Bayou, immediately above the structure, immediately below the structure, Mud Ditch near the site of the proposed New Madrid levee closing (within the New Madrid Floodway), and near the mouth of Mud Ditch/St. Johns where it flows into the Mississippi River. Fish are being captured using various collecting gears, internal sonic transmitters are surgically implanted, and all fish are released where Mud Ditch and St. Johns intersect. Therefore, fish have the choice to go through the structure into St. Johns Bayou, up into Mud Ditch in the New Madrid Basin, or leave the system into the Mississippi River. To date, almost 80 fish representing multiple species that spawn or rear in the basins, have been implanted with transmitters. Fish are being incrementally tagged to evaluate rising and falling stages through the reproductive season. Fish passage through the structure has been documented with telemetry, but data are still being collected and analyzed The telemetry study was designed to strategically monitor fish movement at all possible locations that a fish would travel in the two basins: one mile above St. Johns structure, immediately above St. Johns structure, immediately below St. Johns structure, approximately ¼ mile above the mouth of Mud Ditch as it flows into St. Johns Bayou, and at the mouth of St. Johns/Mud Ditch as it flows into the Mississippi River. Results from the study and gate operating rule curves developed for the EIS will be used to determine if access is restricted for early, mid, or late spawning species. Project monitoring will be conducted to determine if access is limited and if fish are utilizing established mitigation sites. Based on panel recommendations, the project will be adaptively managed and mitigation will be adjusted in the event that access is impacted. Recommendation 2 The telemetry study is designed to evaluate influence of seasonal parameters on fish passage. Fish are being tagged at different water temperatures, river stages, and months. The remote receivers provide a constant monitoring capability throughout the reproductive season. The Corps will use information collected at St. Johns structure to develop operating rules for the New Madrid structure to maximize fish passage opportunities. The Corps can determine the percentage of fish passing through the structure compared to those moving up Mud Ditch or downstream into the Mississippi River. Mitigation for the New Madrid structure will be based partly on the results of the telemetry study, as well as consideration of operating rules.

On-going research appears to indicate fish are passing through the structure on St. Johns Bayou (from interior to the exterior, and vice versa). This research will continue to be conducted throughout the reproductive season.

There are opportunities to increase fish access in the St. Johns Bayou basin by keeping the gates open longer during rising river conditions because the pumps would offer assurances that would prevent economic damages. Additionally, fish access is being considered in the Big Oak Tree State Park hydrologic restoration plan. Both of these measures have the potential to significantly increase fish access to areas where it is extremely limited or does not occur.

Although the Fish and Wildlife Service has repeatedly indicated that batture land mitigation is not suitable to mitigate for project impacts because it does not provide habitat (in-kind) that is similar to that found in the Floodway, based on teleconferences with the panel, the panel stated that batture land would be suitable for mitigation.

Compensatory mitigation sites as well as fish access in newly constructed culverts will be monitored and adaptively managed. Overall mitigation needs would be adjusted in the event that project monitoring determines that access has been significantly restricted.

In addition to batture land mitigation, restoring hydrology to Big Oak Tree State Park, as well as restoring a backwater connection to the St. Johns Bayou Basin, it is also suitable to compensate for impacts to fish on the floodplain by the methods discussed in the Project Work Plan (*e.g.,* borrow pits, floodplain lakes, reforestation, spawning and rearing pool, etc.).

Final Panel BackCheck Response 4

Concur with comment.

Recommendation 1: No additional comment.

Recommendation 2: Concur with comment.
"Although the Fish and Wildlife Service has repeatedly indicated that batture land mitigation is not suitable to mitigate for project impacts because it does not provide habitat (in-kind) that is similar to that found in the floodway, based on teleconferences with the Panel, the Panel stated that batture land would be suitable for mitigation."

This statement from USACE response pertains primarily to the Panel's opinion for mitigation that may be needed due to loss from fish access restrictions. The Panel supports "within" floodway mitigation as the primary location for losses from the project as calculated through the use of Enviro-Fish. However, the Panel does support batture land mitigation as a secondary alternative.

Comment 5:
The fisheries methodology is not adequate to quantify actual spawning and rearing habitat based on Habitat Suitability Index (HSI) values.
USACE Final Evaluator Response Comment 5
Recommendation 1 Compensatory mitigation can occur from converting habitat to a higher HSI value such as conversion of agricultural land to fallow, increasing duration of flooding (increases ADFA), or both. Mitigation measures that compensate for spawning and rearing impacts to inundated floodplain habitat will likely recommend measures that maximize HSI values such as borrow pit creation and bottomland hardwoods restoration. Long-term field studies may not necessarily answer key questions and cause-effect mechanisms required to fully evaluate impacts and mitigation of flood control in large basins. The Corps needs a methodology that incorporates all of the various scenarios, both biologically and structurally, to evaluate large-scale projects. It should be noted that the Corps did fund Dr. Bob Sheehan (Southern Illinois University) to conduct a field study of spring-time fish distribution in the New Madrid and St. Johns Basins in the early 2000s. Although larval fish were not collected, this study identified those species found in the project area, and these data in turn were used to develop the habitat guild for species selection in the Habitat Evaluation Procedure. Preferences of spawning and rearing fishes to specific land use categories (i.e., HSI values) were based on field studies in the lower Mississippi River basin and professional opinion. Based on the 13 and 17 May teleconferences, the panel agrees with the habitat ranking in the Project Work Plan. USACE's justification for the habitat values are contained in the Work Plan. Based on teleconferences with the panel, the panel supports a Delphi Process to establish HSI values since existing data in the Lower Mississippi River Valley is limited. Therefore, USACE intends to conduct the Delphi Process with the interagency team with the values stated in the Work Plan serving as a "starting point". Based on the panel recommendations made during teleconferences, USACE will monitor mitigation sites to test/validate the HSI values utilized in the impact analysis. The project will be adaptively managed and compensatory mitigation will be adjusted in the event that monitoring reveals a need. Based on discussions during the teleconference on 13 and 17 May, the panel is of the opinion that impacts should be assessed up to the five-year floodplain (see Comment 3). However, only "optimal habitat" would be assessed in the 3-5 year floodplain and agricultural areas within the two-year floodplain would be limited to those areas that meet a minimum duration standard (*i.e.,* 8 days). Note: For clarification, the proposed HSI value for agricultural areas is 0.2 (see USACE Work Plan page 70), not 0.1 in the panel response. Recommendation 2 By pooling water with the control structure, acres of habitat remain relatively constant. The

primary purpose of managing water levels is to maximize duration and habitat quality of the waterbody. Therefore, USACE assumes that the habitat value remains constant during the time the pool is maintained. The panel comments suggest that habitat value is constantly changing during this period and therefore, it is not appropriate to utilize a different HSI value. However, the panel did state that habitat units will still increase due to longer durations reflected in ADFAs.

Based on teleconferences and recommendations from the panel, HSI values for the spawning and rearing pool will utilize the values associated for the underlying land use (*i.e.,* HSI values will not change to a waterbody value).

Recommendation 3

Monitoring of mitigation sites and adaptive management will be discussed in the EIS after impacts are quantified.

Final Panel BackChecks Response

Concur with comment.

Recommendation 1: "Although larval fish were not collected, this study identified those species found in the project area, and these data in turn were used to develop the habitat guild for species selection in the Habitat Evaluation Procedure. Preferences of spawning and rearing fishes to specific land use categories (i.e., HSI values) were based on field studies in the lower Mississippi River basin and professional opinion."

Although this statement from USACE final Response is correct, the guild approach was abandoned for a habitat based HSI approach in the Work Plan. The Panel supports the use of the Sheehan study results in a Delphi process for setting HSI habitat based values used in future modeling.

Recommendation 2: "The Panel comments suggest that habitat value is constantly changing during this period and therefore, it is not appropriate to utilize a different HSI value."

The Panel did not suggest that the habitat value (HSI) is constantly changing during this period (as stated in the above sentence from the USACE response), but that the underlying physical habitat structure remains the same. Therefore, the Panel supports the use of the "underlying" habitat HSI value with the potential of habitat unit increases due to changes in ADFA's as stated in the USACE final Response. The Panel will support an HSI increase (i.e. habitat classification change) due to maintaining the rearing pool for extended periods of time if an increase is supported by monitoring studies

Recommendation 3: No additional comment.

Comment 6:
The Waterfowl Assessment Method (WAM) appears to be appropriate; however, the parameter estimates for the model are based on fall migratory and wintering ducks and do not appear to consider spring migrants.
USACE Final Evaluator Response 6
Nonbreeding migrant waterfowl are present in the SJNM from September through March. This is the time frame used in the WAM. Numbers of waterfowl in the SJNM gradually increase through fall to peaks in December and January and then decline through March (Bellrose 1980, www.mdc.mo.gov). This chronology of occurrence includes the sequential annual cycle events of waterfowl of fall migration, prealternate molt, pair formation, prebasic molt, reserve deposition, and spring migration (Heitmeyer 1988, 2002). Consequently, a continuum of annual cycle events is occurring among species and individuals within the SJNM and the SJNM is not a region or complex of habitats that is used solely or primarily for spring migration. Weekly waterfowl counts in the SJNM have been made by the Missouri Department of Conservation from ca. October through January, and often through March since the early 1980s. U.S. Fish and Wildlife Service coordinated mid-winter inventories of the SJNM and surrounding Upper Mississippi Alluvial Valley (MAV) region have been made since the 1960s. Biweekly surveys throughout the year were made for 15 randomly selected four-square mile blocks in the SJNM region from 2000 through mid 2004 (Heitmeyer, unpublished data). All of these data indicate peak waterfowl presence in the SJNM is in December and January. Numbers of waterfowl in the SJNM regional area often are 70% less in March (when most waterfowl species are in spring migration in the Upper MAV – Bellrose 1980) than during mid-winter peaks. Peak numbers of waterfowl (combined ducks and geese) at the Ten Mile Pond Conservation Area (CA) in the SJNM are regularly > 100,000 birds in December and January. Surveys in 2009-10 indicated over 3 million waterfowl use days occurred from November through January. In 1997-2000 over 9 million waterfowl use days occurred each year from November through January at Ten Mile Pond CA. In addition to Ten Mile Pond CA, the SJNM region includes many other important public and private wetlands in western Kentucky (e.g., Ballard County CA), northwest Tennessee (e.g., Reelfoot Lake), and southeast Missouri and northeast Arkansas (e.g., Big Lake National Wildlife Refuge) that support large numbers of waterfowl from fall through spring. For example, waterfowl numbers at Reelfoot Lake alone often exceed 300,000 during December and January and many of these birds move between the SJNM and the Reelfoot Lake area daily. Consequently, the SJNM provides resources to more birds than are present on Ten Mile Pond CA or other regional areas on any given day. Conservative average estimates of total waterfowl within a 30 mile radius of Ten Mile Pond in early January are > 500,000 birds (http://www.fws.gov/birddata/databases/mwi/mwidb.html). Clearly, the SJNM is heavily used by waterfowl from fall through spring periods, and is not primarily a spring migration region. Regarding the statement "… the parameter estimates for the (WAM) model are based on fall migratory and wintering ducks and do not appear to consider spring migrants." This statement is incorrect and appears to be based on the false assumption that the SJNM is most important for spring migration (see above) and does not understand the data, timeframe, energetic basis, and habitat and food production analyses in the WAM. First, the WAM includes estimates of food abundance and energetic requirements of all waterfowl species using the SJNM from September through March. As stated above, this timeframe accurately represents the entire suite of nonbreeding events, species, and times for the SJNM from September through March.

Consequently, the WAM does provide quantitative methods to determine food abundance and energetic requirements for the late winter and spring period through March.

Annual food production, and subsequent availability to waterfowl species, is a function of when specific foods are produced and how the standing crop changes over time. For most plant foods (excepting some above-ground browse), the actual production is during the growing season and usually peaks in late summer or fall. Consequently, estimating potential food abundance must start with understanding the standing crop in summer or fall and then determine changes thereafter through spring. For invertebrates, the chronology of production and turnover rates vary by taxa and habitat. For some benthic crustaceans (e.g., *Cranonyx*) in the Upper MAV the peak production is in spring (e.g., White 1985). In contrast, many aquatic insects (e.g., Chironomidae) reach peak levels in late summer. Throughout the WAM, food production estimates are based on the life history characteristics of the plants/invertebrates involved and state-of-the-art understanding of availability dynamics. Consequently, the parameter estimates are founded on basic plant/invertebrate ecology and reflect their potential abundance and use by waterfowl in the SJNM regardless of when, or which species, uses them. This includes all time periods and events from fall through spring migration.

The comments seem to imply that invertebrates are the primary food consumed by spring migrant waterfowl in the SJNM and that the WAM should be based primarily on invertebrates. First, the WAM does provide estimates of invertebrates in all habitats and times. It also provides estimates of all other foods potentially consumed by waterfowl species. Consequently, the WAM provides appropriate estimates of potential carrying capacity of a region (such as the SJNM) regardless of species, time, or annual cycle event the bird is engaged in.

The assertion that spring migrant waterfowl eat mostly invertebrates is not true for all species or areas. Knowledge that some duck species seek habitats that have, and eat, a higher proportion of invertebrates in late winter and spring compared to fall and early winter periods is well documented and not new (e.g., Heitmeyer and Vohs 1984, Heitmeyer 1985, LaGrange 1985, LaGrange and Dinsmore 1988, Heitmeyer and Fredrickson 1990, Gammonley and Heitmeyer 1990, Heitmeyer 2006 and many others). However, not all species consume large quantities of invertebrates in spring (e.g., wigeon, geese, etc., Heitmeyer and Raveling 1988, Heitmeyer 2002) nor do individuals of a species, such as mallards, always eat large amounts of invertebrates by sex (Combs and Fredrickson 1996) or location (Gruenhagen and Fredrickson 1990). In fact, few invertebrates may be eaten in some locations. Consequently, it is inappropriate for the WAM to speculate on which species will eat what amounts of specific food types by time period.

No doubt, the studies provided by the panel were well conducted, however the locations of the study sites used in these references are not stated, but appear to have been in central Wisconsin, Saginaw Bay in Michigan, Lake Erie, the Scotio River in central Ohio, the central Illinois River Valley in central Illinois, and the Cache River area in southern Illinois (Yerkes 2010). The only study site near the project area is the Cache River location. Using data from sites in the Great Lakes region, and even the central part of the Illinois River Valley, to indicate and project resource use, energetic requirements, habitat food type and abundance, and inclusion in WAM models is scientifically inappropriate. Regardless, the additional literature provided by the panel will be reviewed and the EIS will include a discussion whether or not the literature provided was used to make any modifications to the waterfowl analysis or if it was determined not to be applicable in the analysis.

The WAM clearly states that the model parameter estimates may be refined as new information becomes available from sites that represent the area of coverage, i.e. within the MAV.

Consequently, if new studies can convincingly validate and suggest changes to the parameter estimates, based on equivalent MAV habitats and locations, then food estimate changes can easily be made in the WAM tables. New production information will not change the form of the DUD equations, however. The response further suggests that the DEE used in the WAM may underestimate "true" DEE during spring. The reviewer offers no data to support this assertion and the comments appear to have been based on non-MAV locations mostly from the Great Lakes region (see above). The review comments imply that because waterfowl are storing reserves during spring migration a different DEE estimate should be used than during winter. Nutrient reserve deposition for many waterfowl begins in late winter including during flood events (e.g., Heitmeyer 1988, 2006) and is not confined to spring. The WAM clearly indicates how the DEE estimates for all waterfowl species using the Upper MAV were calculated. The actual estimate of 4x RMR is higher than earlier published estimates and it is acknowledged that the estimate may be conservative. However, until new validated information becomes available for DEE in the Upper MAV and SJNM, the WAM estimates represent the state-of-the-art understanding of DEE for the SJNM and are appropriate for the SJNM project analyses.
Final Panel BackChecks Response 6
Concur with comment. The Panel has provided the documents requested by the USACE and looks forward to the information being integrated into the model.

Comment 7:
It is unclear if the application of the Hydrogeomorphic (HGM) approach to evaluate project impacts and develop proposed mitigation will yield scientifically credible results.
USACE Final Evaluator Response 7
We agree with the panel's assessment that HGM has a long record of development and application in the estimation of functional losses and gains of wetland resources for Corps planning projects. More importantly, the specific Guidebook in question has been used successfully in similar Corps projects in Arkansas, where multiple wetland types and proposed mitigation types were employed, and changes in flood frequency and duration were components in the wetland impact. HGM reviewers concluded that the guidebook has been in use for approximately five years and could potentially be used with the same level of accuracy under the condition that existing users will be the ones who continue to use the method. One or more members from team of experts who developed the regional HGM guidebook will perform the assessments for all wetland sites to ensure the models are used as intended and that there is consistency in the results. The minimum requirements of the review team will be met during the SJNM application of the Delta Region of Arkansas Hydrogeomorphic Methodology (HGM) Guidebook. The panel's assertion that calling an approach a "model" automatically implies that it is a specific type of model is not founded. There are many models that have been developed over the years for ecological assessment purposes; one of the most famous and oldest of these is the Habitat Evaluation Procedure, first developed in 1980. HEP models, as they are called, are clearly models: mathematical aggregations of factors to determine a single metric. They do not involve differential equations or other techniques that might be used in dynamic hydrologic modeling. HGM was originally conceived as a way of extrapolating the techniques and methods used in HEP to address the multiple functions that needed to be addressed for wetlands. The model development is quite comparable to that used in HEP. Unlike HEP, however, HGM models are calibrated using reference data specific to the wetland subclass and a specific reference domain, such as an ecoregion. This makes it actually more scientifically defensible than many models, which are calibrated using literature review data that are aggregated across the entire country. The data collected for the Guidebook in question is from the same EPA Level III ecoregion as the project site, and the models are proven sound by previous use. The EIS will include a discussion on the limitations of the HGM model. However, based upon discussions with the panel, there are no other models that are superior to HGM and it would be suitable to use the model if the same person or persons conducted all of the studies. The HGM model will be conducted by the model developers (*i.e.,* scientists from ERDC). The HGM guidebook calibration process employed direct measurements of thousands of tree diameters, counts of shrub stems, snags, and logs, and similar specific data, and application of the guidebook uses similar direct measures. Variable values that are estimated (such as litter cover) should be consistent in the way that they are applied, as long as the field team is consistent. Since functional loss and gain are calculated as differences between before and after states, the absolute value isn't as important as the consistent application of the variable. An overestimate of 5% across all the sites will yield the same results once the difference between before and after states are compared.

HGM separates wetlands into classes and subclasses using hydrology and landscape position, which directly affect function. A riverine wetland functions differently than a wet flat or an unconnected lacustrine fringe. To lump these wetland types together and then try to determine changes in function is precisely the sort of illogical analysis that HGM was designed to avoid. It's true that splitting the project site into multiple types will increase the amount of data required for analysis, but that is justified if it is required to develop a defensible analysis. The keys provided in the Guidebook are sufficient for splitting out the types, and since the project will lead to changes in flood frequency and duration that will not only affect function within types, but also lead to type conversion, the idea that these functional changes can be assessed in any scientifically defensible way without splitting the wetlands into classes is not supportable.

Any errors in the calculators will be addressed, but as for the issues with the models, they were ultimately certified for use on this project. The form and component variables in the assessment models and the format of the guidebook were constructed to be consistent with previously published guidebooks (specifically, the Yazoo Basin guidebook) and were reviewed and approved by a team of regional experts and the USACE - ERDC. Calibrations were based on actual field data from within the same EPA Level III ecoregion as the project site, which makes them scientifically defensible. They are the best available tools for use in this application, and have been extensively tested in the region, as noted by the panel in their opening comments above.

In order to be classified as riverine, a wetland must be within the 5-year floodplain of a river, according to HGM convention. If a site is not subject to flooding at least 1 year in 5, then the river is not the "main forcing function of the system," and is certainly not the principal hydrologic factor maintaining wetland character. The statement that fringe wetlands are not usually associated with floodplain landscapes is curious, as the cypress fringe communities associated with oxbow lakes are among the most iconic and widely occurring of the remaining wetlands in the Lower Mississippi Valley. Other non-riverine wetlands, such as hardwood flats, sand pond depressions, valley train ponds, and various other communities discussed in detail in the guidebook, have been seriously impacted by historic land use in the study area, and merit more, not less, attention.

Based on discussions with the panel, limitations to the HGM model are based on absolute, not relative terms. Therefore, the EIS will state the uncertainty of the model.

<u>Recommendation 1</u>

It is not clear where the panel has obtained the number 4 as a multiplier for any mitigation ratio determined using HGM. HGM analyses in the region have previously tended to produce mitigation ratios in the range of 2:1 to 4:1, depending on the condition of the impacted wetland, and the type of mitigation proposed. Preservation has been calculated as high as 10:1 due to the lack of functional lift over the course of the project lifetime. In all cases, the rationale and supporting data for calculating these ratios, including developmental trajectory analyses, are presented and discussed clearly, and can be specifically criticized as appropriate if logic or data errors are identified.

The Memphis District Regulatory Branch stated that the following ratios have been developed by the Missouri Department of Natural Resources (MDNR) with cooperation from the Missouri Department of Conservation (MDC), the U.S. Fish and Wildlife Service (USFWS), the U.S. Environmental Protection Agency (EPA), the U.S. Army Corps of Engineers (COE), the Natural

Resources Conservation Service (NRCS) and the Missouri Department of Transportation (MoDOT) for wetland creation/restoration. The ratios are intended for use by projects for which the sequencing requirements have been completed and it has been determined at that point that compensatory mitigation is appropriate. The ratios are not intended for enforcement purposes; however, the high end of the range may be an appropriate place to begin negotiations for enforcement cases.

Farmed Wetlands	1.0-1.5
Emergent	1.0-3.0
Shrub-Scrub Wetlands	1.5-3.0
Wooded Wetlands	2.0-4.0
Open Water	1.0

In subsequent teleconferences, the panel stated that the 4x multiplier was only an example to be used as a safety factor and not necessarily a recommendation. Based on recommendations from the panel and to ensure an adequate safety factor for mitigation planning, USACE will develop a monitoring and adaptive management plan that defines success criteria for mitigation sites. Compensatory mitigation will be adjusted as a safety factor in the event that monitoring reveals a deficiency.

Recommendation 2

During subsequent teleconferences, USACE asked if there were any other wetland models that would be superior to use instead of the HGM Model described in the Work Plan. The panel stated that there were no other readily available superior models. Although not necessarily applicable to this project, USACE scientists, regulators, and engineers will continue to investigate wetland models to assess impacts to function and structure and determine appropriate mitigation for other Civil Works projects as well as Section 404 permits.

Final Panel BackCheck Response 7

Concur with comment.

This discussion has focused on both the reliability and repeatability of the HGM method in providing scientifically defensible results for estimating impact on wetlands and mitigation of those impacts and the use of mitigation ratios to reflect the uncertainty in the mitigation attempted on this project. The mitigation concerns impacts of this water project on waters of the United States, including wetlands. So if the mitigation of impacts is not certain, the Panel believes that a higher mitigation ratio is warranted.

Our principal concerns remain that the uncertainty of the mitigation needs to be reflected in the mitigation ratios, which could be as high as 4:1, and that the field parameters used in the HGM approach be appropriate for identifying the most important functions lost from the impacted wetlands.

The Panel believes that the HGM method should be retained for wetland assessment, mostly because there is no other acceptable method that emphasizes the hydrology and landscape position of the wetlands. For evaluating wetland function unrelated to the support of fish and wildlife, it is more effective than investigating by individual resources, e.g. waterfowl or fisheries by themselves. The Panel is pleased that USACE is open to the idea of "to investigate wetland models to assess impacts to function and structure and determine appropriate mitigation for other Civil Works projects as well as Section 404 permits."

Comment 8:
There is an insufficient level of detail in the Project Work Plan to evaluate the validity of the proposed compensatory mitigation plan.
USACE Final Evaluator Response 8
USACE agrees that project success is dependent on determining the appropriate level of mitigation. However, a specific sequence needs to be employed which first describes the impact, determines its significance, seeks to avoid and minimize the impact, and lastly compensates the impact. Obviously mitigation cannot be determined without first determining what the significant unavoidable impacts of the project are. Therefore, the project work plan only contains conceptual mitigation. Although USACE assumes impacts are likely, USACE does not know if impacts are greater or less than past project recommendations. Therefore, mitigation specifics would be discussed in detail in the EIS. If determined necessary, moist soil units will be primarily managed to compensate for impacts to spring shorebirds. Therefore, moist soil sites would likely have to be inundated prior to spring shorebird arrival for several months to maximize invertebrate productivity. This would likely coincide with spring waterfowl migration. Therefore, waterfowl will likely utilize the sites. Please refer to response to comment 1 for further discussion of waterfowl/shorebird use of moist soil habitats. USACE acknowledges that the discussion on reforestation is brief. This is primarily due to the fact that site specific location needs to be known (elevation, soils, topography, hydrologic regime, etc.) prior to determining the species of trees to be planted, spacing, direct seeding vs. seedlings, etc. The EIS will include a more thorough description of "typical" mitigation sites that would be found throughout the project area. At a minimum the following conceptual sites will be described: • Lands adjacent to Big Oak Tree State Park • Lands that are within the project's sump elevation • Lands that are outside the project's sump elevation • Adjacent batture sites • Moist Soil Unit • Lands within a spawning and rearing pool The Project Work Plan includes transition periods that discount mitigation based on the amount of time necessary for mitigation sites to reach maturity or reach full habitat potential (*i.e.,* forested areas for fish). The EIS will contain additional information regarding the plan to restore Big Oak Tree State Park. Please refer to response to comment 9 on funding issues. Based on subsequent teleconferences, the panel stated that the approach outlined in the Work Plan regarding mitigation is good as long as impacts are well defined and the mitigation plan is adequate. Based on the panel recommendations, the EIS will contain assurances regarding mitigation to ensure that commitments are kept.

Final Panel BackCheck Response 8
Concur with comment. USACE appears to be under the impression the Panel is requesting adequate detail in the modeling approach to determine if the mitigation is appropriate. This is not the case; the Panel is only attempting to determine if each modeling approach is appropriate. Substantial detail in the models, however, is required to do this with any degree of confidence. Areas of concern are as follows: At this point, the philosophical outline of the shorebird model appears to be appropriate. Without knowing the details of this model, however, the Panel cannot make a recommendation on the appropriateness of the final model. The assurance by USACE of an appropriate peer review of the final model would help alleviate this concern. Based on the September 8, 2010 conference call, USACE has assured the Panel the final shorebird model would go through an appropriate peer review process. The Panel agrees that a Delphi method is an appropriate approach for determining HSI values for the fish model. Furthermore, the panel supports HSI values that are determined to be appropriate by the entire interagency team (EPA, USFWS, MDNR, MDOC, and USACE). USACE has agreed to conduct a qualitative assessment of water bodies within the basin. While the Panel agrees that this type of assessment is appropriate for addressing water quality issues, USACE has provided no detailed methodology as to how this assessment would be conducted, so the panel has no way of determining if this assessment would be appropriate. The Panel concurs that the current HGM model is the only tool currently available to assess functional loss and gains of wetlands unrelated to the support of fish and wildlife. The Panel is concerned, however, that although this is the only tool currently available for this type of analysis, the accuracy and precision of this tool is inadequate to estimate the degree of impacts with an appropriate level of confidence; thus, a mitigation ratio of lost wetland function greater than 1:1 should be used for mitigation.

Comment 9:
The adaptive management plan requires a detailed analysis of the ongoing mitigation management costs and a clear funding source adequate to support those activities.
USACE Final Evaluator Response 9
Recommendations regarding adaptive management were included in the Project Work Plan (see Section 8.6). The cost of this management and monitoring will be determined in the EIS. Applicable funding (Federal funds from the Mississippi River and Levees Program, Federal funds from the St. Johns Bayou and New Madrid Floodway project, and non-federal funds from the project sponsor) will be required to implement the plan. The amount of required funding from each source will be described in the EIS. Conditions that would "trigger" adaptive management have not been discussed with the interagency team to date because project impacts, and avoid and minimize measures have not been formulated. However, these conditions will be described in the EIS. Mitigation will increase and or site specific adjustments made in the event that they are not functioning as desired. Conversely, adaptive management may reveal that mitigation sites are functioning at greater rates than modeled, or impacts were not as significant as modeled. If this is the case, overall mitigation may be reduced. Based on panel recommendations made during subsequent teleconferences, adjustments would be made to adaptive management when the level of function falls below expected levels. Therefore, the adaptive management plan will include specific, measurable success criteria that can be used to determine when additional mitigation is required. Specifically, the adaptive management plan will provide the following information: • An on-going monitoring plan sufficient to detect insufficient levels of function for all resources. • A clear statement that mitigation shortfalls will be addressed for each resource • Proposed responses to improve levels of function.
Final Panel BackCheck Response 9
Concur with comment. The Panel concurs with the approach outlined in the response to this Comment.

Comment 10:
The methodology to determine the extent of the wetlands in the project area requires further detail to determine if it is valid.
USACE Final Evaluator Response 10
Wetland ecosystems and their community functions will be analyzed utilizing HGM in accordance with the SJNM Interagency Wetland Team recommendations. USACE will utilize WETSORT, which is based on a 1997 USDA, NRCS method and uses daily water surface elevation readings to determine wetland elevations. The program can be used to determine the median elevation of specified flood durations during the period of record. The flood duration will be fourteen days (according to the supplement to the 1987 Wetlands Delineation Manual). Wetlands above the flooding elevation will also be classified. The team has reviewed available maps and discussed the different approaches (abundance, distribution, and qualitative condition of wetlands as well as FCU's and HGM analyses). The team agreed to use HGM to assess project related wetland impacts, while the probabilistic sampling based on EMAP will provide wetland acreage and a qualitative wetland condition. The team discussed using hydric soil and land use cover maps (and potentially WETSORT data) to help assess farm land (particularly if NRCS cannot provide FW/PC data). The team agreed to use the same proportion of agricultural land on hydric soils that meets wetland parameters (as determined by on-site wetland data collection) within the field- and remote-sampled portions of the project area. Hydric soils will be overlain on the identified agricultural project area landcover GIS layer within the project impact area. Members from the interagency team will assess these probabilistic determined sampling points. After sampling these ~50 points, the same individuals will derive remotely sensed assessments on 50 probabilistic sample points outside of the impact area. These sample points will be determined in the same fashion as the impact sites, except these sites will be outside the impact zone. Aerial imagery will be used in making these assessments. Concerning lack of involvement by USFWS on the interagency wetland team, the Service was asked to participate; however, they decided they would not be a member on the wetland team. USFWS is free to attend any sub-team meeting and is advised of all sub-team meetings and decisions. The full interagency team (including wetland team participants and the Service) are kept apprised of decisions made at the sub-team level, including Memos for Records and updates at interagency team meetings. A detailed description of the WETSORT program was provided to the interagency team and is attached to these responses. Briefly, WETSORT is a utility program written in FORTRAN 77 that uses methods published by the USDA Natural Resources Conservation Service (1997) to determine wetland elevation using daily water surface elevation data and user supplied input. User supplied input to the computer program are: growing season length (begin and end dates) and a percent duration (typically a 5, 12.5 or 15-day duration). WETSORT does not evaluate moist soil conditions, does not evaluate conditions based on shallow groundwater, and does not identify wetlands. WETSORT does identify a median wetland elevation determined by multi-year analysis and requires field verification by experienced professionals. The wetland team will determine the appropriate classification for agricultural areas (wetlands, farmed wetlands, prior converted cropland). Preliminary estimates suggest that the vast majority of lands in the project area are prior converted cropland. Although these areas may not be subject

to Section 404 of the Clean Water Act, the functional floodplain (including agricultural land) value they provide will be assessed with the fish, waterfowl, wetland, and shorebird models. It is possible that areas that are currently in agricultural production could convert to wetlands if farm practices are abandoned and no channel maintenance is conducted on the vast network of drainage ditches. The vast majority of agricultural areas are expected to remain in agricultural production (see response to comment 18). Project mitigation will seek to purchase agricultural areas and restore wetland status to these areas.

Shallowly flooded agricultural land (regardless of wetland jurisdictional status) that provides shorebird habitat will be assessed in the Shorebird impact analysis (See response to comment 1).

Recommendation 1

Based on the teleconferences, the panel has no additional comments regarding wetland area determinations.

Recommendation 2

Additional details regarding WETSORT were provided to the panel.

Note: The EIS will include an expanded discussion on wetland area determinations as well as the WETSORT Program.

Final Panel BackCheck Response 10

Concur

Comment 11:
The assessment of economic impacts of the proposed project may not be valid because the method used to document the future with and without project conditions does not consider trends in real prices and costs.
USACE Final Evaluator Response 11
Current economic guidance ER 1105-2-100 states that only Current Normalized Prices can be used to assess the economic viability of Federal water resources development projects. Current Normalized Prices (CNP's) are calculated by the USDA Economic Research Service and are the values that the Federal government places on the various agricultural commodities. They are calculated by State but they are "national" in scope in that the methodology used is consistent so that they can be used to compare projects in various locations throughout the United States. CNP's are adjusted for inflation and do in fact reflect trends in that they are 5-year lagged averages of actual market prices. The recommendations contained in comment 11 seem to suggest estimating inflation adjusted trends or changes in commodity prices over the 50 year period of analysis. This type of change in prices could only be used in a type of sensitivity analysis to show the effect of these estimated trends. By regulation, they can not be used in the NED analysis of the proposed water resource improvements. Therefore, USACE can not adopt the recommendation. Based on the teleconference, the panel suggested that real process will be likely be significantly higher in the future than today due to a variety of reasons including global climate change. Although USACE can not use the panel's recommendations to calculate the project's benefit to cost ratio, the recommendations would be conducted in the sensitivity analysis. Based on the panel's recommendations the sensitivity analysis will remove the effects of inflation and use real terms not nominal rates. In addition, based on the teleconference, future without project conditions regarding land use will change. The Project Work Plan stated that no changes to land use are expected. This comment referenced that agricultural areas will remain in agricultural production and no clearing of forested areas is anticipated. However, the EIS will be clarified stating that changes to agricultural areas are expected with the project. The expected changes are agricultural practices will likely intensify and there will likely be a shift to more economically valued crops as flood risks are minimized.
Final Panel BackCheck Response 11
Concur with comment. Concur that sensitivity analysis as suggested above will take care of the issues. The main point is that USACE cannot know how *relative* prices change in the future and this is the key point: the price of agricultural goods relative to other goods may change drastically in the future. For example, suppose that home-entertainment related goods prices are currently twice as high as prices of agricultural goods. Over time, this ratio may change substantially, i.e., the situation could be the reverse. An overall price index generally used for inflation may not capture this relative price change adequately. If food becomes more

scarce, its relative price would rise, and the agricultural sector may thus become a larger share of Gross Domestic Product (GDP).

Thus, incorporating unusual future prices in a sensitivity analysis may be worthwhile.

See related argument in Sterner, Thomas and U. Martin Persson. 2008. "An Even Sterner Review: Introducing Relative Prices into the Discounting Debate." *Review of Environmental Economics and Policy* **2** (1/Winter): 61-76.

Comment 12:
The use of two discount rates for the same analysis is confusing and is not warranted in any conventional economic analysis.
USACE Final Evaluator Response 12
During the teleconferences, the panel stated that they have no objection to the use of the 2.5% interest rate and deferred to USACE on what the appropriate/legal rate is based on law and policy. Although construction has previously occurred, the panel recommended not to use past costs in calculating the benefit:cost ratio. These are sunk costs and should be excluded from the economic analysis and can be assumed that they have not happened. The panel clarified that they have a concern with the use of two different interest rates and recommended utilizing one rate. USACE stated that the use of two different rates is necessary due to the two distinct authorizations for the project. The St. Johns Bayou and New Madrid Floodway Project and the Mississippi River Levees (closure levee) projects were combined for NEPA purposes following the completion of the Limited Reevaluation conducted in the late 1990's. The panel recommended not conducting two separate NEPA analyses for these separate projects. Therefore, one EIS will be formulated. To overcome the panel's concerns and to comply with appropriate policy, the economic analysis used to determine the project's benefit to cost ratio would be determined for each of the project's separate elements utilizing the appropriate interest rate for the respective element. Therefore, two separate benefit:cost ratios would be calculated with two separate interest rates. For the sensitivity analysis, the project elements would be combined and treated as one project utilizing one consistent interest rate.
Final Panel BackCheck Response 12
Concur with comment. Concur with final approach suggested. Because of the uncertainties raised by the Panel, it will be especially important to examine benefit-cost ratios at a 7% rate, which is a high rate often used in the presence of risky outcomes. See: Bazelon, Coleman and Kent Smetters. 1999. Discounting Inside the Washington D.C. Beltway. J. of Economic Perspectives 13 (4/Fall): 213-28. Howarth, Richard B. 2009. "Discounting, Uncertainty, and Revealed Time Preference." Land Economics 85 (1/Feb): 24-40.

Comment 12:
The use of two discount rates for the same analysis is confusing and is not warranted in any conventional economic analysis.
USACE Final Evaluator Response 12
During the teleconferences, the panel stated that they have no objection to the use of the 2.5% interest rate and deferred to USACE on what the appropriate/legal rate is based on law and policy. Although construction has previously occurred, the panel recommended not to use past costs in calculating the benefit:cost ratio. These are sunk costs and should be excluded from the economic analysis and can be assumed that they have not happened. The panel clarified that they have a concern with the use of two different interest rates and recommended utilizing one rate. USACE stated that the use of two different rates is necessary due to the two distinct authorizations for the project. The St. Johns Bayou and New Madrid Floodway Project and the Mississippi River Levees (closure levee) projects were combined for NEPA purposes following the completion of the Limited Reevaluation conducted in the late 1990's. The panel recommended not conducting two separate NEPA analyses for these separate projects. Therefore, one EIS will be formulated. To overcome the panel's concerns and to comply with appropriate policy, the economic analysis used to determine the project's benefit to cost ratio would be determined for each of the project's separate elements utilizing the appropriate interest rate for the respective element. Therefore, two separate benefit:cost ratios would be calculated with two separate interest rates. For the sensitivity analysis, the project elements would be combined and treated as one project utilizing one consistent interest rate.
Final Panel Evaluator Response #12
Concur with comment. Concur with final approach suggested. Because of the uncertainties raised by the Panel, it will be especially important to examine benefit-cost ratios at a 7% rate, which is a high rate often used in the presence of risky outcomes. See: Bazelon, Coleman and Kent Smetters. 1999. Discounting Inside the Washington D.C. Beltway. J. of Economic Perspectives 13 (4/Fall): 213-28. Howarth, Richard B. 2009. "Discounting, Uncertainty, and Revealed Time Preference." Land Economics 85 (1/Feb): 24-40.

Comment 13:
The farming survey may not be credible unless a large enough sample size is used, producing a smaller statistical error for the analysis and avoiding many possible sources of bias.
USACE Final Response Comment 1
Based on the 13 and 17 May teleconference, it appears that there was a basic miscommunication regarding the proposed process to estimate future with-project effects on farming practices and land use during the written comment/response process. During the teleconference the proposed process was discussed and clarified. The proposed process is to use present (existing) land use by flood zone as a proxy for with-project land use. For example, assume that present land use for the 5 year flood zone is 50% corn and 50% soybeans and the present 3 year flood zone land use is 100% soybeans. Under a potential scenario (with-project conditions) flooding will be reduced. Let's assume the existing 3 year flood zone now becomes the with-project 5 year flood zone. This will cause a change in land use from 100% soybeans to 50% corn and 50% soybeans for this particular flood frequency zone. This process can be further supported using surveys of the area's farmers regarding how they would react and change their farming practices in response to a reduction in flood risk if the panel feels that surveys will be valuable. The panel suggested that this process seems logical. The only criticism pointed out by the panel is the assumption that past behavior will dictate future behavior. USACE asked the panel if formal surveys to area producers would be value added. The panel did not think so because surveys could be biased to a small percentage of large producers in the area and thereby increase risk. Therefore, based on the panel's recommendations a survey will not be conducted. In lieu of the survey, the process stated above will be utilized.
Final Panel Response #13
Concur with this suggested approach.

Comment 14:
The cumulative impact approach lacks specific information on how the conceptual matrix will be used to evaluate the incremental impacts of the proposed project or address the unique aspects of the study area.
USACE FINAL Evaluator Response 14
In the Handbook, "Considering Cumulative Effect under the National Environmental Policy Act" January 1997, the third method covered is matrices. We will have historical mapping of habitat and plan to develop a trend analysis (method 6). Other methods that will be investigated are Ecosystem Analysis (method 9) and Economic Impact Analysis (method 10). As pointed out in our draft response to comment #16, the project area connection is extremely altered and is not the last remaining connection. The area is entirely protected by levees with the exception of the 1,500-foot gap at the lower end of the Floodway. This gap has significantly changed the timing, depths, and durations of flood events from what could be considered normal/non-altered conditions. Simply stating that this is the last remaining connection between the Mississippi River and its floodplain in the State of Missouri does not provide an accurate assessment of current conditions. Based on the panel's recommendations, the cumulative impact assessment will assess wide scale drainage of the project area's historic bottomland hardwood ecosystem (previously occurred), the clearing of vast tracts of forested areas (previously occurred), leveling of farm fields (previously occurred), construction of private levees (previously occurred), closing off the St. Johns Bayou Basin (previously occurred), on-going Mississippi River Levee and Mississippi River and Tributaries construction (this project), and likely future projects. The spatial boundary for the analysis will include applicable areas within the Lower Mississippi River basin such as the batture areas as well as other backwater areas within adjacent states. The historic land cover survey will be used to start the temporal boundary of the analysis and will extend to reasonable future actions. The cumulative impact is assessment will determine if cumulative impacts are significant (*i.e.,* straw that broke the camel's back as discussed during the teleconferences). It is important to note that previous work/modifications in the project area could have already "broken the camel's back". In fact, the panel stated that remaining wetlands in the project area are "sad". To reverse this trend, this project, with its conceptual mitigation, has the potential to restore significant habitat types that are no longer found in the project area and would likely never be replaced, most notably Big Oak Tree State Park. This trend to restore these habitat types will also be included in the cumulative impact assessment to determine if compensatory mitigation results in significant gains to Lower Mississippi River habitat. As discussed during the teleconference, the EIS will seek additional opportunities that restore river connections and restore historic ecological communities. The cumulative assessment will include both the project's impacts as well as the benefits of compensatory mitigation to the entire floodplain ecosystem.

Final Panel BackCheck Response 14
Concur with comment. Recommendation 1: Concur, if clarification is made. USACE has responded to the Panel request for additional details on their proposed methodologies for determining cumulative impacts. However, they introduced the new issue that the project area connection is extremely altered and is not the last remaining connection (to the Mississippi River). As a point of clarification, the Panel stated that the project area is the last connection in the State of Missouri, not in the entire Mississippi River. USACE went on to state that previous work/modifications in the project area could have already caused impacts that exceeded a significant threshold. Although the panel is concerned that these statements appear to be "lowering expectations," we take note that USACE affirms that they will still evaluate cumulative impacts, including historical trends, and determine whether they are significant. While NEPA cases have not required projects to mitigate for past impacts of previous actions, they generally do expect that projects mitigate for any additional significant impacts, even if these past impacts have exceeded a significant threshold. USACE should clarify that they will mitigate for any additional significant impacts of the proposed project. Recommendation 2: Concur

Comment 15:
More precise contour data (i.e. greater than a 1-foot contour interval) are required to estimate wetland availability and mitigation for waterfowl and shorebirds.
USACE FINAL Evaluator Response 15
Regarding the statement, "Furthermore, waterfowl require water depths less than 12-15 inches for foraging." This statement is incorrect. Optimal foraging depths vary considerably among waterfowl species. Obviously, species that are adapted to dive for food (i.e., Mergini, Aythyini, Oxyurini) can forage in water deeper than 12-15 inches (often up to 10+ feet deep) and some species, conversely, can forage on dry ground (e.g., *Anser, Branta*). Foraging depth also varies by type of food being consumed, habitat type, hydrological event, etc. For example, water depths (mean $\pm$ SE) where mallards foraged during flood events in southeast Missouri were 48.6 $\pm$ 6.3 cm during a February flood and 42.3 $\pm$ 8.9 cm during a January flood (Heitmeyer 2006:105). Foraging depth also varied by habitat, for example water depth in shrub/scrub habitats was 42.6 $\pm$ 9.4 cm compared to 31.2 $\pm$ 4.6 in flooded bottomland hardwood forest. During the shorebird model review, the model review panel stated that obtaining elevations less than 1-foot increments in a project area the size of the current project is impractical. Therefore, USACE proposes to interpolate elevations between one-foot contours. <u>Recommendation</u> Based on discussions with the panel, USACE intends to interpolate elevations between established one-foot contours where necessary.
Final Panel BackCheck Response 15
Concur

Comment 16:
The list of significant resources is not complete because it does not include a discussion of the quality of the wetland resource, which is dependent upon the dynamic nature of the ecosystem's function and its connection to the river.
USACE Final Evaluator Response 16
Regarding the statement, "The project area includes the only significant remaining section of floodplain where Mississippi River backwater flooding still occurs." Concerning the Lower MAV, this is an incorrect statement. Furthermore, the project area connection is extremely altered. The area is entirely protected by levees with the exception of the 1,500-foot gap at the lower end of the Floodway. This gap has significantly changed the timing, depths, and durations of flood events from what could be considered normal/non-altered conditions. The entire Tennessee side of the Mississippi River floodplain from the confluence of the Old Bed of the Forked Deer and Mississippi rivers at the north Lauderdale County, Tennessee line south to Memphis does not have a mainstem, or frontline, levee and the Mississippi River overtops banks and floods portions of this over 40 mile stretch, covering several hundred thousand acres, annually. Additionally, there are approximately 64,000 acres of batture land are immediately adjacent to the 133,000 acre New Madrid Floodway. USACE acknowledges that river-floodplain connection provides wetland function. Hydrologic connection alterations would be assessed in the EIS by documenting impacts to fish spawning and rearing habitat (confined to the five year floodplain), waterfowl, shorebirds, and wetlands (river connected wetlands are defined as those that are within the five-year floodplain). Although USACE concurs that the river connection is an important aspect to providing habitat on the floodplain, it appears that local drainage and topography may play a greater role. For example, areas that are frequently flooded (less than elevation 288-foot NGVD) are still mostly agricultural areas. These areas flood almost every year but water is quickly drained from these sites as the river elevation falls due to the extensive drainage system. However, areas that river connections are greatly altered or severed such as Big Oak Tree State Park and Bogle Woods are not farmed because they were likely too wet to clear and farm. These areas are in there own sub-watersheds and make up the lowest elevations in them because they are found within historic Mississippi River meander belts. Hydrology in these areas is mostly influenced by local drainage and topography, not the Mississippi River. Therefore, the Mississippi River may not play as a significant role as it appears. Nonetheless, based on the panel's recommendation, the EIS will provide a discussion regarding the nature of the wetlands (and functional floodplain) in the project area, including features that may result from the dynamic water level and periodic flooding by the river. The analysis will also include the role that local drainage/topography provides as well. This discussion will include nutrient budgets, vegetative patterns, fish, and wildlife including shorebirds. The nature of the hydroperiod will also be described as it relates to the importance of floodplain habitat as well as the economic and social impacts. Floodplain habitat will be assessed and compensatory mitigation will be determined by utilizing the methodologies outlined in the Work Plan and revisions to the methodologies recommended by the panel.

Final Panel BackCheck Response 16
Concur with comment. The USACE Response reiterates some of the text provided above in the draft Response to this comment, which should not be necessary following the clarification provided by the panel in both written text and discussion. As the Panel clarified in our reply, our intent was to request that USACE highlight the unique ecological functions of the riverine wetlands in the project area resulting from current flooding conditions. USACE agrees in their final Response to do this in the EIS, so the Panel concurs with this approach. USACE suggests that it will pay more attention to the wetland hydroperiods defining the wetlands of the study area. There is still the debate on whether river or local flooding is more important. Since the former has been all but eliminated, of course the latter is more important now. The only place where a natural flood frequency might occur now is at the state park. It appears from the response that USACE will pay more attention in the document to the quality of the wetland resources as the Panel recommended.

Comment 17:
The water quality analysis in the Project Work Plan does not address water quality conditions in any of the study area water bodies and does not compare nutrient loads to the Mississippi River with and without project conditions.
USACE FINAL Evaluator Response 17
Based on discussions with the panel, USACE will conduct qualitative water quality assessments on waterbodies in the St. Johns Bayou and New Madrid Floodway project area as well as conduct an assessment that compares each alternative studied in to future without project conditions.
Final Panel BackCheck Response 17
Concur with comment and/or clarification. Recommendation 1: Concur with comment. The Panel recommended that USACE conduct quantitative assessments of the impacts of the actual proposed project on waterbodies in the St. Johns Bayou/New Madrid Floodway. Based on discussions during the May 13, 2010 and May 17, 2010 teleconferences, USACE responded that they will conduct qualitative water quality assessments of project area waterbodies for each project alternative and compensatory mitigation. However, they provided no details on their methodologies. Lacking any details, it is not possible to determine whether their proposal is an appropriate basis for determination of mitigation of project impacts. The Panel believes there should be three objectives for conducting the recommended water quality assessments: (1) establish baseline conditions without the project; (2) determine whether existing water quality conditions support the intended uses of these habitats with the proposed project; and (3) determine potential impacts of the actual project and compensatory mitigation. The first two objectives can be met by analyzing baseline monitoring data without the project. The third objective can only be met by conducting routine monitoring after the project and compensatory mitigation are initiated. USACE stated they will conduct a query of agencies and academic institutions that would be sources of water quality data in the project area. A possible outcome of this query is that existing water quality data are not adequate to accomplish the first two of the above three objectives. In this case, USACE should conduct baseline monitoring to acquire these data before the project and any compensatory mitigation are initiated. In the event that the project goes forward, USACE should conduct follow-up monitoring of these same waterbodies to determine potential impacts of the actual project and compensatory mitigation. Recommendation 2: Concur with clarification. USACE stated they will use differences in relative load estimates (similar to Ashby et al. 2000) to compare project alternatives. The differences in relative load estimates in Ashby et al. 2000 do not represent differences between current conditions and the actual proposed project. Instead, they compare nitrogen removal efficiencies at an assumed water surface elevation of 290 feet

NGVD between current conditions (without project) and with mitigation associated with restored acreage. None of the hydrologic scenarios in the Consolidated NEPA report was the actual project because each of them involved the same flooded acres at 290 feet NGVD, whereas the proposed project involves blocking the water level beyond 284.2 feet NGVD in the New Madrid Floodway.

As stated previously, the Panel believes that nutrient loads from the project area to the Mississippi River under current conditions (without project) should be compared to those with the actual proposed project. USACE took note of this comment and responded that they will conduct the assessment with the future without project conditions and for each of the project alternatives including compensatory mitigation. USACE should clarify that their proposed assessment will involve actual flooded acres for each project alternative and compensatory mitigation, and not the same flooded acres at 290 feet NGVD.

Comment 18:

The validities of several assumptions for the future without project alternatives are questionable.

USACE Final Evaluator Response 18

Based on preliminary numbers, there are a total of 4,526.8 acres of WRP easements in the project area (Kevin Dacey, NRCS, personal communication).

Year	# of easements	Acres
1995	2	2253.3
1998	5	338.6
2001	1	53.0
2003	2	606.1
2005	1	597.3
2006	1	95.1
2007	1	350.9
2010*	3	281.9

*applications not easements

These numbers will be confirmed in the EIS. Some of the existing WRP sites remain in agricultural production (see Phase 1 Consolidated EIS Appendix M page 341-343). Therefore, even if they have a WRP easement, it is appropriate to classify them as agricultural areas to determine appropriate value and function. Future WRP lands are difficult to estimate and likely have more to do with agricultural prices than whether or not the project is authorized. For example, there was not a dramatic increase in WRP enrollment after the Court decision. In fact, the greatest acreage enrolled occurred during the period when USACE was actively preparing for construction, including purchasing project related mitigation sites. Therefore, the panel's comment may not be correct. Regardless, the existing WRP lands found within the project area will be compared to areas outside the project area (including the batture area that remains subject to flooding) to determine if any changes to the future without project land use are necessary. USACE will coordinate with the NRCS as well as the interagency team to determine the appropriate amount of future without project WRP sites.

It is appropriate to assume that existing drainage ditches will be maintained. As seen during the IEPR site visits made in August 2009, the St. Johns Levee and Drainage District has recently completed maintenance activities that involved channel cleanout on all of their ditches. The drainage district has easements to perform necessary channel maintenance regardless if the lands are enrolled in WRP or not. However, USACE concurs with the panel that smaller ditches that drain specific fields would likely be blocked/removed to restore hydrologic function. USACE intends to conduct this practice as well on compensatory mitigation sites and take the appropriate credit.

The State of Missouri's plan for Big Oak Tree State Park did not include a plan to restore the Mississippi River connection to the park, or increase the size of the park. It only provided funds to use an alternative to Mississippi River (ground water or a pump installed in St. James Bayou). As indicated in Phase 2 IEPR comment 16, "The river connection allows the exchange of nutrients between the wetland systems and the river, which is a unique aspect of riverine wetland

function." Therefore, it is reasonable to assume that the connection of Big Oak Tree State Park to the Mississippi will not be restored without this project, or specific modification/authorization of the Mississippi River and Tributaries Project. Nonetheless, the State of Missouri will be contacted to determine if they have a plan to restore the park independent of this project.

Final Panel BackCheck Response 18

Concur with comment.

As part of the response to 18a the USACE states "*Regardless, the existing WRP lands found within the project area will be compared to areas outside the project area (including the batture area that remains subject to flooding) to determine if any changes to the future without project land use are necessary*." The Panel agrees this approach is adequate to address the potential impact of future without project on WRP easements.

USACE appears to be asserting that because MDNR plans to restore hydrology to the Big Tree State Park did not include a plan to directly connect it to the Mississippi River, it is equivalent to no change without the project; the panel does not agree with this assertion. While connectivity to the river is the preferred method of improving the hydrology to the park, improving hydrology through other methods would certainly be beneficial and should be considered a change without the project. Based on the September 8, 2010 conference call, USACE has agreed to meet with the MDNR to determine level of hydrologic restoration to the Big Tree State Park the MDNR could realistically achieve if the proposed USACE St. Johns Bayou and New Madrid Floodway, Missouri Project was to not go forward. USACE will then determine credit for mitigation conducted at Big Tree State Park based on increased ecological function above and beyond what would have been achieved under the MDNR planned hydrologic restoration.

Comment 19:
The potential impact of global climate change on the proposed project and the conceptual mitigation plan should be acknowledged.
USACE Final Evaluator Response 19
The comments provided will be used to expand the discussion of global climate change to the EIS. Preliminary analysis indicates that the authorized project would be extremely robust to any changes in future hydrology because pump operations and gate management can be modified as a result of any significant changes in precipitation/Mississippi River water levels. Moreover, the gate management/pump operation (*i.e.,* operating rule curve) has the capability to be flexible and can be modified for environmental/habitat reasons as well.
Final Panel BackCheck Response 19
Concur

Comment 20:
The gate closure and pump operation management alternatives proposed for St. Johns Bayou and New Madrid Floodway require further clarification.
USACE FINAL Evaluator Response 20
Preliminary plans call for allowing the river to come up to a certain elevation and closing the gates to provide flood protection. Pumps would be used to evacuate interior drainage. Gates would normally be re-opened once the Mississippi River recedes to allow for gravity drainage. A rapidly falling river in a highly drained project area will lead to the stranding and desiccation of eggs and larvae. Therefore, operating rules will consider multiple factors including flood damage reduction, maximization of periods when gates are open, and reduction of ramping effects that could strand eggs and larvae. The EIS will analyze opportunities that would allow the river to come up to certain elevations but will hold water to create a spawning and rearing pool for fish as well as habitat for other resources (shorebirds, waterfowl, etc.). Although this action would prevent ingress of individual fish when gates are closed constant access is not required for successful spawning and rearing. The spawning and rearing pool will provide habitat for those fish (individuals and species) that have already accessed the site during a rising hydrograph prior to gate closure. Re-opening the gates after a successful spawning and rearing period and a gradual drawdown would allow adult fish that had previously accessed the site and young of the year to egress into the Mississippi River. The EIS will discuss the overall timing of gate operation and the events that would trigger holding water or releasing water such as time of the year, temperatures, dissolved oxygen concentrations, river forecasts, precipitation forecasts, etc. Opportunities will be explored that maximize the exchange of water (and fish) from the Mississippi River and the spawning and rearing pool. In addition to fish benefits, the EIS will analyze management opportunities for other significant resource categories provided by the spawning and rearing pool. Based on panel recommendations made during the teleconferences, the fish access study will also be used to determine access restriction. If access is determined to be impacted through project monitoring the gate will be adaptively managed or mitigation in the batture area may be appropriate.
Final Panel BackCheck Response 20
Concur

Comment Report: All Comments
Project: St. Johns Bayou and New Madrid Floodway
Review: Phase 2 IEPR
Displaying 20 comments for the criteria specified in this report.

609 ms to run this page

Id	Discipline	Section/Figure	Page Number	Line Number
3241201	Biology-Ecology	n/a'	Comment #1	n/a

(Document Reference: High)

There are significant gaps regarding the application of the Shorebird Model, and the major concerns raised in the Phase 1 IEPR of the Consolidated NEPA Document have not been addressed.

(Attachment: Comment_1.doc)

Submitted By: Julian Digialleonardo (561-656-6303). Submitted On: 04-May-10

1-0	Evaluation **Concurred** see attachment Submitted By: Daniel Ward ((901) 544-0709) Submitted On: 14-Jul-10 (Attachment: SJNM_FINAL_USACE_Responses_Phase_2_2010_7_14.pdf)
	Backcheck not conducted
2-0	Evaluation **For Information Only** For clarification: USACE intends to compensate significant unavoidable environmental impacts to the extent economically justified and mandated by law. Significance will be determined in the EIS. The shorebird model would be submitted for peer review. Submitted By: Daniel Ward ((901) 544-0709) Submitted On: 26-Oct-10
2-1	Backcheck Recommendation **Close Comment** Non-concur Question 1a. The USACE response states: "The project work plan states that the goal of mitigation is to compensate for unavoidable significant impact to the extent justified. Significance of impacts will be determined in the EIS." The Panel understands that the specific impacts of the project cannot be determined precisely until the proposed design is finalized in the upcoming EIS. However, the Panel believes that the loss of large areas of seasonally flooded, sparsely vegetated habitats for shorebirds are a significant impact of the proposed project, and that USACE should clearly state in the Work Plan its intention to fully mitigate for the specific impacts to shorebird habitats that will be determined during the EIS analyses. The Panel will concur if USACE states its intent to fully mitigate for impacts to shorebird habitats. Submitted By: Lynn McLeod (781/952-5381) Submitted On: 04-Nov-10
2-2	Backcheck Recommendation **Close Comment** Question 1a, continued. The USACE response states: "Additionally, USACE does not consider a mitigation measure that restores bottomland hardwoods on farmland a significant impact to shorebird habitat because bottomland hardwoods better represent historical/unaltered conditions of the project area." The response reiterates this point on page 19 where it states that: "Note: USACE does not consider measures that restore vegetation to an area, including compensatory mitigation measures, as a significant impact to shorebirds and therefore, does not intend to mitigate for shorebird impacts that the model may show by restoring bottomland hardwoods." The Panel understands that the project area is highly modified from its historic conditions. These conditions notwithstanding, the goal of the mitigation plan is to compensate for losses in ecological function measured by comparing current project conditions to future with-project conditions. Importantly, this mitigation becomes part of the project and, therefore, all wildlife habitat losses that would result from the project, including those directly attributable to mitigation activities for other resource types, should be mitigated. The Panel will concur if USACE states that all wildlife habitat impacts, including those resulting from mitigation of other project impacts, will be mitigated. Submitted By: Lynn McLeod (781/952-5381) Submitted On: 04-Nov-10
2-3	Backcheck Recommendation **Close Comment** Question 1e. The USACE response states: "This is unresolved. What information would an

	additional round of peer review resolve that has not been resolved by this panel, or would not be resolved by subsequent IEPR review of this project (Phase 3 and Phase 4)?" The Panel has explained its rationale for requesting peer review on all major models to be used to measure habitat impacts and determine mitigation requirements. USACE apparently accepted this rationale, and states in the second to last line under Recommendation 1, on p. 19, that "The alternate methodology stated above will undergo peer review." If USACE intends to conduct a peer review on the alternate methodology, then it is unclear to the panel why this issue is listed as unresolved. The Panel will concur if USACE states that the shorebird habitat model will undergo peer review. Submitted By: Lynn McLeod (781/952-5381) Submitted On: 04-Nov-10
2-4	Backcheck Recommendation **Close Comment** Question 1f The USACE response states: "Although the panel recommended expanding the period to 15 March to 15 June in the spring and 1 July to 30 October in the fall, after reviewing small and medium shorebird graphs for latitude 35-40 degree North, the recommended shorebird dates are 15 March to 30 May in spring and 1 July to 15 October in fall (Dan Twedt, personal communication)." The Panel recommends using the entire period of shorebird migration to calculate impacts to shorebirds, as proposed earlier. Because the comment says only what dates USACE recommends, it is not clear what rationale was applied to remove portions of the migration window when shorebirds are present in the study area. The Panel recommends the conservative rationale of calculating impacts to shorebird habitats during the entire periods when migrating shorebirds are present in the study area. Skagen et al. (1999, p. 17, 31, 33) supports shorebirds being present during spring migration through June 15th for both small shorebirds and all shorebirds, and supports shorebirds being present during fall migration through October 30th for all small, all medium, and all shorebirds. Particularly because migration phenology may change in response to climate change on the arctic breeding grounds, the panel recommends using the entire migration window to calculate impacts to shorebird habitats. The panel will concur if USACE uses the recommended migration windows to calculate shorebird habitat impacts. The Panel believes that the development of HSI values and other specifics related to model parameterization are beyond the scope of its review. The Panel believes its role is to comment on the process used to generate models and their output, the results of the peer review of those models, and their application. The Panel will review the models, parameter values, and application of the models during the next phase of the project, but cannot generate the model or parameter values to be used in the limited time available for working on this process. The Panel believes that the recommended peer review will resolve this issue. Submitted By: Lynn McLeod (781/952-5381) Submitted On: 04-Nov-10
2-5	Backcheck Recommendation **Close Comment** Question 1k. The USACE response states in the last line of the response to this question, on page 9, that "The goal of mitigation is not to provide at least the same number of hectare days of shallowly flooded habitat as occur on the project area under existing conditions. Mitigation is based on replacing significant impacted habitat that is defined as the difference between future with the recommended alternative and the future without the project, not existing hectare days that are flooded with no regard whether the flooded area is optimal or sub-optimal." The Panel agrees that it is appropriate to consider the relative value of habitat types in currently existing conditions, and discount acreage affected by the project according to its relative value. This is the basis of the HSI approach. However, the Panel also believes that it is appropriate to compensate for all of the impacts to existing habitats, using the appropriate HSI value as a discounting factor. The Panel has always supported measuring the relative value of different habitat types, and is unclear why this is being raised as an issue at this point, but also continues to believe that the total impacted area, with appropriate discounting for habitat value, should be compensated for in a mitigation plan that replaces lost ecological function. One significant issue relates to the value of a slow drawdown over time for shorebird habitat. Although some areas may be flooded to a depth that shorebirds do not use when deeply flooded, over time as flood waters recede, those areas will be exposed, and will become optimal foraging habitat while they are shallowly flooded or recently exposed. This is important when assigning habitat values as proposed in the alternate methodology, for example under section 5b, where different water depths are given different HSI values. The calculation of impacts now appears to include all areas of shallowly flooded and sparsely vegetated habitat that would be flooded under current conditions but then exposed during the migration window, as the panel recommended. The Panel concurs with the approach outlined in the alternate methodology (Methods, p. 16), where total daily hectares of habitat are rated with respect to their habitat value, and then summed across the migration window. If USACE intends to include all appropriate shorebird habitats in its calculation of impacts, and assign them appropriate

	habitat values when they are exposed by drawdown during the migration window as outlined in the alternate methodology, the panel concurs with this general approach. The Panel still recommends that the alternate methodology be fully developed in a model document with all equations and parameter values specified, and subjected to peer review. Submitted By: Lynn McLeod (781/952-5381) Submitted On: 04-Nov-10
2-6	Backcheck Recommendation **Close Comment** Question 1m Concur with comment In theory, productivity levels used in the parameters of the WAM model can be reached, however, in practice, this rarely happens across large spatially divers areas (e.g., Kross et al. 2008). Equipment fails, levies break or leak, water control structures get clogged, etc., delaying or preventing flooding and draw-downs. If these problems occur, they will no doubt impact the ability of the moist soil units to produce foods for waterfowl. USACE has indicated they will monitor waterfowl food productivity on mitigation wetlands with an adaptive management approach to ensure mitigation wetlands produce food at levels assumed by the model. This approach appears to be an appropriate way to ensure waterfowl are properly mitigated. The Panel is concerned, however, this approach of additional mitigation after the completion of the project, during the adaptive management phase will lead to an artificially decrease in the cost of the project. The Panel believes the estimate of 556 kg/ha of seed production suggested by Kross et al. (2008) as an estimate for planning purposes represents a more realistic value for managed moist soil habitat and would be more appropriate for estimating project costs. Based on the September 8, 2010 conference call, USACE has agreed to use 556kg/ha as an estimate of seed production for managed moist soil habitat for planning purposes. Submitted By: Lynn McLeod (781/952-5381) Submitted On: 04-Nov-10 (Attachment: St_John_Bayou_Ph2__Final_BackCheck_Response__Comment_1.pdf)
	Current Comment Status: **Comment Closed**

3241214	Biology-Ecology	n/a'	Comment #2	n/a

(Document Reference: High)

The Project Work Plan does not respond to the concerns raised during the Phase 1 IEPR regarding the method to analyze the project's impact on shorebird habitat.

(Attachment: Comment_2.doc)

Submitted By: Julian Digialleonardo (561-656-6303). Submitted On: 04-May-10

1-0	Evaluation **Concurred** see attachment Submitted By: Daniel Ward ((901) 544-0709) Submitted On: 14-Jul-10 (Attachment: SJNM_FINAL_USACE_Responses_Phase_2_2010_7_141.pdf)
	Backcheck not conducted
2-0	Evaluation **Concurred** For clarification, the shorebird model would be submitted for peer review. Submitted By: Daniel Ward ((901) 544-0709) Submitted On: 26-Oct-10
2-1	Backcheck Recommendation **Close Comment** Concur with comment The Panel believes that the methodology outlined proposes appropriate scientifically defensible methods to describe existing shorebird habitats that may be impacted by proposed project alternatives. However, the Panel also believes that the methodology needs to be fully developed in a proposed model document as was done with all of the other models, including specification of parameter values and how calculations are to be carried out, and then subjected to peer review. If USACE plans to fully develop this model and conduct a peer review, the Panel concurs with this approach. Submitted By: Lynn McLeod (781/952-5381) Submitted On: 04-Nov-10 (Attachment: St_Johns_Bayou_Ph2__Final_BackCheck_Response_Comment_2.pdf)
	Current Comment Status: **Comment Closed**

3241239	Biology-Ecology	n/a'	Comment #3	n/a

(Document Reference: High)

Information is not provided to support the importance of flood pulses (different from 2-year frequencies) in wetland ecosystems and for wetland-dependent organisms.

(Attachment: Comment_3.doc)

Submitted By: Julian Digialleonardo (561-656-6303). Submitted On: 04-May-10

1-0	Evaluation **Concurred** see attachment Submitted By: Daniel Ward ((901) 544-0709) Submitted On: 14-Jul-10 (Attachment: SJNM_FINAL_USACE_Responses_Phase_2_2010_7_142.pdf)
1-1	Backcheck Recommendation **Close Comment** Concur with comment Recommendation 1: No additional comment. Recommendation 2: Although the Panel agrees that both the St. Johns Basin and New Madrid Floodway are altered ecosystems due to a variety of anthropogenic impacts, wetland ecosystem function still exists and provides habitat for diverse plant and animal communities. In addition, annual variability in flood events, although altered from "natural" conditions, helps maintain ecosystem function in the remaining wetlands of the St. Johns Basin and New Madrid Floodway. Submitted By: Lynn McLeod (781/952-5381) Submitted On: 04-Nov-10 (Attachment: St_Johns_Bayou_Ph2__Final_BackCheck_Response_Comment_3.pdf)
	Current Comment Status: **Comment Closed**

3241279	Biology-Ecology	n/a'	Comment #4	n/a

(Document Reference: High)

A more complete discussion of fish access in St. Johns Bayou and New Madrid Floodway is needed, and the potential quantification of losses and potential mitigation due to access restrictions must be addressed.

(Attachment: Comment_4.doc)

Submitted By: Julian Digialleonardo (561-656-6303). Submitted On: 04-May-10

1-0	Evaluation **Concurred** see attachment Submitted By: Daniel Ward ((901) 544-0709) Submitted On: 14-Jul-10 (Attachment: SJNM_FINAL_USACE_Responses_Phase_2_2010_7_143.pdf)
1-1	Backcheck Recommendation **Close Comment** Concur with comment Recommendation 1: No additional comment. Recommendation 2: Concur with comment. "Although the Fish and Wildlife Service has repeatedly indicated that batture land mitigation is not suitable to mitigate for project impacts because it does not provide habitat (in-kind) that is similar to that found in the floodway, based on teleconferences with the Panel, the Panel stated that batture land would be suitable for mitigation." This statement from USACE response pertains primarily to the Panel's opinion for mitigation that may be needed due to loss from fish access restrictions. The Panel supports "within" floodway mitigation as the primary location for losses from the project as calculated through the use of Enviro-Fish. However, the Panel does support batture land mitigation as a secondary alternative. Submitted By: Lynn McLeod (781/952-5381) Submitted On: 04-Nov-10 (Attachment: St_Johns_Bayou_Ph2__Final_BackCheck_Response_Comment_4.pdf)
	Current Comment Status: **Comment Closed**

3241291	Biology-Ecology	n/a'	Comment #5	n/a

(Document Reference: High)

The fisheries methodology is not adequate to quantify actual spawning and rearing habitat based on Habitat Suitability Index (HSI) values.

(Attachment: Comment_5.doc)

Submitted By: Julian Digialleonardo (561-656-6303). Submitted On: 04-May-10

1-0	Evaluation **Concurred** see attachment Submitted By: Daniel Ward ((901) 544-0709) Submitted On: 14-Jul-10 (Attachment: SJNM_FINAL_USACE_Responses_Phase_2_2010_7_144.pdf)
1-1	Backcheck Recommendation **Close Comment** Concur with comment Recommendation 1: "Although larval fish were not collected, this study identified those species found in the project area, and these data in turn were used to develop the habitat guild for species selection in the Habitat Evaluation Procedure. Preferences of spawning and rearing fishes to specific land use categories (i.e., HSI values) were based on field studies in the lower Mississippi River basin and professional opinion." Although this statement from USACE final Response is correct, the guild approach was abandoned for a habitat based HSI approach in the Work Plan. The Panel supports the use of the Sheehan study results in a Delphi process for setting HSI habitat based values used in future modeling. Recommendation 2: "The Panel comments suggest that habitat value is constantly changing during this period and therefore, it is not appropriate to utilize a different HIS value." The Panel did not suggest that the habitat value (HSI) is constantly changing during this period (as stated in the above sentence from the USACE response), but that the underlying physical habitat structure remains the same. Therefore, the Panel supports the use of the "underlying" habitat HSI value with the potential of habitat unit increases due to changes in ADFA's as stated in the USACE final Response. The Panel will support an HSI increase (i.e. habitat classification change) due to maintaining the rearing pool for extended periods of time if an increase is supported by monitoring studies. Recommendation 3: No additional comment. Submitted By: Lynn McLeod (781/952-5381) Submitted On: 04-Nov-10 (Attachment: St_Johns_Bayou_Ph2__Final_BackCheck_Response_Comment_5.pdf)
	Current Comment Status: **Comment Closed**

3241304	Biology-Ecology	n/a'	Comment #6	n/a

(Document Reference: High)

The Waterfowl Assessment Method (WAM) appears to be appropriate; however, the parameter estimates for the model are based on fall migratory and wintering ducks and do not appear to consider spring migrants.

(Attachment: Comment_6.doc)

Submitted By: Julian Digialleonardo (561-656-6303). Submitted On: 04-May-10

1-0	Evaluation **Concurred** see attachment Submitted By: Daniel Ward ((901) 544-0709) Submitted On: 14-Jul-10 (Attachment: SJNM_FINAL_USACE_Responses_Phase_2_2010_7_145.pdf)
	Backcheck not conducted
2-0	Evaluation **Concurred** see attachment Submitted By: Daniel Ward ((901) 544-0709) Submitted On: 14-Jul-10 (Attachment: SJNM_FINAL_USACE_Responses_Phase_2_2010_7_146.pdf)
2-1	Backcheck Recommendation **Close Comment** Concur with comment. The Panel has provided the documents requested by the USACE and looks forward to the information being integrated into the model. Submitted By: Lynn McLeod (781/952-5381) Submitted On: 04-Nov-10 (Attachment:

	St_Johns_Bayou_Ph2__Final_BackCheck_Response_Comment_6.pdf)
	Current Comment Status: **Comment Closed**

3241319	Hydrology	n/a'	Comment #7	n/a

(Document Reference: High)

It is unclear if the application of the Hydrogeomorphic (HGM) approach to evaluate project impacts and develop proposed mitigation will yield scientifically credible results.

(Attachment: Comment_7.doc)

Submitted By: Julian Digialleonardo (561-656-6303). Submitted On: 04-May-10

1-0	Evaluation **Concurred** see attachment Submitted By: Daniel Ward ((901) 544-0709) Submitted On: 14-Jul-10 (Attachment: SJNM_FINAL_USACE_Responses_Phase_2_2010_7_147.pdf)
1-1	Backcheck Recommendation **Close Comment** Concur with comment. This discussion has focused on both the reliability and repeatability of the HGM method in providing scientifically defensible results for estimating impact on wetlands and mitigation of those impacts and the use of mitigation ratios to reflect the uncertainty in the mitigation attempted on this project. The mitigation concerns impacts of this water project on waters of the United States, including wetlands. So if the mitigation of impacts is not certain, the Panel believes that a higher mitigation ratio is warranted. Our principal concerns remain that the uncertainty of the mitigation needs to be reflected in the mitigation ratios, which could be as high as 4:1, and that the field parameters used in the HGM approach be appropriate for identifying the most important functions lost from the impacted wetlands. The Panel believes that the HGM method should be retained for wetland assessment, mostly because there is no other acceptable method that emphasizes the hydrology and landscape position of the wetlands. For evaluating wetland function unrelated to the support of fish and wildlife, it is more effective than investigating by individual resources, e.g. waterfowl or fisheries by themselves. The Panel is pleased that USACE is open to the idea of "to investigate wetland models to assess impacts to function and structure and determine appropriate mitigation for other Civil Works projects as well as Section 404 permits." Submitted By: Lynn McLeod (781/952-5381) Submitted On: 04-Nov-10 (Attachment: St_Johns_Bayou_Ph2__Final_BackCheck_Response_Comment_7.pdf)
	Current Comment Status: **Comment Closed**

3241331	Environmental	n/a'	Comment #8	n/a

(Document Reference: High)

There is an insufficient level of detail in the Project Work Plan to evaluate the validity of the proposed compensatory mitigation plan.

(Attachment: Comment_8.doc)

Submitted By: Julian Digialleonardo (561-656-6303). Submitted On: 04-May-10

1-0	Evaluation **Concurred** see attachment Submitted By: Daniel Ward ((901) 544-0709) Submitted On: 14-Jul-10 (Attachment: SJNM_FINAL_USACE_Responses_Phase_2_2010_7_148.pdf)
1-1	Backcheck Recommendation **Close Comment** Concur with comment. USACE appears to be under the impression the Panel is requesting adequate detail in the modeling approach to determine if the mitigation is appropriate. This is not the case; the Panel is only attempting to determine if each modeling approach is appropriate. Substantial detail in the models, however, is required to do this with any degree of confidence. Areas of concern are as follows: At this point, the philosophical outline of the

shorebird model appears to be appropriate. Without knowing the details of this model, however, the Panel cannot make a recommendation on the appropriateness of the final model. The assurance by USACE of an appropriate peer review of the final model would help alleviate this concern. Based on the September 8, 2010 conference call, USACE has assured the Panel the final shorebird model would go through an appropriate peer review process. The Panel agrees that a Delphi method is an appropriate approach for determining HSI values for the fish model. Furthermore, the panel supports HSI values that are determined to be appropriate by the entire interagency team (EPA, USFWS, MDNR, MDOC, and USACE). USACE has agreed to conduct a qualitative assessment of water bodies within the basin. While the Panel agrees that this type of assessment is appropriate for addressing water quality issues, USACE has provided no detailed methodology as to how this assessment would be conducted, so the panel has no way of determining if this assessment would be appropriate. The Panel concurs that the current HGM model is the only tool currently available to assess functional loss and gains of wetlands unrelated to the support of fish and wildlife. The Panel is concerned, however, that although this is the only tool currently available for this type of analysis, the accuracy and precision of this tool is inadequate to estimate the degree of impacts with an appropriate level of confidence; thus, a mitigation ratio of lost wetland function greater than 1:1 should be used for mitigation.

Submitted By: Lynn McLeod (781/952-5381) Submitted On: 04-Nov-10 (Attachment: St_Johns_Bayou_Ph2__Final_BackCheck_Response_Comment_8.pdf)

Current Comment Status: **Comment Closed**

3241340	Planning - Plan Formulation	n/a'	Comment #9	n/a

(Document Reference: High)

The adaptive management plan requires a detailed analysis of the ongoing mitigation management costs and a clear funding source adequate to support those activities.

(Attachment: Comment_9.doc)

Submitted By: Julian Digialleonardo (561-656-6303). Submitted On: 04-May-10

1-0 Evaluation **Concurred**
see attachment

Submitted By: Daniel Ward ((901) 544-0709) Submitted On: 14-Jul-10 (Attachment: SJNM_FINAL_USACE_Responses_Phase_2_2010_7_149.pdf)

1-1 Backcheck Recommendation **Close Comment**
Concur with comment. The Panel concurs with the approach outlined in the response to this Comment.

Submitted By: Lynn McLeod (781/952-5381) Submitted On: 04-Nov-10 (Attachment: St_Johns_Bayou_Ph2__Final_BackCheck_Response_Comment_9.pdf)

Current Comment Status: **Comment Closed**

3241361	Environmental	n/a'	Comment #10	n/a

(Document Reference: High)

The methodology to determine the extent of the wetlands in the project area requires further detail to determine if it is valid.

(Attachment: Comment_10.doc)

Submitted By: Julian Digialleonardo (561-656-6303). Submitted On: 04-May-10

1-0 Evaluation **Concurred**
see attachment

Submitted By: Daniel Ward ((901) 544-0709) Submitted On: 14-Jul-10 (Attachment:

	SJNM_FINAL_USACE_Responses_Phase_2_2010_7_1410.pdf)
1-1	Backcheck Recommendation **Close Comment** Concur Submitted By: Lynn McLeod (781/952-5381) Submitted On: 04-Nov-10 (Attachment: St_Johns_Bayou_Ph2__Final_BackCheck_Response_Comment_10.pdf)
	Current Comment Status: **Comment Closed**

3241366	Economics	n/a'	Comment #11	n/a

(Document Reference: High)

The assessment of economic impacts of the proposed project may not be valid because the method used to document the future with and without project conditions does not consider trends in real prices and costs.

(Attachment: Comment_11.doc)

Submitted By: Julian Digialleonardo (561-656-6303). Submitted On: 04-May-10

1-0	Evaluation **Concurred** see attachment Submitted By: Daniel Ward ((901) 544-0709) Submitted On: 14-Jul-10 (Attachment: SJNM_FINAL_USACE_Responses_Phase_2_2010_7_1411.pdf)
1-1	Backcheck Recommendation **Close Comment** Concur with comment. Concur that sensitivity analysis as suggested above will take care of the issues. Submitted By: Lynn McLeod (781/952-5381) Submitted On: 04-Nov-10 (Attachment: St_Johns_Bayou_Ph2__Final_BackCheck_Response_Comment_11.pdf)
	Current Comment Status: **Comment Closed**

3241369	Economics	n/a'	Comment #12	n/a

(Document Reference: High)

The use of two discount rates for the same analysis is confusing and is not warranted in any conventional economic analysis.

(Attachment: Comment_12.doc)

Submitted By: Julian Digialleonardo (561-656-6303). Submitted On: 04-May-10

1-0	Evaluation **Concurred** see attachment Submitted By: Daniel Ward ((901) 544-0709) Submitted On: 14-Jul-10 (Attachment: SJNM_FINAL_USACE_Responses_Phase_2_2010_7_1412.pdf)
1-1	Backcheck Recommendation **Close Comment** Concur with comment. Concur with final approach suggested. Because of the uncertainties raised by the Panel, it will be especially important to examine benefit-cost ratios at a 7% rate, which is a high rate often used in the presence of risky outcomes. See: Bazelon, Coleman and Kent Smetters. 1999. Discounting Inside the Washington D.C. Beltway. J. of Economic Perspectives 13 (4/Fall): 213-28. Howarth, Richard B. 2009. "Discounting, Uncertainty, and Revealed Time Preference." Land Economics 85 (1/Feb): 24-40. Submitted By: Lynn McLeod (781/952-5381) Submitted On: 04-Nov-10 (Attachment: St_Johns_Bayou_Ph2__Final_BackCheck_Response_Comment_12.pdf)
	Current Comment Status: **Comment Closed**

3241377	Economics	n/a'	Comment #13	n/a

(Document Reference: High)

The farming survey may not be credible unless a large enough sample size is used, producing a smaller statistical error for the analysis and avoiding many possible sources of bias.

(Attachment: Comment_13.doc)

Submitted By: Julian Digialleonardo (561-656-6303). Submitted On: 04-May-10

1-0	Evaluation **Concurred** see attachment Submitted By: Daniel Ward ((901) 544-0709) Submitted On: 14-Jul-10 (Attachment: SJNM_FINAL_USACE_Responses_Phase_2_2010_7_1413.pdf)
1-1	Backcheck Recommendation **Close Comment** Concur with comment. The Panel concurs with this suggested approach. Submitted By: Lynn McLeod (781/952-5381) Submitted On: 04-Nov-10 (Attachment: St_Johns_Bayou_Ph2__Final_BackCheck_Response_Comment_13.pdf)
	Current Comment Status: **Comment Closed**

3241384	Environmental	n/a'	Comment #14	n/a

(Document Reference: High)

The cumulative impact approach lacks specific information on how the conceptual matrix will be used to evaluate the incremental impacts of the proposed project or address the unique aspects of the study area.

(Attachment: Comment_14.doc)

Submitted By: Julian Digialleonardo (561-656-6303). Submitted On: 04-May-10

1-0	Evaluation **Concurred** see attachment Submitted By: Daniel Ward ((901) 544-0709) Submitted On: 14-Jul-10 (Attachment: SJNM_FINAL_USACE_Responses_Phase_2_2010_7_1414.pdf)
	Backcheck not conducted
2-0	Evaluation **For Information Only** For clarification, USACE intends to compensate significant unavoidable environmental impacts to the extent economically justified and mandated by law. Submitted By: Daniel Ward ((901) 544-0709) Submitted On: 26-Oct-10
2-1	Backcheck Recommendation **Close Comment** Concur with comment. Recommendation 1: Concur, if clarification is made. USACE has responded to the Panel request for additional details on their proposed methodologies for determining cumulative impacts. However, they introduced the new issue that the project area connection is extremely altered and is not the last remaining connection (to the Mississippi River). As a point of clarification, the Panel stated that the project area is the last connection in the State of Missouri, not in the entire Mississippi River. USACE went on to state that previous work/modifications in the project area could have already caused impacts that exceeded a significant threshold. Although the panel is concerned that these statements appear to be "lowering expectations," we take note that USACE affirms that they will still evaluate cumulative impacts, including historical trends, and determine whether they are significant. While NEPA cases have not required projects to mitigate for past impacts of previous actions, they generally do expect that projects mitigate for any additional significant impacts, even if these past impacts have exceeded a significant threshold. USACE should clarify that they will mitigate for any additional significant impacts of the proposed project. Recommendation 2: No additional comments Submitted By: Lynn McLeod (781/952-5381) Submitted On: 04-Nov-10 (Attachment: St_Johns_Bayou_Ph2__Final_BackCheck_Response_Comment_14.pdf)

	Current Comment Status: **Comment Closed**

3241388	Environmental	n/a'	Comment #15	n/a

(Document Reference: High)

More precise contour data (i.e. greater than a 1-foot contour interval) are required to estimate wetland availability and mitigation for waterfowl and shorebirds.

(Attachment: Comment_15.doc)

Submitted By: Julian Digialleonardo (561-656-6303). Submitted On: 04-May-10

1-0	Evaluation **Concurred** see attachment Submitted By: Daniel Ward ((901) 544-0709) Submitted On: 14-Jul-10 (Attachment: SJNM_FINAL_USACE_Responses_Phase_2_2010_7_1420.pdf)
1-1	Backcheck Recommendation **Close Comment** Concur Submitted By: Lynn McLeod (781/952-5381) Submitted On: 04-Nov-10 (Attachment: St_Johns_Bayou_Ph2__Final_BackCheck_Response_Comment_15.pdf)
	Current Comment Status: **Comment Closed**

3241394	Environmental	n/a'	Comment #16	n/a

(Document Reference: Medium)

The list of significant resources is not complete because it does not include a discussion of the quality of the wetland resource, which is dependent upon the dynamic nature of the ecosystem's function and its connection to the river.

(Attachment: Comment_16.doc)

Submitted By: Julian Digialleonardo (561-656-6303). Submitted On: 04-May-10

1-0	Evaluation **Concurred** see attachment Submitted By: Daniel Ward ((901) 544-0709) Submitted On: 14-Jul-10 (Attachment: SJNM_FINAL_USACE_Responses_Phase_2_2010_7_1415.pdf)
1-1	Backcheck Recommendation **Close Comment** Concur with comment. The USACE Response reiterates some of the text provided above in the draft Response to this comment, which should not be necessary following the clarification provided by the panel in both written text and discussion. As the Panel clarified in our reply, our intent was to request that USACE highlight the unique ecological functions of the riverine wetlands in the project area resulting from current flooding conditions. USACE agrees in their final Response to do this in the EIS, so the Panel concurs with this approach. USACE suggests that it will pay more attention to the wetland hydroperiods defining the wetlands of the study area. There is still the debate on whether river or local flooding is more important. Since the former has been all but eliminated, of course the latter is more important now. The only place where a natural flood frequency might occur now is at the state park. It appears from the response that USACE will pay more attention in the document to the quality of the wetland resources as the Panel recommended. Submitted By: Lynn McLeod (781/952-5381) Submitted On: 04-Nov-10 (Attachment: St_Johns_Bayou_Ph2__Final_BackCheck_Response_Comment_16.pdf)
	Current Comment Status: **Comment Closed**

3241402	Environmental	n/a'	Comment #17	n/a

(Document Reference: Medium)

The water quality analysis in the Project Work Plan does not address water quality conditions in any of the study area water bodies and does not compare nutrient loads to the Mississippi River with and without project conditions. (Attachment: Comment_17.doc) Submitted By: Julian Digialleonardo (561-656-6303). Submitted On: 04-May-10	
1-0	Evaluation **Concurred** see attachment Submitted By: Daniel Ward ((901) 544-0709) Submitted On: 14-Jul-10 (Attachment: SJNM_FINAL_USACE_Responses_Phase_2_2010_7_1416.pdf)
	Backcheck not conducted
2-0	Evaluation **For Information Only** For clarification, USACE's proposed assessment will involve actual flooded acres for each project alternative and compensatory mitigation. Actual flooded acres will be based on the hydrologic period of record. Submitted By: Daniel Ward ((901) 544-0709) Submitted On: 26-Oct-10
2-1	Backcheck Recommendation **Close Comment** Concur with comment and/or clarification. Recommendation 1: Concur with comment. The Panel recommended that USACE conduct quantitative assessments of the impacts of the actual proposed project on waterbodies in the St. Johns Bayou/New Madrid Floodway. Based on discussions during the May 13, 2010 and May 17, 2010 teleconferences, USACE responded that they will conduct qualitative water quality assessments of project area waterbodies for each project alternative and compensatory mitigation. However, they provided no details on their methodologies. Lacking any details, it is not possible to determine whether their proposal is an appropriate basis for determination of mitigation of project impacts. The Panel believes there should be three objectives for conducting the recommended water quality assessments: (1) establish baseline conditions without the project; (2) determine whether existing water quality conditions support the intended uses of these habitats with the proposed project; and (3) determine potential impacts of the actual project and compensatory mitigation. The first two objectives can be met by analyzing baseline monitoring datawithout the project. The third objective can only be met by conducting routine monitoring after the project and compensatory mitigation are initiated. USACE stated they will conduct a query of agencies and academic institutions that would be sources of water quality data in the project area. A possible outcome of this query is that existing water quality data are not adequate to accomplish the first two of the above three objectives. In this case, USACE should conduct baseline monitoring to acquire these data before the project and any compensatory mitigation are initiated. In the event that the project goes forward, USACE should conduct follow-up monitoring of these same waterbodies to determine potential impacts of the actual project and compensatory mitigation. Submitted By: Lynn McLeod (781/952-5381) Submitted On: 04-Nov-10
2-2	Backcheck Recommendation **Close Comment** Recommendation 2: Concur with clarification. USACE stated they will use differences in relative load estimates (similar to Ashby et al. 2000) to compare project alternatives. The differences in relative load estimates in Ashby et al. 2000 do not represent differences between current conditions and the actual proposed project. Instead, they compare nitrogen removal efficiencies at an assumed water surface elevation of 290 feet NGVD between current conditions (without project) and with mitigation associated with restored acreage. None of the hydrologic scenarios in the Consolidated NEPA report was the actual project because each of them involved the same flooded acres at 290 feet NGVD, whereas the proposed project involves blocking the water level beyond 284.2 feet NGVD in the New Madrid Floodway. As stated previously, the Panel believes that nutrient loads from the project area to the Mississippi River under current conditions (without project) should be compared to those with the actual proposed project. USACE took note of this comment and responded that they will conduct the assessment with the future without project conditions and for each of the project alternatives including compensatory mitigation. USACE should clarify that their proposed assessment will involve actual flooded acres for each project alternative and compensatory mitigation, and not the same flooded acres at 290 feet NGVD. Submitted By: Lynn McLeod (781/952-5381) Submitted On: 04-Nov-10 (Attachment: St_Johns_Bayou_Ph2__Final_BackCheck_Response_Comment_17.pdf)

	Current Comment Status: **Comment Closed**

3241408	General	n/a'	Comment #18	n/a

(Document Reference: Medium)

The validities of several assumptions for the future without project alternatives are questionable.

(Attachment: Comment_18.doc)

Submitted By: Julian Digialleonardo (561-656-6303). Submitted On: 04-May-10

1-0	Evaluation **Concurred** see attachment Submitted By: Daniel Ward ((901) 544-0709) Submitted On: 14-Jul-10 (Attachment: SJNM_FINAL_USACE_Responses_Phase_2_2010_7_1417.pdf)
	Backcheck not conducted
2-0	Evaluation **For Information Only** USACE intends to meet with the Missouri Department of Natural Resoruces to establish likely future without project conditions to Big Oak Tree State Park. Submitted By: Daniel Ward ((901) 544-0709) Submitted On: 26-Oct-10
2-1	Backcheck Recommendation **Close Comment** Concur with comment. As part of the response to 18a the USACE states "Regardless, the existing WRP lands found within the project area will be compared to areas outside the project area (including the batture area that remains subject to flooding) to determine if any changes to the future without project land use are necessary." The Panel agrees this approach is adequate to address the potential impact of future without project on WRP easements. USACE appears to be asserting that because MDNR plans to restore hydrology to the Big Tree State Park did not include a plan to directly connect it to the Mississippi River, it is equivalent to no change without the project; the panel does not agree with this assertion. While connectivity to the river is the preferred method of improving the hydrology to the park, improving hydrology through other methods would certainly be beneficial and should be considered a change without the project. Based on the September 8, 2010 conference call, USACE has agreed to meet with the MDNR to determine level of hydrologicrestoration to the Big Tree State Park the MDNR could realistically achieve if the proposed was to not go forward. USACE will then determine credit for mitigation conducted at Big Tree State Park based on increased ecological function above and beyond what would have been achieved under the MDNR planned hydrologic restoration. Submitted By: Lynn McLeod (781/952-5381) Submitted On: 04-Nov-10 (Attachment: St_Johns_Bayou_Ph2__Final_BackCheck_Response_Comment_18.pdf)
	Current Comment Status: **Comment Closed**

3241414	Hydrology	n/a'	Comment #19	n/a

(Document Reference: Medium)

The potential impact of global climate change on the proposed project and the conceptual mitigation plan should be acknowledged.

(Attachment: Comment_19.doc)

Submitted By: Julian Digialleonardo (561-656-6303). Submitted On: 04-May-10

1-0	Evaluation **Concurred** see attachment Submitted By: Daniel Ward ((901) 544-0709) Submitted On: 14-Jul-10 (Attachment: SJNM_FINAL_USACE_Responses_Phase_2_2010_7_1418.pdf)
1-1	Backcheck Recommendation **Close Comment** Concur

	Submitted By: Lynn McLeod (781/952-5381) Submitted On: 04-Nov-10 (Attachment: St_Johns_Bayou_Ph2__Final_BackCheck_Response_Comment_19.pdf)
	Current Comment Status: **Comment Closed**

3241419	Hydraulics	n/a'	Comment #20	n/a

(Document Reference: Low)

The gate closure and pump operation management alternatives proposed for St. Johns Bayou and New Madrid Floodway require further clarification.

(Attachment: Comment_20.doc)

Submitted By: Julian Digialleonardo (561-656-6303). Submitted On: 04-May-10

1-0	Evaluation **Concurred** see attachment Submitted By: Daniel Ward ((901) 544-0709) Submitted On: 14-Jul-10 (Attachment: SJNM_FINAL_USACE_Responses_Phase_2_2010_7_1419.pdf)
1-1	Backcheck Recommendation **Close Comment** Concur Submitted By: Lynn McLeod (781/952-5381) Submitted On: 04-Nov-10 (Attachment: St_Johns_Bayou_Ph2__Final_BackCheck_Response_Comment_20.pdf)
	Current Comment Status: **Comment Closed**

There are currently a total of 388 users online as of 01:01 PM 04-Nov-10.

Patent 11/892,984. | About ProjNet[SM] | About Us | Privacy Policy | Test Browser | Test Connection | Call Center | FOUO / SBU / UCNI Only | SM property of ERDC since 2004.

Questions and comments to Call Center staff@rcesupport.com, 1-217-367-3273 or 1-800-428-HELP (4357)

Classified information is NOT permitted on this site. Do NOT share your ProjNet password.

Volume 3
Part 4

Phase III IEPR Final Comment Response Record

U.S. Army Corps of Engineers
Memphis District

January 13, 2012

Final Panel BackCheck Responses to the Final Evaluator Responses on the Final Panel Comments

Independent External Peer Review of the St. Johns Bayou and New Madrid Floodway Project Draft Environmental Impact Statement (DEIS), Phase 3

Final Comment Response Record

Comment: 1
The estimate of current yields is not clearly explained or based on currently accepted agricultural production modeling.
Basis for Comment:
The Panel believes that the yields are calculated using a simple linear regression model and national-level crop output and input indices. The two regression equations conducted for the analysis are reported, but not explained, in the St. Johns Bayou and New Madrid Floodway, Environmental Impact Statement, Phase 3 Preliminary Working Draft IEPR Submittal (hereinafter: DEIS). In addition, the variables (Y and X) in each of two regressions are not defined, nor are the indices. Explaining the nature of the indices allows the reader to discern whether the crop output model includes key variables such as temperature and natural precipitation. Justification for use of national indices for this region of the United States is not provided, nor is the use of the linear functional form in the regression analysis. National-level indices may be formulated by including regions of the United States that heavily depend on irrigation, and thus may be poorly suited for modeling yields in regions where precipitation is natural. Standard production analysis begins with use of a non-linear production model of yields that allows for diminishing marginal returns. These can often be transformed into log-linear models. A linear model of yield implies that one may increase inputs as high as desired, and always get a constant yield. This runs counter to conventional production analysis. This is important since the project primarily focuses on the issue of excess water from flooding, and the use of a linear model would correspond to the assumption that there is no such thing as excess water. The current yields are estimated with a lack of precision, as are all statistical estimates, but confidence intervals are not provided in the report. Underlying assumptions about how current yields are estimated, as well as changes in these yields, are not provided. Agricultural production under conditions of risk necessarily should be modeled in the presence of such risk. These not only include the usual risk in agricultural prices in the future, but also risks associated with flooding. An expected production or expected utility framework can be used, but the Panel finds no such framework is being used to model yields. The project's benefits in the agricultural sector involve a large amount of risk. The report does model this using a conventional software program that introduces probability distributions for key random variables, enabling some risk analysis. However, the justification for the assumed form for the probability distribution function (which is normal) is not provided, and there is no justification for the assumed levels of variation (i.e., percentages used in introducing a standard deviation).

Final Comment Response Record

Significance: High

The majority of claimed net benefits for the project pertain to changes in agricultural yields that correspond to lower flood risks, but the DEIS does not include the justification to corroborate these findings.

Recommendations for Resolution:

1. Explain the variables used in the regression model, as well as the linear functional form for the model and upon what this is based in theory. Include whether national crop yield models should be used for this region of the United States.
2. Explain the assumptions underlying comparison between "low risk" and "higher risk" land production and why the former can be used to represent the latter after flood risks are reduced by the project.
3. Document actual losses in yields due to large flooding events in past years.
4. Model uncertainties, explain underlying assumptions, and describe how these affect estimates of the benefit-cost ratios. Provide justification for all assumptions using existing literature or data.
5. Present estimates of benefit-cost ratios with their confidence intervals, or present a range of estimated ratios corresponding to various levels of risk.

Final Evaluator Response to FPC1

Concur

Response to Recommendations

1. **Adopt.** More information will be presented in the economic appendix to better explain the process. Further, regional instead of national models were used for this analysis. This will be clarified in the Draft EIS.
2. **Adopt.** This is the process of dividing the flood hazard area into upper and lower zones. The lower zones are impacted more due to the risk of flooding. This process is presented in the economic appendix. The process can be expanded to better explain the assumptions.
3. **Adopt**. Current Corps guidance (ER 1105-2-100) in flood protection studies requires the use of "flood free" yields in evaluating potential projects. These yields can be influenced by the potential risk of flooding. This is taken into account by dividing the flood hazard area into upper and lower flood zones. Although documenting actual losses will not be included in the Benefit:Cost analysis calculations, losses based upon the economic model and specific flood years can be presented in the EIS.
4. **Adopt.** Based on the teleconference, more details would be provided regarding how the yield calculation is made, the time series model, and any other assumptions.
5. **Adopt.** Confidence intervals would be incorporated to account for various levels of risk.

Final Comment Response Record

Final Panel BackCheck Response – FPC1
Concur

Final Comment Response Record

Comment: 2
The project need, which is based on economic losses due to agricultural flood damage, is not quantified.
Basis for Comment:
The DEIS presents the project need by describing a variety of flood impacts; however, these are qualitative descriptions and are not tied to the calculation of the estimated net project benefits. The net benefits estimated for the project are monetized agricultural benefits based on quantified estimated differences between current and expected future yields. The report does not provide an estimate of past and current economic damage due to flooding, which might include economic damage from flooding roadways or homes, as well as the actual past losses in the agricultural sector. Including as many economic damage estimates as possible would demonstrate the need for the project.
Significance: High
The majority of the quantified estimated benefits from the proposed project derive from avoiding flood damage to agriculture. These benefits need to be demonstrated to justify the project need.
Recommendation for Resolution:
1. Provide estimates of past and present economic damage for as many years as is possible, documenting the source of the estimates of this damage and the years in which the damage occurred.
Final Evaluator Response to FPC2
Concur **Response to Recommendation** 1. **Adopt.** The purpose and need section will be strengthened by providing estimates economic damages (See FPC#1, Recommendation 3) based upon model output. For example, average annual damages will be presented in the purpose and need section and social hardships would be expanded.
Final Panel BackCheck Response – FPC2
Concur with Comment The Panel acknowledges that USACE is adopting our recommendations to provide estimates of economic damages based upon model output and expanding discussion of social hardships. To clarify, the Panel suggests that past damages be presented as supporting evidence that the project is needed.

Final Document Response Record

Comment: 3
The economic benefit of the project is unclear because uncertainty is not considered in the analysis.
Basis for Comment:
The assessment of the net benefits of the project is dependent on the estimate of yield variations in the agricultural sector due to lower flood risks. In turn, the assessment of future agricultural production usually incorporates uncertainties regarding future crop prices. The proposed project provides potential benefits 50 years into the future, but does not include uncertainties, such as climate change conditions, the level of mitigation needed, and the costs related to the mitigation. The project analysis does explore the effects of risk by using a standard software package (At Risk), which is applied to the benefits estimates. However, this same procedure is not applied to future mitigation and monitoring costs, which also involve current and future uncertainties. For instance, habitat needed for mitigation cannot be estimated as point estimates with certainty. As both the benefits and costs for this project involve risk, they each involve probability distributions. The benefit-cost ratio itself is not a point estimate, but refers to a ratio that has a distribution of outcomes. The risk outcomes presented in the report might be quite sensitive to assumptions about underlying probability distributions. However, the assumptions do not include justification for the specific underlying distributions, with the exception of the normal distribution for some of the variables. The normal distribution may not be suitable for modeling variables affected by variation in weather, such as temperature or precipitation. For example, the log normal distribution is often used to characterize precipitation. The estimated economic benefits are quantified for the agricultural sector only, which assumes certainty in the calculations; therefore, the justification for the project currently relies on the single point estimates for the benefit-cost ratios for each alternative considered
Significance: High
Uncertainty must be incorporated into the analysis for a full understanding of the project's economic benefits.
Recommendations for Resolution:
1. Document sources of uncertainty for agricultural and other benefits for this project at present and into the future (50 years forward). 2. Develop a model of agricultural production (yield) that demonstrates that such uncertainties are factors in production decisions. Report variation in estimates that depend on the uncertainties using confidence intervals or other documentation of statistical errors.

Final Comment Response Record

3. Document uncertainties related to mitigation costs. These arise from both the quantity of mitigation habitat that is needed, and the variation in future expected costs of that mitigation.
4. Report benefit-cost ranges that correspond to the uncertainties for the project using either models that directly incorporate uncertainty, or ex-post risk analysis of point estimates.
5. Allow for other distributions than the normal for some of the random variables. Show the effect that making different assumptions has on estimates of confidence intervals or standard deviations.
6. Explain the robustness of final decisions regarding project implementation to uncertainties. Discuss the range or extent to which the basic assumptions and information supporting the economic analyses can vary without affecting the ultimate conclusions and recommendations of the study.

Final Evaluator Response to FPC3

Concur

Response to Recommendations

1. **Adopt**. A discussion regarding the sources of uncertainty and other benefits of the project will be included in the economic analysis. As previously indicated in the Phase 2 IEPR, global climate change is difficult if not impossible to quantify. Therefore, the period of record is used to make predictions regarding future conditions (i.e., the project area would experience variable flooding and variable precipitation) and will be ultimately used to determine the project's benefit to cost ratio. Based on past discussions with the panel during Phase 1 and 2 IEPR, global climate change would result in significant increases in agricultural prices. Likewise as indicated by Easterling (1993), global climate change models indicate that agricultural areas within the Missouri, Illinois, Nebraska, Kansas (MINK) region would mimic climatic conditions that occurred during the 1930's due to a lack of surface water/rainfall available for irrigation. Although this study looked at the overall region, it did not consider alternative sources of irrigation. The project area also is located in an area where groundwater supplies are plentiful. The majority of irrigated areas within the project area utilize this groundwater source. The project area is also adjacent to the Mississippi River. Therefore, in the event of surface water shortages and groundwater shortages, the Mississippi River would likely be "tapped" for water supply. Thus, it is logical to conclude that the project area is expected to remain an extremely valuable agricultural area even if other areas of the region experience "drought like" conditions as a result of global climate change. Based on this conclusion that the project area would remain a valuable agricultural area and other agricultural areas within the MINK would be sub-optimal areas, agricultural prices would be expected to substantially rise in the future due to climate change. Since USACE policy only allows for the utilization of Current Normalized Prices and not on forecasted prices, the benefit to cost ratio can be considered a very conservative estimate. Global climate change would likely place a greater demand for this project. Although there are limitations, this discussion will be expanded in the EIS and the economic analysis. The results will be presented in the sensitivity analysis.

Final Comment Response Record

2. **Adopt.** The current model utilized for this project demonstrates that such uncertainties are factors in production decisions. The economics sections would be revised to expand this discussion.
3. **Adopted.** Risk associated with mitigation is captured with a contingency placed on the cost of mitigation. Cost estimates would be presented in the Draft EIS.
4. **Adopt in Future**. This data is currently presented in the economics appendix. However, more detailed explanations or descriptions will be presented.
5. **Adopt in Future**. The process employed and the distributions chosen for the risk analysis sections will be reviewed and revised.
6. **Adopt in Future**. This section of the appendix will be reviewed and expanded as necessary to better explain the recommendations.

Final Panel BackCheck Response – FPC3

Concur

Final Comment Response Record

Comment: 4
The assumptions associated with food availability for waterfowl are not appropriate and provide unreliable estimates of biomass for waterfowl.
Basis for Comment:
In the Phase 2 IEPR and the Duck-use-Days Manual (DUDM) certification review, the Panel stated that the estimates of food availability in moist soil habitat used in modeling the spring migratory period (February and March) and potentially the fall and winter period were inappropriate. The DUDM uses an average of estimates resulting from multiple studies of habitat being managed by professionals with abundant funding, manifesting from multiple regions throughout the fall and winter; the DUDM then models depletion and decomposition to estimate food availability during spring. These estimates are appropriate only if moist soil mitigation is managed by professional wetland ecologists with adequate funding to properly manage hydrology and succession of vegetation. With the current level of ambiguity in the mitigation plan, there is little evidence that management by professional wetland ecologists will occur. In addition, rates of decomposition were estimated from studies conducted primarily from fall until the first of January, making estimates of decomposition into February and March unreliable. More recent studies provide an actual estimate of food availability in moist soil habitat during spring (Pankau 2008, Straub 2008) from a region near the study area. The Panel believes this estimate would be more appropriate for modeling resource loss and mitigation. Similarly, in the DUDM, the estimate of invertebrate biomass in agricultural fields (primarily soybean or corn fields) during February and March is assumed to be the same as for rice fields during fall and winter (5 kg/ha). A recent study (Schultheis et al. in revision) indicates invertebrate biomass during February and March in flooded soybeans and corn is actually 20 kg/ha, 4 times greater than the parameter estimates used in the model based on this assumption. The author of the DUDM used an assumption of food availability based on the best available data at that time; however, use of this now-outdated assumption has led to an underestimate of waterfowl resources provided by flooded agriculture. In turn, the mitigation requirements for waterfowl resources are also underestimated.
Significance: High
The DUDM analysis does not properly account for the natural resources required by waterfowl that are dependent on the natural resources provided by this habitat, likely leading to an underestimate of required mitigation.
Recommendation for Resolution:
1. Reassess the estimates of food availability for February and March, moist soil vegetation, and flooded agriculture using the most recent research (Pankau 2008, Straub 2008, and Schultheis et al. in revision).

Final Comment Response Record

Final Evaluator Response to FPC4

Original Comment - Non Concur (Generated revised statement during comment response teleconference.)

While it is true that most of the studies referenced in the Waterfowl Manual were on public wildlife management areas, it is not true that all sites had high levels of intensive management. It is not appropriate to adjust the values from a single study or site (Pankau and Straub MS theses contain only one geographically relevant site in southern Illinois). The body of evidence from many studies of moist soil production in the MAV clearly demonstrates the large variability in production related to species composition, time and type of disturbance, climate, year and season, hydrology, location, etc. The strength of the DUD manual is that it uses all of the data from all studies, not just one site, to calculate an average and captures the range of conditions that occur in a variety of waterfowl habitats. The past and future production of food from seasonal herbaceous habitats in the SJNM was/is affected by these and other variables and will not be a single tight number every year. The statement that decomposition rates were only until the first of Jan is incorrect - e.g., Greer et al. 2007, Batema 1987, Heitmeyer and McGeorge 2009, Nelms and Twedt 1996, White 1985, Kross et al, and many others. Again, the insistence on using estimates from studies on one site in 1-2 years is not appropriate.

1. Adopt.
   The current analysis did use 20 kg/ha as the estimate for invertebrate availability in agricultural fields, stated on page 7, footnote "b". Therefore, it had previously been adopted for the project-specific analysis.

There were other issues discussed regarding FPC#4 during the teleconferences:

Draft Revised Statement (developed during Comment Response teleconference):
Without additional information, it is difficult to reconstitute estimates of DUD provided in Appendix F "Potential impacts of Proposed Flood Control Projects in the St. John's Bayou Basin/New Madrid Floodway" Tables 1 and 2.

Significance: Medium
The reader should be able to recreate the estimates of DUDs for existing conditions, without project, authorized project, and alternative scenarios; however, this is difficult to do without a table providing the acreage by habitat type that is expected to be present under each scenario.

Recommendation for Resolution:
Provide a table with estimates of acreage under each scenario for each habitat type used to estimate DUDs in Tables 1 and 2 of Appendix F.

1. Adopt. Further details regarding how the stage area curve (land use by elevation) was broken down into specific habitat types utilized for the waterfowl analysis will be provided in the Draft EIS to allow the reader to recreate estimates of DUD for each project alternative. Appropriate figures would also be developed.

Final Comment Response Record

The teleconference also had a discussion regarding bottomland hardwood restoration and herbaceous wetlands. Bottomland hardwood restoration will include the restoration of micro/macro-topography based upon geomorphologic standards. Therefore, it is likely that bottomland hardwood restoration would likely create herbaceous wetlands in the lowest elevations. However, it would represent a very small percentage of the overall mitigation site(s). With the exception of naturally flooding (precipitation, groundwater, or interior sump elevation) or impounding water during the waterfowl season, USACE does not intend to actively "disturb" these areas to maintain herbaceous vegetation. Since it is not know how many acres of herbaceous wetlands would be restored and there is no guarantee that woody vegetation would be prevented from becoming established on herbaceous areas, compensatory mitigation would not attempt to quantify the benefit to waterfowl from restoring herbaceous wetlands. Since herbaceous wetlands provide a greater amount of food availability than cypress-tupelo or riverfront forest (black willow/cottonwood), the result would be that compensatory mitigation calculations are under valuing the benefit to waterfowl. Therefore, mitigation may be over compensating for waterfowl impacts.

Final Panel BackCheck Response – FPC4

Concur with Comment

The Panel concurs that the areas should not be counted as part of the mitigation for lost waterfowl habitat; however, we do not believe that a) these areas will necessarily provide more food than either cypress-tupelo or river front forest and b) the assumption that waterfowl will be over mitigated. The production of these areas will be completely dependent on the hydrology, which controls what species of vegetation are produced, and which is unknown. These areas may very well produce more food than the aforementioned habitats, but may actually produce little to no food for waterfowl.

Final Comment Response Record

Comment: 5

The wetland cover (acreage) and quality are poorly documented.

Basis for Comment:

In the February 2011 Appendix E, Part 1 Report, USEPA identified 149,802 acres of wetlands in the St. Johns/New Madrid Bayou/Floodway. The statistical design of the study that estimated this amount of wetlands included 300 sites above the 5-year flood zone and included farmed (79%) and naturally vegetated (21%) wetlands. The Panel agrees that the Environmental Monitoring and Assessment Procedure (EMAP), which has been a tool used by the USEPA for decades, was used correctly, although there may be arithmetic errors in the tables. The Panel also agrees that it was appropriate for USEPA to include farmed wetlands in their wetland survey.

However, in an April 2011 memorandum, the USEPA acknowledged that the agency was not obligated to estimate wetlands subject to the Clean Water Act regulations. Therefore, there appears to be an unresolved disagreement between the USEPA and USACE on the estimated acreage of affected natural wetlands and wet farmland. This conflict involves up to 117,573 acres of farmed wetlands. The variance and confidence intervals (e.g., 90 or 95%) associated with each estimate needs to be clarified by USEPA in future generations of their report.

Significance: High

Without a firm resolution of the total area of wetlands affected by this project, few of the wetland impact or mitigation estimates are meaningful.

Recommendations for Resolution:

1. Resolve the dispute between the two Federal agencies regarding total wetland acreage. The Panel suggests that the two agencies should contract a third party to estimate wetland area, impacts, and mitigation for this project.
2. Provide additional detail on the wetland estimating methodology used by both agencies.
3. Include the basis of the quantitative assignments of indices to different types of wetlands in the body of the DEIS, along with ecological descriptions of these different types. The wetland "quality" is determined through the use of Functional Capacity Index (FCI) in the HGM technique.

Final Evaluator Response to FPC5

Concur – A firm resolution of the area of wetlands affected by this project is necessary.

Recommendations for Resolution:

1. **Moot Issue.** USACE and EPA have reached resolution on wetlands classified as forested wetlands and farmed wetlands have been clarified. As indicated by EPA, the original estimate did not imply jurisdictional status (*i.e.*, areas subject to regulation by the Clean Water Act). As indicated in the EIS and cited by Mitsch and Gosselink (1993)[1], there are numerous scientific and colloquial definitions of wetlands. To avoid further confusion on an already very confusing subject, the EIS is only utilizing the term

Final Comment Response Record

wetlands including farmed wetlands to refer to areas subject to regulation. USACE was originally very concerned with the estimate and the original use of the term "farmed wetlands" that was utilized in EPA's original report. This term caused confusion within USACE. It appears that that this term has caused additional confusion with the panel. Through interagency coordination and to clarify, these lands were designated as farmland*. The * signifies the area has some wetland indicators but should not be synonymous as farmed wetlands and should not indicate jurisdictional status. Based on the GTRS estimate, utilizing the definition of farmed wetlands and prior converted cropland, and the WETSORT analysis, EPA estimates that there are approximately 5,000 acres of farmed wetlands in the project area. Note that this is existing amount and does not mean that they would be impacted.

Usually the NRCS is the lead Federal agency in determining farmed wetland status. This is especially true in the project area. This is the main reason why the Project Work Plan stated that NRCS would be consulted with and lands that meet the definition of prior converted cropland would be removed from the potential wetland scene. NRCS estimates that there are 520 acres of farmed wetlands in the project area. The NRCS estimate involved transects across the project area with those familiar with the differences between farmed wetlands and prior converted cropland. USACE regulatory staff (not biologists assigned to this project) indicated that they did not observe any reason to question the NRCS estimate while they were in the field conducting the GTRS surveys. Although USACE would usually rely on the NRCS call, pursuant to the Clean Water Act, EPA is the final authority on determining what is or is not a farmed wetland. EPA has not made a jurisdictional call to date.

To maintain consistency in the manner in which the project area is regulated and to adhere to the methodology that was reviewed in the Project Work Plan, USACE is utilizing the EPA determination for forested wetlands and the NRCS determination for farmed wetlands. Although USACE would likely support a third party designee to resolve the disagreement between the NRCS and EPA, it is a moot issue due to mitigation required to compensate for other ecological resources (most notably fish). The HGM analysis was only conducted on areas that were determined to be jurisdictional wetlands. Other ecological models (EnviroFish, waterfowl, shorebirds) were run on functional floodplain habitat regardless of jurisdictional status. Therefore, any functions provided by non-jurisdictional areas were quantified by these models. Compensatory mitigation for fish requires a large amount of reforestation that includes the reestablishment of microtopography and hydrological restoration (plugging farm ditches, levee degradation, etc.). This type of mitigation would also compensate for impacts to wetlands, as long as the mitigation results in jurisdictional wetlands. Therefore, by providing the necessary compensation for fish, wetlands are over-compensated for either the NRCS estimate or the EPA estimate. This will be clarified in the EIS.

2. **Adopt.** Both the EPA and NRCS methodology will be included in an appendix with the appropriate level of detail so one could duplicate the effort.

Final Comment Response Record

3. **Adopt Clarification.** The Draft EIS will include a discussion with greater detail to demonstrate how wetlands were identified, divided into different HGM sub-classes, impacts quantified, and compensatory mitigation calculated. The discussion will be written in a fashion that would allow for duplication.

   In addition, the HGM appendix would be revised and text inserted into the main body of the EIS that better explains the different HGM wetland subclasses and how they provide different wetland functions.

[1]As previously indicated by the panel, this is an old citation. However, it is the version that we currently have.

Final Panel BackCheck Response – FPC5

Concur with Comment

The Panel agrees that with multiple agencies managing wetlands in the USA, cross-communication among agencies continues to be difficult. The Panel remains concerned about wetlands that fall under the category "jurisdictional" but we also recognize that non-jurisdictional wetlands such as some farmed wetlands and most bottomland hardwood forests provide many ecosystem functions and habitats that should be included in an EIS, regardless of their legal standing.

Final Comment Response Record

Comment: 6

The HGM methodology lacks the appropriate detail to validate the analysis results.

Basis for Comment:

The Panel appreciates that the HGM analysis in Appendix E, Part 2, is an important document for estimating the impacts of the project on wetlands and determining how much mitigation for those losses is needed. The HGM model concludes that the minimum wetland impact for the project occurs with Alternative 3.1. Functional losses and mitigation gains are estimated for detaining floodwater, detaining precipitation, cycling nutrients, exporting organic carbon, maintaining plant communities, and providing habitat. However, some of the functions not included in this study include nutrient retention and carbon sequestration.

The Panel believes that there are several assumptions of the HGM analysis that lead to uncertainty in the validity of the results.

- The Panel understands that the analysis is a working draft, not a complete report as it appears that it is waiting for USEPA to finalize estimates of wetland area. A completed estimate of study area wetlands by wetland hydrogeomorphic type is essential for HGM to provide valid results.
- The assignment of Functional Capacity Indices (FCIs) for the various wetland types within the study area seems to have a large amount of uncertainty. For instance, the Panel questions the FCI value of 0.97 for a riverine overbank wetland, but only 0.25 for agricultural wetlands. In addition, agricultural wetlands are given FCIs of 0.0 for providing plant communities and fish and wildlife support, a fact that concerns the Panel. Furthermore, ranges or probabilities are not assigned to these indices and the report contains little justification of the numbers, other than reference to other DEIS reports. For example, FCI assumptions allow conclusions that the project will have economic benefits to farmers by reducing agricultural flooding and that the same hydraulic modification will have little impact on the function of the wetlands.
- The report gives the Panel little information to determine the validity of the FCI values.
- The Panel strongly believes that the HGM report, while exhaustive in detail, is difficult to read and interpret. There are 50 or more tables of results (counting the often divided sub tables) that have poor table legends, far too many abbreviations that are poorly defined in the tables (e.g. LGRB, RGRO, UCD) and poor use of significant figures (e.g. 75.981% should be 76%) in all of these tables. The FCIs contain too many significant figures as well. This is not an indication that less information is needed in the report, but the report needs to better emphasize the pertinent information so it does not get lost in all the details. The report should have enough detail for someone to duplicate the analysis and results that provide the FCI values. Referral to yet other reports is not appropriate for such an important analysis. Overall, presentation of all the calculation details does not add rigor to the report conclusions.

Significance: High

The lack of detail in the HGM methodology leads to uncertainty in the validity and application of the results, and thus in the calculations for mitigation of the project

Final Comment Response Record

Recommendations for Resolution:

1. Revise the draft HGM report to further condense the material.
2. Provide additional documentation of the assignment of FCI indices and their variability.
3. Include detailed methods and results from field work that provided data used in the development of the FCIs and a list of all implicit and explicit assumptions regarding the FCIs.
4. Consider using an alternative method to complement the HGM analysis to better describe the effects of the alternatives on the ecosystem services of wetlands. The USACE could collaborate with the USEPA and other agencies on this effort.

Final Evaluator Response to FPC6

Concur

Response to Basis for Comments

It's true that carbon sequestration and nutrient retention are not functions that are addressed by the HGM models that were approved for this study. Nutrient cycling, which is a function that was addressed by the study, includes the cycling of carbon through the system, and the cycling of other nutrients. Sequestration (long-term retention) is part of that cycling, and a mature forest stores carbon and other nutrients in each of the ecological compartments specified in the model: trees, shrubs, ground cover, soil, snags, and woody debris. Rates of cycling are difficult to address in a rapid assessment, so the model uses indicators (the presence and structure of the various storage compartments) to evaluate the extent to which nutrient storage and cycling processes are intact.

The FCIs were calculated based on the models presented in the Delta Guidebook (Klimas et al. 2011) and the data collected at sites within the project area. They are no more uncertain than any sample data or model. The FCIs for each subclass are calibrated to data for that subclass only. The agricultural wetlands are in the subclass Riverine Backwater. They receive a 0.25 FCI, indicating that they are providing the Floodwater Detention function at only 25% of their potential. The model for that function (Klimas et al. 2011) combines flood frequency, which is the same for agricultural and other Riverine Backwater wetlands, and variables that make up a roughness term. Since roughness is vastly reduced at agricultural sites, the 0.25 FCI is reasonable (and again comes directly from entering site data into the model). On the other hand, the Riverine Overbank sites sampled often had fully intact roughness, meaning that they were performing the function of slowing floodwaters nearly at their maximum capacity. Comparing these indices *across* subclasses is inappropriate, since the models and reference data are only consistent within subclasses. The HGM analysis shows the changes in function within each subclass, or the conversion from one subclass to another. At no point does it try to indicate that the functions of one subclass are linearly relatable to functions in another subclass.

For all FCIs, including that for Fish and Wildlife Support, the top index (of 1.0) is derived from reference data collected in mature bottomland hardwood forested stands that have a relatively stable composition and structure. In other words, they are no longer going through succession, they are experiencing single-tree mortality and gap regeneration, and the young trees coming up in the gap are a similar composition to those that died. The Delta Guidebook (and other

Final Comment Response Record

guidebooks developed for the region) explicitly states that the wildlife models are designed to reflect the habitat needs of species associated with large tracts and mature forest conditions, because those are the species that have suffered the greatest habitat loss, such as the Louisiana black bear, the Ivory-billed woodpecker, and neotropical migrant bird species. Therefore that is the type of habitat that has the highest index value. Of course, other animals are supported during other successional stages, but other models are addressing those (i.e. shorebirds, waterfowl, fish).

The HGM analysis clearly shows impacts to wetlands associated with the hydraulic (and hydrologic) modifications of the project. The vast majority of these involve a change in flood frequency that it actually changes the subclass of the wetland from a river connected subclass (typically Riverine Backwater) to an unconnected subclass (Flat), and a loss of the riverine backwater functions associated with shift in subclass. This functional loss was addressed in the mitigation requirements, despite the fact that in most cases the wetlands are still present on the ground, and there was a gain in functions associated with the increase in acreage in the Flats subclass. These shifts, as well as other project impacts (direct clearing/filling) were used to calculate mitigation requirements. The remaining Riverine Backwater wetlands were also subject to a more modest decrease in FCIs. These are the Riverine Backwater wetlands closest to the channel, where the impacts of the project were least severe. This modest drop in FCI is the smaller impact of the project; the majority of the wetland functional loss in the New Madrid Floodway is due to the shift of large acreages of wetlands completely out of the Riverine Backwater subclass. River-dependant functions, such as the ability to Detain Floodwater, were completely lost for these wetlands. Since the Corps calculated mitigation for wetlands based on the greatest functional loss, all of these wetlands were treated as if they were completely converted to non-wetland, despite the fact that they are still in the landscape, and providing some functions. Therefore, most wetland functions are over compensated and the overall project (with mitigation) results in a greater acreage of wetlands than what currently exists. So the statement that the HGM analysis indicates that "the project will have economic benefits to farmers by reducing agricultural flooding and that the same hydraulic modification will have little impact on the function of the wetlands" is not correct. The panel appears to have overlooked the losses due to shift in subclass, and focused only on the drop in FCI for the remaining Riverine Backwater wetlands.

The FCI values are based on reference data collected in the field, and models presented in the "A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Functions of Forested Wetlands in the Delta Region of Arkansas, Lower Mississippi River Alluvial Valley, Version 2.0 (Klimas et al. 2011). This Guidebook was approved for use on the project, and has since been published and is available from the Corps. It is more than 200 pages, covering models for each function, for each subclass, methods for collected variable data, all assumptions used in the development of the models and justifications for use of both the models and the variables they use. The analysis for the St. Johns New Madrid project involved 5 subclasses (Riverine Overbank, Riverine Backwater, Connected Depression, Unconnected Depression, and Flat) and up to 6 functions for each; a total of 30 models. It was deemed excessive to present all of those models and their justifications in this analysis when it is all available in the Guidebook. However, based on the IEPR teleconferences, additional detail would be provided in the Draft EIS and the wetland appendix would be revised accordingly

Final Comment Response Record

The HGM report was completed at the level of detail needed for the District to make determinations on the alternative with the least impacts, and the flexibility to adjust the calculations as either the alternatives were altered, or the wetland acreages changed, both of which were in flux as the analysis was being completed. The tables included in the report were part of the Excel spreadsheet calculating impacts. Because the acreages being provided by EPA were reported to the nearest acre, and the District wanted the math in the tables to sum correctly, unreasonably detailed percentages (e.g., 75.981%) were used to divide the wetland acreages among the subclasses in order to get a final acreage that remained constant to the nearest acre. When the acreages are finalized, and more reasonable rounding of those percentages will be possible. The use of expanded significant figures in the FCIs was to ensure that any change in function associated with the project would be captured and reflected in the mitigation requirements. Even small changes in FCI can have large impacts on mitigation debt when multiplied across thousands of acres. The Corps was attempting to be very conservative, and account for any loss in function, no matter how slight it appeared on the FCIs. Once the wetland acreages are finalized, the data would be presented with the appropriate level of significant figures

The abbreviations in the tables (LGRB, RGRO, etc.) represent the subclass names that are found throughout the document and described in detail in the Guidebook. We acknowledge that a table listing the abbreviations with the full subclass names would be convenient for the readers. The panel states that referral to another report to address methods, assumptions and models are not appropriate. Although this information is presented in a single report (the Delta Guidebook) and since all models are used for all but one of the subclasses discussed in that guidebook, a discussion regarding the different subclasses would be made in the main body of the EIS to clarify key aspects of the HGM analysis. The report did list any assumptions that were project-specific, and not inherently part of the models or HGM process.

Response to Recommendations:

1. **Adopt.** The HGM report and main body of the Draft EIS will be revised to condense the material as well as clarify key aspects of the HGM model.
2. **Adopt.** Additional documentation regarding the assignment of FCI indices would be provided in the Draft EIS. Variability with the HGM process would also be discussed. We realize that variability in determining FCI is of a concern. For example, two different people could come up with different FCI scores for the same wetland tract. That is precisely the reason why the model developer(s) conducted the analysis because they are the most knowledgeable regarding the particular HGM models, reference sites, and other wetland functions in the project area that are used in the model. See FPC # 8 regarding how risk and uncertainty would be addressed in the HGM model as well as other models.
3. **Adopt.** "A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Functions of Forested Wetlands in the Delta Region of Arkansas, Lower Mississippi River Alluvial Valley, Version 2.0" (Klimas et al. 2011) can be added as an appendix. In addition further details can be included in the main body of the EIS and revised wetlands appendix. All assumptions regarding FCI would be clearly indicated.

Final Comment Response Record

4. **Not Adopt.** Other alternate methods were used to compliment the HGM analysis (fish, waterfowl, shorebirds, and water quality). These methods are intended to compliment the HGM to describe the effects of the alternatives on a suite of environmental services. Although these models were not dependent on the site to be a jurisdictional wetland, they provide other necessary information to describe impacts of the project and formulate appropriate mitigation.

Based on the IEPR teleconferences, necessary revisions would take place prior to the public release of the Draft EIS and would be available to the panel during the Phase 4 IEPR process.

Final Panel BackCheck Response – FPC6

Concur

The FCIs have a great amount of inherent uncertainty, compared to, say, measuring a rate of productivity or a number of plant species. They are an educated professional guess of significance of a wetland's function. Therefore the panel contends that there is a great amount of uncertainty in these assignments of numbers for function. Use of the word "reasonable" above is cited as a cause to go forward, but there is no way to determine analytically or otherwise if it is correct. This is why the Panel suggested a method to determine "ranges or probabilities" to these values. Otherwise, the HGM technique, with all its exquisite details, gives the impression that it is analytically rigorous while it does, in effect, have a great deal of uncertainty associated with it.

We stand by our statement that as written the HGM report is "difficult to read and interpret." It needs to be rewritten and edited, perhaps in a collaboration of the authors with a professional science writer. Every table needs to have proper use of significant figures and all abbreviations described in the table so that reading the text is not required. The panel members also agree that an executive summary would be useful as well.

Final Comment Response Record

Comment: 7
The feasibility of the mitigation plan to compensate for impacts on environmental resources is not demonstrated.
Basis for Comment:
The Panel believes that there is a high level of uncertainty regarding the implementation of the wetland mitigation plan. The DEIS contains mitigation plans for all impacted resources that are in the early stages of development. Substantial acreage (>5,000 acres) will be affected by the project, so substantial acreage will be required to mitigate for loss of environmental resources (wetland, waterfowl, shorebird, fish), along with long-term needs for management. The DEIS indicates this property will be purchased from willing sellers, but there is no indication there is an adequate number of willing sellers available for needed purchases or permanent easements. For example, the wetland mitigation proposed at Big Oak Tree State Park cannot be achieved without property acquisition; however, a back-up plan was not presented if the property acquisition does not occur. In addition, the DEIS does not contain a consensus between USEPA and USACE as to the extent of wetland area within the study area. In addition, the Panel has concerns with the documentation of the HGM indices used to estimate the impact of the alternatives on wetland function. Based on all of these uncertainties, the Panel does not have confidence in the estimates provided in the DEIS on the amount of wetland mitigation needed for the project, nor is the Panel confident that the mitigation will take place as described.
Significance: High
Project success is dependent on the development and implementation of a thorough mitigation plan that accounts for the loss of natural resources in the project area. Without more detail, the Panel is unable to make an accurate assessment of the likely success of the mitigation.
Recommendations for Resolution:
1. Develop the details of the wetland mitigation to include the provision of alternative plans if land cannot be purchased or otherwise acquired. 2. Consider developing a wetland mitigation bank within the project area, perhaps in the vicinity of Big Oak State Park. This should increase the probability of wetland success and provide a secure mitigation future. 3. Develop preliminary agreements between land owners and USACE for land purchase or easements prior to the initiation of the project.

Final Comment Response Record

Final Evaluator Response to FPC7
Note – The recommendations for resolution seem to coincide with the first paragraph of the basis for comment only. It appears that paragraph 2 should be moved to another comment that specifically deals with the EPA wetlands assessment and HGM. Perhaps Comment 5 and 6, respectively. **Concur.** Site specific mitigation plans are necessary with further detail (specific elevation, flood frequencies, and duration) to ensure project success. USACE understands the panel's concerns regarding alternative plans if land cannot be purchased or otherwise acquired. However, mitigation land must be acquired from willing sellers. In addition we do not identify potential landowners until a decision regarding the project is formally made and documented in a Record of Decision. Lastly, we are constrained by the Federal budget. Although it is conceivable that the project could be 100% funded up front, it likely will not. Funding would likely be provided over numerous fiscal years. Compensatory mitigation would occur concurrently with other project construction. Therefore, the following is proposed to ensure that lands are made available and provide a reasonable safeguard: 1. If a Record of Decision is signed to construct the project and following any modifications necessary to the Project Cooperation Agreement (legal contract between the Federal government and non-federal sponsor), landowners would be queried over their willingness to sell and or enroll lands in a conservation-type easement. 2. Each potential tract of land would undergo a preliminary investigation consisting of landscape positions, soil types, source(s) of hydrologic restoration, elevation, etc. Based on this criteria a preliminary determination would be made regarding the type of compensatory mitigation (*i.e*, bottomland hardwood restoration, seasonally inundated farmland, borrow pit) and whether or not the tract should be acquired. The interagency team would be consulted with and available lands would be "ranked" in order of anticipated ecological value. Note that the completion of construction plans and specifications for specific construction items would also be occurring simultaneously but construction would not commence. 3. As funding is made available, specific tracts of lands would be acquired. 4. A site-specific mitigation plan would be developed for each particular tract after it is acquired. The site-specific plan would include the specific gains to ecological/wetland functions from the establishment of mitigation. Although the interagency team will likely participate in the development of site-specific plans (especially MNDR for lands associated with Big Oak Tree State Park), a draft plan would be developed and circulated to the interagency team for official comment. Following the opportunity for the interagency team to comment on the draft and any applicable revisions to the site specific plans, each specific plan would be submitted to MDNR for official approval as part of any state water quality certification requirements.

Final Comment Response Record

5. Construction would not commence on any particular construction increment until there is an adequate amount of mitigation credits that are approved in site specific mitigation plans. Therefore, lands would be acquired and an approved plan in place prior to impact. Although this not the same as a formal mitigation bank, USACE is of the opinion that this would satisfy the intent of a bank. Lands surrounding Big Oak Tree State Park will be a priority. **[Recommendation for Resolution 2 – Adopted in part]** Therefore, the impact would not occur until the lands have been acquired. **[Recommendation for Resolution Number 3 – Adopted in part]** In the event that lands are not made available, construction would not commence. Therefore, an alternative plan is not necessary. **[Recommendation for Resolution Number 1 – Adopted in part].**
6. Mitigation implementation and construction of flood risk management features would occur simultaneously.
7. This process would continue for each respective construction increment. Landowners would be periodically queried to determine willingness and mitigation tracts would be re-ranked accordingly.

Although the above methodology would ensure that mitigation lands are acquired prior to direct impacts and that mitigation would occur concurrent with other project features, the following methodology is proposed for the indirect impacts of the project associated with pumping stations and the closure levee:

1. Based on specific fiscal year funding and to comply with budgetary fiscal law, funding would be split proportionally to project engineering and design, construction, mitigation land acquisition, and mitigation implementation. Construction of pumping stations and the levee closure would also likely take place over several construction increments. For example, construction increment 1 could be necessary cofferdams, increment 2 could be foundations, increment 3 could be installation of pumps, and so on. However, construction of any specific increment could not be started (i.e., contract awarded) until a proportional amount of compensatory mitigation lands acquired and a site-specific detailed mitigation plan developed. For example, assume the St. Johns Bayou portion of the project's total cost is $72 million, including $15million necessary for mitigation (approximately 21% of total cost). Next assume that the project is appropriated $6 million for a given fiscal year. With this formula, $1.26 million in mitigation would be necessary (land acquired and site specific detailed mitigation plan approved) prior to awarding a construction contract for the remainder ($4.74 million) of the fiscal year funds.
2. Although adhering to the procedures outlined above should result in concurrent mitigation, to further ensure mitigation is in place, the St. Johns Bayou portion of the project would not be operated (pumps turned on) until all site specific mitigation plans that demonstrate the St. Johns portion of the project has been mitigated are approved by MDNR.
3. The procedures outlined above would also be implemented for the New Madrid Floodway portion of the project. Construction of the New Madrid Floodway would involve re-routing Mud Ditch around the construction site, constructing a cofferdam at

Final Comment Response Record

the present location of Mud Ditch for construction features, 1,500-foot closure levee with the exception of the area needed for Mud Ditch, and reestablishment of the Mud Ditch alignment following construction. The last construction item would be to reestablish Mud Ditch alignment and close the last remaining portion of the levee. Although the above methodology should result in concurrent mitigation, this last portion of construction would not take place until all site specific plans that demonstrate the New Madrid portion of the project has been mitigated and approved by MDNR.
Final Panel BackCheck Response – FPC7
Concur The Panel acknowledges the added detail that has been provided to ensure that mitigation properties will be purchased or obtained and that landowners will be queried to determine their willingness to sell.

Final Comment Response Record

Comment: 8

It is unclear if the proposed mitigation plan will compensate for impacts on environmental resources because the models do not incorporate uncertainty.

Basis for Comment:

The environmental models used to estimate resource impacts and required mitigation are deterministic and do not include estimates of variance or confidence intervals. This limitation was also recognized during the certification review of the DUDM. While the models may provide the most likely estimates of impacts on resources, there is an equal likelihood the results may either under or overestimate needed mitigation. The Panel believes that there is an unacceptable amount of uncertainty associated with the estimates of required mitigation predicted by the models due to variance associated with a number of the data-based parameter estimates. In addition to this overall uncertainty, many parameter estimates are based on educated guesses with little or no data available for support. For example, the DUDM estimate of invertebrate biomass in agricultural fields (primarily soybean or corn fields) during February and March is assumed to be the same as for rice fields during fall and winter (5 kg/ha). A recent study (Schultheis et al. in revision) indicates invertebrate biomass during February and March in flooded soybeans and corn is actually 20 kg/ha, 4 times greater than the parameter estimates used in the model based on this assumption. Although the author of the model made an assumption based on the best available data at that time, that assumption led to an underestimate of waterfowl resources being provided by flooded agriculture, thus, an underestimate of needed mitigation. Similarly, mitigation for terrestrial wildlife is based on the habitat needs of a few key species, with no supporting evidence that the habitat needs of those species adequately represent all the species typically found in the terrestrial environments. For example, none of the species used in the model requires adjacent wetlands and terrestrial habitat, while many amphibians and reptiles (none of which are in the model) do.

Significance: High

An accurate estimate of the impact of the project on environmental resources within the project area is required to determine the amount of mitigation needed.

Recommendations for Resolution:

1. There are two potential alternatives to resolving this issue:
   a. <u>Preferred resolution</u>: Incorporate variance estimates with parameters for each of the models, allowing for 95% confidence intervals with the model point estimates. The upper 95% confidence limit could then be used as an estimate of required mitigation. Although this approach would not account for error due to invalid assumptions, it would likely ensure most impacted resources are appropriately mitigated. Important assumptions could be assessed later during the adaptive management phase and an appropriate modification to the mitigation could be made as needed. The Panel acknowledges that there are data limitations that may prevent the use of this approach.
   b. <u>Alternate resolution</u> (suggested in the Phase 1 and Phase 2 IEPR): Identify an increase in the level of mitigation required to ensure the level of mitigation is

Final Comment Response Record

adequate for all impacted resources. In the past, Federal agencies have increased mitigation by a ratio of 2:1 to 4:1, estimated level of resource mitigation to estimate level of resource loss, to account for uncertainty in the estimates.

Final Evaluator Response to FPC8

Concur – Pending further USACE review and policy review

We prefer to utilize the language that some model estimates are based upon best professional judgment based upon years of experience for support. Models have been developed by experts within specific fields that underwent further review by independent experts as part of the USACE model certification/approval process. Furthermore, specific estimates were coordinated with the interagency team as well as this independent panel in previous phases of IEPR. Utilizing the term "guess" suggests that we simply made up a number when it is clear we have not.

No herpetological or reptilian species models were used in the HEP analysis. Coordination with USFWS concluded that no readily available HSI models for herpetological resources could capture the hydrologic changes associated with the project. USFWS stated that the models used, coupled with other ecological models (Envirofish, HGM, waterfowl and shorebirds) would adequately quantify impacts to wildlife resources. Based on the IEPR teleconferences, the project could result in a net benefit to amphibians due to fewer acres being available to fish.

1a. Adopt in Part. As stated, the models provide the most likely impacts on resources. Although uncertainty may be an issue if impacts and mitigation were calculated on one particular model, the use of multiple models that account for multiple ecological resources, across multiple habitats, and throughout the entire year, for every day over a 67 year hydrologic period of record addresses this risk. For example, if the mitigation was based solely on the greatest impacted resource (i.e., fish), it would be uncertain if the mitigation plan would compensate for the other resource categories (e.g., wetlands, shorebirds, etc.). This is not the case with the methodology used for this project. The mitigation plan compensates unavoidable significant impacts to multiple resources, not just one resource category.

Although uncertainty with the model conclusions is significantly reduced to levels that would allow for informed decisions regarding the project, one could argue that there will always be additional risks and unknowns. However, this uncertainty is present in both underestimating and overestimating the mitigation requirements. The project team understands the need to incorporate variance estimates with parameters for each of the models. Therefore, 95% confidence intervals will be placed around model results. Based on discussions with the panel, there are numerous methods that could be utilized to establish the confidence intervals. USACE is finalizing methodologies with model developers and statisticians to ensure that confidence intervals are incorporated properly. Many of the models utilize defined HSI scores that would be problematic for the placement of confidence intervals. For example, given that the DUD manual produced estimates of food availability, TME, RMR, etc. from the combination of many studies that used sometimes very different methodologies, locations, techniques, etc., it is not possible to calculate a single CI or Standard Error on the final DUD estimates.

Final Comment Response Record

The presence of stochasticity is acknowledged and discussed on p4 of the DUD manual and we note that the SE's of estimates generally are <20%. For the DUD estimates, it might confuse, rather than clarify, the final estimates to suggest something that we really cannot precisely calculate because of heterogeneity of the many studies that have been averaged. In addition, panels comments seem largely based on the false assumption that estimates of invertebrate biomass in agricultural fields (primarily soybean or corn fields) during February and March is assumed to be the same as for rice fields during fall and winter (5 kg/ha), when in fact the panel recommendation of 20 kg/ha was used in the analysis.

As opposed to placing confidence intervals around defined values, confidence intervals could be placed on model input parameters. For example, Habit Units for fish are defined as Average Daily Flooded Acres (ADFA) multiplied by HSI values. There is no variance in the HSI values, they are defined (*e.g.*, bottomland hardwoods = 1.0, agriculture = 0.2). Confidence limits could be set around the ADFA calculations to account for any unknowns. Likewise, a similar "acreage confidence limit" could be established for the other models. Methodologies will be established and results presented in the Draft EIS.

Based on the teleconference, some confidence limits could be higher than total available amount. If this is the case, logic would be used and the value should default to the maximum available instead of the upper confidence interval. For example, vegetated wetlands confidence intervals below the five-year flood frequency are greater than the total amount of vegetated acreage available. In this case, logic would suggest utilizing the total amount of vegetated area available.

In addition to the establishment of confidence intervals, the Draft EIS will be revised to include a discussion on uncertainty.

Your recommendation stating to base mitigation on the upper 95% confidence limit is noted. For the purposes of the mitigation plan, USACE intends to utilize the results of the model because "they provide the most likely estimates of impacts on resources". The costs associated with basing mitigation on the upper 95% confidence limit will be presented and costs calculated, but it will be utilized as a mitigation contingency cost. This contingency cost, in addition to the original mitigation cost, is factored into the project's Benefit:Cost ratio equation. Therefore, the uncertainty associated with the estimates of mitigation would be addressed in the overall project decision..

As stated in the EIS, mitigation would be monitored and the project will be adaptively managed. In the event that a need for further mitigation is identified, the cost of the associated mitigation would already be accounted for and could be readily available for additional mitigation implementation.

1b. **Not Adopt/Not APPLICABLE.** The utilization of arbitrary mitigation ratios would not correct any "uncertainties" from more rigorous methods utilized to determine project impacts and on which mitigation decisions are based. Likewise, the ratios provided by the panel are mostly used in small regulatory requirements that result in a complete destruction of wetlands and not on large Civil Works projects such as the one proposed. The majority of project impacts for the St. Johns Bayou and New Madrid Floodway Project are indirect impacts. For example, the wetlands would physically still occur,

Final Comment Response Record

although hydrologically altered. Establishment of mitigation ratios would be highly speculative and are not utilized for water resources development projects due to policy.

Final Panel BackCheck Response – FPC8

Non Concur

Estimates of impacts and needed mitigation are presented in the DEIS as if they were measures or known values, but they are not. Estimates of impacts and needed mitigation are derived from models that use either samples of data that provide parameter estimates (model inputs) or parameter estimates based on educated opinions. Because model outputs are estimates, not measured quantities, they include a certain level of uncertainty due to potential biases and variances associated with the model inputs. The most likely biases are associated with untested assumed functions in the HGM, fish, and shorebird models and the HSIs associated with the fish and shorebird models. Although these potential biases lead to uncertainty, the Panel recognizes alternative information is currently not available, thus, potential biases will have to be addressed in the adaptive management process.

In contrast, variance associated with model inputs can be addressed in the EIS by incorporating variances of inputs and estimating 95% confidence intervals. In the cases where actual data were used to derive inputs for the models (the HGM, and DUD Manual), the variance are means taken from the literature with associated measurement and sampling error (the Panel is not suggesting this isn't the appropriate approach; just that approach is available and used in the DEIS). Because the model inputs are means from actual measurements, the technical aspects of incorporating associated variances with the model input to estimate confidence interval with the model outputs is, although time consuming, relatively simple. In the case of the fish and shorebird models the HSI are educated opinions, thus, they include uncertainties both in the form of unknown variance as well as assumed but relatively untested relationships. Because most parameters in the shorebird and fish models are based on opinion rather than data, variances for the parameter estimates do not currently exist.

Variances can be estimated, however, using Monte Carlo type simulations with some assumed distribution to provide an estimate of the certainty of the model outputs. Although this approach would not account for inappropriate assumptions, it would at a minimum provide an indication of how variation in the HSIs influences the model outputs. In the most recent e-mail exchange prior to the Vertical Meeting on 1/11/2012, it appears the UASCE is proposing to include the variance associated with the hydrologic inputs but not the variance associated with all the other model inputs. The Panel believes this approach could be even more misleading than the current approach of ignoring the variance associated with the model outputs. This approach would include a confidence interval based on only one small component of the variance (uncertainty); thus, produce an over estimate in the level of certainty in the model outputs. The Panel believes that to fulfill the requirements of NEPA, USACE must consider uncertainty associated with the model outputs. The most scientifically appropriate way of doing so is providing 95% confidence intervals for the model outputs. The Panel would like to cite a similar recommendation (Recommendation # 4) was made during the certification review of the WAM DUD manual.

Final Comment Response Record

Comment: 9
The feasibility of the mitigation needed to compensate for impacts on the fisheries resources is not demonstrated.
Basis for Comment:
The previously authorized project (Alternative 2) would result in a fish spawning/rearing habitat loss of Average Annual Habitat Units (AAHU) in the New Madrid Floodway of 92.4%, 91.7%, and 88.3% for early, mid, and late seasons, respectively. This improves to 61.6%, 71.2%, and 79.4% of pre-project AAHUs with Alternative 3.1 (tentatively recommended plan). The St. Johns Bayou AAHU habitat loss is the same for both Alternatives 2 and 3.1. Early, mid, and late season loss to fishery resources are 28.5%, 31.1%, and 31.7%, respectively, of pre-project AAHUs. This needs to be clearly stated in terms of both the percentages and changes in AAHUs for each alternative for each season. With this amount of habitat loss and the uncertainty of mitigation due to unknown land acquisition prospects, the project becomes environmentally questionable until a mitigation plan is in place with specific AAHU compensation. The DEIS uses the Ten Mile Pond Conservation Area modifications as part of the mitigation plan for fish spawning/rearing habitat, but mitigation details are lacking and AAHUs have not been quantified. Fish access to Big Oak Tree State Park Restoration through the proposed hydrologic connection to the Mississippi River near Big Oak Tree State Park is not addressed. If fish do not have access or use of this area for spawning/rearing, then this area should not be considered a mitigation feature for fish. As stated in the Phase 1 and Phase 2 IEPRs, gate and pump management was a main feature of the previous NEPA documents. However, examples of potential increases in AAHUs due to holding water during rearing/spawning season have not been provided in the DEIS. Tables 2.5 and 2.6 show the hypothetical gains the AAHUs for fisheries; however, seasonal comparisons are needed to properly evaluate differences between impacts and mitigation gains. Additionally, the AAHU gains for batture land reforestation and floodplain lakes (located on the batture) are the major (56.3%) mitigation feature outlined for the New Madrid Floodway. This AAHU mitigation is high, considering that fish passage reduction into the floodway is anticipated to be 27%. The DEIS states that riparian buffer strips are proposed to compensate for the impacts associated with channel modifications, as well as spawning and rearing habitat. However, quantification of channel modification, AAHU loss, and compensation from mitigation needs to be presented in more detail. Plant communities that will naturally revegetate will vary based on slope and elevation. For example, riverfront forest species are not likely to be found at an elevation greater than 20 ft of the surrounding area since this area would never flood. This elevation would more likely revegetate to terrace hardwood forest species. It is unclear if Table 5.1 takes into account the timing of the flood. For example, if habitat does not meet water duration and depth requirements during the fish spawning/rearing periods, it will not provide mitigation habitat for fish.

Final Comment Response Record

Significance: High

With the potential amount of habitat loss and the uncertainty of mitigation due to unknown land acquisition prospects, the project will be considered environmentally questionable unless a feasible mitigation plan is developed with specific AAHU compensation.

Recommendations for Resolution:

1. Finalize development of land acquisition and mitigation plans prior to construction. This is due to the large amount of fish spawning/rearing habitat loss expected.
2. Explain the AAHU mitigation gains for fish spawning/rearing habitat at Ten Mile Pond.
3. Clarify the required fish access to Big Oak State Park and recommend monitoring of this mitigation feature.
4. Develop mitigation scenarios that show potential gains in AAHUs by holding water on fish spawning/rearing habitat for the entire spawning periods. Revise Tables 2.5 and 2.6 so that they are based on fish spawning/rearing seasons.
5. Limit the percentage of mitigation in the batture to no more than fish passage reduction (27%) of all mitigation in the New Madrid Floodway.
6. Quantify and clearly present the channel modification impacts and riparian buffer mitigation to compensate for loss.
7. Provide details of water depth and duration criteria for Table 5.1.

Final Evaluator Response to FPC9

Concur

Response to Recommendations

1. **Adopt in Future.** Land acquisition and mitigation plans would be finalized prior to construction and necessary safeguards have been incorporated into compensatory mitigation to ensure lands are acquired prior to construction. Additional information is found in FPC # 7.

2. **Adopt in Future.** Anticipated gains in AAHU from restoring hydrology to the Ten Mile Pond Conservation Area will be finalized prior to the release of the Draft EIS. Restoring hydrology to Ten Mile Pond remains an option, but it is not known if the Missouri Department of Conservation would be willing to restore the flood pulse on their managed property. Therefore, this would remain an option that could be used in the future during the development of site-specific mitigation plans but is not necessary to demonstrate that mitigation would be successful.

3. **Adopt in Future.** Fish access is required to Big Oak Tree State Park for it to provide the stated compensatory mitigation amount. Although fish access is expected to occur, methods that maximize fish access to the park will be explored during the completion of site specific mitigation plans and other necessary plans and specifications required for the gated structure. Considerations will be made on the timing of water introduction to maximize benefits to fish reproduction. The depth and velocity of flow and minimization of any head differential that may impede fish access will also be considered.

Final Comment Response Record

4. **Adopt in Future.** Mitigation scenarios that show potential gains in AAHUs by holding water for the entire spawning and rearing periods to create a spawning and rearing pool will be included in the EIS. Mitigation estimates will be documented seasonally (i.e., early, mid, and late seasons) consistent with the way impacts were calculated. Based on previous IEPR phases, HSI would be based on underlying land use and not the formation of a permanent waterbody.

5. **Not Adopt.** Based on the IEPR teleconferences, fish habitat provided in the batture should not be limited to 27%. However, the Draft EIS must demonstrate that other ecological resources are compensated. Based on the teleconference, providing mitigation in the batture is a prime area for some resources (wetlands and fish). USACE acknowledges that batture mitigation is not prime for all resources and specific wetland sub-classes. Therefore, in a similar method that was utilized in previous NEPA documents, USACE will develop a basic mitigation plan that demonstrates that impacts associated with the Clean Water Act (*i.e.*, jurisdictional wetlands and Waters of the United States) are compensated. This will be accomplished by utilizing the HGM model and the Missouri Stream Mitigation Method. Benefits to remaining ecological resources (fish, shorebirds, and waterfowl) would be quantified for this basic mitigation plan utilizing the applicable model. Additional mitigation would be "added" to the basic mitigation plan to demonstrate that all significant impacts as a result of the project are compensated to the extent justified and mandated by law.

6. **Adopt.** The Missouri Stream Mitigation Method is being utilized to compensate for channel modifications. This section would be clarified.

7. **Not Adopt.** The mitigation zones presented in Table 5.1 are used to base mitigation priority. Specific details of water depth and duration as it relates to fish can be found in Section 4.8.5.9. Therefore, it was omitted from Table 5.1 because it was previously discussed.

Final Panel BackCheck Response – FPC9

Concur with Comment

The final Evaluator Responses to FPC9 and FPC7 seem inconsistent. The project construction impacts a relatively small land area compared to the project impacts from the operation of gates and pumps. The Panel concurs that incremental land acquisition and mitigation plans will take place during construction and would be finalized prior to operation. This approach would provide insight regarding land purchases before construction is completed assuming that the construction time period is long enough to make changes to mitigation opportunities if land is unavailable for purchase.

Final Comment Response Record

Comment: 10
The shorebird mitigation plan contains inconsistencies that make its goal unclear.
Basis for Comment:
The DEIS provides a detailed plan to compensate for impacts on shorebird habitat area (pp. 147-152), but then later states (p. 152) that "Additional mitigation for shorebird habitat will not be required, as any needed mitigation will be provided through compensatory actions for impacts to waterfowl, fish, wetlands, and terrestrial wildlife." The references to "additional mitigation" or "any needed mitigation" in this statement are unclear. If this is intended to convey that no mitigation will be performed to replace shorebird habitat lost to other mitigation projects, this issue is no longer relevant with respect to shorebird mitigation. The Panel raised the issue in the earlier versions of the mitigation plan in the Phase 2 IEPR relative to several different resources because that plan did not compensate for all of the impacts on each resource, including shorebird habitats. Since the goal of the current mitigation plan is to compensate for all impacts on shorebird habitats, the discussion about additional mitigation is no longer relevant with respect to shorebird habitat mitigation. As discussed in the Mid-Review Teleconference on 10/31/2011 with USACE, Battelle, and the Panel, this section could be simplified by removing the text starting on p. 151 with "USACE's position…" up to Section 4.8.5. This would help reduce the uncertainty and inconsistency of the presentation of the plan.
Significance: High
The mitigation plan should be described clearly and consistently so that its adequacy can be determined.
Recommendation for Resolution:
1. Remove the text on p. 151 starting with "USACE's position…" through Section 4.8.5.
Final Evaluator Response to FPC10
Non-Concur **Response to Recommendation** Although restoration activities such as bottomland hardwood restoration provide historic habitat, according to the shorebird model, restoration of bottomland hardwoods would result in an impact to shorebirds. USACE is of the opinion that restoration of bottomland hardwoods and other historic habitat does not result in a need for compensatory mitigation. USACE is proposing shorebird mitigation only to impacts of the flood risk management project and not on compensatory mitigation measures needed to compensate for other ecological/wetland resources. As stated in the EIS, there are conflicting resources with different habitat requirements.

Final Comment Response Record

Final Panel BackCheck Response – FPC10

Non Concur

WRDA states that the goal of mitigation is that "any remaining unavoidable damages have been compensated to the extent possible" (WRDA 2007). The DEIS, on page 227, describes the goal of mitigation as to "ensure that other habitat types are mitigated to not less than in-kind condition, to the extent possible." The Panel's opinion is that full mitigation for project impacts to habitat functions is both possible and desirable, and that it is also supported by WRDA. USACE provided a memo dated 22 December 2010 and a reply dated 11 January 2011 on this issue. The Panel's opinion is that the policy expressed in the 6 January 2011 memo does not agree with either the policy quoted in the DEIS or with WRDA, and includes several incorrect statements that understate the impact of the proposed project in terms of shorebird habitat, and possibly other functions as well. As discussed in Final Panel Comment 26, which was adopted by USACE, there was likely historical habitat in the project area for shorebirds before agricultural conversion. Second, simply saying that shorebirds can relocate to other areas does not address the net loss of habitat function that would result from the project if the impact is not fully mitigated. It is impossible for the Panel to determine the extent of potential mitigation plan impacts to other resources, because the mitigation plan has not yet been specified in detail. However, the Panel maintains that the goal of the mitigation plan should be to follow WRDA guidance, and to fully mitigate for all project impacts, with a final goal of not less than in kind replacement of significant ecosystem functions.

<u>Citation</u>

WRDA 2007. Implementation Guidance, Section 2036(a) of the Water Resources Development Act of 2007—Mitigation for Fish and Wildlife and Wetlands Losses requires that the project "… demonstrate that damages to all significant ecological resources, both terrestrial and aquatic, have been avoided and minimized to the extent practicable, and that any remaining unavoidable damages have been compensated to the extent possible… ."

Final Comment Response Record

Comment: 11
The adaptive management plan lacks the details necessary to ensure that environmental resources affected by the project are appropriately mitigated.
Basis for Comment:
Additional detail is needed on the type of parameters to be monitored and what objective criteria will be used to determine if mitigation wetlands for waterfowl have reached their desired objectives. Further, the adaptive management approach requires both a monitoring and response phase. There is no indication as to what type of modification would occur in the mitigation plan (e.g., increase in mitigation acreage) if the mitigation actions do not meet objectives.
Significance: High
Without more detail, it is impossible to determine whether the DEIS meets resource mitigation requirements.
Recommendation for Resolution:
1. Provide a detailed monitoring plan that accounts for more frequent monitoring of herbaceous wetlands (moist soil habitat, e.g.,, every 3 years throughout the life of the project), identification of specific parameters that will be monitored (preferably food availability in each of the habitat types), objective criteria or thresholds for assessment of success (e.g., kilogram of food per hectare), and potential responses if mitigation does not reach objectives (e.g., additional mitigation).
Final Evaluator Response to FPC11
Concur **Response to Recommendations:** The DEIS would be revised to provide greater details regarding short term and long term compensatory mitigation monitoring. Every mitigation tract of land would undergo short term monitoring (expected to occur for 5 years following mitigation implementation). The goal of short term monitoring is to ensure that implementation of mitigation features are functioning as designed. Specific monitoring would be based on the objective of the tract and what type of resource(s) is being compensated. The Draft EIS will be expanded to include more details regarding short term monitoring. In summary, short term monitoring would include parameters such as hydraulics and hydrology and % survivorship of newly planted vegetation. Once specific mitigation tracts are determined to be successful, a portion of mitigation tracts will be utilized for long term monitoring and adaptive management. Section 6 of the Draft EIS will be expanded to include more details. In addition, based upon the teleconferences the following will also be incorporated: 1. Fish access at Big Oak Tree State Park.

Final Comment Response Record

2. Waterfowl – Section 6.4.3 will be expanded to include methods that would be utilized to assess available waterfowl food. 3. Details regarding costs would also be provided.
Final Panel BackCheck Response – FPC11
Concur

Final Comment Response Record

Comment: 12
The adaptive management plan does not provide specific details on the source(s) of funding needed to implement the plan.
Basis for Comment:
Adaptive management is a widely accepted practice, allowing for mid-course corrections when the original mitigation goals are not achieved. Use of adaptive management can significantly increase the effectiveness of mitigation efforts. However, it requires considerable data input on project conditions, because the data are used as the basis for future mitigation decisions. Effectively implementing adaptive management requires a commitment to collect data on which to base ongoing management decisions. The Panel supports the use of adaptive management as described in the DEIS. However, the cost to implement adaptive management can be high, given the need for repeated iterations of management action, collection of field data on site conditions, and reanalysis of approaches required to provide the necessary mitigation. In an era of increasingly tight agency budgets, the costs for implementation need to be determined and appropriate sources of funding identified. The DEIS suggests that the management responsibility for some of the proposed mitigation sites should be transferred to other agencies. However, the source of the funding is not clear. Without a source of funding, crucial adaptive management activities would likely be halted, jeopardizing the success of the project.
Significance: High
The source of funding is a critical aspect of the adaptive management plan that needs to be identified to ensure that the project goals are achieved.
Recommendation for Resolution:
1. Specify the funding source(s) to support ongoing adaptive management of the mitigation projects, and include these costs in the overall cost of the project.
Final Evaluator Response to FPC12
Concur **Response to Recommendations** 1. **Adopted.** Adaptive management costs are included in the project's cost estimate. Funding for adaptive management associated with the New Madrid Floodway closure would be a Mississippi River and Tributary Project item (Mississippi River Levees Feature). Remaining project features would be funded pursuant to the project's cost sharing authorization (75% federal funds St. Johns Bayou and New Madrid Floodway Project and 25% non-federal funds). All federal funds would be subject to Congressional authorization and applicable fiscal laws. Based on cost sharing policies and regulations, non-federal funds cannot be obligated until the cost share control record is in balance with non-federal cost sharing requirements. This usually entails the non-federal sponsor placing the non-federal amount in escrow that can be withdrawn by the

Final Comment Response Record

government at the time of need. These requirements will be established in the Project Cooperation Agreement.

Based on the IEPR teleconferences, specific costs and details associated with adaptive management would be presented in the Draft EIS.

Final Panel BackCheck Response – FPC12

Concur with Comment

The Panel is still unclear what the total cost of adaptive management of the project mitigation features will be, and how adaptive management costs are included in the project's cost estimate as indicated by USACE under Recommendation 1 above. The Evaluator Response indicates that these costs will be detailed in the revised EIS. The Panel encourages USACE to clearly specify these figures. Without a specific cost estimate for adaptive management, the Panel remains concerned that the funds required will not be available when needed.

Final Comment Response Record

Comment: 13
The fisheries adaptive management plan requires additional fish passage studies and lacks the detail needed to establish monitoring frequency.
Basis for Comment:
The index of biotic integrity (IBI) may not be an appropriate method to monitor the resident fish community in the St. Johns Bayou Basin and the New Madrid Floodway due to the difficulty in finding reference streams and/or a diversity of stream conditions. As stated throughout the DEIS, the ditches, streams, and bayous are highly modified habitats, and this may limit the use of an IBI approach. In addition, IBI is a general indicator of stream condition and may not be precise enough to assess changes in individual fish populations. The proposed fish passage studies do not combine fish access with spawning/rearing habitats used by fish that pass through culverts in the St. Johns Bayou Basin and New Madrid Floodway. Additionally, no fish passage studies are planned for Big Oak Tree State Park. The DEIS (Section 6.4.5) indicates that monitoring of the resident fish community will be conducted prior to each assessment report. Specific details relating to the length of monitoring prior to each report and triggering points for adaptive management changes are not included in the DEIS. In addition, specific monitoring details for connectivity, access, hydrograph, and Habitat Suitability Index (HSI) values were not provided in the DEIS and are needed to evaluate mitigation as part of the adaptive management process.
Significance: High
Without scientifically based monitoring, the fisheries adaptive management plan cannot be assured of success.
Recommendations for Resolution:
1. Identify the agency responsible for conducting the monitoring program and writing the adaptive management reports. Include alternatives to IBI development for resident fish monitoring. For example, monitoring commonly used IBI fish matrices through time may be an appropriate alternative if a full IBI is deemed inappropriate. 2. Conduct fish passage studies that identify spawning/rearing habitats used by fish that pass though the culverts in the St. Johns Bayou Basin and New Madrid Floodway. 3. Conduct fish passage/access through culverts at Big Oak Tree State Park if it is used for mitigation of spawning/rearing habitat. 4. Develop a long-term fish monitoring/adaptive management plan prior to project construction that provides specific details relating to the length of monitoring prior to each report, triggering points, and specific monitoring details for connectivity, fish access, hydrograph, and HSI values.
Final Evaluator Response – FPC13
Concur **Response to Recommendations**

Final Comment Response Record

1. **Adopt.** USACE is the agency responsible for conducting the monitoring program and writing the adaptive management reports. However, it is anticipated that the actual monitoring would be conducted by a lab or university.
2. The IBI was suggested as one approach to monitoring environmental benefits. However, given the issues of defining a reference condition, it is not necessary to use a classic IBI approach but rather a multimetric assessment of the fish community without relying on reference stream concepts. Metrics, or attributes of the fish community (e.g., tolerance to habitat changes, species richness, abundance), will be derived using acceptable statistical procedures and monitored before and after mitigation. By tracking metrics, the relative changes in important attributes can be determined and applied to an adaptive management approach. In addition, population modeling can be conducted on key species of interest to determine benefits to recreational, commercial, or sensitive fishes that may benefit from the mitigation.
3. **Adopt in Future.** Spawning and rearing usage on a portion of mitigation sites would be monitored. Adult fish usage will be monitored using conventional collecting techniques and the reproductive condition determined (e.g., condition of gonads). Telemetry can also be employed to assess movement and habitat use of spawning adults. Larval fish will be collected to determine actual spawning events in the mitigated lands.
4. **Adopt.** Section 6.3.6.3.3 will be revised to include monitoring at Big Oak Tree State Park.
5. **Adopt.** Fish monitoring will be conducted as part of the overall project monitoring and adaptive management that is outlined in Section 6 of the pre-Draft EIS. Monitoring of residential fish population would take place prior to channel modification and two years after each construction increment. An additional survey effort would take place in all reaches following a period of five years after the project becomes operational.
6. Fish passage will be assessed for two seasons prior to Floodway closure, and for two seasons prior to each adaptive management report (5, 15, 25, and 50 year intervals). The hydrograph and connectivity would be plotted/calculated for each basin utilizing newly established interior gages (Section 6.6.2). To maintain consistency in the method that impacts were calculated, adaptive management reports would utilize the same HSI value, unless there is compelling reason to change.

Adaptive management triggering points are discussed in Section 6.5 and will be expanded in the EIS (See FPC # 11 and 12).

Final Panel BackCheck Response – FPC13

Concur

Final Comment Response Record

Comment: 14
The shorebird adaptive management plan lacks the detail needed to establish monitoring frequency and to determine the habitat value of rice agriculture.
Basis for Comment:
The DEIS (Table 5.4) lists the parameters necessary to monitor the proposed mitigation, including vegetation present, which is applied to moist soil units but not to seasonally inundated farmland. Monitoring at shorebird mitigation sites should include tracking vegetation on seasonally inundated farmland. The farming activity to be allowed following spring shorebird migration could include plowing or other activities that would maintain low vegetation cover over time. However, if not managed or actively farmed between years, lack of soil disturbance might significantly reduce habitat quality over time. The adaptive management section of the DEIS related to shorebirds (Section 6.4.4, p. 242) states that shorebird compensatory mitigation will be assessed at 5, 15, 25, and 50 years. Because successful establishment of mitigation areas is often most uncertain when first constructed, the Panel believes that the mitigation sites should be evaluated in the years immediately after establishment, particularly in years 1-5 when sites are first being established, as well as during the later years proposed. The DEIS (p. 242), also raises the possibility that increased rice agriculture may be used to provide mitigation for loss of shorebird habitat resulting from the project, including the potential sale of the compensatory mitigation lands. Determining the value of increased rice agriculture to shorebirds would require development of appropriate HSI values for areas newly converted to rice agriculture. In addition, there may be considerable uncertainty in choosing the appropriate HSI values, given the variations in habitat quality that will result from different agricultural management practices, which would make measurement of the habitat value provided challenging.
Significance: High
Monitoring early results for mitigation of shorebird resources is critical to establishing successful mitigation projects, and the selection of appropriate HSI values is critical to determining the value of any additional rice agriculture.
Recommendations for Resolution:
1. Include monitoring of seasonally inundated farmland early in the project to ensure that appropriate habitat is being provided as planned. 2. Include an approach to measuring HSI values for rice agriculture that would be sensitive to variations in agricultural management practices likely to be employed in the project area, and that would determine the value of increases in rice agriculture, if they occur, to migrating shorebirds.

Final Comment Response Record

Final Evaluator Response to FPC14
Concur Response to Recommendations 1. Adopt. Each compensatory mitigation tract would be monitored. Monitoring criteria would include depth of water over the shorebird migration window (time of year) as well as appropriate documentation of shorebird usage. Table 5.4 would be revised to include these criteria. Although overall manipulation of water levels would be relatively simple in the project area due to current farming practices and spring precipitation, monitoring would occur in each of the respective zones over each specified time periods (15 March – 2 April, 3 April – 23 April, 24 April – 23 May, and 24 May – 8 June). Short term monitoring would occur for five years. In a similar fashion to other kinds of mitigation, a site specific monitoring report would be prepared following the five years of monitoring. Costs associated with monitoring are included in the cost estimate wand will be presented in the Draft EIS. 2. Adopt in the future during Adaptive Management. Based on discussions with the project sponsors, land owners, and the amount of rice grown in the region, additional rice acreage is likely. However, it is difficult to estimate future rice acreages as a result of the project. In addition, rice is usually rotated with a soybean crop in the region. Therefore, attempting to quantify future rice acreage is difficult and the DEIS did not attempt to do it. USACE is committed to compensating for unavoidable impacts to shorebirds and have not reduced any compensatory mitigation requirements based on future increases to rice acreage. If there is a significant increase in rice acreage as a result of the project, a study would be commissioned to determine an appropriate HSI value for rice acreage. The study would look at planting dates, inundation periods, depths, and vegetation growth to determine the appropriate HSI value. The results of the study as well as any project modifications would be coordinated in adaptive management reports that would be coordinated with the interagency team and any other interested stakeholder prior to an adaptive management decision.
Final Panel BackCheck Response – FPC14
Concur The Panel concurs that if the additional monitoring proposed in Recommendation1 above, and the additional study of appropriate HSI values for rice agriculture proposed in Recommendation 2 above are conducted, the issues raised in this comment will be addressed.

Final Comment Response Record

Comment: 15
The new shorebird habitat model, Assessment of Shorebird Habitat within the St. Johns-New Madrid Basins, Missouri, should be validated to ensure that the HSI values are correct.
Basis for Comment:
The Panel believes that the new method for assessing shorebird impacts and planning shorebird mitigation, Assessment of Shorebird Habitat Within the St. Johns-New Madrid Basins, Missouri, appears sound. The new model is a significant improvement over the initial approach presented in the Phase 2 IEPR, and the Panel commends USACE for supporting development of the new model. Because this model is new, validation work will be required, in particular to ensure that the proposed HSI values are accurate. The validation of the model suggested in the IEPR model certification review has not yet been conducted, and is an important step in ensuring that the model is accurate and precise. The validation process, including collection of field data showing how the various HSI values compare to actual shorebird use of the various habitat types, should be completed prior to using the model to calculate needed mitigation. The Draft Planning Model Quality Assurance Review Report for the Model Review of the Assessment of Shorebird Habitat within the St. Johns-New Madrid Basins, Missouri, (Volume 3, Part 6.4) includes the recommendation by the expert review panel that "the performance of the model needs to be tested and verified before it is applied for decision-making." Field-based evaluations will be necessary to address the recommendation of the review, and to validate the relative HSI values assigned to the various water depths in the model (DEIS, p. 144). The proposed HSI values are likely good first approximations, but require field data for validation. The Assessment of Digital Elevation Model (DEM) Accuracy on the St. Johns - New Madrid Shorebird Habitat Model (Appendix M, Part 4) concludes that the aggregation of low resolution estimates from the DEM is adequate for estimating the overall inundated area, but further recommends adjusting the mitigation area upward to the 95% confidence interval value to account for uncertainties resulting from the lower resolution of the DEM. Implementation of this recommendation should be applied for the calculations related to the St. Johns Basin portion of the project.
Significance: High
Validation of the Assessment of Shorebird Habitat Within the St. Johns-New Madrid Basins, Missouri must be completed before the model is applied so that any adjustments to model parameters can be applied when calculating necessary mitigation.

Final Comment Response Report

Recommendations for Resolution:

1. Include specific plans for field validation of the shorebird habitat model in the DEIS.
2. Apply the model review recommendation to adjust the St. Johns Basin mitigation upward by the 95% confidence interval to account for any uncertainties related to the DEM.

Final Evaluator Response to FPC15

Concur

Response to Recommendations

1. **Adopt.** HSI values were developed based on best available data. However, the model has not been validated. The model would be validated post Record of Decision during the completion of plans and specifications for the project but prior to construction of features that result in shorebird impacts. Specific aspects regarding validation have not been finalized to date but specifics would be included in the Draft EIS.
2. **Adopt.** See FPC#8 Response 1a.

Final Panel BackCheck Response – FPC15

Concur with Comment

The Panel commends USACE for agreeing to conduct validation exercises prior to construction of features that result in shorebird impacts. Because the model is new and has never been applied in practice, it should be validated before it is used to calculate impacts and plan mitigation, especially since the best available data is sparse. The Panel also commends USACE for exploring approaches to estimating uncertainty related to model parameters and calculated mitigation required to offset project impacts, and encourages USACE to apply estimates of uncertainty to calculations of needed mitigation.

Final Comment Response Record

Comment: 16
The calculation of economic and ecological benefits does not consider the impact of global climate change and the economic opportunities for carbon sequestration and bottomland hardwood forest management.
Basis for Comment:
Emerging markets for carbon to offset the impacts of global climate change have created opportunities to finance afforestation worldwide. The DEIS states that the Lower Mississippi River Valley has seen afforestation of more than 77,000 acres of agricultural land due to carbon finance. This region also receives high attention from carbon market entrepreneurs, attracted by the scientific evidence that bottomland hardwood forests have high capacity to sequester carbon. For example, the Ohio River, located just upstream of this site, is estimated to have 35,000 MW of electrical generation capacity and a high-level need for offsetting carbon credit. Connecting the carbon need between the two locations (i.e., the project site and the power generation facilities upstream) would make economic and ecological sense. However, the assessment of the affected environment in terms of the carbon footprint in the DEIS was limited to the anticipated carbon dioxide emissions produced by the two electrical pumping stations, and did not consider the broader context of global climate change. If the Village of Pinhook relocates to the St. Johns Basin, and other residents have already been displaced by operation of the Floodway in 2011, the Panel believes that conversion from agriculture to silviculture is a more viable option for the New Madrid Floodway. This alternative would also have ancillary economic and ecological benefits. Conversion from agriculture to silviculture in the New Madrid Floodway would have a nutrient trading benefit because taking cropland out of production reduces nutrient loads to the system by eliminating annual fertilizer applications. Afforestation would also have the added benefit of maintaining ecological connectivity with the Mississippi River. The forests, if made up of bottomland hardwood species, would tolerate seasonal flooding, would not require fertilizers, and would be able to assimilate seasonal loadings of water, sediments, and nutrients from upstream rivers. Downstream benefits would include increased flood protection and water quality improvements.
Significance: High
Further analysis is needed in order to justify the decision to eliminate any alternative from further consideration.
Recommendations for Resolution:
1. Conduct an economic analysis of the benefits of carbon sequestration and bottomland hardwood forest management from conversion of the New Madrid Floodway from agriculture to silviculture and/or forest conservation. This analysis should include capturing and storing carbon not only as timber wood, deadwood, litter, and understory, but especially permanently in the soil. 2. Conduct an economic analysis of the nutrient trading benefit of eliminating annual fertilizer applications from conversion of the New Madrid Floodway from agriculture to silviculture and/or bottomland hardwood forest conservation.

Final Comment Response Record

Final Evaluator Response to FPC16

Concur

Response to Recommendations

Recommendations 1 and 2. **Adopt.** Based on the teleconference, the alternative will include the following in the New Madrid Floodway:

1. Construction of the closure levee
2. Construction of the gravity outlet.
3. Associated setback/frontline levee grade raises.
4. Close gates at an elevation of 287.5 feet.
5. Start Pump at 289.5 feet (note this is approximately 0.5-feet below road elevations)
6. Stop Pump at 288 feet.

Unlike the two avoid and minimize alternatives that have set management elevations based on the time of the year (floods are gradually lowered as the growing season commences), the management elevations for this alternative is constant regardless of the time of year. Therefore, the alternative satisfies the project's objective for social well being by keeping roads open year round and preventing community isolation. In addition, the project would provide flood risk management benefits for agricultural lands that are greater than en elevation of 289.5 feet. Likewise, there would be an environmental impact for lands greater than 289.5 feet. With the exception of the fish access coefficient, there would be no environmental impact for lands below an elevation 289.5 feet.

Although there would be no agricultural benefit for farmland below an elevation 289.5 feet, there would be a flood risk management benefit by taking farmland out of production and converting it to a land use that is conducive to the current flood regime. In addition to the benefits that this provides, the additional benefits from nutrient trading and carbon sequestration would be considered. Although it is not known whether or not such an alternative is economically justified, it makes ecological sense due to the poor habitat found within the project area (mostly agriculture) and its location in the vicinity of the Ohio River.

There are many aspects of the alternative that are not known at this time and USACE will have to makes several assumptions regarding the economic benefit of carbon and nutrients. However, the two sources (protocols for Yazoo Backwater and Guidance for Electrical Companies) provided will be utilized. In addition and if this alternative is economically justified, USACE may need additional Congressional authorization to implement.

Lastly, to maintain consistency with other project alternatives, USACE will not propose any mitigation to shorebirds by taking agriculture out of production and reforesting it. USACE is of the opinion that this is a benefit to the ecosystem as a whole and no mitigation is required (See FPC #10). However, USACE will quantify the impact to shorebirds above an elevation 289.5 and propose similar compensatory mitigation as a result of this flood protection.

Final Comment Response Record

Final Panel BackCheck Response – FPC16
Concur

Final Comment Response Record

Comment: 17
The assumptions for the No-Action Alternative are not justified.
Basis for Comment:
The No-Action Alternative (Alternative 1) requires an estimate of future conditions that would prevail in the absence of the project, over the full anticipated life of the project, approximately 50 years. This necessitates a variety of assumptions regarding uncertainties in weather patterns and economic conditions throughout this period. Both may be affected by changes in climate conditions. The observed progression from hydric vegetation to drier species in Big Oak Tree State Park would continue if no action is taken to restore hydrology to the park. However, the assumption that no effort would be made to restore hydrology to the park is problematic since past efforts have been made by the Missouri Department of Natural Resources (MDNR). Table 4.34 indicates changes in acreage between existing conditions and Alternative 1 without providing an explanation. Additionally, based on this table, it is unclear what changes would occur in AAHU between existing conditions and Alternative 1.
Significance: Medium
The No-Action Alternative current and future conditions are used as a basis for comparison of each of the project alternatives, but these conditions are not justified.
Recommendations for Resolution:
1. Provide assumptions and justification for future weather patterns in the region and the associated impact on the No-Action Alternative. 2. State assumptions regarding future economic conditions that pertain to agricultural production (costs, profits, prices, etc.), and provide justification for these. 3. Provide assumptions related to anticipated changes in the region's population profile and justify these for the No Action Alternative. 4. Modify the assumptions regarding the restoration assumption of Big Oak State Park to indicate that it is likely that hydrology will be restored over the next 50 years. 5. Provide narrative to the changes identified in Table 4.34 and also present AAHU changes in this table.
Final Evaluator Response to FPC17
Concur **Recommendations for Resolution** 1. Adopt The Phase 2 IEPR report stated the following: The capabilities of global circulation models to predict future climate are generally recognized as approximate, strongest in predicting temperature changes, and weak in predicting precipitation changes. Climate change modeling capabilities are strongest in

Final Comment Response Record

predicting changes over large regions of the world and weak in downscaling to watersheds. Thus, the panel agrees that accurate quantitative predictions of future changes in stream flow characteristics at the project site would be extremely difficult, if not impossible.

The EIS utilized period of record analysis to determine likely future conditions in both watersheds. The following is stated in Section 4.4.1:

> Since the project area has experienced variable floods/droughts and wet/dry precipitation years during this period, on can reasonably conclude that similar conditions will continue in the future.

The uncertainty of the future values of variables, such as temperature and the amount of precipitation applies to means and variability, both seasonally and over decades. The project design has been optimized for the climatic conditions experienced over the past seven decades. That analysis period in itself comprehends considerable variability in temperature and precipitation.

Since it is difficult to make accurate predictions regarding precipitation in the project area even in the near future, no attempt was made to make predictions over a 50-year period. The hydrologic period of record will continue to be used to determine project benefits and impacts because this is the best information to base project decisions. However, the no action alternative will be expanded to include a discussion on likely future weather conditions as a result of global climate change. Based on Easterling (1993) the project area may experience drier conditions. However, this would make the overall need for the project more because of its close proximity to an available water supply (Mississippi River). This discussion will be included in the No Action Alternative but we must emphasize that the observed period of record (that has measured any changes in climatic conditions over the last 67 years) data will be used to make project decisions.

2. Adopt.

   Economic impacts would continue under future without project conditions. Although there have been some recent changes to land use within the project area as a result of WRP and the project has accounted for likely future trends, current conditions show that farming is very profitable and would likely remain so under future without project conditions. Area producers would continue to attempt to minimize flood risks to predictable floods by delayed planting. Delayed planting limits the types of crops that could be grown as well as yields. However, there would always be a risk due to late season unpredictable floods. In addition to agricultural damages, streets and roads would continue to be damaged as a result of flooding. Assumptions and justification regarding future economic conditions would be included in the Draft EIS.
3. Adopted. Population changes are not expected under future without project conditions. There may be temporary displacement of residents within the New Madrid Floodway during periods of Floodway operation. However, it is anticipated that some residents would return to the Floodway after operation. Additional justification will be provided in the Draft EIS.
4. Not Adopt. As previously stated by USACE, Big Oak Tree State Park staff, and the Missouri Department of Natural Resources, we are not aware of any such restoration

Final Comment Response Record

proposal. Although there was a previous plan that relied on groundwater pumps, it has been abandoned.

Even if such a plan did exist that restored the Mississippi River connection, it would be appropriate to reduce the impacts of the project to account for it, instead of increasing mitigation. Thus, the project would have a lesser impact and no longer the same mitigation need.

The previous plan that was abandoned relied on groundwater pumps to maintain hydrology. This was problematic for a variety of reasons. For example, although groundwater may kill the drier species (*i.e.*, red maple), the clear (non-turbid) groundwater may result in invasive coontail. This would be detrimental to the park. Likewise, the park would remain isolated and would not experience the numerous benefits of connectivity with the Mississippi River. Therefore, it may not be a reasonable assumption to state that the park would re-instate the previous plan absent this project.

Regardless, Big Oak Tree State Park is a priority of this project and we are committed to restoring hydrology to the park. This would be used as a portion of the project's mitigation needs. The State of Missouri will be consulted again to ensure that the assumption regarding the future of the park is still valid.

5. **Adopted in the future.** A narrative to the table would be provided. The difference in functional floodplain acres is the addition of future anticipated WRP enrollment. There are no changes in AAHU. However, there are HU changes at year 0 and year 50.

Final Panel BackCheck Response – FPC17

Concur with Comment

Recommendation 1. Recent evidence suggests that reliance solely on the past period of record in hydrologic modeling may be inappropriate because of changes in stationarity (see Milly, P.C.D., J. Betancourt, M. Falkenmark, R.M. Hirsch, Z.W. Kudzewicz, D. P. Lettenmaier, and R.J. Stouffer. (2008) "Climate Change: Stationarity is Dead: Whither Water Management?" *Science* 319:573-574.).

Recommendation 2. To the Panel's knowledge there is no irrigation infrastructure in the region. Therefore, if reliance on groundwater and imported surface water supplies from the Mississippi or elsewhere is part of future conditions, then economic analysis needs to incorporate the cost of building that infrastructure and supporting it (i.e., through operation and maintenance costs). Thus, it is speculative as to whether profits will increase, decrease, or stay the same.

Final Comment Response Record

Comment: 18
A detailed justification for eliminating project alternatives from further consideration is not provided.
Basis for Comment:
NEPA requires that all "reasonable" alternatives be considered. A project of this magnitude, i.e., one that affects a wide range of resources, should consider land and water management scenarios that would provide major economic, social, and ecological benefits. This is especially relevant given that the economic benefits of the proposed alternatives are uncertain. Specifically, the benefit-cost ratios of the proposed alternatives do not incorporate economic uncertainties that could result in ratios less than 1. Additionally, alternatives with varying locations for setback levies were included in the Consolidated NEPA Document reviewed under the Phase 1 IEPR, but are not included in the Working Draft DEIS. These different locations should be included as subsets of reasonable alternatives or justified as not meeting the purpose and need of the project. The DEIS does not evaluate conservation or silvicultural alternatives that have high ecological benefits and potentially significant economic benefits. Specifically, major land management scenarios that would involve bottomland hardwood forests rather than corn and soybeans were not considered as a viable alternative. Overall, the evaluation process for alternatives lacks the detail and consistency needed for the reader to understand how alternatives were identified and compared. For example, the number of criteria used to identify alternatives (three) is different than the number of criteria (four) used to compare proposed alternatives.
Significance: Medium
The process for evaluating and selecting among alternatives is unclear and incompletely presented, limiting the Panel's understanding of the screening process that led to the selection of the recommended plan.
Recommendations for Resolution:
1. Include a clear and consistent comparison of alternatives. 2. Include an analysis of the economic efficiency of the alternatives that maximizes the present value of net benefits, not just whether the alternative has a benefit-cost ratio greater than 1. 3. Consider the alternative of converting agriculture to silviculture in the St. Johns and New Madrid, i.e., converting the local economy from fertilizer and/or nitrogen fixation-based agriculture to silviculture and/or cover crops and allowing the site to flood more frequently by backwater and overbank flooding. 4. Include the alternatives that contain the various locations for setback levies or justify their exclusion in this draft of the DEIS.
Final Evaluator Response – FPC18
Concur

Final Comment Response Record

Response to Recommendations

1. **Adopt in Future –** The Draft EIS will be revised that presents a better comparison of alternatives. The specific recommendations regarding additional rows to Table 2.7 and a separate parallel table with a brief narrative will be provided in the Draft EIS.
2. **Adopt in Future.** The authorized project maximizes economic efficiency, whereas the avoid and minimize measures reduce the environmental impact.
3. **Adopt in the Future –**Additional clarification required for this alternative can be found in comment/response 16.
4. **Adopt in the Future**. Additional justification for not analyzing levee setbacks in detail would be made in the Draft EIS. Previous NEPA analysis that dismissed this alternative would be re-presented.

Final Panel BackCheck Response – FPC18

Concur

Final Comment Response Record

Comment: 19
The methods and model used to assess the impacts on fish and to estimate the compensatory mitigation are not clearly described.
Basis for Comment:
It is critical that model results are presented clearly to allow a full comparison among project and mitigation alternatives. As currently written, impacts are not fully disclosed and project alternatives are difficult to compare. The Panel suggests that the following specific clarifications be addressed. • The first paragraph of Section 4.8.5.2 states that floodplain water bodies provide spawning and rearing habitat regardless of river conditions. Therefore, Average Daily Flooded Area (ADFA) was not calculated and only based on surface acres. The next paragraph states that river connectivity is needed to benefit the remainder of the fishery. However, timing of this connectivity is not defined or referenced to the section that contains these data. • Connectivity of borrow pits used for mitigation is an important consideration, but connectivity use in mitigation is not evident unless reviewing multiple tables and text. • The Panel agrees that all fish do not need to have access to the floodplain for reproductive success for a particular species. However, the ones that do have access would not likely have "high reproductive success" as stated. Individual reproductive success is typically low for fish due to a variety of factors that can cause high mortality of eggs and larvae. This is particularly true in floodplain habitats. • The fish access coefficient is a reasonable measure in the quantification of available pre- and post-project habitat in the St. Johns Bayou Basin and post-project habitat in the New Madrid Floodway. However, access coefficients may vary by season and were not calculated. • The summary of impacts in Table 4.33 does not include existing AAHUs, which reduces the ability for comparisons among project alternatives. • It is unclear why the 2- and 5-year flood frequencies change with alternatives and if these changes are incorporated into AAHU loss estimates. • AAHU reductions for each method are not clearly presented in Tables 4.34 to 4.39 or stated in Sections 4.8.5.5 through 4.8.5.8. • Although the batture land is suitable to mitigate impacts based on the fish access studies, the amount of AAHU compensation in the batture land is too high and should be based on fish access restrictions.
Significance: Medium
The methods and model used to assess the impacts on fish and compensatory mitigation should be clearly described to achieve completeness and to have the reader correctly interpret the DEIS.

Final Comment Response Record

Recommendations for Resolution:

1. Reference and define the timing of the connectivity in Section 4.8.5.2. Tables 4.47, 4.48, 4.49, and 4.50 should include percentage of connectivity loss for alternatives.
2. Provide discussion on the impact of borrow pit connectivity reductions and how connectivity is incorporated in alternatives.
3. Provide clarification of reproductive success that focuses on population level maintenance that can be achieved and not individual reproductive success.
4. Provide clarification of why access coefficients were not calculated for each spawning/rearing season.
5. Expand Table 4.33 to include existing AAHUs for a more complete comparison of alternatives.
6. Provide clarification of why the 2- and 5-year flood frequencies change with alternatives and if/how these changes are used in AAHU estimates.
7. For comparative purposes, clarity would be improved by presenting reduced AAHUs as both lost AAHUs and as a percentage for each habitat type and total pooled habitats in Tables 4.34 to 4.39. For example, late spawning period alternative 3.1 AAHUs are 1810.8 pre- project and are estimated to be 372.3 post- project. This is a loss of 1438.5 AAHUs or 79.4% of late season spawning habitat in the New Madrid Floodway. The narrative for these tables should briefly explain the reasons for the losses. In addition, functional floodplain acres should be presented in separate tables.
8. Mitigation in batture land and floodplain lakes should be limited to no more than 27% of AAHUs based on the fish access coefficient (0.73) since this estimated access restriction cannot be compensated within the New Madrid Floodway.

Final Evaluator Response to FPC19

Concur

Response to Recommendations

1. **Adopted.** For clarity, ADFA = surface acres as long as the waterbody is within the five year floodplain so fish can access it. The analysis assumed that access at any time of the year would satisfy this criterion (see Table 4.34 and 4.35 where consistent average annual habitat units were taken for open water habitat for each of the respective spawning and rearing seasons). This would be clarified in the Draft EIS.

   One can calculate the impact of connection to existing waterbodies by comparing Tables 4.45 – 4.50. However, the tables will be revised in the Draft EIS to show the impact more clearly

2. **Adopted**. The EIS will clearly state that waterbodies have to be connected (within the post project 5-year flood frequency) to be of benefit. For example, those waterbodies that are no longer connected due to the project, no longer provide spawning and rearing habitat for fish. Therefore, a complete loss (ADFA=surface acres) was taken. Likewise newly established waterbodies as a result of ecologically designed borrow pits have to

Final Comment Response Record

be constructed within the post project 5-year flood frequency to compensate for impacts associated to inundated floodplain habitat.

It was also discussed during the teleconference to explore options that would provide connectivity to existing waterbodies that are impacted by the project. For example a fish access channel (*i.e.*, ditch) could be constructed from an existing isolated waterbody to the interior sump elevation to provide connectivity/fish access. Outlet structures may also have to be constructed. It would be problematic to address this in the EIS due to the need for site specific locations. However, options such as these would be considered during the development of site specific mitigation plans as opportunities arise because they make ecological sense and would be of tremendous value to spawning and rearing habitat (*i.e*, ADAF=surface acres and HSI=1.0). This conceptual option would be discussed in the Draft EIS.

3. **Adopted.** A discussion in the Draft EIS will be provided on population-level success. We can provide concepts and potential benefits in terms of recruitment. Recruitment is directly related to survival of young-of-year, which we believe would be enhanced in mitigated lands by providing optimum spawning and rearing habitat. This can be inferred by monitoring species and abundance of larval fishes. However, it should be noted that population modeling of Mississippi River fishes is a difficult task given the size of the system and the many intervening variables (e.g., both density independent and dependent) that influence recruitment and standing crop.

4. **Adopted.** Clarification will be provided in the EIS. In summary, fish would be able to access the floodplain through the culverts during any time of the year. For example, fish may enter the basin prior to gate closure during the early season but will not necessarily spawn until the mid season period. The elevation of constructed borrow pits will be determined so that connectivity will be known. For any given water year, the percent time a borrow pit is connected will be calculated. Other measures to enhance connectivity (location of borrow pits at lower elevations, providing inlet/outlet channels) can be considered by the mitigation team.

5. **Adopted –** Table 4.33 would be revised to include a column on existing ADFA and AAHU, alternative ADFA and AAHU, and impacted ADFA and AAHU.

6. **Adopted -** The 2 and 5 year flood frequencies are different with each alternative due to the fact that each alternative provides a different level of connectivity. These changes are incorporated into the AAHU loss estimates (along with ADFA and HSI value).

   Since frequency is a key variable in multiple model outputs, the changes in flood frequencies as a result of different alternatives is contained in Section 4.4 of the EIS. Additional clarification would be included that describes the changes in flood frequencies in this section. Appropriate figures would also be added.

   It is important to note that although flood frequency elevations are lowered due to project alternatives, there would still be variable flooding.

7. **Adopted.** The recommendations regarding clarity will be adopted and the Draft EIS will be revised.

Final Comment Response Record

8. **Not Adopt.** See FPC #9. Based on the teleconference, there should not be a maximum allowable mitigation standard placed in the batture land because the batture provides excellent habitat for fish as well as wetlands. However, the EIS will demonstrate that impacts to remaining resources would be compensated. Batture land may not be appropriate or only offer limited value to other ecological resources.
Final Panel BackCheck Response – FPC19
Concur

Final Comment Response Record

Comment: 20
The description of fisheries resources is inconsistent and is not adequately explained.
Basis for Comment:
Inconsistent and incomplete descriptions of the fisheries resources are found in several locations throughout the DEIS and Appendix G. Ultimately, conflicting descriptions and conclusions of the resource and project impacts raise questions regarding mitigation necessity and implementation. Section 3.8.5 of the DEIS states that environmental advocacy group claims are used to support the argument that the ecosystem is "destroyed or in a disastrous state" and has "no remaining value." The two references cited are a fact sheet and a memo. While the Panel agrees that the fish communities have made adjustments to anthropogenic changes, we are unaware of any scientific publications that state the Mississippi River ecosystem is destroyed and has no remaining value either economically or biologically. This section should describe the current fisheries resources in the Mississippi River near the project area and in the St. Johns Bayou Basin and New Madrid Floodway. Section 3.8.5 and Appendix G provide a description and comparison of fisheries resources (species richness and relative abundance) in the St. Johns Bayou Basin and New Madrid Floodway. However, this section does not describe the fisheries resources of the Mississippi River fishes and those species that use floodplain habitat. Quantitative approaches are used throughout the DEIS to estimate existing fish spawning/rearing habitat and project impacts. For example, Alternative 3.1 projects fisheries spawning/rearing habitat loss in the St. Johns Bayou Basin to be 28.5%, 31.1%, and 31.7% for early, mid, and late seasons, respectively. It projects losses in the New Madrid Floodway to be 61.6%, 71.2%, and 79.4% for early, mid, and late seasons, respectively. However, Section 4.17, Cumulative Impacts (p. 216) contains an argument that, due to differences in the fish communities between historic conditions and current conditions, "the project would not have any significant additional impacts because it no longer provides any significant habitat." Section 4.17, Cumulative Impacts (Loss of Connectivity, p. 222-223), has nothing to do with cumulative impacts and qualitatively dismisses the fish resources that were quantified in the DEIS. This section also fails to recognize that batture lands have been affected by the same or similar anthropogenic changes to the Mississippi River as in the St. Johns Bayou Basin and the New Madrid Floodway.
Significance: Medium
The fisheries resources and habitat value (AAHU) has been described and quantified throughout the DEIS. However, inconsistencies with the fisheries resource and habitat values affect the completeness of the report.

Final Comment Response Record

Recommendations for Resolution:

1. Revise the DEIS to include a description of the current fisheries resources in the Mississippi River near the project area and in the St. Johns Bayou Basin and New Madrid Floodway and eliminate environmental advocacy group claims.
2. Correct the inconsistency between the quantitative evaluation and qualitative suggestions of no fish resource value and remove the language in the DEIS suggesting that the project area has no value or significant habitat for fish resources
3. Remove Section 4.17, Loss of Connectivity, from the DEIS.

Final Evaluator Response to FPC20

Concur

Response to Recommendations

1. **Adopt.** The EIS will be revised stating environmental advocacy groups claim that the Mississippi River is a lost cause but the scientific community does not agree with their statements.
2. **Adopt.** The inconsistency would be corrected. The project area still provides habitat.
3. **Not Adopt.** This entire section was placed into the EIS in response to the Phase 2 IEPR discussion FPC #14. The panel stated the following:

   The panel believes that the New Madrid Floodway is unique because, in context, it is the last remaining connection between the Mississippi River and its floodplain in the State of Missouri. Therefore, it plays a much larger role in providing natural floodplain services than the other areas. If the other originally connected areas had not been disconnected, the Floodway would be playing a proportionally smaller, and less important, role in maintaining the natural ecosystem. The loss of this last remaining connection and its ecosystem functioning would be the "straw that broke the camel's back" in terms of the total cumulative impact. That is, not all incremental impacts are equal and it is the impact that exceeds a threshold that is significant. In this case, the adverse impact of removing the last floodplain connection, once the other connections have already been removed, is disproportionally high.

Although backwater flooding persists in the New Madrid Floodway due to constructed levees and other highly modified engineered structures, it is not unique and is not the last remaining connection in the State of Missouri. In addition, the tentatively recommended plan specifically outlines a plan that would retain connectivity to the remaining natural habitat found within the Floodway and contains a plan that would restore connectivity to the last remaining uncut bottomland hardwood tract (Big Oak Tree State Park) in the region.

Based on the discussion during the teleconferences, the paragraph will be revised to demonstrate that the existing connectivity, although it is highly modified, provides functions to ecological resources (*i.e.*, the language in the paragraph will be softened).

Final Comment Response Record

Final Panel BackCheck Response – FPC20
Concur

Final Comment Response Record

Comment: 21
The species used to construct the Habitat Evaluation Procedure (HEP) model analysis for assessing terrestrial wildlife are not representative of the affected species.
Basis for Comment:
The Panel recognizes that the representative terrestrial animals (fox squirrel, mink, barred owl, muskrat, pileated woodpecker, black-capped chickadee, red-winged black bird, and great blue heron) were selected based on the availability of habitat suitability index models for the HEP analysis. However, the Panel believes that the life history characteristics of the animals used to represent terrestrial animals only represent birds and mammals and are not adequate to represent reptiles and amphibians.
Significance: Medium
A broader range of animals should be used to ensure adequate mitigation for terrestrial wildlife.
Recommendation for Resolution:
1. Include representatives of amphibians and reptiles in the HEP model.
Final Evaluator Response to FPC21
Non-Concur 1. **Not Adopt.** The Memphis District had coordinated with USFWS and MDC and concluded that the indicator species used in the analysis would adequately describe likely project induced direct impacts to terrestrial wildlife habitat. Discussion included the hydrologic impacts of the project and the need to model herpetological resources. It was determined that no readily available HSI models for herpetological resources could capture the hydrologic changes associated with the project and concluded that the models used, coupled with other ecological models (Envirofish, HGM, waterfowl and shorebirds) would adequately quantify impacts to wildlife resources. Based on the teleconference, a sub-heading titled Herpetological Resources would be added to Section 3 and Section 4 that describes existing conditions and environmental consequences, respectively. Although impacts to herpetological resources would not be quantified, other models account for impacts. In addition, based on the discussions during the teleconferences, amphibians may benefit from the project because there would be more "isolated" forested areas than under existing conditions. This isolation would be a benefit to amphibians because fish would likely not have access to areas above the interior sump elevation (post project 5-year flood frequency elevation).
Final Panel BackCheck Response – FPC21
Concur

Final Comment Resolution Record

Comment: 22

The positive ecological effects of the flood pulse on the landscape are not considered and the flood pulse is applied inaccurately in a social impact context.

Basis for Comment:

The historical accounts of human suffering due to flood pulses are interesting and relevant, but they should not be tied to Junk's concept of flood pulsing. The Panel believes that this is an artificial connection between an ecological concept and social effects of flooding; the link should be removed from the document.

More importantly, the economic benefits of flood pulsing are not described in the DEIS or in the benefit-cost section. Flood pulses are natural subsidies to ecosystems such as bottomland hardwood forests and backwater swamps. Floods cause an increase in nutrient availability to wetlands in these settings, as well as increased nutrient cycling due to water level fluctuations. Historically, flood pulses supported entire civilizations (i.e., Mesopotamia, Nile Delta) where nutrient-rich waters and sediments subsidized agriculture. Artificial fertilizers and drainage control are now employed to achieve similar effects, and the flood pulses are considered nuisances and destructive.

Significance: Medium

Scientific concepts such as "flood pulse," as described well in the scientific literature, should be used properly in impact statements.

Recommendations for Resolution:

1. Include a balanced discussion of both the negative impacts of flooding on human culture and the positive impact of flooding on ecological systems.

Final Evaluator Response to FPC22

Concur

The EIS set out to describe the ecological benefits as well as socio-economic damages related to flooding within the project area. Consistent terminology (i.e., the flood pulse) was used to describe both and was used to develop project specific objectives. However, terminology will be modified in the EIS because the term flood pulse is widely accepted to describe ecological benefits and not used to describe economic losses or human suffering.

Response to Recommendations

1. The EIS provides the balanced discussion. In fact the tentatively recommended plan provides a balance between the remaining natural ecosystem and providing socio-economic benefits. The positive impact flooding provides to bottomland forests and backwater swamps have been quantified with the various ecological models. These two types of habitat are lacking in the over 80% agricultural project area. Compensatory mitigation would provide this much needed habitat in the project area. Likewise, nutrient cycling was also quantified in the water quality section. Although, the project

Final Comment Response Record

area serves as a nutrient sink during floods, its role in the overall nutrient cycle is that of a nutrient source due to the thousands of tons of fertilizer that are applied on an annual basis. The project area would still serve as a nitrogen sink during periods of floods due to the connectivity provided by the avoid and minimize measures. In fact it will likely take more nutrients out of the system due to the mitigation. Although the project area would still serve as a nutrient source due to the agricultural landscape, compensatory mitigation would reduce the overall nutrient load to the river.

The avoid and minimize measures are a new concept that seeks to retain connectivity to a large portion of the project area for environmental reasons while providing socio-economic benefits. Therefore, many of the beneficial ecological functions the project area provides would still occur with the project. In fact one could argue that there would be a greater amount of natural habitat occurring in the project area with compensatory mitigation measures than what currently exists. Therefore, the project could be considered a positive for the environment as well as socio-economic resources.

Based on the teleconferences, ecosystem services will be analyzed to carbon sequestration and nutrients (See FPC #23).

Final Panel BackCheck Response – FPC22

Concur

Final Comment Response Record

Comment: 23
The cumulative impacts analysis does not consider the value of ecosystem services that have diminished over time.
Basis for Comment:
The DEIS assigns little value to the ecosystem services (e.g., carbon sequestration) provided by floodplain connection to the Mississippi River, based on the argument that the system has been significantly changed over time. However, the Panel believes that the ecological value of the remaining connection to the Mississippi River is high. As described in CEQ (1997), the loss of this last remaining connection is an example where additional impacts, no matter how small, will have a disproportionate cumulative effect by exceeding the threshold where floodplain connection ecosystem functioning is eliminated. The Panel believes that closing the last connection would have a significant cumulative impact on the flood-dependent system. While it is not required that a project compensate for historical impacts, it is incumbent on the project not to contribute the incremental impact that may cause the project to exceed this overall threshold. The value of the flood-dependent system can be characterized in terms of ecosystem services such as carbon and nitrogen sequestration (Costanza et al. 1997). Throughout the DEIS, ecosystem services are not considered or are undervalued, while economic benefits may be inflated and based on previous socioeconomic data, particularly given the major changes in the Floodway after the 2011 floods.
Significance: Medium
The analysis of cumulative impacts is incomplete without a proper consideration of the effect of closing this river connection on the diminution over time of regional ecosystem services (such as carbon and nitrogen sequestration) provided by this flood-dependent ecosystem.
Recommendations for Resolution:
1. Prepare an analysis of cumulative effects that includes evaluation of the last remaining connection to the Mississippi River in terms of ecosystem services that have diminished over time. 2. Evaluate each of the alternatives (including any new alternatives) in terms of cumulative impacts on ecosystem services.
Final Evaluator Response to FPC23
Concur **Response to Recommendations** 1. **Adopt** Numerous ecological values were quantified in the EIS utilizing the methods established during the Project Work Plan that underwent Phase 2 IEPR review. These models quantified the ecological value on multiple habitats over different periods of the year to ensure that ecological value was adequately described. These same models were utilized in the cumulative impacts section of the EIS. In general terms, the project area

Final Comment Response Record

was once a vast bottomland hardwood swamp that had a vast array of ecological value that is difficult to imagine in the present context. However, the project area is now extremely valuable farmland that deserves special recognition as prime farmland from the USDA. Obviously this transformation to highly productive farmland has come at the expense of the environment. However, this is true of all human development.

Although the Floodway is not the last remaining connection to the Mississippi River in the State of Missouri or the region, avoid and minimize measures were specifically formulated to reduce the impact associated with a reduced connection. Moreover, compensatory mitigation measures for Big Oak Tree State Park would restore this connection that presently does not exist at frequencies necessary to maintain the park's natural vegetation. As indicated in the cumulative impact write-up, avoid and minimize measures for this project represents a new change in the overall thinking regarding flood risk management in the Lower Mississippi Valley. Gates and pumping stations are a common management technique. Lessons learned from the project monitoring and management of the St. Johns Bayou and New Madrid Floodway project could be adopted to other areas. Therefore, it is a reasonable argument that although this project would reduce the connection to the New Madrid Floodway, lessons learned could lead to a cumulative increase of connection if other areas incorporate similar management scenarios.

Based on the teleconferences, two additional ecological services would be analyzed (1) Carbon Sequestration and (2) Nutrients. It was advised not to make an attempt to economically quantify the value of ecosystem services. Both of these ecological services would have a heading in Sections 3 and 4 to describe the impact/benefit of the project in the project area as well as a section devoted in the Cumulative impacts section to describe impacts/benefits to adjacent/downstream areas.

2. **Adopt**

We respectfully disagree with your statement regarding major changes in the Floodway after the 2011 floods. Prior to operation of the Floodway the project area was mostly agriculture. Following operation and the resulting flood pulse, the project area is still mostly agriculture. Crevassed levees are being restored that provide the same level of flood protection that existed prior to operation. Local government and drainage districts have removed sediment from the vast network of drainage ditches. Area farmers have replanted. Although the Village of Pinhook will likely relocate to the St. Johns Bayou basin, other residents have moved back. The EIS will be clarified in regards to how the 2011 flood has not significantly changed the New Madrid Floodway.

The panels' recommendation regarding ecological services and the reference to Costanza et al. (1997) indicated that this recommendation may be beyond the current state of science. The referenced research could identify no valuation studies at all for some major biomes, including cropland. In an area where agricultural accounts for ≈80% of the landscape, using methods described by Constanza et al. (1997) may lead to inaccurate results. However, the Draft EIS will be revised to analyze project impacts/cumulative impacts to ecological services (specifically to nutrients and carbon sequestration

Final Comment Response Record

Costanza, R., R. d'Arge, R. de Groot, S. Farberk, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R.V. O'Neill, J. Paruelo, R.G. Raskin, P. Sutton, and M. van den Belt (1997). The value of the world's ecosystem services and natural capital. Nature 387:253-260.

Final Panel BackCheck Response – FPC23

Concur with Comment

The Panel notes that there are a host of studies that consider the value of agricultural land beyond the dimension of its value in agricultural production. The database known as "Econlit", available at all university libraries, showed well over 100 studies. Costanza et al. (1997) may indeed be inappropriate for many reasons, but this does not mean that the issues should be ignored completely. The Panel agrees that it would be too difficult to quantify the ecological values in monetary terms, but these should be discussed qualitatively.

Final Comment Response Record

Comment: 24
The project's direct and indirect impacts on ecosystem services are not fully addressed.
Basis for Comment:
The DEIS does not contain an evaluation of the ecosystem services that will be directly or indirectly affected by the project. In addition, an economic value has not been apportioned to compensate for the loss of these services. For instance, the DEIS estimates the economic benefit to cropland when water levels are decreased (i.e., implementation of the recommended alternative); however, the report does not contain an estimate of the loss in ecosystem services to bottomland forests and other wetlands associated with that corresponding drop in water level. Furthermore, the indirect impact of the proposed project on downstream ecosystem services, such as flood mitigation or water quality improvement, is also not included in the DEIS.
Significance: Medium
Ecosystem services such as flood prevention, water quality improvement, and carbon sequestration are an important part of the true value of natural ecosystems whether they occur at the project site or downstream.
Recommendations for Resolution:
1. Implement the use of the ecosystem services paradigm in the HGM analysis and other analyses that determine impacts on ecological function. 2. Estimate the ecosystem services that wetlands caused indirectly by the project on downstream and adjacent landscapes. 3. Include the cost of protecting the existing wetlands from potential impacts from proposed project alternatives in the benefit-cost calculations. 4. Include the benefits in the project alternatives that could enhance downstream services such as silviculture or bottomland hardwood forest conservation/management.
Final Evaluator Response to FPC24
Concur **Response to Recommendations** 1. **Adopt.** Current analysis in the DEIS accounts for impacts to identified significant resources. A discussion of ecosystem services would be included in the EIS. 2. **Adopt.** Significant impacts to wetlands were quantified utilizing the HGM model. This method was specifically chosen as "the best available tool" to quantify the partial impacts to wetlands as a result of changes to hydrology (*i.e.*, drop in water level). The HGM includes variables such as detain floodwaters and detain precipitation. The Draft EISD will be revised to include a discussion on downstream and adjacent landscapes. 3. **Adopted.** The avoid and minimize measures were specifically formulated to protect existing wetlands from the proposed project. These avoid and minimize measures are captured in the benefit to cost calculations as a reduction in benefits associated to

Final Comment Response Record

agriculture. We did not quantify ecological values to protecting wetlands in the economic analysis. These were all captured as non-monetary units and converted to project costs if mitigation was required. The Draft EIS will be revised to clarify this point.

4. **Adopted.** As authorized by Congress, the purpose of the project is Flood Risk Management. Although there are numerous projects that could be implemented by USACE, other federal agencies, and the private sector to enhance downstream services, this project is not authorized to do so. Your recommendation specifically mentions bottomland hardwoods and potential for silviculture. Since this project will result in a greater area of forested areas compared to future without project conditions, it is likely that this project will provide the stated benefits. An additional alternative will also be considered in the Draft EIS (See FPC# 16).

Final Panel BackCheck Response – FPC24

Concur

Final Comment Response Record

Comment: 25
It is unlikely that the warm season grass buffers proposed for use on the project channel will be successfully established.
Basis for Comment:
Native warm season grasses and forbs require substantial disturbance such as burning every 3 to 5 years to be successfully maintained. Difficulties in maintaining the desired vegetative communities are exacerbated when the ratio of edge to total patch size is great, such as when the patch is a long narrow strip rather than a square. Because even under ideal conditions (large, >20 ha square plots) it is difficult to maintain warm season grasses, the Panel believes that it is unlikely the establishment of warm season grasses in long narrow buffers would be successful or successfully maintained. Furthermore, because grass buffers do not currently exist in the region, they would not be appropriate for mitigating lost habitat, thus the Panel recommends forested riparian buffers if these areas are to be used for mitigation.
Significance: Medium
Many habitat types can be used as buffers for restoration along riparian corridors, but native warm season grass would be difficult to maintain successfully in such an application.
Recommendation for Resolution:
1. Remove the native warm season grass buffers from use as stream bank mitigation.
Final Evaluator Response to FPC25
Concur **Response to Recommendations** 1. **Not Adopt.** Due to maintenance activities associated with agricultural ditch systems, forested riparian buffers would impede access; however, warm season grass buffers would likely quickly recover from equipment use. In a landscape where agriculture accounts for ≈80% of the landcover, field burning after harvest is a common occurrence and could easily be expanded to burn grass buffers. Wolf (2009) stated that switchgrass provides excellent erosion control when used as filter strips, grass hedges, or cover such as river levee banks. Rinehart (2006) also noted that *switchgrass is an excellent plant to use in riparian buffer strips or on other sensitive lands, as its root system prevents erosion while slowing the travel of surface water, decreasing run-off from agricultural fields, and allowing for greater water infiltration.* It is also important to note that many of the areas proposed for grass buffer establishment are currently being farmed to top bank and the addition of the proposed buffer would improve water quality in the immediate area. Castel et al. (1994) reported that grass buffers 30 feet wide had NH_4-N, NO_3-N and PO_4-P trapping efficiencies between 96 and 99.9%. Based on the teleconference, the comment was based on concerns with overall management, we can incorporate these concerns into the Project Cooperation

Final Comment Response Record

Agreement, monitoring, and adaptive management to ensure that grass buffers are maintained.

An alternative conceptual plan was also discussed that USACE will adopt in the Draft EIS. The plan calls for the following:

1. Installation of previously recommended instream structures that provide low flow habitat.
2. Provide a tree buffer on one side of the channels.
3. Provide a grass buffer on the opposite side of the channel.
4. Place necessary disposal areas for future maintenance outside of the grass buffer.

The grass buffer will be maintained by prescribed burning and or mowing. The grass buffer will serve as a construction right of way for future maintenance but will be reestablished following any maintenance activities. Although grass buffer strips provide outstanding water quality improvements, they do not provide all of the habitat improvements as a tree buffer. Therefore, the Missouri Mitigation Method will be modified to take a less valuable credit for grass buffers.

Castle, A.J., A.W. Johnson and C. Conolly. 1994. Wetland and stream buffer size requirements – a review. J. Environ. Qual. 23: 878-882.

Rinehart, L. 2006. Switchgrass as a bioenergy crop. ATTRA – National Sustainable Agriculture Information Service. https://attra.ncat.org/attra-pub/summaries/summary.php?pub=311

Wolf, D.D. 2009. Planting and managing switchgrass for forage, wildlife, and conservation. Virginia Cooperative Extension, Virginia Tech and Virginia State University. http://pubs.ext.vt.edu/418/418-013/418-013.html

Final Panel BackCheck Response – FPC25

Concur

Final Comment Response Record

Comment: 26
The description of shorebird resources includes inconsistencies and inaccuracies..
Basis for Comment:
The DEIS contains assumptions about shorebird use of the project area that are not accurate. For example, it is stated that "Historically, the project area did not provide any suitable shorebird habitat (DEIS, p. 212)." The Panel believes it is likely, based on general geomorphologic principles, that river scour areas and other similar river features, as well as margins of open wetland areas, provided sparsely vegetated areas suitable for shorebirds before landscape conversion, even though these areas were probably not extensive in the project area. Several places in the DEIS describe historic habitat conditions as having no value for shorebirds. While the historical conditions analysis (Heitmeyer et al 2010, Appendix D) includes an estimation of the former extent of various forested habitat types, other habitats not accounted for in the analysis were likely also present in smaller amounts. For example, river scour areas, depositional alluvial fan areas, recently formed wetlands around river channels, and other features likely to result from the actively meandering main channel could be expected to provide some sparsely vegetated habitat for shorebirds. The statement (DEIS, p. 98) that the area "previously did not attract large flocks of shorebirds" may be accurate, but the places within the DEIS which specifically mention that there was no value for shorebirds should be revised. The DEIS is also inconsistent in its description of shorebird use of the area, and some editing would improve the document in this respect. In Section 3.8.4 (p. 98), it is correctly stated that "Away from coastal areas, most shorebird species forage in areas of sparse vegetation…" In contrast, in Section 4.8.4 (p. 152), it is stated that "By definition, shorebirds frequent coastal areas…" This is a common and understandable misconception of the term "shorebirds." However, as correctly pointed out on p. 98 of the document, many shorebirds migrate through interior areas and use seasonally inundated and sparsely vegetated habitats as foraging areas. Consistent descriptions of the use of the project area by shorebirds would strengthen the document.
Significance: Low
The historical value of the project area for shorebirds should be accurately described so that the resource is accurately represented throughout the DEIS.
Recommendations for Resolution:
1. Remove the statements suggesting that the area did not historically provide any habitat for shorebirds. 2. Remove the statement suggesting that by definition shorebirds frequent coastal areas.

Final Comment Response Record

Final Evaluator Response to FPC26
Concur **Response to Recommendations:** 1. **Adopt.** DEIS will be updated to state that small patches may have historically supported shorebirds. 2. **Adopt.** Removed "that by definition, shorebirds frequent coastal areas" from DEIS.
Final Panel BackCheck Response – FPC26
Concur with Comment USACE has indicated that it will address the recommendations of the Panel on this comment. Under Recommendation 1, the Panel suggests that, rather than saying "small patches of habitat may have historically occurred", which likely understates historical conditions, USACE describe the historic conditions in the project area as including the dynamic feature of river meandering that would be expected to establish appropriate habitat conditions for shorebirds persistently through time.

Final Comment Response Record

Comment: 27
The impacts/benefits to water quality are not thoroughly discussed in the DEIS, nor are they consistently treated in Section 4.11 of the DEIS and Appendix I.
Basis for Comment:
In Ashby et al. (2000), sensitivity analyses were conducted for wetland function factors, export coefficients, constituent concentrations in floodwaters, and the assumed 50 percent reduction in the available load associated with inundation. No sensitivity analyses are presented for the revised export model. The discussion of constituent export in Section 4.11 of the DEIS is confined to decreased export due to capture of winter runoff with the project in place. However, the revised export model in Appendix I calculates net total export for the entire annual cycle, thus including non-winter periods of reduced flooding and periods coinciding with fertilizer applications. These annual constituent export results provide a more complete context for the discussion of water quality impacts. The following appear to be inconsistencies or errors: • DEIS, p. 103 -- It is stated that the project area serves more as a nutrient source rather than a nutrient sink. Appendix I (p. ii) -- It is stated that overall the basin is expected to retain or remove materials from headwaters and floodwaters. • DEIS, Table 4.51 -- The caption refers to Season 1 and Season 2. These seasons are defined in Appendix I, but not in Section 4.11 of the DEIS. • Appendix (p. 5) -- It is stated that the revised export model calculates a net total export for each year. The captions for Table 1 and Figures 3-10 refer to export model results for seasons, not the entire annual cycle. • Appendix I, Equations 1-7 —They contain plus signs instead of multiplication signs and do not show any units for volumes, concentrations, or mass loads. • Appendix I, Equation 3 -- The first term on the right hand side appears to be mass and the second term appears to be mass per unit time.
Significance: Low
Providing results from a sensitivity analysis of the revised export model, and correcting inconsistencies and errors, will strengthen the conclusions of the water quality analysis and improve the organization and readability of the DEIS.
Recommendations for Resolution:
1. Conduct sensitivity analyses for wetland function factors, export coefficients, constituent concentrations in floodwaters, and the assumed 50 percent reduction in the available load associated with inundation. 2. Improve the discussion in Section 4.11 of the DEIS by ensuring that summarized results from each of Sections 3.2, 3.3, 3.4, and 3.5 in Appendix I are incorporated. 3. Improve the discussion in Section 3.3 of Appendix I by integrating the results from Robertson et al. (2009) (cited on p. 103 in the DEIS) on watershed yields of nitrogen and phosphorus.

Final Comment Response Record

4. Include a conceptual diagram of the revised export model.
5. Include a box-and-arrow diagram showing individual constituent mass flux components for each land cover (wetlands, upland, agricultural lands, and "dry land"). It should also include inundation export and trapping fluxes.

Final Evaluator Response to FPC27

Concur

Response to Recommendations: Adopt, Not Adopt, or Adopt in Future

1. **Adopt.** Per discussion with the panel the sensitivity analysis conducted by Ashby et al. (2000) will be re-run for the current analysis.
2. **Adopt.**
3. **Adopt.**
4. **Adopt.**
5. **Adopt.**

Final Panel BackCheck Response – FPC27

Concur

Final Comment Response Record

Volume 3
Part 6.1

Model Certification Review Report for EnviroFish

U.S. Army Corps of Engineers
Memphis District

Battelle
The Business of Innovation

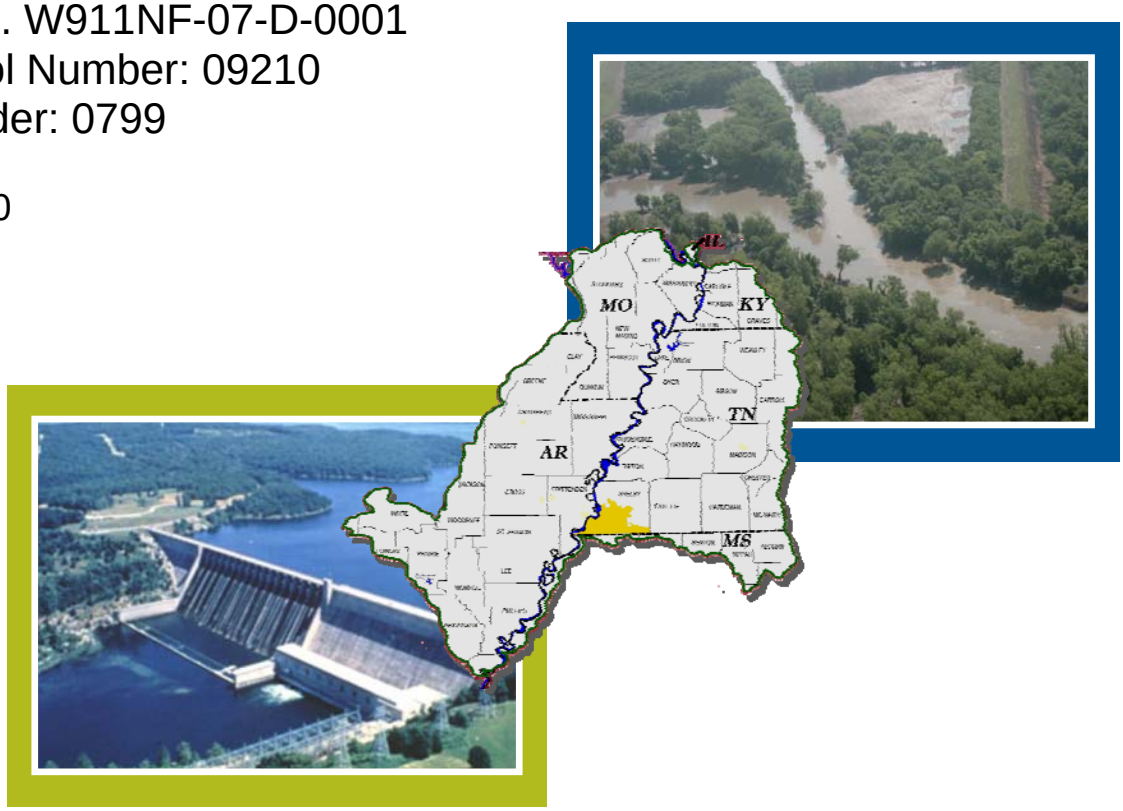
Final Model Certification Review Report for the Enviro Fish Model, Version 1.0

Prepared by
Battelle Memorial Institute

Prepared for
Department of the Army
U.S. Army Corps of Engineers
Ecosystem Restoration Planning Center of Expertise
Mississippi Valley Division

Contract No. W911NF-07-D-0001
Task Control Number: 09210
Delivery Order: 0799

March 5, 2010



SHORT-TERM ANALYSIS SERVICE (STAS)

Final Model Certification Review for the Enviro Fish Model, Version 1.0

Prepared by:

Battelle
505 King Avenue
Columbus, OH 43201

for:

Department of the Army
U.S. Army Corps of Engineers
Ecosystem Restoration Planning Center of Expertise
Mississippi Valley Division

Contract Number: W911NF-07-D-0001
Task Control Number: 09210
Delivery Order Number: 0799

March 5, 2010

Scientific Services Program

The views, opinions, and/or findings contained in this report are those of the authors and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

This page intentionally left blank.

FINAL MODEL CERTIFICATION REVIEW REPORT
for the
Enviro Fish Model, Version 1.0

EXECUTIVE SUMMARY

An independent external peer review of the Enviro Fish Version 1.0 User's Manual and software was conducted for the U.S. Army Corps of Engineers (USACE) Ecosystem Restoration Planning Center of Expertise (ECO-PCX) under Contract Number W911NF-07-D-0001, Task Control Number 09210, to support the process for the certification of the Enviro Fish planning model. The Enviro Fish model is a tool used to evaluate potential changes in available floodplain spawning and rearing habitat for riverine fishes in the Alluvial Lower Mississippi River Valley. It models Average Daily Flooded Area (ADFA) for a project landscape over a given period of time, to which Habitat Evaluation Procedures (HEP) can be applied. HEP was developed by the U.S. Fish and Wildlife Service (USFWS) and other agencies to evaluate the impacts of development projects on fish and wildlife resources, and is now also used to evaluate the impacts and benefits of ecosystem restoration, mitigation, and flood risk management projects, as well as other similar projects that result in changes in ecological habitat. By applying HEP to Enviro Fish model results, changes in potential spawning and rearing opportunities can be measured as a function of changes in ADFA and/or suitability of fish spawning and rearing habitats, reflecting changes in potential spawning and rearing opportunities.

The USACE Planning Models Improvement Program (PMIP) was established in 2003 to assess the state of USACE planning models and to assure that high quality methods and tools are available so that informed decisions on investments in the Nation's water resources infrastructure and natural environment can be made. The main objective of the PMIP is to carry out "a process to review, improve and validate analytical tools and models for USACE Civil Works business programs" (USACE EC 1105-2-407, May 2005). In accordance with USACE's *Planning Models Improvement Program: Model Certification* (EC 1105-2-407, May 2005), certification is required for all planning models developed and/or used by USACE. The objective of model certification is to ensure that models used by USACE are technically and theoretically sound, computationally accurate, and in compliance with USACE planning policy.

As a 501(c)(3) nonprofit science and technology organization with experience in establishing and administering peer review panels for USACE, Battelle was engaged to conduct the model certification review for the Enviro Fish Version 1.0 User's Manual and software. Independent, objective peer review is regarded as a critical element in ensuring technical quality, system quality, and usability of the models. Five subject matter experts (i.e., model reviewers) were selected to serve on the model review panel from more than 37 candidates identified. As appropriate for the technical nature of the Enviro Fish model, the technical expertise of the five selected reviewers included a Habitat Evaluation Procedures (HEP) specialist, two fishery biologists, a hydraulic engineer, and a Java expert.

The model reviewers were provided with an electronic version of the Enviro Fish Version 1.0 User's Manual and the associated Enviro Fish software, along with a charge (included with Attachment A) that solicited their comments on specific aspects of the documentation and model software. The charge questions solicited comments regarding key technical quality, system

quality, and usability criteria that are critical for model review as described in USACE's *Protocols for Certification of Planning Models* (July 2007). A teleconference between the model reviewers and model developers was facilitated by Battelle at the beginning of the review to discuss how to use the Enviro Fish software. Although not strictly prohibited, there was no other communication between the model reviewers and the model developers during the peer review of the Enviro Fish User's Manual and software.

Approximately 140 individual comments were received from the model reviewers in response to 37 charge questions. Following the individual reviews of the model documentation and spreadsheets by the model reviewers, a model review teleconference was conducted to discuss comments on the key model review criteria, discuss charge questions for which there were conflicting responses, and reach agreement on the Final Panel Comments to be provided to USACE. The findings of the model's independent external peer review regarding its technical quality, system quality, and usability are documented in specific sections of this report, and Final Panel Comments are provided in Appendix B.

This Final Model Certification Review Report for the Enviro Fish Model describes the model review process, describes the model review panel members and their selection, and summarizes the findings and Final Panel Comments of the model reviewers. Comments on the Draft Model Certification Review Report were received from USACE on February 9, 2010 after discussions with USACE and the model reviewers during a teleconference held on January 29, 2010. Model reviewers have also provided specific responses to individual comments in a memo sent on March 5, 2010 accompanying this final report. This final report presents the overall results of the model review and will be taken into consideration for certifying or revising the Enviro Fish Version 1.0 User's Manual and software.

Overall, the model reviewers agreed that the Enviro Fish model is well-suited for its intended purpose of evaluating relative changes in potential fish spawning and rearing opportunities. However, the model is not designed to measure these changes directly and it only models changes in ADFA for various habitats or land use types. The current version of the model code and user's manual should be improved. Although the Enviro Fish User's Manual provides a good general description of the model, several issues were identified with the documentation that affect the user's understanding of the model, it's intended purpose, and how it should be applied. Furthermore, evaluation of the Java model code found an interpolation error, showed that the code could be simplified, and demonstrated that additional error checking should be added that could prevent incorrect use of the model. The model review panel recommends the following actions in order to improve comprehension of the Enviro Fish model outputs, confidence in the ability of the Enviro Fish model to achieve its intended purpose, and model usability:

1. Provide a clearer explanation of the model objectives.
2. Provide a brief description in the user's manual of how the Enviro Fish model fits with contemporary theory.
3. Develop a process that allows repeatable, documented Habitat Suitability Index (HSI) values to be assigned.
4. Provide a more detailed explanation of the model assumptions and limitations.

5. Provide a more clear definition of what constitutes functional floodplain and what biologists should consider when they are delineating these areas.
6. Provide a discussion of code testing and model validation.
7. Provide guidance on the data requirements, how to prepare the data for input, the required data sensitivity and precision, and the specific roles of the multidisciplinary team.
8. Provide guidance on how the user could use the output files to actually compute the final metric of Habitat Units (HUs) or revise the model to calculate HUs and Average Annual Habitat Units (AAHUs).
9. Make the software more user friendly by adding labels to the model's inputs and outputs, returning to the project directory, making the software compatible with the current version of the USACE's HEC-DSSVue utility, changing how constraints are applied in the user interface, and making the software more flexible to facilitate accomplishing multiple runs at a time.
10. Fix errors and issues in the programming code and build additional error checks and warnings into the model.
11. Improve model transparency by partitioning the relative contributions of the different limiting factors (minimum and maximum water elevations, deep and shallow nests) to habitat area in the model output and including an example model run in an appendix to the user's manual.
12. Simplify the code by removing redundancies, better organizing the code and separating it by logic classes, separating computations from the output format, providing additional comments, and using Java's libraries.

Failure to address the issues identified may lead to incorrect interpretation and improper use of Enviro Fish outputs. The current version of Enviro Fish can only be set-up and run by experts. The generality and flexibility of the model, coupled with the minimal guidance provided in the user's manual, leave the user responsible for much of the input preparation. Guidance on the preparation of model inputs is necessary for the proper use of Enviro Fish and, ultimately, for the proper interpretation of the meaning of model outputs by a larger user audience. In addition to guidance on preparing model inputs, interpretation of model results can also be enhanced with: (a) more specific statement of objectives in the manual, (b) better labeling of output files, (c) increased transparency by adding example calculations to the manual and by providing information on which depth constraints cause the changes in computed habitat areas, and (d) modifications to the code to make sensitivity and uncertainty analyses easier.

Many of the issues identified by the model review panel stemmed from limited documentation of the model. The user's manual only described the model itself, and this description was limited. The theoretical and scientific bases were not well-documented, and no guidance was provided on how to develop the input data. The model reviewers also strongly suggest simplifying the code and further developing the documentation of the code for easier maintenance of the model software and comprehension of the various functions. Making the recommended revisions will allow better comprehension of the scientific basis and logic behind the model and better comprehension of the model results, promote model transparency, and allow uncertainty and sensitivity analysis to be easily performed. The model will also be better able to achieve its

intended purpose. This is critical for supporting the selection of project alternatives based on model results.

At a minimum, an interpolation error identified in the code needs to be addressed in order for the model software to produce the correct ouput. The model should not be used until this error is repaired. Once this error in the code is addressed, the model reviewers support immediate conditional use of the model only if the following criteria are met:

1. The HSI values used are defensible and developed specifically to represent the habitats being assessed in the project area.
2. The model developers are the ones who will be running the model.
3. The model users coordinate with the appropriate local experts (biologists and hydraulic engineers).

The model reviewers strongly recommend addressing the remaining review comments before the model is certified for widespread use. The model reviewers concur with some of the USACE model developers responses to the Final Panel Comments that assert some of the issues do not need to be addressed for widespread use of the model, although the model reviewers think adopting the suggested resolutions would be desirable to improve model usability. However, there are other Final Panel Comments that need to be addressed, for example, by adopting the suggested changes to the documentation or model code, before allowing widespread use of the model. The details of USACE responses to the Final Panel Comments and the model reviewers' responses to those comments are provided in a memo submitted with this final report on March 5, 2010. The model reviewers highly recommend the changes recommended in the memo be made as soon as possible in order to allow more widespread use of this useful planning tool.

Table of Contents

EXECUTIVE SUMMARY ..... **iii**

ACRONYMS ..... **x**

1.0 Introduction **1**
- 1.1 Model Purpose 2
- 1.2 Model Assessment 2
- 1.3 Contribution to Planning Effort 4
- 1.4 Report Organization 4

2.0 Model Description **5**
- 2.1 Model Applicability 5
- 2.2 Model Summary 5
- 2.3 Model Components 6

3.0 Model Evaluation **7**
- 3.1 Model Review Approach 7
- 3.2 Assessment Criteria 11
  - 3.2.1 Technical Quality 11
  - 3.2.2 System Quality 12
  - 3.2.3 Usability 12
- 3.3 Approach to Model Testing 12
- 3.4 Technical Quality Assessment 12
  - 3.4.1 Review of Theory 12
  - 3.4.2 Review of Representation of the System 17
  - 3.4.3 Review of Analytical Requirements 20
  - 3.4.4 Review of Model Assumptions 23
  - 3.4.5 Review of Ability to Evaluate Risk and Uncertainty 26
  - 3.4.6 Review of Ability to Calculate Benefits for Total Project Life 26
  - 3.4.7 Review of Model Calculations/Formulas 27
- 3.5 System Quality 29
  - 3.5.1 Review of Supporting Software 29
  - 3.5.2 Review of Programming Accuracy 30
  - 3.5.3 Review of Model Testing and Validation 34
- 3.6 Usability 35
  - 3.6.1 Review of Data Availability 35
  - 3.6.2 Review of Results 37
  - 3.6.3 Review of Documentation 39
- 3.7 Model Assessment Summary 42

4.0 Conclusions **43**

5.0 References **46**

Appendix A: Biographic Information for Model Peer Review Panel Experts

Appendix B: Final Panel Comments

1. The model output does not directly calculate Habitat Units (HUs) for a project as presented, but provides the area data needed to complete the HU values needed for a Habitat Evaluation Procedures (HEP) analysis.
2. The development of Habitat Suitability Index (HSI) values is not supported in the documentation.
3. The definition of a functional floodplain needs to be clearly stated.
4. The analytical requirements of the model are identified, but guidance needs to be provided on how to prepare the data for input and the roles of the multidisciplinary team.
5. The limitations on the ability of the model to calculate benefits for project life need to be clearly documented.
6. Errors and issues in the programming code were identified and need to be corrected.
7. Additional error checks and warnings need to be built into the program.
8. Unit testing for the model should be performed if it has not been.
9. Testing of the code and validation of the underlying model needs to be documented.
10. The current model is not a stand-alone product and it is tedious to run for individual or multiple scenarios, rendering it error prone and difficult to use for compensatory mitigation.
11. Checking orphaned nests should apply a constraint, rather than remove a constraint.
12. The assumption that an increase in Habitat Units (HUs) will linearly increase spawning and rearing opportunities is incorrect.
13. The Introduction (Chapter 1) to the Enviro Fish User's Manual should be more informative.
14. While the results of the Enviro Fish model can be understood by a wide range of people, those results can only be generated by experts.
15. The sensitivity of the results is driven by the precision and accuracy of the input data. Unless the precision is known, the sensitivity is unknown.
16. The quality and accuracy of the data required by the model needs to be stated.
17. It needs to be clearly stated that similar input data used for the alternatives analysis should be of the same accuracy and precision.
18. The model is based on well-established habitat suitability theory, but not necessarily contemporary theory.
19. Documentation with the output data should include units of measure.
20. Examples in the fisheries section of the documentation should be expanded to inform decision-makers more about the benefits of the project.
21. The model transparency is limited, and it is difficult to understand why different outputs are generated across scenarios, and this limitation needs to be stated in the documentation.
22. Enviro Fish should be able to work with the current version of DSSVue installed.

23. Model calculations should be moved to either a Model-View or Model-View-Controller design which would separate the model's logic from the user interface.
24. The Enviro Fish code could be made more compact and flexible by using a template engine to separate the model computations from the format of the output.
25. Additional comments should be added to the code to explain what the code is doing and what the programmer's intentions were.
26. There are several instances in the model where the code could be simplified by using Java's libraries, using a more object-oriented design, or taking more advantage of the languages control structures.
27. Java is an object-oriented language, and there are opportunities in the code to define classes that would provide more structure to the code.
28. The Output Path "Browse…" option should default to the last directory that was accessed in a previous run.
29. Output files should not return to the "My Documents" root directory each time the user saves, but should default to the "Output Path" directory.
30. The data for calculating HUs do not stand out in the output.
31. Headers for the two DSS file groups, such as "Daily Stage Data" and "Stage – Elevation Curves," should be included in the main program screen.
32. The term "nests" should be replaced.

Attachment A: Work Plan

LIST OF TABLES

1. Experts Selected for the Enviro Fish Model Review Panel
2. Data Requirements and Disciplines Required for Using the EnviroFish Model

ACRONYMS

AAHU	Average Annual Habitat Units
ADFA	Average Daily Flooded Area
CECW	Corps of Engineers Directorate of Civil Works
CE/ICA	Cost-Effective Incremental Cost Analysis
COI	Conflicts of Interest
DSS	Data Storage System
ECO-PCX	USACE Ecosystem Restoration Planning Center of Expertise
EROS	Earth Resources Observation and Science Center (USGS)
FPC	Final Panel Comments
HEP	Habitat Evaluation Procedures
HGM	Hydrogeomorphic Methodology
HSI	Habitat Suitability Index
HU	Habitat Unit
IEPR	Independent External Peer Review
PCX	Planning Center of Expertise
PMIP	Planning Models Improvement Program
SOW	Statement of Work
STAS	Short Term Analysis Service
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WAM	Waterfowl Assessment Methodology
WRDA	Water Resources Development Act

1.0 INTRODUCTION

Planning models are defined as any models and analytical tools that planners use to define water resources management problems and opportunities, formulate potential alternatives to address the problems and take advantage of the opportunities, and evaluate potential effects of alternatives and to support decision-making. The United States Army Corps of Engineers (USACE) Planning Models Improvement Program (PMIP) was established in 2003 to assess the state of planning models in the USACE and to make recommendations to assure that high quality methods and tools are available to enable informed decisions on investments in the Nation's water resources infrastructure and natural environment. The main objective of the PMIP is to carry out a process to review, improve and validate analytical tools and models for USACE Civil Works business programs. The PMIP Task Force collected the views of USACE leaders and recognized technical experts, and conducted investigations and numerous discussions and debates on issues related to planning models. This task force identified an array of model-related problems, conducted a survey of planning models, prepared papers on model-related issues, analyzed numerous options for addressing these issues, and formulated recommendations.

Use of certified models for all USACE planning activities is mandatory. This policy is applicable to all planning models currently in use by USACE, as well as models under development and new models. District Commanders are responsible for providing high quality, objective, defensible, and consistent planning products. Development of these products requires the use of tested and defensible models. National certification of planning models will result in significant efficiencies in the conduct of planning studies and enhance the capability to produce high quality products. The appropriate USACE Planning Center of Expertise (PCX) will be responsible for model certification. The goal of certification is to establish that USACE planning products are theoretically sound, compliant with USACE policy, computationally accurate, based on reasonable assumptions, and are in compliance with the requirements of the Office of Management and Budget's *Final Information Quality Bulletin for Peer Review* (Federal Register Vol. 70, No. 10, January 14 2005, pp 2664-2677). The use of a certified model does not constitute technical review of the planning product. Independent technical review of the selection and application of the model and the input data is still the responsibility of the users. Once a model is certified, the PCXs will work with model developers and managers to ensure that documentation and training in model use are available and that model updates comply with certification requirements.

The primary criterion identified for model certification is technical soundness. Technical soundness reflects the ability of the model to represent or simulate the processes and/or functions it is intended to represent. The performance metrics for this criterion are related to theory and computational correctness. In terms of the theory, the certified model should: 1) be based on validated and accepted "state of the art" theory; 2) incorporate USACE policies and requirements; 3) properly incorporate the conceptual theory into the software code; and, 4) clearly define the assumptions inherent in the model. In terms of computational correctness, the certified model should: 1) employ proper functions and mathematics to estimate functions and processes represented; and, 2) properly estimate and forecast the actual parameters it is intended to estimate and forecast. Other criteria for certification are efficiency, effectiveness, usability, and clarity in presentation of results. A certified model will stand the tests of technical

soundness based on theory and computational correctness, efficiency, effectiveness, usability and clarity in presentation of results.

An independent external peer review of the Enviro Fish Version 1.0 Model was conducted for the USACE Ecosystem Restoration Planning Center of Expertise (ECO-PCX) under Contract Number W911NF-07-D-0001, Task Control Number 09210. The objective of the review was to evaluate the technical quality, system quality, and usability of the Enviro Fish model in accordance with *Planning Models Improvement Program: Model Certification* (EC 1105-2-407, dated May 31, 2005) and the *Protocols for Certification of Planning Models* (July 2007). USACE's ultimate goal is to certify the Enviro Fish model for use within the geographic area specified in the model documentation. The review did not include a technical evaluation of the application of the model on a specific project.

1.1 Model Purpose

Enviro Fish was developed over a 15-year period, beginning in the early 1990s, to predict the potential response by fish assemblages to altered flood regimes. Enviro Fish can be used to predict changes in functional reproductive fish habitat over large or small geographic areas. It has been applied in the planning of USACE flood management projects in the lower Mississippi River Valley, and continues to be refined and updated. However, the approach is applicable to any alluvial river system where floodplain fish spawning habitat is being managed. It is a tool intended to be used in the selection of project alternatives based on projected changes in area and suitability of habitat for fish spawning and rearing.

1.2 Model Assessment

The main objective of the USACE PMIP is to carry out "a process to review, improve and validate analytical tools and models for USACE Civil Works business programs" (USACE EC 1105-2-407, May 2005). In accordance with the *Planning Models Improvement Program: Model Certification* (EC 1105-2-407, May 2005), certification is required for all planning models developed for and/or used by USACE. The objective of model certification is to ensure that models used by USACE are technically and theoretically sound, computationally accurate, and in compliance with USACE planning policy. Model assessments are conducted in accordance with the USACE *Protocols for Certification of Planning Models* (July 2007).

The following outlines the basic steps of the USACE model certification process, which are designed to guide the model review. Model development is a multi-step, iterative process, with the number of steps and iterations being dependent upon the complexity of the model. In general, these steps occur in four fundamental stages.

- Stage 1 (Requirements Stage) involves identifying the need for a specific analytical capability and the options for tools to meet the need.
- Stage 2 (Development Stage) involves the development of software programming code or a spreadsheet and testing by the model developer.
- Stage 3 (Model Testing Stage) involves a beta test of the model by selected users whose objective is to validate the model and ensure that it is usable in real-world applications.

- Stage 4 (Implementation Stage) involves providing training, user support, maintenance and continuous evaluation of the model.

The certification procedure depends on the stage of model development. The process may include the following steps.

Model reviewers determine whether project needs/objectives are clearly identified and whether the model described is meeting those needs/objectives.

1. Model reviewers evaluate the technical quality of the models (review of model documentation), including whether:
    a. The model is based on well-established contemporary theory.
    b. The model is a realistic representation of the actual system.
    c. Analytical requirements of the model are properly identified and the model addresses and properly incorporates the analytical requirements.
    d. Assumptions are clearly identified, valid, and support the analytical requirements.
    e. USACE policies and procedures related to the model are clearly identified, and the model properly incorporates USACE policies and accepted procedures.
    f. Formulas used in the model are correct and model computations are appropriate and done correctly.
2. Model reviewers evaluate system quality (review by running test data sets or reviewing the results of beta tests) to determine whether:
    a. The rationale for selection of supporting software tool/programming language and hardware platform is adequately described, and supporting software tool/programming language is appropriate for the model.
    b. The supporting software and hardware are readily available.
    c. The programming was done correctly.
    d. The model has been tested and validated, and all critical errors have been corrected.
    e. Data can be readily imported from/into other software analysis tools, if applicable.
3. Model reviewers evaluate the usability of the model to:
    a. Examine the data required by the model and determine the availability of the required data.
    b. Examine how easily model results are understood.
    c. Evaluate how useful the information in the results is for supporting project objectives.
    d. Evaluate the ability to export results into project reports.
    e. Determine whether training is readily available.
    f. Determine whether user documentation is available, user friendly and complete.
    g. Determine whether adequate technical support is available for the model.
    h. Determine whether the software/hardware platform is available to all or most users.
    i. Determine whether the model is easily accessible.
    j. Determine whether the model is transparent and allows for easy verification of calculations and outputs.

The Enviro Fish model is at Stage 4 in the development process. The model has already been applied for planning projects throughout the Mississippi River Valley. In addition to providing an assessment of the criteria listed above, this review is intended to help with the continued maintenance and evaluation of the model for widespread use. Because Enviro Fish is being reviewed for certification, most of the assessment criteria are being evaluated by independent external peer review; however, some of the assessment criteria can only be evaluated internally by USACE, including whether the model complies with USACE policy and procedures, the model is easily accessible, training is readily available, and adequate technical support is available.

The level of effort for a model review depends on the complexity of the model developed, the risks associated with planning decisions made using the model, and the stage of model development. Enviro Fish has undergone an intermediate level of review based on the model's intermediate level of complexity relative to other planning models. The intermediate level of review, which is the subject of this report, included an Independent External Peer Review (IEPR) of the Enviro Fish User's Version 1.0 and software and limited model testing.

1.3 Contribution to Planning Effort

The USACE planning regulations require that ecosystem restoration benefits be estimated. Benefit results are included in a Cost-Effective Incremental Cost Analysis (CE/ICA) to determine the best project for implementation. As stated in the user's manual, "Enviro Fish has been developed with the intent of making a powerful, physically-based technique for modeling fish spawning and rearing available to a wide range of stakeholders drawn from government, academia, environmental organizations, and the communities for which water resources and environmental projects are planned."

1.4 Report Organization

This report is organized into the following sections:

Section 2.0 Model Description — Describes the applicability of the Enviro Fish model and summarizes the model inputs and components.

Section 3.0 Model Evaluation — Describes the model review approach, including the review process and the criteria used to assess technical quality, system quality, and usability; and describes the results of the model assessment.

Section 4.0 Conclusions — Summarizes the overall conclusions of the model review.

Section 5.0 References — Lists the references used for this model assessment and referenced from the model documentation.

Appendix A – Contains biographic information on the expert model review panel members selected to perform the review of the model.

Appendix B – Contains the Final Panel Comment forms, which include the key comments from the model review as well as each comment's basis, significance, and recommendations for resolution.

Attachment A – This is the Final Work Plan for the Independent External Peer Review for Certification of Four Ecological Models: Enviro Fish, Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley, Waterfowl Assessment Methodology (WAM), and the Delta Region of Arkansas Hydrogeomorphic Methodology (HGM) Guidebook. This workplan contains the final charge guidance and questions to the model reviewers to guide the review of the models and model documentation.

2.0 MODEL DESCRIPTION

2.1 Model Applicability

Enviro Fish can be used to assess whether a flood control alternative, restoration/mitigation activity, or other water allocation decision would have positive or negative effects on floodplain fish spawning and rearing habitat. Different alternatives can be compared during project planning, which is consistent with standard USACE policy. Provided enough data are available, or may be synthesized, the Enviro Fish approach can be applied to a wide range of project alternatives, including existing conditions, future without project conditions, particular project alternatives, and pristine conditions. If project impacts are to be mitigated within the project landscape, the Enviro Fish approach may be applied to the mitigation area itself to evaluate the value of the mitigation as affected by project-induced changes in hydrology and hydraulics.

2.2 Model Summary

Enviro Fish is both a modeling approach and computer software. The Enviro Fish modeling approach estimates the value of floodplain habitat suitable for fish spawning and rearing under certain hydrologic and hydraulic conditions. The Enviro Fish software is a Java computer program that implements the modeling approach. Enviro Fish integrates the reproductive needs of fish with the reproductive opportunities afforded by a flooded landscape. Reproductive needs are reflected by the reproductive strategy of riverine floodplain fishes, and value is assigned to the different land use types for spawning and rearing of individual fish species, guilds, or the entire assemblage. Reproductive opportunities at a project site are reflected by the hydrology, hydraulics, and the land use types present.

The integration of reproductive requirements with reproductive opportunities is reflected in the model output as average daily flooded area (ADFA) by land use category type. The comparative value of a given land use type is represented by multiplying ADFAs by the weighted reproductive values, called Habitat Suitability Indices (HSIs), assigned to different land use types. This calculation yields the units of measure, Habitat Units (HUs), based on the amount and quality of fish reproductive habitat for each land use type, which culminates in a consolidated measure of habitat for the project landscape as a whole. The response variable, HUs, allows Habitat Evaluation Procedures (HEP) to be used to complete the analysis of project alternatives (USFWS 1980).

2.3 Model Components

The main elements of the Enviro Fish model include:

- The fish species, guild, or assemblage being modeled
- Topography of the project area
- Land use types present
- Water elevation over the floodplain
- Fish spawning requirements
- Fish rearing requirements

Enviro Fish estimates the amount of habitat available for a single species of fish, a guild of fish species with similar reproductive requirements, or for the more general condition of the entire fish assemblage. Topographic information for the area subject to inundation is required to determine how much of the inundated land surface satisfies the adopted habitat constraints for a given water surface elevation. Topography is described by elevation vs. area tables, and suitable reproductive habitat is determined within a contiguous floodplain area as the area of habitat within a selected water depth range during a period of inundation.
The suitability of the area for spawning and rearing within the inundated floodplain is determined by land use type. Land use is categorized to reflect the distribution of surface characteristics across the landscape, and boundaries of the various land uses are delineated on a map of the landscape. When combined with topographic information, elevation vs. land area tables are produced for each land use category. An experienced biologist then classifies land use based on the selected fish species, guild, or assemblage and assigns an HSI value to each land use classification.

Daily changes in water surface elevation during the spawning and rearing seasons determine how much inundated area (by land use type) can be successfully used for spawning and rearing. Analysis over a period of several years is valuable, since the variability between wet, dry, and normal years is reflected in the output.

The spawning period is defined as the total time required for deposition, fertilization, incubation, and hatching of an egg. Fertilization and deposition are considered to occur on Day 1 of the spawning period. Hatching is considered to occur on the final day of the spawning period. The spawning season is defined by the beginning and ending dates, inclusive, on which fertilization and deposition of eggs can be successfully accomplished. This information is combined with information on daily changes in water surface elevation, and minimum and maximum depths required for successful spawning are defined.

Rearing refers to the first period of life of hatchlings, and the rearing season is defined to coincide with the spawning period. Unlike spawning, for which each day of a multi-day spawning period must be satisfactory, each day of rearing is evaluated as an individual instance of a rearing opportunity, without respect to conditions on other days. The Enviro Fish software provides two approaches to model rearing – total rearing depth and restricted rearing depth.

Although the input requirements for Enviro Fish are fairly simple, the preparation of those inputs may be complex. The first body of input required is daily water surface elevations throughout the analysis period for the landscape being analyzed, referred to as "daily elevations." Typically, different project alternatives have different water surface elevation inputs for the same analysis period. The second body of input is a set of elevation vs. area tables, with one table for each category of land use in the landscape. The user sets the habitat constraints, including rearing constraints (maximum and minimum depth), season constraints (period of analysis and spawning period for the species), and spawning constraints (duration, deep nests, maximum depth of deposition, minimum depth of deposition, and orphaned nests).

The outputs produced include daily results for the analysis period (including the date, amount of land area within the floodplain confined by the minimum and maximum rearing depths, daily stage, stage area curves, and daily flooded area) and a summary of results for the entire analysis period (including the averages for restricted rearing, spawning, total rearing, and restricted rearing; minimum and maximum restricted rearing, spawning, stage, and total rearing; and the year corresponding to each season's results). Overall summary results output include averages for season stage, restricted rearing, spawning, and total rearing, as well as maximum and minimum average season stage, restricted rearing, spawning, and total rearing. The Average Daily Flooded Area (ADFA) is the output that is used for the Habitat Evaluation Procedures (HEP) analysis, and this value is multiplied by Habitat Suitability Indices (HSIs) for each land use type present to calculate Habitat Units (HUs) and Average Annual Habitat Units (AAHUs).

3.0 MODEL EVALUATION

USACE requires that planning models be reviewed and certified. The purpose of the review is to evaluate the technical quality, system quality, and usability of the planning models. The results of the model review are used by USACE to determine whether the Enviro Fish Version 1.0 User's Manual and software is of sufficient quality to certify the model for widespread use for projects in the Lower Mississippi River Valley. The ECO-PCX conducted an intermediate level review of Enviro Fish based on its intermediate level of complexity relative to other planning models. It is important to confirm the quality of the model and model results that are being used for making decisions that will ultimately impact the quality of the valuable ecological resources in the study area. As a 501(c)(3) nonprofit science and technology organization with experience in establishing and administering external peer review panels for USACE, Battelle was engaged to conduct the model certification review for the Enviro Fish model and software.

3.1 Model Review Approach

Independent, objective peer review is regarded as a critical element in ensuring the technical quality, system quality, and usability of models used by USACE for planning purposes. Details of the review process and charge guidance are provided in the Revised Final Work Plan for the Independent External Peer Review for Certification of Four Ecological Models: Enviro Fish, Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley, Waterfowl Assessment Methodology (WAM), and the Delta Region of Arkansas Hydrogeomorphic Methodology (HGM) Guidebook (Attachment A). The review consisted of eight tasks, including:

Task 1	Participate in Kick-off Meeting
Task 2	Prepare Work Plan
Task 3	Prepare and Finalize Charge to Model Reviewers
Task 4	Identify Candidate Model Reviewers and Select and Finalize Contracts with Candidate Model Reviewers
Task 5	Conduct Model Assessment
Task 6	Prepare Draft Report for Model Review
Task 7	Participate in Meeting to Discuss Draft Report for Model Review
Task 8	Prepare Final Report for Model Review

Battelle participated in a kick-off teleconference meeting with representatives from the USACE ECO-PCX and the model developers (Task 1). The purpose of the meeting was to allow Battelle to brief USACE on the approach used to conduct the model review and for USACE to brief Battelle on USACE's specific goals and objectives for the model review. Battelle prepared a draft and final work plan, which included charge questions and guidance to the model review panel that were based on the goals and objectives discussed as well as the USACE Statement of Work (SOW) (Tasks 2 and 3).

Battelle initially identified more than 37 candidate model review panel members for the Enviro Fish model review, evaluated their technical expertise, and inquired about potential conflicts of interest (COI). Of those contacted initially, Battelle chose nine of the most qualified candidates based on background, years of experience, and lack of actual or perceived COI (Task 4) and confirmed their interest and availability. Of those nine candidates, five were proposed for the final model review panel and four were proposed as backup model reviewers. These experts were approved by the USACE ECO-PCX (Task 4). The five proposed primary model reviewers constituted the final model review panel. The remaining candidates were not proposed as model review panel members or backup model reviewers for a variety of reasons including lack of availability, disclosed conflicts of interest, or because they did not possess the precise technical expertise required.

One of the model reviewers was replaced shortly after the review kick-off teleconference and receipt of the model review materials because it was determined that, although a programmer/spreadsheet auditor expert with Java experience was requested for the review in the USACE SOW, a Java expert was more appropriate for the review. With the help of the programmer/spreadsheet auditor, a Java programming expert was identified, asked about interest in participating in the review, evaluated for technical expertise and COI, approved by USACE, and subcontracted to perform the review. The final model review panel included:

- A planner/HEP specialist with experience conducting evaluations of projects to achieve ecological benefits.
- Two fishery biologists with experience evaluating fish habitat suitability and knowledge of the Lower Mississippi River Valley fisheries.
- A hydraulic engineer with experience in estimating the effects of flood protection on floodplain hydrology using the HEC-RAS 1-D Flow and associated DSS (Data Storage System) files and conducting ecosystem restoration output evaluations.

- A software programmer with Java experience and experience testing, debugging and auditing computer programs to check for accuracy of formulas and computer code.

Information on the experts selected for the model review panel is summarized in Table 1, and a short biography for each panel member is provided in Appendix A.

Table 1. Experts Selected for the Enviro Fish Model Review Panel

Name	Affiliation	Location	Education	Years of Experience
Planner\Habitat Evaluation Procedures Specialist				
Richard Stiehl	Independent Consultant	AZ	Ph.D. in Environmental Science/Biology	25+
Fishery Biologist				
Charles Rabeni	University of Missouri	MO	Ph.D. in Zoology	37
Fishery Biologist				
Kenneth Rose	Louisiana State University	LA	Ph.D. in Fisheries	24
Hydraulic Engineer				
Lyle Zevenbergen	Ayres Associates, Inc.	CO	Ph.D. in Earth Science	22
Software Programmer/Auditor				
Robert Burnham	Tuck School of Business, Dartmouth College	NH	M.A. in Urban Affairs	20

After the model reviewers were under subcontract, Battelle conducted a kick-off teleconference to brief the model review panel on the purpose and approach for the review process. Another kick-off teleconference was convened with Battelle, the model reviewers, representatives from the USACE ECO-PCX, and the model developers. This provided the model reviewers an opportunity to be briefed specifically on the model and its intended purpose and provide the model reviewers an opportunity to ask questions directly of USACE. The model reviewers were provided with electronic versions of the review document and software, along with guidance and a charge that solicited their comments on specific aspects of the materials that were to be reviewed.

The following document and software (files names are in *italics*) were provided to the model reviewers for the review.

- Enviro Fish Version 1.0 User's Manual (Draft) (*EnviroFish_User_Manual_10-30-09.pdf)*
- Enviro Fish Version 1.0 software (*envirofish_version_1.0.zip* containing 35 individual files)

Model reviewers were asked to review the Enviro Fish Version 1.0 User's Manual and software. The following additional documents were provided for reference only and were not to be reviewed:

1. Protocols for Certification of Planning Models (http://www.usace.army.mil/CECW/PlanningCOP/Pages/models.aspx)
2. EC 1105-2-407, Planning Models Improvement Program: Model Certification (http://www.usace.army.mil/CECW/PlanningCOP/Pages/models.aspx)

The model reviewers were asked to review the Enviro Fish model and its documentation using guidance and charge questions provided to them. A teleconference with the model reviewers and USACE model developers was facilitated shortly after the model review kick-off teleconference to instruct the model reviewers on how to use the Enviro Fish software because most of the model reviewers had difficulty getting the software to function. It was determined that the underlying problem was that Enviro Fish is not compatible with the most recent version of USACE HEC-DSSVue software, and that an older version of HEC-DSSVue is needed for the Enviro Fish program to work properly. Although not strictly prohibited, there was no other communication between the model review panel and the model developers during the model review process.

The guidance and charge questions are based on the model certification criteria discussed in the USACE *Protocols for Certification of Planning Models* (July 2007). The intent of the charge questions was to focus the review on the assessment criteria that are critical for the certification of planning models. The process and evaluation criteria for the review are outlined in the *Protocols for Certification of Planning Models* (USACE 2007) and described in Section 1.2 of this report.

Thirty-seven charge questions developed by Battelle and approved by USACE were provided to the model review panel in Individual Charge Response Forms to be used by the model reviewers during their review. Following the model reviewers' individual reviews of the Enviro Fish model, Individual Charge Response Forms were compiled into a Merged Charge Response Form that contained all of the model review comments. Approximately 140 individual comments were received.

Battelle identified the key issues based on a review of the 140 comments received. A model review teleconference was facilitated by Battelle to discuss key technical comments and conflicting comments identified in the model review panel's individual comments and reach agreement on the key findings of the review (Final Panel Comments [FPCs]) to be provided to USACE in the Model Certification Review Report. At the conclusion of the teleconference meeting, 34 FPCs had been developed to present the key issues identified during the review of the model software and user's manual. Each of the model reviewers was assigned lead responsibility for developing specific FPCs into a four-part format that included the comment statement, a description of the basis for the comment, the level of significance of the issue, and recommendations for resolution. The model reviewers were also assigned the responsibility of drafting specific sections of the Draft Model Certification Review Report.

With guidance and coordination from Battelle, the model reviewers developed the sections that discuss the results of the model review for the Draft Model Review Report (Sections 3.4 through 3.6). Battelle integrated the individual sections into the report, and the results of the model review are discussed in Sections 3.4 through 3.7 of this final report. Conclusions of the model review are presented in Section 4.0

Battelle also guided the model reviewers on the development the FPCs to ensure that the model reviewers' viewpoints are clearly represented, appropriate for the review, and not duplicated between FPCs. During the development of the FPCs, some of the comment statements were revised, one comment was eliminated, and two of the original FPCs were merged, for a total of 32 FPCs. Final Panel Comments are provided in Appendix B.

Battelle and the model review panel members met via teleconference with the USACE Directorate of Civil Works (CECW) representatives, representatives from the ECO-PCX, and Model Proponents to discuss the Draft Model Review Report at 2:00 EST on January 29, 2010. During the teleconference, the findings of the model certification review, as documented in the draft report and final panel comments, were discussed. Suggested revisions to the draft report have been included in this Final Model Certification Review Report.

3.2 Assessment Criteria

In accordance with the *Planning Models Improvement Program: Model Certification* (EC 1105-2-407, May 2005), the Enviro Fish model was subjected to an independent external peer review. The review was conducted based on guidance in the USACE *Protocols for Certification of Planning Models* (July 2007). As required by USACE (*Protocols for the Certification of Planning Models*, July 2007), this ecological model was reviewed and assessed for technical quality, system quality, and usability. The review of these three criteria is described in the following sections.

3.2.1 Technical Quality

Analytical tools, including models, used for planning purposes need to be technically sound and based on widely accepted contemporary scientific theory. The riverine fish communities in the Lower Mississippi River Valley, and how their spawning and rearing responds to the influence of hydrologic and hydraulic parameters during inundation of the floodplain, must be realistically represented by the model. The architecture of the model calculations must reflect how the system is expected to respond to changes in measured variables based on the application of scientific theory. Formulas and calculation routines that form the mechanics of the models must be accurate and correctly applied, with sound relationships among variables. The model should be able to reflect natural changes as well as the influence of anthropogenic laws, policies, and practices. All model assumptions must be valid and should be well-documented. The analytical requirements of the model must be identified, and the model must address these requirements. The model should also produce robust, reproducible results that stand up to rigorous scrutiny in later stages of the plan formulation process.

3.2.2 System Quality

System quality refers to the quality of the entire system used to develop, use, and support the models, including the software and hardware platform. System quality is generally assessed by testing the hardware and software components, design verification planning for customer acceptance, third party interoperability, compatibility with various hardware and operating systems such as Windows and MacIntosh, and the development of a problem-tracking database. Most of this is done through USACE internal review and tracking. However, some criteria can be evaluated by external peer reviewers. In general, model reviewer evaluation of system quality can include assessing whether supporting software tools/programming language are appropriate for the model, programming is done correctly, software and hardware are available, the model has been tested and validated, and data can be readily imported into other software analysis tools (if applicable). The Enviro Fish model software is a Java computer program, and the review of system quality focused on the accuracy of the code.

3.2.3 Usability

Usability refers to how easily model users can access and run the models, interpret model output, and use the model output to support planning decisions. An assessment of model usability includes evaluating the availability of data required to run the models and the ability of the user to learn how to use the model properly and effectively. Model outputs should be easy to interpret, useful for supporting the purpose of the model, easy to export to project reports, and sufficiently transparent to allow for easy verification of calculations and outputs.

3.3 Approach to Model Testing

Although the model reviewers were not provided with a dataset for testing the use of the Enviro Fish models, limited testing was performed by applying the formulas in the models to sensible and non-sensible test data (i.e., both realistic and impossible variable measures). Some of the formulas were also checked by reproducing the model formulas and calculations in a spreadsheet and evaluating whether the same result could be obtained as with using the Enviro Fish software. Results of the testing approach are discussed in Sections 3.4.7 and 3.5 of this report. The model reviewers' assessment also included a review of the information available in the model documentation and notes associated with the code.

3.4 Technical Quality Assessment

The technical quality assessment was based on an assessment of the criteria described in Section 1.2 of this report. The assessment was based on a review of the Enviro Fish Version 1.0 User's Manual and software provided by USACE. Without knowing all of the relevant USACE policies and procedures, the model reviewers were only able to perform a limited assessment of whether the model properly incorporates USACE policies and procedures. The results of the model reviewers' assessment of the other criteria are summarized in the following sections.

3.4.1 Review of Theory

The Enviro Fish model is based on sound hydrological and ecological theory but would not be considered state-of-the-art in terms of contemporary thinking (FPC #18). This is not considered to be a weakness, as Enviro Fish appears to have been developed as a model that is relatively

simple but realistic enough for most situations and, therefore, widely applicable. Thus, Enviro Fish relies on ideas that are well-established and easy to explain. Contemporary theories are, by definition, still evolving as they are continually being tested and revised. It would be very difficult, if not impossible, to make a state-of-the-art model based on contemporary theory that was widely applicable and easily useable by others. However, it is important that Enviro Fish users know how Enviro Fish fits into the broader picture. The user's manual provides little information about the theory upon which Enviro Fish is based and nothing about how Enviro Fish fits in with contemporary theory. The model reviewers are not suggesting the manual provide a complete, comprehensive discussion of contemporary theory, but additional information should be added to the user's manual that briefly explains the position of Enviro Fish with respect to current thinking about hydrology and fish reproductive responses associated with floodplains. A bibliography would also help for those who want to learn more, and those references cited at the end of this section could be included. When the user and the general audience are more informed, it is more likely that Enviro Fish will be applied and interpreted correctly.

The hydrologic component of Enviro Fish allows for a variety of techniques to be used to generate the model inputs of daily stage and elevation-area relationships because these relationships are determined external to the Enviro Fish code. The use of a standard input format (HEC-DSS) is also helpful because it ensures that, regardless of how the inputs are generated, the appropriate sets of values are used in Enviro Fish (i.e., must conform to the DSS format). Little guidance is provided in the Enviro Fish User's Manual on the various approaches available to generate the daily stage and area-stage relationships. It is up to the user to determine the approach for estimating hydraulic model inputs; thus, if the user uses methods that conform to contemporary theory, then one can say that hydraulics in Enviro Fish are based on contemporary theory. For example, the development of daily stage time series can use, in order of increasing complexity, simple rating curves, normal-depth calculations, HEC-RAS steady-state modeling, HEC-RAS (or other) hydrodynamic modeling, and 2-dimensional and 3-dimensional hydraulic and hydrodynamic modeling. Once the hydraulic modeling is complete, the daily stage record is then easily stored in HEC-DSS format. Similarly, because elevation-area curves are developed externally to Enviro Fish, it is up to the user to generate these values prior to running Enviro Fish. Therefore, as the knowledge base expands and the theoretical basis for what constitutes functional floodplain becomes more complex, the development of the elevation-area curves can become more detailed and involved. Therefore, from the standpoint of hydraulic data requirements, an advantage of the Enviro Fish model is that the level of analysis can range from simple, well-established approaches to very contemporary approaches, depending on the requirements, data availability, and complexities of a specific project.

At a more fundamental level, there are some aspects of the hydraulics of Enviro Fish that, based on contemporary theory, may be too simplified for some applications. For example, if the biological questions and the system being modeled require that the spatial arrangement of the land use types and their proximity to the river (i.e., connectivity) be explicitly considered, then it is difficult to use Enviro Fish. The issue of connectivity as part of contemporary theory has been discussed by others (Bunn and Arthington 2002; Junk and Wantzen 2004; Schiemer 2000). When connectivity is important to the biology, Enviro Fish output would need to be extensively adjusted in post-processing, or more likely, the hydraulics of Enviro Fish, which ignores

connectivity, would likely need to be replaced with spatially-explicit approaches. This would also require extensive data being available to support the spatially-explicit hydraulic and hydrodynamics modeling. Other models being used to generate hydrologic and hydraulic inputs to Enviro Fish are described above. In order for the models to reflect contemporary theory, the other models could replace the hydraulics of Enviro Fish, and essentially the user would not be using the Enviro Fish model but rather a new model based on a different set of assumptions about hydraulics, and likely a different set of calculations to quantify the fish reproduction response.

The biological component of the Enviro Fish model is also based on well-established theories. It is based on habitat suitability theory, which has a long history, and Enviro Fish appropriately accommodates the systems theory ideas that evaluation of fish reproduction involves the explicit linkage between the river and its associated floodplain (i.e., the Flood Pulse Concept, Junk et al. 1989). The Flood Pulse Concept emerged to complement the older River Continuum Concept (Vannote et al. 1980). The Flood Pulse Concept says that the bulk of animal biomass derives directly or indirectly from the floodplain, rather than from downriver transport of organic matter produced elsewhere (Galat and Zweimuller 2001). The use of habitat suitability is appropriate because it reflects the typical data and information available for many projects, and generates results in a form that is useful for decision-making. People have recognized the distinction between habitat and population abundance, so with proper caveats and in the correct situations, habitat suitability is the best available approach. The explicit treatment of rivers connected to floodplains is also appropriate.

Current thinking about fish reproduction and floodplains has evolved somewhat from the simple, original exposition of the Flood Pulse Concept. Four aspects of contemporary theory not treated by Enviro Fish are multi-factor interactions, spatially-explicit modeling, full life cycle effects, and species interactions. As the model developers state, the basis of Enviro Fish goes back to the early 1980s. Enviro Fish appropriately focuses on water depths (i.e., single factor analysis), but has little discussion about how other environmental variables (e.g., temperature) may be important. Fish reproduction can be influenced by multiple factors, which can have variable influence over time and space and interactive effects on reproductive success. For example, water temperature and stage can either be highly correlated or almost completely uncoupled from each other (Junk et al. 1989), and these patterns can greatly influence fish dynamics such as growth (Schramm and Eggleton 2006) and food web structure (Winemiller 2004).

Our ability for mapping bathymetry and handling spatially-resolved data, modeling hydraulics and hydrodynamics, and tagging and following fish on fine spatial and temporal scales has greatly increased in the past decade. Spatially-explicit modeling of fish habitat is now possible that was not feasible 10-15 years ago (Ferrier and Guisan 2006; Boisclair 2001). A spatially-explicit approach allows for the spatial arrangement of different habitat patches relative to each other and relative to the river (i.e., connectivity) to be explicitly considered in the analysis. In some situations, river-to-habitat connectivity and habitat-to-habitat connectivity can be an important determinant of species utilization and productivity and biodiversity (Bunn and Arthington 2002; Junk and Wanrzen 2004; Schiemer 2000). In situations where the system is well-studied or controversial decisions need to be made, a spatially-explicit (perhaps even

population-level) approach should be considered in addition to the application of Enviro Fish. The models would complement each other.

Contemporary theory has also moved from single life stage analyses and single-species approaches to more explicit consideration of population level responses and community and food web dynamics. Enviro Fish is very much a single species (or guild) approach, and is even further limited to certain life stages (eggs and rearing stages). Galat and Zweimuller (2001) caution about focusing on a single life stage too much because of potential bottlenecks in other life stages (e.g., habitat limitation, density-dependence) that would cause the population response to differ from what is expected by Enviro Fish's predictions of changes in reproductive habitat. Arthington et al. (2004) discuss various methods for assessing flow effects on the population level. Concepts such as food web structure and stability (Winemiller 2004), holistic (ecosystem) methodologies (Arthington et al. 2004), and ecological integrity (Schiemer 2000) are being increasingly discussed in the context of flow effects on fish in large rivers and their associated floodplains. Ecological integrity includes measures from individuals (e.g., growth, condition) to populations (e.g., year-class strength) to communities (e.g., biodiversity). Johnson et al. (1995) describe how biological interactions can control local species abundance and resource use at small scales.

The user needs to understand how Enviro Fish fits in the bigger picture. Enviro Fish was purposely designed to be widely applicable, and thus focuses on a few primary factors: water depth, seasonality and substrate (land type), ignoring the spatial arrangement of the land use types within the floodplain. Information that would enable the reader to place Enviro Fish within this broader context of contemporary theory is absent from the user's manual.

The model reviewers are not suggesting that Enviro Fish include additional environmental factors beyond what is presented. The water depth, land use type, seasonality, and life stage foci of Enviro Fish are reasonable because these factors are fundamental variable for measuring suitability of fish reproductive and spawning habitat. Furthermore, modeling multiple factors or population dynamics (full life cycle) is not possible in most situations because of limited data, and this would result in a highly complicated model that would require highly specialized skills to implement. One major advantage to Enviro Fish in its current form is that it is useable and understandable by a wide audience. Dealing with species interactions within the life stage of interest is also difficult because our knowledge about predation and competition is also lacking. But these contemporary theory issues should be discussed in the user's manual so that the user has a clear idea of the benefits and limitations of using only a few important variables for measuring habitat suitability and ignoring connectivity issues, and so the user understands where Enviro Fish fits in within contemporary theory.

Although not a comprehensive list, the following are examples of the literature available on relevant contemporary theory.

> Arthington A.H., R.E., Tharme S.O. Brizga, B.J. Pusey, and M.J. Kennard. 2004. Environmental flow assessment with emphasis on holistic methodologies. In: Proceedings of the Second International Symposium on the Management of Large Rivers for Fisheries Volume II. R. Welcomme and T. Petr (eds.). FAO Regional Office for Asia

and the Pacific, Bangkok, RAP Publication 2004/17, pages 37 to 65.

Boisclair, D. 2001. Fish habitat modeling: from conceptual framework to functional tools. Canadian Journal of Fisheries and Aquatic Sciences 58: 1–9.

Bunn, S.E., and A.H. Arthington. 2002. Basic principles and ecological consequences of altered flow regimes for aquatic biodiversity. Environmental Management 30: 492–507.

Ferrier, S., and A. Guisan. 2006. Spatial modeling of biodiversity at the community level. Journal of Applied Ecology 43: 393–404.

Galat, D.L. and I. Zweimüller. 2001. Conserving large-river fishes: Is the highway analogy an appropriate paradigm. Journal of the North American Benthological Society 20: 266-279.

Johnson, B.L., W.B. Richardson, and T.J. Naimo. 1995. Past, Present, and Future Concepts in Large River Ecology. BioScience 45: 134-141.

Junk, W.J., and K.M. Wantzen. 2004. The flood pulse concept: new aspects, approaches and applications - an update. . In: Proceedings of the Second International Symposium on the Management of Large Rivers for Fisheries Volume II. R. Welcomme and T. Petr (eds.). FAO Regional Office for Asia and the Pacific, Bangkok, RAP Publication 2004/17, pages 117 to 140.

Junk, W.J., P.B. Bayley, and R.E. Sparks. 1989. The flood pulse concept in river-floodplain ecosystems. In Proceedings of the International Large River Symposium, D.P. Dodge (ed.). Canadian Special Publications in Fisheries and Aquatic Sciences 106: 110–127.

Schramm, H.L, and M.A. Eggleton. 2006. Applicability of the flood-pulse concept in a temperate floodplain river ecosystem: thermal and temporal components. River Research and Applications 22: 543–553.

Scheimer, F. 2000. Fish as indicators for the assessment of the ecological integrity of large rivers. Hydrobiologia 422/423: 271–278.

Winemiller, K.O. 2004. Floodplain river food webs: generalizations and implications for fisheries management. In: Proceedings of the Second International Symposium on the Management of Large Rivers for Fisheries Volume II. R. Welcomme and T. Petr (eds.). FAO Regional Office for Asia and the Pacific, Bangkok, RAP Publication 2004/17, pages 285 to 310.

Vannote, R.L., G. W. Minshall, K. W. Cummins, J. R. Sedell and C. E. Cushing. 1980. The river continuum concept. Canadian Journal of Fisheries and Aquatic Sciences 37:130-137.

3.4.2 Review of Representation of the System

The theoretical basis of a model is closely linked to the ability of a model to accurately represent a particular system, which is an obvious prerequisite for its usefulness. Models explain "how something works" and can be of any level of complexity. Increased complexity is often accompanied by greater accuracy but also requires more specialized knowledge. Models are, by definition, abstractions of real-world systems. As such, they are inherently simpler than the ecosystems they represent.

The Enviro Fish model integrates several factors that affect floodplain-spawning fish. The model itself is relatively simple, but the number of factors that must be considered when developing the input for Enviro Fish are quite large. These include habitat suitability (land use/habitat), spawning and rearing requirements (minimum and maximum water depth, flooding duration, and season), hydrology, and other factors that are collectively grouped into the definition of functional floodplain. The definition of functional floodplain is discussed at more length below. The generality of the Enviro Fish model is a strength because the development of input data can be tailored to the needs of a specific project. Its generality can also be a weakness unless effective guidance can be provided for developing the input data to effectively represent the system being modeled.

The degree of realism afforded by a model depends on the question asked, how well it is implemented (i.e., satisfies assumptions), the quality and quantity of the data and other inputs, and proper interpretation of the model results and outputs by the user. A useful model requires a balance between accurately representing the system being modeled and the ability of the intended audience to comprehend model results. When Enviro Fish is used in appropriate situations, with proper implementation, using sufficient data, and with appropriate interpretation of results, it can be considered a reasonably realistic representation of the actual ecosystem. Because the Enviro Fish model ecosystems are represented using the HEP approach integrated with straightforward hydraulic modeling, the model's conceptual approach and outputs are easily understood by a wide and diverse audience.

However, accuracy can be increased without affecting the understanding of the model outputs. As previously mentioned, the Enviro Fish model is based on the generally-accepted concept of habitat suitability, which has a long history, and Enviro Fish appropriately accommodates the systems concepts that evaluation of fish reproduction involves the explicit linkage between the river and its associated floodplain (i.e., The Flood-Pulse Concept). The model uses the typical data and information available for many projects, and generates results in a form that is useful for making decisions. While the HEP approach, or elements of HEP, has been widely accepted and used for many aquatic situations, especially those involving instream flow analyses, it does rely heavily on ideas that have never been adequately documented to be very accurate in stream/river applications.

Consequently, there are several aspects of the HEP process that can hinder the ability of the model to properly represent the ecosystem. The default HSI values given to the various land types provided with Enviro Fish, which are then multiplied by available acreage to obtain spatially explicit HUs, were obtained primarily from the fisheries literature and professional judgment (a variation of the Delphi Technique). The subjective judgment by biologists of fair,

good, very good, etc., was translated into a score ranging from 0 to1.0 in 0.1 intervals. If empirical evidence is unavailable, an HSI designation of 0.3, for instance, might just as well be 0.2 or a 0.4 because professional judgment cannot be quantified that precisely. A small difference in an HSI value (e.g., 0.1) could result in a 50% difference in HU calculations. This potential subjectivity of HSI values would be problematic if the model were actually used to "estimate the value of floodplain habitat," as stated on page 1-1 of the user's manual, instead of more appropriately for "comparing alternatives" of available floodplain habitat, as stated in other places of the manual. Using the example provided in Chapter 4 to compare outputs, when HSI values were changed in various combinations, there was very little difference in the ratio of existing HUs to alternative HUs. This observation should be incorporated into the user's manual, and it should be clearly stated that the most accurate and useful outputs are those that are used to compare existing conditions with alternatives.

As the U.S. Fish and Wildlife Service (USFWS) recognized when the HEP process was developed, HSIs can be developed three ways: by expert opinion, with use criteria, or with preference criteria. The most accurate method, using preference criteria (more appropriately called "selection" criteria) requires field sampling, preferably at the location of the project. HSIs developed based on expert opinion were always considered by the original USFWS developers as interim measures, as were the default values provided with Enviro Fish, even while they promoted the Delphi technique.

If accurate HSIs are truly valuable, they could be developed for specific projects (FPC #2). A large enough project, such as the one mentioned in the Enviro Fish User's Manual, would justify the relatively small costs to provide the best biological data (i.e., HSI values specific to the taxa and system). If there are ongoing USACE, USFWS, or state assessment programs of floodplain fisheries, it would be simple to organize sampling in a manner to sample replicates of flooded land types over a restricted period using the same gear and methodologies to obtain representative samples so that actual spawning and rearing use, rather than assumed potential spawning and rearing use, of different habitats could be compared to each other on a relative basis. Only then could differences in HSI values (for example, the difference between an HSI of 0.5 and 1.0) be understood in a meaningful way.

Although the Enviro Fish model sufficiently represents the ecosystem being modeled for planning purposes, it should not be misinterpreted as being representative of actual biological conditions or biological potential. Many of the assumptions on which the model and, more specifically, HEP are based are too simplistic to allow estimation of absolute spawning and rearing areas. Enviro Fish should be used to compare changes in areas among alternative scenarios. This needs to be made clear in the user's manual.

It is assumed that an increase in area for any single habitat type with an HSI value greater than 0.0 will linearly increase spawning and rearing opportunities. While technically correct, the implication is that increasing opportunities will increase spawning and rearing and, ultimately, fish abundances. This result has rarely been shown in peer-reviewed literature, but is integral to HEP, where HSI values are multiplied by acreage to obtain HUs (FPC #12). More HUs are considered to be better. There is evidence in the published literature that an increase in favorable

habitat will result in an increase in spawning, but beyond a certain level, the increase in favorable habitat is inconsequential since other factors (fish abundances, food) become limiting.

The general HEP approach also assumes that a large area of poor habitat is biologically equal to a small area of very good habitat. An HSI of 0.1 with 100 acres results in the same potential for fish as 10 acres with a HSI of 1.0. This has not been well substantiated in the peer-reviewed fisheries literature. One HU should not be equal to another in habitat value unless the habitats are exactly the same. In reality, a small area of high-quality habitat is likely to outperform a large number of low-quality habitat areas, even if they both have equal HU values. This assumption allows the potential for rationally choosing a project alternative that provides a lot of corn field stubble and no bottomland hardwood forest over one where bottomland hardwood forest is present in moderate amounts. This assumption precludes the model from organizing the output to maximize the highest quality habitat type.

The model reviewers recognize the value of using the HEP approach but suggest that the user's manual present additional pathways for determining HUs. This suggestion recognizes that, while experienced biologists may not be able to always agree on an exact quantification of habitat value, they likely agree on what is good habitat versus what is poor habitat. In the example provided in the Enviro Fish User's Manual, by default, cropland is considered low quality (HSI=0.1) without any explanation of why it is considered to be low quality and for what fish species. Carp will do well spawning in cornfield stubble, but many other species will not. Enviro Fish should not allow the opportunity to increase lots of acreage of really poor habitat for an alternative or future situation without regard for the absolute acreage of very high quality habitat. It might be more appropriate to calculate total HUs using only habitats with HSIs greater than some minimum value, for example 0.4. Then planning decisions would be based on changes from what is known to be fair/good habitat to other fair/good habitat because the value of HUs would be much more comparable. Other avenues to correct for very poor or very good habitat (e.g., weighting) should also be considered.

Some aspects of contemporary biological theory for floodplain fish ecology that may hinder highly accurate representation of the ecosystem are multi-factor interactions, spatially-explicit modeling, full life cycle effects, and species interactions because they are not addressed by Enviro Fish. These limitations are discussed in detail in Section 3.4.1, Review of Theory.

Some attention to the concept of "functional floodplain" would help with representation of the biological system within the model (FPC #3). Delineating the functional floodplain is at the core of the Enviro Fish method. Therefore, the manual should provide more complete discussion on what constitutes functional floodplain and what biologists should consider when they are delineating these areas. Without clear direction from the biologist, a hydrologist or hydraulic engineer may erroneously apply a very different definition of functional floodplain than the biologist. Similarly, biologists need input from hydrologists when defining the functional floodplain.

From the discussion in the user's manual, it appears that the starting point for defining the functional floodplain may be the 2-year floodplain, although there could be many other factors that limit and define the functional floodplain. These include physical barriers, proximity to the

river (even the 2-year flood may inundate areas remote from the river, rendering them non-functional), flow velocity (some floodplain areas may convey water at velocities too high for spawning). There are probably other factors that should also be identified as considerations when delineating the functional floodplain.

The topic of "capping the functional habitat area" also factors into this discussion. Presumably, an area of bottomland hardwood that is outside the 2-year floodplain would not be included, and only the area within the 2-year floodplain would be included. For example, at elevation X (corresponding to the 2-year water surface) there is an area of Y. At elevation X+1 the actual area would increase, but the elevation-area table is "capped," or limited, to the value of Y.

The model reviewers suggest that a more accurate representation of the functional floodplain could be achieved by describing the factors that should be considered when delineating functional floodplain areas. This includes defining the methods for determining whether an area is functional floodplain, including an example of a moderately complex situation where the functional floodplain could have been incorrectly delineated, and providing an example of "capping" the area.

While the daily time step is reasonable for most applications, a stronger cautionary note is needed that explains that very flashy systems in which water levels can change in hours would not be well-represented by this model. Commenting on the spatial resolution is more involved because land features are not geo-referenced in the analysis. The model software relies on the cleverness of the user(s) to properly set-up and estimate the stage-area relationships.

Ultimately, model validation would have been useful in determining how representative the model is to an actual ecosystem (FPC #9). It is unclear whether the model has been validated, either by a comparison of model predictions of changes in habitat with spatially-referenced field data or the output of a more detailed model (habitat compared to habitat) or by a comparison of predicted changes in habitat to observed changes in fish reproduction (habitat versus biology).

Nevertheless, the biological sections of the user's manual does a good job in merging ecological concepts with the constraints of limited biological information and the multitude of species in the system. The model appears realistic, or realistic enough, if it is appropriately used in planning situations to compare existing conditions with future alternative conditions and between alternatives, and to facilitate communication among a diverse group of constituents.

3.4.3 Review of Analytical Requirements

The analytical objective of Enviro Fish is to calculate the area of habitat suitable for fish spawning and rearing. This is then used for the quantification of HUs. HUs are the product of HSI values and the ADFA. HSI values range from 0.0 to 1.0 based on the suitability of habitat for fish spawning and rearing. ADFA is the average number of acres over which flooding occurs for a given land use based on a large number of constraints that depend on the requirements of fish species.

Determining HSI values requires an in-depth knowledge of fish ecology, particularly the spawning and rearing requirements of floodplain spawning fish species. However, the Enviro

Fish User's Manual provides default HSI values that were developed from the peer-reviewed literature and based on best professional judgment (FPC #2). The analytical requirements for the development of HSIs are not described. The result is default HUs, less meaningful measures of differences between current and future conditions and between project alternatives, and less sensitive HEP results. An additional section discussing the development of HSI values for Enviro Fish should be developed (FPC #2). This section should not put forward "default" HSI values; instead, the user should be advised to consult with a knowledgeable fishery biologist and collect field data associated with the HSI species model (e.g. spawning season water level, water temperature, percent vegetative cover, percent pools, dissolved oxygen level) to develop more meaningful taxa-specific and site-specific HSI values.

Calculating ADFA is an involved process requiring the expertise of several scientific, engineering, and technical disciplines. Enviro Fish is designed to compute the ADFA using daily stage data, area-elevation data, and spawning and rearing requirements for each species. This involves knowledge and skills in hydrology of rivers and associated floodplains, manipulation of spatially-referenced data (e.g., GIS) related to land use, extrapolation and interpolation methods applicable to time series data (e.g., stage records), the ability to fuse data from different sources, and biological knowledge about the reproduction of key fish species (e.g., quality of different land use types and the effects of water depth).

The Enviro Fish method and code do an excellent job of representing how water depth affects the availability of habitat for floodplain-spawning fish species when stage data and elevation-area data by land use type are available. These data are commonly available for many large project evaluations. The model reviewers are concerned that, given the large number of biological requirements and physical processes that Enviro Fish incorporates, the user's manual does not provide sufficient guidance and discussion on correctly developing the input data for an analysis (FPC #4). In other words, the analytical requirements for the data needed for Enviro Fish are not clear. The data that are needed to meet the analytical requirements are listed below in a hierarchical format:

- HSI (Habitat Suitability Index)
    - Relative quality of different land use types in terms of reproductive success for the fish species (or groups) of concern
    - Mobility, tolerances, and sensitivities of life stages for each species related to reproductive success
    - Community structure to identify key species
    - Habitat requirements
    - Habitat structure (e.g., barriers, edge permeability) that may affect heterogeneous habitats
    - Other constraints stipulated by the multi-disciplinary team (e.g., minimum HSI acceptable, minimum area considered, proximity of compensation areas)
- ADFA (Average Daily Flooded Area)
    - Daily Stage Data
        - Daily Flow Data
            - Historic Record, possibly transformed to the project location

            - Historic Record transformed for existing conditions
            - Historic Record transformed for future project alternative conditions
        - Hydraulic Analysis to convert flows at a gage to stage at the project location
    - Elevation-Area Curves
        - Functional Floodplain definition and constraints
            - Proximity to river
            - Barriers
            - 2-year floodplain
            - Flow velocity
            - Capping the area based on water depth
            - Perched depressions (to be eliminated from the analysis)
        - Land-use data
            - Aerial photography (current and historic)
            - GPS survey
            - Ground truth
        - Topographic data
            - USGS Quadrangles or Digital Elevation Models (DEMs)
            - LIDAR
            - Photogrammetry
            - GPS survey
    - Spawning and Rearing Requirements
        - Season Constraints
    - Spawning Requirements
        - Minimum and Maximum water depths constraints
        - Orphaned and Deep nest constraints
        - Number of consecutive flooded days constraint
    - Rearing Requirements
        - Minimum and Maximum water depth constraints

The user's manual provides little guidance on the analytical requirements for these data that are input to the model (FPC #16 and 17). Although the model does not currently compute HUs within the model code, the model reviewers suggest that it should, which would require the user to input HSIs (FPC #1).

The scientific, engineering, and technical disciplines that will be involved in an Enviro Fish analysis include HEP specialists, fishery biologists, riparian ecologists, hydrologists, hydraulic engineers, and GIS specialists. The Table 2 shows the data requirements and the disciplines that would be involved in developing the input data and interpreting model output predictions.

Table 2. Data Requirements and Disciplines Required for Using the EnviroFish Model

Data Required	HEP Specialist	Fishery Biologist	Riparian Ecologist	Hydrologist	Hydraulic Engineer	GIS Specialist
HSI Values	X	X	X			
Daily Stage				X	X	
Functional Floodplain	X	X	X	X	X	X
Land-Use	X	X	X			X
Topography		X			X	X
Spawning and Rearing Requirements		X				

The members of this multi-disciplinary team must be informed about the analytical requirements of the HEP procedure and the biological requirements of the fish species in order to produce the correct input data for the calculation of ADFA. The primary avenues for this communication are the project-specific definition of the functional floodplain and communication of spawning and rearing requirements. Although careful study of the user's manual could provide each of these disciplines with an idea of the data and analytical requirements, the model reviewers suggest that more detailed and thorough guidance should be provided to each of these disciplines. This is likely available considering the long experience of Enviro Fish being used by experts. Detailed guidance on how to best analyze the data to prepare model inputs would greatly enhance the usability and confidence in Enviro Fish.

3.4.4 Review of Model Assumptions

The assumptions underlying Enviro Fish can be grouped into assumptions about hydrology, fish spawning, and model output post-processing (HSI/HEP) analysis. All models involve assumptions, and that is what makes them approximations of reality. It is very important that the major assumptions be known to model users in order to ensure that the results of Enviro Fish are properly interpreted and correctly implemented. The reviewers are not suggesting that Enviro Fish be changed but rather that the major assumptions should be clearly stated in the user's manual. These assumptions can be addressed quite well in practice, as long as they are explicitly known and a research team comprised of appropriate experts is assembled to implement and interpret Enviro Fish.

Hydrological Assumptions

A major assumption of Enviro Fish is that the definition of a functional floodplain is a valid delineation of the area utilized by fish. The user's manual suggests that the floodplain inundated by the 2-year frequency flood is assumed to be the functional floodplain, although the reviewers are concerned that there may be other considerations. Specifically, if an area of the floodplain is

included that is not accessible by fish or fish can access areas outside of the defined functional floodplain, then predicted changes in suitable habitat will be inaccurate.

The hydrology submodel of Enviro Fish assumes that the water level data and elevation-area relationships for each land use type capture the flooding patterns within the functional floodplain. The accuracy of the water level data is usually sufficient; however, an assessment should be made to determine whether monitored locations are sufficiently representative of the entire floodplain. The accuracy of the derived stage-area relationships can vary significantly as they are dependent on the methods used to estimate the relationships.

Analyses further assume that the historic daily flow and/or stage record can be used directly or modified to project future conditions and that the land use pattern in the functional floodplain will remain the same into the future. The longer the data record, the more likely extreme conditions are captured in the data series. The analyses assume that such water levels observed historically apply in the forward-looking analyses, which can project decades into the future for many projects. Similarly, the analyses assume that the current land use patterns will persist in the future as well. If information is available on how water levels or land use may change, such information should be analyzed as scenarios, with the proper explanation and caveats. The model also assumes that any hydrologic and hydraulic constraints that are not represented in the daily stage record are adequately represented within the definition of functional floodplain. For example, if a fish species spawns in areas with flow velocities less than 1.0 ft/s, then the functional floodplain should exclude areas, regardless of the land use, that have flow velocities greater than 1.0 ft/s.

Biological (fish spawning)Assumptions

Enviro Fish has the advantage of relatively simple biological calculations. While this is one strength of the model, it can erroneously appear to some users that only a few assumptions are needed to conduct the analyses. Enviro Fish makes many assumptions about fish spawning and rearing. A major assumption is that ready-to-spawn fish will respond to rising waters, enter a floodplain, and disperse in the spatial mosaic of multiple habitats according to the quality and quantity of each habitat type. One corollary to this assumption is that the spatial details of the arrangement of the habitat types can be ignored. Other assumptions were already discussed in other sections (3.4.1, Review of Theory, and 3.4.2, Representation of the System). Current fisheries literature suggests that spawning success can also be influenced by habitat size, shape, configuration, proximity, within-habitat heterogeneity at the micro scale, water velocity, and other factors, most of which can be important in different situations but are generally not yet understood well enough to be included in a general model. The representation of fish spawning and rearing in Enviro Fish is reasonable and effective for comparative purposes, but the major biological assumptions underlying the calculations should be clearly stated.

Post-Processing (HSI and HEP Analysis)

Enviro Fish generates output that is then imported into another software package where its output (area as ADFA) is combined with HSI functions to obtain HUs and AAHUs. Enviro Fish uses HSI and the philosophy of HEP, and so carries with it some of the same assumptions that underlie HSI and HEP analyses in general. The validity of HSI and HEP has been discussed in the scientific literature. First, Enviro Fish assumes that a reasonably realistic HSI value can be

determined for the species and system of interest. As discussed in Section 3.4.2, the importance of carefully determining the HSI function is not emphasized enough in the user's manual (FPC #2). As only 20 of the 90 fish species listed in Tables 2.2 and 2.3 in the user's manual have published HSI models, it may be necessary to consult with fishery biologists to develop the HSI models needed for a project.

Second, long-established HEP protocol assumes that an increase in area of any single habitat type with a value greater than zero will linearly increase potential spawning and rearing opportunities (FPC #12). This is generally true of a certain range of habitat areas. When suitable habitat is limiting, then additional habitat will result in a positive response in spawning and rearing. However, it is important to note that spawning can be limited by other factors besides water levels (e.g., egg production, crowding, temperature, substrate type) so eventually more habitat would not result in increased spawning.

Third, even though HEP values are based on *potential* populations, the inference for less informed users may be that more spawning and rearing opportunities will increase spawning and rearing, which would ultimately lead to an increased abundance of the fish species. Enviro Fish only assesses flooding effects on spawning and rearing *opportunities*. Whether increased spawning and rearing opportunities result in more fish over the long term is not determined, as Enviro Fish only quantifies the changes in the amount of suitable habitat available. Increased spawning habitat may have a less than proportional increase in fish because the abundance of fish can be limited by juvenile and adult habitat and by density-dependent responses. For example, more eggs and young can result in crowding of juveniles in their habitat, who then show slowed growth and higher mortality rate that act to negate the increased spawning success.

Fourth, as discussed in Section 3.4.2 (Review of Representation of the System), another assumption of HEP is that a large area of poor habitat is biologically equal to a small area of very good habitat (e.g., a 100 acre area with an HSI of 0.1 results in the same habitat potential for fish as 10 acres with an HSI of 1.0). In reality, small areas of high-quality habitat may outperform a large area of low-quality habitat, even with equal HU values. Because of this assumption, the model may not accurately represent fish spawning and rearing opportunities. Unless model output is carefully reviewed, this assumption has the potential for uniformed users choosing an alternative that provides a lot of cornfield and no bottomland hardwood forest over an alternative where bottomland hardwood forest is present in moderate amounts.

In summary, the assumptions discussed above should be clearly explained in the user's manual to ensure proper implementation of Enviro Fish and proper interpretation of model results. The validity of these assumptions should be assessed on a project-specific basis, keeping in mind that Enviro Fish output is used to make comparisons among scenarios and is not for predicting fish abundances or absolute changes in reproductive success. Enviro Fish is not intended to represent what is actually occurring or could occur within a system, but rather to provide a way to compare flooding effects on habitat suitability among different project alternatives. An enormous amount of responsibility is placed on the model user without much guidance from the model software or user's manual. While a team of appropriate experts would be aware of these assumptions and likely solutions and appropriate caveats, the Enviro Fish model and modeling results are also

meant for a more general audience. These model assumptions should be clearly stated in the user's manual to ensure maximum use of Enviro Fish as a planning tool.

3.4.5 Review of Ability to Evaluate Risk and Uncertainty

Risk and uncertainty have become an important part of USACE analysis and design procedures in recent years, as noted by Moser (1997). Uncertainty is the degree to which responses may deviate from what is projected. The term "risk" is used in many ways to define hazards, losses, and potential problems. Risk is frequently defined as expected losses, generally calculated by combining the probability of system failure with the consequences associated with that failure. This can be computed on a project life or an annual basis. The performance of a project or system is defined as the probability that specific loads will cause the system to fail, and losses are defined as the adverse impacts of that failure if it occurs. In simplified mathematical terms:

Risk = Probability of Failure * Consequences of Failure

Enviro Fish does not appear to have the ability to evaluate any risk or uncertainty associated with the biological assumptions necessary to process the required input data. Because each comparative evaluation is analyzed separately, and multiple simulations are often needed to complete a single scenario, it is impractical to assess risk. If risk and uncertainty are incorporated into the underlying project data, then the model is able to incorporate them, but only with a very large effort and extensive re-running of the model code. Enviro Fish does not seem intended to evaluate risk and uncertainty associated with model outputs.

3.4.6 Review of Ability to Calculate Benefits for Total Project Life

During the project planning phase, USACE is usually required to evaluate the benefits of various project alternatives over the projected life of the project. As the Enviro Fish model does not calculate either HUs or AAHUs, its application as a project planning tool by itself is limited. The model allows a comparison of available fish spawning and rearing habitat between existing conditions and at least two project alternatives; however, relative impacts of project alternatives on fish spawning and rearing habitat are adequately addressed by the Enviro Fish model alone. The model seems capable of evaluating the impacts and benefits of a project, although the output generated requires significant post-processing to calculate HUs and AAHUs, especially if there are time-dependent aspects to the project development and operations (FPC #5).

Relative changes in floodplain habitat quality for fish reproduction are not easily calculated, as there is no convenient way to input any potential changes in either HSI or area values (e.g., from land use changes) that may be predicted over the life of the project. The impacts and benefits can be evaluated to the extent that changes in topography, land use, and daily stage data can be projected over the total project life. Another condition that cannot be predicted for future conditions is water level based on stage record that is developed from historic gage data, which must be addressed on a project by project basis. Although this does not limit the use of Enviro Fish as a planning tool, the model would be more useful for calculating benefits for total project life it is able to directly project changes in the availability of fish reproductive habitat.

3.4.7 Review of Model Calculations/Formulas

The user's manual states (pg. iii) that "Enviro Fish can be used to calculate habitat units for specific floodplain habitats." However, the Enviro Fish model does not calculate HUs. Enviro Fish calculates ADFAs, which is a measure of the area component of HUs. Additionally, Enviro Fish gives only a cursory consideration of HSI determination, providing only a set of "default" HSIs with incomplete documentation of their development. An additional section discussing the development of HSI values for Enviro Fish should be included in the user's manual. This section should not put forward "default" HSI values, but should advise the user to consult with a knowledgeable fishery biologist and recommend the collection of field data on the affected habitats.

ADFAs are calculated for both spawning and rearing habitat. For rearing, land area is included when it is flooded during the season constraint and within the minimum and maximum depth constraints. The same type of calculation is made for spawning, except that an additional constraint is applied such that the water depth constraints must persist for a number of days (i.e., the spawning period). Because the water depth can change over the specified spawning period, the area for spawning can be more limited than for rearing because each spawning event must experience satisfactory conditions over multiple days. Spawning areas (nests) can be lost during the spawning period when water is too shallow (orphaned nests) or too deep (deep nests). The orphaned and deep nests are separate constraints that can be applied independently, together, or not applied.

The model calculations of ADFA were checked using a spread sheet for one daily stage record (Existing Conditions) and one land use (Bottom Land Hardwood – BLH). The ADFAs for spawning, restricted rearing, and unrestricted rearing were checked and the results from the Enviro Fish program were replicated. This test is obviously not exhaustive, but indicates that the calculations of ADFA for spawning and rearing for the sample data can be replicated.
Another test was performed using a set of simple elevation-area curves similar to the BLH data set. The new curves were added to the sample HEC-DSS database using HEC-DSSVue software. Each of the curves included area of 0.0 between elevation 500.0 and 510.0 and increased linearly to an area of 1200.0 at an elevation of 520.0 and remained at 1200.0 for greater elevations. The elevation-area curves differed only in the elevation increment, which included 0.5 ft, 1.0 ft, 2.0 ft and 5.0 ft. The elevation-area curves are shown in the Figure 1 below.

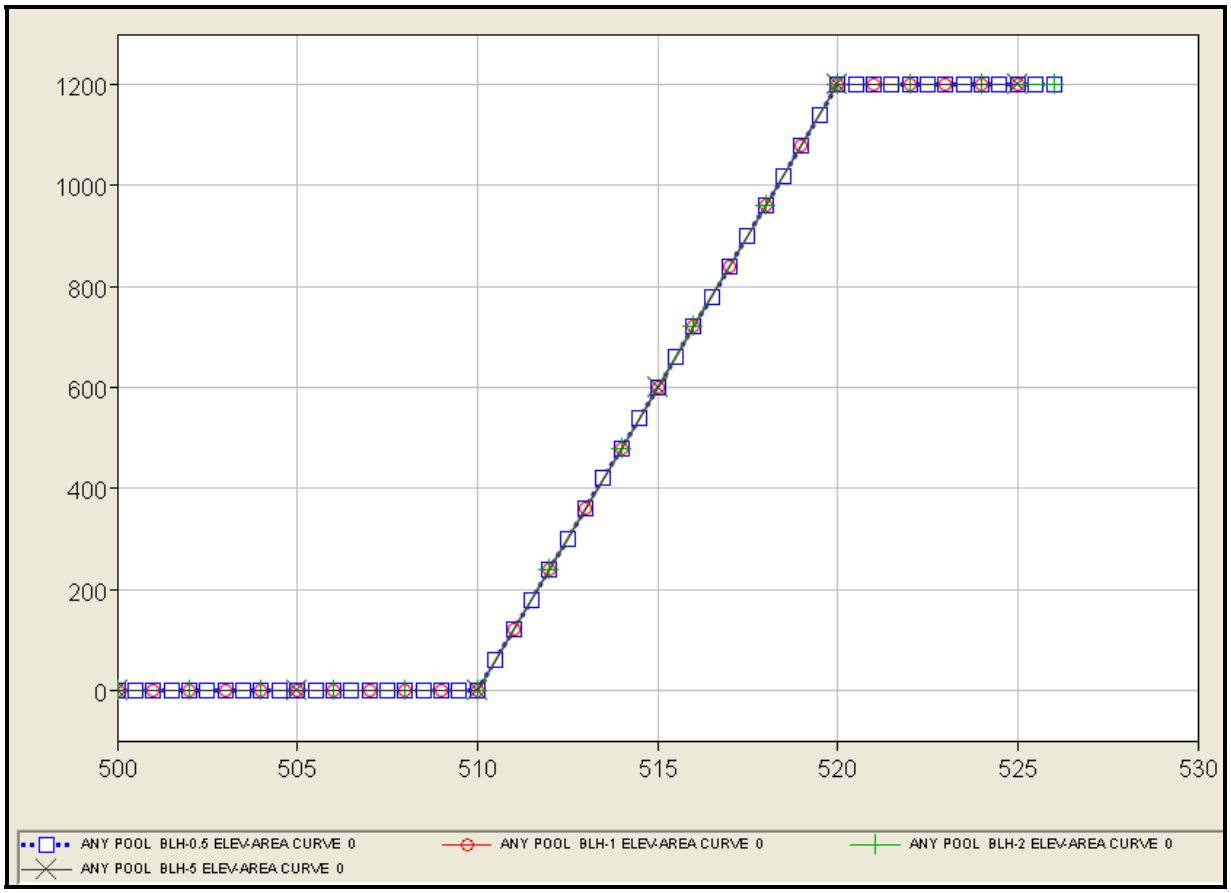


Figure 1. Elevation-Area Curve

Each of the Enviro Fish runs should have produced identical results for these four elevation-area curves. However, different results were generated. The results were checked using the spread sheet and the 1.0 ft increment run was verified as correct. This indicated an interpolation error, which was identified in the Java code (FPC #6) and is discussed in Section 3.5.3.

The calculations and formulas were also tested to determine whether they would use non-sensible data. The software also ran for some non-sensible data. Although the software checked and disallowed minimum depths that were greater than maximum depths, it did not check for negative depths. The software ran for negative depths, which have no physical meaning, and produced results that would be correct if fish were capable of spawning and rearing above the water surface.

Before the model calculations are run, there is one input requirement on the Enviro Fish main screen that is counterintuitive and could lead to incorrectly running and interpreting the model. To apply the orphaned and deep nest constraints, the boxes for these constraints must be left unchecked. A user would have to remember that not applying these constraints requires checking the boxes. Because the area where these boxes resides in the spawning constraints area, users are likely check these boxes when they want to apply the constraints and will produce

ADFAs for the opposite scenario than was intended. The function of checking these boxes should be reversed.

3.5 System Quality

The system quality assessment was based on an assessment of the criteria described in Section 1.2. The assessment was based on a review of the Enviro Fish Version 1.0 User's Manual and software provided by USACE. The results of the model reviewers' assessment of the criteria are summarized in the following sections.

3.5.1 Review of Supporting Software

The model reviewers' broad consensus was that the software supporting the Enviro Fish model produced useful and accurate results with one exception in the interpolation code discussed in Section 3.5.2. However, the model reviewers did find several issues that the model developers should address in terms of making the software more user friendly and adding labels to the model's inputs and outputs (FPC #28, 29, 30, and 31). These include making the software compatible with the current version of the USACE's HEC-DSSVue utility (FPC #22), adding a comprehensive example of software application to the model's documentation, and making the software more flexible to facilitate easy sensitivity analysis of the results.

The Enviro Fish model software uses data stored in the USACE Data Storage System (DSS) format. The USACE's HEC-DSSVue utility is required to edit and manipulate HEC-DSS database files, and Appendix D of the Enviro Fish User's Manual states that "there is not a substitute for using DSSVue in the windows environment." The Enviro Fish software is reportedly incompatible with the current release of HEC-DSSVue, Version 2.0, which was released in August of 2009 (FPC #22). According to the release notes for HEC-DSSVue 2.0, previous installations of HEC-DSSVue are removed by the installer, which makes it difficult for model users to use the new version of HEC-DSSVue and keep a legacy version available for use with the Enviro Fish model. The Enviro Fish User's Manual does not address the version incompatibility, and the older version of HEC-DSSVue is difficult to locate under the "Archived versions" menu on the download page. Updating the Enviro Fish model to be compatible with the current release of HEC-DSSVue would make the using the software more straightforward.

When using the model software, the program saves the path of the last DSS file used using the Java Preferences API. This is a helpful element of the user interface, and the model reviewers recommend that more default values should be made persistent when the model is run (FPC #28 and #29). At a minimum, the output path should not reset to the root directory each time the user saves results. Several model reviewers agreed that the model should also be setup in a way to facilitate a sensitivity analysis of the results. If the model cannot be easily modified to loop over a range of inputs, then having the current inputs made persistent would improve model usability.

The introduction in the Enviro Fish User's Manual would lead most readers to infer that the model calculates habitat units (HUs). The model actually calculates areas and the user is left to use data from the model output and default HSI values to calculate HUs (FPC #1). The important datum (ADFA) for this computation should either be highlighted or extracted and placed in a separate output file. Ideally, developing habitat units should be incorporated into the model so there is direct computation of HEP data for project alternative analysis. The model's

mechanism for exporting data to Excel does not facilitate easy calculation of HUs, and documentation in the user's manual is lacking. The Enviro Fish User's Manual should have an annotated example of how the model should be used in the field. The example should cover all of the steps necessary to use the model effectively, including considerations on the accuracy of the input data, the process of running the software multiple times for different project alternatives, and subsequently analyzing the data and calculating HUs.

The Enviro Fish manual states that "the daily and summary output files can be saved in *.txt, *.csv, and *.xls (Excel) formats." Data can be exported to Excel via the open source Java Excel (JExcel) API. The supported file formats make up the common language for research data, and most analytical software can read at least one of these formats natively. The data load into Excel as expected, but the *.csv files require some manual editing before they can be imported into some statistical packages.

Lastly, the two HEC-DSS data types should be labeled on the user interface for consistency and to clarify the data types to the user (FPC #31). Labels for *HEC-DSS Daily Stage Data* and *HEC-DSS Elevation-Area Curves* should be added to the main form.

Implementing the recommended changes to the software and the accompanying documentation will guide users to employ the software more efficiently and reduce possibilities for user errors. Making the software compatible with the current version of HEC-DSSVue will make the Enviro Fish model more accessible to users. All users would benefit from a comprehensive example of using the software including the post-processing calculation of habitat units.

3.5.2 Review of Programming Accuracy

The model reviewers found several issues in the programming which need to be addressed. Detailed descriptions of the errors are described in FPCs #6 and #7 along with additional suggestions for improving the code throughout the comments.

3.5.2.1 Errors

Dead Stores. One model reviewer replicated the computations for one of the example land uses in a spreadsheet and uncovered an error in the interpolation routine that computes area for a given daily stage. The Enviro Fish software only computes (interpolates) accurate areas when the elevation-area curves are input at 1-ft increments. If a DSS data file contains an elevation-area curve at stage increments other than 1-ft (either smaller or larger) the interpolated values are incorrect. A review of the underlying Java code detected a dead store in the getAreaForStage method which was the source of the problem.
The original source code was:

```
double l = high_stage - low_stage;
double scale = (stage - low_stage) / 1;
```

A new double variable, l, was declared and defined but never used again. The subsequent line defined the scale variable with a division by the number one instead of the just defined l variable. Simplifying the source code as follows eliminated the problem:

```
double scale = (stage - low_stage) / (high_stage - low_stage);
```

There were several other dead stores involving return codes from system operations (e.g., the opening and closing of DSS files or output files). Java was specifically designed so that these types of operations would throw exceptions that the program would have to handle. Unfortunately, the DSS library that the model uses does not appear to throw exceptions, which makes it vital that the program check return values from methods that interact with the system. For example in the following code:

```
// open the interfaces to the dss file
rv = ts.setDSSFileName(lastFile.getAbsolutePath(),true);
rv = pd.setDSSFileName(lastFile.getAbsolutePath(),true);

java.util.Vector paths = new java.util.Vector();

rv = ts.searchDSSCatalog("",paths);
```

The rv variable is set three times in a row and the return values from these methods are never checked. As a result, errors can occur in the program which the user is not informed of. For example, a DSS file can be selected in the file chooser which is not readable by the current user. Selecting the unreadable file triggers an error message from the HEC Data Manager which is echoed to the console and not to the graphical user interface where the user's attention would be. The model should be checking these return values and handling them appropriately.

Incorrect Finalizer. The finalize method defined in MainWindow.java is declared as public. For security reasons the principle is that only the class and derived subclasses should be able to access finalizer methods, thus the method should be declared as protected.

Duplicate code. The runRange method in MainWindow.java has an if-else construct that checks a variable for the same value, negative two, in the if and else statements.

3.5.2.2 Warnings

The source code should be built with the -Xlint command line argument to turn on all recommended warnings. The lint tool will report possible flaws so it might not be necessary to make changes in every instance, but each report should be evaluated and understood to make sure that it is not masking a more serious error. In the Enviro Fish model, the warnings are in a few broad categories:

- Serializeable classes not having a serialVersionUID field
- Potential fall-throughs in switch statements
- Unchecked or unsafe operations

3.5.2.3 Suggested Modifications

The following modifications are suggested to ensure that the software is functioning as intended, to better organize the code for maintenance, and to simplify the code.

Unit Testing. There is no indication that unit testing of the Enviro Fish software code has been performed. If unit tests have not been written for the Enviro Fish model, then this step should be taken. Unit testing involves writing tests for the smallest units of the program, which are classes in Java. Java has mature libraries for writing unit tests; in particular JUnit is an open source industry standard.

Unit testing is considered an essential practice in Java development for several reasons:

- Unit testing ensures that each unit of a program satisfies testing gives increased confidence that the program as a whole is correct.
- Unit testing allows developers to know the anticipated result for a given input. Developers have to work through how their methods will work so that they can make assertions about what the results will be. For example, in order to test a method designed to convert text to upper case the programmer would assert that HELLO would be generated when given hello as an input.
- Unit tests give developers more confidence when modifying their programs. Unit tests provide for what is called regression testing, which ensures that new code generates consistent results.
- Tests are a form of documentation. Unit tests are working and documented examples of how the pieces of a program function.

To facilitate unit testing and improve the overall design of the programming code, the fields and methods related to the model's calculations should be moved into a new class (or several classes) and unit tests should be written for all of the public methods.

Model-View-Controller. Currently, most of the calculations in the Enviro Fish model take place in the MainWindow class which is also responsible for displaying the model's main interface. The model developers should move this logic into its own classes and adopt either a Model-View or Model-View-Controller design which would separate the model's logic from the user interface.

The Model-View-Controller (MVC) design pattern is the dominant methodology for designing programs with user interfaces. The three parts of the design pattern are:

- The Model is part of the program that encapsulates the data and all of the logic (methods, functions) that operates on it.
- The View is the visual representation of the Model which gets input from and delivers output to the user. There can be multiple Views for a particular model. For example, charts and pivot tables can be considered as two different views of a spreadsheet matrix.
- The Controller coordinates exchanges between the Model and the View.

Computational Precision. The computational precision of the model is much greater than the accuracy of the input data (daily stage data or the elevation-area curves). The user's manual should state that the data accuracy should be the same for all alternatives for both land use and stage data. The accuracy of topographic and daily stage data each have similar impact on the accuracy of the results.

There are many places throughout the code where floating-point numbers are divided by integers. It would be preferable to go through the code and ensure that floating-point operations are done consistently on floating-point values. In addition, there should be some checks for the special floating-point values that in Java: NaN (not a number), POSITIVE_INFINITY and NEGATIVE_INFINITY.

Template engine. The Enviro Fish code could be made more compact and flexible by using a template engine to separate the model computations from the format of the output. The logic behind using a template engine is similar to using the MVC design pattern for the graphical user interface; separating the model and view makes each component easier to work with.

The MainWindow class currently has approximately 140 lines of code where output buffers are handled for generating the reports. The majority of this code could be moved out of the Java classes and into template files. There would be two immediate benefits to the separation:

- A change in the structure of the output no longer requires the modification or re-compilation of the code.
- A variety of templates can be generated which present different views of the same data. For example, if the template was marked up with HTML tags then the same program would generate output suitable for the web (or for directly importing into Excel).

Comments. Documentation is a time consuming but essential part of any project. The code does have comments, but adding more documentation to the different methods would be very helpful. Comments should explain what the code is doing it and what the programmer's intentions were. Java has documentation standard called JavaDoc that allows API documentation to be generated automatically from Java source code. Adhering to that standard would allow documentation to be generated in a variety of formats.

Object Orientation. There are several places throughout the program where code is repeated with an identical structure differentiated only in name. For example, the following variables are used by the program to keep track of spawning:

```
private HecDoubleArray yearSpawningArea;
private HecDoubleArray yearMaxSpawningArea;
private HecDoubleArray yearMinSpawningArea;
private HecDoubleArray dailySpawning;
private double sAvg;
private double sMax;
private double sMin;
```

Identical variables are defined for calculating rearing and total habitats, which indicates the

opportunity to simplify the code by creating a new class to encapsulate these fields, and the methods that operate on them. In this instance the class could start with seven fields (yearArea, yearMaxArea, yearMinArea, daily, avg, max and min) and the program could then declare an instance of the class for spawning, rearing and total. Implementing this one class would organize 21 variables into three objects and making the code more concise and maintainable.

There are several other sets of variables that could benefit from being organized into classes including several pairs of minimum/maximum values, and the stageArea and stageData variables.

Idiomatic Java. There are several instances in the model where the code could be simplified by using Java's libraries, using a more object-oriented design, or taking more advantage of the languages control structures.

3.5.3 Review of Model Testing and Validation

Two major aspects of using models such as Enviro Fish is how well has the code been checked to ensure the calculations are done properly (code testing), and how well the model performs in predicting changes in fish reproduction habitat in response to water level fluctuations relative to observed data (model validation). Users and stakeholders often assume the code is correct (i.e., tested) but want to know whether the model has been "validated."

As discussed in the previous section, testing of the model code uncovered several issues. To start, there were few checks on the realism of user-specified inputs. The model will run with non-sensible data inputs, and errors, if generated, are written to the console rather than reported to the user in a file. Input checking should be added to the code to catch unintentional (e.g., typos) and deliberately-incorrect inputs with the intent of minimizing inadvertent user errors. The model reviewers also noted an error in the interpolation scheme, and the non-checking of return codes from system commands (e.g., opening and closing files). As previously mentioned in Section 3.5.2, Review of Programming Accuracy, unit testing should also be implemented to ensure software quality.

The model reviewers did not find any information in the Enviro Fish User's Manual describing validation of the underlying model. If model validation has been performed, then it would be useful to add how the validation was done and provide a summary of the performance of the model (skill assessment). If validation has not been completed then there are two types that could be undertaken:

- Habitat-to-habitat – A comparison of model predictions of changes in habitat area with spatially-referenced field data, or with the output of a more detailed model.

- Habitat versus biology – A comparison of predicted changes in habitat to observed changes in fish reproductive success.

The habitat-to-habitat comparison would involve using data or another model to corroborate the direction and magnitude of predicted changes generated by Enviro Fish. Enviro Fish and a second source of predictions (data or another model) would be run under a known scenario to

determine the degree of agreement in the predicted changes in habitat area. The second source of predictions could be a GIS model that includes hydrology or a hydrodynamics model with bathymetry. Several well-studied locations and species (or guilds) would be identified that had both types of information (i.e., application of Enviro Fish and extensive spatially-detailed data or a spatially-explicit modeling). If the spatially-detailed data were available, then Enviro Fish would need to be set up using these same data to ensure comparability. Similarly, if a spatially-explicit model was available, then Enviro Fish would be configured and inputs estimated using the same data and information that went into the other model. Then several scenarios could be run with both, and their predicted changes in habitat calibrated so that both are predicting the habitat in the same units and at the same temporal and spatial scales (i.e., same level of aggregation).

The habitat versus biology comparison is more difficult to perform than the habitat-to-habitat comparison because the observed biological data includes the effects of many other variables not included in Enviro Fish. High quality biological datasets would need to be identified first, and then Enviro Fish would be applied to those species and locations. Expectations for agreement would be lower for a habitat versus biology comparison than for a habitat-to-habitat comparison because of the effects of environmental variables not considered, and even agreement at the level of direction of change in the habitat versus biology comparisons would be considered as supporting the underlying model of Enviro Fish. Both types of comparisons will greatly enhance the usefulness of Enviro Fish and help in the proper interpretation of its predictions. Although the reviewers believe that Enviro Fish is a reasonable or useful tool for planning purposes, making these comparisons would increase the accuracy of Enviro Fish prediction and users would accept the results with greater confidence.

3.6 Usability

The model usability assessment was based on an assessment of the criteria described in Section 1.2. The assessment was based on a review of the Enviro Fish Version 1.0 User's Manual and software provided by USACE. Model usability was assessed based on data availability, how easily results are interpreted and understood, and how well the model documentation supports and explains the model. The results of the model reviewers' assessment are summarized in the following sections.

3.6.1 Review of Data Availability

There are two types of data that need to be available for the application of Enviro Fish for planning purposes: data for input to the Enviro Fish model to calculate ADFAs and data for calculating HUs and AAHUs for the HEP analysis. The specific analytical requirements are discussed in Section 3.5.3 of this report. Each of these data must be measured, retrieved from other sources, or developed specifically for a project. The section titled "Selecting habitat suitability index values" (beginning on page 2-5 of the Enviro Fish User's Manual) discusses default HSI values and the assumptions on the use of these default values. The constraints for fish spawning and rearing are similar to the HSI data in that the biological requirements, as they relate to flooding depths and durations, must be quantified.

One of the strengths of Enviro Fish is its ability to generate reasonable outputs for a variety of biological organization levels, from entire fish communities (very general outputs) to guilds

(intermediate outputs) to single species(very specific outputs). Appropriate data on spawning and rearing requirements are usually available in the scientific literature for a small subset of species potentially affected by a proposed project. Data for community and guild analyses can be extrapolated from the results obtained for a subset of representative species that are analyzed using Enviro Fish. For example, life history strategies can be used to group similar species, and then the results for a representative species within the group be used to infer how the suite of species might respond. Analyses designed to be truly species-specific should use data unique to that species; rarely are comprehensive data available at the species-level. Basic ecological information for many threatened and endangered fish species is also very limited, and the situation is not much better for invasive species, or even for many recreationally harvested species. Often times extrapolating from "surrogate" species (i.e., closely related species) to the species of interest, for which some data are available, is necessary. The challenge to model users then becomes not necessarily the availability of sufficient biological data to run the model, but rather the quality of the data and how well the species with the data represents the species of interest.

Much of the remaining data, which relates to land use and hydrology, can be developed for the project using standard approaches. Topographic data can be downloaded as DEMs (Digital Elevation Models) from USGS websites; however, the accuracy of USGS DEMs may not be adequate for an Enviro Fish analysis because elevation in USGS DEMs is often accurate only to the nearest meter. More accurate topographic data may be obtained using LIDAR, photogrammetric, and GPS survey techniques because the accuracy is specified as part of the data collection. With each of these methods, within limits, the precision of the extracted data can be specified. Aerial photography for current conditions can be obtained for the project or recent photography can be downloaded from internet sites (e.g., Terra Server, Google Earth). If comparisons need to be made with historic land use conditions, historic aerial photography can be ordered from the USGS Earth Resources Observation and Science (EROS) Center or from the Farm Service Agency. Historic Aerial Photography may also be available within the USACE from the development of river atlases for major waterways.

Hydraulic models will usually need to be developed for the project in order to obtain accurate water surface elevations. The only case when a hydraulic model is not required would be when the project is in the proximity of a USGS gage. The hydraulic models will be needed to determine flooding impacts and benefits of the project and will be well-suited for providing input to the Enviro Fish model. There are often other hydraulic models in existence for other USACE projects or from FEMA flood insurance studies that can be used for an Enviro Fish model.

Depending on the location of the project, hydrologic data may be either readily available or extremely difficult to develop. For large river systems, the daily flow records may be easily downloaded from USGS or USACE gages. These data may be available for a record of many decades. These data will also be available for many smaller river systems. If the project site is very close to a gage, then the daily stage record may be used directly. For other sites the daily flow record will need to be transformed to a daily stage record using a hydraulic model. One difficulty is a project site where no USGS or USACE gage is available and the daily flow record does not exist. In these cases, the daily flow record will need to be generated using gage data from a similar contributing basin and making appropriate adjustments to the data.

A difficulty that applies to all of the data used to derive model input values is adjusting for future conditions. Future conditions may be affected by several factors including changing climate, land-use, topography, and even the land-use quality (as expressed by the HSI value) of an aging land-use type over time. Because the available data for make projections is limited, the future is unknown and unpredictable. Projections are only as good as the data available for making projections. Guidance must be provided in the user's manual on developing future conditions including sensitivity analysis and uncertainty.

A large number of computer runs must be performed for a complete Enviro Fish analysis. This is because the program must be run separately for each alternative daily stage record with each elevation-area curve. This issue is the topic of FPCs #5, 28 and 29. Anything that can be done to make the software more efficient would be welcome to the user, improving the availability of output data to be used for the HEP analysis. Greater efficiency could be achieved by allowing the user to select a flow alternative to be run with a group of area-elevation curves (or an area-elevation curve to be run with a group of flow alternatives).

3.6.2 Review of Results

Enviro Fish is a general model that is appropriate for many situations and generates useful results for evaluating the effects of water level fluctuations on potential fish reproductive success in floodplains. The model is constructed in a very clever way to allow for its applications to many locations and fish species. Enviro Fish is designed to be general so that the user can define the land use types. It also allows for "nests" (i.e., spawning areas) to be evaluated over their natural time duration and permits selection among several options for limiting useable habitat based on water depth constraints. The data needed to estimate model inputs (elevation-area relationships by land use type, time series of water levels) are readily available in many situations. Thus, Enviro Fish was developed so that it could be used to quantify habitat area changes for many situations. Enviro Fish is well-designed in terms of the balance between wide applicability while, at the same time, representing the hydraulics and fish reproduction on reasonably realistic biological, temporal, and spatial scales. Enviro Fish does this and generates useful output variables (i.e., habitat area) for evaluating the effects of water levels on fish reproductive success in floodplains.

Enviro Fish produces output that is well grounded in habitat suitability theory and well-suited for HEP. Both daily and annual values of habitat area are generated for each land use type within each scenario. Such output is easy to explain to people, compact, and therefore easy to interpret and compare among alternative scenarios. Changes in habitat area as a result of different water level scenarios are useful for comparing among alternative projects and for evaluating compensatory mitigation options.

However, there are several aspects of the current version of Enviro Fish related to the generation of results that, if addressed, would increase the model's usefulness. These include more clearly stating the objectives, modifying the existing output files, providing guidance on the development of HSI values, providing simple examples of model calculations to increase transparency, generating additional outputs to allow for better understanding of model results,

providing more guidance on preparing model inputs, and changing the model code to allow for easier sensitivity analyses. Each is discussed in detail below.

First, the objective of the Enviro Fish model should be more clearly stated and expanded in the users' manual. Stating the objective very clearly is important for setting the stage for why the model was constructed and why certain key assumptions were made, and provides context for why the results (outputs) are generated and how to properly interpret them (FPC #13). This is especially important for new users so they use the model appropriately (i.e., as it was intended and designed for), and so that a general audience can best interpret the results.

Second, several modifications to the output files themselves would increase the usability of the results. The output should be labeled with units of measure (FPC #19), and how the user should use the output files to actually compute the final metric of HUs should be clarified (FPC #30). Why Enviro Fish has an HSI function as part of code is not clear, as the HSI is not used; the user applies an HSI as part of post-processing of the output files. However, the results would provide the user with the desired endpoint if the model actually calculated HUs and AAHUs (using the HSI values) rather than simply generating the area values to be used for calculating HUs and AAHUs. Also, the implication that the default HSI values (with vague documentation) should be used to compute HUs (FPC #2) may lead to flawed conclusions as to the overall project impacts.

Third, the usefulness of the model results can be increased by making the model calculations more transparent and by adding a way to partition the relative contributions of the different depth-related constraints to computed areas (FPC #21). The user's manual provides a good description of the model and calculations, but it is unlikely that most users can reproduce the calculations outside of Enviro Fish with the exception of very experienced users or for a few simple cases (part 1 of FPC #21). In general, the more transparent the calculations, the more comfortable users and the general audience are with the generated results. Transparency also results in users and stakeholders properly interpreting model results. Adding an appendix to the user's manual that actually shows the calculations for a limited number of land use types and for a short time period (i.e., a very simplified situation) would increase the transparency of Enviro Fish.

Similarly, understanding why the computed habitat areas differ among scenarios would also lead to increased transparency and better interpretation of model results (part 2 of FPC #21). Presently, Enviro Fish only generates habitat areas in the output files. It is not possible to determine the relative contributions to habitat areas of minimum depth, maximum depth, deep nest option, and shallow nest option based on the output. Knowing which of these is most limiting to habitat can be especially useful when comparing alternative scenarios. It was not obvious to the model reviewers that such calculations are possible in Enviro Fish. If determining the relative contribution of different constraints is possible, then it should be added to the output. If not, and it may well not be possible to do as part of the calculations, then the code should be modified to allow easy sensitivity analysis using multiple runs. Sensitivity analysis can be used to explore how different values of model inputs (e.g., maximum depth; deep nest option on or off) affect the computed habitat areas.

Fourth, model results would be more useful if their uncertainty and sensitivity to the various inputs were easily quantified. Enviro Fish generates point estimates of area (i.e., without any estimate of variability, such as standard errors). The sensitivity of the model results is driven by the precision and accuracy of the input data (FPC #15). This applies to how the floodplain is subdivided; the definitions and identification of land use types; estimation of elevation-area relationships; assumptions about spawning period, development period, and depth constraints; and post-processing of output using HSI relationships. Presently, little guidance is provided in the user's manual on how best to prepare these model inputs to ensure sufficient accuracy and precision so that one knows how to compare the results among scenarios (i.e., what differences in the point estimates are biologically meaningful). In ecological and fishery modeling, the state-of-the-art uses a variety of techniques (e.g., error propagation, Monte Carlo) to assign variability estimates to point predictions. At minimum, sensitivity analysis is practically a requirement. Yet, making multiple runs to explore sensitivity and uncertainty is very cumbersome in Enviro Fish due to the code requiring a run for each land use type within each scenario. This affects the usability of the model, including the results, because it discourages exploratory simulations, and can lead to user error in file management and post-processing of the output files (FPC #10).

Presently, the results of the Enviro Fish model can be understood by a wide range of people; however, the current version of Enviro Fish can only be set-up and run by experts (FPC #14). Balancing a model code to be general and flexible on one hand and user-friendly on the other hand is always a major challenge. Generality and flexibility means much of input preparation is the responsibility of the user, and model runs must be kept simple in scope. The more user-friendly the interface, the easier it is to use the code, but at the cost of generality and flexibility. Interpretation of model results can be enhanced with: (a) more specific statement of objectives in the user's manual, (b) better labeling of output files, (c) increased transparency by adding example calculations to the user's manual and by providing information on which depth constraints cause the changes in computed habitat areas, (d) guidance on preparing model inputs to ensure adequate accuracy and precision of results, and (e) modifications to the code to make sensitivity and uncertainty analyses easier.

3.6.3 Review of Documentation

Documentation for Enviro Fish should involve explanations of the technical aspects for using the computer code, conceptual information on the ecological processes that are relevant to understanding the model, and a brief overview of contemporary theory relevant to the model. Two audiences would then be served:

> Users with an understanding of biology, programming, and engineering, which will be applying the model
>
> Users primarily interested in interpreting the output results.

While the user documentation is well written and provides a good general description of Enviro Fish, it is too limited in describing the model and how to use the code. The documentation should include more information on the relevant biology and guidance on how to prepare model hydrologic and hydraulic data inputs and assess the effects of deviations from key model assumptions. It should also explain how Enviro Fish fits into the bigger picture (i.e., contemporary theory) of assessing flow effects on fish reproduction. This is where case studies,

published example applications, an expanded bibliography, and reports of actual assessments that used Enviro Fish would be very helpful.

Changes to the user's manual helpful to a general audience

The model reviewers believe a stronger Introduction to the user's manual is important to overall understanding and, therefore, effective use of the model. The objective of Enviro Fish, as stated in the user's manual (page 1-2), comes across to the reader as a planning tool which models fish spawning and rearing and is available to a wide constituency. The inadequacies of this statement set the stage for confusion on its scope, on why it is useful to the intended user audience, and what the possible products are. Therefore, the objective of Enviro Fish should more clearly and succinctly state why Enviro Fish was developed, and include the purpose, products, and the intended audience. Otherwise, uncertainty exists, especially on the part of the potential users.

The model reviewers suggest a more inclusive and informative objective statement such as: "The objective of Enviro Fish, a modeling approach and computer software, is to facilitate planning for large-river civil projects by predicting changes in the value of spawning and rearing habitat for floodplain fishes from current to projected future conditions for various project alternatives, in a manner understandable to a diverse constituency." An objective statement of this type is needed to more clearly state the intent and usefulness of Enviro Fish by initially addressing several key issues: that the model is a tool for planning, it predicts opportunities for spawning and rearing fishes to compare present conditions and alternative possibilities, and is intended to be used by a diverse constituency of interested parties and decision makers (FPC #13). The model reviewers suggest that it be made very clear throughout the user's manual that actual implementation of Enviro Fish is best done by a team of experts working together. This is stated in some places in the user's manual but is not consistent with the text in the user's manual in other places that implies Enviro Fish can be "used" by a wide audience.

Once the Objective is more clearly stated, other elements of Chapter 1 should be modified. The Background section should provide more information on why the model was developed. As it stands, it provides background of the model development and how it can be used and also contains some misleading statements. For example, the user's manual states that the model can "predict a quantitative response of the fish assemblage." This can be misunderstood by users, especially those not familiar with habitat suitability theory. The Background section might include ecological information on the importance of floodplain habitats to the river system, and if some projects require modification or elimination of these habitats, then Enviro Fish will assist in planning for mitigation or compensation. The Background section should also provide a brief overview of where Enviro Fish fits in terms of available methods (contemporary theory) for assessing water level effects on floodplain fish reproduction. For example, the issues of multiple factors affecting fish reproduction, connectivity, and life-stage specifics versus higher order (population, community) responses provide an important context for properly selecting and interpreting Enviro Fish. The Method section would be more useful if the series of numbered "bullets" were expanded into a narrative, succinctly explaining the function and the integration of biological and physical information – perhaps referring to Figure 2-1. The Scope section should be expanded and should contain information on model usefulness, strengths, limitations, generality, and assumptions

Chapter 2 also offers many possibilities to increase the overall understanding and usability of Enviro Fish. Because the intended audience (at least for the results) is diverse, a more complete description of individual fish species and guild requirements or preferences for particular variables needs to be included or referenced in the user's manual. A compendium in table form for species and guilds (using Tables 2-2 and 2-3 as a basis) that includes land-use habitat preference, preferred spawning substrates, spawning temperatures, depths for eggs, depths for larvae, and egg incubation time would be useful. At minimum, key sources for this type of information need to be listed. Discussion about Enviro Fish and how it should be applied to recreationally important, threatened and endangered, and invasive species is also needed.

Such additions to the user's manual would make model input choices more understandable to users and stakeholders. Choices on representative species should not simply be left to the biologists. Such information would allow model runs that could point out tradeoffs necessary to promote or deter various species.

While user documentation is fairly complete in terms of running the model, it would be easier for some model users to use if the model did not stop where the output had to be transferred to a spreadsheet by the user in order to develop graphs and tables. Because post-processing is required, the user's manual should provide more information on to properly post-process files.

Changes to the user's manual useful to technical users

To summarize what has been discussed in previous sections of this report, the documentation should go into more detail on how the user should develop the necessary topographic, land use, hydrologic, and hydraulic data (FPC #4). GIS technicians, hydrologists, and hydraulics engineers should be able to generate this information, but there needs to be more guidance on how to do this in a way that results in high quality input data going into Enviro Fish.

Several topics should be discussed in greater detail. These include: (a) more clearly defining the Functional Floodplain, (b) guidance on determining the Functional Floodplain, (c) a better description of the purpose for capping the (limiting) Functional Habitat Area, including examples (distance, barriers, etc.), (d) expansion on the importance of Flowlines, including horizontal versus nearly parallel flow lines (FPC #3).

Documentation of analytical requirements of the model is uneven. Chapter 3 provides sufficient descriptions of the land-use, topographic, and daily stage data, and Chapter 4 provides sufficient descriptions about the input decisions related to depth constraints made by the user that controls the runs. It is reasonably clear what the model is computing; however, an example set of calculations (perhaps in an appendix) would be helpful. It is much less clear how to prepare the data for input to the model to ensure useable results with sufficient certainty are generated.

The model and documentation that is presented is reasonable. However, what is missing presents issues. Missing information includes: (a) background information on habitat suitability and contemporary theory, (b) guidance on implementation (including how closely assumptions need to be met), (c) example detailed calculations, (d) examples of applications to provide a

context and a basis for practical guidance, and (e) examples of validation. Of particular importance to the usability and proper interpretation of Enviro Fish is:

The need for more guidance on preparing model inputs

How to assess if major assumptions are sufficiently met

The consequences of different degrees of violation of the assumptions

Documentation of the Code

The introduction of the User Guide states that "Enviro Fish is a Java computer program facilitating the application of the modeling approach," but no rationale is specifically stated for why Java was chosen as the implementation language.

Documentation of a computer code is a time consuming but essential part of any project. The Enviro Fish code would benefit from more comments explaining how the program is structured and how the logic of each section is intended to work (FPC #25). Currently anyone trying to understand the logic of the program has to go line-by-line through the code and infer what the purpose of each section is. For example, this comment was helpful in understanding the purpose of a loop:

```
//DAY_INCREMENT = 3 minutes, so multiply by 480 so that its one day
for(int a = 0; a < (Integer.parseInt(jDurField.getText()) * 480); a++)
  stopTime.add(HecTime.DAY_INCREMENT);
```

In contrast, this comment added very little explanation:

```
//close the file
ts.close();
```

Java has documentation standard called JavaDoc that allows API documentation to be generated automatically from Java source code. Adhering to that standard would allow documentation to be generated in a variety of formats.

3.7 Model Assessment Summary

A review of the technical quality, system quality, and usability of the Enviro Fish model determined that the model and approach are generally appropriate for the intended purpose of evaluating alternatives for planning projects, but some improvements and corrections to the model code and augmented documentation to guide the user in model development and application is needed. In addressing and answering charge questions designed to focus the review of Enviro Fish based on the model assessment criteria in the USACE *Protocols for Certification of Planning Models*, the following underlying issues were identified:

1. Documentation on the Enviro Fish model's intended use, scientific basis, approach, limitations and assumptions, and outputs is limited (FPC #3 - 5 and #12 - 20).
2. A process for the development of HSIs has not been provided (FPC #2).

3. The current software does not directly apply HEP and only models areas (ADFA) that can be used in HEP analysis to determine HUs based on habitat/land use acreage and habitat suitability for fish spawning and rearing in floodplains (FPC #1).
4. It is not clear whether code testing and model validation have been performed (FPC #8 and #9), and errors and issues were identified in the code that need to be addressed (FPC #6 and #7).
5. The current version of the Enviro Fish software is cumbersome to use and could be made more user friendly by adding labels to the model's inputs and outputs, returning to the project directory after each run, making the software compatible with the current version of the USACE's HEC-DSSVue utility, changing how constraints are selected, and making the software more flexible to facilitate accomplishing multiple runs at a time (FPC #10, #11, #22, #28 - 31).
6. The model transparency is reduced because the outputs are not partitioned by the relative contributions of the different limiting factors (minimum and maximum water elevations, deep and shallow nests) to habitat area in the model output, and no examples of model runs are provided in the user's manual (FPC #14 and #21).
7. The model code is unnecessarily complex (FPC #23 – 27).

These issues affect the ability of users to apply the model and the ability of users, reviewers, and readers to fully understand the scientific basis and logic of the model; how model outputs are linked to on-the-ground changes in fish reproductive habitat; the ability of the model to evaluate changes in fish reproductive habitat for project life; and the ability to perform uncertainty and sensitivity analysis associated with each of the alternatives evaluated. The core aspects of the hydrology and biology of Enviro Fish model are sound and defensible for situations when sufficient data and information on land use, water stage, elevation-area relationships, and reproductive biology of representative species and taxa are available. Many of the issues identified by the model reviewers are the direct result of limited documentation to support the method and the model.

4.0 CONCLUSIONS

Overall, the model reviewers agreed that the Enviro Fish model and approach is appropriate for the intended purpose of evaluating alternatives for planning projects that affect fish reproduction on floodplains. However, there were some errors and issues with the software code, issues identified with the model's documentation, potential difficulties in applying HEP to model results, cumbersome user interface, and limited transparency in model results. In order to improve the usability of the Enviro Fish model and, consequently, the ability of the Enviro Fish to meet the model's objective of evaluating changes in floodplain fish reproductive habitat from implementation of various project alternatives, the model review panel recommends the following actions:

1. Provide a clearer explanation of the model objectives (FPC #13 and 14).
2. Provide a brief description in the user's manual of how the Enviro Fish model fits with contemporary theory (FPC #18 and #20).

3. Develop a process that allows repeatable, documented HSI values to be assigned (FPC #2).
4. Provide a more detailed explanation of the model assumptions and limitations (FPC #5, #12).
5. Provide a more clear definition of what constitutes functional floodplain and what biologists should consider when they are delineating these areas (FPC #3).
6. Provide a discussion of code testing and model validation (FPC #8 and #9).
7. Provide guidance on the data requirements, how to prepare the data for input, the required data sensitivity and precision, and the specific roles of the multidisciplinary team (FPC #4, #14, #16, and #17).
8. Provide guidance on how the user could use the output files to actually compute the final metric of HUs (FPC #30) or revise the model to calculate HUs and AAHUs (FPC #1 and #5).
9. Make the software more user friendly by adding labels to the model's inputs and outputs, returning to the project directory, making the software compatible with the current version of the USACE's HEC-DSSVue utility, changing how constraints are applied in the user interface, and making the software more flexible to facilitate accomplishing multiple runs at a time (FPC #10, #11, #14, #15, #19, #21, #22, and #28 - #31).
10. Fix errors and issues in the programming code (FPC #6) and build additional error checks and warning into the model (FPC #7).
11. Improve model transparency by providing additional model outputs that allow the determination of the different limiting factors (minimum and maximum water elevations, deep and shallow nests) to habitat area in the model output and including an example model run in an appendix to the user's manual (FPC #14 and #21).
12. Simplify the code by removing redundancies, better organizing the code and separating it by logic classes, separating computations from the output format, providing additional comments, and using Java's libraries (FPC #23 – 27).

This list of actions summarizes the recommendations for resolution in the FPCs, and more specific detailed recommendations are provided in the FPCs in Appendix B of this report. Failure to address the issues identified may lead to incorrect interpretation or use of Enviro Fish model and outputs. The current version of Enviro Fish can only be set-up and run by experts. The generality and flexibility in the model leave the user responsible for much of the input preparation. Therefore, guidance on the preparation of model input is necessary for its proper use and, ultimately, proper interpretation of the meaning of model outputs by a larger user audience. Interpretation of model results can also be enhanced with: (a) a more specific statement of objectives in the user's manual, (b) better labeling of output files, (c) increased transparency by adding example calculations to the user's manual and by providing information on which depth constraints cause the changes in computed habitat areas, (d) guidance on preparing model inputs to ensure adequate accuracy and precision of results, and (e) modifications to the code to make sensitivity and uncertainty analyses easier.

Many of the issues identified by the model review panel stemmed from limited documentation of the model. The theoretical and scientific bases were not well-documented, and no guidance was provided on how to develop the input data, making a review of the technical quality of the model difficult. The flow of the calculations in the code also was not well-documented, making it difficult to follow the logic of the model code. The model reviewers also strongly suggest simplifying further development of the documentation of the code for easier maintenance of the model software and comprehension of the various functions. Making the recommended revisions will allow better comprehension of the scientific basis and logic behind the model and better comprehension of the model results, promote model transparency, and allow uncertainty and sensitivity analysis to be performed. The model will also be better able to achieve its intended purpose. This is critical for supporting the selection of project alternatives based on model results.

At a minimum, an interpolation error identified in the code needs to be addressed in order for the model software to produce the correct output. The model should not be used until this error is repaired. Once this error in the code is addressed, the model reviewers support immediate conditional use of the model only if the following criteria are met:

1. The HSI values used are defensible and developed specifically to represent the habitats being assessed in the project area.
2. The model developers are the ones who will be running the model.
3. The model users coordinate with the appropriate local experts (biologists and hydraulic engineers).

The model reviewers strongly recommend addressing the remaining review comments before the model is certified for widespread use. The model reviewers concur with some of the USACE model developers responses to the Final Panel Comments that assert some of the issues do not need to be addressed for widespread use of the model, although the model reviewers think adopting the suggested resolutions would be desirable to improve model usability. However, there are other Final Panel Comments that need to be addressed, for example, by adopting the suggested changes to the documentation or model code, before allowing widespread use of the model. The details of USACE responses to the Final Panel Comments and the model reviewers' responses to those comments are provided in a memo submitted with this final report on March 5, 2010. The model reviewers highly recommend the changes recommended in the memo be made as soon as possible in order to allow more widespread use of this useful planning tool.

5.0 REFERENCES

Arthington A.H., R.E., Tharme S.O. Brizga, B.J. Pusey, and M.J. Kennard. 2004. Environmental flow assessment with emphasis on holistic methodologies. In: Proceedings of the Second International Symposium on the Management of Large Rivers for Fisheries Volume II. R. Welcomme and T. Petr (eds.). FAO Regional Office for Asia and the Pacific, Bangkok, RAP Publication 2004/17, pages 37 to 65.

Boisclair, D. 2001. Fish habitat modeling: from conceptual framework to functional tools. Canadian Journal of Fisheries and Aquatic Sciences 58: 1–9.

Bunn, S.E., and A.H. Arthington. 2002. Basic principles and ecological consequences of altered flow regimes for aquatic biodiversity. Environmental Management 30: 492–507.

Ferrier, S., and A. Guisan. 2006. Spatial modeling of biodiversity at the community level. Journal of Applied Ecology 43: 393–404.

Galat, D.L. and I. Zweimüller. 2001. Conserving large-river fishes: Is the highway analogy an appropriate paradigm. Journal of the North American Benthological Society 20: 266-279.

Johnson, B.L., W.B. Richardson, and T.J. Naimo. 1995. Past, Present, and Future Concepts in Large River Ecology. BioScience 45: 134-141.

Junk, W.J., and K.M. Wantzen. 2004. The flood pulse concept: new aspects, approaches and applications - an update. . In: Proceedings of the Second International Symposium on the Management of Large Rivers for Fisheries Volume II. R. Welcomme and T. Petr (eds.). FAO Regional Office for Asia and the Pacific, Bangkok, RAP Publication 2004/17, pages 117 to 140.

Junk, W.J., P.B. Bayley, and R.E. Sparks. 1989. The flood pulse concept in river-floodplain ecosystems. In Proceedings of the International Large River Symposium, D.P. Dodge (ed.). Canadian Special Publications in Fisheries and Aquatic Sciences 106: 110–127.

Moser, D. A. 1997. The Use of Risk Analysis by the U. S. Army Corps of Engineers. In Proceedings of a Hydrology and Hydraulics Workshop on Risk-Based Analysis for Flood Damage Reduction Studies. Davis, Calif.: U.S. Army Corps of Engineers Hydrologic Engineering Center.

Office of Management and Budget. 2005. Final Information Quality Bulletin for Peer Review. Federal Register Vol. 70, No. 10, January 14 2005, pp 2664-2677.

Schramm, H.L, and M.A. Eggleton. 2006. Applicability of the flood-pulse concept in a temperate floodplain river ecosystem: thermal and temporal components. River Research and Applications 22: 543–553.

Scheimer, F. 2000. Fish as indicators for the assessment of the ecological integrity of large rivers. Hydrobiologia 422/423: 271–278.

USACE. 2007. Protocols for Certification of Planning Models Under the Planning Models Improvement Program (PMIP). July 2007.

USACE. 2005. Planning Models Improvement Program (PMIP): Model Certification. Engineering Circular No. 1105-2-407, May 2005.

USACE. 2000. Planning Guidance Notebook. CECW-P Engineering Regulation No. 1105-2-100, April 2000.

USFWS. 1980. Habitat evaluation procedures. ESM 102, U.S. Fish and Wildlife Service, Washington, DC.

Winemiller, K.O. 2004. Floodplain river food webs: generalizations and implications for fisheries management. In: Proceedings of the Second International Symposium on the Management of Large Rivers for Fisheries Volume II. R. Welcomme and T. Petr (eds.). FAO Regional Office for Asia and the Pacific, Bangkok, RAP Publication 2004/17, pages 285 to 310.

WRDA (Water Resources Development Act). 1996. Public Law 104–303, 110 STAT. 3660 — October 12, 1996.

Vannote, R. L., G. W. Minshall, K. W. Cummins, J. P. Sedell, and C. E. Cushing. 1980. The river continuum concept. Canadian Journal of Fisheries and Aquatic Sciences 37:130-137.

This page intentionally left blank

Appendix A

Biographic Information for Model Peer Review Panel Experts

This page intentionally left blank.

Civil Works Planner/HEP Specialist - Richard Stiehl

Dr. Stiehl earned his Ph.D in environmental science/biology from Portland State University in 1978 and has over 25 years of experience with Habitat Evaluation Procedures (HEP), wildlife biology, avian ecology, and habitat and community modeling. He is currently an independent consultant. He completed his original HEP training in 1981, and the U.S. Fish and Wildlife Service (USFWS_ invited him to write several sections and be the chief editor of the new (and still in use) USFWS HEP Manual. To date, Dr. Stiehl has taught over 30 certified HEP workshops. Other work with USFWS has included revising and/or writing all HEP manuals, rewriting HEP and Habitat Suitability Index (HSI) software, and conducting wildlife research. He has provided HEP expertise to 20 states and many federal agencies, including the USACE, Bureau of Land Management, Natural Resources Conservation Service, and U.S. Environmental Protection Agency, and has led HEP teams on large projects, including HEP analyses for shorebird habitat and the impacts of weapons training for the U.S. Air Force in Utah. After leaving USFWS, he continued his HEP leadership role as a private consultant, constructing community HSI models for riparian, desert, and desert wetland habitats. He has developed software to evaluate long-term impacts to desert ecosystems for the Washington Department of Wildlife and the Columbia Basin Fish and Wildlife Agency. Other high profile HEP projects include consulting with General Electric for Upper Hudson River PCB contamination, New York State for post-9/11 communications network evaluation, and the Theodore Roosevelt Conservation Trust for impacts in central Wyoming gas/oil field development. His experience in the Lower Mississippi River Valley includes his being an assistant and associate professor of biology at Southeast Missouri State University (Cape Girardeau, MO) for ten years and conducting extensive fieldwork in southeastern Missouri on fish and bird populations. Dr. Stiehl also has experience conducting restoration and mitigation analyses for USFWS and tribal lands.

Fishery Biologist - Charles Rabeni

Dr. Rabeni received his Ph.D. in zoology from the University of Maine in 1977 and has over 30 years of professional experience as a fishery biologist. He served as the Leader of the Missouri Cooperative Fish and Wildlife Research Unit from 1985-2008, where he was responsible for administering and conducting research and graduate teaching programs related to natural resource issues involving state and federal stakeholders. Throughout his career, Dr. Rabeni has worked on 50 projects directly related to fishes and their habitats in the lower Missouri/Mississippi River Valley. He has authored or co-authored over 100 papers in peer-reviewed scientific journals, as well as contributing chapters to a number of text books largely focused on fish-habitat relations and habitat analysis. Dr. Rabeni has instructed graduate students on habitat analysis, including HEP and in-stream flow analysis for over 30 years. Dr. Rabeni has had major collaborations with hydrologic and hydraulic modelers, including the development of a hydraulic and process oriented model for classifying aquatic habitat in Ozark streams. Most recently, Dr. Rabeni's research group completed a project, also in collaboration with a USGS hydrologist, to develop a habitat model for spawning river fishes utilizing information on spring flow rates. He has experience in floodplain management demonstrated by his graduate level teaching of watershed management and in some of his written work. He is currently a reviewer of Fish Habitat Evaluation and Habitat Improvement Projects for the Chicago Area Waterways System/Metropolitan Water Reclamation District of Greater Chicago. For the past six years he has served on the national Ecological Processes and Effects Committee

of the EPA's Science Advisory Board charged with evaluating various EPA programs and presenting scientific and technical recommendations directly to the Administrator of the EPA. Dr. Rabeni has worked with the National Park Service (Midwest Region) on numerous issues involving aquatic monitoring and assessment projects, including the Prairie Cluster Park and Heartland Park networks. He served on an expert panel for the USGS's Grand Canyon Monitoring and Research Center to evaluate the existing biological program for the Colorado River. Dr. Rabeni has also been invited to participate in several international joint research efforts and consultations, including as an invited consultant to the China Academy of Sciences to evaluate biological effects of the Three Gorges Dam on the biota of the Yangtze River.

Fishery Biologist - Kenneth Rose

Dr. Rose is the E.L. Abraham Distinguished Professor in Louisiana Environmental Studies at the Department of Oceanography and Coastal Sciences of Louisiana State University. Dr. Rose received his Ph.D. in fisheries science from the University of Washington in 1985, and has been conducting fisheries research at LSU for over 11 years. Dr. Rose has been involved with several projects on the fish and shellfish associated with marsh habitat in the lower part of the Mississippi River Valley. These include modeling the population dynamics of brown shrimp on a 500 x 500 spatial grid configured to represent marsh types. He is currently working on a similar type of model that will represent fish community dynamics (e.g., Gulf killifish, grass shrimp, bay anchovy, silverside, and blue crab) on marshes subjected to fluctuating water levels, as well as a project modeling the responses of the freshwater riverine fish community downstream from the Caernarvon River Diversion in Breton Sound that alters the salinity, water depths, and food productivity. Dr. Rose served as an author on a type of HEP analysis (a summed Habitat Suitability Index approach) used to evaluate how restoration scenarios would affect the habitat for a variety of species endemic to coastal Louisiana. He has been involved with several projects utilizing Habitat Suitability approaches to assess flow fluctuations on fish reproduction, recovery potential of the Moapa dace, and evaluation of large-scale restoration activities for coastal Louisiana. He has regularly collaborated with modelers working to develop 1-D, 2-D, and 3-D hydrodynamics and water quality models, including the Regional Oceanographic Modeling System (ROMS), a widely-used hydrodynamics code, as well as a 3-D water quality model of Chesapeake Bay. He has served as a member of the review panel for the state of California for the Delta Risk Management Study, which focused on events that would cause floodplain flooding due to levee failure. His specific role for that project was to determine how such flooding would affect fish. Dr. Rose currently is a member of the Ecosystem Management Science and Statistical Committee for the Gulf of Mexico Fisheries Management Council. He is a fellow of the American Association for the Advancement of Science and serves as an associate editor for Transactions of the American Fisheries Society, Ecological Applications, Environmetrics, and Canadian Journal of Fisheries and Aquatic Sciences, Marine and Coastal Fisheries, among others.

Hydraulic Engineer - Lyle Zevenbergen

Dr. Zevenbergen earned a Ph.D. in earth science from the University of London in 1989 and has 22 years of experience as a hydraulic engineer. He is a registered professional engineer in six states (AZ, CO, GA, NH, NM, and SC) and is currently the manager of the river engineering department at Ayres Associates, Inc. in Fort Collins, Colorado. While at Ayers, Dr.

Zevenbergen has been responsible for projects requiring computer modeling of hydraulics, hydrology, scour, erosion, and sediment transport. Dr. Zevenbergen combines mathematical modeling and programming skills with in-depth knowledge of fluid mechanics and channel dynamics. His modeling experience includes 1-D and 2-D hydraulic models (WSPRO, HEC-2, HEC-RAS, UNET, FESWMS-2DH, RMA-2V), 1-D and 2-D sediment transport models (HEC-6, HEC2-SR, STUDH), and hydrology models (HEC-1, MULTSED). Dr. Zevenbergen has been involved in numerous floodplain hydrology analyses. For a project with USACE Omaha District, he used the DAMBRK model to simulate a hypothetical failure of Denver's Westerly Creek and Kelly Road dams during a Probable Maximum Flood. Dr. Zevenbergen checked the accuracy of dynamic routing by comparing results of HEC-1 storage routing for a no-failure scenario. The project also required the development of split flow rating curves, use of lateral outflow and inflow options, and utilizing the iterative solution technique. Another project involved Dr. Zevenbergen providing technical oversight of the steady and unsteady hydraulic modeling for the Nassau River Floodplain Study for the USACE Jacksonville District. The project was a floodplain study including data reconnaissance, model development, model calibration, and hydrologic and hydraulic simulation of Nassau River Basin using HEC-HMS, UNET, and HEC-RAS. The Albuquerque Metropolitan Arroyo Flood Control Authority in New Mexico had Dr. Zevenbergen supervising the analysis and design processes related to sediment transport, short-term erosion potential, long-term arroyo shifting, and countermeasure design on the Tijeras Arroyo. This project included an evaluation of arroyo hydrology and hydraulics using HEC-RAS. Dr. Zevenbergen's experience in conducting ecosystem restoration output evaluation has been on projects related to aquatic habitat for endangered species (silvery minnow on the Rio Grande and Colorado pikeminnow on the Yampa River). For these projects, he used 2-D model results to compute the amount of preferred habitat over a range of flows for existing conditions and a number of restoration alternatives.

Java Programming Expert - Robert Burnham

Mr. Burnham earned an M.A. in urban affairs from Boston University in 1990. He has 20 years of professional experience as a programmer working primarily in a research capacity. For the past 10 years he has been a senior research computing associate at the Tuck School of Business at Dartmouth College, where he co-teaches Programming for Decision Support Systems which teaches students to extend spreadsheet models with programming. He has used Java in a professional capacity since the language became commercially available and is the developer of a widely-used toolkit for conducting sensitivity analysis on spreadsheet models. Mr. Burnham has been the principal programmer on dozens of research projects in all areas of finance, economics and decision science and he has proficiency in economic and statistical analysis as well as computer software engineering. He is a frequent presenter and author on topics relating to statistical programming and has extensive experience building solutions for research and consulting clients. Mr. Burnham maintains TuckPERC, the Tuck Platform for Empirical Research Computing, an Open Source web tool for extracting data from large financial databases in C++, Perl, and Java.

This page intentionally left blank.

APPENDIX B

Final Panel Comments

This page intentionally left blank.

Final Panel Comments

The following forms include the Final Panel Comments from the review of the Enviro Fish model. These comments reflect the key issues identified during the assessment according to the model certification criteria described in the USACE *Protocols for the Certification of Planning Models*. Each form contains a concise statement of the issue (the comment), the basis of the comment, the significance of the comment, and recommendations for resolution. Significance levels are defined as follows:

High: Describes a fundamental problem with the model(s) that could affect the models' ability to serve their intended purpose

Medium: Affects the completeness or understanding of the model(s), model usability, or the level of performance of the model(s)

Low: Affects the technical quality of the model documentation but will not affect the performance of the model(s).

Final Panel Comments are arranged from High to Low significance, but in no other particular order. The Final Panel Comments are:

1. The model output does not directly calculate Habitat Units (HUs) for a project as presented, but provides the area data needed to complete the HU values needed for a Habitat Evaluation Procedures (HEP) analysis.
2. The development of Habitat Suitability Index (HSI) values is not supported in the documentation.
3. The definition of a functional floodplain needs to be clearly stated.
4. The analytical requirements of the model are identified, but guidance needs to be provided on how to prepare the data for input and the roles of the multidisciplinary team.
5. The limitations on the ability of the model to calculate benefits for project life need to be clearly documented.
6. Errors and issues in the programming code were identified and need to be corrected.
7. Additional error checks and warnings need to be built into the program.
8. Unit testing for the model should be performed if it has not been.
9. Testing of the code and validation of the underlying model needs to be documented.
10. The current model is not a stand-alone product and it is tedious to run for individual or multiple scenarios, rendering it error prone and difficult to use for compensatory mitigation.
11. Checking orphaned nests should apply a constraint, rather than remove a constraint.
12. The assumption that an increase in Habitat Units (HUs) will linearly increase spawning and rearing opportunities is incorrect.
13. The Introduction (Chapter 1) to the Enviro Fish User's Manual should be more informative.
14. While the results of the Enviro Fish model can be understood by a wide range of people, those results can only be generated by experts.

15. The sensitivity of the results is driven by the precision and accuracy of the input data. Unless the precision is known, the sensitivity is unknown.
16. The quality and accuracy of the data required by the model needs to be stated.
17. It needs to be clearly stated that similar input data used for the alternatives analysis should be of the same accuracy and precision.
18. The model is based on well-established habitat suitability theory, but not necessarily contemporary theory.
19. Documentation with the output data should include units of measure.
20. Examples in the fisheries section of the documentation should be expanded to inform decision-makers more about the benefits of the project.
21. The model transparency is limited, and it is difficult to understand why different outputs are generated across scenarios, and this limitation needs to be stated in the documentation.
22. Enviro Fish should be able to work with the current version of DSSVue installed.
23. Model calculations should be moved to either a Model-View or Model-View-Controller design which would separate the model's logic from the user interface.
24. The Enviro Fish code could be made more compact and flexible by using a template engine to separate the model computations from the format of the output.
25. Additional comments should be added to the code to explain what the code is doing and what the programmer's intentions were.
26. There are several instances in the model where the code could be simplified by using Java's libraries, using a more object-oriented design, or taking more advantage of the languages control structures.
27. Java is an object-oriented language, and there are opportunities in the code to define classes that would provide more structure to the code.
28. The Output Path "Browse…" option should default to the last directory that was accessed in a previous run.
29. Output files should not return to the "My Documents" root directory each time the user saves, but should default to the "Output Path" directory.
30. The data for calculating HUs does not stand out in the output.
31. Headers for the two DSS file groups, such as "Daily Stage Data" and "Stage – Elevation Curves," should be included in the main program screen.
32. The term "nests" should be replaced.

Comment 1:
The model output does not directly calculate Habitat Units (HUs) for a project as presented, and only provides the area data needed to calculate the HU values needed for a Habitat Evaluation Procedures (HEP) analysis.
Basis for Comment:
The Enviro Fish model is a sufficiently realistic representation of the area of a system being modeled; however, it provides only one of the data sets needed to complete a HEP analysis for a project area. The model accurately calculates changes in the potential fish spawning and rearing areas affected by the proposed project. The model is presented as calculating HUs, but it does not do any HU calculations within the model. All calculations of HUs must be completed as an additional operation after the Enviro Fish model calculations are completed. To complete a HEP analysis, the user is required to transfer selected Enviro Fish output data into a suitable spreadsheet application, enter HSI values, and input the required mathematical operations for each habitat to be included in the analysis to calculate HUs and Average Annual Habitat Units (AAHUs). The limitation is significant, as the current HSI data input presented in Enviro Fish is arbitrary, and final conversion to determine HUs is poorly documented. Furthermore, HEP is based on accurate information concerning both area quantity (which the model does), and habitat quality (which the model suggests as default values). In order to calculate HUs, the user is required to further analyze data from the model output, and enter HSI values to determine Habitat Units. The model suggests default HSI values, which the reviewers were concerned would lead to "default" results. As HEP considers both area and suitability are of equal value, if an analysis uses a "default" area and accurate HSI, it would be just as incorrect as the Enviro Fish model using accurate area and default suitability.
Significance – High:
As Enviro Fish was developed to provide the area data required in a HEP analysis, the tacit implication is that *default* HSI values can provide representative results. Entry errors associated with data transfer and erroneous mathematical entries may further compound the problems associated with requiring additional data manipulation.
Recommendations for Resolution:
To resolve these concerns, an additional capability should be included in Enviro Fish so that with the input of HSI data, no additional computations outside of Enviro Fish are needed to complete a HEP analysis.

Comment 2:
The development of Habitat Suitability Index (HSI) values is not supported in the documentation.
Basis for Comment:
To complete a HEP analysis, the user is required to separately enter HSI values. Table 2-1 provides "default" HSI values for five habitats common in the Lower Mississippi River Valley. These "default" HSI values were obtained primarily using the Delphi Technique, where subjective judgments of fair, good, very good, etc., were translated into scores from 0 to 1.0 in 0.1 intervals. Additionally, the fisheries literature and professional judgment were used to establish the "default" HSIs. As judgment cannot be quantified precisely, published references comprise the only objective input into the development of the HSIs. This potential subjectivity of HSI values is problematic as the subjective selection of habitat suitability values affects any conclusion that might be drawn from the output data provided by the Enviro Fish Model. The HSI's developed from expert opinion were always considered by the original USFWS developers as interim measures, even while they promoted the Delphi technique. The HSI's developed from expert opinion require field sampling, preferably at the location of the project. An accurate HSI is truly valuable, and should be developed on a project-specific basis. The importance of accurate HSI values is underestimated, as the model suggests a suite of default HSI values. The use of default values undermines the evaluation process demanded by HEP. There is scant documentation concerning the development of the values presented in Table 2-1 (pg. 2-5). The model would benefit from using HSIs based on actual biological and habitat data, instead of just estimating habitat potential, assigning meaning to the real differences between HSI values (i.e., what an HSI of 0.1 means for fish habitat versus and HSI of 0.5), especially for large projects.
Significance – High:
Because users will apply default HSI values without field verification, the ability of the model to yield accurate comparable HEP results is diminished.
Recommendations for Resolution:
Develop a process that allows repeatable, documented HSI values to be assigned. Additionally, another step in the program should be developed that allows direct input of HSI data, allowing model results to converted to HUs within the Enviro Fish code.

Comment 3:
The definition of a functional floodplain needs to be more clearly stated.
Basis for Comment:
In the Enviro Fish User's Manual page 2-3, Section "Delineating the boundaries of the functional floodplain," the only definition for functional floodplain is: "In an EnviroFish analysis, functional floodplain refers to inundated areas available for fishes to use in spawning and rearing." Another suggestion contained in this section is: "At this time, the elevation-area table in DSS must be revised to cap the functional habitat area." Delineating functional floodplain is at the core of the Enviro Fish method. Therefore, the user's manual should provide more complete discussion on what constitutes functional floodplain and what biologists should consider when they are delineating these areas. Without clear direction, a hydrologist or hydraulic engineer may apply a very different definition of functional floodplain than the biologist. Similarly, a biologists needs input from the hydrologists to properly define a functional floodplain. From the discussion, it appears that the starting point may be the 2-year floodplain, although there could be many other factors that limit the functional floodplain. These include barriers, proximity to the river (even the 2-year flood may inundate areas remote from the river), flow velocity (some floodplain areas may convey water at velocities too high for spawning). There may be other considerations, as well. The topic of "capping the functional habitat area" also factors into this discussion. Presumably, an area of bottomland hardwood that is outside the 2-year floodplain would not be included and only the area within the 2-year floodplain would count. For example, at elevation X (corresponding to the 2-year water surface) there is an area of Y. At elevation X+1 the actual area would increase, but the elevation-area table is "capped," or limited, to the value of Y.
Significance – High:
The concept of "Functional Floodplain" is crucial to obtaining correct input data and computing meaningful results from an Enviro Fish analysis. Without a detailed understanding of this fundamental concept, users may not obtain correct results for the intended use.
Recommendations for Resolution:
To resolve these concerns: ▪ Describe the factors that would be considered when delineating functional floodplain areas. ▪ Describe the methods for determining whether an area is functional floodplain. ▪ Include an example of a moderately complex situation where functional floodplain could have been incorrectly delineated. ▪ Provide an example of "capping" the area.

Comment 4:
The analytical requirements of the model are identified, but guidance needs to be provided on how to prepare the data for input and the roles of the multidisciplinary team.
Basis for Comment:
In order to complete the Habitat Evaluation Procedures (HEP) analysis for fish reproduction in floodplains, the multidisciplinary team should include: HEP specialists, fishery biologists, riparian ecologists, hydrologists, hydraulic engineers, and GIS specialists. The Enviro Fish User's Manual does not discuss the roles of these individuals nor provide guidance on developing the input data. The HEP specialist or fishery biologist would lead the team and define the data needs and constraints, but each team member would need to perform their duties based on the system hydrology, geography, ecology, and fish biology. Although there does not need to be guidance on creating a HEC-DSS file per se, there should be more guidance on developing the data from the standpoint of hydrology, hydraulics, and land use as it pertains to the HEP process. The daily flow record must be analyzed for suitability for future conditions. The flow record would then be transformed into a daily stage record using a hydraulic model, and the land use must be evaluated for habitat suitability. Each step must consider future conditions. A complete HEP analysis requires data acquisition (including topography, land use and hydrology), preliminary analysis (assigning Habitat Suitability Index (HSI) values, and performing hydraulic and hydrologic analyses), and final analysis (computing Average Daily Flooded Area [ADFAs] and Habitat Units [HUs]). If these steps are performed without the expertise of each of the disciplines, erroneous results are likely.
Significance – High:
If the complete HEP analysis is not led by the proper individual and with the support of several specialized disciplines, the results may be meaningless and the model will fall short of its intended purpose.
Recommendations for Resolution:
To resolve these concerns: ▪ Clearly define the roles of the members of the multidisciplinary team required for an Enviro Fish analysis. ▪ Include sections in the user's manual describing how each discipline would conduct their portion of the analysis.

Comment 5:
The assumptions and limitations on the ability of the model to calculate benefits for project life need to be clearly documented.
Basis for Comment:

The reviewers recognize that current and historic data must be the basis for developing model input to represent conditions over the project life. This is both an assumption and a limitation of Enviro Fish that needs to be documented. Guidance needs to be provided to assess the suitability of current and historic data for this purpose.
 	
• There is an assumption that realistic hydrology, particularly daily flow and stage data, can be developed for future conditions over the life of the project.
  o It appears that historic gage data are applied as the existing condition.
  o It appears that the historic gage data are then manipulated to create future alternative hydrology.
  o A limitation of this approach is the suitability of the historic gage data. For example, if a 50-year project life is required but there are only 10 years of gage data, the gage data must be used to represent the longer period or manipulated to generate a longer time series. If the gage data are from a time period that is wetter or drier than the long-term average, then the results can be misleading, even for a relative comparison of alternatives.
• There is an assumption that land use and topography are either constant through time or that future conditions can be projected over the life of the project. This is a limitation because the quantity and quality (Habitat Suitability Index [HSI]) of a particular land use type can change over the relatively long life of a project.
• The model has a usability limitation because it is designed to run only one daily stage record with one elevation-area curve at a time (rather than combining multiple data sets). It would, therefore, be very cumbersome to perform the number of program runs required to evaluate alternative future scenarios.

Significance – High:
Failure to understand the model assumptions could result in misinterpretation of model results and incorrect application of the model.
Recommendations for Resolution:
To resolve these concerns: ▪ Provide discussion related to the limitations of a typical Enviro Fish analysis. The limitations include use of historic gage data (especially short term records) and accounting for changing future conditions (including HSI, land use, topography, hydrology, and hydraulics). ▪ Provide guidance in the user's manual for developing the hydrologic and land use data that are representative of future conditions. These methods could include sensitivity analysis, Monte Carlo simulation, review of historic aerial photography, comparisons with other long-term flow gages, etc. ▪ Modify the software to loop through selected flow alternatives with selected land use alternatives and generate easily understood summary output. ▪ Modify the model be able to generate output by looping through the values of Parameter X and generating labeled output so that it is easier to perform a sensitivity analysis.

Comment 6:

Errors and issues in the programming code were identified and need to be corrected.

Basis for Comment:

One error was located which lead to incorrect results from the model. Several other issues should also be corrected in order to ensure that erroneous results are not generated inadvertently.

Dead stores to variables. Values are being assigned to variables and then not referenced by the program. While these errors are bad style on their own, they are often helpful in diagnosing more serious errors. The Enviro Fish model has several of these that need to be addressed.

- The getAreaForStage method defined in MainWindow.java has the following code which generates incorrect results when interpolating stages:

  ```
  double l = high_stage - low_stage;
  double scale = (stage - low_stage) / 1;
  ```

  The intent of the programmer was most likely to divide by the variable l, but the code divided by 1 (one) instead. In this case it makes more sense to forgo creating a local variable to use once and simplify the code to:

  ```
  double scale = (stage - low_stage) / (high_stage - low_stage);
  ```

- In the loadDSSFile method defined in MainWindow.java there are several calls to methods that store return values from methods that interact with the system in a variable named `rv`. Those return values are never checked for errors, which violates an important rule of software engineering: System calls should have their return status checked.

  There is another instance of this bug in ReportDiplay.java. The method createNewFile is called twice without checking the method's return status.

- Neither loadDSSFile nor closeDSSFile return values (they are of type void) so the program does not check whether these methods completed successfully. These methods should either throw an exception or return a value that indicates whether they were successful in opening or closing the DSS files.

- In the jTextArea1KeyReleased method defined in ReportDisplay.java, the String variable msg is defined and initialized but not referenced again.

Incorrect finalizer. The finalize method defined in MainWindow.java is declared as public. For security reasons the principle is that only the class and derived subclasses should be able to access finalizer methods, thus the method should be declared as protected.

Stream not closed. The loadFile method defined in CategoryWindow.java opens a stream that is never closed.

Duplicate code. The runRange method in MainWindow.java has the following return status checks near the beginning of the method:

```
if ( rv == -2)
{
  javax.swing.JOptionPane.showMessageDialog(this,
```

```
            "No data found in Stage Area Curve",
            "Missing Data",
            javax.swing.JOptionPane.ERROR_MESSAGE);
        }
        else if ( rv == - 2)
        {
          javax.swing.JOptionPane.showMessageDialog(this,
            "Could not read Stage Area Curve",
            "Corrupt DSS File",
            javax.swing.JOptionPane.ERROR_MESSAGE);
        }
```

In this case the "else" clause is testing for the same value as the "if" clause (negative two) so the "else" code will never be executed.

Error Checking. There are some checks built-in, e.g., the program checks that the min depth must be less than the max depth for both spawning and season constraints. There are additional tests that need to be included:

- No checking is done on where the DSS files are opened successfully. When a DSS file is selected in the file chooser, there is no check to see if the file is readable by the current user. Selecting an unreadable file does trigger error messages from the HEC Data Manager which are echoed to the console and not to the GUI where the user's attention would be.
- It is acceptable to enter a negative number of days as an input. This throws a Java ArrayIndexOutOfBounds exception.
- Negative depths can be entered for both spawning and season constraints.
- Entering an extremely small negative year as a period throws a NullPointerException.
- Entering a year such as 1000 as a starting period triggers an OutOfMemory error.
- If the end year is before the start year then a NegativeArraySizeException is generated.
- If the model needs data for a time period that is missing then a warning message is written to the log saying "Data block not found in file" but no messages are displayed to the user.

Significance – High:

The error in the interpolation code leads to incorrect results. The remaining errors can also lead to incorrect results and violate important principles for developing software.

Recommendations for Resolution:

To resolve these concerns:

- Fix the issues in the code specified.
- Implement unit testing (detailed in Comment #9).
- Consider using a code analysis tool. There are several Open Source tools that work with Java including PMD and FindBugs.
- Test the user interface often to enter unexpected data and try and break the model. Check that the software is verifying inputs and informing the user of any unexpected conditions (such as Out of Memory errors) that occur during processing.

Comment 7:

Additional error checks and warnings need to be built into the program.

Basis for Comment:

The source code should be built with the –Xlint flag to turn on all recommended warnings. The warnings generated by the Enviro Fish code include:

- **Warnings about serializeable classes not having a serialVersionUID field.** The Java documentation states: "The serialization runtime associates with each serializable class a version number, called a serialVersionUID, which is used during deserialization to verify that the sender and receiver of a serialized object have loaded classes for that object that are compatible with respect to serialization." The majority of these warnings can be taken care of by running the JDK's *serialver* utility on the classes and adding the generated field code to the source. The form editor that was used to build the model's graphical user interface generated many of the impacted classes.

- **Potential fall throughs in switch statements.** On line 104 of EvfCatagory.java there is a switch statement where the last case before the default does not have a break statement. While this is not an error in this case, it is preferable to code defensively and make sure that each case does have a break statement. It would also be preferable if the class was renamed EvfCategory so that the spelling was correct and consistent with the rest of the code in the project.

  The switch statement starting on line 141 of ReportDisplay.java has only one case before the default statement; however, this should also end with a break statement as good style.

- **Unchecked or unsafe operations.** In MainWindow.java there are several instances where code is similar to the following:

  ```
  java.util.Vector paths = new java.util.Vector();
  ```

  Since generics were introduced in Java 1.5, this code has produced a warning. This vector is intended to hold strings, so the preferred way to declare the vector is as follows:

  ```
  java.util.Vector<String> paths = new java.util.Vector<String>();
  ```

Significance – High:

Building the code without enabling all warnings and addressing sections of the code tagged as problematic leads to errors in the model output.

Recommendations for Resolution:

To resolve these concerns:

- Always compile the Java code with the –Xlint compiler flag and understand and address warnings as needed.
- A combination of techniques including the lint compiler argument, unit testing and static code analysis tools will improve the quality of the code.

Comment 8:

Unit testing for the model should be performed if it has not been.

Basis for Comment:

One of the strengths of Java is that it has mature libraries for writing unit tests; in particular JUnit is an open source industry standard. Unit testing involves writing tests for the smallest units of the program, which are classes in Java.

Unit testing is considered an essential practice in Java development for several reasons:

- Knowing that each unit of a program satisfies testing gives increased confidence that the program as a whole is correct.
- Unit tests force developers to know the anticipated result for a given input. Developers have to work through how their methods will work so that they can make assertions about what the results will be. For example, in order to test a method designed to convert text to upper case, the programmer would assert that *HELLO* would be generated when given *hello* as an input.
- Unit tests give developers more confidence when modifying their programs. Unit tests provide for what is called regression testing, which ensures that new code generates consistent results.
- Tests are a form of documentation. Unit tests are working and documented examples of how the pieces of a program function.

The simplest example for the Enviro Fish model would be the code currently in the MainWindow class. The getMonthName method returns the abbreviation of a month given the month's number in the calendar; so we would expect getMonthName(1) to return JAN. Unit testing is normally done on the accessible member of a class so for purposes of this example assume that getMonthName is declared as protected rather than private. A sample test case might look like this:

```
import junit.framework.TestCase;

public class MainWindowTest extends TestCase {
    private MainWindow window;
    public void testGetMonthName() {
        assertEquals("JAN", window.getMonthName(1));
    }
}
```

A sample run would look like this:

```
> java junit.textui.TestRunner MainWindowTest
.
Time: 0.005
OK (1 test)
```

Significance – High:

The lack of unit testing increases the likelihood that code bugs will be missed and that further development of the program will inadvertently introduce new errors.

Recommendations for Resolution:

To resolve these concerns:

- Implement unit testing using JUnit, TestNG, or another unit testing framework.

Comment 9:
Testing of the code and validation of the underlying model needs to be documented.
Basis for Comment:
The model reviewers did not find any information in the Enviro Fish User's Manual describing testing of the code or validation of the underlying model. **Code testing.** The output of the computer program should be compared to results that are obtained by performing the same calculations as in the code but in another manner (e.g., through a spreadsheet). Both USACE and the rest of the user community would benefit from having these benchmark results presented in the documentation along with all of the parameters necessary to duplicate them using the program. Users would benefit from annotated results explaining how the model was applied, and USACE would have verified results to check against when modifications are made to the code. **Model validation.** If validation of Enviro Fish, or any comparisons to other models or data, has been performed, it would be useful to add how the validation was done and a summary of the performance of the model (skill assessment). If model validation has not been completed, then there are two types of validation that could be undertaken: • Habitat-to-habitat – A comparison of model predictions of changes in habitat area with spatially-referenced field data or with the output of a more detailed model. • Habitat versus biology – A comparison of predicted changes in habitat to observed changes in fish reproductive success. The habitat-to-habitat comparison is more straightforward and could be done for several well-studied projects that also have more detailed models already developed. The habitat versus biology comparison is more difficult because biological data reflect the effects of many other factors not included in Enviro Fish. Exact agreement is not expected in either situation, but similar direction of responses would further people's confidence in Enviro Fish.
Significance – High:
The code needs to generate correct results, and the underlying biological realism of the model should be established. USACE needs to reference results that are confirmed correct for code testing purposes. The user community will benefit from understanding how the underlying biological model was evaluated against empirical data or the predictions from other models.
Recommendations for Resolution:
To resolve these concerns: ▪ Provide information in the user's manual on code testing that has been completed. If no testing has been completed then this needs to be done. ▪ Provide information in the user's manual on any model validation that has been performed. Consideration should be given to using existing applications of Enviro Fish as a basis for performing model validation comparisons.

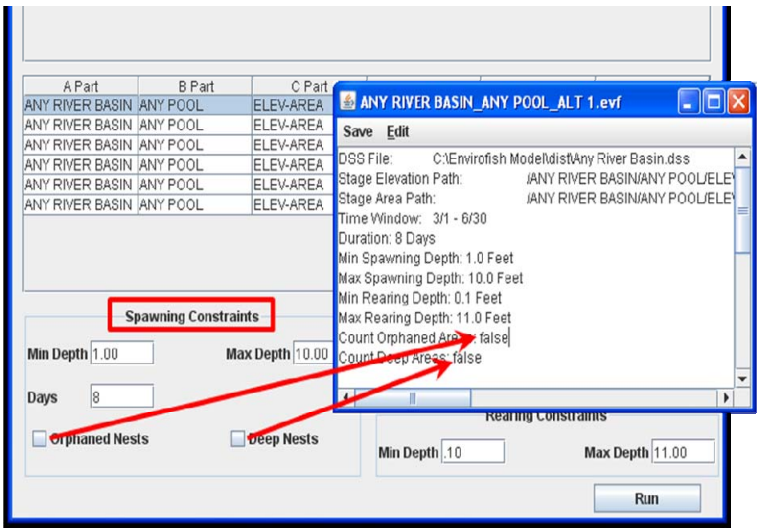
Comment 10:
The current model is not a stand-alone product and it is tedious to run for individual or multiple scenarios, rendering it error prone and difficult to use for compensatory mitigation.
Basis for Comment:
The model requires a separate run for each land use type within each flow scenario. This will result in many individual runs for a single flow scenario, and even more runs when alternative scenarios are analyzed. The possibility of the user making a mistake increases with the more individual runs that are required. One advantage of using a model like Enviro Fish is that it formalizes the assumptions and enables quantitative comparison of alternative scenarios and alternative assumptions (e.g., different minimum and maximum depths within each scenario). The current structure of the Enviro Fish model does not enable easy exploration of scenarios and assumptions because the model requires a run for each land use type within each scenario. Many projects will involve multiple land types, and for each type, multiple alternative assumptions are nested within multiple scenarios. Keeping track of inputs and output files in such situations can lead to errors in file naming and errors in importing the many output files into other software (e.g., Excel) for post-run comparisons. Furthermore, Enviro Fish generates point predictions, and the current structure prevents easy sensitivity and uncertainty analysis.
Significance – High:
Making runs in Enviro Fish is cumbersome, which can result in errors and limits the user's ability to fully explore multiple scenarios and alternative assumptions. This is considered "high significance" because one of the major purposes and advantages of models like Enviro Fish is to allow exploration of alternatives.
Recommendations for Resolution:
To resolve these concerns: ▪ At minimum, the user interface to Enviro Fish should be expanded to allow multiple land uses to be simulated with one run (i.e., one run per scenario). The output files would also need to be expanded and the current easy importing into other software should be maintained with the expanded output files. ▪ Optionally, the user interface could be expanded even further to allow multiple scenarios to be run in an easy manner, and the outputs sent to files with names defined by the user. Ideally, the Enviro Fish interface would generate some simple plots and tables for easy comparison among scenarios.

Comment 11:

Checking "Orphaned Nests" and "Deep Nests" should apply a constraint, rather than remove a constraint.

Basis for Comment:

Orphaned nests and deep nests are areas that may be abandoned or lost when the water depth changes after a nest is established and spawning occurs. Because these lost nests reduce the amount of spawning habitat, not counting them is applying a constraint. The other items in the "Spawning Constraints" (Min Depth, Max Depth and Days) are all truly constraints. However, when running Enviro Fish, <u>not checking these boxes applies a constraint</u>. This is evident in the output file indicated by a value of "false" for "Count Orphaned Areas" and "Count Deep Areas" when the boxes are not checked. Checking these boxes actually removes the constraints. This is counter-intuitive and could result in some users producing results opposite to their intention.



Significance – High:

The importance is high because it would be easy for a user to obtain the opposite results from the model than their intended purpose.

Recommendations for Resolution:

To resolve these concerns:

- Reverse the result of checking either of these options so the constraint is applied when the box is checked. The caption should also be made clearer by revising to "Apply Orphaned Nest Constraint" and "Apply Deep Nest Constraint."
- Alternatively, replace "Orphaned Nests" with "Checking Removes the Orphaned Nest Constraint" and similar revision for "Deep Nests."

Comment 12:
The assumption that an increase in Habitat Units (HUs) will linearly increase spawning and rearing opportunities is incorrect.
Basis for Comment:
The foundation of the Habitat Evaluation Procedures (HEP) process is the calculation of HUs at incremental surface elevations and the assumption of a positive linear relation between HU area and fish spawning and rearing. While it is technically correct that the relation might exist between HUs and "opportunities for spawning and rearing," it is biologically misleading to assume that more HUs, after a point, produce more young fish. The fisheries literature does not support this.
Significance –Medium:
Not addressing this important assumption could lead some readers to develop unrealistic expectations for projects.
Recommendations for Resolution:
The user's manual could increase transparency by providing a more detailed explanation of the HEP process and assumptions as they apply to aquatic systems. This, along with a clearer explanation of the biological objectives of the model (see Comment #13), will give users a more complete and realistic understanding of model outputs.

Comment 13:

The Introduction (Chapter 1) to the Enviro Fish User's Manual should be more informative.

Basis for Comment:

The Introduction chapter of the Enviro Fish User's Manual incompletely informs the reader on three important issues: the model's intended use, its approach, and possible products. Because the Introduction of any document is usually one of the first sections read for guidance, a clearer and more complete statement on the above issues would allow potential users to better estimate how the model might fit with their expectations and needs.

The Background section does not clearly explain why the model was developed. As it stands, it is more of a background of the model development and how it can be used and includes misleading statements such as, "…predict a quantitative response of the fish assemblage."

Significance – Medium:

The Introduction sets the stage for a clear explanation of the scope, importance and usefulness of the model. An incomplete Introduction hinders understanding of the full utility of Enviro Fish, and makes it less likely that stakeholders and other interested parties will become full participants in the overall project.

Recommendations for Resolution:

The model reviewers believe a stronger Introduction in the user's manual is essential to the overall understanding and therefore efficient use of the model. There is a need for a more inclusive and informative objective statement such as, "The objective of Enviro Fish, a modeling approach and computer software, is to facilitate planning for large-river civil projects by predicting the value of spawning and rearing habitat for floodplain fishes in extant versus project alternatives, in a manner understandable to a diverse constituency."

An objective statement of this type is needed to more clearly state its intent and usefulness by initially addressing such questions as:

a) What is it? A tool useful for planning.
b) What is it capable of doing? It predicts opportunities for spawning and rearing fishes in present conditions and alternative possibilities.
c) For whom is it intended? Users are a diverse constituency of interested parties and decision makers.

Other elements of Chapter 1 should be modified, as well. The Background section should include information of value to a variety of users, including ecological information on the importance of floodplain habitats to the river system and a general description of the fish community. An explanation of why some projects require modification or elimination of certain floodplain habitats, and how Enviro Fish will assist in planning for mitigation or compensation would be very useful to the overall understanding by the average reader.

The Method section of the Introduction (pg. 1-2) would be more useful if the series of numbered statements was expanded into a narrative succinctly explaining the function and the integration of biological and physical information, perhaps referring to Figure 2-1.

The Scope section should be expanded to contain information on model usefulness, strengths, limitations, geographic and temporal generality, and assumptions.

Comment 14:
While the results of the Enviro Fish model can be understood by a wide range of people, those results can only be generated by experts.
Basis for Comment:
Enviro Fish was developed for planning purposes for comparatively large civil projects with involvement of a large number of decision makers, stakeholders, and other interested organizations and individuals. The model is intended to explain likely outcomes of various alternatives that are understandable by all participants. Enviro Fish has the stated objective that includes providing a modeling tool to "government, academia, environmental organizations, and communities..." The model meets this objective, but only when used by experts. Even experts would likely need guidance from the model developers or a greatly expanded, more informative user's manual to apply the model to new situations. A significantly complex data set, comprised of geomorphological, hydrological, and biological input is required to complete an accurate assessment. The current model stops just before the final computation of HUs, but does provide the area data needed to compute it.
Significance – Medium:
Lack of proper guidance as to the complexity of Enviro Fish input requirements increases the possibility of improper model implementation, erroneous interpretation of model results, and misleading conclusions being drawn.
Recommendations for Resolution:
To resolve these concerns, provide expanded guidance in the user's manual that fully informs potential users of the expertise and the complex data set required to produce comprehensive results.

Comment 15:

The sensitivity of the results is driven by the precision and accuracy of the input data. Unless the precision is known, the sensitivity is unknown.

Basis for Comment:

1. The Habitat Suitability Index (HSI) values given to the various land types, which are then multiplied by available acreage to obtain spatially explicit Habitat Units (HUs), were obtained primarily from the fisheries literature and professional judgment – the Delphi Technique. The subjective judgments of fair, good, very good, etc. were translated into a score from 0 to 1.0 in 0.1 intervals. If empirical evidence is unavailable, the designation of, for instance, 0.3 might just as well have been a 0.2 or a 0.4 because professional judgment cannot be quantified that precisely. As an example of results from a small difference in HSI values: 0.2 HSI X 100 acres = 20 HU, and 0.3 HSI X 100 acres = 30 HU. A 0.1 increase results in a 50% difference, and some might conclude this represents a 50% "better" habitat.

   This potential subjectivity of HSI values would be problematic if the model were actually used, as stated on page 1-1, to "estimate the value of floodplain habitat" instead of more appropriately, as stated in other places in the user's manual, for "comparing alternatives" of available floodplain habitat. A test of model outputs using the example provided in Chapter 4 for comparing outputs when HSI values were changed in various combinations indicated very little difference in the **ratio** of existing HUs to alternative HUs. Therefore, it seems that the perceived "weakness" of using non-empirically determined HSI values (primarily from literature and professional judgment) likely does not negate their value in this case when average fish community values are used and the outcomes are comparisons between existing conditions and project alternatives.

   However, increasing accuracy is never a bad thing. As the USFWS recognized over 30 years ago, HSIs can be developed three ways: expert opinion, with use criteria, or with preference criteria. The most accurate method, using preference criteria (more appropriately named "selection" criteria) requires field sampling, preferably at the location of the project. HSIs developed from expert opinion were always considered by the original USFWS developers as interim measures, even while they promoted the Delphi Technique.

   If accurate HSI's are truly valuable, they would be developed for specific projects. A large enough project – such as the one mentioned in the Enviro Fish User's Manual would justify the relatively small costs to provide the best biological data. If there are ongoing USACE, USFWS, or state assessment programs of floodplain fisheries, it would be simple to organize sampling in a manner to sample replicates of flooded land types over a restricted period using the same gear and methodologies to obtain representative samples so that spawning and rearing use (instead of just assumed potential) of different habitats could be compared to each other on a relative basis. Only then could we get a realistic idea of what an HSI of, for example, 0.5 really means as compared to an HSI of 1.0.

2. A central Habitat Evaluation Procedures (HEP) assumption states that a large area of poor habitat is biologically equal to a small area of very good habitat. An HSI of 0.1 with 100 acres results in the same potential for fish as 10 acres with a HSI of 1.0. This has never been shown in the peer-reviewed fisheries literature. One HU should not be equal to another in habitat value unless the habitats are exactly the same. In reality, a low area of high-quality habitat is likely to outperform a high number of low-quality habitat areas even if they both have equal HU values. This assumption creates the potential for choosing an alternative that provides a lot of cornfield, and no bottomland hardwood forest over one where bottomland hardwood forest is present in moderate amounts. This assumption precludes the model from organizing the output to maximize the highest quality habitat type.

Significance – Medium:
While some lack of sensitivity and precision are inherent in the HEP process, a better explanation of limitations of the model and expected variance allows the reader to better evaluate the value of model outputs.
Recommendations for Resolution:
To resolve these concerns: ▪ Be very specific in the user's manual that the most accurate outputs of the model are those comparing the relative difference between existing and future conditions. ▪ Present options for determining final habitat areas. While experienced biologists may not always agree on a quantification of habitat, they likely agree on what is good habitat versus what is poor habitat. In this user's manual's example, cropland land use is considered poor quality, but how poor is not defined. Carp will do well spawning in cornfield stubble, but maybe not many other species will. The opportunity exists to greatly increase the area of lower quality habitat for an alternative or future condition without regard for the absolute acreage of high quality habitat. It might be more appropriate to develop HSI's for all habitat types but then ignore any habitats that are, for example, <0.4 in the calculation of HUs. Then the trade off would be for what is known to be good habitat for other good habitat. The value of HUs would be much more comparable.

Comment 16:
The quality and accuracy of the data required by the model needs to be stated.
Basis for Comment:
The Enviro Fish model is based on several major simplifying assumptions which, when satisfactorily met, will result in reasonable predictions of flooding effects on fish reproductive success. However, no guidance is provided regarding how close the assumptions (i.e., quality of the input data) need to be met to ensure the model predictions are of sufficient confidence. For example, no specific guidance is provided on how finely to subdivide the floodplain so that the stage-area relationship can be best estimated for each unit, and the tradeoffs of dividing the floodplain into increasingly finer subareas are not explained. There are also no recommendations on the required accuracy of the topographic data or on the desired quality of the hydraulic analysis. Some guidance is provided regarding defining land use types, but even that is minimal. Enviro Fish has the advantage of having been used for many years, so there is an accumulated knowledge base that can be used to provide a new user with guidance and tips on how to prepare the inputs required by the model. This will help users and the audience for model results by providing them with information on the appropriate level of confidence to associate with model results.
Significance – Medium:
Lack of guidance on the quality and accuracy of data required by the model does not prevent the model from being used appropriately, but does allow for the possibility of unnecessary uncertainty in model predictions in some situations when the user could have made better decisions for preparing the model inputs. Some guidance would enable more efficient use of Enviro Fish, especially by inexperienced users, and maybe more accurate model predictions when alternative decisions about input preparation are available.
Recommendations for Resolution:
To resolve these concerns: ▪ The user's manual should be expanded (perhaps an Appendix) to include guidance for preparing model inputs. ▪ Examples of how decisions were made in previous applications of Enviro Fish should either be summarized in the user's manual or referenced.

Comment 17:
It needs to be clearly stated that similar input data used for the alternatives analysis should be of the same accuracy and precision.
Basis for Comment:
Alternative scenarios can involve preparation of a new set of inputs. For example, mitigation may involve a different area of the floodplain than was analyzed in the primary (baseline) analysis. In order to allow for direct comparison among such scenarios, the accuracy, precision, and temporal and spatial resolution of the different sets of inputs should be very similar. Otherwise, differences in model predictions between the alternatives become confounded with differences in the quality or timing of the inputs. With inputs of differing quality or temporal coverage, it becomes difficult to compare the effects of alternative scenarios on fish reproduction habitat. This is because a user may incorrectly attribute either similarities or differences between alternatives to other properties when they are actually caused by differences in data quality.
Significance – Medium:
Although lack of guidance for using input data of the same accuracy and precision does not prevent Enviro Fish from being used, such information would increase the completeness of the documentation and assure that model results are comparable among all alternative scenarios.
Recommendations for Resolution:
To resolve these concerns: ▪ The user's manual should be expanded to include a discussion of how input data should be of similar quality and temporal and spatial resolution when scenarios involve different sets of input values. ▪ More extensive examples and summaries of how previous applications dealt with differing input sets should be added to the user's manual.

Comment 18:
The model is based on well-established habitat suitability theory, but not necessarily contemporary theory.
Basis for Comment:
The Enviro Fish model is based on well-established theory of habitat suitability, which has a long history, and appropriately accommodates the systems theory ideas that evaluation of fish reproduction involves the explicit linkage between the river and its associated floodplain (i.e., watershed thinking). The use of habitat suitability is appropriate because it reflects the typical data and information available for many projects, and generates results in a form that is useful for decision-making. People have recognized the distinction between habitat and population abundance, so with proper caveats and in the correct situations, habitat suitability is the best available approach. The explicit treatment of rivers connected to floodplains is also appropriate. Whether the model is based on "contemporary" theory requires more discussion. Four aspects of contemporary theory not directly addressed by Enviro Fish are multi-factor interactions, spatially-explicit modeling, full life cycle effects, and species interactions. As the authors state, the basis of Enviro Fish goes back to the early 1990s. Enviro Fish appropriately focuses on water depths (i.e., single factor analysis), but has little discussion about how other environmental variables (e.g., temperature) may be important in some situations. We now recognize that fish reproduction can be influenced by multiple factors, which can vary in time and space as to their influence and can have interactive effects on reproductive success. Second, our ability for mapping bathymetry and handling spatial-resolved data, modeling hydraulics and hydrodynamics, and tagging and following fish on fine spatial and temporal scales has greatly increased in the past decade. In some situations of well-studied systems or controversial decisions, a spatially-explicit approach, in addition to Enviro Fish, should be considered. A spatially-explicit approach allows for the connectance among land use types and their spatial arrangement relative to each other to the river to be explicitly considered in the analysis. Similarly, contemporary theory has moved from single life stage analyses and single-species approaches to more explicit consideration of population level responses and community and food web dynamics. Enviro Fish is very much a single species (or guild) approach, and is even further limited to certain life stages. It is not being suggested that Enviro Fish add additional environmental factors beyond water depth or become a population or multi-species model. The water depth and life stage foci are reasonable because water depth is a fundamental variable and modeling multiple factors or population dynamics (full life cycle) is not possible within an off-the-shelf model. Dealing with species interactions within the life stage of interest is also difficult because our knowledge about predation and competition is also lacking. But these issues should be discussed so that the user has a clear idea of the benefits and limitations of using habitat suitability and where Enviro Fish fits in within contemporary theory. A user can erroneously assume Enviro Fish is state-of-the-art, which it is not; but Enviro Fish is very flexible and can be applied to many situations because it uses readily-available data. However, there are important assumptions underlying habitat suitability, and there other approaches that may be more reflective of contemporary theory that should be discussed.
Significance – Medium:
This is a documentation issue related to completeness and does not hinder the use of Enviro Fish. Additional information on the appropriate interpretation of habitat suitability and how Enviro Fish fits in with contemporary theory would make for a more informed user by helping the user understand the limitations of Enviro Fish and under what conditions Enviro Fish is best applied.
Recommendations for Resolution:
To resolve these concerns: ▪ Enviro Fish should not be modified or expanded to incorporate the aspects of contemporary theory discussed.

- The user documentation should better explain the assumptions of habitat suitability and the limitations of the approach used by Enviro Fish, and should briefly describe the alternative approaches to Enviro Fish that are available.

Comment 19:
Documentation with the output data should include units of measure.
Basis for Comment:
Although Enviro Fish output provides an array of data for each user-requested year, the program output data do not have any units of measure assigned. The user is left to interpret the appropriate units of measure for each data category. Although the basic unit of measure is incorporated into the header (e.g., Duration in days, Depths in feet), the data table could be improved by including the units of measure for each of the data categories (e.g., Avg Stage, Max Total Rearing), all of the Average Season data, and all of the Period Averages data.
Significance – Medium:
Without explicit units of measures, mathematical errors based on assumptions of measure may occur.
Recommendations for Resolution:
To resolve these concerns, incorporate "Units of measure" (e.g., "in feet") in the header section of the model output or as a legend with each output page.

Comment 20:
Examples in the fisheries section of the documentation should be expanded to inform decision-makers more about the possible benefits of the project.
Basis for Comment:
Enviro Fish is highly usable, but the model documentation could be improved by expanding the Biological section with some additional information on elementary fish ecology. Additional information on ecological requirements of spawning fishes would be very helpful. Because the intended audience is diverse (pg 1-2 paragraph 1), a more complete description of potential outcomes for the project is warranted. Information on individual fish species and guild requirements or preferences for particular variables needs to be included or referenced in the user's manual. Special emphasis should be given recreationally important and threatened and endangered species. Invasive species (e.g., Asian carp) are a major concern for our great rivers, not only for the rivers themselves, but also as conduits into reservoirs and tributaries and for the Mississippi River and the Great Lakes. Project alternatives should explain the potential effect of floodplain changes or alterations on these and other species. Such additions to the user's manual would make model input choices more understandable to project participants. Increasing the knowledge base among stakeholders should increase their active participation in the process, which in turn increases chances of a satisfactory outcome for the most people.
Significance – Medium:
The suggested changes would make the user's manual more informative and useful to a diverse audience. Involved, committed stakeholders are important to a successful project outcome. Without the changes, stakeholders will have less understanding of the ecological processes that are involved and may be less likely to feel they are full participants in the process.
Recommendations for Resolution:
A compendium in table form for species and guilds (using Tables 2-2 and 2-3 as a basis) that includes land-use habitat preference, preferred spawning substrates, spawning temperatures, depths for eggs, depths for larvae, and egg incubation time should be added for reference by project participants to facilitate discussions with project biologists.

Comment 21:

The model is moderately transparent, and it is difficult to fully interpret the different outputs generated across scenarios.

Basis for Comment:

The model has an intermediate level of transparency in terms of the user having detailed knowledge of the calculations and in terms of the user being able to understand why certain results are generated. The user's manual provides a good description of the model and calculations, but it is unlikely that most users can reproduce the calculations outside of Enviro Fish except for very simple cases. Also, because of the nature of the calculations, the model reviewers believe it is difficult to tease apart the model predictions to understand why the results occurred. For example, within a scenario, it is not presently possible to determine the relative contributions to habitat area of the minimum depth constraint, maximum depth constraint, the deep nest option, and the shallow nest option. Knowing which of these is most limiting to habitat can also be especially useful when comparing alternative scenarios. The inability to easily perform sensitivity analysis further contributes to a lack of complete transparency because the approach of making many multiple runs to better understand model results is cumbersome.

Significance – Medium:

Reduced transparency limits the user in fully understanding model predictions.

Recommendations for Resolution:

To resolve these concerns:

- Expand the model user interface to allow for easy generation of multiple runs, allowing the user to more easily explore alternative assumptions.
- Add as an appendix to the user's manual a detailed set of example calculations for a simple case (e.g., one land use type for a few time steps).
- Partition the relative contributions to habitat area of the different limiting factors. Given the time constraints, how to do this was not obvious to the model reviewers. If such information is not possible to generate, then suggestions on a sensitivity analysis approach to better understanding the model predictions could be added to the user's manual.
- If feasible, change the program to automatically calculate areas for one-foot depth increments on a daily and yearly basis so that the user can better determine the range of depths that are controlling the results. For example, for an average annual spawning of 275 acres produced by a 1.0 to 10.0 ft depth range, a table of areas could be produced similar to the following:

Depth Range (ft)	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	1-10 (total)
Area (acres)	90	70	30	20	18	17	15	10	5	275

This shows that the greater depths are not contributing significantly to habitat.

- Change the program to automatically run with and without the deep and shallow nest options rather than requiring the user to select this as an option and make multiple runs.

Comment 22:
Enviro Fish should be able to work with the current version of DSSVue installed.
Basis for Comment:
The Enviro Fish software requires the use of HEC-DSS data storage system for the Daily Water Surface Elevation (Daily Stage) data and for the Elevation-Area curves. HEC-DSS is an excellent choice for storing and retrieving data for Enviro Fish. When the Enviro Fish software was first distributed to the reviewers, it was not clear that DSSVue needed to be installed, nor was it clear that only a previous version of DSSVue (Version 1.2) was compatible with Enviro Fish. Many users will have the most recent version of DSSVue (currently Version 2.0) installed on their computer. If Enviro Fish is not compatible with the most recent version of DSSVue, it will not be contemporary with other USACE software. Because the USACE - HEC Center makes archived versions of their software available for download, this does not significantly impact the use of Enviro Fish. However, a user cannot have more than one version of DSSVue on a computer, so this could significantly impact the ease of use by some users who would want (or need) the most recent version of DSSVue installed on their computer.
Significance – Medium:
Although it does not affect the results of the model, the significance is medium because it could significantly impact the usability of the model by some users.
Recommendations for Resolution:
To resolve these concerns: ▪ Investigate and correct this compatibility issue. ▪ Once the issue is resolved, test Enviro Fish with benchmark data to ensure that correct results are generated.

Comment 23:

Model calculations should be moved to either a Model-View or Model-View-Controller design which would separate the model's logic from the user interface.

Basis for Comment:

Currently, most of the calculations in the Enivro Fish model take place in the MainWindow class which is also responsible for displaying the model's main interface. The model reviewers strongly recommend that the model developers move this logic into separate classes and adopt either a Model-View or Model-View-Controller design that would separate the model's logic from the user interface.

The Model-View-Controller (MVC) design pattern is the dominant methodology for designing programs with user interfaces. The three parts of the design pattern are:

1. The *Model* is part of the program that encapsulates the data and all of the logic (methods, functions) that operate on it.

2. The *View* is the visual representation of the Model which gets input from and delivers output to the user. There can be multiple Views for a particular model. For example, charts and pivot tables can be considered as two different views of a spreadsheet matrix.

3. The *Controller* coordinates exchanges between the Model and the View.

Separating the model's logic and interface will facilitate two immediate improvements:

- The model code, separated from the verbose GUI, will be easier for the developers to develop and test.

- The individual components become more reusable. For example, it becomes much easier to integrate the model code into a command line or web based architecture. Alternatively, the view code could be re-used with a different model that calculates things in a different manner.

Significance – Low:

Switching to an MVC design would make the program more flexible and easier to maintain but is not essential.

Recommendations for Resolution:

To resolve these concerns, refactor the Java code to use a Model View Controller (MVC) paradigm. An example structure would include the following classes:

- Enviro FishModel: The fields and methods currently in MainWindow.java that comprise the project's logic (e.g. maxDepth, dailyStage, getMaxRearingStage). This class would be independent of the program's user interface.

- MainWindow: The remaining code in MainWindow.java (mostly generated by the Netbeans IDE) would consist of the code that lays out the window's components (text boxes, buttons, etc.). This would be the project's principal view

- EnviroFishController: The controller would connect the model and view. It would provide listeners to the view's interface widgets that would respond to events (such as the Run button being pressed) by passing user input from the view to the model and then calling the appropriate methods to calculate the model's outputs.

- Main: The Main class would create instances of the model, view and controller and make the main window visible to the user.

Comment 24:

The Enviro Fish code could be made more compact and flexible by using a template engine to separate the model computations from the format of the output.

Basis for Comment:

The logic behind using a template engine is similar to using the MVC design pattern for the graphical user interface; separating the model and view makes each component easier to work with.

The MainWindow class currently has approximately 140 lines of code where output buffers are handled for generating the reports. The majority of the code looks something like this:

```
dBuffer.append("Time Window:\t");
dBuffer.append(jSeasonField.getText() + "\n");
dBuffer.append("Duration: " + periodDays + " Days\n");
dBuffer.append("Min Spawning Depth: " + minDepth + " Feet\n");
```

As an example, using the open source StringTemplate engine, the code might be separated like this:

Java:

```
public class Example {
  public static void main(String[] args) {
    StringTemplateGroup templates =
      new StringTemplateGroup("example", "templates");
    StringTemplate tmpl = templates.getInstanceOf("envirofish");
    Model model = new Model();
    tmpl.setAttribute("season", model.getSeason());
    tmpl.setAttribute("period", model.getPeriodDays());
    tmpl.setAttribute("min_depth", model.getMinDepth());
    System.out.println(tmpl.toString());
  }
}
```

Template:

```
Time Window: $season$
Duration: $period$ Days
Min Spawning Depth: $min_depth$ Feet
```

There are two immediate benefits to the separation:

1. A change in the structure of the output no longer requires the modification or re-compilation of the code.

2. A variety of templates can be generated which present different views of the same data. For example, if the template is marked up with HTML tags then the same program could generate output suitable for the web (or for directly importing into Excel).

Significance – Low:

Using a template engine would make the code more flexible and succinct but is not essential.

Recommendations for Resolution:

To resolve these concerns, consider using a string template engine to simplify the Java code and separate out the calculations from the format of the output.

Comment 25:

Additional comments should be added to the code to explain what the code is doing and what the programmer's intentions were.

Basis for Comment:

Documentation is a time consuming but essential part of any project. There should be more comments explaining how the code is supposed to work. Anyone trying to understand the logic of the program would have to go line by line through the code trying to infer what sections of code do.

Comments should document the purpose of the code and explain the programmer's logic. For example, this comment was helpful in understanding the purpose of a loop:

```
//DAY_INCREMENT = 3 minutes, so multiply by 480 so that its one day
for(int a = 0; a < (Integer.parseInt(jDurField.getText()) * 480); a++)
  stopTime.add(HecTime.DAY_INCREMENT);
```

In contrast, this comment added very little explanation:

```
//close the file
ts.close();
```

Java has documentation standard called JavaDoc that allows API documentation to be generated automatically from Java source code. Adhering to that standard would allow documentation to be generated in a variety of formats.

Significance – Low:

Documentation makes code easier to maintain and reuse in other projects.

Recommendations for Resolution:

To resolve these concerns:

- Search the code looking for instances where additional comments would document how the program works and why certain things were done. For example, inserting comments along the lines of, "Parse the third component of the DSS path and increment the date." would have instantly made everything clearer.
- Comment using the JavaDoc standard, generate the documentation, and keep it up to date as and integral part of the project.

Comment 26:

There are several instances in the model where the code could be simplified by using Java's libraries, using a more object-oriented design, or taking more advantage of the languages control structures.

Basis for Comment:

Here are some examples of where the use of more idiomatic Java could simplify the code and make it easier to adapt and maintain.

- The getMonthName method in MainWindow.java is currently implemented in a switch statement with a different case for each month:

```
private String getMonthName(int m) {
  switch(m) {
    case 1:
      return "JAN";
    ...
       case 12:
      return "DEC";
        default:
      return "JAN";
  }
}
```

Since Java already has a library with the names of the months, it would be more concise to say:

```
private String getMonthName(int m) {
  if ((m < 1) || (m > 12)) { m = 1; }
  String month = new
    DateFormatSymbols(new Locale("en","US")).getMonths()[m-1];
  return month.substring(0,3).toUpperCase();
}
```

An implementation closer to the original programming would be:

```
private String getMonthName(int m) {
    if ((m < 1) || (m > 12)) { m = 1; }
    String months[] = { "JAN","FEB","MAR","APR","MAY","JUN",
                        "JUL","AUG","SEP","OCT","NOV","DEC" };
    return months[m-1];
}
```

- In the loadDSSFile method defined in MainWindow.java there is code that adds each element of a string array to a vector, one at a time like this:

```
java.util.Vector path = new java.util.Vector();
path.add(selectedParts[0]);
path.add(selectedParts[1]);
path.add(selectedParts[2]);
path.add(selectedParts[3] + " - " + currentParts[3]);
```

It would be more concise to initialize the vector with the array in the constructor such as:

```
java.util.Vector<String> path = new
  java.util.Vector<String>(java.util.Arrays.asList(selectedParts));
path.set(3, path.elementAt(3) + " - " + currentParts[3]);
```

- In the runRange method defined in MainWindow.java there is some code that counts the instances of the path separator to find the position of a string to be replaced:

```
pos1 = buffer.indexOf("/",1);      // 2nd /
pos1 = buffer.indexOf("/",pos1+1); // 3rd /
pos1 = buffer.indexOf("/",pos1+1); // 4th /
pos2 = buffer.indexOf("/",pos1+1); // 5th /

// make the path for the current year
buffer.replace(pos1+1, pos2, tmp);
```

In this case the path could be transformed in a function in a more straight forward fashion:

```
private StringBuffer incrementDatePath(StringBuffer b, String dateStr) {
  // split the buffer and replace one segment with a new date

  StringBuffer result = new StringBuffer();
  String pathBuffer[] = b.toString().split("/");
  pathBuffer[4] = dateStr;
  for(int i = 0; i < pathBuffer.length; i++) {
    result.append(pathBuffer[i] + "/");
  }
  return result;
}
```

- There are several instances where the String(String) constructor is used. For example:

```
return new String("DSS File filter");
```

This code can be simplified to:

```
return "DSS File filter";
```

- In the loadDSSFile method in MainWindow.java is a while statement that looks like this:

```
while ( selectedParts[0].equals(currentParts[0]) &&
        selectedParts[1].equals(currentParts[1]) &&
        selectedParts[2].equals(currentParts[2]) &&
        selectedParts[4].equals(currentParts[4]) &&
        selectedParts[5].equals(currentParts[5]) &&
        ++i < paths.size() );
```

When you have code that looks like this, it is almost always preferable to use a loop rather than hard code each value:

```
private boolean pathsAreEqual(String[] current, String[] selected) {
  int i;
  for(i = 0; i <= 5; i++) {
    if(i == 3) { continue; }
    if(!current[i].equals(selected[i])) {
      return false;
    }
  }
  return true;
}
```

Significance – Low:

The suggested changes will not change the results or performance of the model noticeably. However, these modifications, in concert with the other suggested code changes, will make the model much easier to maintain over time.

Recommendations for Resolution:

To resolve these concerns:

- Implement the changes noted and look for other instances in the code where things can be simplified.
- Considering the amount of code dedicated to working with the DSS paths and files, it might make sense to develop a class to encapsulate that level of functionality.

Comment 27:

Java is an object-oriented language, and there are opportunities in the code to define classes that would provide more structure to the code.

Basis for Comment:

There are several places throughout the program where code is repeated with an identical structure differentiated only in name. For example, the following variables are used by the program to keep track of spawning:

```
private HecDoubleArray yearSpawningArea;

private HecDoubleArray yearMaxSpawningArea;

private HecDoubleArray yearMinSpawningArea;

private HecDoubleArray dailySpawning;

private double sAvg;

private double sMax;

private double sMin;
```

Identical variables are defined for calculating rearing and total habitats, which indicates the opportunity to simplify the code by creating a new class to encapsulate these fields and the methods that operate on them. In this instance the class could start with seven fields (yearArea, yearMaxArea, yearMinArea, daily, avg, max and min) and the program could then declare an instance of the class for spawning, rearing and total. Implementing this one class would organize 21 variables into three objects and making the code more concise and maintainable.

There are several other sets of variables that could benefit from being organized into classes including several pairs of minimum/maximum values, and the stageArea and stageData variables.

Significance – Low:

The current structure of the code does not impact the results or performance of the model, but it does make the code unnecessarily verbose and complex.

Recommendations for Resolution:

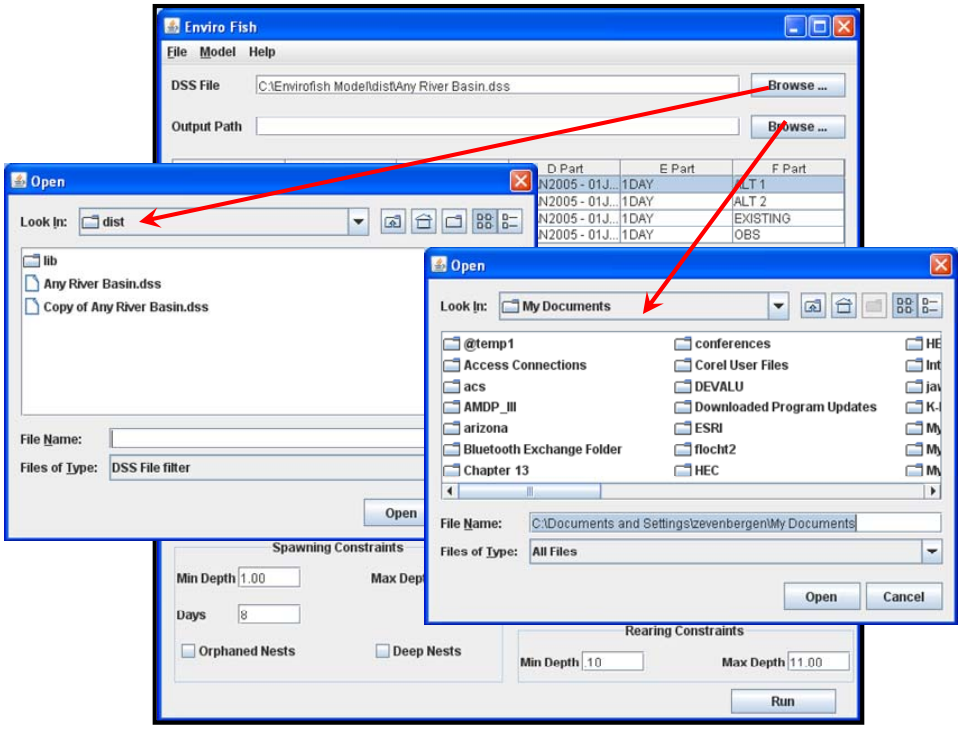
To resolve these concerns, refactor the code to simplify the code by organizing repetitive data structures into new Java classes.

Comment 28:

The "Output Path" "Browse…" option should default to the last directory that was accessed in a previous run.

Basis for Comment:

The "Browse…" option for the "DSS File" does default to the directory that was last accessed in the previous Enviro Fish run. This is not the case for the "Browse…" option for the "Output Path", as it always defaults to the "My Documents" directory. The software has the functionality to perform this task so it should be included for the "Output Path" for consistency and user friendliness.



Significance – Low:

This does not affect the results of the analysis but would improve user friendliness.

Recommendations for Resolution:

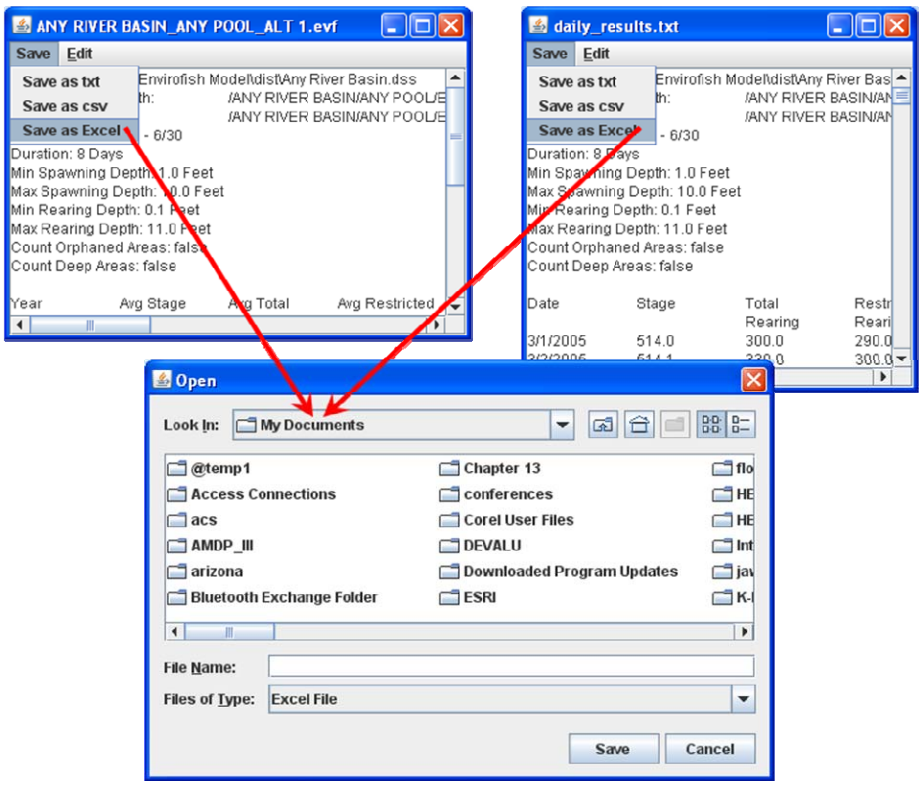
To resolve these concerns, incorporate the same functionality of the "DSS File" "Browse…" button for the "Output Path" "Browse…" button.

Comment 29:

Output files should not return to the "My Documents" root directory each time the user saves, but should default to the "Output Path" directory.

Basis for Comment:

The Enviro Fish program is designed to run each flow alternative with each land use type, resulting in a large number of individual output files. Each run may generate two output files: "daily_result.txt" and an ".evf" file, and each file may be saved in three different formats (txt, csv and Excel). Each time the user saves any of these files, the software defaults to the "My Documents" directory and then the user must navigate to the desired directory, which really should be the "Output Path" directory.



Significance – Low:

This is low significance because it does not affect the model results. However, it is significant for program usability.

Recommendations for Resolution:

To resolve these concerns, default to the "Output Path" directory.

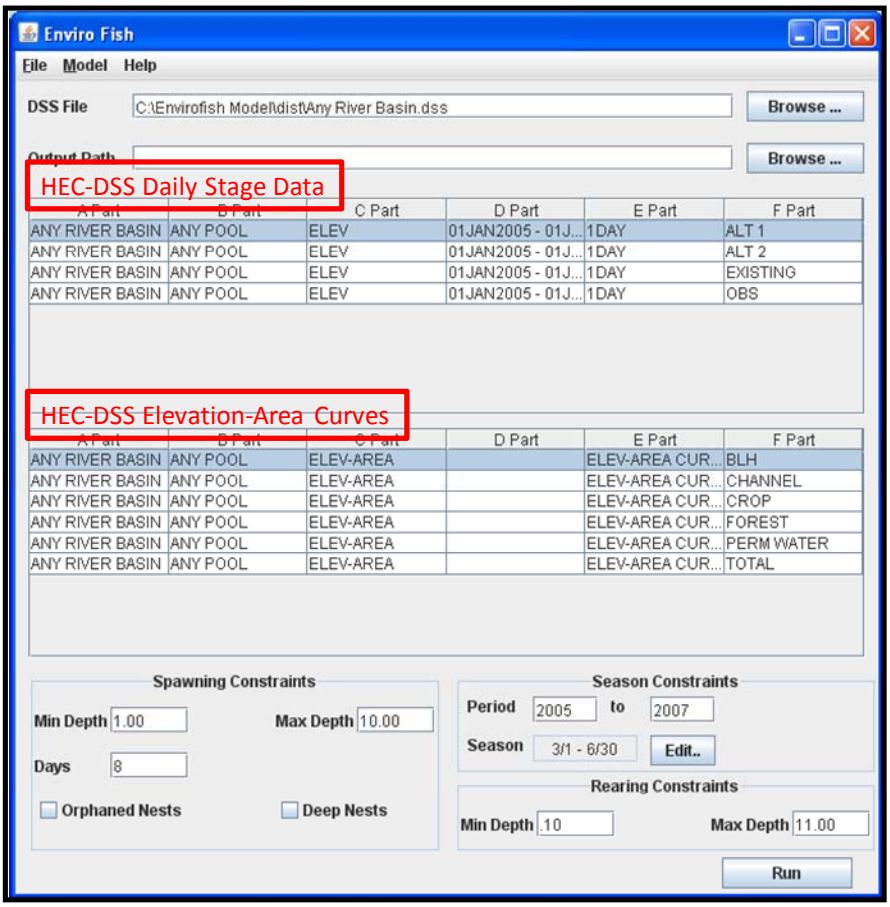
Comment 30:
The data for calculating HUs does not stand out in the output.
Basis for Comment:
The Enviro Fish model output provides a large array of data. The data needed for a HEP application is presented in the lower portion of the data table in the *Period Averages* section. If Enviro Fish is not expanded to incorporate a HEP analysis, these HEP-required data should be highlighted to allow the user to more easily locate the information necessary for a HEP analysis.
Significance – Low:
Highlighting allows a straightforward method to efficiently locate the area data needed to complete a HEP analysis after Enviro Fish calculates the area.
Recommendations for Resolution:
To resolve these concerns, highlight the cells needed for HEP analysis in the Enviro Fish output.

Comment 31:

Headers for the two DSS file groups, such as "Daily Stage Data" and "Stage – Elevation Curves," should be included in the main program screen.

Basis for Comment:

Each of the Enviro Fish user interface components (e.g., "DSS File", "Spawning Constraints", etc.) is identified with a header except for the two HEC-DSS data types. These should be included for consistency and to clarify the data types for the user.



Significance – Low:

This does not affect the model results, but would slightly improve user friendliness.

Recommendations for Resolution:

To resolve these concerns, include headers similar to those shown in red in the Basis for Comment section.

Comment 32:
The term "nests" should be replaced.
Basis for Comment:
The term "nest" is used many times in the narrative and as a variable for input for the model (e.g., page3-4, second sentence under Spawning). This is after Chapter 2 details the diversity of spawning strategies – including preferred substrates. The term "nests" generally refers to a structure or area for the deposition of eggs. The majority of floodplain spawners do not have this reproductive strategy.
Significance – Low:
Changing this term would help avoid potential confusion and make the model more accurate.
Recommendations for Resolution:
To resolve these concerns, substitute the term "nest" in the document narrative and in the model input with a more appropriate descriptor suitable for all floodplain species, such as "shallow allowable spawning area," and "deep allowable spawning area."

ATTACHMENT A

Work Plan

This page intentionally left blank.

Battelle
The Business of Innovation

US Army Corps of Engineers®

REVISED FINAL WORK PLAN

INDEPENDENT EXTERNAL PEER REVIEW

for

Certification of Four Ecological Models: EnviroFish, Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley, Waterfowl Assessment Methodology (WAM), and the Delta Region of Arkansas Hydrogeomorphic Methodology (HGM) Guidebook

Battelle Memorial Institute
505 King Avenue
Columbus, OH 43201

Prepared for
U.S. Army Corps of Engineers
Ecosystem Planning Center of Expertise

Contract No. W911NF-07-D-0001
Task Control Number: 09-210
Delivery Order Number: 0799

October 8, 2009

This page intentionally left blank.

REVISED FINAL WORK PLAN

Independent External Peer Review
for
Certification of Four Ecological Models:
EnviroFish, Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley, Waterfowl Assessment Methodology (WAM), and the Delta Region of Arkansas Hydrogeomorphic Methodology (HGM) Guidebook

Submitted to:

Department of the Army
U.S. Army Corps of Engineers
Ecosystem Planning Center of Expertise

Contract No. W911NF-07-D-0001
Task Control Number: 09-210
Delivery Order Number: 0799

Prepared by:

Battelle
505 King Avenue
Columbus, OH 43201

October 8, 2009

Battelle
The Business *of* Innovation

This page intentionally left blank.

Table of Contents

1.0 **Background, Objectives, and Scope of Work 1**

2.0 **Methods and Technical Approach 4**

3.0 **Quality Control and Quality Assurance 11**

4.0 **Reporting 12**

5.0 **Schedule 13**

6.0 **Project Organization and Communication 14**

7.0 **Budget 15**

Appendix A. Final Charge Guidance and Questions to the Peer Reviewers for the Model Certification Review A-1

Appendix B. Four Ecological Models Model Certification Review Panels, Considerations and Proposed Selection/Exclusion Criteria B-1

Appendix C. Peer Review Conflict of Interest Inquiry C-1

List of Tables

Table 1. Number of Required Panel Members. 6

Table 2. Estimated Levels-of-Effort for Panel Members 7

Table 3. Four Ecological Models Certification Review Milestones and Deliverables 13

Table 4. Battelle Staff for the Four Ecological Models Project IEPR 15

Table 5. USACE Staff for the Four Ecological Models Project 15

This page intentionally left blank.

REVISED FINAL WORK PLAN
Independent External Peer Review
for
Certification of Four Ecological Models:
EnviroFish, Waterfowl Assessment Methodology (WAM), Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley, and the Delta Region of Arkansas Hydrogeomorphic Methodology (HGM) Guidebook

General Project Information

- Project Title: Independent External Peer Review (IEPR) for Model Certification for Four Ecological Models: EnviroFish, Waterfowl Assessment Methodology (WAM), Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley, and the Delta Region of Arkansas Hydrogeomorphic Methodology (HGM) Guidebook (Four Ecological Models Review).
- Project Number: TG/G898592
- Client: U.S. Army Corps of Engineers, Ecosystem Planning Center of Expertise
- Effective Date of Work Plan: September 8, 2009
- Version Number: 1
- Project Manager: Karen Johnson-Young
- Deputy Project Manager: Amanda Maxemchuk
- Deliverable Due Dates: Draft Work Plan: October 1, 2009; Final Work Plan: October 8, 2009; Draft Charge: October 1, 2009; Final Charge: October 8, 2009; List of Peer Reviewers: October 16, 2009; Draft Model Review Reports: (A) January 5, 2009, (B) March 1, 2010; (C) February 3, 2010; (D) February 3, 2010; Final Model Review Reports: (A) January 22, 2010; (B) March 17, 2010; (C) February 22, 2010; (D) February 22, 2010
- Period of Performance: September 8, 2009 – April 30, 2010

1.0 **Background, Objectives, and Scope of Work**

1.1 **Background**

Planning models are defined as any models and analytical tools that planners use to define water resources management problems and opportunities, formulate potential alternatives to address the problems and take advantage of the opportunities, and evaluate potential effects of alternatives and to support decision-making. The United States Army Corps of Engineers (USACE) Planning Models Improvement Program (PMIP) was established in 2003 to assess the state of planning models in the USACE and to make recommendations to assure that high quality methods and tools are available to enable informed decisions on investments in the Nation's water resources infrastructure and natural environment. The main objective of the PMIP is to carry out a process to review, improve and validate analytical tools and models for USACE Civil Works business programs. The PMIP Task Force collected the views of USACE leaders and recognized technical experts, and conducted investigations and numerous discussions and

debates on issues related to planning models. This task force identified an array of model-related problems, conducted a survey of planning models, prepared papers on model-related issues, analyzed numerous options for addressing these issues, and formulated recommendations.

Use of certified models for all USACE planning activities is mandatory. This policy is applicable to all planning models currently in use by USACE, as well as models under development and new models. District Commanders are responsible for providing high quality, objective, defensible, and consistent planning products. Development of these products requires the use of tested and defensible models. National certification of planning models will result in significant efficiencies in the conduct of planning studies and enhance the capability to produce high quality products. The appropriate USACE Planning Center of Expertise (PCX) will be responsible for model certification. The goal of certification is to establish that USACE planning products are theoretically sound, compliant with USACE policy, computationally accurate, based on reasonable assumptions, and are in compliance with the requirements of the Office of Management and Budget's *Final Information Quality Bulletin for Peer Review* (Federal Register Vol. 70, No. 10, January 14 2005, pp 2664-2677). The use of a certified model does not constitute technical review of the planning product. Independent technical review of the selection and application of the model and the input data is still the responsibility of the users. Once a model is certified, the PCXs will work with model developers and managers to ensure that documentation and training in model use are available and that model updates comply with certification requirements.

The primary criterion identified for model certification is technical soundness. Technical soundness reflects the ability of the model to represent or simulate the processes and/or functions it is intended to represent. The performance metrics for this criterion are related to theory and computational correctness. In terms of the theory, the certified model should: 1) be based on validated and accepted "state of the art" theory; 2) incorporate USACE policies and requirements; 3) properly incorporate the conceptual theory into the software code; and, 4) clearly define the assumptions inherent in the model. In terms of computational correctness, the certified model should: 1) employ proper functions and mathematics to estimate functions and processes represented; and, 2) properly estimate and forecast the actual parameters it is intended to estimate and forecast. Other criteria for certification are efficiency, effectiveness, usability, and clarity in presentation of results. A certified model will stand the tests of technical soundness based on theory and computational correctness, efficiency, effectiveness, usability and clarity in presentation of results.

1.2 Objectives

The objectives of this work are to conduct a review for the USACE Ecosystem Planning Center of Expertise (ECO-PCX) to evaluate the technical quality, system quality, and usability of the following models in accordance with *Planning Models Improvement Program: Model Certification* (EC 1105-2-407, dated May 31, 2005) and the *Protocols for Certification of Planning Models* (July 2007), with the goal of certifying each model for use within the geographic area specified in the model documentation.

Model A EnviroFish Functional Reproductive Habitat Model

Model B Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley
Model C Waterfowl Assessment Methodology (WAM)
Model D Delta Region of Arkansas Regional HGM Guidebook

The review will not include a technical evaluation of the application of these models on a specific project. However, sample documentation of model application may be provided for informational purposes.

The general objectives of this work are to: a) prepare a work plan that will describe the process for conducting the model certification reviews of the four ecological models, b) identify potential panel members for the external peer review panel, and c) execute the work plan to conduct the model certification review.

1.3 Scope of Work

As a 501(c)(3) nonprofit science and technology organization with experience in establishing and administering peer review panels for USACE, Battelle was engaged to conduct the Model Review of the Four Ecological Models. Independent review ensures the quality and credibility of USACE planning tools. The Model Certification Review will follow the procedures described in the Department of the Army, USACE guidance entitled *Planning Models Improvement Program: Model Certification* (EC 1105-2-407), dated May 31, 2005, and the PMIP document entitled *Protocols for the Certification of Planning Models*, dated July 2007.

To accomplish the model certification review, subject matter experts will be recruited to participate on the peer review panel. Potential candidates for the peer review panel will be screened for availability, interest, and technical experience in defined areas of expertise and any actual or perceived conflicts of interest (COIs) will be determined. Ultimately, no more than 12 total panel members will be selected for the model certification review panels using predetermined criteria related to technical expertise and credentials in the subject matters related to the documents and materials to be reviewed. The following is a list of documents and reference materials that will be provided to the panel members for the review.

1. EnviroFish User Manual
2. EnviroFish Software
3. EnviroFish model code
4. Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley documentation
5. Habitat Model for Migrating Shorebirds communications
6. A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Forested Wetlands in the Delta Region of Arkansas, Lower Mississippi River Alluvial Valley, including HGM spreadsheets (Appendix D) and spatial data (Appendix E)
7. Waterfowl Assessment Methodology (WAM), also called the Duck-use-day Model

2.0 **Methods and Technical Approach**

One of the initial steps in the review process is to prepare a detailed work plan (this document) under Task 2. Additional tasks are detailed below in Section 2.0 (this section). The tasks described are based on the key tasks defined and described in detail in the USACE Model Certification For Four Ecological Models: Envirofish, Waterfowl Assessment Methodology (WAM), Migrating Shorebird Habitat Suitability Index Model, and the Delta Region of Arkansas Hydrogeomorphic Methodology (HGM) Guidebook Statement of Work (SOW). All tasks for the reviews shall be performed independent of government supervision, direction, or control.

Task 1: Kick-off Meeting.
Battelle will hold a kick-off teleconference with the PMIP team and representatives from the ECO-PCX. The purpose of the kick-off is to review the schedule, discuss the model review process, and address any questions regarding the scope, review documents, or required panel member expertise. Battelle will review the model documentation provided with the SOW and, based on a comparison with Table 2 of the USACE *Protocols for the Certification of Planning Models*, determine if additional information will be required to conduct the model reviews. A plan for the ECO-PCX providing the additional information required will be developed at this kick-off meeting.

Task 2: Work Plan.
Battelle will prepare a draft and final work plan (this document) that describes the process for conducting four separate and consecutive model reviews, including the screening criteria and process for selecting model review panel members, the schedule, charges to model review panel members (including charge questions), the process for conducting the reviews and drafting and finalizing four reports that summarize the results of each model review, communication and meetings with the USACE project team, and quality control. Battelle will also conduct a cursory review of each model to determine the level of effort required for panel members to conduct their reviews.

USACE has provided comments on the draft work plan and draft charge questions. Battelle has consolidated and address all comments in this final work plan, which was submitted within three (3) working days of the receipt of comments.

Task 3: Prepare and Finalize Charge to Reviewers.
Battelle will prepare and finalize the charge to each model review panel based on technical direction received from USACE and guidance provided in Department of the Army, U.S. Army Corps of Engineers EC No. 1105-2-407, *Planning Models Improvement Program: Model Certification*, dated 31 May 2005, and *Protocols for the Certification of Planning Models*, dated July 2007.

The process and evaluation criteria for the review, as outlined in the *Protocols for Certification of Planning Models* (July 2007), may include any or all of the following steps:

1. Panel members determine whether project needs/objectives are clearly identified and whether the model described is meeting those needs/objectives.

2. Panel members evaluate the technical quality of the models (review of model documentation).
    a. Model is based on well-established contemporary theory.
    b. Model is a realistic representation of the actual system.
    c. Analytical requirements of the model are properly identified and the model addresses and properly incorporates the analytical requirements.
    d. Assumptions are clearly identified, valid, and support the analytical requirements.
    e. USACE policies and procedures related to the model are clearly identified, and the model properly incorporates USACE policies and accepted procedures.
    f. Formulas used in the model are correct and model computations are appropriate and done correctly.
3. Panel members evaluate system quality (review by running test data sets or reviewing the results of beta tests).
    a. Rationale for selection of supporting software tool/programming language and hardware platform is adequately described, and supporting software tool/programming language is appropriate for the model.
    b. Supporting software and hardware is readily available.
    c. Programming was done correctly.
    d. Model has been tested and validated, and all critical errors have been corrected.
    e. Data can be readily imported from/into other software analysis tools, if applicable.
4. Panel members evaluate the usability of the model.
    a. Examine the data required by the model and the availability of the required data.
    b. Examine how easily model results are understood.
    c. Evaluate how useful the information in the results is for supporting project objectives.
    d. Evaluate the ability to export results into project reports.
    e. Training is readily available.
    f. User documentation is available, user friendly and complete.
    g. Adequate technical support is available for the model.
    h. Software/hardware platform is available to all or most users.
    i. Model is easily accessible.
    j. Model is transparent and allows for easy verification of calculations and outputs.

Each model review panel member will be provided with a charge that will guide their review of any model documentation, software, and code provided. The charge will include an assessment of the criteria listed above which are relevant to each review and ask panel members to respond to specific charge questions or directives regarding individual sections of the model document, as appropriate.

Battelle prepared a generic draft charge to the model review panels. The draft charge has been finalized based on technical direction received from USACE. The final charge is being submitted to USACE (Appendix A of this document) for final approval and distribution to the model review panel members.

Task 4: Identify Candidate Reviewers.

Screen Candidate Reviewers

Battelle will develop criteria for selecting the candidate reviewers; contact potential reviewers to evaluate technical skills, potential COIs, availability, and hourly rates; and identify up to 24 (12 primary and 12 backup) available potential experts to serve on the model review panels. The selection criteria used to identify candidate reviewers are provided in Appendix B to this work plan. Battelle will also develop a detailed COI screening questionnaire to be included in recruiting communications (Appendix C of this document). USACE will review the questionnaire, suggest changes (if needed), and approve this COI list prior to any potential reviewer receiving it.

To identify potential reviewers, Battelle will review candidates in Battelle's database of peer reviewers, seek recommendations from colleagues, contact former panel members, and conduct targeted internet searches. Preliminary information about the up to 24 potential reviewers, including brief biographical information and their responses to the COI questionnaire, will be provided to USACE as early as possible.

Specifically, the final model review panels will include members with the expertise described in Table 1 below.

Table 1. Number of Required Panel Members

Panel Member Expertise	A. EnviroFish Model	B. Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley	C. Waterfowl Assessment Model	D. HGM Guidebook
Civil Works Planner/Habitat Evaluation Procedures (HEP) Specialist	1	1	1	
Civil Works Planner/HGM Specialist				1
Programming/Spreadsheet Auditor	1			1
Fisheries Biologist	2			
Hydraulic Engineer	1			
Avian Biologist		2		
Waterfowl Biologist			2	
Wetland Ecologist				1
Forester				1
Total Number of Reviewers	**5**	**3**	**3**	**4**

Greater detail on the desired expertise for each of the panel members is presented in Appendix B of this work plan, along with the selection criteria. Each panel member will review one model, with the exception of the civil works planner/HEP specialist (who will review three models) and the programmer/spreadsheet auditor (who will review two models).

Finalize Contracts with Peer Reviewers

Battelle will identify up to 24 potential panel members and select no more than 12 final panel members according to the selection criteria. For each reviewer, Battelle will prepare a tailored scope of work that describes required panel member activities for this project. This scope of work description, along with a request for quotation and a COI inquiry form (Appendix C) will be sent to each selected peer reviewer. Upon receipt of the reviewers' written quotations indicating willingness to participate and the absence of a COI, Battelle will establish contracts with the panel members at agreed-upon rates and hours to ensure/secure participation. Each contract established also includes a non-disclosure statement.

The scope of work for each peer reviewer will consist of:

- Participation in a Battelle kick-off meeting (via teleconference)
- Participation in a USACE kick-off meeting (via teleconference) with the PDT and Battelle
- Participation in a Habitat Evaluation Procedures (HEP) training teleconference (8 panel members)
- Review and assessment of the technical quality, system quality, and usability of the Four Ecological Models and preparation of individual written comments
- Participation in a panel review teleconference to discuss findings and agree on a list of key topics/issues that will be presented in the Draft Model Certification Review Report and form the basis for the model certification review Final Panel Comments
- Preparation of the model certification review Final Panel Comments
- Review of the Draft Model Certification Review Report before it is submitted to USACE
- Review of USACE comments on the Draft Model Certification Review Report and Final Panel Comments
- Participation in a teleconference with USACE to discuss USACE's comments on the Draft Model Certification Review Report and Final Panel Comments
- Revision of the Draft Model Certification Review Report and Final Panel Comments in response to USACE comments
- Review of the Final Model Certification Review Report before it is submitted to USACE
- Provide additional technical support as directed.

Battelle has estimated the level-of-effort required for each panel member for the reviews in Table 2.

Table 2. Estimated Levels-of-Effort (hours) for Panel Members

	Kickoff Meeting	HEP short-course	A. EnviroFish Model	B. Shorebird Model	C. Waterfowl Model	D. HGM Guidebook	Total Hours
CWP/HEP Specialist	3	15	74	29	74		195

	Kickoff Meeting	HEP short-course	A. EnviroFish Model	B. Shorebird Model	C. Waterfowl Model	D. HGM Guidebook	Total Hours
Fisheries Biologists	3	3	74				80
Hydraulic Engineer	3	3	74				80
Spreadsheet Auditor	3		74			74	151
Avian Biologists	3	3		29			35
Waterfowl Biologists	3	3			74		80
CWP/HGM Specialist	3					74	77
Wetland Ecologist	3					74	77
Forester	3					74	77

Note: CWP = Civil Works Planner; HEP = Habitat Evaluation Procedures

The estimated hours listed above include time for the model review and charge question response, teleconferences, preparation of final comments and Draft Model Certification Review Report, report review, responding to USACE comments on the draft report, Final Model Certification Review Report review, and support-related activities.

Task 5 A-D: Conduct Assessment of Model.
A kick-off meeting with Battelle, the model review panel members, representatives from the USACE ECO-PCX, and Model Proponents will be held via teleconference to discuss the model certification requirements and expectations and to facilitate information exchange for each of the model reviews. One kick-off meeting will be conducted and it will cover all four model certification reviews for models A through D.

The description of the model review process in the following paragraphs applies to each of the four models being reviewed. Battelle will provide the panel members with electronic copies of the documentation for the model, software, and model code; *Protocols for Certification of Planning Models;* EC 1105-2-407, *Planning Models Improvement Program: Model Certification*; and other supporting documentation. USACE will provide these documents to Battelle via its FTP site. Battelle will prepare and deliver a memorandum instructing the panel members to undertake the review and outlining the steps and deadlines. Working with USACE, Battelle will respond to any panel member questions or information requests during the review process.

The panel members will complete their review and provide comments to Battelle. After receipt of all individual panel member comments, Battelle will merge all comments into one document and share the document with the panel members. In addition, Battelle will carefully review the comments and identify key issues/topics related to the technical quality, system quality, and usability of the model, as well as the model description and model testing. These key

issues/topics identified in the merged individual comments will be distributed to the panel members.

A panel review teleconference will be convened to ensure the exchange of technical information among the panel members, many of whom will be from diverse scientific backgrounds, and to identify key issues/topics specifically associated with the technical quality, system quality, and usability of the model. The result of the teleconference will be a list of key issues/topics (i.e., findings) that the panel members agree should be presented to USACE in the Draft Model Certification Review Report (Task 7) and as final panel comments. During the teleconference, the specific wording for the final panel comment statement will be agreed upon by all panel members, and final panel comments will be assigned "high," medium," or "low" significance based on the following definitions:

- High: Describes a fundamental problem with the model that could affect the model's ability to serve the intended purpose.
- Medium: Affects the completeness or understanding of the model, model usability, or the level of performance of the model.
- Low: Affects the technical quality of the model documentation but will not affect the performance of the model.

At the end of the teleconference, Battelle will prepare a memorandum to the panel members directing them to prepare specific sections of the Draft Model Certification Review Report (Task 6) based on the findings discussion and the technical quality, system quality, and usability criteria outlined in the *Protocols for Certification of Planning Models*, July 2007. The panel members will also be directed to prepare final panel comments, each of which will include the following four parts: (1) a clear statement of the comment; (2) the basis for the comment; (3) the significance of the comment (high, medium, or low); and (4) recommendations to resolve the comment (including additional research or analysis that may influence the conclusions). The individual comments in response to the charge and the panel review teleconference notes will be used as background information to prepare the final panel comments and the Model Certification Review Report.

Task 6 A-D: Prepare Draft Certification Report.
Four separate Draft Model Certification Review Reports for models A through D will be prepared and submitted. Battelle will prepare each Draft Model Certification Review Report and submit it to USACE for review. The report will assess the degree to which the model meets the technical quality, system quality, and usability criteria outlined in the *Protocols for Certification of Planning Models*, July 2007.

The report will follow the general outline below:

1.0 Introduction

1.1. Model Purpose

1.2. Model Assessment

1.3. Contribution to Planning Effort

1.4. Report Organization

2.0 Model Description

2.1. Model Applicability

2.2. Model Summary

2.3. Model Components

3.0 Model Evaluation

3.1. Assessment Criteria

3.1.1.Technical Quality

3.1.2.System Quality

3.1.3.Usability

3.2. Approach to Model Testing

3.3. Technical Quality Assessment

3.3.1.Review of Theory and External Model Components

3.3.2.Review of Representation of the System

3.3.3.Review of Analytical Requirement

3.3.4.Review of Model Assumptions

3.3.5.Review Ability to Evaluate Risk and Uncertainty

3.3.6.Review Ability to Calculate Benefits for Total Project Life

3.3.7.Review of Model Calculations/Formulas

3.4. System Quality

3.4.1.Review of Supporting Software

3.4.2.Review of Programming Accuracy

3.4.3.Review of Model Testing and Validation

3.5. Usability

3.5.1.Review of Data Availability

3.5.2.Review of Results

3.5.3.Review of Model Documentation

3.6. Model Assessment Summary

4.0 Conclusions

5.0 References

The final panel comments will be included as an appendix to the Draft Model Certification Review Reports. Individual comments will not be included in the Draft Model Certification Review Reports.

The Draft Model Certification Review Reports will be submitted electronically to USACE for review. The ECO-PCX and PMIP will review the Reports and provide comments back to Battelle.

Task 7 A-D: Meeting to Discuss Findings.

As necessary, for each model review (A – D), Battelle and the panel members will meet via teleconference with USACE's Technical Point of Contact, representatives from the ECO-PCX

and CECW-P, and Model Proponents to discuss their initial findings and ask clarifying questions that will aid in determining the information to be included in each of the Model Certification Review Reports.

Task 8 A-D: Prepare Final Certification Report.
For each model review (A – D), Battelle will prepare a Final Model Certification Review Report including a description of the process used to assess the model, assessment of the model based on the criteria outlined in Section 3.a. of *Protocols for Certification of Planning Models* (July 2007) and issues related to model recommendation.

3.0 **Quality Control and Quality Assurance**

During the review of the Four Ecological Models, there are numerous instances when quality assurance and/or quality control (QA/QC) practices will be implemented to ensure products of the highest quality are being provided to USACE. These QA/QC practices are described below.

Deliverable Review
It is Battelle policy that every deliverable be independently reviewed to ensure that it is accurate, technically sound, has objective interpretation, solid conclusions, satisfying presentation, and meets or exceeds client expectations. The deliverables for this project are listed in Section 4.0 of this work plan. The review may include a technical, editorial, and/or quality assurance component, depending on the document and project requirements. The Project Manager (PM) will determine the type(s) of review appropriate for each deliverable. In addition, per Battelle policy, all deliverables must have a one-over-one review and approval by the appropriate Battelle Manager prior to external distribution.

In addition to general technical, editorial, and/or QA reviews, Battelle will assign at least two people familiar with the project to review the panel members' responses to the charge questions. Because the charge question responses are used to develop the key themes of the panel members' findings, it is important that the responses be reviewed by a second person to ensure that the key themes have been appropriately captured. In addition to the charge question responses, each final panel comment is carefully reviewed by both the PM and the Deputy Project Manager (DPM) to ensure accuracy and thoroughness.

Peer Review Panel Recruitment
As an unbiased panel is critical to the successful completion of the Model Certification Review process, Battelle conducts a thorough peer review panel recruitment process. The first step in this process is the preparation of a COI questionnaire. Each potential panel member must fully complete the COI (see Appendix C for the COI issues identified for the Four Ecological Models reviews). In addition, USACE will provide information on more general COI issues that have been identified by USACE. USACE must approve the final list of potential COI issues before the questionnaire is distributed to potential panel members.

A detailed review is conducted for each candidate panel member. The Battelle recruitment team will present each candidate panel member's technical qualifications and COI screening responses to the Battelle PM and DPM. The candidate's qualifications are compared to the scope of work

and to the pool of potential candidates. If there are any outstanding questions regarding the candidates' responses to the COI screening, the candidate is contacted and the questions resolved prior to submitting the candidate's name to USACE.

Teleconferences

Teleconferences are an important component of conducting a Model Certification Review. They are critical to developing the final panel comments and discussing the final panel comments with USACE. Thus, accurate recording of action items, resolutions, and other information discussed during these teleconferences is critical to the process. To ensure that important information is not missed, Battelle provides at least two note-takers for all teleconferences and kick-off meetings with USACE and/or the panel members. All sets of notes taken by Battelle staff are compared and consolidated after each teleconference to provide one set of official notes. These notes are retained in the project files.

Development of Talking Points for Panel Review Teleconference

After reviewing all the panel members' comments in response to charge questions on the review documents, a talking points memorandum is developed by the DPM prior to the panel review teleconference. This document guides the teleconference and includes the key themes identified from the panel's comments, in addition to specific issues where the reviewers may have disagreed with one another. After drafting the talking points memo, the DPM sends it to at least one member of the Battelle project team to ensure that no important issues were omitted. The talking points are also provided to the panel members prior to the teleconference for review.

4.0 **Reporting**

Deliverables for the Certification of Four Ecological Models project include the following:

- Draft and final version of the work plan and Model Certification Review Charges
- Final list of up to 24 (primary and backup) selected model review panel members
- Draft and final Model Certification Review Report – EnviroFish Model
- Draft and final Model Certification Review Report – Shorebird Model
- Draft and final Model Certification Review Report – Waterfowl Model
- Draft and final Model Certification Review Report – HGM Guidebook

All draft and final deliverables will be provided to USACE electronically only and in PDF format, with the exception of each Final Model Certification Review Report, which will be sent to the USACE Technical Representative in hard copy (in addition to electronically). The draft work plan and charges were also provided to the USACE in Microsoft Word 2003 format to facilitate their review and allow comments and suggested revisions to be made in track changes.

There are no monthly report requirements for this project.

5.0 **Schedule**

The due dates for milestones and deliverables in Table 3 below are based on the date Battelle was supplied the final decision regarding the process to follow for conducting these four reviews (September 22, 2009). The asterisks indicate deliverables. All changes to the schedule will be documented and a revised schedule will be submitted to the USACE for approval.

Table 3. Four Ecological Models Certification Review Milestones and Deliverables

TASK	ACTION	DUE DATE
	Receipt of final decision on review process	**9/22/09**
	Review documents available	various
1	USACE/Battelle Kick-off Meeting	09/17/09
	USACE/Battelle/Panel Kick-off Meeting with all panel members	10/28/09
2	*Battelle submits Draft Work Plan to USACE	10/1/09
	USACE provides comments on Draft Work Plan	10/5/09
	Conference Call (if necessary)	TBD
	*Battelle submits Final Work Plan to USACE	10/8/09
3	*Battelle submits Draft Charge (combined with Draft Work Plan – Task 1) to USACE	10/1/09
	USACE provides comments on draft charge	10/5/09
	*Battelle submits Final Charge (combined with Final Work Plan – Task 1) to USACE	10/8/09
	USACE approves Final Charge	10/13/09
4	Battelle provides USACE with conflict of interest (COI) statements for review	9/14/09
	Battelle recruits and screens up to **24** candidate panel members	10/16/09
	*Battelle submits list and summary information of candidate panel members	10/16/09
	USACE provides comments on candidate panel members	10/21/09
	Battelle completes subcontracts for panel members	10/30/09
5A	Battelle provides review documents to panel members	11/2/09
	Panel **A** completes its review	11/20/09
	Battelle collates comments from panel **A**	11/24/09
	Battelle convenes panel review teleconference for panel **A**	12/01/09
	Panel **A** provides final panel comments and report section writing assignments to Battelle	12/11/09
6A	Battelle convenes teleconference with USACE to ask clarifying questions	As needed
7A	*Battelle submits Draft Model Certification Review Report **A** to USACE for review	1/5/10
	USACE provides comments on Draft Model Certification Review Report **A**	1/11/10
	Battelle convenes teleconference to discuss USACE comments on Draft Model Certification Review Report **A**	1/14/10
8A	*Battelle submits Final Model Certification Review Report **A** to USACE	1/22/10
5B	Battelle provides review documents to panel members	11/2/09
	Panel **B** completes its review	1/29/10
	Battelle collates comments from panel **B**	2/2/10

TASK	ACTION	DUE DATE
	Battelle convenes panel review teleconference for panel **B**	2/3/10
	Panel **B** provides final panel comments and report section writing assignments to Battelle	2/15/10
6B	Battelle convenes teleconference with USACE to ask clarifying questions	As needed
7B	*Battelle submits Draft Model Certification Review Report **B** to USACE for review	3/1/10
	USACE provides comments on Draft Model Certification Review Report **B**	3/8/10
	Battelle convenes teleconference to discuss USACE comments on Draft Model Certification Review Report **B**	3/10/10
8B	*Battelle submits Final Model Certification Review Report **B** to USACE	03/17/10
5C	Battelle provides review documents to panel members	11/2/09
	Panel **C** completes its review	1/7/09
	Battelle collates comments from panel **C**	1/11/09
	Battelle convenes panel review teleconference for panel **C**	1/12/09
	Panel **C** provides final panel comments and report section writing assignments to Battelle	1/20/10
6C	Battelle convenes teleconference with USACE to ask clarifying questions	As needed
7C	*Battelle submits Draft Model Certification Review Report **C** to USACE for review	2/3/10
	USACE provides comments on Draft Model Certification Review Report **C**	2/10/10
	Battelle convenes teleconference to discuss USACE comments on Draft Model Certification Review Report **C**	2/15/10
8C	*Battelle submits Final Model Certification Review Report **C** to USACE	2/22/10
5D	Battelle provides review documents to panel members	11/2/09
	Panel **D** completes its review	1/7/09
	Battelle collates comments from panel **D**	1/11/09
	Battelle convenes panel review teleconference for panel **D**	1/12/09
	Panel **D** provides final panel comments and report section writing assignments to Battelle	1/20/10
6D	Battelle convenes teleconference with USACE to ask clarifying questions	As needed
7D	*Battelle submits Draft Model Certification Review Report **D** to USACE for review	2/3/10
	USACE provides comments on Draft Model Certification Review Report **D**	2/10/10
	Battelle convenes teleconference to discuss USACE comments on Draft Model Certification Review Report **D**	2/15/10
8D	*Battelle submits Final Model Certification Review Report **D** to USACE	2/22/10
	Project Closeout	4/30/2010

Note: A indicates tasks for the review of the EnviroFish model, B indicates tasks for the review of the Habitat Model for Migrating Shorebirds in the Upper Mississippi Aluvial Valley, C indicates tasks for the review of the Waterfowl Assessment Methodology, and D indicates tasks for the review of the Delta Region of Arkansas Hydrogeomorphic Methodology Guidebook.
* = deliverable

6.0 **Project Organization and Communication**

Role and contact information for the key persons who will be working on the Four Ecological Models Review are presented in Table 4 (Battelle staff members), and Table 5 (USACE Project Delivery Team).

Table 4. Battelle Staff for the Four Ecological Models Project IEPR

Name	Project Role	Phone	E-mail
Karen Johnson-Young	Project Manager	(561) 656-6304	johnson-youngk@battelle.org
Amanda Maxemchuk	Deputy Project Manager	(781) 952-5384	maxemchuka@battelle.org
Rachel Sell; Corey Wisneski	Recruiting	(614) 424-3579; (781) 952-5296	sellr@battelle.org; wisneskic@battelle.org
Anne Gregg	Subcontracting Lead	(614) 424-7419	gregga@battelle.org

Table 5. USACE Staff for the Four Ecological Models Project

Name	Project Role	Phone	E-mail
Charles Theiling	Technical Representative/Point of Contact (Rock Island District)	(309) 794-5636	charles.h.theiling@usace.army.mil
Jodi K. Staebell	Alternate Technical Representative/Alternate Point of Contact (Mississippi Valley Division)	(309) 794-5448	jodi.k.staebell@usace.army.mil
Daniel Ward	Alternate Technical Representative/Alternate Point of Contact PDT (Memphis District)	(901) 544-0709	daniel.d.ward@usace.army.mil
Kelly Baerwaldt	Contracting Officer's Representative (Rock Island District)	(309) 794-5285	kelly.l.baerwaldt@usace.army.mil

Communication with USACE

Battelle's Point of Contact (POC) is the Technical Representative for the ECO-PCX. The alternate POC will be copied on all emails to the POC. If the POC is not available (e.g., on vacation), Battelle will contact the alternate POC directly. Communications may include status reports, questions, and/or requests for additional information from the panel.

Communication with the Model Review Panel

Battelle will be the main POC between USACE and model review panel members. Direct contact between the USACE and model review panel members will only occur during teleconferences with a Battelle representative present. All other communications will be directed through Battelle's Project Manager and Deputy Project Manager. The panel will be briefed that they are to have no direct communication with USACE and if they are contacted by USACE, they are to immediately inform Battelle.

7.0 **Budget**

The approved budget for this project is $392,531.

This page intentionally left blank.

APPENDIX A

Final Charge Guidance and Questions to the Peer Reviewers for the Model Certification Review of *Model Name*[1]

BACKGROUND
Model-specific background will be added.

OBJECTIVE

The objective of this effort is to conduct a review to evaluate the technical approach, system quality, and usability of the ***Model Name***. The ***Model Name*** will be evaluated in accordance with EC 1105-2-407, *Planning Models Improvement Program: Model Certification* (May 2005) and the *Protocols for Certification of Planning Models* (July 2007).

The U.S. Army Corps of Engineers Planning Models Improvement Program (PMIP) was established in 2003 to assess the state of planning tools and models in the U.S. Army Corps of Engineers (USACE) and to make recommendations to assure that high quality methods and tools are available to enable informed decisions on investments in the Nation's water resources infrastructure and natural environment. The main objective of the PMIP is to carry out "a process to review, improve and validate analytical tools and models for USACE Civil Works business programs." The model review for the ***Model Name*** will follow the guidance described in the Department of the Army, U.S. Army Corps of Engineers document entitled *Planning Models Improvement Program: Model Certification* (EC 1105-2-407), dated May 31, 2005, and the Planning Models Improvement Programs document entitled *Protocols for the Certification of Planning Models*, dated July 2007.

MODEL REVIEW

The following outlines the basic steps for the USACE model certification process. These steps are designed to guide the review of models being certified for widespread use and are also used to assess the technical quality and applicability of project-specific models. Model development is a multi-step, iterative process, with the number of steps and iterations being dependent upon the complexity of the model. In general, these steps occur in four fundamental stages.

- Stage 1 (Requirements Stage) involves identifying the need for a specific analytical capability and the options for tools to meet the need.
- Stage 2 (Development Stage) involves the development of software programming code or a spreadsheet and testing by the model developer.
- Stage 3 (Model Testing Stage) involves a beta test of the model by selected users whose objective is to validate the model and ensure that it is usable in real world applications.
- Stage 4 (Implementation Stage) involves providing training, user support, maintenance and continuous evaluation of the model.

[1] Note that all highlighted items in this draft charge will be changed to be specific for the model under review

The certification procedure depends on the stage of model development. The process may include the following steps.

1. Panel members determine whether project needs/objectives are clearly identified and whether the model described is meeting those needs/objectives.
2. Panel members evaluate the technical quality of the models (review of model documentation).
    a. Model is based on well-established contemporary theory.
    b. Model is a realistic representation of the actual system.
    c. Analytical requirement of the model are properly identified and the model addresses and properly incorporates the analytical requirements.
    d. Assumptions are clearly identified, valid, and support the analytical requirements.
    e. USACE policies and procedures related to the model are clearly identified, and the model properly incorporates USACE policies and accepted procedures.
    f. Formulas used in the model are correct and model computations are appropriate and done correctly.
3. Panel members evaluate system quality (review by running test data sets or reviewing the results of beta tests).
    g. Rationale for selection of supporting software tool/programming language and hardware platform is adequately described, and supporting software tool/programming language is appropriate for the model.
    h. Supporting software and hardware is readily available.
    i. Programming was done correctly.
    j. Model has been tested and validated, and all critical errors have been corrected.
    k. Data can be readily imported from/into other software analysis tools, if applicable.
4. Panel members evaluate the usability of the model.
    l. Examine the data required by the model and the availability of the required data.
    m. Examine how easily model results are understood.
    n. Evaluate how useful the information in the results is for supporting project objectives.
    o. Evaluate the ability to export results into project reports.
    p. Training is readily available.
    q. User documentation is available, user friendly and complete.
    r. Adequate technical support is available for the model.
    s. Software/hardware platform is available to all or most users.
    t. Model is easily accessible.
    u. Model is transparent and allows for easy verification of calculations and outputs.

The final deliverable for this effort will be a Model Certification Review Report that Battelle will deliver to USACE. The model review panel members will contribute to the preparation of the draft and final reports, as well as participate in two teleconferences with USACE and the Model Proponents to discuss review panel comments on the method (first teleconference) and USACE comments on the Draft Model Certification Review Report (second teleconference). The general outline for the report will be:

1.0 Introduction

1.1. Model Purpose

1.2. Model Assessment

1.3. Contribution to Planning Effort

1.4. Report Organization

2.0 Model Description

2.1. Model Applicability

2.2. Model Summary

2.3. Model Components

3.0 Model Evaluation

3.1. Assessment Criteria

3.1.1. Technical Quality

3.1.2. System Quality

3.1.3. Usability

3.2. Approach to Model Testing

3.3. Technical Quality Assessment

3.3.1. Review of Theory and External Model Components

3.3.2. Review of Representation of the System

3.3.3. Review of Analytical Requirement

3.3.4. Review of Model Assumptions

3.3.5. Review Ability to Evaluate Risk and Uncertainty

3.3.6. Review Ability to Calculate Benefits for Total Project Life

3.3.7. Review of Model Calculations/Formulas

3.4. System Quality

3.4.1. Review of Supporting Software

3.4.2. Review of Programming Accuracy

3.4.3. Review of Model Testing and Validation

3.5. Usability

3.5.1. Review of Data Availability

3.5.2. Review of Results

3.5.3. Review of Model Documentation

3.6. Model Assessment Summary

4.0 Conclusions

5.0 References

DOCUMENTS PROVIDED

The following is a list of documents and reference materials that will be provided for the review. **The documents and files presented in bold font are those which are to be reviewed.** All other documents are provided for reference.

- **Model Documentation**
- **Software**
- **Model Code**
- Department of the Army, U.S. Army Corps of Engineers *Planning Models Improvement Program: Model Certification* (EC 1105-2-407), dated May 31, 2005
- USACE Planning Models Improvement Programs document entitled: *Protocols for the Certification of Planning Models*, dated July 2007

SCHEDULE

Task	Activity	Due Date	Projected Date
5	*Conduct kick-off conference call with panel members and Model Proponents	Within 3 days of completing contracts	October 28, 2009
	Model review panel members submit comments to Battelle	Within 12 days of kick-off conference call with panel members	*Date*
	Contractor convenes meeting with panel members to discuss initial findings	Within 3 days of receipt of model team comments	*Date*
6	*Convene teleconference with USACE to ask clarifying questions on initial findings	Within 5 days of receipt of model team comments	As needed
	*Submit Draft Model Review Report to USACE for review	Within 14 days of receiving final panel comments and writing assignment from panel members	*Date*
	USACE provide comments on Draft Model Review Report	Within 5 days of receipt of draft report	*Date*
7	Convene a teleconference with USACE to discuss the Draft Review Report	Within 2 days of receipt of USACE comments	*Date*
8	*Submit the Final Model Review Report to the USACE	Within 5 days of review conference call on USACE draft report comments	*Date*

* denotes a deliverable

CHARGE FOR PEER REVIEW

The charge questions and guidelines are based on the model certification criteria discussed in the guidance document *Protocols for Certification of Planning Models* (July 2007) from the USACE

Planning Models Improvement Program. The intent of these questions is to focus your thinking, not to suggest or dictate your answers. We want you to consider several aspects of models during your review, from the inputs to the outputs to the underlying structure of the method.

General Charge Guidance

1. Please answer the scientific and technical questions listed below and conduct a broad overview of the model. Please focus on your areas of expertise and technical knowledge.
2. Evaluate the soundness of model as applicable and relevant to your area of expertise. Comment on whether model explains past events and how model will be validated.
3. Please focus the review on scientific information, including factual inputs, data, the use and soundness of model calculations, assumptions, and results that inform decision makers.
4. Offer opinions as to whether the model parameters and formulas are sufficient to quantify ecosystem function.
5. Panel members may contact each other. However, panel members **should not** contact anyone who is or was involved in the project, prepared the subject documents, developed the model, or was part of the USACE Independent Technical Review.
6. Please contact the Battelle Deputy Project Manager, Amanda Maxemchuk (maxemchuka@battelle.org) and cc: Karen Johnson-Young (johnson-youngk@battelle.org) if you have questions for Battelle or the USACE or need additional information.
7. In case of media contact, notify the Battelle project manager immediately.

Your name will appear as one of the panelists in the peer review. Your comments will be included in the Final Model Certification Review Report, but will remain unattributed. The Final Model Certification Review Report is expected to be released to the public by the USACE at some time in the future.

Please submit your comments in electronic form to Amanda Maxemchuk (maxemchuka@battelle.org) **no later than *Date*.**

MODEL ASSESSMENT CRITERIA

General Questions

1. Are the project needs/objectives clearly identified?

2. Does the model described meet those needs/objectives?

Technical Quality

3. Comment on the overall technical quality of the model.

4. Comment on the temporal and spatial resolution of the model.

5. Is it clear where the model's geographic boundaries fall?

6. Are the limitations of the model clearly defined?
   a. How do the limitations impact the ability of the model to evaluate ecological benefits?
   b. What are the potential impacts to the project?
   c. How can those limitations be overcome?

7. Is the model based on well-established contemporary theory?

8. Is the model a realistic representation of the actual ecosystem?

9. Does the model effectively capture the variables that are most important for the intended use of the model?

10. Comment on the precision and accuracy of the model for evaluating potential outcomes of project alternatives. What factors/variables provide the greatest impact on precision and accuracy?

11. Comment on the sensitivity of the model.

12. Are the analytical requirements of the model properly identified?

13. Does the model address and properly incorporate the analytical requirements?

14. Are the assumptions clearly identified, valid, and do they support the analytical requirements?

15. Comment on the ability of the model to evaluate risk and uncertainty.

16. Comment on the ability of the model to evaluate impacts and benefits for total project life.

17. Comment on the ability of the model to determine adequate compensatory mitigation.

18. Are the formulas used in the models correct and are the model macros and computations appropriate and done correctly?

19. Are USACE policies and procedures related to the model clearly identified, and does the model properly incorporate USACE policies and accepted procedures?

20. Do the models allow the user(s) to make assumptions regarding future global events such as, but not limited to, global climate change and changes to sea level.

System Quality

21. Is the rationale for the selection of the supporting software tool/programming language and hardware platform adequately described?

22. Is the supporting software tool/programming language is appropriate for the model?

23. Was the programming done correctly?

24. Can data be readily imported from/into other software analysis tools?

25. Has the model been sufficiently tested and validated, and have all critical errors been corrected?

26. Are error checks built into the models?

27. Do the models work using both sensible and non-sensible data?

Usability

28. Comment on the model usability.

29. Comment on the availability of the data required by the model.

30. How easily are model results understood?

31. Comment on how useful the information in the results is for supporting project objectives.

32. Comment on the usability of the model for selecting the best project alternative.

33. Is user documentation user friendly, and complete?

34. Are the models transparent and do they allow for easy verification of calculations and outputs?

APPENDIX B

Four Ecological Models Model Certification Review Panels Considerations and Proposed Selection/Exclusion Criteria

According to the documents for the Certification of Four Ecological Models, the overall model review scope includes:

- Two avian biologists (Migrating Shorebird Habitat Suitability Index Model)
- One civil works planner/HEP specialist (EnviroFish, Migrating Shorebird Habitat Suitability Index Model, Waterfowl Assessment Method)
- One civil works planner/HGM specialist (Delta Region of Arkansas HGM Guidebook)
- Two fisheries biologists (EnviroFish)
- One forester (Delta Region of Arkansas HGM Guidebook)
- One hydraulic engineer (EnviroFish)
- One programmer/spreadsheet auditor (EnviroFish, Delta Region of Arkansas HGM Guidebook)
- Two waterfowl biologists (Waterfowl Assessment Method)
- One wetland ecologist (Delta Region of Arkansas HGM Guidebook)

Technical Criteria /Areas of Expertise for Potential Independent External Peer Reviewers

All panel members should have at least 5-10 years of experience and have familiarity with large, complex civil works projects with high public and interagency interests. The panel members should at least have M.S. degrees, although Ph.Ds are preferred.

Technical areas related to **avian biology** (2 experts; Migrating Shorebird Habitat Suitability Index Model):

- Familiarity with methods for evaluating bird habitat suitability and have knowledge of the Lower Mississippi River Valley bird populations, specifically shorebirds.

Technical areas related to **civil works planning and Habitat Evaluation Procedures** (1 expert; EnviroFish, Migrating Shorebird Habitat Suitability Index Model, and Waterfowl Assessment Method reviews):

- Experience in the area of floodplain management including ecosystem restoration, impact analysis, compensatory mitigation and knowledge of Lower Mississippi River Valley ecosystems.
- Experience in the use of HEP.

Technical areas related to **civil works planning and Hydrogeomorphic Models** (1 expert; Delta Region of Arkansas HGM Guidebook):

- Experience in the area of floodplain management including ecosystem restoration, impact analysis, compensatory mitigation and knowledge of Lower Mississippi River Valley ecosystems.
- Experience in the use of Hydrogeomorphic approach for assessing wetland functions.

Technical areas related to **fisheries biology** (2 experts, EnviroFish):

- Familiarity with the methods for evaluating fish habitat suitability and have knowledge of the Lower Mississippi River Valley fisheries.
- Experience working with hydrologic and hydraulic modelers to evaluate floodplain hydraulics is desirable.

Technical areas related to **forestry** (1 expert, Delta Region of Arkansas HGM Guidebook):

- Experience in riverine forest ecology, experience in bottomland hardwood community structure and dynamics within the Lower Mississippi River Valley.
- Familiarity with ecosystem output evaluation, particularly the hydrogeomorphic approach to assessing wetland function, is essential.

Technical areas related to **hydraulic engineering** (1 expert, EnviroFish):

- Experience in estimating the effects of flood protection on floodplain hydrology using the HEC-RAS 1-D Flow and associated DSS (direct storage system) files and conducting ecosystem restoration output evaluations.

Technical areas related to **programmer/spreadsheet auditing** (1 expert, EnviroFish and Delta Region of Arkansas HGM Guidebook):

- Experience testing, debugging and auditing computer programs/spreadsheets to check for accuracy of formulas, cell references, and computer code.
- Must have experience with Java programming language.

Technical areas related to **waterfowl biology** (2 experts, Waterfowl Assessment Method):

- Familiarity with methods for evaluating waterfowl habitat suitability and have knowledge of the Mississippi River Valley migratory waterfowl.

Technical areas related to **wetland ecology** (1 expert, Delta Region of Arkansas HGM Guidebook):

- Experience in wetland ecology of large floodplain rivers, preferably experience in southern bottomland wetlands.
- Familiarity with ecosystem output evaluation, particularly the Hydrogeomorphic approach to assessing wetland function, is essential.

Other considerations:

- Participation in previous USACE technical review panels
- Other technical review panel experience

Reviewer Categories [candidate may fit into more than one category]

- Academic
- Consultant (company-affiliated, *e.g.*, architect-engineer or consulting firm)
- Consultant (independent)
- Non-governmental organization (*e.g.*, public agency)

Potential Exclusion Criteria/Conflicts of Interest

- Involvement by you or your firm[1] in any part of the development, assessment, or review of the following models:
    - EnviroFish Functional Reproductive Habitat Model
    - Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley/Migrating Shorebird Model
    - Waterfowl Assessment Methodology/ Duck Use Days Model
    - A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Forested Wetlands in the Delta Region of Arkansas, Lower Mississippi River Alluvial Valley
- Involvement by your firm[1] in any part of the St. Johns Bayou and New Madrid Floodway Environmental Impact Statement process, including:
    - Final Environmental Impact Statement entitled Mississippi River and Tributaries, Mississippi River Levees (MRL) and Channel Improvement (1976);
    - Final EIS entitled St. Johns Bayou/New Madrid Floodway Project Final EIS (1982);
    - 1998 Mississippi River Mainline Levees Enlargement and Seepage Control EIS
    - Draft Supplemental EIS (1999)
    - Final Supplemental EIS (2000)
    - Revised Supplemental EIS (2002); or,
    - Second Revised Supplemental EIS (2006).
- Any involvement by you or your firm[1] in the conceptual or actual design, construction, or O&M of the St. Johns Bayou and New Madrid Floodway, MO project or the Mississippi River and Tributaries Project.
- Involvement as an expert or provided testimony for the civil action (04-1575) Environmental Defense, et al. v. U.S. Army Corps of Engineers (USACE) et al.
- Involvement as an expert or provided testimony for Water Quality Certification for the St. Johns Bayou and New Madrid Floodway Project (06-0421) Missouri Coalition for the Environment, et al. v. Missouri Department of Natural Resources *et al*.
- Any involvement by you or your firm[1] in any litigation involving the United States of America and the U.S. Army Corps of Engineers in particular
- Any application by you or your firm[1] for a USACE permit of any nature or representation for a client that applied for a USACE permit of any nature within the boundaries of the Memphis or Vicksburg Districts.
- Current employment by the USACE.
- Current or previous employee or affiliation with the interagency mitigation team or the local sponsor, the U.S. Fish and Wildlife Service, Environmental Protection Agency, Missouri Department of Conservation, Missouri Department of Natural Resources, and the St. Johns Levee and Drainage District.
- Any employment as an individual or contractually by a State agency, levee or drainage district, or a city or municipality that had committed to serve as a local sponsor for a USACE project within the boundaries of the Memphis, or Vicksburg Districts.
- Current or previous employment or affiliation with Environmental Defense, National Wildlife Federation, or Missouri Coalition for the Environment (for pay or pro bono).

- Any voluntary service by you or your firm[1] to provide expert opinions or testimony in connection for any party in connection with a federal project.
- Current or future interests in the St. Johns Bayou and New Madrid Floodway Project.
- Involvement with paid or unpaid expert testimony related to the models or document listed above in numbers 1 and 2.
- Current personal involvement with other USACE projects, including whether involvement was to author any manuals or guidance documents for USACE. If yes, provide titles of documents or description of project, dates, and location (USACE district, division, Headquarters, ERDC, etc.), and position/role. Please highlight and discuss in greater detail any projects that are specifically with the Vicksburg District or the Memphis District.
- Current firm[1] involvement with other USACE projects, specifically those projects/contracts that are with the Vicksburg District or the Memphis District. If yes, provide title/description, dates, and location (USACE district, division, Headquarters, ERDC, etc.), and position/role.
- Previous employment by USACE as a direct employee or contractor (either as an individual or through your firm[1]) within the last 10 years, notably if those projects/contracts are with the Vicksburg District or the Memphis District. If yes, provide title/description, dates employed, and place of employment (district, division, Headquarters, ERDC, etc.), and position/role.
- Other USACE affiliation [e.g., scientist employed by USACE (except as described in NAS criteria, see EC 1105-2-410 section 8d)].
- Previous experience conducting technical peer reviews. If yes, please highlight and discuss any technical reviews concerning flood risk management projects, and include the client/agency and duration of review (approximate dates).
- A significant portion (i.e., greater than 50%) of personal or firm[1] revenues within the last 3 years came from USACE contracts.
- A significant portion (i.e., greater than 50%) of personal or firm[1] revenues within the last 3 years came from U.S. Fish and Wildlife Service contracts.
- Any publicly documented statement (including, for example, advocating for or discouraging against) related to the models or document listed above in numbers 1 and 2.
- Any publically documented statement advocating for or against the Mississippi River and Tributaries Project, including the St. Johns Bayou and New Madrid Floodway Project.
- Is there any past, present or future activity, relationship or interest (financial or otherwise) that could make it appear that you would be unable to provide unbiased services on this project? If so, please describe:
- Any other perceived COI not listed, such as:
    - Repeatedly served as USACE technical reviewer
    - Paid or unpaid participation in litigation related to the work of the USACE.
    - Prior repeated service as technical advisor to, or expert witness for, Environmental Defense, National Wildlife Federation, the Missouri Coalition for the Environment, or any other interest group that opposed a USACE Project.
    - Any other perceived COI not listed.

[1] Note: Includes any joint ventures in which your firm is involved.

APPENDIX C

Peer Review Conflict of Interest Inquiry

Dear (Peer Reviewer -- insert name):

You have been requested by the U.S. Army Corps of Engineers (USACE) to serve as an external peer reviewer for the Independent External Peer Review of the Model Certification for Four Ecological Models: EnviroFish, Waterfowl Assessment Methodology (WAM), Migrating Shorebird Habitat Suitability Index Model, and the Delta Region of Arkansas Hydrogeomorphic Methodology. Your participation in this review will be greatly appreciated. However, it is possible that your personal affiliations and involvement in particular activities could pose a conflict of interest or create the appearance that you lack impartiality in your involvement for this peer review. Although your involvement in these activities is not necessarily grounds for exclusion from the peer review, you should consult the contact named below or other appropriate official to discuss these matters. Affiliations or activities that could potentially lead to conflicts of interest might include:

a) current work or arrangements concerning future work in support of industries or other parties that could potentially be affected by developments or other actions based on material presented in the document (or review materials) that you have been asked to review;
b) your personal benefit (or benefit of your employer, spouse or dependent child) from the developments or other actions based on the document (or review materials) you have been asked to review;
c) any previous involvement you have had with the development of the document (or review materials) you have been asked to review;
d) any financial interest held by you (or your employer, spouse or dependent child) that could be affected by your participation in this matter;
e) any financial relationship you have or have had with USACE such as employment, research grants, or cooperative agreements;
f) significant portion (i.e., greater than 50%) of your personal or firm's revenues within the last 3 years came from USACE contracts;
g) you or your firm made a publicly documented statement advocating for or against the subject project;
h) litigation associated with USACE; and
i) past, present or future activity, relationship or interest (financial or otherwise) that could potentially be perceived by a third party, or give the appearance that you would be unable to provide independent unbiased subject matter knowledge, expertise, and/or services on this project.

[1] Note: Includes any joint ventures in which your firm is involved

If you have any concerns over a potential conflict of interest, please contact Mr. Mike Genovese, Battelle (GenoveseM@Battelle.org, (614) 424-4007) to discuss any potential conflict of interest

issues at your earliest convenience, but no later than two (2) days after receiving this request.

If you agree to be on this peer review panel, please check one of the following boxes, sign this form, and fax to Mr. Mike Genovese, Battelle, at (614) 458-4007 no later than two (2) days after receiving this request.

This form does not constitute an authorization to participate in this review; authorization for performance will come from Battelle's Government Subcontracts office.

[ ] I have no known existing or potential conflicts of interest associated with this task.

[ ] I have identified and disclosed in writing all known existing or potential conflicts of interest associated with this task.

_____ _____

Signature *Date* *Printed Name*

Volume 3
Part 6.2

Model Certification Review Report for Waterfowl Assessment Methodology

U.S. Army Corps of Engineers
Memphis District

Final Model Certification Review Report for the Waterfowl Assessment Methodology

Prepared by
Battelle Memorial Institute

Prepared for
Department of the Army
U.S. Army Corps of Engineers
Ecosystem Restoration Planning Center of Expertise
Mississippi Valley Division

Contract No. W911NF-07-D-0001
Task Control Number: 09210
Delivery Order: 0799

February 18, 2010

This page is intentionally left blank.

SHORT-TERM ANALYSIS SERVICE (STAS)

Final Model Certification Review Report for the Waterfowl Assessment Methodology

Prepared by

Battelle
505 King Avenue
Columbus, OH 43201

for:

Department of the Army
U.S. Army Corps of Engineers
Ecosystem Restoration Planning Center of Expertise
Mississippi Valley Division

Contract Number: W911NF-07-D-0001
Task Control Number: 09210
Delivery Order Number: 0799

February 18, 2010

Scientific Services Program

The views, opinions, and/or findings contained in this report are those of the author and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

This page is intentionally left blank.

FINAL
MODEL CERTIFICATION REVIEW REPORT
for the
WATERFOWL ASSESSMENT METHODOLOGY

EXECUTIVE SUMMARY

A model certification review of the Waterfowl Assessment Methodology (WAM) was conducted for the U.S. Army Corps of Engineers (USACE) Ecosystem Restoration Planning Center of Expertise (ECO-PCX) under Contract Number W911NF-07-D-0001, Task Control Number 09210. The objective of the review was to evaluate the technical quality and usability of the WAM in accordance with USACE's *Planning Models Improvement Program: Model Certification* (EC 1105-2-407, dated May 31, 2005) and *Protocols for Certification of Planning Models* (July 2007). The WAM is not a software- or spreadsheet-based model and, therefore, was not evaluated for system quality. USACE's ultimate goal is to certify the WAM for use within the geographic area specified in the model documentation. The review did not include a technical evaluation of the application of the model to a specific project.

The USACE Planning Models Improvement Program (PMIP) was established in 2003 to assess the state of USACE planning models and to assure that high quality methods and tools are available so that informed decisions on investments in the Nation's water resources infrastructure and natural environment can be made. The main objective of the PMIP is to carry out "a process to review, improve and validate analytical tools and models for USACE Civil Works business programs" (EC 1105-2-407, May 2005). In accordance with the *Planning Models Improvement Program: Model Certification* (EC 1105-2-407, May 2005), certification is required for all planning models developed and/or used by USACE. The objective of model certification is to ensure that models used by USACE are technically and theoretically sound, computationally accurate, and in compliance with USACE planning policy.

As a 501(c)(3) nonprofit science and technology organization with experience in establishing and administering peer review panels for USACE, Battelle was engaged to conduct the model certification review for the WAM. Independent, objective peer review is regarded as a critical element in ensuring technical quality, system quality, and usability of the models. Three subject matter experts (i.e., model reviewers) were selected to serve on the model review panel from 20 identified candidates. As appropriate for the technical nature of the WAM, the technical expertise of the three selected peer reviewers included one civil works planner with experience in Habitat Evaluation Procedures and two waterfowl biologists.

The model reviewers were provided with an electronic version of the WAM document along with a charge (included as part of Attachment A) that solicited their comments on specific aspects of the document. The charge questions solicited comments regarding key technical quality and usability criteria that are critical for model certification as described in the USACE *Protocols for Certification of Planning Models* (July 2007). The WAM is not a software- or spreadsheet-based model and, therefore, was not evaluated for system quality. Other than the kickoff teleconference, there was no communication between the model reviewers and the model developers during the review of the WAM document.

Approximately 100 individual comments were received from the model reviewers in response to 30 charge questions. Following the individual reviews of the model documentation by the model reviewers, a model review teleconference was conducted to review comments on the key model review criteria, discuss charge questions for which there were conflicting responses, and reach agreement on the Final Panel Comments to be provided to USACE. The panel members' findings regarding the model's technical quality and usability are documented in specific sections of this report, and Final Panel Comments are provided in Appendix B.

This Final Model Certification Review Report for the WAM summarizes the model review process, describes the model reviewers and their selection, and summarizes the findings and Final Panel Comments of the model reviewers. Comments on the Draft Model Certification Review Report were received from USACE on February 10, 2010 and discussed with the model reviewers during a teleconference at 3:00 PM EST on February 16, 2010. This final report presents the results of the model review and will be taken into consideration for certifying or revising the WAM.

Overall, the model reviewers agreed that the concept and application of the WAM are sound for planning efforts. Models are simple representations of complex systems and, as such, must balance complexity and reality with simplicity and usability. For the WAM, this goal has been achieved. The model seems to sufficiently capture the habitats being modeled and does not have any irreparable deficiencies.

However, there were some concerns regarding the accuracy of the WAM's model inputs, the ability to measure uncertainty, and the completeness of the documentation. The model review panel provided the following recommendations for improving the model based on the most significant concerns identified by the model reviewers.

1. Construct a simpler model that includes more known inputs based on key studies versus a review of all studies from which a mean is then chosen.
2. The model's time frame should be extended into April to address species that remain in the upper Mississippi Alluvial Valley (MAV) well into spring.
3. Include a section in the WAM manual that addresses the issue of model applicability and accuracy relative to all potential model uses.
4. Incorporate stochasticity into the WAM model for calculating duck-use-days (DUDs) in the MAV by using point estimates and a measure of precision.
5. Include a section early in the WAM manual that lists key model assumptions.
6. Provide better justification of the 4x multiplier by using time budget data along with the resting metabolic rate (RMR) equation to calculate an energy budget for at least mallards, which will provide a better defense of the 4x multiplier or potentially lead to a different multiplier.
7. Acknowledge that daily existence energy (DEE) likely varies over the nonbreeding period, regardless of the multiplier, and have the model examine potential changes in DUD estimates over time (e.g., early, mid-, and late in the nonbreeding period).
8. Include temperature in the estimation of DEE.

9. Make the WAM more user-friendly and decrease errors by translating it into spreadsheet or database software.
10. Correct the typographical or mathematical error in the example on page 25.

The reviewers suggest incorporating the recommended resolutions to the issues identified into the WAM and WAM documentation to improve the model for widespread use for planning purposes. The model will be better able to achieve its stated purpose with less potential for errors if suggested revisions are made.

TABLE OF CONTENTS

1 Introduction 1
- 1.1 Model Purpose 1
- 1.2 Model Assessment 1
- 1.3 Contribution to Planning Effort 3
- 1.4 Report Organization 3

2 Model Description 4
- 2.1 Model Applicability 4
- 2.2 Model Summary 4
- 2.3 Model Components 4

3 Model Evaluation 7
- 3.1 Model Review Approach 7
- 3.2 Assessment Criteria 10
  - 3.2.1 Technical Quality 10
  - 3.2.2 System Quality 10
  - 3.2.3 Usability 11
- 3.3 Approach to Model Testing 11
- 3.4 Technical Quality Assessment 11
  - 3.4.1 Review of Theory and External Model Components 11
  - 3.4.2 Review of Representation of the System 12
  - 3.4.3 Review of Analytical Requirements 13
  - 3.4.4 Review of Model Assumptions 13
  - 3.4.5 Review of Ability to Evaluate Risk and Uncertainty 13
  - 3.4.6 Review of Ability to Calculate Benefits for Total Project Life 15
  - 3.4.7 Review of Model Calculations/Formulas 15
- 3.5 System Quality 16
- 3.6 Usability 16
  - 3.6.1 Review of Data Availability 16
  - 3.6.2 Review of Results 16
  - 3.6.3 Review of Model Documentation 17
- 3.7 Model Assessment Summary 18

4 Conclusions 18

5 References 18

Appendix A: Biographic Information for Model Review Panel Experts

Appendix B: Final Panel Comments

1. Due to the Mississippi Alluvial Valley (MAV) being such a broad geographic area and the inherent variability in the data needed to feed the model, the accuracy of some of the model inputs are very poorly known, making the overall accuracy of the model predictions questionable.
2. The model is written as deterministic rather than stochastic, which does not account for uncertainty in inputs and model predictions (i.e., outputs).

3. The document would benefit from a separate section which details each of the model's assumptions.
4. The model does not adjust for the changes in Daily Existence Energy (DEE) requirements across the nonbreeding period.
5. The model would be easier to use if developed into a spreadsheet or relational database.
6. There appears to be a typographical or mathematical error in the example at the top of page 25.

Attachment A: Work Plan

LIST OF ACRONYMS

BLH	Bottomland Hardwood Forest
COI	Conflict of Interest
DEE	Daily Existence Energy
DUD	Duck-Use-Days
EC	Engineering Circular
ECO-PCX	Ecosystem Restoration Planning Center of Expertise
HEP	Habitat Evaluation Procedures
MAV	Mississippi Alluvial Valley
PMIP	Planning Models Improvement Program
RMR	Resting Metabolic Rate
TME	True Metabolizable Energy
USACE	United States Army Corps of Engineers
WAM	Waterfowl Assessment Methodology

1 INTRODUCTION

A model certification review of the Waterfowl Assessment Methodology (WAM) was conducted for the U.S. Army Corps of Engineers (USACE) Ecosystem Restoration Planning Center of Expertise (ECO-PCX) under Contract Number W911NF-07-D-0001, Task Control Number 09210. The objective of the review was to evaluate the technical quality and usability of the WAM in accordance with USACE's *Planning Models Improvement Program: Model Certification* (EC 1105-2-407, dated May 31, 2005) and the *Protocols for Certification of Planning Models* (July 2007). The WAM is not a software- or spreadsheet-based model and, therefore, was not evaluated for system quality. USACE's ultimate goal is to certify the WAM for widespread use within the geographic area specified in the model documentation. The review did not include a technical evaluation of the application of the model on a specific project.

1.1 Model Purpose

As stated in the WAM documentation, the WAM is a modeling approach that estimates the number of individual waterfowl that could potentially be supported within a particular area or habitat type for a particular period of time, or "duck-use days" (DUDs). The objective of the WAM documentation is to identify quantitative methods to estimate DUDs, based on daily energy requirements of waterfowl species. The objective of the method is to determine incremental benefits or impacts of land and water resource development projects on waterfowl habitats and populations in the Mississippi Alluvial Valley (MAV) during the nonbreeding period (ca. September-March). The WAM uses the basic concepts of estimating DUDs from resource abundance in the MAV and expands data and model equations using contemporary data on: 1) daily energetic needs of waterfowl species commonly present in the Upper MAV during the nonbreeding period; 2) estimates of resource values and dynamics in a complete array of Upper MAV habitats and management scenarios; 3) estimates of energy values of specific foods relative to different species; and 4) seasonal and annual probabilities of foods being available to waterfowl.

1.2 Model Assessment

The USACE Planning Models Improvement Program (PMIP) was established in 2003 to assess the state of USACE planning models and to assure that high quality methods and tools are available so that informed decisions on investments in the Nation's water resources infrastructure and natural environment can be made. The main objective of the PMIP is to carry out "a process to review, improve and validate analytical tools and models for USACE Civil Works business programs" (USACE, 2005). In accordance with the *Planning Models Improvement Program: Model Certification* (USACE, 2005; EC 1105-2-407), certification is required for all planning models developed for and/or used by USACE. The objective of model certification is to ensure that models used by USACE are technically and theoretically sound, computationally accurate, and in compliance with USACE planning policy. Model assessments are conducted in accordance with the USACE *Protocols for Certification of Planning Models* (USACE, 2007).

The following outlines the basic steps of the USACE model certification process which are designed to guide the model review. Model development is a multi-step, iterative process, with the number of steps and iterations being dependent upon the complexity of the model. In general, these steps occur in four fundamental stages.

- Stage 1 (Requirements Stage) involves identifying the need for a specific analytical capability and the options for tools to meet the need.
- Stage 2 (Development Stage) involves the development of software programming code or a spreadsheet and testing by the model developer.
- Stage 3 (Model Testing Stage) involves a beta test of the model by selected users whose objective is to validate the model and ensure that it is usable in real-world applications.
- Stage 4 (Implementation Stage) involves providing training, user support, maintenance and continuous evaluation of the model.

The certification procedure depends on the stage of model development. The process may include the following steps.

1. Model reviewers determine whether project needs/objectives are clearly identified and whether the model described is meeting those needs/objectives.
2. Model reviewers evaluate the technical quality of the model (review of model documentation), including whether:
   a. The model is based on well-established contemporary theory.
   b. The model is a realistic representation of the actual system.
   c. Analytical requirements of the model are properly identified and the model addresses and properly incorporates the analytical requirements.
   d. Assumptions are clearly identified, valid, and support the analytical requirements.
   e. USACE policies and procedures related to the model are clearly identified, and the model properly incorporates USACE policies and accepted procedures.
   f. Formulas used in the model are correct and model computations are appropriate and done correctly.
3. Model reviewers evaluate system quality (review by running test data sets or reviewing the results of beta tests) to determine whether:
   a. The rationale for selection of supporting software tool/programming language and hardware platform is adequately described, and supporting software tool/programming language is appropriate for the model.
   b. The supporting software and hardware are readily available.
   c. The programming was done correctly.
   d. The model has been tested and validated, and all critical errors have been corrected.
   e. Data can be readily imported from/into other software analysis tools, if applicable.
4. Model reviewers evaluate the usability of the model to:
   a. Examine the data required by the model and determine the availability of the required data.

b. Examine how easily model results are understood.
c. Evaluate how useful the information in the results is for supporting project objectives.
d. Evaluate the ability to export results into project reports.
e. Determine whether training is readily available.
f. Determine whether user documentation is available, user friendly and complete.
g. Determine whether adequate technical support is available for the model.
h. Determine whether the software/hardware platform is available to all or most users.
i. Determine whether the model is easily accessible.
j. Determine whether the model is transparent and allows for easy verification of calculations and outputs.

In addition to providing an assessment of Steps 1, 2, and 4 above, this review is intended to help with the continued maintenance and evaluation of the WAM for widespread use. Because the WAM is being reviewed for certification, most of the assessment criteria are being evaluated by independent external peer review; however, some of the assessment criteria can only be evaluated internally by USACE, including whether the model complies with USACE policy and procedures, the model is easily accessible, training is readily available, and adequate technical support is available.

The level of effort for a model review depends on the complexity of the model developed, the risks associated with planning decisions made using the model, and the stage of model development. The WAM has undergone an intermediate level of review based on the model's intermediate level of complexity relative to other planning models. The intermediate level of review, which is the subject of this report, included a model certification review of the WAM documentation.

1.3 Contribution to Planning Effort

The WAM has been developed with the intent of making a technique for modeling waterfowl habitat use available to a wide range of stakeholders.

1.4 Report Organization

This report is organized into the following sections:

Section 2.0	Model Description — Describes the applicability of the model for planning projects and summarizes the model inputs and components.
Section 3.0	Model Evaluation — Describes the criteria used to assess technical quality, system quality, and usability; summarizes the approach to the model review; and describes the results of the model assessment.
Section 4.0	Conclusions — Summarizes the overall conclusions of the model review.
Section 5.0	References — Lists the references used for this model assessment.
Appendix A	Contains biographic information on the model reviewers selected to perform the review of the model certification assessment criteria.

Appendix B Contains the Final Panel Comment forms, which include the key comments from the model review as well as each comment's basis, significance, and recommendations for resolution.

Attachment A This is the Final Work Plan for the Four Ecological Models Model Certification Review (of which the Waterfowl Assessment Methodology is a part) which contains the final charge guidance and questions to the model reviewers to guide the review of the models and model documentation.

2 MODEL DESCRIPTION

2.1 Model Applicability

The WAM is designed to determine how many individual waterfowl an area/habitat type will support during a particular period. The user must identify the daily nutrient requirements of a given waterfowl species and the amount and availability of resources in the area by habitat type. The WAM is best used as an assessment of waterfowl populations and habitats before and after a specific land and water resource development project implemented in the MAV during the nonbreeding period (September-March). The WAM can also be used to compare different potential management actions.

The variety of habitats and communities in the MAV include bottomland hardwood forest (BLH), floodplain forest, riverfront forest, seasonal herbaceous wetland including bottomland prairie, shrub/scrub, dead timber, open water/aquatic, and agricultural fields. The WAM was specifically developed for use in the MAV.

2.2 Model Summary

The WAM is a modeling approach that estimates the number of individual waterfowl that could potentially be supported on a particular area or habitat type for a particular period of time, or DUDs. The objective of the WAM documentation is to identify quantitative methods to estimate DUDs. The objective of the model is to estimate DUDs based on daily energy requirements of waterfowl species to determine incremental benefits or impacts of land and water resource development projects on waterfowl habitats and populations in the MAV during the nonbreeding period (ca. September-March). The WAM documentation uses the basic concepts of estimating DUDs from resource abundance in the MAV and expands data and model equations using contemporary data on: 1) daily energetic needs of waterfowl species commonly present in the Upper MAV during the nonbreeding period; 2) estimates of resource values and dynamics in a complete array of Upper MAV habitats and management scenarios; 3) estimates of energy values of specific foods relative to different species; and 4) seasonal and annual probabilities of foods being available to waterfowl.

2.3 Model Components

The outputs produced by the WAM methodology are DUDs, which represent the energy needs of an individual waterfowl for one day. As stated in the WAM documentation, estimates of DUD

vary in relation to: 1) species, sex, mean body mass, and annual cycle events of waterfowl; 2) area of specific habitats; 3) amount of food produced and available to ducks in various habitat types; 4) nutritional composition of food types; 5) the efficiency of waterfowl in converting food nutrients to metabolizable energy; 6) environmental/climatic conditions; 7) decomposition rates of food types; 8) consumption of foods by non-waterfowl species; and 9) densities of food at which waterfowl cease foraging due to low foraging efficiency (often referred to as a "giving up density").

The main elements of the WAM include the following:

- The daily nutrient requirements of waterfowl species present during different periods of the year and annual cycle events in which they are engaged.
- The abundance of resources potentially present in an area by habitat type.
- The availability of resources in an area by habitat type related to waterfowl species foraging capabilities and climatic/hydrological events.

Nutrient Requirements of Waterfowl

The WAM uses a 4x resting metabolic rate (RMR) allometric equation (Miller and Eadie, 2006) to estimate daily existence energy (DEE) requirements for waterfowl species in the upper MAV and uses kcal as the energy currency. Using a value 4x the RMR helps to account for a variety of nonbreeding season daily activities, including flight, swimming, courtship, nutrient deposition, and molting. DEE for waterfowl species commonly present in the MAV was calculated from published information on body mass from a variety of sources and the 4x RMR equations.

A related model element is the measurement of the amount of energy available to waterfowl through their diet, or true metabolizable energy (TME). Estimates of TME for most of the major food groups consumed by waterfowl in the MAV are available from published literature.

Food Abundance

Food abundance in the MAV varies depending on the season, annual temperature and rainfall, growing season days and latitudinal position, timing of floods or droughts, water depth, and food consumption by other wildlife (e.g., blackbirds). Waterfowl food in the MAV habitats can be generally classified into eight groups:

1. Mast (hard and soft)
2. Invertebrates and zooplankton
3. Seeds from herbaceous and aquatic plants
4. Below-ground tubers, roots, rhizomes
5. Above-ground browse
6. Aquatic plants and algae
7. Small vertebrates
8. Agricultural grains and browse

Calculating DUDs for MAV waterfowl requires matching food abundance and availability (see next section) by habitat type to species. The WAM documentation provides an example: food abundance and habitat values for hooded mergansers is primarily a function of small vertebrate and invertebrate foods in forest and open water/aquatic habitats while green-winged teal consume mostly seed and invertebrate foods in seasonally flooded and open areas.

With long-term MAV annual food production studies lacking, estimates of food abundance often are based on short time periods, period-specific habitat conditions (e.g., flooding regimes, management practices, plant species composition), or similar habitats outside the MAV that may not accurately reflect MAV conditions. The WAM documentation has presented data means and ranges where available and an attempt was made to provide a reasonable (i.e., conservative) estimate of average potential annual food abundance and production among habitat types. Future research will help to provide more accurate and reliable quantification of these data.

Food Availability

Food availability in the MAV varies depending on the birds' behavioral/ morphological adaptations, foraging capabilities, and climatic/hydrologic events (e.g., floods, droughts, water depth, etc.). Food availability in the MAV also depends on which species is foraging as well as what life stage or annual event an individual bird is experiencing. An abundant food resource in the MAV is not necessarily completely available for foraging waterfowl. Availability of food is influenced by:

- Chronology of seasonal production and presence in the foraging space of species
- Annual dynamics of extent and depth of flooding
- Decomposition and deterioration rates
- Consumption by nonwaterfowl species
- Disturbance or other factors preventing physical or behavioral access to foods
- Thresholds of foraging efficiency

For the model, food availability is determined by: 1) when production occurs and whether it is within the foraging space of a species, and 2) when the habitat becomes flooded (annually or seasonally), as some foods must be flooded before they become accessible to waterfowl. The WAM documentation also discusses evidence that waterfowl may stop foraging for specific foods in certain habitats if the quantity of food becomes low or the food is difficult to obtain, thereby reducing the feeding efficiency for the birds (i.e., giving up density). The WAM manual provides a hypothetical matrix of the percentage of food availability by type and time (Table 14 in the WAM documentation). This matrix combines the seasonal dynamics of production with the cumulative effects of germination, deterioration, and consumption (including a giving up density) by nonbreeding waterfowl.

Another important factor influencing food availability is disturbance or other factors limiting physical or behavioral access. Access can be restricted because of water depth, species morphology, location and attributes of fields/tracts, competition from other species, predation risk, or human-caused disturbance. In the MAV, human disturbance, in particular from hunting, may be a significant factor affecting waterfowl use of habitats, although few data exist on how

much use of habitats is affected. Assuming that there is at least some hunting-related impact on food availability to foraging waterfowl in the MAV, the WAM manual uses an average of 25% reduction in food availability for all food types in hunted sites during November to January (waterfowl hunting season).

Another factor affecting food availability is whether habitats on a site are recently restored or have been relatively unaltered over time. For example, substantial areas in the MAV have been restored under the U.S. Department of Agriculture Wetland Reserve Program during the past decade and former agricultural land has been reforested or restored to other wetland communities. Sites at different stages of restoration provide different food sources. Assessing food types and production in restored sites will require site-specific evaluation, and perhaps field data collection, to determine production dynamics.

Other WAM Inputs

In addition to the DEE, TME, and food abundance and availability requirements discussed above, the WAM user must provide field data on: 1) the number and species of waterfowl present in an area/region; 2) habitat types present, management, and the area of each; 3) composition, stand density, and tree size of forested habitats; 4) annual flood frequency by area and habitat; and 5) the presence or absence of hunting.

3 MODEL EVALUATION

USACE requires that planning models be reviewed, and those intended for widespread, repeated use are also required to be certified. Independent, objective peer review is regarded as a critical element in ensuring technical quality, system quality, and usability of the models. The purpose of the WAM review is to evaluate the technical quality and usability of the planning model. The WAM is not a software- or spreadsheet-based model and, therefore, was not evaluated for system quality. The results of the model review will be used by USACE to determine whether to certify the model for inclusion in the toolbox of USACE planning models. As a 501(c)(3) nonprofit science and technology organization with experience in establishing and administering external peer review panels for USACE, Battelle was engaged to conduct the model certification review for the WAM.

3.1 Model Review Approach

Details of the review process and charge guidance are provided in the Final Charge for the Model Certification Review for the Waterfowl Assessment Methodology (part of Attachment A). The review consisted of eight tasks, including:

Task 1 – Participate in Kick-off Meeting
Task 2 – Prepare Work Plan
Task 3 – Prepare and Finalize Charge to Model Reviewers
Task 4 – Identify Candidate Model Reviewers and Select and Finalize Contracts with Model Reviewers

Task 5 – Conduct Model Assessment
Task 6 – Prepare Draft Report for Model Review
Task 7 – Participate in Meeting to Discuss Draft Report for Model Review
Task 8 – Prepare Final Report for Model Review

Battelle participated in a kick-off teleconference meeting with representatives from the USACE ECO-PCX and the model developers (Task 1). The purpose of the meeting was to allow Battelle to brief USACE on the approach used to conduct the model review and for USACE to brief Battelle on USACE's specific goals and objectives for the model review. Battelle prepared a draft and final work plan, which included charge questions and guidance to the model review panel that were based on the goals and objectives discussed as well as the USACE Statement of Work (SOW) (Tasks 2 and 3).

Battelle initially identified more than 20 candidate model reviewers, evaluated their technical expertise, and inquired about potential conflicts of interest (COI). Of those contacted initially, Battelle chose four of the most qualified candidates based on background, years of experience, and lack of actual or perceived COI (Task 4) and confirmed their interest and availability. Of those four candidates, three were proposed for the final model review panel and one was proposed as a backup model reviewer. These experts were approved by the USACE ECO-PCX (Task 4). The three proposed primary model reviewers constituted the final panel. The remaining candidates were not proposed as model reviewers for a variety of reasons, including lack of availability, disclosed conflicts of interest, or because they did not possess the precise technical expertise required.

The model review panel included:

- A civil works planner/Habitat Evaluation Procedures (HEP) expert with experience in floodplain management including ecosystem restoration and knowledge of the Lower Mississippi River Valley.
- Two (2) waterfowl biologists with experience with methods for evaluating waterfowl habitat suitability and knowledge of the Mississippi River Valley migratory waterfowl.

Information on the experts selected for the model review panel is summarized in Table 1, and a short biography for each model reviewer is provided in Appendix A.

Table 1. Experts Selected for the Waterfowl Assessment Methodology Review

Name	Affiliation	Location	Education	Experience (years)
Civil Works Planner/HEP Specialist				
Richard Stiehl	Independent consultant	Tucson, AZ	Ph.D. in environmental science/biology	25+
Waterfowl Biologists				
Stephen Dinsmore	Iowa State University	Ames, IA	Ph.D. in fishery and wildlife biology	20
Guy Baldassarre	SUNY College of Environmental Science and Forestry	Syracuse, NY	Ph.D. in wildlife science	30

After the model reviewers were under subcontract, Battelle conducted a kick-off teleconference to brief them on the purpose and approach for the review process. Another kick-off teleconference was convened with Battelle, the model reviewers, representatives from the USACE ECO-PCX, and the model developers to provide the model reviewers an opportunity to be briefed specifically on the models and to ask questions directly of USACE. The model reviewers were provided with an electronic version of the review document, along with guidance and a charge that solicited their comments on specific aspects of the document that was to be reviewed.

The document that was provided to the model reviewers for the review was the *Manual for Calculating Duck-use-days to Determine Habitat Resource Values and Waterfowl Population Energetic Requirements in the Mississippi Alluvial Valley*. The following additional documents were provided for reference only and were not to be reviewed:

1. Protocols for Certification of Planning Models (http://www.usace.army.mil/CECW/PlanningCOP/Pages/models.aspx)
2. EC 1105-2-407, Planning Models Improvement Program: Model Certification (http://www.usace.army.mil/CECW/PlanningCOP/Pages/models.aspx)

The model reviewers were asked to review the WAM documentation using guidance and charge questions provided to them. There was no communication between the model reviewers and the model developers during the peer review process. The guidance and charge questions were based on the model certification criteria discussed in *Protocols for the Certification of Planning* Models (USACE, 2007). The intent of the charge questions was to focus the review on the assessment criteria that are critical for the certification of planning models. The process and evaluation criteria for the review are outlined by USACE (2007) and described in Section 1.2 (Model Assessment) of this report.

Thirty charge questions developed by Battelle and approved by USACE were provided to the model reviewers to guide them during their review. Following the model reviewers' individual

reviews of the WAM documentation, individual comments were compiled into a merged comment form. Approximately 100 individual comments were received.

A panel review teleconference was conducted to discuss the key technical and conflicting comments identified from all of the individual comments, and to reach agreement on the key findings of the review that should be provided to USACE in the Model Certification Review Report. At the conclusion of the teleconference meeting, six Final Panel Comments had been developed. These six comments discuss the key issues identified with the model and model document during the review and present recommendations for resolution. The model reviewers were also assigned the responsibility of drafting specific sections of the Model Certification Review Report. Battelle assembled the individual report sections and developed the summary of the review results and conclusions of the review. The results and conclusions of the model review are discussed in Sections 3.4 through 4.0 of this final report. Final Panel Comments are provided in Appendix B.

Battelle and the model reviewers met via teleconference with USACE representatives and model developers to discuss the Draft Model Certification Review Report on February 16, 2010 at 3PM EST. No revisions to the report were suggested, and Battelle provided USACE with the Final Model Certification Review Report within two working days of the teleconference.

3.2 Assessment Criteria

In accordance with USACE (2005), the Waterfowl Assessment Methodology was subjected to an independent external peer review. The review was conducted based on guidance in the USACE *Protocols for Certification of Planning Models* (July 2007). As required by the PMIP, the WAM model was reviewed and assessed for technical quality and usability. The WAM is not a software- or spreadsheet-based model and, therefore, was not evaluated for system quality. The review of technical quality and usability is described in the following sections.

3.2.1 Technical Quality

Analytical tools, including models, used for planning purposes need to be technically sound and based on widely accepted contemporary scientific theory. The waterfowl populations and habitats in the MAV must be realistically represented by the components of the models. The architecture of the model calculations must reflect how the system is expected to respond to changes in measured variables based on the application of scientific theory. Formulas and calculation routines that form the mechanics of the models must be accurate and correctly applied, with sound relationships among variables. The models should be able to reflect natural changes as well as the influence of anthropogenic laws, policies and practices. All model assumptions must be valid and should be well-documented. The analytical requirements of the models must be identified, and the model must address these requirements. The models should also produce robust, reproducible results that stand up to the rigorous scrutiny in later stages of the plan formulation process.

3.2.2 System Quality

As previously discussed, a review of the system quality was not performed as part of this effort because the WAM does not have any software and is not spreadsheet-based.

3.2.3 Usability

Usability refers to how easily model users can access and run the models, interpret the model output, and use the model output to support planning decisions. An assessment of model usability includes evaluating the availability of data required to run the models and the ability of the user to learn how to use the model properly and effectively. Model outputs must also be easy to interpret, useful for supporting the purpose of the models, easy to export to project reports, and sufficiently transparent to allow for easy verification of calculations and outputs.

3.3 Approach to Model Testing

The WAM model reviewers did not test the model because the WAM does not have software and is not spreadsheet-based.

3.4 Technical Quality Assessment

The WAM technical quality assessment was based on an assessment of the criteria described in Section 1.2 of this report. Without knowing all of the relevant USACE policies and procedures, the model reviewers were only able to perform a limited assessment of whether the model properly incorporates USACE policies and procedures. The results of the model reviewers' assessment of the other criteria are summarized in the following sections.

3.4.1 Review of Theory and External Model Components

Model certification requires that each model is "based on well-established contemporary theory" (USACE, 2007). Contemporary theory may be based on professional judgment, literature reviews, and/or current and previous research.

The WAM model is founded on well-established theory and the model documentation contains the most current information on waterfowl ecology, waterfowl energetic requirements, food abundance, and food availability. Most of the model inputs have been published in respected peer-reviewed journals; those that haven't are gleaned from unpublished sources or the personal experience of the author, who is an acknowledged expert on this topic in the Mississippi Alluvial Valley. This information has been assembled into a DUD model that has a long history of use in estimating carrying capacity of waterfowl during a specified period (Reinecke et al., 1989). While DUD models are useful, they are not without problems. The equation for a DUD is simplistic and incorporates constants such as estimates of food availability, true metabolizable energy (TME), and DEE. Site-specific data are often not included (and may not be available), temporal variation is not formally addressed, and the models are often broadly applied to large areas where inputs would be expected to be variable. Despite these limitations, the concept of a DUD has the potential to be a useful tool to guide project management where waterfowl are a focus.

Estimates of DUDs vary in response to many factors including (but not necessarily limited to): 1) species, sex, body size, and portion of the annual cycle; 2) habitat area; 3) forage production and availability to waterfowl; 4) nutritive composition of forage types; 5) waterfowl efficiency converting food to metabolizable energy; 6) environmental conditions; 7) forage decomposition rates; 8) forage consumption by non-waterfowl species; and 9) food densities at which waterfowl

cease feeding. Collectively, this list touches on all of the key factors known to influence the calculation of a DUD, and each of these is considered in the WAM model.

Contemporary modeling theory suggests that the many factors that contribute to variation in DUDs could be best represented in a stochastic model (see Final Panel Comments 1 and 2). This is easy to handle mathematically, although model calculations may be too complicated to do by hand and may require the development of simple spreadsheets to aid computations (see Final Panel Comment 5). A stochastic model could be built to produce a probability of each outcome. The user is then presented with a range of options, each with an associated probability, and thus has greater insight into how the system is behaving. The model reviewers further note that stochastic models are often the preferred modeling approach in systems (e.g., wintering waterfowl in the MAV) where there is information to specify the frequency distributions of model inputs. While this does not affect model theory per se, it does highlight that the theory is there to support a more complex model (one with stochasticity) to assess waterfowl responses to USACE management actions and project development.

3.4.2 Review of Representation of the System

By definition, models are abstractions of real-world systems and, as such, they are inherently simpler than the ecosystems they represent. While basic ecological conditions are represented in the models, human disturbance factors, which may impact the analysis, are not consistently or thoroughly incorporated into the evaluation process. A project site should not be considered isolated in space; ecological processes are often impacted by adjacent or surrounding human activities. Land use changes (e.g., increased impervious surface area or increased high intensity uses) should be considered when predicting future ecological conditions at the site level. Similarly, larger-scale drivers that are affected by anthropogenic activities (e.g., climate change, sea level rise (SLR), change in storm frequency/intensity, change in river sediment loads, etc.) should be considered in these models.

The WAM documentation states that the model seeks to identify quantitative methods to estimate DUDs based on daily energy requirements of waterfowl species in the MAV during the nonbreeding period (September-March). The estimate of maximum DUDs requires three key inputs for each habitat type involved: 1) an estimate of DEE, 2) the amount of food present in a given habitat, and 3) the energy yield of that food in terms of TME. However, the documentation also presents methodologies to adjust the maximum DUD estimate by adjusting the amount of food present based on availability (Table 14 in the WAM documentation), flooding probability, and availability as influenced by hunting.

The model reviewers believe that representation of the system in the WAM documentation is near flawless in relation to the task of calculating both maximum and adjusted DUDs. Every significant natural and man-made habitat important to nonbreeding waterfowl in the MAV has been included, including eight major types and associated subtypes: 1) bottomland hardwood forest (low, intermediate, and high); 2) floodplain forest; 3) riverfront forest; 4) seasonal herbaceous and bottomland prairie wetlands (including “moist-soil impoundments); 5) scrub/shrub; 6) dead timber; 7) open water/aquatic; and 8) agricultural fields. The model also considers every major food category used by nonbreeding waterfowl in the MAV, which included eight major types: 1) mast (hard and soft); 2) invertebrates and zooplankton; 3) seeds;

4) belowground tubers, roots, rhizomes; 5) aboveground browse; 6) aquatic plants and algae; 7) small invertebrates; and 8) agricultural grains and browse. The adjustments of maximum DUDs as influenced by food availability are also based on the key factors involved (e.g., Table 14 in the WAM documentation).

3.4.3 Review of Analytical Requirements

Determining DUDs requires knowledge of the amount of a given food type, the caloric value of that food type, and the DEE requirement for a given species. The analytical requirements are simple, straightforward, and comprehensive (unless temporal variation in DEE is a desired variable) and are clearly stated in the last section of the model documentation. These analytical requirements include: 1) number and species of waterfowl present in an area/region; 2) habitat types present, management, and the area of each; 3) composition, stand density, and tree size of forested habitats; 4) annual flood frequency by area and habitat; and 5) presence or absence of hunting. The number and species of waterfowl present in an area/region may be difficult to accurately assess across large areas or broad time periods. Determining the habitat types present along with their area and management could utilize GIS data for most/all sites. It may be difficult to classify emergent marshes and moist-soil impoundments as they cycle through stages known as dry marsh, regenerating marsh, degenerating marsh, and lake marsh.

Although the model will generate precise results, it will not necessarily generate accurate results, given the variability in the input parameters. This model does a good job identifying many analytical requirements for calculating DUDs. Any model must balance between simplicity and complexity. Simple models have fewer assumptions and more straightforward inputs, and are easier and more useable. Increasing model complexity results in more assumptions and requires more field work to gather variable data, therefore making it more expensive to run and perhaps of limited use for more sensitive applications.

3.4.4 Review of Model Assumptions

The WAM model requires inputs that fall into three general categories, each of which has associated assumptions: 1) calculation of DEE requirements, 2) abundance of food, and 3) availability of food. The author has addressed the assumptions for each input parameter throughout the model's description and has chosen conservative inputs based on the data available. However, given the combination of variability, limitations, and, in some cases, sparse input data on food abundance and availability, some assumptions are considerably less reliable than others. For example, following a review of the food abundance assumptions the author correctly states, "Undoubtedly, future investigation will refine, and provide, more accurate and reliable quantification of these estimates."

Relative to the three general input parameters, the model review panel believes the assumption that DEE is best estimated by multiplying RMR equations (presented in Miller and Eadie, 2006) by 4x is not well justified. Also, the assumption that a single calculation of DEE is representative for the entire nonbreeding period does not account for variations due to temperature and activities; hence, calculation of DUDs could be very different during mild versus cold winters. There are data (e.g., time budgets) that could be used to provide better defense of the 4x multiplier, and calculation of DEE can be adjusted for ambient temperature.

Relative to estimates of food abundance, there is tremendous variation in the quality and hence reliability of input data, varying from fairly accurate estimates for agricultural grains (e.g., waste rice) to virtually nothing for belowground roots, tubers, rootlets and other groups. The model documentation states that this variation is an issue but still offers an input variable for each food group. Hence, there is a tacit assumption that all model inputs are of equal reliability. For example, under the Aquatic Plants and Algae section it states, "In the absence of having specific data on potential waterfowl forage from these aquatic foods, an estimate of 100 kg/ha aquatic vegetation is used in this manual." Reliability of input variables is a critical assumption to the model and hence should be more strongly defended, which can potentially be done by working with a few major studies (e.g., those with large sample sizes, low variation, broader spatial scales), as opposed to using all available studies on a given input parameter to generate input variables. In contrast, where input data are especially limited, the model could provide a single, "best justified" estimate as input for a variety of habitat types (as on pg. 15). In some cases, it may be best not to provide an estimate at all, as was done for the Small Vertebrates section.

The food availability assumptions are probably the most problematic, in large part because estimating them is so difficult. The model documentation identifies six factors that affect availability (pg. 16), but extrapolating existing data into estimates used in the model are tenuous for some of these factors. For example, the review panel finds little basis for to assume that food availability is reduced by 25% due to hunting activity (pg. 20). Also, the values presented in Table 14 in the WAM documentation are very important to assumptions about food availability but are weakly justified. Essentially, the values in Table 14 are supported by 21 literature citations, but there is again a tacit assumption that all are of equal value in providing estimates for input variables; hence, it becomes difficult to assess the reliability of the inputs because the user has not detailed assessment of the strength/reliability of the underlying source of the data. Lastly, the review panel believes that the calculation of rice deterioration may not be correct in relation to estimates outlined by Stafford et al. (2006), which appear to be much greater than those presented for use in the WAM.

3.4.5 Review of Ability to Evaluate Risk and Uncertainty

Ecological models are most useful when they incorporate uncertainty directly into estimates of model outcomes. In the case of the WAM model, the model reviewers recognized that this was a deterministic model that failed to directly incorporate uncertainty. However, the model documentation identified ranges of values for many model inputs (e.g., acorn production) and these could easily be incorporated into the WAM model to evaluate risk and uncertainty. The panel suggests that the DUD model be used to develop a range of possible outcomes resulting from different model inputs. For example, a range of values could be input for acorn availability, producing a range of estimated DUDs. This would allow a user to tailor the model to local conditions (inputs) and evaluate potential DUDs for a range of conditions. The use of a range of input values will also counter the model uncertainty that arises from sparse data supporting some input values.

The model documentation further states that the equations "represent potential maximum carrying capacity for areas/habitats by assuming all foods are present and available in all months and years" and that "the actual carrying capacity of areas/habitats is at some level below the

maximum potential." The model reviewers believe that knowing the maximum potential only is not enough information to support key decision-making activities. Nor should the user rely on simple linear correction factors (e.g., the 0.75 multiplier for hunting) to approximate actual carrying capacity. The best solution is to incorporate model uncertainty either with the use of a stochastic model (see Final Panel Comment 2), or by evaluating a range of model inputs.

3.4.6 Review of Ability to Calculate Benefits for Total Project Life

Based on the model's calculations of waterfowl population variability factors other than the supply of food resources (e.g., changes in migratory and breeding habitats), the WAM is not designed to provide long-term (Total Project Life) estimates. The model produces comparable before-and-after project impacts that can provide valid estimates of functional losses or gains via a particular project, but calculation of long-term benefits is not possible because the WAM does not incorporate natural changes in area and/or composition of wintering habitat. Through a series of calculations, it may be possible, albeit tedious to determine benefits over the life of the project. Such a series would need to include any change in areas, and predict any potential change in the food available. The last example in the manual (pgs. 25-27) briefly mentions how the WAM can be used for mitigation, and this example warrants a more thorough discussion. As stated above, the WAM is well-suited to assessing simple before-and-after project impacts relative to project implementation. However, if uncertainty were incorporated directly into the equations to produce a realistic range of values for a site, the model would be more useful for longer time periods, perhaps for Total Project Life. The WAM may be used to determine the relative changes in DUDs due to a proposed project; however the calculation of long-term benefits would be cumbersome and tedious, as the data for both area and food availability would need to be repeatedly entered to conduct the long term analysis.

3.4.7 Review of Model Calculations/Formulas

The WAM model formulae and calculations are generally correct and easy to follow. The model reviewers did find one error (see Final Panel Comment 6). In the example beginning on the top of page 25, the opening sentence reads:

> For example, 100 ha of naturally flooded BLH habitat with a medium 50-60 basal area of red oak and medium size tree stand producing 300 kg acorns/ha, a TME value of 2.67 kcal/g for acorns, a total winter period, flooded at a 5-year or 20% flood frequency recurrence interval, and hunted would equate to:
>
> 100 ha x [300 kg/ha x 1 (total winter availability) x 0.2 annual recurrence x 1.0 hunting availability] =
>
> 6,000,000 kcal available
> ---------- = 13,261 mallard DUD annualized/year
> 452.44 DEE for mallards

The word "hunted" appears near the end of this sentence, so the panel was expecting that the equation below this sentence would contain a hunting availability value of 0.75. Instead, this value is 1.0, which according to earlier material indicates that this system is not hunted. The next two equations on this page, which are part of this same example, appear to correctly handle

the hunting availability term. Because hunting availability is a key term in model calculations, the panel believes it is critical that this be presented as accurately as possible in this section.

The panel checked the remaining formulae and calculations and did not find any errors. However, the model reviewers have two additional comments on this topic:

1) All formulae in the WAM model documentation appear to have been written in plain text and some (e.g., Equation 3) are difficult to interpret. The panel suggests presenting all equations and sample calculations using mathematical software (e.g., the Microsoft Equation function in Microsoft Word) (see Final Panel Comment 5). This will consolidate the formulae, substantially reduce wasted "white space," and make operators such as summations easier to calculate.
2) Throughout the calculations, the shift from calories to kcal is not clear or explicitly stated. For example, in the calculation on page 22, the numerator has a value of 540,000 kcal/ha. However, by just doing the math in the previous step this number is 540 [(150*2.5) + (15*4) + (30*3.5) = 540)]. This is also true in all remaining calculations.

The model reviewers suggest that the single error be corrected and that the two suggestions noted above be incorporated in the final WAM model.

3.5 System Quality

In this case, a review of the system quality was not performed because the Waterfowl Assessment Methodology does not have software and is not spreadsheet-based.

3.6 Usability

3.6.1 Review of Data Availability

The WAM methodology lists five data inputs needed to calculate DUDs in addition to the DEE and food abundance values: 1) number and species of waterfowl present in the target areas; 2) habitat types present, management, and area; 3) composition, stand density, and tree size of forested habitats; 4) annual flood frequency; and 5) presence or absence of hunting.
The number and species of waterfowl present are available from surveys conducted by state or federal personnel or new surveys can be conducted on site. However, the WAM documentation provides no time frame for collecting such data (e.g., weekly, biweekly, monthly). For example, the Midwinter Survey conducted by the U.S. Fish and Wildlife Service is an annual survey, which might not be sufficient depending on the area involved for calculation of DUDs.
As stated, documentation of habitat types and area present can usually be done via maps and photographs for a given site, but field evaluation may be needed to "ground-truth." Field reconnaissance also may be needed to delineate subtypes of habitats such as low, intermediate, and high bottomland hardwood forest (BHF) and other habitats where the differentiation of boundaries may be difficult to discern from maps and/or photographs. The management regime can be determined by presence or absence of structures such as dikes or water control structures, and consultation with local resource agency personnel.

Field work will be required to document composition, stand density, and tree size of forested habitats. Such measurements will need to include species composition, size, and density. As

standard forest mensuration techniques exist to measure these variables, the collection of these data is straightforward.

Annual flood frequency data are generally attainable from U.S. Army Corps of Engineers District offices. More localized data could be needed and may be available from satellite imagery or other local records, as stated in the WAM documentation.

Information on the presence or absence of hunting can be obtained for some areas, especially state and federal refuges and private hunting areas. However, the WAM documentation is very unclear on how hunting values are generated in terms of affecting the model. For example, it is unclear how much hunting needs to occur before food abundance input into the DUD equation is adjusted by 25%, or 50%, or 100%.

3.6.2 Review of Results

The WAM results are extremely easy to understand. The model output is in DUDs, a well-established, widely-used measure of carrying capacity. DUD is clearly defined in the beginning of the documentation so the reader should be able to interpret the numerical model output. The model accounts for food deterioration and various other factors (e.g., water levels, flooding) that can affect food availability and resulting DUDs. The model addresses four needs: 1) evaluating project impacts; 2) determining carrying capacity of a given area; 3) setting habitat and conservation goals; and 4) evaluating management actions and techniques. The model use is most valid for items 1 and 3, least valid for item 2, and somewhat valid for item 4.
The model provides a general framework for comparing potential management scenarios by calculating estimates of DUDs, and therefore, the potential ecological benefits and losses associated with a project. As extensive data and multipart mathematical operations are required, and all inputs of model data (with field verification as recommended on pg. 28) are subject to entry error, the use of the model may be limited to “professional” users, or cases where accurate estimates of waterfowl wintering habitat quality are desired.

The model would be valuable in comparing potential changes in waterfowl habitat as the result of a proposed project. The model produces comparable before and after estimates that can then provide valid estimates of function losses or gains via a particular project, but calculation of long-term assessment is not possible in the current configuration as the model does not incorporate natural changes in either area or composition or both of wintering habitat. If a spreadsheet or relational database application were developed, and changes in habitat area and habitat values needed to evaluate impacts were added, then life of the project mitigation could be calculated through the application of a computer-aided application. However, if there is uncertainty in the pre- or post-project conditions, independent model runs will need to be jointly evaluated because the model is deterministic rather than stochastic.

The overall accuracy of model predictions is questionable, as some model inputs are not well supported by published studies (e.g., the DEE multiplier) or are based on conflicting data (e.g., acorn production). However, the potential ecological benefits and losses may be relatively compared. The model would be valuable in comparing potential changes in waterfowl habitat as the result of a proposed project. Its best use is as a project planning tool.

3.6.3 Review of Model Documentation

The WAM model is mathematically simple (there are only five equations) and hence easy to use, but that simplicity does not detracts from its usefulness. The overall approach is very user-friendly, beginning with a documentation of the rationale and data required for all model inputs, including an extensive number of tables (16) and figures (7). Hence, the user has a very well documented review of the state of knowledge relative to all aspects of the model — in essence, a reference. The WAM then presents the model equations, starting with the most simple. Easily followed examples are presented for each of the five equations, followed by a brief section on input data requirements and availability.

Overall, the WAM is a thorough representation of feeding waterfowl ecology in the MAV during the nonbreeding season (September-March). The model then guides the user well with useful examples for every step and equation. Hence, the model is simple and easy to use.

3.7 Model Assessment Summary

A review of the technical quality and usability of the WAM determined that the model and approach are of high technical quality and usability, but some improvements and corrections to the methodology are needed. In addressing and answering charge questions designed to focus the review of WAM based on the model assessment criteria in the USACE *Protocols for Certification of Planning Models*, the following underlying issues were identified:

1. Due to the Mississippi Alluvial Valley (MAV) being such a broad geographic area and the inherent variability in the data needed to feed the model, the accuracy of some of the model inputs are very poorly known, making the overall accuracy of the model predictions questionable.
2. The model is written as deterministic rather than stochastic, which does not account for uncertainty in inputs and model predictions (i.e., outputs).
3. The document would benefit from a separate section which details each of the model's assumptions.
4. The model does not adjust for the changes in DEE requirements across the nonbreeding period.
5. The model would be easier to use if developed into a spreadsheet or relational database.
6. There appears to be a typographical or mathematical error in the example at the top of page 25.

These underlying issues are further discussed in Appendix B: Final Panel Comments.

4 CONCLUSIONS

Overall, the model reviewers agreed that the concept and application of the WAM are sound for planning efforts. Models are simple representations of complex systems and, as such, must balance complexity and reality with simplicity and usability. For the WAM, this goal has been

achieved. The model seems to sufficiently capture the habitats being modeled and does not have any irreparable deficiencies.

However, there were some concerns regarding the accuracy of the WAM's model inputs, the ability to measure uncertainty, and completeness of the documentation. The model reviewers provided the following recommendations for improving the model based on the most significant concerns identified by the model reviewers.

1. Construct a simpler model that includes more known inputs based on key studies versus a review of all studies from which a mean is then chosen.
2. The model's time frame should be extended into April to address species that remain in the upper Mississippi Alluvial Valley (MAV) well into spring.
3. Include a section in the WAM manual that addresses the issue of model applicability and accuracy relative to all potential model uses.
4. Incorporate stochasticity into the WAM model for calculating DUDs in the MAV by using point estimates and a measure of precision.
5. Include a section early in the WAM manual that lists key model assumptions.
6. Provide better justification of the 4x multiplier by using time budget data along with the RMR equation to calculate an energy budget for at least mallards, which will provide a better defense of the 4x multiplier or potentially lead to a different multiplier.
7. Acknowledge that DEE likely varies over the nonbreeding period, regardless of the multiplier, and have the model examine potential changes in DUD estimates over time (e.g., early, mid-, and late in the nonbreeding period).
8. Include temperature in the estimation of DEE.
9. Make the WAM more user-friendly and decrease errors by translating it into spreadsheet or database software.
10. Correct the typographical or mathematical error in the example on page 25.

The reviewers suggest incorporating the recommended resolutions to the issues identified into the WAM and WAM documentation to improve the model for widespread use for planning purposes. The model will be better able to achieve its stated purpose with less potential for errors if suggested revisions are made.

5 REFERENCES

Miller, M.R. and J.M. Eadie. 2006. The allometric relationship between resting metabolic rated and body mass in wild waterfowl (Anatidae) and an application to estimation of winter habitat requirements. Condor 108:166-177.

Reinecke, K.J., R.M. Kaminski, D.J. Moorhead, J.D. Hodges and J.R. Nassar. 1989. Mississippi Alluvial Valley. Pages 203-247 *in* L.M Smith, R.L. Pederson and R.M. Kaminski, editors. Habitat management for migrating and wintering waterfowl in North America. Texas Tech University Press, Lubbock.

Stafford, J.D., R.M. Kaminski, K.J. Reinecke and S.W. Manley. 2006. Waste rice for waterfowl in the Mississippi Alluvial Valley. Journal of Wildlife Management 70:61-69.

USACE. 2007. Protocols for Certification of Planning Models Under the Planning Models Improvement Program (PMIP). July 2007.

USACE. 2005. Planning Models Improvement Program (PMIP): Model Certification. Engineering Circular No. 1105-2-407, May 2005.

USACE. 2000. Planning Guidance Notebook. Engineering Circular No. 1105-2-100, April 2000.

Appendix A

Biographic Information for Model Review Panel Experts

This page intentionally left blank.

Habitat Evaluation Procedures Expert - Richard Stiehl

Dr. Stiehl earned his Ph.D in environmental science/biology from Portland State University in 1978 and has over 25 years of experience with Habitat Evaluation Procedures (HEP), wildlife biology, avian ecology, and habitat and community modeling. He is currently an independent consultant. He completed his original HEP training in 1981 and the U.S. Fish and Wildlife Service (USFWS) invited him to write several sections and be the chief editor of the new (and still in use) USFWS HEP Manual. To date, Dr. Stiehl has taught over 30 certified HEP workshops. Other work with USFWS has included revising and/or writing all HEP manuals, rewriting HEP and Habitat Suitability Index (HSI) software, and conducting wildlife research. He has provided HEP expertise to 20 states and many federal agencies, including USACE, Bureau of Land Management (BLM), Natural Resources Conservation Service (NRCS), and U.S Environmental Protection Agency (USEPA), and has led HEP teams on large projects, including HEP analyses for shorebird habitat and the impacts of weapons training for the U.S. Air Force in Utah. After leaving USFWS, he continued his HEP leadership role as a private consultant, constructing community HSI models for riparian, desert, and desert wetland habitats. He has developed software to evaluate long-term impacts to desert ecosystems for the Washington Department of Wildlife and the Columbia Basin Fish and Wildlife Agency. Other high profile HEP projects include consulting with General Electric for Upper Hudson River PCB contamination, New York State for post-9/11 communications network evaluation, and the Theodore Roosevelt Conservation Trust for impacts in central Wyoming gas/oil field development. His experience in the Lower Mississippi River Valley includes his being an assistant and associate professor of biology at Southeast Missouri State University (Cape Girardeau, MO) for ten years and conducting extensive fieldwork in southeastern Missouri on fish and bird populations. Dr. Stiehl also has experience conducting restoration and mitigation analyses for USFWS and tribal lands.

Waterfowl Biology Expert – Guy Baldassarre

Dr. Baldassarre earned a Ph.D. in wildlife science from Texas Tech University in 1982 and is currently a Distinguished Teaching Professor in the wildlife sciences program at the State University of New York (SUNY), College of Environmental Science and Forestry. At SUNY, he teaches courses in ornithology, waterfowl ecology, and wildlife ecology and management. He has also taught a course entitled "Waterfowl Ecology and Management" through the National Conservation Training Center of the U.S. Fish and Wildlife Service several times. He has conducted research in Texas and Louisiana on the role of wetland complexes in meeting the life-history requirements of nonbreeding waterfowl. Dr. Baldassarre's experience with large civil works projects includes his work studying waterfowl responses to hydrological management of Wetlands Reserve Program habitats in New York. He also served on the Advisory Board for the expansion of the Montezuma National Wildlife Refuge, a board appointed by the New York State Department of Environmental Conservation (DEC) Commissioner and regional director of the U.S. Fish and Wildlife Service. Other relevant research has included studies of wood ducks in Alabama and Georgia, wintering green-winged teal in Louisiana, and mallards and black ducks in New York State. He is a past Editor-in-Chief for *The Journal of Wildlife Management* (1998-99), author of two editions of *Waterfowl Ecology and Management* (1994 and 2006), and editor of *Conservation Biology of Flamingos*, a special publication of the Waterbirds Society (2000). He has mentored more than 40 graduate students and authored more than 75 referred papers on various ecological aspects of waterfowl, flamingos, and other wetland birds, working

in the United States, Mexico, Canada, and Venezuela. In 2008, he received a Ducks Unlimited Conservation Achievement Award in the research/technical category. His current work is focused on a revision of the classic waterfowl book, *Ducks, Geese and Swans of North America.*

Waterfowl Biology Expert – Stephen Dinsmore

Dr. Dinsmore earned his Ph.D. in fishery and wildlife biology from Colorado State University in 2001. Currently Dr. Dinsmore is an associate professor of wildlife ecology for the Department of Natural Resource Ecology and Management at Iowa State University, and has taught graduate and undergraduate courses in ornithology, avian biology, and applied wildlife population ecology. He has over eight years of professional experience as a wildlife ecologist, and prior to his university appointments worked for federal, state, and private organizations. Dr. Dinsmore has extensive experience with avian ecology, including waterfowl ecology, which is the focus of his current research program at Iowa State University. Dr. Dinsmore has worked with Habitat Evaluation Procedures (HEP) for mountain plovers in Montana and piping plovers on the Atlantic Coast and is broadly familiar with other approaches or assessing wildlife habitat use. He has extensive knowledge of bird use of the entire Mississippi Valley, both from personal interests as an avid birdwatcher and his research activities, including habitat use modeling in the Lower Mississippi Alluvial Valley. Other research activities include projects assessing wintering waterfowl use of the Mississippi Delta region in MS/LA/AR, participation in joint venture activities to benefit shorebirds, and formal shorebird surveys in the Mississippi Delta region of northwestern Mississippi. He has conducted intermittent contractual bird surveys for the USACE Rock Island District, Saylorville Lake Project, and is familiar with large civil works projects. Dr. Dinsmore has also provided bird survey data used to modify pool level management on the Saylorville project. Additionally, in the late 1990s, he had provided public comment on proposed changes to the Saylorville Lake Project. He has authored or co-authored over 30 peer reviewed journal articles and five textbooks on wildlife ecology. Dr. Dinsmore has served as the Associate Editor for the Auk since 2006 and has been a member of the Cooper Ornithological Society since 1993.

Appendix B

Final Panel Comments

This page intentionally left blank.

Final Panel Comments

Final Panel Comment 1:
Due to the Mississippi Alluvial Valley (MAV) being such a broad geographic area and the inherent variability in the data needed to feed the model, the accuracy of some of the model inputs are very poorly known, making the overall accuracy of the model predictions questionable.
Basis for Comment:
The Waterfowl Assessment Methodology (WAM) model will produce precise estimates of before and after duck-use days (DUDs) for a given project. However, the model reviewers believe accuracy of model inputs is important to properly evaluate any given project. As an example, if accuracy of "before project" input data were biased low in terms of DUDs but "after project" inputs were biased high, project benefits would be overestimated (or vice versa). A specific example is the Stafford et al. (2006) study that reexamined the amounts of waste rice remaining after harvest in the MAV, finding that carrying capacity for waterfowl may have been previously underestimated by 53-83%. Hence, accuracy of input data was of obvious importance for a very significant food source for waterfowl in the MAV, especially in the lower MAV. The accuracy issue arises because the WAM model seeks to explain DUDs over eight primary habitat types, eight food types, and multiple factors that affect food availability within habitat types. These combinations lead to two sources of uncertainty in the model, both of which will affect model accuracy. First, model inputs, except DUDs, are notorious for their high variability, wherein choosing mean values for use in the model is tenuous, albeit more so for some inputs than others. As an example, estimates of moist-soil seed abundance range from 45 to 3,155 kilograms/hectare (kg/ha; Table 11), and yet the model uses values from 422-1,000 kg/ha, based on management intensity (Table 12). Invertebrate abundance among habitat types ranges from 0.5 kg/ha in flooded rice to 80 kg/ha in bottomland hardwood forest (BLH), but the model uses 5-50 kg/ha (Table 10). Production estimates for acorns range from <10 to >400 kg/ha in one example and 131-807 kg/ha in another (pg.10), which is followed by five tables on acorn abundance, culminating in recommended averages that range from 200-350 kg/ha, based on tree size, basal area, and flooding regime. Table 14, which provides estimates of food availability over winter, is another example where tremendous variability is condensed to single point estimates of questionable validity. Second, some input variables are highly uncertain estimates based on limited data (e.g., below ground roots/tubers, above-ground browse, aquatic plants/algae, small vertebrates). The assessment of factors affecting availability (i.e., Table 14, flooding regime, management status, and hunting) also introduces significant variation in the model. In particular, the author does not provide a basis for the assumption that food availability is reduced 25% due to hunting, or even what constitutes hunting intensity an area, which should include consideration of the number of hunters and the frequency with which they use a given site. Lastly, although the primary objective of the WAM is to estimate DUDs as a measure of benefits or impacts of water development projects in the MAV (pgs. 2-3), other potential uses are referenced in the first paragraph: 1) determining carrying capacity of local and regional landscapes, 2) setting habitat and acreage goals for conservation, and 3) evaluating the effectiveness of management actions. Although the model reviewers believe inherent variability of the input data is a general problem for the primary objective of the WAM model, such variability also can differentially affect use of the model if considered for other purposes (i.e., it is more accurate for some uses than others). Specifically, accuracy of input variables is considerably more important when estimating carrying

capacity (Use 1, above), as over or underestimates of food abundance and availability will dramatically affect DUDs. Perhaps the best example of such a case again is the example from harvested rice fields in the lower MAV, where earlier estimates of waste remaining after harvest dramatically underestimated DUDs wherein the study recommended that 1980s-estimates of 1,858 DUDs for waste rice in the MAV be reduced to 325 (Stafford et al., 2006). In contrast, the WAM appears more accurate in determining acreage goals for various conservation plans (Use 2) in that it does identify important habitats and hence can provide a guide to acreages and/or targeted habitats to protect. Use 3, above is very similar to the primary objective and thus subject to the same accuracy issues.

Significance – Medium:

The accuracy of model inputs affects model usability and level of performance by limiting the ability of the model to generate accurate DUD estimates, which in turn can inhibit the model's ability to evaluate before and after project impacts

Recommendations for Resolution:

To resolve these concerns, the WAM model reviewers recommend:

- Constructing a simpler model that includes more known inputs based on *key* studies versus a review of all studies from which a mean is then chosen. For example, estimates of waste rice in the MAV can be nicely defended by referring to only a few major studies (Manley et al., 2004; Stafford et al., 2006; Kross et al., 2008).
    - Similarly, a few major studies from moist-soil and BLH would yield a more defendable and accurate estimate of food abundance and availability of all studies.
- Grouping the lesser known habitats, such as was done for open water/aquatic, scrub/shrub, and others (pg.15). In general, for example, data are probably strongest for habitats such as BLH, moist-soil, and agriculture, and much less so for habitats such as scrub/shrub, dead timber, etc.
- Considering calculating DUDs based on average values for guilds (e.g., puddle ducks, diving ducks) instead of for each species.
- Extending the model's time frame into April to address species that remain in the upper MAV well into spring.
- Including a section in the WAM manual that addresses the issue of model applicability and accuracy relative to all potential model uses.

References:

Kross, J., R. M. Kaminski, K. J. Reinecke, and A. T. Pearse. 2008. Conserving waste rice for wintering waterfowl in the Mississippi Alluvial Valley. Journal of Wildlife Management 72:1383-1387.

Manley, S. W., R. M. Kaminski, K. J. Reinecke. 2004. Waterbird foods in winter managed ricefields in Mississippi. Journal of Wildlife Management 68:78-83.

Stafford, J.D., R.M. Kaminski, K.J. Reinecke and S.W. Manley. 2006. Waste rice for waterfowl in the Mississippi Alluvial Valley. Journal of Wildlife Management 70:61-69.

Final Panel Comment 2:
The model is written as deterministic rather than stochastic, which does not account for uncertainty in inputs and model predictions (i.e., outputs).
Basis for Comment:
Models can be extremely useful tools for predicting future outcomes. In general, a model can be classified as deterministic or stochastic. In a deterministic model the value of every variable (model input) is specified exactly and the mathematical equation will always produce the same outcome. This is contrasted with a stochastic model where model inputs are not known exactly and are instead specified as a range of values (random variables) that produces a probability distribution of potential outcomes. The Waterfowl Assessment Methodology (WAM) model is deterministic and many model inputs represent an average or conservative estimate from a range of values published in the literature. In some cases, the numerical range of values was so large that the use of the mean may mask much of the underlying information. For example, the values for acorn production (kg/ha) in tables 4-7 of the WAM document are so variable that the derivation of a single value (Table 8) for duck-use day (DUD) models may not be appropriate for all sites. The model review panel believes that the WAM model could be strengthened if it were stochastic and included uncertainty in model inputs. For this to happen, the model needs defensible estimates of model inputs along with some sense of variation in those inputs (e.g., regionally or by habitat type). Up front, some model input values were not well justified. This was primarily because: a) model input values varied across the large region included in the Mississippi Alluvial Valley (MAV) and it is difficult to assign a single representative value, or b) data to estimate some model inputs are sparse. In the case of (a), the panel believes the model would be more realistic with less bias if these values were input as a point estimate with an associated measure of precision (e.g., standard error or confidence interval). A stochastic model could then be built and it would produce a probability of each outcome. The user is then presented with a range of options, each with an associated probability, and thus has greater insight into how the system is behaving. The model reviewers further note that stochastic models are often the preferred modeling approach in systems where there is information to specify the frequency distributions of model inputs. The MAV is one such system with respect to wintering waterfowl.
Significance – Medium:
The use of a deterministic model for calculating DUDs in the MAV may not accurately reflect waterfowl responses to management actions and, therefore, affects model performance. The use of point estimates only for model inputs in a deterministic model should be avoided when there is sufficient information to specify distributions for some/all inputs.
Recommendations for Resolution:
To resolve these concerns, the WAM model reviewers recommend: ▪ Incorporating stochasticity into the WAM model for calculating DUDs in the MAV by using point estimates and a measure of precision.   o Not all parameters need to be stochastic, although this could easily be done for any model input for which there are differing estimates (e.g., from different parts of the MAV or from studies using different methodology).

Final Panel Comment 3:
The document would benefit from a separate section which details each of the model's assumptions.
Basis for Comment:
The Waterfowl Assessment Methodology (WAM) model for calculating duck-use-days (DUDs) in the Mississippi Alluvial Valley (MAV) makes many assumptions about model inputs. Unfortunately, these assumptions are scattered throughout the text of the WAM model and are not readily and easily available to the reader. The model reviewers suggest that a list of key model assumptions should be included near the beginning of the WAM document. This list does not need to be exhaustive and could focus on key assumptions only.
Significance – Low:
Model assumptions should be listed up-front because they are an integral part of the model documentation. This is important so that the reader can evaluate the utility of this model for their particular needs.
Recommendations for Resolution:
To resolve these concerns, the WAM model reviewers recommend: ▪ Adding a section entitled "Key model assumptions" or something similar early in the WAM model documentation, perhaps on pg. 3 before the section on daily existence energy (DEE). At a minimum, we suggest including the following topics in this list: o The choice of a formula for calculating resting metabolic rate (RMR). o Why the 4x multiplier of resting metabolic rate (RMR) was used to calculate DEE. o The choice of the 0.75 hunting availability multiplier

Final Panel Comment 4:
The model does not adjust for the changes in daily existence energy (DEE) requirements across the nonbreeding period.
Basis for Comment:
The Waterfowl Assessment Methodology (WAM) model appropriately uses the equation presented in Miller and Eadie (2006) for calculation of resting metabolic rate (RMR), which is a critical model input. As the author notes, however, RMR must be adjusted to account for energy expenditure due to normal daily activities (e.g., flying, feeding. preening feathers), as well as major life-history events such as molting and migration. So, RMR must be adjusted to produce an estimate of DEE requirements, for which the WAM model chooses a 4x multiplier. The model reviewers believe the choice of the 4x multiplier in the model was not well justified. Further, a single calculation of DEE for the entire wintering period cannot account for variations due to temperature and activities; hence, the model could be biased toward a high estimate of duck use days (DUDs) during a mild winter, or mild periods within a given winter, because less energy is required by wintering ducks. The opposite would be true during a cold winter.
Significance – Low:
This shortcoming affects the technical quality of the model in that the calculation of DEE is not as accurate as it could be.
Recommendations for Resolution:
To resolve these concerns, the WAM model reviewers recommend: ▪ Including better justification of the 4x multiplier by using time budget data along with the RMR equation to calculate an energy budget for at least mallards, which will provide a better defense of the 4x multiplier or potentially lead to a different multiplier. ▪ Acknowledging that DEE likely varies over the nonbreeding period, regardless of the multiplier, and having the model examine potential changes in DUD estimates over time (e.g., early, mid-, and late in the nonbreeding period). ▪ Including temperature in the estimation of DEE.

Reference:

Miller, M.R. and J.M. Eadie. 2006. The allometric relationship between resting metabolic rate and body mass in wild waterfowl (Anatidae) and an application to estimation of winter habitat requirements. Condor 108:166-177.

Final Panel Comment 5:
The model would be easier to use if developed into a spreadsheet or relational database.
Basis for Comment:
Extensive data and multipart mathematical operations are required, and as any input is subject to entry error and extensive input is tedious, the use of the model may be limited only to cases where accurate estimates of waterfowl wintering habitat quality are desired. Development of a spreadsheet or relational database application would reduce errors and increase usability.
Significance – Low:
The addition of a computer-based calculation would enhance the usability of the model, but will not affect the performance of the model.
Recommendations for Resolution:
To resolve these concerns, the WAM model reviewers recommend: ▪ Developing the appropriate spreadsheet or database software.

Final Panel Comment 6:
There appears to be a typographical or mathematical error in the example at the top of page 25.
Basis for Comment:
The Waterfowl Assessment Methodology (WAM) includes detailed examples illustrating the calculation of duck-use-days (DUDs) in several scenarios. These examples are a critical component of the manual and will provide a basis for the reader to understand and later apply these equations to particular management scenarios. As such, it is important that these be mathematically correct and clearly written so that they are easy to follow. The model reviewers studied the examples carefully and found only one possible error. In the example beginning on the top of pg. 25, the opening sentence reads: "For example, 100 ha of naturally flooded BLH habitat with a medium 50-60 basal area of red oak and medium size tree stand producing 300 kg acorns/ha, a TME value of 2.67 kcal/g for acorns, a total winter period, flooded at a 5-year or 20% flood frequency recurrence interval, and **hunted** would equate to: 100 ha x [300 kg/ha x 1 (total winter availability) x 0.2 annual recurrence x 1.0 hunting availability] = 6,000,000 kcal available ---------- = 13,261 mallard DUD annualized/year 452.44 DEE for mallards" The word "hunted" appears near the end of this sentence, so the panel was expecting that the equation below this sentence would contain a hunting availability value of 0.75. Instead, this value is 1.0, which according to earlier material indicates this system is not hunted. The next two equations on this page, which are part of this same example, appear to correctly handle the hunting availability term.
Significance – Low:
This is the only error found in the six pages of examples and it directly affects the technical quality of the model documentation. It is important that all of the examples be correct because they form a template for others to follow.
Recommendations for Resolution:
To resolve these concerns, the WAM model reviewers recommend: ▪ Correcting the hunting availability term in this equation (replace 1.0 with 0.75). This will reduce the numerator of the equation to 4,500,000 kcal and the solution will be 9,946 mallard DUDs annualized/year.

This page is intentionally left blank.

ATTACHMENT A

Work Plan

This page is intentionally left blank.

Battelle
The Business of Innovation

US Army Corps of Engineers®

REVISED FINAL WORK PLAN

INDEPENDENT EXTERNAL PEER REVIEW

for

Certification of Four Ecological Models: EnviroFish, Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley, Waterfowl Assessment Methodology (WAM), and the Delta Region of Arkansas Hydrogeomorphic Methodology (HGM) Guidebook

Battelle Memorial Institute
505 King Avenue
Columbus, OH 43201

Prepared for
U.S. Army Corps of Engineers
Ecosystem Planning Center of Expertise

Contract No. W911NF-07-D-0001
Task Control Number: 09-210
Delivery Order Number: 0799

October 8, 2009

This page intentionally left blank.

REVISED FINAL WORK PLAN

Independent External Peer Review
for
Certification of Four Ecological Models:
EnviroFish, Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley, Waterfowl Assessment Methodology (WAM), and the Delta Region of Arkansas Hydrogeomorphic Methodology (HGM) Guidebook

Submitted to:

Department of the Army
U.S. Army Corps of Engineers
Ecosystem Planning Center of Expertise

Contract No. W911NF-07-D-0001
Task Control Number: 09-210
Delivery Order Number: 0799

Prepared by:

Battelle
505 King Avenue
Columbus, OH 43201

October 8, 2009

Battelle
The Business *of* Innovation

This page intentionally left blank.

Table of Contents

1.0 **Background, Objectives, and Scope of Work 1**

2.0 **Methods and Technical Approach 4**

3.0 **Quality Control and Quality Assurance 11**

4.0 **Reporting 12**

5.0 **Schedule 13**

6.0 **Project Organization and Communication 14**

7.0 **Budget 15**

Appendix A. Final Charge Guidance and Questions to the Peer Reviewers for the Model Certification Review A-1

Appendix B. Four Ecological Models Model Certification Review Panels, Considerations and Proposed Selection/Exclusion Criteria B-1

Appendix C. Peer Review Conflict of Interest Inquiry C-1

List of Tables

Table 1. Number of Required Panel Members. 6

Table 2. Estimated Levels-of-Effort for Panel Members 7

Table 3. Four Ecological Models Certification Review Milestones and Deliverables 13

Table 4. Battelle Staff for the Four Ecological Models Project IEPR 15

Table 5. USACE Staff for the Four Ecological Models Project 15

This page intentionally left blank.

REVISED FINAL WORK PLAN
Independent External Peer Review
for
Certification of Four Ecological Models:
EnviroFish, Waterfowl Assessment Methodology (WAM), Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley, and the Delta Region of Arkansas Hydrogeomorphic Methodology (HGM) Guidebook

General Project Information

- Project Title: Independent External Peer Review (IEPR) for Model Certification for Four Ecological Models: EnviroFish, Waterfowl Assessment Methodology (WAM), Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley, and the Delta Region of Arkansas Hydrogeomorphic Methodology (HGM) Guidebook (Four Ecological Models Review).
- Project Number: TG/G898592
- Client: U.S. Army Corps of Engineers, Ecosystem Planning Center of Expertise
- Effective Date of Work Plan: September 8, 2009
- Version Number: 1
- Project Manager: Karen Johnson-Young
- Deputy Project Manager: Amanda Maxemchuk
- Deliverable Due Dates: Draft Work Plan: October 1, 2009; Final Work Plan: October 8, 2009; Draft Charge: October 1, 2009; Final Charge: October 8, 2009; List of Peer Reviewers: October 16, 2009; Draft Model Review Reports: (A) January 5, 2009, (B) March 1, 2010; (C) February 3, 2010; (D) February 3, 2010; Final Model Review Reports: (A) January 22, 2010; (B) March 17, 2010; (C) February 22, 2010; (D) February 22, 2010
- Period of Performance: September 8, 2009 – April 30, 2010

1.0 **Background, Objectives, and Scope of Work**

1.1 **Background**

Planning models are defined as any models and analytical tools that planners use to define water resources management problems and opportunities, formulate potential alternatives to address the problems and take advantage of the opportunities, and evaluate potential effects of alternatives and to support decision-making. The United States Army Corps of Engineers (USACE) Planning Models Improvement Program (PMIP) was established in 2003 to assess the state of planning models in the USACE and to make recommendations to assure that high quality methods and tools are available to enable informed decisions on investments in the Nation's water resources infrastructure and natural environment. The main objective of the PMIP is to carry out a process to review, improve and validate analytical tools and models for USACE Civil Works business programs. The PMIP Task Force collected the views of USACE leaders and recognized technical experts, and conducted investigations and numerous discussions and

debates on issues related to planning models. This task force identified an array of model-related problems, conducted a survey of planning models, prepared papers on model-related issues, analyzed numerous options for addressing these issues, and formulated recommendations.

Use of certified models for all USACE planning activities is mandatory. This policy is applicable to all planning models currently in use by USACE, as well as models under development and new models. District Commanders are responsible for providing high quality, objective, defensible, and consistent planning products. Development of these products requires the use of tested and defensible models. National certification of planning models will result in significant efficiencies in the conduct of planning studies and enhance the capability to produce high quality products. The appropriate USACE Planning Center of Expertise (PCX) will be responsible for model certification. The goal of certification is to establish that USACE planning products are theoretically sound, compliant with USACE policy, computationally accurate, based on reasonable assumptions, and are in compliance with the requirements of the Office of Management and Budget's *Final Information Quality Bulletin for Peer Review* (Federal Register Vol. 70, No. 10, January 14 2005, pp 2664-2677). The use of a certified model does not constitute technical review of the planning product. Independent technical review of the selection and application of the model and the input data is still the responsibility of the users. Once a model is certified, the PCXs will work with model developers and managers to ensure that documentation and training in model use are available and that model updates comply with certification requirements.

The primary criterion identified for model certification is technical soundness. Technical soundness reflects the ability of the model to represent or simulate the processes and/or functions it is intended to represent. The performance metrics for this criterion are related to theory and computational correctness. In terms of the theory, the certified model should: 1) be based on validated and accepted "state of the art" theory; 2) incorporate USACE policies and requirements; 3) properly incorporate the conceptual theory into the software code; and, 4) clearly define the assumptions inherent in the model. In terms of computational correctness, the certified model should: 1) employ proper functions and mathematics to estimate functions and processes represented; and, 2) properly estimate and forecast the actual parameters it is intended to estimate and forecast. Other criteria for certification are efficiency, effectiveness, usability, and clarity in presentation of results. A certified model will stand the tests of technical soundness based on theory and computational correctness, efficiency, effectiveness, usability and clarity in presentation of results.

1.2 Objectives

The objectives of this work are to conduct a review for the USACE Ecosystem Planning Center of Expertise (ECO-PCX) to evaluate the technical quality, system quality, and usability of the following models in accordance with *Planning Models Improvement Program: Model Certification* (EC 1105-2-407, dated May 31, 2005) and the *Protocols for Certification of Planning Models* (July 2007), with the goal of certifying each model for use within the geographic area specified in the model documentation.

Model A EnviroFish Functional Reproductive Habitat Model

Model B Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley
Model C Waterfowl Assessment Methodology (WAM)
Model D Delta Region of Arkansas Regional HGM Guidebook

The review will not include a technical evaluation of the application of these models on a specific project. However, sample documentation of model application may be provided for informational purposes.

The general objectives of this work are to: a) prepare a work plan that will describe the process for conducting the model certification reviews of the four ecological models, b) identify potential panel members for the external peer review panel, and c) execute the work plan to conduct the model certification review.

1.3 Scope of Work

As a 501(c)(3) nonprofit science and technology organization with experience in establishing and administering peer review panels for USACE, Battelle was engaged to conduct the Model Review of the Four Ecological Models. Independent review ensures the quality and credibility of USACE planning tools. The Model Certification Review will follow the procedures described in the Department of the Army, USACE guidance entitled *Planning Models Improvement Program: Model Certification* (EC 1105-2-407), dated May 31, 2005, and the PMIP document entitled *Protocols for the Certification of Planning Models*, dated July 2007.

To accomplish the model certification review, subject matter experts will be recruited to participate on the peer review panel. Potential candidates for the peer review panel will be screened for availability, interest, and technical experience in defined areas of expertise and any actual or perceived conflicts of interest (COIs) will be determined. Ultimately, no more than 12 total panel members will be selected for the model certification review panels using predetermined criteria related to technical expertise and credentials in the subject matters related to the documents and materials to be reviewed. The following is a list of documents and reference materials that will be provided to the panel members for the review.

1. EnviroFish User Manual
2. EnviroFish Software
3. EnviroFish model code
4. Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley documentation
5. Habitat Model for Migrating Shorebirds communications
6. A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Forested Wetlands in the Delta Region of Arkansas, Lower Mississippi River Alluvial Valley, including HGM spreadsheets (Appendix D) and spatial data (Appendix E)
7. Waterfowl Assessment Methodology (WAM), also called the Duck-use-day Model

2.0 **Methods and Technical Approach**

One of the initial steps in the review process is to prepare a detailed work plan (this document) under Task 2. Additional tasks are detailed below in Section 2.0 (this section). The tasks described are based on the key tasks defined and described in detail in the USACE Model Certification For Four Ecological Models: Envirofish, Waterfowl Assessment Methodology (WAM), Migrating Shorebird Habitat Suitability Index Model, and the Delta Region of Arkansas Hydrogeomorphic Methodology (HGM) Guidebook Statement of Work (SOW). All tasks for the reviews shall be performed independent of government supervision, direction, or control.

Task 1: Kick-off Meeting.
Battelle will hold a kick-off teleconference with the PMIP team and representatives from the ECO-PCX. The purpose of the kick-off is to review the schedule, discuss the model review process, and address any questions regarding the scope, review documents, or required panel member expertise. Battelle will review the model documentation provided with the SOW and, based on a comparison with Table 2 of the USACE *Protocols for the Certification of Planning Models*, determine if additional information will be required to conduct the model reviews. A plan for the ECO-PCX providing the additional information required will be developed at this kick-off meeting.

Task 2: Work Plan.
Battelle will prepare a draft and final work plan (this document) that describes the process for conducting four separate and consecutive model reviews, including the screening criteria and process for selecting model review panel members, the schedule, charges to model review panel members (including charge questions), the process for conducting the reviews and drafting and finalizing four reports that summarize the results of each model review, communication and meetings with the USACE project team, and quality control. Battelle will also conduct a cursory review of each model to determine the level of effort required for panel members to conduct their reviews.

USACE has provided comments on the draft work plan and draft charge questions. Battelle has consolidated and address all comments in this final work plan, which was submitted within three (3) working days of the receipt of comments.

Task 3: Prepare and Finalize Charge to Reviewers.
Battelle will prepare and finalize the charge to each model review panel based on technical direction received from USACE and guidance provided in Department of the Army, U.S. Army Corps of Engineers EC No. 1105-2-407, *Planning Models Improvement Program: Model Certification*, dated 31 May 2005, and *Protocols for the Certification of Planning Models*, dated July 2007.

The process and evaluation criteria for the review, as outlined in the *Protocols for Certification of Planning Models* (July 2007), may include any or all of the following steps:

1. Panel members determine whether project needs/objectives are clearly identified and whether the model described is meeting those needs/objectives.

2. Panel members evaluate the technical quality of the models (review of model documentation).
    a. Model is based on well-established contemporary theory.
    b. Model is a realistic representation of the actual system.
    c. Analytical requirements of the model are properly identified and the model addresses and properly incorporates the analytical requirements.
    d. Assumptions are clearly identified, valid, and support the analytical requirements.
    e. USACE policies and procedures related to the model are clearly identified, and the model properly incorporates USACE policies and accepted procedures.
    f. Formulas used in the model are correct and model computations are appropriate and done correctly.
3. Panel members evaluate system quality (review by running test data sets or reviewing the results of beta tests).
    a. Rationale for selection of supporting software tool/programming language and hardware platform is adequately described, and supporting software tool/programming language is appropriate for the model.
    b. Supporting software and hardware is readily available.
    c. Programming was done correctly.
    d. Model has been tested and validated, and all critical errors have been corrected.
    e. Data can be readily imported from/into other software analysis tools, if applicable.
4. Panel members evaluate the usability of the model.
    a. Examine the data required by the model and the availability of the required data.
    b. Examine how easily model results are understood.
    c. Evaluate how useful the information in the results is for supporting project objectives.
    d. Evaluate the ability to export results into project reports.
    e. Training is readily available.
    f. User documentation is available, user friendly and complete.
    g. Adequate technical support is available for the model.
    h. Software/hardware platform is available to all or most users.
    i. Model is easily accessible.
    j. Model is transparent and allows for easy verification of calculations and outputs.

Each model review panel member will be provided with a charge that will guide their review of any model documentation, software, and code provided. The charge will include an assessment of the criteria listed above which are relevant to each review and ask panel members to respond to specific charge questions or directives regarding individual sections of the model document, as appropriate.

Battelle prepared a generic draft charge to the model review panels. The draft charge has been finalized based on technical direction received from USACE. The final charge is being submitted to USACE (Appendix A of this document) for final approval and distribution to the model review panel members.

Task 4: Identify Candidate Reviewers.

Screen Candidate Reviewers

Battelle will develop criteria for selecting the candidate reviewers; contact potential reviewers to evaluate technical skills, potential COIs, availability, and hourly rates; and identify up to 24 (12 primary and 12 backup) available potential experts to serve on the model review panels. The selection criteria used to identify candidate reviewers are provided in Appendix B to this work plan. Battelle will also develop a detailed COI screening questionnaire to be included in recruiting communications (Appendix C of this document). USACE will review the questionnaire, suggest changes (if needed), and approve this COI list prior to any potential reviewer receiving it.

To identify potential reviewers, Battelle will review candidates in Battelle's database of peer reviewers, seek recommendations from colleagues, contact former panel members, and conduct targeted internet searches. Preliminary information about the up to 24 potential reviewers, including brief biographical information and their responses to the COI questionnaire, will be provided to USACE as early as possible.

Specifically, the final model review panels will include members with the expertise described in Table 1 below.

Table 1. Number of Required Panel Members

Panel Member Expertise	A. EnviroFish Model	B. Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley	C. Waterfowl Assessment Model	D. HGM Guidebook
Civil Works Planner/Habitat Evaluation Procedures (HEP) Specialist	1	1	1	
Civil Works Planner/HGM Specialist				1
Programming/Spreadsheet Auditor	1			1
Fisheries Biologist	2			
Hydraulic Engineer	1			
Avian Biologist		2		
Waterfowl Biologist			2	
Wetland Ecologist				1
Forester				1
Total Number of Reviewers	**5**	**3**	**3**	**4**

Greater detail on the desired expertise for each of the panel members is presented in Appendix B of this work plan, along with the selection criteria. Each panel member will review one model, with the exception of the civil works planner/HEP specialist (who will review three models) and the programmer/spreadsheet auditor (who will review two models).

Finalize Contracts with Peer Reviewers

Battelle will identify up to 24 potential panel members and select no more than 12 final panel members according to the selection criteria. For each reviewer, Battelle will prepare a tailored scope of work that describes required panel member activities for this project. This scope of work description, along with a request for quotation and a COI inquiry form (Appendix C) will be sent to each selected peer reviewer. Upon receipt of the reviewers' written quotations indicating willingness to participate and the absence of a COI, Battelle will establish contracts with the panel members at agreed-upon rates and hours to ensure/secure participation. Each contract established also includes a non-disclosure statement.

The scope of work for each peer reviewer will consist of:

- Participation in a Battelle kick-off meeting (via teleconference)
- Participation in a USACE kick-off meeting (via teleconference) with the PDT and Battelle
- Participation in a Habitat Evaluation Procedures (HEP) training teleconference (8 panel members)
- Review and assessment of the technical quality, system quality, and usability of the Four Ecological Models and preparation of individual written comments
- Participation in a panel review teleconference to discuss findings and agree on a list of key topics/issues that will be presented in the Draft Model Certification Review Report and form the basis for the model certification review Final Panel Comments
- Preparation of the model certification review Final Panel Comments
- Review of the Draft Model Certification Review Report before it is submitted to USACE
- Review of USACE comments on the Draft Model Certification Review Report and Final Panel Comments
- Participation in a teleconference with USACE to discuss USACE's comments on the Draft Model Certification Review Report and Final Panel Comments
- Revision of the Draft Model Certification Review Report and Final Panel Comments in response to USACE comments
- Review of the Final Model Certification Review Report before it is submitted to USACE
- Provide additional technical support as directed.

Battelle has estimated the level-of-effort required for each panel member for the reviews in Table 2.

Table 2. Estimated Levels-of-Effort (hours) for Panel Members

	Kickoff Meeting	HEP short-course	A. EnviroFish Model	B. Shorebird Model	C. Waterfowl Model	D. HGM Guidebook	Total Hours
CWP/HEP Specialist	3	15	74	29	74		195

	Kickoff Meeting	HEP short-course	A. EnviroFish Model	B. Shorebird Model	C. Waterfowl Model	D. HGM Guidebook	Total Hours
Fisheries Biologists	3	3	74				80
Hydraulic Engineer	3	3	74				80
Spreadsheet Auditor	3		74			74	151
Avian Biologists	3	3		29			35
Waterfowl Biologists	3	3			74		80
CWP/HGM Specialist	3					74	77
Wetland Ecologist	3					74	77
Forester	3					74	77

Note: CWP = Civil Works Planner; HEP = Habitat Evaluation Procedures

The estimated hours listed above include time for the model review and charge question response, teleconferences, preparation of final comments and Draft Model Certification Review Report, report review, responding to USACE comments on the draft report, Final Model Certification Review Report review, and support-related activities.

Task 5 A-D: Conduct Assessment of Model.
A kick-off meeting with Battelle, the model review panel members, representatives from the USACE ECO-PCX, and Model Proponents will be held via teleconference to discuss the model certification requirements and expectations and to facilitate information exchange for each of the model reviews. One kick-off meeting will be conducted and it will cover all four model certification reviews for models A through D.

The description of the model review process in the following paragraphs applies to each of the four models being reviewed. Battelle will provide the panel members with electronic copies of the documentation for the model, software, and model code; *Protocols for Certification of Planning Models;* EC 1105-2-407, *Planning Models Improvement Program: Model Certification*; and other supporting documentation. USACE will provide these documents to Battelle via its FTP site. Battelle will prepare and deliver a memorandum instructing the panel members to undertake the review and outlining the steps and deadlines. Working with USACE, Battelle will respond to any panel member questions or information requests during the review process.

The panel members will complete their review and provide comments to Battelle. After receipt of all individual panel member comments, Battelle will merge all comments into one document and share the document with the panel members. In addition, Battelle will carefully review the comments and identify key issues/topics related to the technical quality, system quality, and usability of the model, as well as the model description and model testing. These key

issues/topics identified in the merged individual comments will be distributed to the panel members.

A panel review teleconference will be convened to ensure the exchange of technical information among the panel members, many of whom will be from diverse scientific backgrounds, and to identify key issues/topics specifically associated with the technical quality, system quality, and usability of the model. The result of the teleconference will be a list of key issues/topics (i.e., findings) that the panel members agree should be presented to USACE in the Draft Model Certification Review Report (Task 7) and as final panel comments. During the teleconference, the specific wording for the final panel comment statement will be agreed upon by all panel members, and final panel comments will be assigned "high," medium," or "low" significance based on the following definitions:

- High: Describes a fundamental problem with the model that could affect the model's ability to serve the intended purpose.
- Medium: Affects the completeness or understanding of the model, model usability, or the level of performance of the model.
- Low: Affects the technical quality of the model documentation but will not affect the performance of the model.

At the end of the teleconference, Battelle will prepare a memorandum to the panel members directing them to prepare specific sections of the Draft Model Certification Review Report (Task 6) based on the findings discussion and the technical quality, system quality, and usability criteria outlined in the *Protocols for Certification of Planning Models*, July 2007. The panel members will also be directed to prepare final panel comments, each of which will include the following four parts: (1) a clear statement of the comment; (2) the basis for the comment; (3) the significance of the comment (high, medium, or low); and (4) recommendations to resolve the comment (including additional research or analysis that may influence the conclusions). The individual comments in response to the charge and the panel review teleconference notes will be used as background information to prepare the final panel comments and the Model Certification Review Report.

Task 6 A-D: Prepare Draft Certification Report.
Four separate Draft Model Certification Review Reports for models A through D will be prepared and submitted. Battelle will prepare each Draft Model Certification Review Report and submit it to USACE for review. The report will assess the degree to which the model meets the technical quality, system quality, and usability criteria outlined in the *Protocols for Certification of Planning Models*, July 2007.

The report will follow the general outline below:

1.0 Introduction

1.1. Model Purpose

1.2. Model Assessment

1.3. Contribution to Planning Effort

1.4. Report Organization

2.0 Model Description

2.1. Model Applicability

2.2. Model Summary

2.3. Model Components

3.0 Model Evaluation

3.1. Assessment Criteria

3.1.1.Technical Quality

3.1.2.System Quality

3.1.3.Usability

3.2. Approach to Model Testing

3.3. Technical Quality Assessment

3.3.1.Review of Theory and External Model Components

3.3.2.Review of Representation of the System

3.3.3.Review of Analytical Requirement

3.3.4.Review of Model Assumptions

3.3.5.Review Ability to Evaluate Risk and Uncertainty

3.3.6.Review Ability to Calculate Benefits for Total Project Life

3.3.7.Review of Model Calculations/Formulas

3.4. System Quality

3.4.1.Review of Supporting Software

3.4.2.Review of Programming Accuracy

3.4.3.Review of Model Testing and Validation

3.5. Usability

3.5.1.Review of Data Availability

3.5.2.Review of Results

3.5.3.Review of Model Documentation

3.6. Model Assessment Summary

4.0 Conclusions

5.0 References

The final panel comments will be included as an appendix to the Draft Model Certification Review Reports. Individual comments will not be included in the Draft Model Certification Review Reports.

The Draft Model Certification Review Reports will be submitted electronically to USACE for review. The ECO-PCX and PMIP will review the Reports and provide comments back to Battelle.

Task 7 A-D: Meeting to Discuss Findings.

As necessary, for each model review (A – D), Battelle and the panel members will meet via teleconference with USACE's Technical Point of Contact, representatives from the ECO-PCX

and CECW-P, and Model Proponents to discuss their initial findings and ask clarifying questions that will aid in determining the information to be included in each of the Model Certification Review Reports.

Task 8 A-D: Prepare Final Certification Report.
For each model review (A – D), Battelle will prepare a Final Model Certification Review Report including a description of the process used to assess the model, assessment of the model based on the criteria outlined in Section 3.a. of *Protocols for Certification of Planning Models* (July 2007) and issues related to model recommendation.

3.0 **Quality Control and Quality Assurance**

During the review of the Four Ecological Models, there are numerous instances when quality assurance and/or quality control (QA/QC) practices will be implemented to ensure products of the highest quality are being provided to USACE. These QA/QC practices are described below.

Deliverable Review
It is Battelle policy that every deliverable be independently reviewed to ensure that it is accurate, technically sound, has objective interpretation, solid conclusions, satisfying presentation, and meets or exceeds client expectations. The deliverables for this project are listed in Section 4.0 of this work plan. The review may include a technical, editorial, and/or quality assurance component, depending on the document and project requirements. The Project Manager (PM) will determine the type(s) of review appropriate for each deliverable. In addition, per Battelle policy, all deliverables must have a one-over-one review and approval by the appropriate Battelle Manager prior to external distribution.

In addition to general technical, editorial, and/or QA reviews, Battelle will assign at least two people familiar with the project to review the panel members' responses to the charge questions. Because the charge question responses are used to develop the key themes of the panel members' findings, it is important that the responses be reviewed by a second person to ensure that the key themes have been appropriately captured. In addition to the charge question responses, each final panel comment is carefully reviewed by both the PM and the Deputy Project Manager (DPM) to ensure accuracy and thoroughness.

Peer Review Panel Recruitment
As an unbiased panel is critical to the successful completion of the Model Certification Review process, Battelle conducts a thorough peer review panel recruitment process. The first step in this process is the preparation of a COI questionnaire. Each potential panel member must fully complete the COI (see Appendix C for the COI issues identified for the Four Ecological Models reviews). In addition, USACE will provide information on more general COI issues that have been identified by USACE. USACE must approve the final list of potential COI issues before the questionnaire is distributed to potential panel members.

A detailed review is conducted for each candidate panel member. The Battelle recruitment team will present each candidate panel member's technical qualifications and COI screening responses to the Battelle PM and DPM. The candidate's qualifications are compared to the scope of work

and to the pool of potential candidates. If there are any outstanding questions regarding the candidates' responses to the COI screening, the candidate is contacted and the questions resolved prior to submitting the candidate's name to USACE.

Teleconferences

Teleconferences are an important component of conducting a Model Certification Review. They are critical to developing the final panel comments and discussing the final panel comments with USACE. Thus, accurate recording of action items, resolutions, and other information discussed during these teleconferences is critical to the process. To ensure that important information is not missed, Battelle provides at least two note-takers for all teleconferences and kick-off meetings with USACE and/or the panel members. All sets of notes taken by Battelle staff are compared and consolidated after each teleconference to provide one set of official notes. These notes are retained in the project files.

Development of Talking Points for Panel Review Teleconference

After reviewing all the panel members' comments in response to charge questions on the review documents, a talking points memorandum is developed by the DPM prior to the panel review teleconference. This document guides the teleconference and includes the key themes identified from the panel's comments, in addition to specific issues where the reviewers may have disagreed with one another. After drafting the talking points memo, the DPM sends it to at least one member of the Battelle project team to ensure that no important issues were omitted. The talking points are also provided to the panel members prior to the teleconference for review.

4.0 **Reporting**

Deliverables for the Certification of Four Ecological Models project include the following:

- Draft and final version of the work plan and Model Certification Review Charges
- Final list of up to 24 (primary and backup) selected model review panel members
- Draft and final Model Certification Review Report – EnviroFish Model
- Draft and final Model Certification Review Report – Shorebird Model
- Draft and final Model Certification Review Report – Waterfowl Model
- Draft and final Model Certification Review Report – HGM Guidebook

All draft and final deliverables will be provided to USACE electronically only and in PDF format, with the exception of each Final Model Certification Review Report, which will be sent to the USACE Technical Representative in hard copy (in addition to electronically). The draft work plan and charges were also provided to the USACE in Microsoft Word 2003 format to facilitate their review and allow comments and suggested revisions to be made in track changes.

There are no monthly report requirements for this project.

5.0 **Schedule**

The due dates for milestones and deliverables in Table 3 below are based on the date Battelle was supplied the final decision regarding the process to follow for conducting these four reviews (September 22, 2009). The asterisks indicate deliverables. All changes to the schedule will be documented and a revised schedule will be submitted to the USACE for approval.

Table 3. Four Ecological Models Certification Review Milestones and Deliverables

TASK	ACTION	DUE DATE
	Receipt of final decision on review process	**9/22/09**
	Review documents available	various
1	USACE/Battelle Kick-off Meeting	09/17/09
	USACE/Battelle/Panel Kick-off Meeting with all panel members	10/28/09
2	*Battelle submits Draft Work Plan to USACE	10/1/09
	USACE provides comments on Draft Work Plan	10/5/09
	Conference Call (if necessary)	TBD
	*Battelle submits Final Work Plan to USACE	10/8/09
3	*Battelle submits Draft Charge (combined with Draft Work Plan – Task 1) to USACE	10/1/09
	USACE provides comments on draft charge	10/5/09
	*Battelle submits Final Charge (combined with Final Work Plan – Task 1) to USACE	10/8/09
	USACE approves Final Charge	10/13/09
4	Battelle provides USACE with conflict of interest (COI) statements for review	9/14/09
	Battelle recruits and screens up to **24** candidate panel members	10/16/09
	*Battelle submits list and summary information of candidate panel members	10/16/09
	USACE provides comments on candidate panel members	10/21/09
	Battelle completes subcontracts for panel members	10/30/09
5A	Battelle provides review documents to panel members	11/2/09
	Panel **A** completes its review	11/20/09
	Battelle collates comments from panel **A**	11/24/09
	Battelle convenes panel review teleconference for panel **A**	12/01/09
	Panel **A** provides final panel comments and report section writing assignments to Battelle	12/11/09
6A	Battelle convenes teleconference with USACE to ask clarifying questions	As needed
7A	*Battelle submits Draft Model Certification Review Report **A** to USACE for review	1/5/10
	USACE provides comments on Draft Model Certification Review Report **A**	1/11/10
	Battelle convenes teleconference to discuss USACE comments on Draft Model Certification Review Report **A**	1/14/10
8A	*Battelle submits Final Model Certification Review Report **A** to USACE	1/22/10
5B	Battelle provides review documents to panel members	11/2/09
	Panel **B** completes its review	1/29/10
	Battelle collates comments from panel **B**	2/2/10

TASK	ACTION	DUE DATE
	Battelle convenes panel review teleconference for panel **B**	2/3/10
	Panel **B** provides final panel comments and report section writing assignments to Battelle	2/15/10
6B	Battelle convenes teleconference with USACE to ask clarifying questions	As needed
7B	*Battelle submits Draft Model Certification Review Report **B** to USACE for review	3/1/10
	USACE provides comments on Draft Model Certification Review Report **B**	3/8/10
	Battelle convenes teleconference to discuss USACE comments on Draft Model Certification Review Report **B**	3/10/10
8B	*Battelle submits Final Model Certification Review Report **B** to USACE	03/17/10
5C	Battelle provides review documents to panel members	11/2/09
	Panel **C** completes its review	1/7/09
	Battelle collates comments from panel **C**	1/11/09
	Battelle convenes panel review teleconference for panel **C**	1/12/09
	Panel **C** provides final panel comments and report section writing assignments to Battelle	1/20/10
6C	Battelle convenes teleconference with USACE to ask clarifying questions	As needed
7C	*Battelle submits Draft Model Certification Review Report **C** to USACE for review	2/3/10
	USACE provides comments on Draft Model Certification Review Report **C**	2/10/10
	Battelle convenes teleconference to discuss USACE comments on Draft Model Certification Review Report **C**	2/15/10
8C	*Battelle submits Final Model Certification Review Report **C** to USACE	2/22/10
5D	Battelle provides review documents to panel members	11/2/09
	Panel **D** completes its review	1/7/09
	Battelle collates comments from panel **D**	1/11/09
	Battelle convenes panel review teleconference for panel **D**	1/12/09
	Panel **D** provides final panel comments and report section writing assignments to Battelle	1/20/10
6D	Battelle convenes teleconference with USACE to ask clarifying questions	As needed
7D	*Battelle submits Draft Model Certification Review Report **D** to USACE for review	2/3/10
	USACE provides comments on Draft Model Certification Review Report **D**	2/10/10
	Battelle convenes teleconference to discuss USACE comments on Draft Model Certification Review Report **D**	2/15/10
8D	*Battelle submits Final Model Certification Review Report **D** to USACE	2/22/10
	Project Closeout	4/30/2010

Note: A indicates tasks for the review of the EnviroFish model, B indicates tasks for the review of the Habitat Model for Migrating Shorebirds in the Upper Mississippi Aluvial Valley, C indicates tasks for the review of the Waterfowl Assessment Methodology, and D indicates tasks for the review of the Delta Region of Arkansas Hydrogeomorphic Methodology Guidebook.
* = deliverable

6.0 **Project Organization and Communication**

Role and contact information for the key persons who will be working on the Four Ecological Models Review are presented in Table 4 (Battelle staff members), and Table 5 (USACE Project Delivery Team).

Table 4. Battelle Staff for the Four Ecological Models Project IEPR

Name	Project Role	Phone	E-mail
Karen Johnson-Young	Project Manager	(561) 656-6304	johnson-youngk@battelle.org
Amanda Maxemchuk	Deputy Project Manager	(781) 952-5384	maxemchuka@battelle.org
Rachel Sell; Corey Wisneski	Recruiting	(614) 424-3579; (781) 952-5296	sellr@battelle.org; wisneskic@battelle.org
Anne Gregg	Subcontracting Lead	(614) 424-7419	gregga@battelle.org

Table 5. USACE Staff for the Four Ecological Models Project

Name	Project Role	Phone	E-mail
Charles Theiling	Technical Representative/Point of Contact (Rock Island District)	(309) 794-5636	charles.h.theiling@usace.army.mil
Jodi K. Staebell	Alternate Technical Representative/Alternate Point of Contact (Mississippi Valley Division)	(309) 794-5448	jodi.k.staebell@usace.army.mil
Daniel Ward	Alternate Technical Representative/Alternate Point of Contact PDT (Memphis District)	(901) 544-0709	daniel.d.ward@usace.army.mil
Kelly Baerwaldt	Contracting Officer's Representative (Rock Island District)	(309) 794-5285	kelly.l.baerwaldt@usace.army.mil

Communication with USACE

Battelle's Point of Contact (POC) is the Technical Representative for the ECO-PCX. The alternate POC will be copied on all emails to the POC. If the POC is not available (e.g., on vacation), Battelle will contact the alternate POC directly. Communications may include status reports, questions, and/or requests for additional information from the panel.

Communication with the Model Review Panel

Battelle will be the main POC between USACE and model review panel members. Direct contact between the USACE and model review panel members will only occur during teleconferences with a Battelle representative present. All other communications will be directed through Battelle's Project Manager and Deputy Project Manager. The panel will be briefed that they are to have no direct communication with USACE and if they are contacted by USACE, they are to immediately inform Battelle.

7.0 **Budget**

The approved budget for this project is $392,531.

This page intentionally left blank.

APPENDIX A

Final Charge Guidance and Questions to the Peer Reviewers for the Model Certification Review of *Model Name*[1]

BACKGROUND
Model-specific background will be added.

OBJECTIVE

The objective of this effort is to conduct a review to evaluate the technical approach, system quality, and usability of the ***Model Name***. The ***Model Name*** will be evaluated in accordance with EC 1105-2-407, *Planning Models Improvement Program: Model Certification* (May 2005) and the *Protocols for Certification of Planning Models* (July 2007).

The U.S. Army Corps of Engineers Planning Models Improvement Program (PMIP) was established in 2003 to assess the state of planning tools and models in the U.S. Army Corps of Engineers (USACE) and to make recommendations to assure that high quality methods and tools are available to enable informed decisions on investments in the Nation's water resources infrastructure and natural environment. The main objective of the PMIP is to carry out "a process to review, improve and validate analytical tools and models for USACE Civil Works business programs." The model review for the ***Model Name*** will follow the guidance described in the Department of the Army, U.S. Army Corps of Engineers document entitled *Planning Models Improvement Program: Model Certification* (EC 1105-2-407), dated May 31, 2005, and the Planning Models Improvement Programs document entitled *Protocols for the Certification of Planning Models*, dated July 2007.

MODEL REVIEW

The following outlines the basic steps for the USACE model certification process. These steps are designed to guide the review of models being certified for widespread use and are also used to assess the technical quality and applicability of project-specific models. Model development is a multi-step, iterative process, with the number of steps and iterations being dependent upon the complexity of the model. In general, these steps occur in four fundamental stages.

- Stage 1 (Requirements Stage) involves identifying the need for a specific analytical capability and the options for tools to meet the need.
- Stage 2 (Development Stage) involves the development of software programming code or a spreadsheet and testing by the model developer.
- Stage 3 (Model Testing Stage) involves a beta test of the model by selected users whose objective is to validate the model and ensure that it is usable in real world applications.
- Stage 4 (Implementation Stage) involves providing training, user support, maintenance and continuous evaluation of the model.

[1] Note that all highlighted items in this draft charge will be changed to be specific for the model under review

The certification procedure depends on the stage of model development. The process may include the following steps.

1. Panel members determine whether project needs/objectives are clearly identified and whether the model described is meeting those needs/objectives.
2. Panel members evaluate the technical quality of the models (review of model documentation).
    a. Model is based on well-established contemporary theory.
    b. Model is a realistic representation of the actual system.
    c. Analytical requirement of the model are properly identified and the model addresses and properly incorporates the analytical requirements.
    d. Assumptions are clearly identified, valid, and support the analytical requirements.
    e. USACE policies and procedures related to the model are clearly identified, and the model properly incorporates USACE policies and accepted procedures.
    f. Formulas used in the model are correct and model computations are appropriate and done correctly.
3. Panel members evaluate system quality (review by running test data sets or reviewing the results of beta tests).
    g. Rationale for selection of supporting software tool/programming language and hardware platform is adequately described, and supporting software tool/programming language is appropriate for the model.
    h. Supporting software and hardware is readily available.
    i. Programming was done correctly.
    j. Model has been tested and validated, and all critical errors have been corrected.
    k. Data can be readily imported from/into other software analysis tools, if applicable.
4. Panel members evaluate the usability of the model.
    l. Examine the data required by the model and the availability of the required data.
    m. Examine how easily model results are understood.
    n. Evaluate how useful the information in the results is for supporting project objectives.
    o. Evaluate the ability to export results into project reports.
    p. Training is readily available.
    q. User documentation is available, user friendly and complete.
    r. Adequate technical support is available for the model.
    s. Software/hardware platform is available to all or most users.
    t. Model is easily accessible.
    u. Model is transparent and allows for easy verification of calculations and outputs.

The final deliverable for this effort will be a Model Certification Review Report that Battelle will deliver to USACE. The model review panel members will contribute to the preparation of the draft and final reports, as well as participate in two teleconferences with USACE and the Model Proponents to discuss review panel comments on the method (first teleconference) and USACE comments on the Draft Model Certification Review Report (second teleconference). The general outline for the report will be:

1.0 Introduction

1.1. Model Purpose

1.2. Model Assessment

1.3. Contribution to Planning Effort

1.4. Report Organization

2.0 Model Description

2.1. Model Applicability

2.2. Model Summary

2.3. Model Components

3.0 Model Evaluation

3.1. Assessment Criteria

3.1.1. Technical Quality

3.1.2. System Quality

3.1.3. Usability

3.2. Approach to Model Testing

3.3. Technical Quality Assessment

3.3.1. Review of Theory and External Model Components

3.3.2. Review of Representation of the System

3.3.3. Review of Analytical Requirement

3.3.4. Review of Model Assumptions

3.3.5. Review Ability to Evaluate Risk and Uncertainty

3.3.6. Review Ability to Calculate Benefits for Total Project Life

3.3.7. Review of Model Calculations/Formulas

3.4. System Quality

3.4.1. Review of Supporting Software

3.4.2. Review of Programming Accuracy

3.4.3. Review of Model Testing and Validation

3.5. Usability

3.5.1. Review of Data Availability

3.5.2. Review of Results

3.5.3. Review of Model Documentation

3.6. Model Assessment Summary

4.0 Conclusions

5.0 References

DOCUMENTS PROVIDED

The following is a list of documents and reference materials that will be provided for the review. **The documents and files presented in bold font are those which are to be reviewed.** All other documents are provided for reference.

- **Model Documentation**
- **Software**
- **Model Code**
- Department of the Army, U.S. Army Corps of Engineers *Planning Models Improvement Program: Model Certification* (EC 1105-2-407), dated May 31, 2005
- USACE Planning Models Improvement Programs document entitled: *Protocols for the Certification of Planning Models*, dated July 2007

SCHEDULE

Task	Activity	Due Date	Projected Date
5	*Conduct kick-off conference call with panel members and Model Proponents	Within 3 days of completing contracts	October 28, 2009
	Model review panel members submit comments to Battelle	Within 12 days of kick-off conference call with panel members	*Date*
	Contractor convenes meeting with panel members to discuss initial findings	Within 3 days of receipt of model team comments	*Date*
6	*Convene teleconference with USACE to ask clarifying questions on initial findings	Within 5 days of receipt of model team comments	As needed
	*Submit Draft Model Review Report to USACE for review	Within 14 days of receiving final panel comments and writing assignment from panel members	*Date*
	USACE provide comments on Draft Model Review Report	Within 5 days of receipt of draft report	*Date*
7	Convene a teleconference with USACE to discuss the Draft Review Report	Within 2 days of receipt of USACE comments	*Date*
8	*Submit the Final Model Review Report to the USACE	Within 5 days of review conference call on USACE draft report comments	*Date*

* denotes a deliverable

CHARGE FOR PEER REVIEW

The charge questions and guidelines are based on the model certification criteria discussed in the guidance document *Protocols for Certification of Planning Models* (July 2007) from the USACE

Planning Models Improvement Program. The intent of these questions is to focus your thinking, not to suggest or dictate your answers. We want you to consider several aspects of models during your review, from the inputs to the outputs to the underlying structure of the method.

General Charge Guidance

1. Please answer the scientific and technical questions listed below and conduct a broad overview of the model. Please focus on your areas of expertise and technical knowledge.
2. Evaluate the soundness of model as applicable and relevant to your area of expertise. Comment on whether model explains past events and how model will be validated.
3. Please focus the review on scientific information, including factual inputs, data, the use and soundness of model calculations, assumptions, and results that inform decision makers.
4. Offer opinions as to whether the model parameters and formulas are sufficient to quantify ecosystem function.
5. Panel members may contact each other. However, panel members **should not** contact anyone who is or was involved in the project, prepared the subject documents, developed the model, or was part of the USACE Independent Technical Review.
6. Please contact the Battelle Deputy Project Manager, Amanda Maxemchuk (maxemchuka@battelle.org) and cc: Karen Johnson-Young (johnson-youngk@battelle.org) if you have questions for Battelle or the USACE or need additional information.
7. In case of media contact, notify the Battelle project manager immediately.

Your name will appear as one of the panelists in the peer review. Your comments will be included in the Final Model Certification Review Report, but will remain unattributed. The Final Model Certification Review Report is expected to be released to the public by the USACE at some time in the future.

Please submit your comments in electronic form to Amanda Maxemchuk (maxemchuka@battelle.org) **no later than *Date*.**

MODEL ASSESSMENT CRITERIA

General Questions

1. Are the project needs/objectives clearly identified?

2. Does the model described meet those needs/objectives?

Technical Quality

3. Comment on the overall technical quality of the model.

4. Comment on the temporal and spatial resolution of the model.

5. Is it clear where the model's geographic boundaries fall?

6. Are the limitations of the model clearly defined?
   a. How do the limitations impact the ability of the model to evaluate ecological benefits?
   b. What are the potential impacts to the project?
   c. How can those limitations be overcome?

7. Is the model based on well-established contemporary theory?

8. Is the model a realistic representation of the actual ecosystem?

9. Does the model effectively capture the variables that are most important for the intended use of the model?

10. Comment on the precision and accuracy of the model for evaluating potential outcomes of project alternatives. What factors/variables provide the greatest impact on precision and accuracy?

11. Comment on the sensitivity of the model.

12. Are the analytical requirements of the model properly identified?

13. Does the model address and properly incorporate the analytical requirements?

14. Are the assumptions clearly identified, valid, and do they support the analytical requirements?

15. Comment on the ability of the model to evaluate risk and uncertainty.

16. Comment on the ability of the model to evaluate impacts and benefits for total project life.

17. Comment on the ability of the model to determine adequate compensatory mitigation.

18. Are the formulas used in the models correct and are the model macros and computations appropriate and done correctly?

19. Are USACE policies and procedures related to the model clearly identified, and does the model properly incorporate USACE policies and accepted procedures?

20. Do the models allow the user(s) to make assumptions regarding future global events such as, but not limited to, global climate change and changes to sea level.

System Quality

21. Is the rationale for the selection of the supporting software tool/programming language and hardware platform adequately described?

22. Is the supporting software tool/programming language is appropriate for the model?

23. Was the programming done correctly?

24. Can data be readily imported from/into other software analysis tools?

25. Has the model been sufficiently tested and validated, and have all critical errors been corrected?

26. Are error checks built into the models?

27. Do the models work using both sensible and non-sensible data?

Usability

28. Comment on the model usability.

29. Comment on the availability of the data required by the model.

30. How easily are model results understood?

31. Comment on how useful the information in the results is for supporting project objectives.

32. Comment on the usability of the model for selecting the best project alternative.

33. Is user documentation user friendly, and complete?

34. Are the models transparent and do they allow for easy verification of calculations and outputs?

APPENDIX B

Four Ecological Models Model Certification Review Panels Considerations and Proposed Selection/Exclusion Criteria

According to the documents for the Certification of Four Ecological Models, the overall model review scope includes:

- Two avian biologists (Migrating Shorebird Habitat Suitability Index Model)
- One civil works planner/HEP specialist (EnviroFish, Migrating Shorebird Habitat Suitability Index Model, Waterfowl Assessment Method)
- One civil works planner/HGM specialist (Delta Region of Arkansas HGM Guidebook)
- Two fisheries biologists (EnviroFish)
- One forester (Delta Region of Arkansas HGM Guidebook)
- One hydraulic engineer (EnviroFish)
- One programmer/spreadsheet auditor (EnviroFish, Delta Region of Arkansas HGM Guidebook)
- Two waterfowl biologists (Waterfowl Assessment Method)
- One wetland ecologist (Delta Region of Arkansas HGM Guidebook)

Technical Criteria /Areas of Expertise for Potential Independent External Peer Reviewers

All panel members should have at least 5-10 years of experience and have familiarity with large, complex civil works projects with high public and interagency interests. The panel members should at least have M.S. degrees, although Ph.Ds are preferred.

Technical areas related to **avian biology** (2 experts; Migrating Shorebird Habitat Suitability Index Model):

- Familiarity with methods for evaluating bird habitat suitability and have knowledge of the Lower Mississippi River Valley bird populations, specifically shorebirds.

Technical areas related to **civil works planning and Habitat Evaluation Procedures** (1 expert; EnviroFish, Migrating Shorebird Habitat Suitability Index Model, and Waterfowl Assessment Method reviews):

- Experience in the area of floodplain management including ecosystem restoration, impact analysis, compensatory mitigation and knowledge of Lower Mississippi River Valley ecosystems.
- Experience in the use of HEP.

Technical areas related to **civil works planning and Hydrogeomorphic Models** (1 expert; Delta Region of Arkansas HGM Guidebook):

- Experience in the area of floodplain management including ecosystem restoration, impact analysis, compensatory mitigation and knowledge of Lower Mississippi River Valley ecosystems.
- Experience in the use of Hydrogeomorphic approach for assessing wetland functions.

Technical areas related to **fisheries biology** (2 experts, EnviroFish):

- Familiarity with the methods for evaluating fish habitat suitability and have knowledge of the Lower Mississippi River Valley fisheries.
- Experience working with hydrologic and hydraulic modelers to evaluate floodplain hydraulics is desirable.

Technical areas related to **forestry** (1 expert, Delta Region of Arkansas HGM Guidebook):

- Experience in riverine forest ecology, experience in bottomland hardwood community structure and dynamics within the Lower Mississippi River Valley.
- Familiarity with ecosystem output evaluation, particularly the hydrogeomorphic approach to assessing wetland function, is essential.

Technical areas related to **hydraulic engineering** (1 expert, EnviroFish):

- Experience in estimating the effects of flood protection on floodplain hydrology using the HEC-RAS 1-D Flow and associated DSS (direct storage system) files and conducting ecosystem restoration output evaluations.

Technical areas related to **programmer/spreadsheet auditing** (1 expert, EnviroFish and Delta Region of Arkansas HGM Guidebook):

- Experience testing, debugging and auditing computer programs/spreadsheets to check for accuracy of formulas, cell references, and computer code.
- Must have experience with Java programming language.

Technical areas related to **waterfowl biology** (2 experts, Waterfowl Assessment Method):

- Familiarity with methods for evaluating waterfowl habitat suitability and have knowledge of the Mississippi River Valley migratory waterfowl.

Technical areas related to **wetland ecology** (1 expert, Delta Region of Arkansas HGM Guidebook):

- Experience in wetland ecology of large floodplain rivers, preferably experience in southern bottomland wetlands.
- Familiarity with ecosystem output evaluation, particularly the Hydrogeomorphic approach to assessing wetland function, is essential.

Other considerations:

- Participation in previous USACE technical review panels
- Other technical review panel experience

Reviewer Categories [candidate may fit into more than one category]

- Academic
- Consultant (company-affiliated, *e.g.*, architect-engineer or consulting firm)
- Consultant (independent)
- Non-governmental organization (*e.g.*, public agency)

Potential Exclusion Criteria/Conflicts of Interest

- Involvement by you or your firm[1] in any part of the development, assessment, or review of the following models:
    - EnviroFish Functional Reproductive Habitat Model
    - Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley/Migrating Shorebird Model
    - Waterfowl Assessment Methodology/ Duck Use Days Model
    - A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Forested Wetlands in the Delta Region of Arkansas, Lower Mississippi River Alluvial Valley
- Involvement by your firm[1] in any part of the St. Johns Bayou and New Madrid Floodway Environmental Impact Statement process, including:
    - Final Environmental Impact Statement entitled Mississippi River and Tributaries, Mississippi River Levees (MRL) and Channel Improvement (1976);
    - Final EIS entitled St. Johns Bayou/New Madrid Floodway Project Final EIS (1982);
    - 1998 Mississippi River Mainline Levees Enlargement and Seepage Control EIS
    - Draft Supplemental EIS (1999)
    - Final Supplemental EIS (2000)
    - Revised Supplemental EIS (2002); or,
    - Second Revised Supplemental EIS (2006).
- Any involvement by you or your firm[1] in the conceptual or actual design, construction, or O&M of the St. Johns Bayou and New Madrid Floodway, MO project or the Mississippi River and Tributaries Project.
- Involvement as an expert or provided testimony for the civil action (04-1575) Environmental Defense, et al. v. U.S. Army Corps of Engineers (USACE) et al.
- Involvement as an expert or provided testimony for Water Quality Certification for the St. Johns Bayou and New Madrid Floodway Project (06-0421) Missouri Coalition for the Environment, et al. v. Missouri Department of Natural Resources *et al*.
- Any involvement by you or your firm[1] in any litigation involving the United States of America and the U.S. Army Corps of Engineers in particular
- Any application by you or your firm[1] for a USACE permit of any nature or representation for a client that applied for a USACE permit of any nature within the boundaries of the Memphis or Vicksburg Districts.
- Current employment by the USACE.
- Current or previous employee or affiliation with the interagency mitigation team or the local sponsor, the U.S. Fish and Wildlife Service, Environmental Protection Agency, Missouri Department of Conservation, Missouri Department of Natural Resources, and the St. Johns Levee and Drainage District.
- Any employment as an individual or contractually by a State agency, levee or drainage district, or a city or municipality that had committed to serve as a local sponsor for a USACE project within the boundaries of the Memphis, or Vicksburg Districts.
- Current or previous employment or affiliation with Environmental Defense, National Wildlife Federation, or Missouri Coalition for the Environment (for pay or pro bono).

- Any voluntary service by you or your firm[1] to provide expert opinions or testimony in connection for any party in connection with a federal project.
- Current or future interests in the St. Johns Bayou and New Madrid Floodway Project.
- Involvement with paid or unpaid expert testimony related to the models or document listed above in numbers 1 and 2.
- Current personal involvement with other USACE projects, including whether involvement was to author any manuals or guidance documents for USACE. If yes, provide titles of documents or description of project, dates, and location (USACE district, division, Headquarters, ERDC, etc.), and position/role. Please highlight and discuss in greater detail any projects that are specifically with the Vicksburg District or the Memphis District.
- Current firm[1] involvement with other USACE projects, specifically those projects/contracts that are with the Vicksburg District or the Memphis District. If yes, provide title/description, dates, and location (USACE district, division, Headquarters, ERDC, etc.), and position/role.
- Previous employment by USACE as a direct employee or contractor (either as an individual or through your firm[1]) within the last 10 years, notably if those projects/contracts are with the Vicksburg District or the Memphis District. If yes, provide title/description, dates employed, and place of employment (district, division, Headquarters, ERDC, etc.), and position/role.
- Other USACE affiliation [e.g., scientist employed by USACE (except as described in NAS criteria, see EC 1105-2-410 section 8d)].
- Previous experience conducting technical peer reviews. If yes, please highlight and discuss any technical reviews concerning flood risk management projects, and include the client/agency and duration of review (approximate dates).
- A significant portion (i.e., greater than 50%) of personal or firm[1] revenues within the last 3 years came from USACE contracts.
- A significant portion (i.e., greater than 50%) of personal or firm[1] revenues within the last 3 years came from U.S. Fish and Wildlife Service contracts.
- Any publicly documented statement (including, for example, advocating for or discouraging against) related to the models or document listed above in numbers 1 and 2.
- Any publically documented statement advocating for or against the Mississippi River and Tributaries Project, including the St. Johns Bayou and New Madrid Floodway Project.
- Is there any past, present or future activity, relationship or interest (financial or otherwise) that could make it appear that you would be unable to provide unbiased services on this project? If so, please describe:
- Any other perceived COI not listed, such as:
    - Repeatedly served as USACE technical reviewer
    - Paid or unpaid participation in litigation related to the work of the USACE.
    - Prior repeated service as technical advisor to, or expert witness for, Environmental Defense, National Wildlife Federation, the Missouri Coalition for the Environment, or any other interest group that opposed a USACE Project.
    - Any other perceived COI not listed.

[1] Note: Includes any joint ventures in which your firm is involved.

APPENDIX C

Peer Review Conflict of Interest Inquiry

Dear (Peer Reviewer -- insert name):

You have been requested by the U.S. Army Corps of Engineers (USACE) to serve as an external peer reviewer for the Independent External Peer Review of the Model Certification for Four Ecological Models: EnviroFish, Waterfowl Assessment Methodology (WAM), Migrating Shorebird Habitat Suitability Index Model, and the Delta Region of Arkansas Hydrogeomorphic Methodology. Your participation in this review will be greatly appreciated. However, it is possible that your personal affiliations and involvement in particular activities could pose a conflict of interest or create the appearance that you lack impartiality in your involvement for this peer review. Although your involvement in these activities is not necessarily grounds for exclusion from the peer review, you should consult the contact named below or other appropriate official to discuss these matters. Affiliations or activities that could potentially lead to conflicts of interest might include:

a) current work or arrangements concerning future work in support of industries or other parties that could potentially be affected by developments or other actions based on material presented in the document (or review materials) that you have been asked to review;
b) your personal benefit (or benefit of your employer, spouse or dependent child) from the developments or other actions based on the document (or review materials) you have been asked to review;
c) any previous involvement you have had with the development of the document (or review materials) you have been asked to review;
d) any financial interest held by you (or your employer, spouse or dependent child) that could be affected by your participation in this matter;
e) any financial relationship you have or have had with USACE such as employment, research grants, or cooperative agreements;
f) significant portion (i.e., greater than 50%) of your personal or firm's revenues within the last 3 years came from USACE contracts;
g) you or your firm made a publicly documented statement advocating for or against the subject project;
h) litigation associated with USACE; and
i) past, present or future activity, relationship or interest (financial or otherwise) that could potentially be perceived by a third party, or give the appearance that you would be unable to provide independent unbiased subject matter knowledge, expertise, and/or services on this project.

[1] Note: Includes any joint ventures in which your firm is involved

If you have any concerns over a potential conflict of interest, please contact Mr. Mike Genovese, Battelle (GenoveseM@Battelle.org, (614) 424-4007) to discuss any potential conflict of interest

issues at your earliest convenience, but no later than two (2) days after receiving this request.

If you agree to be on this peer review panel, please check one of the following boxes, sign this form, and fax to Mr. Mike Genovese, Battelle, at (614) 458-4007 no later than two (2) days after receiving this request.

This form does not constitute an authorization to participate in this review; authorization for performance will come from Battelle's Government Subcontracts office.

[ ] I have no known existing or potential conflicts of interest associated with this task.

[ ] I have identified and disclosed in writing all known existing or potential conflicts of interest associated with this task.

_____ _____

Signature *Date* *Printed Name*

Volume 3
Part 6.3

Model Certification Review Report for Arkansas HGM Guidebook

U.S. Army Corps of Engineers
Memphis District

Final Model Certification Review Report for the Delta Region of Arkansas Hydrogeomorphic Methodology (HGM) Guidebook

Prepared by
Battelle Memorial Institute

Prepared for
Department of the Army
U.S. Army Corps of Engineers
Ecosystem Restoration Planning Center of Expertise
Rock Island District

Contract No. W911NF-07-D-0001
Task Control Number: 09210
Delivery Order: 0799

April 14, 2010

SHORT-TERM ANALYSIS SERVICE (STAS)

Final Model Certification Review Report for the Delta Region of Arkansas Hydrogeomorphic Methodology (HGM) Guidebook

by

Battelle
505 King Avenue
Columbus, OH 43201

for:

Department of the Army
U.S. Army Corps of Engineers
Ecosystem Restoration Planning Center of Expertise
Rock Island District

Contract Number: W911NF-07-D-0001
Task Control Number: 09210
Delivery Order Number: 0799

April 14, 2010

Scientific Services Program

The views, opinions, and/or findings contained in this report are those of the author and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

This page intentionally left blank

Final
MODEL CERTIFICATION REVIEW REPORT
for the
Delta Region of Arkansas Hydrogeomorphic Methodology (HGM) Guidebook

EXECUTIVE SUMMARY

An independent external peer review of the Delta Region of Arkansas Hydrogeomorphic Methodology Guidebook (HGM Guidebook) was conducted for the U.S. Army Corps of Engineers (USACE) Ecosystem Restoration Planning Center of Expertise (ECO-PCX) under Contract Number W911NF-07-D-0001, Task Control Number 09-210. The Guidebook supports efforts for assessing the most common types of wetlands that occur in the Delta Region of Arkansas in the Lower Mississippi River Alluvial Valley in the United States. The HGM Guidebook provides a method for developing functional indices and the protocols used to apply these indices to the assessment of wetland conditions at a site-specific scale. The HGM approach initially was designed to be used in the context of the Clean Water Act, Section 404 Regulatory Program, to analyze project alternatives, minimize impacts, assess unavoidable impacts, determine mitigation requirements, and monitor the success of compensatory mitigation. However, a variety of other potential uses have been identified, including the determination of minimal effects under the Food Security Act, design of wetland restoration projects, and management of wetlands.

Normally, a HGM Guidebook focuses on a single regional wetland subclass. This HGM Guidebook, however, considers multiple regional wetland subclasses. Its objectives are to:

- Characterize selected regional wetland subclasses in the Delta Region of Arkansas within the Lower Mississippi River Alluvial Valley.
- Present the rationale used to select functions to be assessed in these regional subclasses.
- Present the rationale used to select assessment variables and metrics.
- Present the rationale used to develop assessment models.
- Describe the protocols for applying the functional indices to the assessment of wetland functions.

Use of certified models for all USACE planning activities is mandatory; therefore the HGM Guidebook models were subjected to a model certification review. The USACE Planning Models Improvement Program (PMIP) was established in 2003 to assess the state of USACE planning models and to assure that high quality methods and tools are available so that informed decisions on investments in the Nation's water resources infrastructure and natural environment can be made. The main objective of the PMIP is to carry out "a process to review, improve and validate analytical tools and models for USACE Civil Works business programs" (USACE EC 1105-2-407, May 2005). In accordance with the *Planning Models Improvement Program: Model Certification* (EC 1105-2-407, May 2005), certification is required for all planning models developed and/or used by USACE. The objective of model certification is to ensure that models used by USACE are technically and theoretically sound, computationally accurate, and in compliance with USACE planning policy.

As a 501(c)(3) nonprofit science and technology organization with experience in establishing and administering peer review panels for USACE, Battelle was engaged to conduct the model certification review for the HGM models. Independent, objective peer review is regarded as a critical element in ensuring technical quality, system quality, and usability of the models.

Four subject matter experts (i.e., model reviewers) were selected to serve on the model review panel from 32 identified candidates. As appropriate for the technical nature of the HGM Guidebook models, the technical expertise of the four selected model reviewers included Civil Works planning/HGM modeling, wetland ecology, forestry, and programming/spreadsheet auditing.

The model reviewers were provided with electronic versions of the HGM Guidebook and associated spreadsheets along with a charge (included with Attachment A) that solicited their comments on specific aspects of the document and model spreadsheets. The charge questions solicited comments regarding key technical quality, system quality, and usability criteria that are critical for model certification as described in the USACE *Protocols for Certification of Planning Models* (July 2007). There was no communication between the model reviewers and the model developers during the review of the documents and models.

Approximately 100 individual comments were received from the model reviewers in response to 34 charge questions. Following the individual reviews of the model documentation and spreadsheets by the model reviewers, a model review teleconference was conducted to review comments on the key model review criteria, discuss charge questions for which there were conflicting responses, and reach agreement on the Final Panel Comments (FPC) to be provided to USACE. The findings of the models' independent external peer review regarding their technical quality, system quality and usability are documented in specific sections of this report, and FPCs are provided in Appendix B.

This Draft Report for the Model Certification Review of the Delta Region of Arkansas HGM Guidebook describes the model review process, describes the model review panel members and their selection, and summarizes the findings and FPCs of the model reviewers. This report is subject to USACE review. USACE comments on the draft report (expected by February 10, 2010) will be the subject of discussion with USACE and the model reviewers during a teleconference (scheduled for 9:00 am EDT February 16, 2010). Once the report has been finalized, the results of the model review as presented in the final report will be taken into consideration for certifying or revising the HGM Guidebook and models.

Overall, the model reviewers agreed that the models are suitable for limited application to meet some of their intended purposes; however, they were concerned that the models have some conceptual flaws that limit their ability to achieve all of the intended purposes. One model reviewer believes these flaws are serious. Models are simple representations of complex systems and, as such, must balance complexity and reality with simplicity and usability. The ability of the HGM Guidebook models to assess wetland functions is undetermined; the models are more appropriate for limited assessment of wetland condition. Although the guidebook has deficiencies, they are not insurmountable and can be resolved.

There were some issues identified with the models' documentation, application, and variables, and some potentially serious errors were noted in the spreadsheet calculations and formulas. The model reviewers provided the following recommendations for improving the models based on the most significant concerns they identified during their review.

1. Describe the relationships between wetland condition and function from the point of scientific validity and program requirements under the Clean Water Act.
2. Provide in an appendix a description of the process for selecting and measuring data from reference wetlands. Also, show reference data points on the graphs of Functional Capacity Index curves relating independent variables to the dependent subindex, and explain how recovery trajectory curves were developed.
3. Provide a better method for capturing frequency and duration of flooding as controlling factors, or provide a clear statement explaining why these indicators could not be reasonably measured.
4. Include an explanation for each of the FCI functions that describes why the specific mathematical form was chosen.
5. Provide information on the relationship between actual measurements of wetland functions and FCI curves.
6. Provide additional information on 1) the sensitivity of the FCIs to their inputs and on the least significant differences for policy analysis, 2) empirical validation of the FCIs against field data, and 3) precision, accuracy, and uncertainty for the FCI calculations.
7. Redesign the forms and spreadsheets as an integrated system to prevent errors.
8. Provide better justification in the guidebook for classifying anthropogenically disconnected floodplain depressions (depressions behind mainstem levees), as unconnected alluvial depressions rather than treating them as altered floodplain depressions.
9. Include non-wetland sites that were former wetlands as part of the reference data set in order to represent the most altered end of the gradient and provide a basis for identifying potential restoration sites.
10. Consider using indicators of channelization and flooding duration in the FCIs.
11. Consider changing how V_{POND}, V_{LITTER} V_{SSD}, V_{GVC}, V_{OUT}, and V_{TBA} are measured and used in the FCIs.
12. Provide additional documentation to: (1) provide links or citations for easily obtainable case studies that apply this method, (2) provide a series of tables, sorted by wetland subclass, showing variable-by-function matrices, and (3) explain that the models have not been designed to address climate change.
13. Improve field measurements to remove subjectivity and to improve precision.
14. Summarize the assumptions implicit in the HGM approach and FCI models.
15. Ensure consistency in terminology and names of variables throughout the HGM Guidebook.

This list of actions summarizes the recommendations for resolution in the FPCs; more detailed recommendations are provided in the FPCs in Appendix B. Failure to address the issues identified may lead to incorrect interpretation or use of the HGM models and outputs.

The reviewers strongly suggest incorporating the recommended resolutions into the FCI models and modifying the documentation before allowing widespread use of the models for planning purposes. Making the recommended revisions will result in better precision of model inputs, accuracy of model outputs, comprehension of the scientific basis and logic behind the models, and understanding of the models results, as well as promote model transparency and allow uncertainty and sensitivity analysis to be performed. The model will also be better able to achieve its intended purpose.

During a teleconference on April 5, 2010 to discuss the review findings with USACE, the model reviewers were asked whether the guidebook was usable prior to making the suggested revisions (as described above). The model reviewers' response was that there could be continued conditional use. The guidebook has been in use for approximately five years and could potentially be used with the same level of accuracy under the condition that existing users will be the ones who continue to use the method. Upon further consideration of this question, the model reviewers agreed that, at the very least, the errors noted in the spreadsheets and the potential for errors in transferring data among field sheets and spreadsheets must be corrected to improve the ability of the models to yield accurate results. Failure to correct the errors and data transfer issues may lead to unreliable model outputs (see FPC #7 and Appendix C). Once these issues are addressed, the models could continue to be used prior to addressing all other comments under the following conditions:

1) The same team of experts who developed the regional HGM guidebook will perform the assessments for all wetland sites to ensure the models are used as intended and that there is consistency in the results. Otherwise, scores among sites are not likely to be comparable (see FPC #15).
2) All other comments will be addressed as soon as possible to certify the regional HGM guidebook for widespread application by users external to the development team. The reviewers understand the immediate need to use the guidebook; however, the guidebook should not continue to be used beyond the immediate needs without the technical issues identified being addressed.
3) Users understand that the regional HGM guidebook's process for assessing wetland functions did not include any actual measurement of wetland functions and is based on measurements of wetland characteristics hypothesized to be indicators of wetland functions. The relationships between these indicators and wetland functions have yet to be independently tested and verified with field data. Therefore, the ability of the guidebook to assess wetland functions will remain unknown until appropriate testing and validation are carried out.

Although the panel concurs that the guidebook is usable once the spreadsheet errors and data transfer issues are corrected, there are still risks associated with its continued use. Those risks include (1) potential for inaccurate measurement of changes in wetland function among project alternatives, (2) potential misapplication of the HGM approach from reclassifying floodplain

wetlands to non-floodplain types following an alteration by levee construction (and thus overlooking loss of functions related to the loss of overbank flooding), and (3) the possible selection of an incorrect alternative for minimizing wetland impacts. The question on usability of the guidebook asked by USACE was primarily in reference to the St. John's/New Madrid project. Although addressing the issues identified by this independent external peer review (IEPR) would improve the usability and accuracy of the models for application to projects in the region, the question of application of the guidebook for the St. John's/New Madrid project was not specifically addressed because it was out of the scope for this review and the model reviewers were not provided with review materials specific to the selection of alternatives for the St. John/New Madrid project.

This page intentionally left blank

TABLE OF CONTENTS

1 Introduction 1
- 1.1 Model Purpose 2
- 1.2 Model Assessment 2
- 1.3 Contribution to Planning Effort 4
- 1.4 Report Organization 5

2 Model Description 5
- 2.1 Model Applicability 5
- 2.2 Model Summary 6
- 2.3 Model Components 6

3 Model Evaluation 8
- 3.1 Model Review Approach 8
- 3.2 Assessment Criteria 11
  - 3.2.1 Technical Quality 11
  - 3.2.2 System Quality 12
  - 3.2.3 Usability 12
- 3.3 Approach to Model Testing 12
- 3.4 Technical Quality Assessment 12
  - 3.4.1 Review of Theory and External Model Components 12
  - 3.4.2 Review of Representation of the System 13
  - 3.4.3 Review of Analytical Requirements 15
  - 3.4.4 Review of Model Assumptions 16
  - 3.4.5 Review Ability to Evaluate Risk and Uncertainty 16
  - 3.4.6 Review Ability to Calculate Benefits for Total Project Life 19
  - 3.4.7 Review of Model Calculations/Formulas 20
- 3.5 System Quality 21
  - 3.5.1 Review of Supporting Software 21
  - 3.5.2 Review of Programming Accuracy 21
  - 3.5.3 Review of Model Testing and Validation 22
- 3.6 Usability 22
  - 3.6.1 Review of Data Availability 22
  - 3.6.2 Review of Results 23
  - 3.6.3 Review of Model Documentation 24
- 3.7 Model Assessment Summary 26

4 Conclusions 27

5 References 28

Appendix A: Biographic Information for Model Review Panel Experts

Appendix B: Final Panel Comments

1. It appears that the models in the Hydrogeomorphic (HGM) Guidebook assess ecological condition rather than wetland functions.
2. The Hydrogeomorphic (HGM) Guidebook did not explain how raw field data were used to calibrate the derived subindices, why subindex graphs were

straight lines, and why the minimum subindex score for some altered conditions equaled zero while others were greater than zero.

3. The treatment of flood frequency and flood duration within the models implies greater ecological measurement of flood frequency and duration than is actually occurring.
4. The justification for the mathematical form of the six Functional Capacity Indices (FCIs) should be expanded.
5. The Functional Capacity Indices (FCIs) have not been validated against independent empirical estimates of the actual function in the relevant terrains.
6. The Hydrogeomorphic (HGM) Guidebook needs to explain more fully the overall reliability of the outputs of the model.
7. The procedures used to transform raw field data into tables of Functional Capacity Indices (FCIs) and Functional Capacity Units (FCUs) are overly complex and prone to errors.
8. The Unconnected Alluvial Depression subclass should not include wetlands that have been cut off from the channel of major river floodplains by man-made levees.
9. The reference data set does not seem to have included former wetlands (now non-wetlands) as part of the model calibration, which means that the most altered end of the gradient is not well represented in the calibration, and former wetlands will likely be overlooked as potential restoration sites.
10. The Functional Capacity Index (FCI) for Detain Floodwater could be improved by use of channelization and flooding duration indicators and by careful consideration of the calibration of V_{FREQ}.
11. The Functional Capacity Index (FCI) for Detains Precipitation could be improved by changing how V_{POND} and V_{LITTER} are measured.
12. The Functional Capacity Indices (FCIs) for Cycles Nutrients and Export Organic Carbon could be improved by changing the use or measurement of V_{SSD}, V_{GVC}, V_{OUT}, and V_{TBA} in the FCI calculation.
13. The Functional Capacity Index (FCI) for Provide Habitat for Fish and Wildlife could be made more robust by using fewer subindices in its calculation.
14. The Hydrogeomorphic (HGM) Guidebook should include references to easily-obtainable case studies that apply this method.
15. Some field measurement approaches should be improved to improve the precision (repeatability of measurements) of variables in the models.
16. At the beginning of the document, a clear statement needs to be provided about how the guidebook is intended to support decisions made by regulators and managers and how the guidebook supports that purpose.
17. The Hydrogeomorphic (HGM) Guidebook should explain why some functions commonly included in HGM assessments were not chosen for this HGM assessment method.

18. The Hydrogeomorphic (HGM) Guidebook should summarize the assumptions implicit in its approach, including those pertaining to the Functional Capacity Index (FCI) models.
19. The descriptions of some model variables needs to be more clear, consistent, and complete.
20. The model, as designed, does not address global climate change issues as required by EC 1165-2-211 Water Resource Policies and Authorities Incorporating Sea-Level Change Considerations in Civil Works Programs (01 July 2009).
21. The Hydrogeomorphic (HGM) Guidebook should include a table for each wetland subclass that provides a matrix of subindices and the FCI models in which they occur.

Appendix C: Specific Comments on Spreadsheets

Appendix D: Additional Suggested Edits

Attachment A: Revised Final Work Plan

LIST OF TABLES

Table 1. Experts Selected for the HGM Guidebook Model Review Panel 9
Table 2. Example of Data Sources and URL's that Might be Included in the HGM Guidebook 23
Table 3. The 21 Predictor or Independent Variables Used in Calculating FCIs in the HGM Guidebook for the Delta Region of Arkansas 25

LIST OF ACRONYMS

CECW	Corps of Engineers Directorate of Civil Works
CE/ICA	Cost-Effective Incremental Cost Analysis
COI	Conflict of Interest
dbh	diameter at breast height
ECO-PCX	Ecosystem Restoration Planning Center of Expertise
FCI	Functional Capacity Index
FCU	Functional Capacity Unit
FPC	Final Panel Comment
HGM	Hydrogeomorphic
IEPR	Independent External Peer Review
LSD	Least Significant Difference
PCX	Planning Center of Expertise
PMIP	Planning Models Improvement Program
SOW	Statement of Work
USACE	U.S. Army Corps of Engineers
WAA	Wetland Assessment Area

1 INTRODUCTION

Planning models are defined as any models and analytical tools that planners use to define water resources management problems and opportunities, formulate potential alternatives to address the problems and take advantage of the opportunities, and evaluate potential effects of alternatives and to support decision-making. The U.S. Army Corps of Engineers (USACE) Planning Models Improvement Program (PMIP) was established in 2003 to assess the state of planning models used by USACE and to make recommendations to assure that high quality methods and tools are available to enable informed decisions on investments in the Nation's water resources infrastructure and natural environment. The main objective of the PMIP is to carry out a process to review, improve, and validate analytical tools and models for USACE Civil Works business programs. The PMIP Task Force collected the views of USACE leaders and recognized technical experts, and conducted investigations and numerous discussions and debates on issues related to planning models. This task force identified an array of model-related problems, conducted a survey of planning models, prepared papers on model-related issues, analyzed numerous options for addressing these issues, and formulated recommendations.

Use of certified models for all USACE planning activities is mandatory. This policy is applicable to all planning models currently in use by USACE, as well as models under development and new models that may be developed in the future. District Commanders are responsible for providing high quality, objective, defensible, and consistent planning products. Development of these products requires the use of tested and defensible models. National certification of planning models will result in significant efficiencies in the conduct of planning studies and enhance the capability to produce high quality products. The appropriate USACE Planning Center of Expertise (PCX) is responsible for model certification. The goal of certification is to establish that USACE planning products are theoretically sound, compliant with USACE policy, computationally accurate, based on reasonable assumptions, and in compliance with the requirements of the Office of Management and Budget's *Final Information Quality Bulletin for Peer Review* (Federal Register Vol. 70, No. 10, January 14 2005, pp 2664-2677). The use of a certified model does not constitute technical review of the planning product. Independent technical review of the selection and application of the model and the input data is still the responsibility of the users. Once a model is certified, the PCXs will work with model developers and managers to ensure that documentation and training in model use are available and that model updates comply with certification requirements.

The primary criterion for model certification is technical soundness. Technical soundness reflects the ability of the model to represent or simulate the processes and/or functions it is intended to represent. The performance metrics for this criterion are related to theory and computational correctness. In terms of theory, the certified model should:

- be based on validated and accepted "state of the art" theory
- incorporate USACE policies and requirements
- properly incorporate the conceptual theory into the software code
- clearly define the assumptions inherent in the model.

In terms of computational correctness, the certified model should:

- employ proper functions and mathematics to estimate functions and processes represented
- properly estimate and forecast the actual parameters it is intended to estimate and forecast.

Other criteria for certification are efficiency, effectiveness, usability, and clarity in presentation of results. A certified model will stand the tests of technical soundness based on theory and computational correctness, efficiency, effectiveness, usability and clarity in presentation of results.

An independent external peer review of the Delta Region of Arkansas Hydrogeomorphic Methodology Guidebook (HGM Guidebook) was conducted for the USACE Ecosystem Restoration Planning Center of Expertise (ECO-PCX) under Contract Number W911NF-07-D-0001, Task Control Number 09-210. The objective of the review was to evaluate the technical quality, system quality, and usability of the HGM Guidebook models in accordance with *Planning Models Improvement Program: Model Certification* (EC 1105-2-407, dated May 31, 2005) and the *Protocols for Certification of Planning Models* (July 2007). USACE's ultimate goal is to certify the HGM models developed for use within the geographic area specified in the HGM Guidebook. The review did not include a technical evaluation of the application of the model on a specific project.

1.1 Model Purpose

The HGM approach is a method for developing functional capacity indices (FCIs) and the protocols used to apply these indices to the assessment of wetland condition at a site-specific scale. The HGM classification was developed specifically to identify groups of wetlands that function similarly using three criteria that fundamentally influence how wetlands function:

- Geomorphic setting--the position of the wetland in the landscape.
- Water source--the primary origin of the water that sustains wetland characteristics, such as precipitation, floodwater, or groundwater.
- Hydrodynamics--the level of energy with which water moves through the wetland, and the direction of water movement.

Based on these three criteria, any number of functional wetland groups can be identified at different spatial or temporal scales. Although the HGM approach is applicable to any wetland, the models included in this HGM Guidebook are specifically applicable to the Delta Region of Arkansas in the Lower Mississippi River Alluvial Valley in the United States.

1.2 Model Assessment

In accordance with the *Planning Models Improvement Program: Model Certification* (USACE, 2005; EC 1105-2-407), certification is required for all planning models developed for and/or used by USACE. The objective of model certification is to ensure that models used by USACE are technically and theoretically sound, computationally accurate, and in compliance with

USACE planning policy. Model assessments are conducted in accordance with the USACE *Protocols for Certification of Planning Models* (USACE, 2007).

Model development is a multi-step, iterative process, with the number of steps and iterations being dependent upon the complexity of the model. In general, the basic steps of the USACE model certification process, designed to guide the model review, occur in four stages.

- Stage 1 (Requirements Stage), identify the need for a specific analytical capability and the options for tools to meet the need.
- Stage 2 (Development Stage), develop software programming code or a spreadsheet and have it tested by the model developer.
- Stage 3 (Model Testing Stage), conduct a beta test of the model by selected users whose objective is to validate the model and ensure that it is usable in real-world applications.
- Stage 4 (Implementation Stage), provide training, user support, maintenance, and continuous evaluation of the model.

The certification procedure depends on the stage of model development. The process may include the following steps.

1. Model reviewers determine whether project needs/objectives are clearly identified and whether the model described is meeting those needs/objectives.
2. Model reviewers evaluate the technical quality of the models (review of model documentation), including whether:
   a. The model is based on well-established contemporary theory.
   b. The model is a realistic representation of the actual system.
   c. Analytical requirements of the model are properly identified and the model addresses and properly incorporates the analytical requirements.
   d. Assumptions are clearly identified, valid, and support the analytical requirements.
   e. USACE policies and procedures related to the model are clearly identified, and the model properly incorporates USACE policies and accepted procedures.
   f. Formulas used in the model are correct and model computations are appropriate and done correctly.
3. Model reviewers evaluate system quality (review by running test data sets or analyzing the results of beta tests) to determine whether:
   a. The rationale for selection of supporting software tool/programming language and hardware platform is adequately described, and supporting software tool/programming language is appropriate for the model.
   b. The supporting software and hardware are readily available.
   c. The programming was done correctly.
   d. The model has been tested and validated, and all critical errors have been corrected.
   e. Data can be readily imported from/into other software analysis tools, if applicable.

4. Model reviewers evaluate the usability of the model to:
    a. Examine the data required by the model and determine the availability of the required data.
    b. Examine how easily model results are understood.
    c. Evaluate how useful the information in the results is for supporting project objectives.
    d. Evaluate the ability to export results into project reports.
    e. Determine whether training is readily available.
    f. Determine whether user documentation is available, user friendly, and complete.
    g. Determine whether adequate technical support is available for the model.
    h. Determine whether the software/hardware platform is available to all or most users.
    i. Determine whether the model is easily accessible.
    j. Determine whether the model is transparent and allows for easy verification of calculations and outputs.

The HGM models are at Stage 3 in the development process. They have already been applied to projects from other areas, and are being assessed for quality and applicability to this area. This review of the HGM Guidebook and spreadsheets focused on the technical quality, system quality, and usability of the FCI models and the approach to their application.

The level of effort for a model review depends on the complexity of the models developed, the risks associated with planning decisions made using the models, and the stage of model development. The HGM models have undergone an Intermediate Level Review, based on the models' intermediate level of complexity relative to other planning models. The Intermediate Level Review included an Independent External Peer Review (IEPR) of the models. Although the technical review of the models has been conducted external to USACE, it is ultimately USACE's decision whether to certify planning models for use on other projects or in other geographic areas.

1.3 Contribution to Planning Effort

The USACE planning regulations require that ecosystem restoration benefits be estimated. Benefit results are included in a Cost-Effective Incremental Cost Analysis (CE/ICA) to determine the best project for implementation. As stated in the HGM Guidebook "The HGM Approach initially was designed to be used in the context of the Clean Water Act, Section 404 Regulatory Program, to analyze project alternatives, minimize impacts, assess unavoidable impacts, determine mitigation requirements, and monitor the success of compensatory mitigation. However, a variety of other potential uses have been identified, including the determination of minimal effects under the Food Security Act, design of wetland restoration projects, and management of wetlands" (page 1).

1.4 Report Organization

The remainder of this report is organized into the following sections:

Section 2.0 Model Description — Describes the applicability of the models for planning projects and summarizes the models' inputs and components.

Section 3.0 Model Evaluation — Describes the criteria used to assess technical quality, system quality, and usability; summarizes the approach to the model review; and describes the results of the model assessment.

Section 4.0 Conclusions — Summarizes the overall recommendations of the model review.

Section 5.0 References — Lists the references used for this model assessment.

Appendix A Biographic Information for Model Review Panel Experts — Contains biographic information on the expert model review panel members selected to perform the review of the model certification assessment criteria.

Appendix B Final Panel Comments — Contains the Final Panel Comments (FPCs) from the model review as well as each comment's basis, significance, and recommendations for resolution.

Appendix C Specific Comments on Spreadsheets — Contains specific comments on the spreadsheets provided as part of the review

Appendix D Additional Suggested Edits — Contains additional suggested edits to the HGM Guidebook provided by the model reviewers

Attachment A Revised Final Work Plan — Contains the Revised Final Work Plan for the Certification of Four Ecological Models: Envirofish, Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley, Waterfowl Assessment Methodology, and the Delta Region of Arkansas Hydrogeomorphic Methodology Guidebook, which contains the final charge guidance and questions to the model reviewers to guide the review of the models and model documentation.

2 MODEL DESCRIPTION

2.1 Model Applicability

The HGM Guidebook is a Regional Guidebook developed for assessing the most common types of wetlands that occur in the Delta Region of Arkansas, which is that portion of the alluvial valley of the Mississippi River that lies within Arkansas, bounded on the west by the Ozark and Ouachita Mountains, the Arkansas River Valley, and the West Gulf Coastal Plain, and bounded on the east by the Mississippi River levee. The HGM models in this HGM Guidebook were developed for the Delta Region of Arkansas and are intended for use only on forested wetlands (or sites that could support forested wetlands). The subclasses modeled are Non-Alkali Flat (Flat), Low Gradient Riverine Backwater, Low-Gradiant Overbank, headwater depression, unconnected depression, and connected depression. Models were not included within this HGM

Guidebook for Alkali Flat, Mid-Gradient Riverine, Fringe Class, or Riverine Impounded subclasses.

2.2 Model Summary

Normally, a Regional Guidebook focuses on a single regional wetland subclass (the term for wetland types in HGM terminology). This Regional Guidebook, however, considers multiple regional wetland subclasses. The rationale for this approach is that the Lower Mississippi River and its tributaries have created a complex landscape that supports a variety of interspersed wetland types in the Delta Region of Arkansas specifically and the Lower Mississippi River Alluvial Valley generally. Subtle differences in terrain and water movement result in distinctly different functions being performed by wetlands that are in close proximity to, or contiguous with, one another. Further, massive flood control and drainage works instituted in the twentieth century have dramatically affected nearly all of the wetlands in the Lower Mississippi River Alluvial Valley. Because these wetland systems have closely related origins and have been universally influenced by flood protection and drainage efforts, it is most sensible to deal with their classification and assessment in a single integrated Regional Guidebook. This does not mean that wetlands of different hydrogeomorphic classes and regional wetland subclasses are lumped for assessment purposes, but rather that the factors influencing their functions and the indicators employed in their evaluation are best developed and presented in a unified manner. Therefore, this Regional Guidebook was developed for multiple regional wetland subclasses that commonly occur together in a subbasin. It is expected that the classification of regional wetland subclasses, assessment variables, and the assessment models developed for the Delta Region of Arkansas will have general applicability in other subbasins of the Lower Mississippi River Alluvial Valley. The objectives of the HGM Guidebook are:

- Characterize selected regional wetland subclasses in the Delta Region of Arkansas within the Lower Mississippi River Alluvial Valley,
- Present the rationale used to select functions to be assessed in these regional subclasses,
- Present the rationale used to select assessment variables and metrics,
- Present the rationale used to develop assessment models, and
- Describe the protocols for applying the functional indices to the assessment of wetland functions.

2.3 Model Components

The HGM approach consists of four components:

- HGM classification
- Reference wetlands
- Assessment variables and assessment models from which functional indices are derived
- Assessment protocols.

The HGM classification and reference wetlands components are determined during the development phase in which an interdisciplinary Assessment Team (A-Team) of experts develop and integrate the classification, reference wetland information, assessment variables, models, and protocols of the HGM approach into a Regional Guidebook. During a second phase, the

Application Phase, the assessment variables, models, and protocols are used to assess wetland functions. The Application Phase involves two steps. The first is to apply the assessment protocols outlined in the Regional HGM Guidebook to complete the following tasks:

- Define assessment objectives
- Characterize the project site
- Screen for red flags[1]
- Define the Wetland Assessment Area
- Collect field data
- Analyze field data.

The second step involves applying the results of the assessment at various decision-making points in the planning or permit review sequence, such as alternatives analysis, impact minimization, assessment of unavoidable impacts, determination of compensatory mitigation, design and monitoring of mitigation, comparison of wetland management alternatives or results, determination of restoration potential, or identification of acquisition or mitigation sites.

In the HGM approach, an assessment model is a simple representation of a function performed by a wetland ecosystem. The assessment model defines the relationship between the characteristics and processes of the wetland ecosystem and the surrounding landscape that influence the functional capacity of a wetland ecosystem. Characteristics and processes are represented in the model by assessment variables. Functional capacity is the ability of a wetland to perform a specific function relative to the ability of reference standard wetlands to perform the same function based on the wetland's condition. Application of assessment models results in a Functional Capacity Index (FCI) ranging from 0.0 to 1.0. Wetlands with an FCI of 1.0 perform the assessed function at a level that is characteristic of reference standard wetlands. A lower FCI indicates that the wetland is performing a function at a level below the level that is characteristic of reference standard wetlands.

The wetland functions that can be assessed using this HGM approach were identified by participants in a workshop held in Arkansas in 1997. That group selected hydrologic, biogeochemical, and habitat functions that are important and measurable in Arkansas wetlands from a suite of potential functions identified in *A Guidebook for Application of Hydrogeomorphic Assessments to Riverine Wetlands* (Brinson et al., 1995). This regional HGM Guidebook, based on the workshop recommendations, provides models and reference data required to determine the extent to which forested wetlands of the Arkansas Delta perform the following functions:

- Detain Floodwater
- Detain Precipitation
- Cycle Nutrients
- Export Organic Carbon

[1] "Red flags are features in the vicinity of the project area to which special recognition or protection has been assigned on the basis of objective criteria" (HGM Guidebook, page 108). For example, areas supporting endangered species.

- Maintain Plant Communities
- Provide Habitat for Fish and Wildlife.

3 MODEL EVALUATION

USACE requires that planning models be reviewed and certified. The purpose of the review is to evaluate the technical quality, system quality, and usability of the planning models. The results of the model review will be used by USACE to determine whether to certify the model for inclusion in the toolbox of USACE planning models. The ECO-PCX conducted an Intermediate Level review of these regional models based on their anticipated wide use for wetland projects in the Lower Mississippi River Alluvial Valley. As a 501(c)(3) nonprofit science and technology organization with experience in establishing and administering external peer review panels for USACE, Battelle was engaged to conduct the model certification review for the HGM Guidebook models.

3.1 Model Review Approach

Independent, objective peer review is regarded as a critical element in ensuring technical quality, system quality, and usability of the models. Details of the review process and charge guidance are provided in the Final Charge for the Model Certification Review for the HGM Guidebook Models (see as part of Attachment A). The review consisted of eight tasks:

Task 1 – Kick-off Meeting
Task 2 – Work Plan
Task 3 – Prepare and Finalize Charge to Reviewers
Task 4 – Identify Candidate Reviewers
Task 5 – Conduct Assessment of Model
Task 6 – Prepare Draft Certification Report
Task 7 – Meeting to Discuss Findings
Task 8 – Prepare Final Certification Report.

Battelle participated in a kick-off teleconference meeting with representatives from the USACE ECO-PCX and the Model Proponents (Task 1). The purpose of the meeting was for USACE to brief Battelle on USACE's specific goals and objectives for the model review and for Battelle to present to USACE its approach to conducting the model review. Battelle prepared a work plan, which included charge questions and guidance to the model review panel, based on the goals and objectives discussed and the USACE Statement of Work (SOW) (Tasks 2 and 3).

Battelle initially identified 32 candidates for model review panel positions, evaluated their technical expertise, and inquired about potential conflicts of interest (COI). Of those contacted initially, Battelle chose seven of the most qualified candidates based on background, years of experience, and lack of actual or perceived COI (Task 4) and confirmed their interest and availability. Of those seven candidates, four were proposed for the final model review panel and three as backup model reviewers. These experts were approved by the USACE ECO-PCX (Task 4). The four proposed primary model reviewers constituted the final panel. The remaining

candidates were not proposed as model review panel members for a variety of reasons including lack of availability, disclosed COI, or because they did not possess the precise technical expertise required.

The model review panel included:

- A Civil Works Planner/HGM expert with experience in floodplain management including ecosystem restoration, impact analysis, compensatory mitigation, knowledge of Lower Mississippi River Valley ecosystems, and the use of the HGM approach.
- A wetland ecology expert with experience in the wetland ecology of large floodplain rivers, including experience in southern bottomland wetlands and familiarity with ecosystem output evaluation, particularly the HGM approach.
- A forestry expert with experience in riverine forest ecology and bottomland hardwood community structure and dynamics within the Lower Mississippi River Valley, and familiarity with ecosystem output evaluation, particularly the HGM approach.
- A programmer/spreadsheet audit expert with experience testing, debugging, and auditing computer programs/spreadsheets to check for accuracy of formulas, cell references, and computer code.

Information on the experts selected for the model review panel is summarized in Table 1, and a short biography for each panel member is provided in Appendix A.

Table 1. Experts Selected for the HGM Guidebook Model Review Panel

Name	Affiliation	Location	Education	Exp (yr)
Civil Works Planner/HGM Specialist				
Richard Rheinhardt	Independent consultant	Pocasset, MA	Ph.D. in marine science/ biological oceanography	15
Wetland Ecologist				
Paul Keddy	Independent consultant	Carleton Place, Ontario, Canada	Ph.D. plant ecology	35
Forester				
James Shepard	Mississippi State University	Mississippi State University, MS	Ph.D. in forest soils	34
Programmer/Spreadsheet Auditor				
Stephen Powell	Tuck School of Business, Dartmouth College	Hanover, NH	Ph.D. in engineering-economic systems	15

After the model reviewers were under subcontract, Battelle conducted a kick-off teleconference to brief the model review panel on the purpose and approach for the review process. Another kick-off teleconference was convened with Battelle, the model reviewers, ECO-PCX, and the model developers to provide the model reviewers an opportunity to be briefed specifically on the models and to ask questions directly of USACE. The model reviewers received electronic versions of the review documents, along with guidance and a charge that solicited their comments on specific aspects of the documents that were to be reviewed.

The following documents and reference materials (*file names are provided in italics*) were provided to the model reviewers for the review (most of the documents contained HGM Guidebook and Methodology information):

- A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Forested Wetlands in the Delta Region of Arkansas, Lower Mississippi River Alluvial Valley (*Draft Revision_AR_Delta_HGM_6-8-09.pdf)*
- *Delta_FCI_Calculators_6-17-09.xls* (containing six worksheets)
- *Appendix D_trel04-16-spreadsheet.zip* (containing three files *ArkansasBasalAreaCondensed12_2001.xls; ArkansasWoodyDebrisFinal12_2001.xls; DeltaFCICalculators12_2003.xls*)
- *AppendixE_trel04-16-spatial.zip* (containing six shape files [.dbf, .prj, .sbn, .sbx, .shp, .shx]for the following items – AR_Roads_27; CitiesandTowns_27_delta; DeltaCounties_27; DeltaHydrology_27; DeltaRoads_27; DeltaStatsgosoils; Final_WPA&WPR; Saucier_Nad_27_AR_only).

Model reviewers were asked to review the documentation for the HGM models and supporting worksheets. They also received the following additional documents, for reference only and not for review:

- Protocols for Certification of Planning Models (http://www.usace.army.mil/CECW/PlanningCOP/Pages/models.aspx)
- EC 1105-2-407, Planning Models Improvement Program: Model Certification (http://www.usace.army.mil/CECW/PlanningCOP/Pages/models.aspx).

The model reviewers were asked to review the models and their documentation using guidance and charge questions provided to them. There was no communication between the model review panel and the model developers during the peer review process. The guidance and charge questions are based on the model certification criteria discussed in USACE *Protocols for Certification of Planning Models* (July 2007). The intent of these questions was to focus the review on the assessment criteria that are critical for the certification of planning models. The process and evaluation criteria for the review are outlined in the *Protocols for Certification of Planning Models* (USACE, 2007) and described in Section 1.2, Model Assessment, of this report.

Thirty-four charge questions developed by Battelle and approved by USACE were provided to the model review panel in Individual Charge Response Forms to be used by the model reviewers. Following the panel members' individual reviews of the HGM Guidebook and spreadsheets, the Individual Charge Response Forms were compiled into a Merged Charge Response Form that

contained all of the model review comments. Approximately 100 individual comments were received.

A teleconference between Battelle and the model reviewers was conducted to discuss key technical comments and conflicting opinions identified from the Merged Charge Response Form and to reach agreement on the key findings of the review to be provided to USACE in the Model Certification Review Report. By the end of the teleconference, the participants had formulated 22 Final Panel Comments (FPCs) that identify and discuss the key concerns with the models and model documents found during the review and present recommendations for their resolution. The model reviewers were also assigned the responsibility of drafting specific sections of the Draft Model Certification Review Report. The results and conclusions of the model review are discussed in Sections 3.4 through 4.0 of this draft report. All the FPCs are presented in Appendix B.

Battelle and the model reviewers will meet via teleconference with representatives of the Corps of Engineers Directorate of Civil Works (CECW), representatives of the ECO-PCX, and Model Proponents to discuss the Draft Report for Model Certification Review on February 16, 2010 9:00 am EDT. Suggested revisions will be incorporated into the report within five days of the teleconference, after which Battelle will provide USACE with the Final Report on February 23, 2010.

3.2 Assessment Criteria

In accordance with the *Planning Models Improvement Program: Model Certification* (EC 1105-2-407, May 2005), the Delta Region of Arkansas HGM Guidebook and models were subjected to an independent external peer review. Based on guidance in the USACE *Protocols for Certification of Planning Models* (July 2007). The models were reviewed and assessed for technical quality, system quality, and usability. These three criteria are described in the following sections.

3.2.1 Technical Quality

Analytical tools used for planning purposes, including models, need to be technically sound and based on widely accepted contemporary scientific theory. The study area, and how it responds to the influences that act upon it, must be realistically represented by the components of the models. The architecture of the model calculations must reflect how the system is expected to respond to changes in measured variables based on the application of scientific theory. Formulas and calculation routines that form the mechanics of the models must be accurate and correctly applied, with sound relationships among variables. The models should be able to reflect natural changes as well as the influence of anthropogenic laws, policies, and practices. All model assumptions must be valid and should be well-documented. The analytical requirements of the models must be identified, and the model must address these requirements. The models should also produce robust, reproducible results that stand up to rigorous scrutiny in later stages of the plan formulation process.

3.2.2 System Quality

System quality refers to the quality of the entire system used to develop, use, and support the models, including the software and hardware platform. System quality is assessed by testing the hardware and software components, design verification planning for customer acceptance, third party interoperability, compatibility with various hardware and operating systems such as USB, Windows, and MacIntosh, and the development of problem-tracking database. Most of this is done through USACE internal review and tracking. However, some criteria can be evaluated by external model reviewers. In general, peer review evaluation of system quality can include assessing whether supporting software tools/programming language are appropriate for the models, programming is done correctly, software and hardware are available, the models have been tested and validated, and data can be readily imported into other software analysis tools (if applicable).

In this case, the model reviewers were not asked to assess software for the models because the models are spreadsheet based. Therefore, the model reviewers were provided with spreadsheets containing each of the HGM FCI models. The review of the spreadsheets included model testing and validation.

3.2.3 Usability

Usability refers to how easily model users can access and run the models, interpret the model output, and use the model output to support planning decisions. An assessment of model usability includes evaluating the availability of data required to run the models and the ability of the user to learn how to use the model properly and effectively. Model outputs must also be easy to interpret, useful for supporting the purpose of the models, easy to export to project reports, and sufficiently transparent to allow for easy verification of calculations and outputs.

3.3 Approach to Model Testing

USACE did not provide the model reviewers with example data for which to test the HGM models for accuracy; therefore, testing was not conducted as part of this model review. The model reviewers' assessment included only a review of the information available in the model documentation and associated spreadsheets.

3.4 Technical Quality Assessment

The reviewers assessed the technical quality of the models against the criteria described in Section 1.2, and based on a review of the HGM Guidebook (September 2004) and spreadsheets provided by USACE. Without knowing all of the relevant USACE policies and procedures, the model reviewers were unable to determine whether the models properly incorporate USACE policies and procedures. The results of the model reviewers' assessment of the other criteria are summarized in the following sections.

3.4.1 Review of Theory

The HGM Guidebook incorporates standard scientific knowledge about patterns and processes in alluvial wetlands. The 21 input variables for the FCI models measure a wide array of physical, biological, and structural attributes that are generally accepted as indicators of wetland condition.

The six FCI equations transform these indicators of condition into estimates of function. There is a clear rationale provided for the selection and weighting of variables, but the structure of the equations themselves needs more theoretical justification. The relationship between condition and function is still an area of research with emerging theory, but the variables and equations in the guidebook appear to represent current expert opinion. Other theoretical approaches to measuring ecosystem services exist. The HGM Guidebook should explain why these other approaches are less desirable and how the HGM approach compares to them.

Each measured variable is indexed by wetland subclass relative to the value attained by the least-altered wetlands of the subclass. The individual indices are then aggregated into a mathematical form (FCI equations) that represent the capacity of a wetland to provide ecological functions at a level relative to the least altered wetlands of the subclass. The theoretical justification for selecting and aggregating variables into models is based on expert opinion, founded on current scientific understanding of functional processes. The FCI equations represent coarse, logic-based models of relationships that have not yet been empirically validated (i.e., the theory has not been tested for accuracy).

3.4.2 Review of Representation of the System

The general purpose of any ecological model or theory is to represent one or more selected aspects of an ecological system, and to make predictions about future states of the system. All modeling requires simplification, and the challenge of simplifying while retaining important properties is one of the real challenges of modeling (Starfield and Bleloch, 1991).

For the HGM Guidebook, it was difficult for the reviewers to assess whether the model represents actual Arkansas Delta wetland ecosystems because data were not presented for the reference wetlands. The guidebook states, "Each subclass was the focus of detailed sampling during development of this HGM Guidebook, and the reference data collected for each subclass have been independently summarized for application" (Chapter 5, page 74). However, the documentation does not provide sufficient information to enable the end user to understand how field data were calibrated to produce the subindex graphs that are in turn used to calculate subindex scores when applying the protocol. Without seeing the agreement between the actual data and the subindex curves, the model reviewers could not determine whether the model represents the wetland ecosystems being modeled

The purported strength of the HGM approach is that the use of reference data provides a transparent framework for assessing functions. Lack of user access to the raw data, or a raw data summary, and the procedures used to calibrate the subindex curves inhibits transparency and reduces the user's confidence in assessment results. For a more thorough review of representation of the system being modeled, the model reviewers would need to see the data from reference wetlands relating measurements of wetland functions to the measurements of the variables that comprise the FCI curves. Therefore, an appendix with information about reference sites, the field data collected in the reference sites and an explanation of how field data were used to calibrate subindex graphs would provide the transparency necessary for users to have confidence in the assessment method (see FPC #2).

In the *Guidebook for Developing Regional Guidebooks*, Smith and Wakeley (2001) said, "The final step in functional definition is to identify an independent measure of each function, along with appropriate quantitative units. ...[I]dentification of an independent, quantitative measure of function is mandatory if assessment models are to be amenable to testing and validation and accepted by the scientific and regulatory communities. Assessment models are validated by comparing their output (i.e., the FCI) against the independent measure of function (e.g., a direct count of breeding bird species, or a direct measure of sediment accretion)." However, this process was not reported in the HGM Guidebook (see FPC #2 for additional information). Therefore, the documentation does not provide sufficient information to enable the end user to understand how field data were calibrated to produce the subindex graphs that are in turn used to calculate subindex scores when applying the protocol. The purported strength of the HGM approach is that the use of reference data provides a transparent framework for assessing functions. Lack of user access to the raw data, or a raw data summary, and the procedures used to calibrate the subindex curves inhibits transparency and reduces the user's confidence in assessment results. An appendix with information about reference sites, the field data collected in the reference sites and an explanation of how field data were used to calibrate subindex graphs would provide the transparency necessary for users to have confidence in the assessment method (see FPC #2).

There is still uncertainty about the relationship between condition and function that requires further testing (see FPC #1). Cole (2006) noted that models which rely on structural variables may not relate to actual wetland function. Likewise, Stein et al. (2009) observed that the "determination of function requires repeated measurements that quantify rates of processes over time," and so rapid assessment approaches like HGM are designed only to "measure a combination of physical and biological structural attributes at a moment in time, providing a snapshot of the status of a wetland that is used to infer the degree, or functional capacity, to which functions are being performed." Fennessy et al. (2007) stated, "The relationship between the rapid method and comprehensive data must be established so that the rapid method, with careful sampling design, can be used to extrapolate the more detailed results to the resource base as a whole (i.e., through probability based sample design). It will also allow confidence limits on the use of a rapid assessment to be determined, increasing the reliability and defensibility of the method." Hill et al. (2006) observed that "…most regional HGM Guidebooks include functional assessment models that have not been subjected to even the crudest levels of testing and validation." According to Hoeltje and Cole (2009), "The most important limitation is that HGM does not actually measure function."

Since the HGM models may be used to implement federal policy on water resources and wetland protection, the model reviewers need to see how FCI curves were developed and how well the models fit the data used in model construction. This could be included in an appendix to the HGM Guidebook. A particular issue that concerned model reviewers is the treatment of flood frequency (V_{FREQ}) and flood duration (V_{DUR}) (see FPC#3). These are two key drivers that control wetlands, of which neither is directly measured. If measures of flooding are not incorporated, then the most important driver in the system is missing. Failure to capture the nature of changes in flooding frequency and duration may result in an inability to effectively capture changes in wetland condition, which is the focus of the approach. Extreme events on a fifty-year cycle (typical life of USACE projects) are important for many wetlands. It is the

wettest and driest extremes which determine many of the conditions. Therefore, deviation from reference standard conditions (which should represent natural variations in extremes) should be the basis for calibrating a flooding variable.

Furthermore, flood frequency subindices are based on mid-20th century condition (after "major river engineering projects") and is assumed to be unaltered (V_{FREQ}= 1.0) unless flood frequency has been *recently* modified or a change to flood frequency is proposed. The implication of using mid-20th century conditions as baseline is that the approach will not be applicable for restoring hydrologic regime to conditions in existence before wide scale river engineering projects, should that be proposed. Furthermore, the composition of bottomland forests established before mid-20th century cannot be used as a reference standard condition because they developed under a flood regime that was explicitly eliminated from consideration as reference standard. The decision for choosing reference standard for flood frequency as mid-20th century condition is practical, but the effects on other reference standards (e.g., tree composition) and the implications for restoration should be clearly articulated in the guidebook.

3.4.3 Review of Analytical Requirements

For a model to provide reliable information to its user, four attributes of the model must be fully communicated: precision, accuracy, sensitivity, and degree of uncertainty. Precision (degree of repeatability) can only be determined by having more than one field team measure the same field variables in the same location and compare the similarity of their results. It is unclear whether this comparison was conducted, as it is not reported in the documentation (see FPC #6 for additional information).

Potential lack of precision in the HGM approach is likely associated with measuring or estimating litter cover (V_{LITTER}), tree composition based on cover estimates (V_{TCOMP}), percent of floodplain ponded (V_{POND}), composition of the tallest stratum (V_{COMP}), composition of the canopy tree stratum (V_{COMP}), woody debris volume (V_{WD}), snag density (V_{SNAG}), and down log volume (V_{LOG}). These variables either vary spatially or are difficult to measure using the methods provided. The model reviewers suggested the following recommendations:

- Consider using indicators of channelization (e.g., intensity of channelization: depth of channel, height of levees) in the Detain Floodwater FCI.
- Incorporate a flooding duration variable (e.g., based on regional curves, unless affected by backwater flooding) as a potential model subindex for the Detain Floodwater function.
- Estimate alterations to depressional storage using cover categories.
- Consider eliminating the variable V_{LITTER}, and using V_{TBA} in its place.
- Consider using V_{TBA} of trees greater than some threshold size that represents canopy individuals (e.g., >15 cm dbh) as a variable in the Provide Habitat for Fish and Wildlife FCI.
- If the first recommendation is adopted, consider eliminating the use of V_{STRATA}, V_{SNAG}, V_{LOG}, and V_{OHOR} in the Provide Habitat for Fish and Wildlife FCI equation.
- Consider using more objective methods to measure V_{TCOMP}, V_{COMP}, and V_{TBA}.

- Reduce the relative weights of or eliminate the variables V_{LITTER}, V_{SNAG}, V_{LOG}, and V_{WD} (which tend to vary widely in space and/or time), thereby reducing their relative effect on the models that incorporate them.

More precise methods for measuring some of these variables (e.g., V_{TCOMP}) and the elimination of others were recommended in FPCs #11, 13, and 15. Also, a few additional variables were suggested that would increase robustness of the FCI models and understanding by end-users (see FPC #10).

Accuracy reflects how closely the model's output matches what it is purported to measure. These models do not appear to reflect true functional capacity, a fact that should be clearly articulated in the documentation along with providing reasons why the models are not meant to be predictive (see FPC#5 for additional information).

Sensitivity measures the degree to which a change in inputs (subindices) or assessment measures affect a change in output (FCI). For example, the FCI for the Detain Floodwater function changes as one of the input variables (e.g., V_{SSD}) changes from zero to 1.0. In functions that have many variables, one variable has little influence on the FCI score, so although it would not tend to be very sensitive, it could dilute the effect of more explanatory variables by reducing their sensitivity depending on how they are weighted. This problem could be particularly problematic in complex functions with many variables (e.g., the Provide Habitat for Fish and Wildlife function with 10 variables).

Although many of the input variables likely co-vary, a sensitivity analysis would determine how any given variable affects the FCI score and whether the variable is weighted correctly. Based on the current documentation, the user has no idea how sensitive the various variables are and therefore cannot assess the reliability of the models. A sensitivity analysis should be conducted, if it has not been already, and the results provided in an appendix (see FPC #6 for additional information).

Uncertainty in a model partly reflects the uncertainty of its inputs. If the level of uncertainty is known for a variable, then its effect on an FCI can be quantified. Uncertainty could arise from degree of precision in measuring the variable or degree to which the variation in a variable is related to a change in condition (how predictive it is). In either case, the user should know that a certain FCI can only be interpreted to within $\pm$ 10%, for example, due to uncertainty in its inputs. An estimate of uncertainty for each variable and model should be provided. Information regarding the uncertainty associated with model inputs is critical for understanding the accuracy of model outputs and how much of a change in the FCIs is meaningful.

3.4.4 Review of Model Assumptions

The review of assumptions is complicated by the scale of the Regional Guidebook – it is a package of models with five components, and each with its own set of assumptions:

- Wetland classification
- Assessment models
- Assessment variables/Subindices

- Subindex graphs
- Reference data.

1. Wetland Classification.

Wetland classification by hydrogeomorphic criteria is the underpinning of the hydrogeomorphic (HGM) approach to wetland assessment, in that wetlands in similar landscape position with similar sources and fates of water are similar to one another from a functional perspective (Brinson, 1993). Although variation is likely continuous, the assumption that the landscape can be divided into wetland types based on hydrogeomorphic similarities is reasonable and has been accepted by the scientific community. Further, the assumption that classification by hydrogeomorphic similarities can reduce the amount of variation that has to be accounted for in assessment models has been generally accepted by the scientific community as well.

The principal factors for predicting wetland composition and function would normally be independent variables such as flooding and fertility. The HGM approach assumes that many of these are incorporated into the model without direct measurement by using the habitat classification (Smith et al., 1995). This assumption is generally justified, since each habitat type in the HGM Guidebook has its own characteristic flood regime and water chemistry.

The wetland classification scheme provided in this guidebook reasonably represents the variation that is required, and the illustrations of wetland subclasses are helpful and clearly describe this region of Arkansas. However, for the Unconnected Alluvial Depression subclass, the classification is inconsistent with the stated definition (page 9) that reference standard wetlands represent "the least altered wetland sites in the least altered landscapes." The inconsistency is due to the fact that some unconnected alluvial depressions are really disconnected (altered) Floodplain Depressions (page 52). To be consistent with the definition of reference standard wetlands, the former floodplain depressions that were now reclassified as unconnected alluvial depressions should be treated as hydrologically altered (disconnected) floodplain depressions because they were artificially disconnected from the overbank flooding that once controlled them. Making an exception to the definition of reference standard for former floodplain depressions is likely to lead to unanticipated repercussions, discussed in detail in FPC #8, Appendix B.

2. Assessment Models

Normally the assumptions of a model are tested by exploring its sensitivity to changes in input, and by applying it to a number of situations and looking for instances of failure (i.e., where the model predicts an outcome that is known to be wrong). The model reviewers noted that the FCI equations do not appear to have been tested or validated in such a way. The guidebook assumes there is a good relationship between FCIs predicted from wetland condition data and actual wetland functions. This assumption was not tested by analyzing the relationship between actual measurements of wetland functions and FCIs (see FPC #5 for more information).

Six assessment models (FCI models) are the foundation of the document. Although the model equations seem complex, in most cases the equations use arithmetic or geometric means of

assessment sub-indices to obtain FCI scores. In general, the rationale for each equation is clearly stated, but the rationale for the specific mathematical form chosen for the functions is not. The assumptions applied for the development of mathematical relationships between model variables needs to be provided.

3. Assessment Variables/Subindices

There are 21 variables used as input data for the FCI models. The key assumption is that these measurements adequately capture the condition of a site and that such measurements of condition are appropriate for being transformed into measures of function. The model reviewers agreed that the measurements in the guidebook are typical of those used in wetland ecology but had suggestions for better measurement of several variables that might better capture the condition of the site in relation to function (e.g., FPC's #11 and #12).

Two of the most important variables, V_{FREQ} and V_{DUR}, stood out because of the overwhelming importance of flooding in determining wetland structure and function. The guidebook assumes that these two key ecological drivers can be assessed indirectly from conditions in reference wetlands rather than by using actual measurements of flood regimes. It is also assumed that the complexity of flood regimes can be captured on a scale of zero to one. This assumption may limit the predictive capacity of the model for projects where natural flood regimes are being restored because, as previously mentioned in 3.4.2, reference conditions represent conditions for wetlands that have been altered by flood risk management projects, and restoration may not be assessed as an improvement.

4. Subindex Graphs and 5. Reference Data

The HGM Guidebook provides a large number of subindex graphs that describe the relationships between the measured field variables (horizontal axis) and the variable subindices. There are a large number of these relationships and they differ among wetland types. The HGM Guidebook did not document the reference site conditions nor explain how raw field data were used to calibrate the derived subindices (FPC #2). The model reviewers had to assume that the field data were appropriately collected, the analyses were appropriately made, and therefore that the subindex curves are valid.

One important assumption in the HGM Guidebook is that current forest composition reflects present and ongoing flood regimes. Dams and levees have already heavily modified flow patterns of the Mississippi River and its major tributaries, in particular, and the world's wetlands in general (Dynesius and Nilsson, 1994; Middleton, 2002). Ecosystems, particularly those with long-lived organisms such as trees, may be derived from past events such as extreme historic floods or fires (Botkin, 1990; Brown and Kennett, 1999). The HGM Guidebook assumes that the water level regime of the mid-20th century is the baseline condition, and that any deviations away from this will reduce function. Projects that attempt to restore, at least partially, the original water level fluctuations to pre-levee construction conditions, which might eventually increase certain functions like "Provide Habitat for Fish and Wildlife," would automatically be assumed negative when the HGM is applied. This could also lead to underestimation of the

current negative effects of levees and dams overall, and the potential functional benefits from removing dams and levees.

3.4.5 Review Ability to Evaluate Risk and Uncertainty

Risk and uncertainty cannot be directly evaluated by the models in their current form. The purpose of the model is to provide one index of the condition and function of wetlands. There are no confidence intervals on the resulting values (e.g., FPC #6). Small differences in indices between projects may not be biologically meaningful, but may yield large differences when multiplied by large acreages. Therefore, there is a risk that two projects might appear to have different impacts on function, when in fact the differences are not statistically significant.

In principle, if the FCI values are calculated for a before-and-after condition, it should allow assessment of the risk of negative consequences from projects. Similarly, if the FCI values are calculated for a series of competing projects, they should also identify which has the lowest risk of damaging wetland function. Such decisions, however, are dependent on how sensitive the FCI equations are to different kinds of ecological perturbations.

To further explore the issue of risk and uncertainty, it would be necessary to document the performance of the FCI output under different kinds of perturbations or with different sets of field data. For example, a plot of FCI scores against proportion of watershed that was forested or the proportion of spring flood pulse removed would allow users to judge the sensitivity of the indices to potential perturbations.

From one perspective, the calculation of an index between zero and one gives the impression of being cardinal numbers (quantity). However, the model's coarse nature suggests that a small number of ordinal labels should be used, such as low, medium, or high functional capacity (i.e., condition). Having the model output a number from 0 to 1 gives a false impression of the model's resolution. Although the FCI equations give the appearance of producing quantitative estimates of functional capacity, they may only being giving information that is qualitative.

One way the HGM approach does incorporate risk is the use of red flags, as described on page 108. This is a procedure for identifying potential impacts that might not be detected by the FCIs. In some cases FCI values may not be appropriate since, as the report notes, "… if a proposed project has the potential to adversely affect threatened or endangered species, an assessment may be unnecessary since the project may be denied or modified based on the impacts to the protected species alone."

3.4.6 Review Ability to Calculate Benefits for Total Project Life

Functional assessments were designed to be conducted on a wide variety of "projects" to determine pre- and post-construction condition or changes in functional capacity through time in restoration projects. A project life could be short, as when a wetland is converted to a use that has no wetland functions (wetland to a highway), or long, as when changes in functional capacity are to be determined over a 75-year life of a mitigation bank. In the first example, pre-project FCIs are compared with post-project FCIs (either actually measured or predicted prior to construction), and loss of wetland functions (determined as FCIs) could be assumed to last forever. In the second example (a restoration scenario), FCIs are measured at periodic intervals

over time or predicted using the projected recovery trajectories provided in Figure 32 of the HGM Guidebook (page 133), providing the user with a measure of change (presumably an increase) in FCIs over time.

Theoretically, an HGM functional assessment approach should be able to evaluate or predict both losses of functional capacity (project-induced degradation) and increases in functional capacity (following restoration). The protocol therefore measures current condition, a change in condition, or a predicted change in condition. However, the utility of this assessment depends on its ability to provide repeatable results for subindex scores and the ability of the models to accurately approximate condition relative to the identified functions. If project benefits are defined as the change in the functional capacity of a wetland over time due to a project, then the approach has the ability to provide output that can be used to calculate benefits for total project life.

However, the accuracy of calculated benefits depends on the precision of the methods used to measure variables, the accuracy of models used to calculate FCI, the sensitivity of variables and models as an integrated whole, and the level of uncertainly is related to precision and accuracy. Given the concern that the HGM Guidebook lacks this information for present conditions, estimates of project lifetime benefits are even more problematic. Suggestions for improving the utility of the models and usefulness of results to end users include discussing that the FCIs are measures of wetland condition rather than function (FPC #1); improving how several subindex variables, including those for flood duration and flood frequency, are used or measured for the models (FPCs # 3, 10, 11, 12, 13); improving how field measurements are performed (FPC #15); validating FCIs against actual wetland function for relevant subclasses (FPC #5); not including wetlands that have been anthropogenically cut off in the calculations for the Unconnected Alluvial Depression FCI; and including former wetlands in the reference data set for model calibrations (FPC #9). These issues and recommendations are discussed in more detail in the FPCs in Appendix B.

3.4.7 Review of Model Calculations/Formulas

Field measurements or remote data are converted to subindices in order to normalize extremely different types of data and make them comparable. The derived subindices are then used in the function models (FCI equations) provided for each wetland subclass. All conversions from variable to subindex to FCIs could be done by hand, with a calculator, or with a spreadsheet program. Unfortunately, the spreadsheets and data sheets may confuse the end user because they are unnecessarily complex and filled with internal errors. The current mixed paper-spreadsheet procedure has a number of shortcomings, including:

- Inconsistencies in variable names, field names, units of measure, and spreadsheet layouts
- Inconsistencies between paper forms and spreadsheets
- Limitations in model and user documentation in the spreadsheets
- Unnecessarily complex linkages between spreadsheets, and more spreadsheets than necessary
- The inclusion of hand calculations
- Incorrect references to data forms

- Missing formulas
- Duplicate output cells
- Parameters used inside formulas
- Unexplained conversions from metric to English units
- Unnecessarily complex IF statements
- Lack of data validation and error controls (see FPC #7 and Appendix C).

Another problem related to transparency of the model calculations and formulas is the lack of sufficient explanations concerning why variables were weighted as they were in the functional capacity models and why the particular mathematical forms of the models were chosen (averaging, multiplication, square roots). Explanations were provided concerning why identified variables were mathematically grouped in the models. However, the model reviewers thought it would be useful to provide the end user with an explanation for how the mathematical relationships were defined, as this is directly related to the sensitivity and level of uncertainty associated with the model outputs.

3.5 System Quality

3.5.1 Review of Supporting Software

The procedure that is currently used to transform field data into outputs (FCIs and Functional Capacity Units [FCUs]) is largely based on paper forms with limited spreadsheet support. No reason is given in the report for this approach, or why a more integrated spreadsheet approach has not been developed. The current system may be adequate, but it is far from ideal. As noted in 3.4.7, the current mixed paper-spreadsheet procedure has a number of shortcomings. For instance instead of using Excel to conduct some of the calculations, the user is expected to do them by hand then enter them into the spreadsheet. Complex, error-prone procedures, such as this one, could lead to erroneous outputs and thereby decrease confidence in planning decisions made based on the outputs. In addition, it requires far more time than is needed and allows no facility for sensitivity analysis of the results. The model reviewers recommend that an integrated spreadsheet template be developed for this application (see FPC#7 and Appendix C for more information).

3.5.2 Review of Programming Accuracy

During the review of the three spreadsheets provided, the model reviewers identified places where errors could arise due to inconsistencies in naming conventions between the forms and the spreadsheets, places where the user performs calculations or transfer of numbers by hand which can be prone to errors, conversions between metric and English units, etc. However, the more significant problem with the approach taken is not the accuracy of the programming, but rather that most of the procedure is not programmed at all. As noted in 3.5.1, the model reviewers suggest that this process be automated to increase accuracy. See Appendix C for more details on specific problems with the paper forms and current spreadsheets.

3.5.3 Review of Model Testing and Validation

The discussion of each FCI includes a justification of why the relevant function is appropriate to an overall assessment, but does not include evidence that the FCIs accurately measure the *actual* function in the field. The user of the HGM Guidebook may assume that the FCI measures of function have been validated in the field and thus can be taken as accurate estimates of actual function. However, there was no evidence in the HGM Guidebook that the procedure for transforming field data into tables of FCIs and FCUs was either verified or validated (see FPC#5). Verification of the logic of the procedure would require providing a test dataset that produced correct outputs. Validation would require showing that the outputs of the model correspond to actual values in the field with sufficient accuracy.

3.6 Usability

3.6.1 Review of Data Availability

Data are required for different phases of an assessment, including the pre-project assessment, field data collection from the project wetlands, and assessment of post-project conditions. The pre-project assessment and field data are well-described.

The methods for measuring the model variables and for converting field measurements or remote data to subindices using subindex graphs (Figure 21 in the HGM Guidebook) are explained in detail in the HGM Guidebook. Anyone familiar with making basic ecological field measurements should be able to conduct the field assessments with a little field training, and technical requirements are not beyond those currently possessed by field personnel conducting wetland delineations.

The HGM Guidebook provides a good description of data needed to characterize a project area on page 106. A useful addition may be to identify the data sources and perhaps URLs to their locations, although the latter could change after the HGM Guidebook has been published. A table such as the example provided below (Table 2) could be included. Data for the models are already readily available; however, providing this information would improve their availability.

Table 2. Example of Data Sources and URLs That Could Be Included in the HGM Guidebook

Data Required	Data Source	URL
Aerial Photography	ArcGIS Explorer (ESRI) Google Earth TerraServer USDA Farm Services Agency USGS National Aerial Photography Program	http://www.esri.com/software/arcgis/explorer/index.html http://earth.google.com/ http://terraserver-usa.com/ http://www.fsa.usda.gov/FSA/apfoapp?area=apfohome&subject=landing&topic=landing http://www.usgs.gov/pubprod/aerial.html
Topographic Maps	USGS	http://topomaps.usgs.gov/
Geomorphic Maps	Saucier 1994	In Appendix E the HGM Guidebook gives this URL: http://el.erdc.usace.army.mil/publications.cfm?Topic=techreport&Code=emrrp for Saucier (1994) and other data, but neither Saucier nor the other data were there. The URL needs revision.
Soil Survey	Natural Resources Conservation Service	http://soils.usda.gov/survey/
National Wetlands Inventory	U. S. Fish and Wildlife Service	http://www.fws.gov/wetlands/

3.6.2 Review of Results

The result of applying the HGM Guidebook approach to a unit of landscape will be a matrix of FCI values between zero and one. This matrix provides one tool for describing functional capacity occurring in a landscape, watershed, or set of wetlands. It is difficult to judge the significance of any single matrix without knowledge of the typical matrices found in natural systems, as well as those found in heavily altered landscapes. It would be helpful if the guidebook included some representative matrices to illustrate typical patterns. A matrix typical of a highly industrialized or highly agricultural watershed might be contrasted with a matrix from a more natural watershed within a large protected area such as Big Woods in Arkansas.

In the same way, the sensitivity of individual elements in the matrices, the FCI values, is not shown. A site with a function of 0.45 may not be significantly different from a site with 0.52. Users of the HGM Guidebook might benefit from a better understanding of the sensitivity of FCI values, perhaps again with a series of examples from reference sites, to prevent over-interpretation or misinterpretation of results.

3.6.3 Review of Model Documentation

The quality of the model's documentation varies. Chapter 6 on the Assessment protocol and the appendices provide good, detailed explanations of how the model are to be used to produce the FCIs. However, in general, the report is written in an overly abstract style, devoid of simple examples that could make the task of the reader far easier. The model reviewers provided the following examples of ways in which the HGM Guidebook could be made more user-friendly.

1. On page 1, the HGM Guidebook states:

   > "The HGM Approach initially was designed to be used in the context of the Clean Water Act, Section 404 Regulatory Program, to analyze project alternatives, minimize impacts, assess unavoidable impacts, determine mitigation requirements, and monitor the success of compensatory mitigation. However, a variety of other potential uses have been identified, including the determination of minimal effects under the Food Security Act, design of wetland restoration projects, and management of wetlands."

   This provides information on how the HGM approach could be used. However, no references were provided to specific examples of how HGM has been used. Given that HGM has been in use for over a decade, it is expected that there are examples that could be provided in an appendix to describe how the HGM method and its FCIs were used to assess project alternatives, minimize impacts, determine mitigation requirements, and monitor success of mitigation (see FPCs #14 for more information).

2. The HGM Guidebook does not provide documentation on the accuracy and precision of the FCI predictions. Users need to know the "least significant difference" (LSD) for each FCI for each subclass. Specification of LSD would help users interpret FCIs in the context of such applications as project alternatives and impact minimization.

3. The model lacks clear documentation on the computational form of the FCI equations and why some variables were combined with equal weighting.

4. There is no section summarizing and discussing the model's assumptions and limitations.

Technical terms are not defined in one place, such as a "Definitions Section," and are used inconsistently throughout the report. One example: metrics are called *indicators* on Data Form 2.
A table of all variables and their definitions should be included in the HGM Guidebook, similar to Table 3 below.

Additional specific comments regarding typographical errors, suggestions for clarity, and inconsistencies are provided in Appendix D.

Table 3. The 21 Predictor or Independent Variables Used in Calculating FCIs in the HGM Guidebook for the Delta Region of Arkansas*

Variable	Condition Measured	Definition of Measure
V_{AHOR}	A Horizon Organic Accumulation	Total mass of organic matter in the A horizon below O horizon
V_{COMP}	Composition of Tallest Woody Vegetation Stratum	Species composition of the tallest woody stratum (tree, shrub-sapling, or seedling) as percent concurrence
$V_{CONNECT}$	Habitat Connectivity	Proportion of the perimeter of forested wetland tract connected to suitable wildlife habitat
V_{CORE}	Core Area	Portion of a wetland tract that lies to the inside a 100-meters (m) (330-feet [ft]) perimeter buffer
V_{DUR}	Change in Growing Season Flood Duration	Maximum number of continuous days in the growing season that overbank or backwater flooding from a stream inundates the wetland assessment area (WAA)
V_{FREQ}	Change in Frequency of Flooding	The frequency (return interval in years, 1-5) with which overbank or backwater flooding from a stream inundates the WAA
V_{GVC}	Ground Vegetation Cover	Percent cover of herbaceous and woody ground vegetation (less than or equal to 1.4 m (4.5 ft) in height.
V_{LITTER}	Litter Cover	Average percent of the ground surface covered by recognizable dead plant materials (primarily decomposing leaves and twigs) excluding undecomposed woody material larger than 0.6 centimeters (cm) (0.25 inches [in.]) in diameter
V_{LOG}	Log Biomass	Log biomass per hectare
V_{OHOR}	O Horizon Organic Accumulation	Thickness of the O soil horizon (soil layer dominated by organic material that consists of partially decomposed organic matter such as leaves, needles, sticks or twigs < 0.6 cm in diameter, flowers, fruits, insect frass, dead moss, or detached lichens on or near the surface of the ground
V_{OUT}	Change in Surface Water Flow	Change in frequency at which water is discharged as surface flow from a headwater depression wetland to a downslope stream
V_{POND}	Total Ponded Area	Percent of the WAA ground surface likely to collect and hold precipitation for periods of days or weeks at a time
V_{SNAG}	Snag Density	Density of snag stems (standing dead woody stems at least 1.4 m (4.5 ft) tall with a diameter at breast height (dbh) greater than or equal to 10 cm (4 in.) per hectare
V_{SOIL}	Soil Integrity	Assume that soil integrity exists where evidence of alteration is lacking
V_{SSD}	Shrub-Sapling Density	Density of shrub-sapling (woody stems less than 10 cm (4 in.) dbh and greater than 1.4 m (4.5 ft) in height) stems per hectare
V_{STRATA}	Number of Vegetation Strata	Canopy, subcanopy, understory, ground (0-4)
V_{TBA}	Tree Basal Area	Basal area of living woody stems greater than or equal to 10 cm (4 in.) dbh
V_{TCOMP}	Tree Composition	Percent concurrence of the dominant tree species in the assessment area with the species composition of reference wetlands in various conditions; calculated if the total canopy cover of trees (living woody stems ≥ 10 cm or 4 in. at breast height) within the plot is 20 percent or more
V_{TDEN}	Tree Density	Number of trees (living woody stems greater than or equal to 10 cm or 4 in.dbh) per hectare
V_{TRACT}	Wetland Tract	Area of contiguous forested wetland that includes the WAA
V_{WD}	Woody Debris Biomass	Volume of woody debris per hectare

* Not all of the listed variables are applicable to all wetland subclasses or functions.

3.7 Model Assessment Summary

A review of the technical quality, system quality, and usability of the Delta Region of Arkansas HGM models determined that the models and approaches are generally appropriate for the intended purpose of evaluating coarse level impacts for planning projects. Some improvements, however, are needed, particularly corrections to the model spreadsheets and augmented documentation to guide the user in model development and application. In addressing and answering charge questions designed to focus the review of the HGM Guidebook based on the model assessment criteria in the USACE *Protocols for Certification of Planning Models*, (USACE, 2007) the following underlying issues were identified:

1. Documentation on the HGM Guidebook model's intended use, scientific basis, approach, limitations and assumptions, reliability, and outputs is limited (FPCs #4-6, 10-13, 16 - 21)
2. The FCI models described in the HGM Guidebook are measuring ecological condition or functional capacity, not function (FPC #1). The relationship between function and FCI models may be a reasonable assumption, but it has yet to be validated independently.
3. Without the raw data, or raw data summary, and information on the process used to calibrate the derived subindices and projected recovery trajectories, the validity of the subindex graphs, which are the basis for the entire HGM Guidebook approach, is not supported (FPC #2).
4. Flood frequency and flood duration subindices within the models do not account for extreme events (FPC #3), and the use of 20th century data (before large-scale levee construction) as the reference conditions could result in the appearance of negative impacts if the area is restored to conditions occurring prior to those of the mid-20th century (FPC #10).
5. The current mixed version of paper forms and spreadsheets to perform the subindex and model calculations is cumbersome to use and prone to errors and could be made more user friendly by redesigning it as an integrated spreadsheet-based system that takes field data as inputs and produces the FCI and FCU outputs (FPC #7).
6. The HGM Guidebook should include references to easily obtainable case studies that apply this method (FPC #14).
7. Some of the field measurement approaches should be improved or explained in more detail to ensure that subjectivity invoked by each user does not affect precision (repeatability of measurements) (FPC#15).
8. The Unconnected Alluvial Depression subclass should not include wetlands that have been cut off from the channel of major river floodplains by man-made levees (FPC#8).
9. Stream channelization, channel incision, and drainage by ditches should be included as model variables in a number of FCIs for a number of subclasses (FPC#10)
10. Several FCI models are unnecessarily complex, leading to potentially less robust model results (FPC #13).
11. A table showing a function by sub-index matrix should be provided for each subclass, matching the sub-indices with the functions in which they occur (FPC#21).

These issues affect the ability of users to apply the model and the ability of users, reviewers, and readers to fully understand the scientific basis and logic of the model; how model outputs are linked to on-the-ground changes in wetland ecosystems; the ability of the model to evaluate changes in wetland ecosystems for project life; and the ability to perform uncertainty and sensitivity analysis associated with each of the models evaluated. Many of the issues identified by the model reviewers are the direct result of limited documentation to support the method and the model and can be addressed relatively easily.

4 CONCLUSIONS

Models are simple representations of complex systems and, as such, must balance complexity and reality with simplicity and usability. Overall, the model reviewers agreed that the models are suitable for limited application to meet some of their intended purposes; however, they were concerned that the models have some conceptual flaws that limit their ability to achieve all of the intended purposes. One model reviewer believes these flaws are serioU.S. The HGM models have an unknown ability to assess wetland functions and are more appropriate for limited assessment of wetland condition. Although the HGM models have deficiencies, they are not insurmountable and can be resolved.

There were some issues identified with the models' documentation, application, and variables, and some potentially serious errors were noted in the spreadsheet calculations and formulas. The model reviewers provided the following recommendations for improving the models based on the most significant concerns they identified during their review.

1. Describe the relationships between wetland condition and function from the point of scientific validity and program requirements under the Clean Water Act.
2. Provide a description of the process for selecting and measuring data from reference wetlands in an appendix. Also, show reference data points on the graphs of FCI curves relating independent variables to the dependent subindex, and explain how recovery trajectory curves were developed.
3. Provide a better method for capturing frequency and duration of flooding as controlling factors, or provide a clear statement explaining why these indicators could not be reasonably measured.
4. Include an explanation for each of the FCI functions that describes why the specific mathematical form was chosen.
5. Provide information on the relationship between actual measurements of wetland functions and FCI curves.
6. Provide additional information on 1) the sensitivity of the FCIs to their inputs and on the least significant differences for policy analysis, 2) empirical validation of the FCIs against field data, and 3) precision, accuracy, and uncertainty for the FCI calculations.
7. Redesign the forms and spreadsheets as an integrated system to prevent errors.
8. Provide better justification in the guidebook for classifying anthropogenically disconnected floodplain depressions (depressions behind mainstem levees), as

unconnected alluvial depressions rather than treating them as altered floodplain depressions.

9. Include non-wetland sites that were former wetlands as part of the reference data set in order to represent the most altered end of the gradient and provide a basis for identifying potential restoration sites.
10. Consider using indicators of channelization and flooding duration in the FCIs.
11. Consider changing how V_{POND}, V_{LITTER} V_{SSD}, V_{GVC}, V_{OUT}, and V_{TBA} are measured and used in the FCIs.
12. Provide additional documentation to: (1) provide links or citations for easily obtainable case studies that apply this method, (2) provide a series of tables, sorted by wetland subclass, showing variable-by-function matrices, and (3) explain that the models have not been designed to address climate change.
13. Improve field measurements to remove subjectivity and to improve precision.
14. Summarize the assumptions implicit in the HGM approach and FCI models.
15. Ensure consistency in terminology and names of variables throughout the HGM Guidebook.

This list of actions summarizes the recommendations for resolution in the FPCs; more detailed recommendations are provided in the FPCs in Appendix B. Failure to address the issues identified may lead to incorrect interpretation or use of the HGM models and outputs.

The reviewers strongly suggest incorporating the recommended resolutions into the FCI models and modifying the documentation before allowing widespread use of the models for planning purposes. Making the recommended revisions will result in better precision of model inputs, accuracy of model outputs, comprehension of the scientific basis and logic behind the models, and understanding of the models results, as well as promote model transparency and allow uncertainty and sensitivity analysis to be performed. The model will also be better able to achieve its intended purpose.

During a teleconference on April 5, 2010 to discuss the review findings with USACE, the model reviewers were asked whether the guidebook was usable prior to making the suggested revisions (as described above). The model reviewers' response was that there could be continued conditional use. The guidebook has been in use for approximately five years and could potentially be used with the same level of accuracy under the condition that existing users will be the ones who continue to use the method. Upon further consideration of this question, the model reviewers agreed that, at the very least, the errors noted in the spreadsheets and the potential for errors in transferring data among field sheets and spreadsheets must be corrected to improve the ability of the models to yield accurate results. Failure to correct the errors and data transfer issues may lead to unreliable model outputs (see FPC #7 and Appendix C). Once these issues are addressed, the models could continue to be used prior to addressing all other comments under the following conditions:

1) The same team of experts who developed the regional HGM guidebook will perform the assessments for all wetland sites to ensure the models are used as intended and that there

is consistency in the results. Otherwise, scores among sites are not likely to be comparable (see FPC #15).

2) All other comments will be addressed as soon as possible to certify the regional HGM guidebook for widespread application by users external to the development team. The reviewers understand the immediate need to use the guidebook; however, the guidebook should not continue to be used beyond the immediate needs without the technical issues identified being addressed.
3) Users understand that the regional HGM guidebook's process for assessing wetland functions did not include any actual measurement of wetland functions and is based on measurements of wetland characteristics hypothesized to be indicators of wetland functions. The relationships between these indicators and wetland functions have yet to be independently tested and verified with field data. Therefore, the ability of the guidebook to assess wetland functions will remain unknown until appropriate testing and validation are carried out.

Although the panel concurs that the guidebook is usable once the spreadsheet errors and data transfer issues are corrected, there are still risks associated with its continued use. Those risks include (1) potential for inaccurate measurement of changes in wetland function among project alternatives, (2) potential misapplication of the HGM approach from reclassifying floodplain wetlands to non-floodplain types following an alteration by levee construction (and thus overlooking loss of functions related to the loss of overbank flooding), and (3) the possible selection of an incorrect alternative for minimizing wetland impacts. The question on usability of the guidebook asked by USACE was primarily in reference to the St. John's/New Madrid project. Although addressing the issues identified by this independent external peer review (IEPR) would improve the usability and accuracy of the models for application to projects in the region, the question of application of the guidebook for the St. John's/New Madrid project was not specifically addressed because it was out of the scope for this review and the model reviewers were not provided with review materials specific to the selection of alternatives for the St. John/New Madrid project.

5 REFERENCES

Botkin, D. B. 1990. *Discordant Harmonies. A New Ecology for the Twenty-first Century*. New York, NY: Oxford University Press.

Brinson, M. M. 1993. A Hydrogeomorphic Classification for Wetlands. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS, USA. Technical Report WRP-DE-4, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Brinson, M. M., K. H. Miller, R. Rheinhardt, R. Christian, G. Meyer, J. O'Neal. 2006. Developing reference data to identify and calibrate indicators of riparian ecosystem condition in rural coastal plain landscapes in North Carolina. Report to the Ecosystem Enhancement Program, North Carolina Department of Environment and Natural Resources. Raleigh, NC, USA. *http://www.nceep.net/pages/resources.htm*

Brown, P. and J.P. Kennett 1999. Marine evidence for episodic Holocene megafloods in North America and northern Gulf of Mexico. Paleoceanography 14: 498-510.

Cole, C. A. 2006. HGM and wetland functional assessment: Six degrees of separation from the data? *Ecological Indicators* 6:485-493.

Dynesius, M. and C. Nilsson. 1994. Fragmentation and flow regulation of river systems in the northern third of the world. *Science*, **266**, 753–62.

Fennessy, M. A. Siobhan, D. Jacobs, and M. E. Kentula. 2007. An evaluation of rapid methods for assessing the ecological condition of wetlands. *Wetlands* 27(3):543-560.

Hill, A., V. Jason, S. Neary, and L. K. Morgan. 2006. Hydrologic modeling as a development tool for HGM functional assessment models. *Wetlands* 26(1):161-180.

Hoeltje, S.M. and C. A. Cole. 2009. Comparison of Function of Created Wetlands of Two Age Classes in Central Pennsylvania. *Environmental Management* 43:597-608.

Middleton, B.A. (ed.) 2002. *Flood Pulsing in Wetlands: Restoring the Natural Hydrological Balance*. New York, NY: John Wiley.

Smith, R. D., A. A. Ammann, C. Bartoldus, and M. M. Brinson. 1995. An approach for assessing wetland functions using hydrogeomorphic classification, reference wetlands, and functional indices. Technical Report WRPDE-9. Vicksburg, MS: US Army Engineer Waterways Experiment Station.

Smith, R. D. and J. S. Wakeley. 2001. Hydrogeomorphic approach to assessing wetland functions: Guidelines for developing regional guidebooks. Chapter 4 Developing assessment models. Report ERDC/EL TR-01-30, U.S. Army Corps of Engineers.

Starfield, A. M. and A.L. Bleloch. 1991. *Building Models for Conservation and Wildlife Management*. 2nd edn. Edina, MN: Burgers International Group.

Stein, E. D., M. M. Brinson, M. C. Rains, W. Kleindl, F. R. Hauer. 2009. Wetland assessment alphabet soup: How to choose (or not choose) the right assessment method. *Wetland Science and Practice* 26(4): 20-24.

USACE. 2007. Protocols for Certification of Planning Models Under the Planning Models Improvement Program (PMIP). July 2007.

USACE. 2005. Planning Models Improvement Program (PMIP): Model Certification. Engineering Circular No. 1105-2-407, May 2005.

Appendix A

Biographic Information for Model Review Panel Experts

This page intentionally left blank

Richard Rheinhardt (Civil Works Planner/HGM Specialist). Dr. Rheinhardt earned his Ph.D. in marine science and biological oceanography from the College of William and Mary's Virginia Institute of Marine Science in 1991. As a Marine Scientist with the Virginia Institute if Marine Science (VIMS), he conducted research on the impacts of nutrient enrichment in tidal salt and freshwater marshes. He is currently an independent consultant and a research associate professor in the biology department at East Carolina University. Dr. Rheinhardt is a member of the original team that developed the HGM approach to wetland assessment. He co-authored the first National HGM Guidebook (for riverine wetlands) and was a primary author of a Regional HGM Guidebook for assessing wet pine flats on mineral soils. He has conducted training for and provided technical advice on reference-based wetland assessment approaches, including HGM, to federal, state, and private sector resource managers throughout the United States. He is currently a member of a team developing a Regional HGM Guidebook for riverine wetlands for the Gulf and Atlantic coastal plans, which involves collecting reference field data for the Virginia, North Carolina, Alabama, and Mississippi portion of the reference domain. He has extensive experience developing assessment procedures for assessing and monitoring stream and riparian restoration projects for the North Carolina Ecosystem Enhancement Program. Dr. Rheinhardt's compensatory mitigation expertise includes research evaluating the effectiveness of existing North Carolina Department of Transportation (NCDOT) wetland mitigation sites. Also for the NCDOT, he designed methods and conducted an HGM wetland assessment for the mitigation of a fen wetland in the Piedmont of North Carolina. Dr. Rheinhardt has researched the role of reference wetlands in functional assessment, mitigation, and restoration. While a senior biologist with USFWS, he contributed to and reviewed numerous environmental impact statements.

Dr. Rheinhardt has a also conducted numerous published studies on the relationships between plant composition and environmental factors (including hydrologic factors) in a wide variety of ecosystems, including subalpine forests, tidal freshwater swamps, bottomland hardwood forests, headwater riparian forests, forested fens, vernal pools, and interdunal swale wetlands.

Paul Keddy (Wetland Ecologist). Dr. Keddy holds a Ph.D in plant ecology and, in addition to acting as an independent consultant, is currently a professor at Southeastern Louisiana University. He has 35 years of experience working with freshwater and coastal wetland ecosystems, particularly in Louisiana, the Great Lakes, and central and eastern North America. His research focuses on biotic (plant and animal) and abiotic (hydrology, nutrients, salinity, sedimentation, disturbance) factors controlling the composition, productivity, distribution, and extent of wetland plant communities and on predicting the effects and assessing the results of environmental manipulation in the context of wetland restoration and ecological benefit. Dr. Keddy worked for eight years on restoration of the Lake Pontchartrain estuary (the second largest estuarine system in the U.S.) to maximize ecological benefits. He was the co-author of the *Comprehensive Habitat Management Plan (CHMP) for the Lake Pontchartrain Basin*, which included a comprehensive analysis of the historic form and function of diverse bottomland habitats of both the Mississippi River and the Pearl River valleys. Development of the CHMP involved evaluating the relative ecological benefits of different coastal wetland and estuarine management strategies as well as the establishment of quantitative restoration targets for these ecosystems. Dr. Keddy has evaluated the ecological benefits of different Mississippi River management scenarios on a variety of habitats, including swamp, fresh marsh, intermediate

marsh, brackish marsh, saline wetlands, open water, and uplands. As the principal author of a comprehensive review, The Wetlands of Lakes Pontchartrain and Maurepas: Past, Present and Future, Dr. Keddy prepared a synthesis of plant communities and their ecological drivers for bottomland wetlands found in the Pontchartrain-Maurepas region at the southeastern end of the Mississippi River alluvial plain. This scientific paper included an environmental history of the wetlands and a review of existing vegetation patterns and their causes as a basis for identifying restoration targets and priorities for wetland conservation. Additionally, Dr. Keddy's research has focused on vegetation classification and quantification of the relative importance of biotic and abiotic controls on plant species assemblages in bottomland wetlands in Louisiana analogous to the shrub- and tree-dominated marshes and wet savannas of the Delta Region of Arkansas. Dr. Keddy served on the Coastal Restoration and Enhancement Through Science and Technology (CREST) Technical Advisory Committee until 2007, designing terms of reference and evaluating restoration project proposals with emphasis on maximizing cost effectiveness in terms of ecological benefit. He served on the review panel of the Everglades Restoration Acceleration Project and acted as an expert witness at a Special Master Hearing on Everglades water quality. Dr. Keddy recently completed a review book chapter on the measurement of ecological services and benefits from wetlands and he is familiar with the latest conceptual and technical advances in measuring benefits. Dr. Keddy has authored five books including *Wetland Ecology: Principles and Conservation*, the second edition of which is in currently in press.

James Shepard (Forester). Dr. Shepard earned his Ph.D. in forest soils from Mississippi State University in 1985 and has 34 years of experience in forestry. He is currently a professor of forestry at Mississippi State University in addition to being the Associate Director of the Forest and Wildlife Research Center and the Mississippi Water Resources Research Institute. Dr. Shepard is the former Forest Wetlands Program Manager for the National Council for Air and Stream Improvement (NCASI), a non-profit organization that conducts environmental research for its large forest products company members. NCASI invests in university studies investigating the compatibility of timber management operations and wetland functions, especially examining indicators such as timber harvesting, effects on hydrology, water quality, soil organic matter, nutrients, chemical and physical properties, wildlife habitat, and wildlife populations. Most of these studies were conducted in bottomland hardwood wetland forests adjacent to rivers and streams. Dr. Shepard's work with NCASI involved reviewing the potential for the hydrogeomorphic method (HGM) to assess wetland functions in NCASI projects and participating in an HGM training course. His experience with evaluating ecosystem restoration output includes the Sharkey Restoration Project, a large-scale, long-term reforestation study in a Sharkey County, Mississippi bottomland hardwood forest area. For the Sharkey Restoration Project, Dr. Shepard and other investigators have spent almost 15 years evaluating a variety of parameters related to reforestation such as survival and growth of planted trees, colonization of the site by other plant species, soil organic matter and soil carbon, and small mammal and bird populations. He has received numerous forestry-related grants, including for *Forest restoration in the Lower Mississippi Alluvial Valley: Science at the crossroads of economics and ecology* from the USDA Forest Service (2007-2008) and *Implementation of new technologies for hardwood reforestation demonstration project* from the USDA Farm Service Agency (2008-2009). His experience with large civil works projects includes providing wetland-related technical support for a public road project and supporting landowners, foresters, loggers, and mills to better utilize wood damaged in large-scale wind events in the eastern United States.

Stephen Powell (Programmer/Spreadsheet Auditor). Dr. Powell holds a Ph.D. in engineering-economic systems and is currently a professor of business administration at Dartmouth College's Tuck School of Business. His research interests include modeling production lines and service sector business processes, as well as how novices formulate models and use models in decision making. Additionally, Dr. Powell was the co-director of the Tuck Spreadsheet Engineering Research Project (SERP) which sought to improve the design and use of spreadsheets by individuals and organizations. SERP's research focused on identifying best practices in spreadsheet development (design, testing, documenting); procedures for implementing, modifying, sharing, and archiving spreadsheets; and organizational policies relating to standards, training and quality control. One of the first SERP tasks involved collecting numerous spreadsheet models from a variety of companies and performing audits on them to assess the quality of design, technical correctness, and suitability of use. SERP ultimately designed a training program for spreadsheet engineering. Dr. Powell has authored numerous papers and books, including the spreadsheet textbook *Management Science: The Art of Modeling with Spreadsheets* (2007; J. Wiley & Sons) and *Modeling for Insight: A Master Class* (2009; J. Wiley & Sons), an advanced spreadsheet modeling book. With his co-investigators from SERP, he also developed an auditing protocol for spreadsheets, which was published in *Information and Management* in 2008 and co-authored two papers on errors in operational spreadsheets. He is also the associate editor for the *International Journal of Simulation and Process Modeling* and offers spreadsheet consulting services for spreadsheet design, debugging, optimization, and sensitivity analysis.

This page intentionally left blank

APPENDIX B

Final Panel Comments

This page intentionally left blank

Final Panel Comments

The following forms include the Final Panel Comments from the review of the HGM Guidebook. These comments reflect the key issues identified during the assessment according to the model certification criteria described in the USACE *Protocols for the Certification of Planning Models*. Each form contains a concise statement of the issue (the comment), the basis of the comment, the significance of the comment, and recommendations for resolution. Significance levels are defined as follows:

> **High:** Describes a fundamental problem with the model(s) that could affect the models' ability to serve their intended purpose
>
> **Medium:** Affects the completeness or understanding of the model(s), model usability, or the level of performance of the model(s)
>
> **Low:** Affects the technical quality of the model documentation but will not affect the performance of the model(s).

Final Panel Comments are arranged from High to Low significance, but in no other particular order. The Final Panel Comments are:

1. It appears that the models in the Hydrogeomorphic (HGM) Guidebook assess ecological condition rather than wetland functions. .
2. The Hydrogeomorphic (HGM) Guidebook did not explain how raw field data were used to calibrate the derived subindices, why subindex graphs were straight lines, and why the minimum subindex score for some altered conditions equaled zero while others were greater than zero.
3. The treatment of flood frequency and flood duration within the models implies greater ecological measurement of flood frequency and duration than is actually occurring.
4. The justification for the mathematical form of the six Functional Capacity Indices (FCIs) should be expanded.
5. The Functional Capacity Indices (FCIs) have not been validated against independent empirical estimates of the actual function in the relevant terrains.
6. The Hydrogeomorphic (HGM) Guidebook needs to explain more fully the overall reliability of the outputs of the model.
7. The procedures used to transform raw field data into tables of Functional Capacity Indices (FCIs) and Functional Capacity Units (FCUs) are overly complex and prone to errors.
8. The Unconnected Alluvial Depression subclass should not include wetlands that have been cut off from the channel of major river floodplains by man-made levees.
9. The Functional Capacity Index (FCI) for Detain Floodwater could be improved by use of channelization and flooding duration indicators and by careful consideration of the calibration of V_{FREQ}.
10. The Functional Capacity Index (FCI) for Detains Precipitation could be improved by changing how V_{POND} and V_{LITTER} are measured.

11. The Functional Capacity Indices (FCIs) for Cycles Nutrients and Export Organic Carbon could be improved by changing the use or measurement of V_{SSD}, V_{GVC}, V_{OUT}, and V_{TBA} in the FCI calculation.
12. The Functional Capacity Index (FCI) for Provide Habitat for Fish and Wildlife could be made more robust by using fewer subindices in its calculation.
13. The Hydrogeomorphic (HGM) Guidebook should include references to easily-obtainable case studies that apply this method.
14. Some field measurement approaches should be improved to improve the precision (repeatability of measurements) of variables in the models.
15. At the beginning of the document, a clear statement needs to be provided about how the guidebook is intended to support decisions made by regulators and managers and how the guidebook supports that purpose.
16. The Hydrogeomorphic (HGM) Guidebook should explain why some functions commonly included in HGM assessments were not chosen for this HGM assessment method.
17. The Hydrogeomorphic (HGM) Guidebook should summarize the assumptions implicit in its approach, including those pertaining to the Functional Capacity Index (FCI) models.
18. The descriptions of some model variables needs to be more clear, consistent, and complete.
19. The model, as designed, does not address global climate change issues as required by EC 1165-2-211 Water Resource Policies and Authorities Incorporating Sea-Level Change Considerations in Civil Works Programs (01 July 2009).
20. The Hydrogeomorphic (HGM) Guidebook should include a table for each wetland subclass that provides a matrix of subindices and the FCI models in which they occur.

Final Panel Comment 1:
It appears that the models in the Hydrogeomorphic (HGM) Guidebook assess ecological condition rather than wetland functions.
Basis for Comment:
The HGM's success in assessing wetland functions hinges on its ability to relate wetland condition to wetland function in a statistically rigorous manner. However, this information is not provided in the HGM Guidebook, and this adds to the uncertainty associated with the models' ability to assess wetland functional capacity. Many of the variables used in the HGM—organic matter, tree species composition, amount of coarse woody debris—describe condition. Most of these variables have good ecological justification as meaningful measures of site conditions. Moreover, some of the key variables that will affect function, like flood frequency and flood duration, are not incorporated in the FCI equations as actual measurements. Only changes in these variables are considered relevant to the FCI calculation (and for the latter variable this is assumed to be zero, page 119). Some model reviewers thought that this weakens the value of the FCI as a real functional index. The variables are put into equations which attempt to extract function levels relative to reference standard wetlands. This requires an added degree of complexity. From the documentation provided, there does not appear to have been any independent testing of how the model results are related to wetland functions. The model reviewers suggest, however, that it would be simpler and more realistic to acknowledge that the HGM approach provides a rapid assessment of wetland condition, but that the indicators of condition are organized in a way that provides information about functional capacity (Stein et al., 2010). The explanation/rationale for the transformation of measures of condition into measures of function is generally clear, and expert opinion is that functions will arise from conditions. However, the FCIs are actually a reflection of condition.
Significance – High:
Implying that the HGM models are measuring function, rather than condition, could lead users to incorrectly interpret projected changes that could result from project alternatives. Since changes in condition do not necessarily reflect similar changes in function, this could lead to the selection of an alternative that may result in decreased wetland function over one that may result in no change or improved wetland function.
Recommendations for Resolution:
To resolve these concerns, the Delta Region of Arkansas Regional HGM Guidebook would need to: Describe the relationships between condition and function, both from the point of view of scientific validity and program requirements under the Clean Water Act. Acknowledge early in the HGM Guidebook that the FCIs measure wetland condition, rather than function, and that a change in condition does not necessarily reflect a similar change in function.

Final Panel Comment 2:
The Hydrogeomorphic (HGM) Guidebook did not explain how raw field data were used to calibrate the derived subindices, why subindex graphs were straight lines, and why the minimum subindex score for some altered conditions equaled zero while others were greater than zero.
Basis for Comment:
Without access to raw data or raw data summaries, the model reviewers could not critique the validity of the subindex curves, (i.e., the relationship between variable metrics and subindices) and projected recovery trajectories presented in Chapter 6, or the models overall. Only by examining the subindex graphs in Chapter 5 can readers infer how metrics might have been distributed among reference sites. Values for the most-altered wetlands and the range of values for reference standard wetlands (the wetlands representing the least altered condition represented by a subindex score of 1.0) can be inferred most easily from the graphs, but inferring the variation of values between the least and most altered sites is not possible without the raw data. The reviewers had to assume that the calibrations were conducted in a statistically valid manner. The form of all the subindex graphs shows a straight-line relationship between the reference standard values and conditions less than standard, but the assumption for this relationship was not justified. Further, there was no explanation of why, in some cases, the lowest possible subindex score was defined to be zero, while in other cases the lowest score was defined to be a value greater than zero.
Significance – High:
If subindex scores are not directly related to wetland condition, the user will not be able to fully understand the meaning of the subindex values and, consequently, the meaning of the model results on which planning decisions are based.
Recommendations for Resolution:
To resolve these concerns, the Delta Region of Arkansas Regional HGM Guidebook would need to be expanded to include: 1. An appendix providing raw field data (e.g., size, location) and a description of how those data were used to calibrate the derived indices (e.g., raw data plotted on the graphs, measure of scatter, and rationale for the chosen shape). At a minimum, several examples should be included in an appendix (or in Chapter 2) explaining how the calibrations were achieved. 2. An assumption or justification for each case where the lowest score for a subindex value is not zero. 3. Supporting data for the projected recovery trajectories graphed in Chapter 6.

Final Panel Comment 3:
The treatment of flood frequency and flood duration within the models implies greater ecological measurement of flood frequency and duration than is actually occurring.
Basis for Comment:
Wetlands are produced by a set of flooding factors including (1) the number of flood events in a year, (2) the duration of each flood event, (3) the timing of each flood event and (4) the variation in these events among years. None of these is directly included in the calculation of subindices and Functional Capacity Indices (FCIs). <u>1. Input variables describing flooding are weak to non-existent</u> The HGM Guidebook uses flood frequency, transformed as the index $V_{FREQ,}$ and flood duration, transformed as V_{DUR}, to measure flooding effects. There is no real flood record data for input into the FCI. For V_{DUR}, "Estimates of growing-season flood durations are not typically readily available for any particular site, and in most cases the change in duration will be assumed to be zero unless specific information to the contrary is available from project planning or permit application documents" (page 119). <u>2. Key input variables describing flooding are changes, not current conditions</u> Neither of these is input as an actual value, but only as a potential change from existing conditions. Thus they only measure potential impacts of changes from the current situation, not an existing situation. <u>3. Flood duration is used only in a subset of situations</u> Flood duration (V_{DUR}) appears only in equations e and f : Maintain Plant Communities and Provide Wildlife Habitat, respectively, and only for a subset of habitats. Flood duration would be expected to affect many wetland functions, but it is used in only two of the six FCIs. <u>4. All change is regarded as negative.</u> The variation in water level among years is an important factor in many wetlands. Occasional flood peaks likely determine the distribution of wetlands, their species, and their functions. The model reviewers appreciate that measuring the extreme conditions that affect ecological phenomena is a difficult problem. However, the document should acknowledge that it is the pattern of extreme high and low water years that likely sets the limits of wetlands, and the use of typical frequency and duration of the longest annual flood, captures some, but not all, of the effects of flooding. Extreme events on a fifty-year cycle are important for many wetlands. It is the wettest and driest extremes which determine many of the conditions. Therefore, deviation from reference standard conditions (which should represent natural variations in extremes) should be the basis for calibrating a flooding variable.

Significance – High:
Wetlands are controlled by flooding. If measures of flooding are not incorporated, then the most important driver in the system is missing. Failure to capture the nature of changes in flooding frequency and duration may result in an inability to effectively capture changes in wetland condition, which is the focus of the approach.
Recommendations for Resolution:
To resolve these concerns, the Delta Region of Arkansas Regional Hydrogeomorphic Guidebook would need to be expanded to include: 1. A better method for capturing frequency and duration of flooding as controlling factors such as using the long term water level data available for the Mississippi River. 2. A clear statement explaining why these variables could not reasonably be measured and incorporated in the models if a better method for capturing frequency and duration of flooding is no adopted.. 3. A clear statement of the importance of infrequent flood maxima (i.e., naturally occurring extreme conditions) in determining wetland boundaries and functions. 4. A rationale for the use of V_{DUR} in only two of the six FCI equations.

Final Panel Comment 4:
The justification for the mathematical form of the six Functional Capacity Indices (FCIs) should be expanded.
Basis for Comment:
All of the FCI functions (pages 58-73) involve averages of two or more assessment variables. In these cases, a justification should be offered for the relative weights of each of the assessment variables in the function. FCI functions 1, 4, 5, and 6 involve multiplication of terms or the taking of roots. These mathematical forms carry certain implications for the output that should be explained and justified. FCI functions 1 and 4, which involve products of two terms, should perhaps include a square root (geometric mean), as does FCI 5. If not, the difference in form between FCI functions 1, 4, and 5 should be explained.
Significance – High:
Lack of justification for the mathematical form of each of the individual FCIs could lead to improper use if the user is not aware of the importance of and rationale for the functions. Improper use could lead to model results that will not be able to support planning decisions.
Recommendations for Resolution:
To resolve these concerns, the Delta Region of Arkansas Regional Hydrogeomorphic Guidebook would need to add an explanation to each of the sections on the FCI functions for why the specific mathematical form was chosen.

Final Panel Comment 5:
The Functional Capacity Indices (FCIs) have not been validated against independent empirical estimates of the actual function in the relevant terrains.
Basis for Comment:
The discussion of each FCI includes a justification of why the relevant function is appropriate to an overall assessment, but does not include evidence that the FCIs accurately measure the *actual* function in the field. The report cites an "independent quantitative measure that can be used to validate the functional index," but provides no evidence that these measures actually validate the FCI functions. This is an important gap in the justification for these functions of which the reader should be fully aware.
Significance – High:
The user of this report might naturally assume that the FCI measures of function have been validated in the field and thus can be taken as accurate estimates of actual function. Since this final step has not yet been carried out, a naïve user might place unwarranted confidence in FCI estimates and thereby make erroneous planning decisions.
Recommendations for Resolution:
To resolve these concerns, the Delta Region of Arkansas Regional Hydrogeomorphic Guidebook would need to be expanded to include a description of how FCI values have been validated against independent empirical estimates of wetland function. If validation has not been performed, then FCI model outputs need to be validated against actual field conditions.

Final Panel Comment 6:
The Hydrogeomorphic (HGM) Guidebook needs to explain more fully the overall reliability of the outputs of the model.
Basis for Comment:
For a model to provide reliable information to its user, four attributes of the model must be fully communicated: 1. precision 2. accuracy 3. sensitivity 4. uncertainty The *precision* of a model reflects how stable its outputs are when its inputs are measured repeatedly. In this context, the question would be how similar would estimates based on measurements from two or more independent field teams be if they were compared. The *accuracy* of a model reflects how closely its output matches actual conditions in the field. In this situation, this would require information on how well a Functional Capacity Index (FCI) such as Export Organic Carbon measured the actual ability of a terrain to export organic carbon. The *sensitivity* of a model measures the degree of change in model outputs that result from a change in inputs. For example, how much the FCI for Detain Floodwater changes when our assessment of V_{SSD} changes by 1%. If these FCIs are to be successfully used in planning decisions, it is essential for the user to understand how sensitive the results are to the inputs (subindices) and to the mathematical form of the model. For example, if an FCI is an arithmetic average of two subindices (measured as 0.5), then a 0.1 error in either input translates into a 0.05 error in the FCI. On the other hand, if an FCI is a geometric mean of two subindices, then a 0.1 error in either input translates into a 0.0477 error in the output. In addition, the user needs to know the potential error or uncertainty in the input values to know how reliable the output might be. If a subindex can only be measured to $\pm$ 10%, the resulting FCI is less accurate than if the subindex can be measured to $\pm$ 1% Finally, *uncertainty* in a model reflects the uncertainty in the outputs that follows from uncertainty in the inputs. If, for example, there is an element of uncertainty in one or more assessment variables, then there will be uncertainty in the output. For example, the user should know that a certain FCI can only be measured to within $\pm$ 10% due to uncertainty in its inputs. The uncertainty in the results of a model is important because it relates directly to how a user interprets differences in those results. For example, if the current FCI is 0.5 and we estimate that this will improve to 0.6 under a proposed alternative, the user would need to

know if this difference of 0.1 *meaningful*, or if it could be due to a) errors in the estimation of subindices, or b) the mathematical form of the function. Specifying a *least significant difference* (LSD) for each FCI would assist the user in making good policy. For example, if the LSD for a particular FCI were 0.3, and two alternatives measured 0.5 and 0.7, the user would know that this difference as not meaningful.
Significance – High:
Users of this model are likely to put unwarranted confidence in the numerical estimates of FCIs and Functional Capacity Units unless these issues are addressed fully in the report. This could negatively affect the ability of the model to achieve its stated purposes.
Recommendations for Resolution:
To resolve these concerns, the Delta Region of Arkansas Regional Hydrogeomorphic Guidebook would need to be expanded to include a discussion of the precision, accuracy, sensitivity, and uncertainty associated with each of the FCIs.

Final Panel Comment 7:
The procedures used to transform raw field data into tables of Functional Capacity Indices (FCIs) and Functional Capacity Units (FCUs) are overly complex and prone to errors.
Basis for Comment:
The procedure described here, which transforms field data into FCIs/FCUs, is a complex combination of paper forms and spreadsheets. Data must be transferred manually back and forth between forms, and between forms and spreadsheets. This is both time-consuming and error-prone. Some of the paper forms require manual calculations that could be performed more easily and safely in a spreadsheet. The three spreadsheets provided with this review apply to only a portion of the overall procedure, and two spreadsheets exist alongside alternative paper forms in a different format. The current mixed paper-spreadsheet procedure has a number of shortcomings, including: a. Inconsistencies in variable names, field names, units of measure, and spreadsheet layouts b. Inconsistencies between paper forms and spreadsheets c. Limitations in model and user documentation in the spreadsheets d. Unnecessarily complex linkages between spreadsheets, and more spreadsheets than necessary e. The inclusion of hand calculations f. Incorrect references to data forms g. Missing formulas h. Duplicate output cells i. Parameters used inside formulas j. Unexplained conversions from metric to English units k. Unnecessarily complex IF statements l. Lack of data validation and error controls
Significance – High:
Complex, error-prone procedures could lead to erroneous outputs and thereby decrease confidence in planning decisions made based on the outputs.
Recommendations for Resolution:
To resolve these concerns, the Delta Region of Arkansas HGM forms and spreadsheets would need to be redesign as an integrated spreadsheet-based system that takes field data as inputs and produces two seven-by-six tables for FCIs and FCUs as outputs. This can be accomplished in a single spreadsheet, although that spreadsheet may have to be tailored to a specific application from a generic template.

Final Panel Comment 8:
The Unconnected Alluvial Depression subclass should not include wetlands that have been cut off from the channel of major river floodplains by man-made levees.
Basis for Comment:
Page 52 of the guidebook states that, "Unconnected alluvial depressions occur in major river floodplains that have been cut off from the channel by levees," which means that they were disconnected due to levee construction (a major alteration). Reclassifying altered wetlands rather than treating them as altered wetlands is a departure from the usual procedure in HGM to classify wetlands as the type they were prior to alteration. Wetlands that are hydrologically separated from their floodplains by man-made levees or berms represent a major altered hydrologic condition. They may resemble other unaltered wetland types in some respects, but are anthropogenic. Such anthropogenically disconnected floodplain depressions should be treated as hydrologically altered floodplain depressional wetlands because they are disconnected from the overbank flooding that once controlled them. These disconnected floodplain depressions may still possess some functional capacity, but none of these wetlands should be capable of attaining reference standard condition for HGM, which could occur by reclassifying them. This is a particular problem for hydrologic functions dealing with flood detention and wildlife functions dealing with potential fish habitat. Restoration could be conducted in disconnected depressions, but they can never be restored to reference standard condition unless they are hydrologically reconnected to the channel with which they were once associated.
Significance – High:
The significance of this problem is high for two reasons. First, reclassifying wetlands in an altered condition creates the erroneous impression that some wetlands appear to be in better condition than they are. Second, it sets a precedent for reclassifying other wetland types following large-scale anthropogenic alteration. For example, former floodplains behind levees might be reclassified as wet flats. Were the HGM assessments used to evaluate wetland functional capacity over a large region (rather than for just an individual project), depressional wetlands behind levees would be shown to be in much better condition than they are by ignoring the deleterious regional effects of mainstem levees on floodplain wetlands. This would tend to both erase the historical reference point (that these were once fully connected and fully functional wetlands) and it would mask the future degradation of wetlands through time as more levees are constructed.
Recommendations for Resolution:
To resolve these concerns, the Delta Region of Arkansas Regional Hydrogeomorphic Guidebook should treat depressions on former floodplains as floodplain depressional wetlands and not reclassify them as unconnected depressions. In the analyses of projects, the best attainable score for floodplain depressions behind levees should be determined and treated as HGM would normally treat unaltered wetlands in determining compensation. For example, if 0.6 is the best FCI attainable score for the fauna maintenance function, then a score of 0.6 would be treated as one would normally treat a score of 1.0. This would be a policy choice, but it would be better to invoke policy in the

dealing with compensation rules rather than override science by reclassifying. Treating former floodplain wetlands as altered floodplain wetlands would maintain the integrity of HGM in defining standards relative to unaltered wetlands. In contrast, ignoring the hydrogeomorphic origin of former (now altered) floodplain wetlands would lead to ignoring large areas of wetland that are potentially restorable and the loss of ecological services associated with levee construction.

Final Panel Comment 9:
The reference data set does not seem to have included former wetlands (now non-wetlands) as part of the model calibration, which means that the most altered end of the gradient is not well represented in the calibration, and former wetlands will likely be overlooked as potential restoration sites.
Basis for Comment:
The hydrogeomorphic (HGM) Guidebook states that in developing the HGM Guidebook, "reference wetlands are identified to represent the range of variability exhibited by the regional subclass, and field data are collected and used to calibrate assessment variables and indices resulting from assessment models." However, the most altered part of the reference population is the former wetlands that are no longer functioning as wetlands. These former wetlands are in the correct geomorphic landscape position, but are no longer wetlands because they lack one or more of the three parameters that are used to define them jurisdictionally as wetlands (vegetation, soils, and wetland hydrology). By restricting the reference data set to jurisdictional wetlands, the low end of the continuum of alteration is not represented in the calibration of sub-index scores. Another ramification of excluding the former wetlands (now non-wetlands) is that a large population of useful sites could be excluded from being considered as potential restoration sites. Furthermore, including non- (but former) wetland sites in the reference set could provide information to managers that could be used to develop site-specific restoration plans and develop sampling protocol to assess the condition of wetland resources at a regional scale.
Significance – High:
Excluding the most altered wetlands from the reference data set could compromise the validity of the calibrations of the models, and hence, their performance.
Recommendations for Resolution:
To resolve these concerns, the Delta Region of Arkansas Regional HGM approach would need to be expanded to: 1. Include non-wetland sites that were formerly wetlands in the reference data set so that their values can be used to help calibrate subindices. 2. Explain, in Chapters 2 and 6, the importance of non- (but former) wetlands for calibrating models and providing an important potential basis for identifying restoration sites. 3. If these recommendations are not adopted, the HGM Guidebook should state why non-wetlands were excluded from the reference data set and the potential ramifications of doing so. If non-wetlands were a part of the data set, then that fact should be clearly stated along with the importance for including them.

Final Panel Comment 10:
The Functional Capacity Index (FCI) for Detain Floodwater could be improved by use of channelization and flooding duration indicators and by careful consideration of the calibration of V_{FREQ}.
Basis for Comment:
The Detain Floodwater FCI model (pages 58-60) is a reasonable representation of this function, particularly in estimating potential changes to the function due to alteration. However, indicators of the extent of channelization and flooding duration might make on-site evaluations possible and improve the end user's understanding of the relationship between these indicators and floodwater detention. Channelization affects frequency and duration of overbank flow, and a variable related to channelization could be a very useful indicator (model variable) for representing flooding frequency. In fact, channelization disconnects a floodplain wetland from its main source of water (the channel); thus, channelized streams rarely or never overtop their banks, and frequency of flooding becomes zero. The variables V_{FREQ} and V_{DUR} (used in other functions) are designed to measure the effects of alterations such as channelization, but they are not straightforward, site-level indicators like degree of channelization because models and/or external data are required to calculate their values. Flooding duration is an important indicator of a floodplain's capacity to store and reduce the velocity of floodwater as it moves through the floodplain, two important characteristics identified for the Detain Floodwater function. Impediments to flow on the floodplain surface (logs, ground cover, woody vegetation density) are modeled as factors that increase the capacity of the floodplain to slow flow (detain floodwater), presumably because flooding duration is difficult to quantify in a rapid assessment procedure. However, a change (deflection from normal) in flooding duration (V_{DUR}) is used as a model variable in some functions (e.g., plant and wildlife models) and for some wetland subclasses (Table 9, page 112). V_{DUR} "is intended to reflect changes in function that result where changes in growing season hydrology have occurred or are expected to occur as a result of levees, drainage, impoundments, or other engineering projects" (page 118). Where flooding duration cannot be calculated or is not available, the end user is instructed to assume no change (thus giving V_{DUR} a value of 1.0). Thus, the protocol provides a placeholder for V_{DUR}, with the realization that determining deflection from normal flooding duration is difficult to determine using a rapid assessment procedure. It seems that changes in flooding duration should also be used in the Detain Floodwater function when appropriate data are available, particularly since V_{DUR} was "structured specifically to accommodate the type of hydrologic information generated in the Corps project planning process" (page 118). Because the reference standard (baseline) condition is the mid-20th Century condition (i.e., after Mississippi River flood control projects), the way V_{FREQ} is scored in the Detain Floodwater function could potentially cause a problem with the resulting FCI scores if hydrologic restorations are designed to mimic pre-20thCentury conditions. For example, if restoration causes a large change in the "return interval group" for V_{FREQ} because the

hydrologic mimics flooding regimes prior to mid-20th century flood control projects, the resulting FCI might show a negative environmental impact rather than the planned beneficial one. Therefore, the calibration of V_{FREQ} should be examined regarding how it might affect post-project projections associated with the New Madrid/St. Johns project. It is possible that the HGM approach would not be appropriate for predicting post-project conditions for such projects.
Significance – Medium:
Without on-site indicators of flooding frequency and duration, the ability of the Detain Floodwater model to link on-site condition with the ability of a floodplain to detain water is limited and the accuracy of the outputs is lower; including these indicators in the model would improve the utility of model outputs for planning projects.
Recommendations for Resolution:
To resolve these concerns: 1. Consider using indicators of channelization (e.g., intensity of channelization: depth of channel, height of levees) in the Detain Floodwater FCI. 2. Incorporate a flooding duration variable (e.g., based on regional curves, unless affected by backwater flooding) as a potential model subindex for the Detain Floodwater function. The variable could replace the field indicators of flooding duration used in the model if data are available to show that flood duration was being deflected from normal conditions. 3. Determine how the current calculation of V_{FREQ} might affect post-project projections for large-scale hydrologic restoration projects that return flooding regime to conditions prior to the mid-20th Century baseline condition and consider how the V_{FREQ} subindex calibration would be appropriate for such situations.

Final Panel Comment 11:
The Functional Capacity Index (FCI) for Detains Precipitation could be improved by changing how V_{POND} and V_{LITTER} are measured.
Basis for Comment:
The Detains Precipitation FCI model (pages 61-62) is a reasonable representation of a site's ability to detain precipitation. However, the methods for measuring the variables may pose a problem with repeatability and may miss removal of ponding that is evident. For the model variable V_{POND} (page 124), estimating percentage of a wetland assessment area (WAA) that is ponded is imprecise (unlikely to be repeatable), particularly since WAAs and depressions vary so widely in size. The fact that the V_{POND} variable (page 69) is calibrated to underlying geology is helpful, and the fact that the variable constitutes 50% of the FCI score is reasonable. However, although V_{POND} was described as focusing on the *removal* of microtopography, the variable is measured as *coverage* of ponded area. (Removal of storage is assumed if ponding coverage is less than reference standard coverage.) An estimate of depressional storage would not measure a removal of storage (e.g., due to fill) that might be evident. An alternative to estimating coverage would be to more directly measure the amount of ponding removed (usually by fill), since measuring coverage alone might not be sensitive enough to depict alteration, except in the most severe cases (e.g., burial by fill or land leveling). The model variable V_{LITTER} (page 62) would likely vary spatially and temporally (as indicated on page 62). Guidance in the guidebook suggests excluding the variable if measurement is problematic. However, considering that the variable is so spatially and temporally variable, it is probably not a very good predictive indicator of condition. In contrast, tree basal areas (V_{TBA}) could be used as a surrogate for litter in forested wetlands because there is a positive relationship between tree biomass and the litter it produces.
Significance – Medium:
Lack of precision in the way V_{POND} and V_{LITTER} input variables are currently measured limits the accuracy and performance of the Detains Precipitation FCI model.
Recommendations for Resolution:
To resolve these concerns, the Delta Region of Arkansas Regional HGM approach would need to: 1. Directly measure alterations to depressional storage. If percent area ponded is required, then precision (repeatability) would be increased by using the midpoint of cover categories, for example (midpoints in parentheses): 0-5% (2.5%), 5-25% (15%), 25-50% (37.5%), 50% (50%), 50-75% (62.5%), 75-95% (85%), 95-100% (97.5%), 100% (100%). 2. Consider eliminating the variable V_{LITTER}, and using V_{TBA} in its place.

Final Panel Comment 12:
The Functional Capacity Indices (FCIs) for Cycles Nutrients and Export Organic Carbon could be improved by changing the use or measurement of V_{SSD}, V_{GVC}, V_{OUT}, and V_{TBA} in the FCI calculation.
Basis for Comment:
Both models essentially use the same variables, except that a hydrologic component is a part of the export model and V_{AHOR} is replaced by V_{LITTER} in the Export Organic Carbon model. The Cycles Nutrients FCI model (pages 62-65) and Export Organic Carbon FCI model (pages 65-67) reasonably represents nutrient cycling and carbon export, respectively, by incorporating indicators of living and detrital biomass, a precedent established by other HGM approaches. However, selectively using only the most predictive model variables, and realistically weighting them in the FCI equations, would improve the performance of the models and make them sensitive to alterations. Although many components of living and detrital biomass are useful indicators, aboveground tree biomass (V_{TBA}) constitutes 99.6% of total aboveground biomass in mature riparian forests in North Carolina based on published regression equations for tree species, derived regression equations for shrubs and saplings, and organic carbon content of groundcover (Brinson et al. 2006). Therefore, shrub/sapling density (V_{SSD}) and ground vegetation cover (V_{GVC}) are likely of limited value as model variables for indicating living biomass. Percent contributions of detrital biomass in the Brinson et al (2006) study were 37% for litter, 49% for soil organic matter, 4% for woody debris adjusted for the density of five decay data classes, and 10% for snag. These percentages will vary somewhat among forested wetlands, and belowground root biomass (probably correlated best with tree biomass) was not included; but these percentages can provide some guidance for more realistically weighting model variables, rather than weighting every variable the same, as is the currently done for the models. By not emphasizing the overwhelming importance of tree biomass (V_{TBA}) to total forest biomass, the Cycles Nutrients model might show a more rapid rate of recovery during restoration than is warranted. For example, a site in early stages of restoration might not have any canopy-sized trees, but will have a well-developed understory. Such sites might then have higher FCI scores than is warranted. Also, although variables mathematically associated with V_{TBA} in the models might simply be redundant (i.e., they should be highly correlated with V_{TBA}), under some situations the importance of V_{TBA} could be diluted by those variables. For example, if a mature swamp were very wet, shrub/sapling density and ground vegetation cover might be naturally low (e.g., in a cypress-tupelo swamp). This could lead to a wetland assessment area (WAA) having lower FCI scores than would be warranted. Alternatively, a successional swamp might have dense understory and few canopy trees, thus leading to a higher FCI score than is warranted. For V_{OUT} (page 123), the field procedure identifies impediments to flow and additional inputs of water as alterations in headwater depressions. Another potential (and perhaps common) alteration would be ditching or other drainage activities that remove water

more quickly and lower the water table. Indicators of drainage should be considered as an additional type of alteration to V_{OUT}.
Significance – Medium:
Using models variables that are of poor predictive power make the models that use them less predictive and sensitive to alteration, and dilute the effect of more predictive variables.
Recommendations for Resolution:
To resolve these concerns for the Export Organic Carbon and the Cycles Nutrients models: 1. Eliminate the model variables V_{SSD}, V_{GVC}, and V_{WD}. 2. Adjust the FCI models to reflect the overwhelming importance of canopy tree biomass. 3. Adjust the relative weights of detrital components to more realistically reflect their contribution to organic carbon. 4. Add indicators of drainage activities as an additional alteration to V_{OUT}

Final Panel Comment 13:
The Functional Capacity Index (FCI) for Provide Habitat for Fish and Wildlife could be made more robust by using fewer subindices in its calculation.
Basis for Comment:
The Provide Habitat for Fish and Wildlife FCI model (pages 69-73) incorporates all the potentially useful indicators for the function, but doing so makes the model unnecessarily complex. The hydrologic and landscape portions of the model are suitable for indicating habitat condition, but the number of variables in the forest structure and detrital components reduces the potential robustness of the model. As forests mature, they produce snags and large down wood, build soil organic matter, and increase the number of strata (to a maximum value). Thus, forest structure measured by tree basal area (V_{TBA}) greater than some diameter threshold (e.g., >15 cm diameter at breast height [dbh]) could be used as a mega-indicator of forest structure, since canopy tree basal area incorporates information available in V_{STRATA}, V_{SNAG}, V_{LOG}, and V_{OHOR}. The importance of canopy tree basal area, an indicator of living and detrital forest structure, is diluted by the weaker and covarying indicators for number of strata, number of snags, volume of down wood, and soil organic matter. Including a greater number of variables reduces the robustness of the model. This is particularly true of V_{SNAG} and V_{LOG}, which are patchily distributed in most forests and so would likely be imprecisely measured.
Significance – Medium:
A proliferation of model variables, incorporating weak and strong variables, dilutes the effect of the stronger variables in the function models when the variables are weighted equally, making the model less robust.
Recommendations for Resolution:
To resolve these concerns: 1. Consider using V_{TBA} of trees greater than some threshold size that represents canopy individuals (e.g., >15 cm dbh) as a variable in the Provide Habitat for Fish and Wildlife FCI. 2. If the first recommendation is adopted, consider eliminating the use of V_{STRATA}, V_{SNAG}, V_{LOG}, and V_{OHOR} in the FCI equation.

Final Panel Comment 14:
The Hydrogeomorphic (HGM) Guidebook should include references to easily-obtainable case studies that apply this method.
Basis for Comment:
The model reviewers suggest that the guidebook should include examples of the proper use of the model, how the model has been applied elsewhere, what sort of output values have been obtained, and how these have been used to make management decisions. It should be possible for potential users better understand how the model has been applied elsewhere in several well-documented case studies. These studies should be cited early on in the HGM Guidebook and should be easily accessible to potential users. References to articles in journals or book chapters are a first step, but providing URLs for links to on-line studies would provide more rapidly accessible information.
Significance – Medium:
Lack of example case studies for the application of the Regional HGM approach limits the user's ability to fully comprehend how the approach can be applied.
Recommendations for Resolution:
To resolve these concerns, the Delta Region of Arkansas Regional HGM Guidebook would need to be expanded to include: 1. Citations to a set of case studies that have applied these methods. 2. Assurance of the on-line availability of these documents on an appropriate public web site.

Final Panel Comment 15:

Some field measurement approaches should be improved to improve the precision (repeatability of measurements) of variables in the models.

Basis for Comment:

Field methods for various field measurements should be either improved or explained more clearly. Some field measurements should be considered for removal because they are likely to be imprecise (not repeatable among users due to the subjectivity of the measurements). Potentially problematic variables and methods are discussed below.

1. The data form for calculating V_{TCOMP} and V_{COMP} (page B5) shows that *Quercus falcata* and *Ulmus americana* are listed in Column B as disturbance indicator species. Model reviewers note that these two species should represent reference standard conditions.
2. The method for determining percent tree cover is unnecessarily subjective. When measuring basal area with an angle gauge (Bitterlich stick, prism, Relaskop), each tree "counted" (eligible stems) needs to be identified by species to get an indicator of relative dominance (i.e., relative basal area is a good estimate of relative cover or dominance). The angle gauge biases the outcome slightly by including some understory trees too, but understory stems would rarely be counted and so they would not affect the outcome using the 50/20 rule. Counting understory stems could be avoided by only recording trees (by species) if they were larger than some critical diameter. For example, if only trees greater than 15 cm diameter at breast height [dbh] were counted, all trees would be canopy size and measuring them would provide an objective, consistent, and unbiased determination of relative dominance. Restricting V_{TBA} to basal area of canopy-sized trees would likely not affect the calibration already provided for V_{TBA} and it would have the added advantage of providing an unbiased estimate of relative dominance, by species, for canopy trees. The variable V_{COMP} could still be estimated for sites with <20% cover, but estimating dominance for such sites would be easier than it would be in fully stocked stands (where subjectively estimating cover might bias results). The guidebook states that a 10-factor English angle gauge is the most appropriate tool for measuring basal area (page 113, 127). However, a 2-factor SI angle gauge is comparable to a 10-factor English gauge and would provide a direct measure of basal area in m^2/ha(when multiplying counts by 2). Using the SI prism would reduce the likelihood of error when converting English units (ft^2/acre) to the SI units (m^2/ha) needed for obtaining the index for V_{TBA}.

The following variables have the highest potential to be imprecise: V_{COMP}, V_{TCOMP}, V_{POND}, V_{WD}, V_{LOG}, V_{LITTER}, and V_{SNAG}. These seven variables are either subjectively measured, can be difficult to measure, or vary widely in space and/or time

Significance – Medium:

Field measurements that do not generate repeatable results could cause FCI scores to vary among users, thus reducing the model's usability and the level of performance.

Recommendations for Resolution:
To resolve these concerns,: 1. Consider using more objective methods to measure V_{TCOMP}, V_{COMP}, and V_{TBS}, such as those suggested in the Basis for Comment. 2. Reduce the relative weights of or eliminate the variables V_{LITTER}, V_{SNAG}, V_{LOG}, and V_{WD} (which tend to vary widely in space and/or time), thereby reducing their relative effect on the models that incorporate them.

Final Panel Comment 16:
At the beginning of the document, a clear statement needs to be provided about how the guidebook is intended to support decisions made by regulators and managers and how the guidebook supports that purpose.
Basis for Comment:
It is not clear whether the Hydrogeomorphic (HGM) Guidebook is meant exclusively for state and federal agency personnel or for a wider audience. A manager or engineer needs to be provided succinct information about how the HGM approach works and how they can use it for their projects. Since the HGM approach has been in use for over a decade, the model review panel notes that there must be many examples that can be cited in the document or provided in an appendix.
Significance – Low:
Not providing a clear statement regarding how the HGM approach is intended to support decision-making can lead limits understanding about the target audience and the potential application of the models by the potential user community.
Recommendations for Resolution:
To resolve these concerns, the Delta Region of Arkansas Regional HGM Guidebook would need to be expanded to include: 1. Statements early in the Introduction that the process entails the following steps: - Documentation of the project's assessment purpose and characteristics - Collection of field data from assessment areas - Summarizing assessment results by transforming field data to subindices and combining these into Functional Capacity Indices (FCIs). - Multiplying FCIs by area to obtain FCUs. - Application of assessment results 2. Statements that the process will take data measured in the field (independent variables) and predict a FCI number from 0-1 (dependent variables) for each of six wetland functions for each wetland assessed. 3. A description of how these FCIs can be used to analyze project alternatives, minimize impacts, assess unavoidable impacts, determine mitigation requirements, and monitor the success of compensatory mitigation. Specific examples of how the HGM approach and the FCIs have been applied in actual projects should be provided in an appendix. 4. The reference set in an appendix, including locations of reference sites, particularly any well-known regional examples of reference standard sites. By including this information, users could better understand the natural and anthropogenically-mediated variation of the subclass and visit reference field sites if needed.

Final Panel Comment 17:
The Hydrogeomorphic (HGM) Guidebook should explain why some functions commonly included in HGM assessments were not chosen for this HGM assessment method.
Basis for Comment:
The HGM Guidebook notes the six functions included in the HGM Guidebook were developed during a workshop in Arkansas in 1997. It provides adequate discussion regarding why these particular six functions were chosen. Other HGM documents and Guidebooks identify anywhere from 8 to 15 functions. Why other functions commonly included in HGM assessments were not chosen for this one is not explained.
Significance – Low:
Not providing an explanation of why functions typically used for other HGM approaches are not used for this approach does not affect the technical quality or comprehension of the approach, but it does reduce the quality of the documentation of the approach.
Recommendations for Resolution:
To resolve these concerns, the Delta Region of Arkansas Regional HGM Guidebook would need to be expanded to include an explanation of why wetland functions commonly used in other HGM approaches were not included.

Final Panel Comment 18:
The Hydrogeomorphic (HGM) Guidebook should summarize the assumptions implicit in its approach, including those pertaining to the Functional Capacity Index (FCI) models.
Basis for Comment:
Assumptions are stated throughout the HGM Guidebook, but they are never summarized in one place. In addition, very few of the HGM Guidebook's assumptions are supported by literature citations or data.
Significance – Low:
Lack of a summary of assumptions affects the technical quality of the model documentation but will not affect the performance of the model.
Recommendations for Resolution:
To resolve these concerns, the Delta Region of Arkansas Regional HGM Guidebook would need to be expanded to include a complete list of assumptions and scientific justification to support the assumptions.

Final Panel Comment 19:
The descriptions of some model variables needs to be more clear, consistent, and complete.
Basis for Comment:
Inconsistencies in naming variables are confusing, i.e., giving different names to the same variables in different functions. 1. Terminology for V_{LITTER} should be reconciled throughout the hydrogeomorphic (HGM) Guidebook, i.e., V_{LITTER} is referred to as both litter thickness (page 62) and litter cover (page 122). (Litter cover is preferred because that is what was measured.) 2. The terminology defining the model variable V_{OHOR} is inconsistent. It is called "O horizon thickness" on page 62, 64, 66 (etc.) and "O horizon organic accumulation" on page 123. Also, on page 61, on line 7 under Rationale, "overbank" should be inserted before the word, "flooding" (end of third sentence of paragraph). 3. The terminology for V_{POND} should be made consistent; it varies throughout the HGM Guidebook (see pages 62, 68, 124 for variations). 4. The model variable V_{AHOR} is inconsistently named throughout the HGM Guidebook, A-horizon thickness (e.g., page 75), A-horizon biomass (e.g., page 62), and A-horizon organic matter accumulation (e.g., page vi, 115). 5. The variable V_{LOG} is not consistently named in the HGM Guidebook. Sometimes it is called log density, sometimes log volume, and sometimes log biomass. Log volume is the most descriptive term to use since log density was not measured and log biomass could vary widely depending on the log's state of decay (volume was not partitioned by decay state).
Significance – Low:
Although clarifying terminology will not affect the performance of the function models, clarification would improve an understanding of the protocol by end users and minimize mistakes in application of the protocol.
Recommendations for Resolution:
To resolve these concerns, the Delta Region of Arkansas Regional Hydrogeomorphic Guidebook would need to be revised to make sure that terminology and names of variables are consistent throughout the HGM Guidebook, particularly $V_{LITTER,}$, V_{OHOR}, V_{POND}, V_{AHOR}, and $V_{LOG.}$

Final Panel Comment 20:
The model, as designed, does not address global climate change issues as required by EC 1165-2-211 Water Resource Policies and Authorities Incorporating Sea-Level Change Considerations in Civil Works Programs (01 July 2009).
Basis for Comment:
Current USACE guidance for planning, engineering, and design (EC 1165-2-211, July 2009) and USACE policy for plan formulation (ER 1105-2-100) indicate that the effects of sea level rise are to be incorporated into analytical methods used to support planning decisions. The model was designed to address potential changes in wetland condition that may be related to climate change, however, climate change is not incorporated into the models. As one example, the model uses changes in frequency of flooding as its main flooding variable. Changing climate will likely affect timing of floods, which is not included in the model. Another example is the shape of the subindex graphs in the Hydrogeomorphic (HGM) Guidebook is fixed. Changing climates might affect the shape of the subindex graphs. However, sea level rise and other climate change responses can be addressed external to the model.
Significance – Low:
Since the model was not designed to accomplish this purpose, it is necessary only to be aware of this limitation on its application.
Recommendations for Resolution:
1. To resolve these concerns, the Delta Region of Arkansas Regional HGM Guidebook would need to be expanded to include: 2. A discussion that the models are not designed to address effects of changing climate, particularly where these affect flood duration, flood timing, or the subindex graphs. 3. A discussion of how climate change issues could be addressed external to the model. 4. If climate change issues need to be addressed in the Delta HGM Guidebook, it would need to be expanded to examine climate change sensitivity. This could include: - Possible effects from changes in timing of flooding - Potential effects on subindex graphs - Possible changes in equation structure - Possible changes in species composition and function in reference wetlands.

Final Panel Comment 21:
The Hydrogeomorphic (HGM) Guidebook should include a table for each wetland subclass that provides a matrix of subindices and the FCI models in which they occur.
Basis for Comment:
It is often difficult to keep track of all the many functions and variables (with different standards), all used in various combinations in six wetland subclasses. It would benefit the end user if there were a matrix table for each subclass matching the subindices and the functions in which they occur (a function by sub-index matrix). These matrices would also allow users to get a general idea about how frequently each variable is used within the context of a given wetland subclass, i.e., it would provide an idea of each variable's relative importance. An estimate of a variable's relative importance, combined with an indication of its sensitivity and precision, could help users decide if the models are likely to realistically differentiate functional condition among wetlands within a subclass.
Significance – Low:
Without a matrix table showing the subindices within each FCI model, it is difficult to keep track of the variables that are included in each function.
Recommendations for Resolution:
To resolve these concerns, the Delta Region of Arkansas Regional HGM Guidebook would need to be expanded to include a matrix table of the subindices in each FCI model for each wetland subclass.

This page intentionally left blank

APPENDIX C

Specific Comments on Spreadsheets

This page intentionally left blank

The following issues were noted while performing the review of the following spreadsheets.

Appendix B Page #B3 - Data Form 1

HGM Variable Addressed: There is a conceptual error here – these variable names (e.g., V_{TRACT}) are used throughout to refer to subindices, not to metrics.

Indicator Value: This is the raw field data. It has been referred to before as "variable metric," or "metric," or (in the FCI/FCU spreadsheet) as "metric value." However, it is now referred to it as "Indicator Value."

Geomorphic surface (Check One): Notice that in the FCI/FCU spreadsheet these checkboxes and the single value below for V_{Pond} will be entered in one of the cells B20:B22. Here is just one instance where the paper form and the spreadsheet are inconsistent.

Appendix B Pages #B4-6 - Data Form 2

As in Data Form 1, the language used ("HGM Variable Addressed" and "Indicator Value") is confusing.

Under "Observations from the Center Point," a calculation is required that involves a conversion factor. The first paragraph says "using the appropriate conversion factor," leaving that decision up to the user. The bottom paragraph suggests using the worksheet (model reviewer assumed Alternate Data Form C1) in Appendix C. It fails to mention that the spreadsheet Basal Area Calculator can be used as well. Why there is an Alternate Data Form and a spreadsheet (which differ in formats) is unknown and confusing.

Note that the user of this form is expected to perform various calculations (presumably using a hand calculator), entering the results on the form. The form provides inconsistent assistance in this effort. In some places formatting is used to help the user enter the necessary data and the result; in others no such assistance is given. For example, under "Observations within a 0.04-HA Plot" the user is expected to calculate a complex weighted average without recording the partial results. This is a potential location where errors can occur.

Under "Observations along Transects" the user enters data that will eventually be used to calculate V_{LOG} and V_{WD}. There are three size classes; for the first two we record #stems for two transects. For size-class 3 we can record up to five entries for each of two transects. This is confusing and should be further explained.

Appendix B Page #B7 - Data Form 3

As in Data Forms 1 and 2, the language used ("HGM Variable Addressed" and "Indicator Value") is confusing.

"Transfer the data below from Data Form 1" Transferring data from sheet to sheet is prone to errors. If it has to be done this way, the model reviewer suggests that the location of the source number should be made unambiguous, perhaps with a line number (as it is done on federal tax forms: e.g., "Enter line 42 here."

"Transfer the plot data below from Data Form 2 and average all values" This requires the user to scan multiple versions of Data Form 2, one for each plot, and manually enter the values for 10 metrics, and then average them. This is another place where errors could easily occur.

"Use the Woody Debris Calculator spreadsheet (or the worksheet in Appendix C) …." This procedure requires the user to find Data Form 2 for Plot 1, find the data for Size Class 1 for one transect, transfer it to the appropriate cell in the Woody Debris Calculator spreadsheet, and repeat for Transect 2. Then go on to Plot 2 and repeat. Then do the same for Size Class 2, and Size Class 3. OR, accomplish the same thing by using Alternate Data Form C2, which uses a very different layout for recording the data, and requires extensive manual calculations. This form applies to just one plot, whereas the spreadsheet calculates the results for all plots. The model reviewer feels this is very confusing and believes that a simpler way can be developed.

Spreadsheet: Basal Area Calculator

Cell A3: Currently reads "Data Form 4" but should read "Data Form 3."

Alternate Data Form C1 is all in metric units but the spreadsheet is in both centimeters and inches. This should be consistent.

This spreadsheet seems to be built as a calculator, rather than for documentation. For example, there is no way to document the instance being evaluated. By contrast, Alternate Form C1 allows for Subclass, WAA#, and Plot# to be recorded. The model reviewer suggests adding fields for user, date, plot location, description, etc.

Documentation in C4:D4 is inconsistent: The model reviewer suggests using names like "tree diameter" or row/column labels like "Column C," but not both.

Cells C12:C18: These cells contain the number 0 instead of the formula required in that column.

Cells D12:D18: These cells contain the number 0 instead of the formula required in that column.

Cells D56:D59: These cells contain the number 0 instead of the formula required in that column.

Cells D56:D59: These cells contain the number 0 instead of the formula required in that column.

Cells D36 and D70: The model reviewer believes that having duplicate output cells (only one of which is to be manually copied to Data Form 3) is dangeroU.S.

Alternative spreadsheet model.
To illustrate some alternative ways of building this model, the model reviewer has provided an Excel spreadsheet entitled *Basal Area Alternative.xls* that suggests some useful features that could be incorporated. Some of its features are:

a. Cell A3: One set of instructions.
b. Cells B4:B7: User documentation.
c. Cell B8: Pull-down menu for user to specify centimeters or inches; created using Data Validation.
d. B9: Result pulled up from end of calculations to where user can easily see it.
e. Cells C13:C42: Formula uses IF function to calculate correctly for inputs in centimeter or inches.
f. Errors in formulas in existing spreadsheet corrected.

This example spreadsheet will be provided in addition to the final report as an Excel file.

Spreadsheet: Arkansas Woody Debris

Cell A2: The model reviewer noted that the instructions tell the user what to do, but not where this information comes from (Data Form 2) or where it is going (Data Form 3). It is suggested that this additional information be provided.

Output data for V_{LOG} and V_{WD} is in columns by plot in the spreadsheet but must be transposed to rows for Data Form 3. It then must be averaged. The model reviewer suggests that this be done electronically in the spreadsheet.

Spreadsheet layout:
This sheet is laid out as if it were a paper form. Color coding is used to try to separate modules where white space and blank rows and columns would work better. Separate Size Classes 1, 2, and 3 physically and give instructions for each. Note that Size Class 3 uses a completely different format from the previous two Size Classes. The model reviewer suggests that this be laid out across one row rather than two.

Isolate parameters:
One of the basic principles of good spreadsheet design is to isolate parameters outside of formulas. Thus, formulas themselves should contain no numbers (except, perhaps, 1 and 3.14159). The model reviewer suggests that the following numbers should be removed from the formulas, placed in a *single* cell location, and referred to using cell references: 0.1866, 0.892, 0.3937, 0.0687, 32.5, 0.58, and 0.07. Also, each of these parameters should be documented. This would make the spreadsheet easier to audit and would reduce the chances for errors.

Cells C15:D24: It is unclear to the model reviewer why these cells convert diameters in centimeters into diameter^2 in inches. The result is in metric units so it is unclear

why the users would not want to keep the data in metric units throughout. Tons/acre in Size Classes 1 and 2 are in English units. The model reviewer suggests using one set of units throughout to simplify the calculations.

Suggested redesign:
The model reviewer suggests redesigning this spreadsheet so that the user can enter the inputs and read off the outputs. Everything else should be moved out of the way. The user (as far as the model reviewer can tell) has no interest in the intermediate calculations that clutter up the current design. The model reviewer suggests the following:

a. Take all the input cells and collect them in one module.
b. Copy the outputs (yellow cells) so they are alongside the inputs for easy reference.
c. Move the intermediate calculations to a separate module.
d. Stay in metric units throughout.
e. Isolate parameters and document.

Alternative spreadsheet model.
To illustrate some alternative ways of building this model, the model reviewer has provided an Excel spreadsheet entitled *Arkansas Woody Debris Alternative.xls*.

Spreadsheet: Delta FCI Calculators

Use of multiple sheets:
The overall output of this workbook should be two seven by six cell tables: one for the FCI values by subclass and function; the other for FCU values, also by subclass and function. This workbook uses nine sheets, one each for the six subclasses in the Delta, plus three duplicates for alternative methods. The various FCI and FCU values are distributed across these sheets and should be pulled together into the two tables described above. This could be accomplished by combining all nine sheets into one, or by retaining the nine sheets but creating a single OUTPUT worksheet with the two tables. This would also reduce a great deal of duplication across the sheets. The model reviewer has provided an Excel spreadsheet entitled *Delta FCI Calculator Alternative.xls* to demonstrate how these ideas could be implemented.

Cell A7: Data Form 4 should be Data Form 3.

Cells C10:C31: Listing the units in which the inputs in Column B should be given is a good idea. However, using "%" is ambiguous and could result in incorrect values being entered (e.g., "five percent" could be entered as 5 or 0.05, or 5%). The model review suggests changing "%" to "%: i.e., 5% or 0.05."

Cells D10:D31: These cells use very complex IF statements, such as the following:

=IF(ISBLANK(B10),"invalid entry",IF(CELL("type",B10)="l","invalid entry",IF(B10<0,"invalid entry",IF(B10>=6,0.5,IF(B10>=4,2+(-0.25*B10),IF(B10>=2,1,IF(B10>=0,0.5+(0.25*B10)))))))

This formula does two different things: 1) it checks for invalid data entry in cells B10:B31; and 2) it transforms the metric values into subindex values using the piece-wise linear functions described in the report. The model reviewer has three suggestions for improving these IF functions:

1. Use Data Validation to enforce valid inputs and warn the user when data requirements are violated.
2. Remove the numbers in the formulas to a separate location where they can be documented.
3. Write the IF statement in a repeating form to reduce errors and ease auditing.

1. Data Validation is a tool in Excel (on the Data ribbon in Excel 2007) that allows the user to require certain values in a cell or range. Here the model reviewer believes the designer would want to require that the inputs in B10:B31 be Whole Numbers between a Minimum (usually 0) and a Maximum (the maxima would be specific to the subindex function, for example, 6 in the case of the V_{AHOR}). The designer could also insert a warning message that would appear on the screen whenever a user entered an invalid input.

Removing the data validation task from the IF statements accomplishes two things: it removes the first several tests for invalid entries, and it allows the range numbers to be removed from the formula.

2 and 3. Another problem with the existing IF statements is that the subindex function values are embedded in them. This is always a poor practice, as it makes errors highly likely and makes the formula very difficult to audit. A better approach would be to enter the subindex functions as data in a separate part of the spreadsheet and then use cell references in these formulas to that data. This is difficult to describe in words. The model reviewer has provided an Excel spreadsheet entitled *FCI-FCU Demonstration.xls* as a sample of this implementation. The subindex function for V_{AHOR} is shown in table form in cells C4:D7 and plotted to the right. In cells C23:D37 the model review has plotted this function for a range of inputs. See the IF statement in cell D23. This looks complex at first blush, but it has two advantages over the one in the current spreadsheet: all the input numbers are taken via cell references from the table above, and the functional form of each IF is identical: if the input is in the following range, interpolate the subindex value between the low and high values in that range.

Alternate Data Form C1:

As stated above, this form is not consistent in layout with the spreadsheet alternative, which could cause confusion. For example, it uses “dbh” while the spreadsheet uses

"diameter." Also, the form is entirely in metric units, while the spreadsheet allows for both metric and English units.

The form is laid out so that Column 4 appears twice, and the user is expected to sum the values in *both* Column 4s to get the total basal area. It would be an easy mistake to leave out the first Column 4. And having users do the calculations of squaring a column of diameters, multiplying by a constant (0.00196), and then summing seems pretty archaic in the age of spreadsheets.

A value like 0.00196 should be documented. The model reviewer eventually figured out that it is 3.14159*0.0001*25/4, but that's a lot to ask of a user.

Alternate Data Form C2:
This is a manual alternative to the Woody Debris spreadsheet. As with Alternate Data Form C1, the manual form and the spreadsheet are designed on completely different patterns. While the spreadsheet performs all calculations for Class Sizes 1, 2, and 3 for two transects and multiple plots, here a separate sheet is devoted to each plot.

To use this sheet requires finding transect data on Data Form 2, transferring it to this form, carrying out some algebra, and then transferring the results to Data Form 3. The model reviewer believes this will be prone to errors.

APPENDIX D

Additional Suggested Edits

This page intentionally left blank

The model review panel provides these additional specific comments regarding typographic errors, suggestions for clarity, and inconsistencies:

(pages 40, 44) Loblolly pine flats are probably successional communities of hardwood and oak flats and not a separate subclass.

(pages 56, 57, 59) Three changes to the introduction to Chapter 4 are needed: (1) page 56, behind "a. Flat," add "(non-alkali)," (2) page 57, 2nd ¶, change "seven functions" to "six functions", and (3) page 59, end of 1st ¶, change "are consistent" with "vary little."

(page 61, line 7 under Rationale) The word "overbank" should be inserted before the word, "flooding" (end of third sentence of paragraph).

(page 63) Beginning sentence under "Rationale" should read, "In fully functioning wetlands," and last sentence before "General form of the model," "for a rapid assessment approach" should be replaced with, "and is a relatively minor component of biomass."

(page 67) The top sentence on page 67 should be broken into two sentences, i.e., "…relative immobility. In addition, flooding..."

(page 116) The second sentence (¶ 1) starting with "Note that" should be deleted because it repeats the last sentence at the end of page 115. For V_{CORE}, Figure 29 needs a scale (e.g., 100m) and the 100m buffer line should be shown for the region to the right of the purple wetland boundary. A dashed line denoting the buffer boundary on the right side would be helpful. The core area and the wetland area outside the core area should be labeled (e.g., A1 and A2, respectively).

(page 116, end of first paragraph and page 129, end of section 3) The words, "get help" should be changed to "get assistance from someone who can."

(page 117, Figure 28) Although the landscape variables are useful indicators for the wildlife model, the methods and illustrations for calculating them are confusing in places. Fig. 28 needs a scale (e.g., 500m) to show that the purple line running between the thick green line is indeed >500m from the forest edge. The caption could be expanded to identify the length (in meters) of total forested wetland tract boundary (purple line), the connected forested wetland tract boundary (thick green line), and the % of connected wetland tract boundary. These changes would clarify how the variable is calculated.

(page 117) The $V_{CONNECT}$ explanation in the narrative needs clarification to be consistent with part (3). Under part (1), sentence 1, "total" should be inserted before "forested" and "(purple line, Figures 25 and 28)" should be appended to the end of the sentence. Under part (2), sentence 1, "connected" should be inserted before forested and "(thick green line, Figure 28)" should be appended to the end of the sentence.

(page 117, 118) The narrative accompanying Fig.29 needs improvement for clarification. Under V_{CORE}, ¶ 1, line 6, "contiguous forested wetlands" should be changed to "contiguous forests (upland and wetland)." Under part (1), append "(dashed line in Figure 29)" to the end of the last sentence: Under part (2), append "(A1, Figure 29)" (or some other appropriate label for metric A1) to the last line. Under part (3), second line, insert "total" before "wetland tract."

(page 118) Figure 29, the caption should include, "V_{CORE}= (A1/(A1+A2)*100 (if A1 and A2 are used to designate portions of core area).

This page intentionally left blank

ATTACHMENT A

Revised Final Work Plan

This page intentionally left blank

Battelle
The Business of Innovation

US Army Corps of Engineers

REVISED FINAL WORK PLAN

INDEPENDENT EXTERNAL PEER REVIEW

for

Certification of Four Ecological Models: EnviroFish, Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley, Waterfowl Assessment Methodology (WAM), and the Delta Region of Arkansas Hydrogeomorphic Methodology (HGM) Guidebook

Battelle Memorial Institute
505 King Avenue
Columbus, OH 43201

Prepared for
U.S. Army Corps of Engineers
Ecosystem Planning Center of Expertise

Contract No. W911NF-07-D-0001
Task Control Number: 09-210
Delivery Order Number: 0799

October 8, 2009

This page intentionally left blank.

REVISED FINAL WORK PLAN

Independent External Peer Review
for
Certification of Four Ecological Models:
EnviroFish, Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley, Waterfowl Assessment Methodology (WAM), and the Delta Region of Arkansas Hydrogeomorphic Methodology (HGM) Guidebook

Submitted to:

Department of the Army
U.S. Army Corps of Engineers
Ecosystem Planning Center of Expertise

Contract No. W911NF-07-D-0001
Task Control Number: 09-210
Delivery Order Number: 0799

Prepared by:

Battelle
505 King Avenue
Columbus, OH 43201

October 8, 2009

Battelle
The Business *of* Innovation

This page intentionally left blank.

Table of Contents

1.0 Background, Objectives, and Scope of Work 1
2.0 Methods and Technical Approach 4
3.0 Quality Control and Quality Assurance 11
4.0 Reporting 12
5.0 Schedule 13
6.0 Project Organization and Communication 14
7.0 Budget 15

Appendix A. Final Charge Guidance and Questions to the Peer Reviewers for the Model Certification Review A-1
Appendix B. Four Ecological Models Model Certification Review Panels, Considerations and Proposed Selection/Exclusion Criteria B-1
Appendix C. Peer Review Conflict of Interest Inquiry C-1

List of Tables

Table 1. Number of Required Panel Members. 6
Table 2. Estimated Levels-of-Effort for Panel Members 7
Table 3. Four Ecological Models Certification Review Milestones and Deliverables 13
Table 4. Battelle Staff for the Four Ecological Models Project IEPR 15
Table 5. USACE Staff for the Four Ecological Models Project 15

This page intentionally left blank.

REVISED FINAL WORK PLAN
Independent External Peer Review
for
Certification of Four Ecological Models:
EnviroFish, Waterfowl Assessment Methodology (WAM), Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley, and the Delta Region of Arkansas Hydrogeomorphic Methodology (HGM) Guidebook

General Project Information

- Project Title: Independent External Peer Review (IEPR) for Model Certification for Four Ecological Models: EnviroFish, Waterfowl Assessment Methodology (WAM), Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley, and the Delta Region of Arkansas Hydrogeomorphic Methodology (HGM) Guidebook (Four Ecological Models Review).
- Project Number: TG/G898592
- Client: U.S. Army Corps of Engineers, Ecosystem Planning Center of Expertise
- Effective Date of Work Plan: September 8, 2009
- Version Number: 1
- Project Manager: Karen Johnson-Young
- Deputy Project Manager: Amanda Maxemchuk
- Deliverable Due Dates: Draft Work Plan: October 1, 2009; Final Work Plan: October 8, 2009; Draft Charge: October 1, 2009; Final Charge: October 8, 2009; List of Peer Reviewers: October 16, 2009; Draft Model Review Reports: (A) January 5, 2009, (B) March 1, 2010; (C) February 3, 2010; (D) February 3, 2010; Final Model Review Reports: (A) January 22, 2010; (B) March 17, 2010; (C) February 22, 2010; (D) February 22, 2010
- Period of Performance: September 8, 2009 – April 30, 2010

1.0 Background, Objectives, and Scope of Work

1.1 Background

Planning models are defined as any models and analytical tools that planners use to define water resources management problems and opportunities, formulate potential alternatives to address the problems and take advantage of the opportunities, and evaluate potential effects of alternatives and to support decision-making. The United States Army Corps of Engineers (USACE) Planning Models Improvement Program (PMIP) was established in 2003 to assess the state of planning models in the USACE and to make recommendations to assure that high quality methods and tools are available to enable informed decisions on investments in the Nation's water resources infrastructure and natural environment. The main objective of the PMIP is to carry out a process to review, improve and validate analytical tools and models for USACE Civil Works business programs. The PMIP Task Force collected the views of USACE leaders and recognized technical experts, and conducted investigations and numerous discussions and

debates on issues related to planning models. This task force identified an array of model-related problems, conducted a survey of planning models, prepared papers on model-related issues, analyzed numerous options for addressing these issues, and formulated recommendations.

Use of certified models for all USACE planning activities is mandatory. This policy is applicable to all planning models currently in use by USACE, as well as models under development and new models. District Commanders are responsible for providing high quality, objective, defensible, and consistent planning products. Development of these products requires the use of tested and defensible models. National certification of planning models will result in significant efficiencies in the conduct of planning studies and enhance the capability to produce high quality products. The appropriate USACE Planning Center of Expertise (PCX) will be responsible for model certification. The goal of certification is to establish that USACE planning products are theoretically sound, compliant with USACE policy, computationally accurate, based on reasonable assumptions, and are in compliance with the requirements of the Office of Management and Budget's *Final Information Quality Bulletin for Peer Review* (Federal Register Vol. 70, No. 10, January 14 2005, pp 2664-2677). The use of a certified model does not constitute technical review of the planning product. Independent technical review of the selection and application of the model and the input data is still the responsibility of the users. Once a model is certified, the PCXs will work with model developers and managers to ensure that documentation and training in model use are available and that model updates comply with certification requirements.

The primary criterion identified for model certification is technical soundness. Technical soundness reflects the ability of the model to represent or simulate the processes and/or functions it is intended to represent. The performance metrics for this criterion are related to theory and computational correctness. In terms of the theory, the certified model should: 1) be based on validated and accepted "state of the art" theory; 2) incorporate USACE policies and requirements; 3) properly incorporate the conceptual theory into the software code; and, 4) clearly define the assumptions inherent in the model. In terms of computational correctness, the certified model should: 1) employ proper functions and mathematics to estimate functions and processes represented; and, 2) properly estimate and forecast the actual parameters it is intended to estimate and forecast. Other criteria for certification are efficiency, effectiveness, usability, and clarity in presentation of results. A certified model will stand the tests of technical soundness based on theory and computational correctness, efficiency, effectiveness, usability and clarity in presentation of results.

1.2 Objectives

The objectives of this work are to conduct a review for the USACE Ecosystem Planning Center of Expertise (ECO-PCX) to evaluate the technical quality, system quality, and usability of the following models in accordance with *Planning Models Improvement Program: Model Certification* (EC 1105-2-407, dated May 31, 2005) and the *Protocols for Certification of Planning Models* (July 2007), with the goal of certifying each model for use within the geographic area specified in the model documentation.

Model A EnviroFish Functional Reproductive Habitat Model

Model B Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley
Model C Waterfowl Assessment Methodology (WAM)
Model D Delta Region of Arkansas Regional HGM Guidebook

The review will not include a technical evaluation of the application of these models on a specific project. However, sample documentation of model application may be provided for informational purposes.

The general objectives of this work are to: a) prepare a work plan that will describe the process for conducting the model certification reviews of the four ecological models, b) identify potential panel members for the external peer review panel, and c) execute the work plan to conduct the model certification review.

1.3 Scope of Work

As a 501(c)(3) nonprofit science and technology organization with experience in establishing and administering peer review panels for USACE, Battelle was engaged to conduct the Model Review of the Four Ecological Models. Independent review ensures the quality and credibility of USACE planning tools. The Model Certification Review will follow the procedures described in the Department of the Army, USACE guidance entitled *Planning Models Improvement Program: Model Certification* (EC 1105-2-407), dated May 31, 2005, and the PMIP document entitled *Protocols for the Certification of Planning Models*, dated July 2007.

To accomplish the model certification review, subject matter experts will be recruited to participate on the peer review panel. Potential candidates for the peer review panel will be screened for availability, interest, and technical experience in defined areas of expertise and any actual or perceived conflicts of interest (COIs) will be determined. Ultimately, no more than 12 total panel members will be selected for the model certification review panels using predetermined criteria related to technical expertise and credentials in the subject matters related to the documents and materials to be reviewed. The following is a list of documents and reference materials that will be provided to the panel members for the review.

1. EnviroFish User Manual
2. EnviroFish Software
3. EnviroFish model code
4. Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley documentation
5. Habitat Model for Migrating Shorebirds communications
6. A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Forested Wetlands in the Delta Region of Arkansas, Lower Mississippi River Alluvial Valley, including HGM spreadsheets (Appendix D) and spatial data (Appendix E)
7. Waterfowl Assessment Methodology (WAM), also called the Duck-use-day Model

2.0 Methods and Technical Approach

One of the initial steps in the review process is to prepare a detailed work plan (this document) under Task 2. Additional tasks are detailed below in Section 2.0 (this section). The tasks described are based on the key tasks defined and described in detail in the USACE Model Certification For Four Ecological Models: Envirofish, Waterfowl Assessment Methodology (WAM), Migrating Shorebird Habitat Suitability Index Model, and the Delta Region of Arkansas Hydrogeomorphic Methodology (HGM) Guidebook Statement of Work (SOW). All tasks for the reviews shall be performed independent of government supervision, direction, or control.

Task 1: Kick-off Meeting.
Battelle will hold a kick-off teleconference with the PMIP team and representatives from the ECO-PCX. The purpose of the kick-off is to review the schedule, discuss the model review process, and address any questions regarding the scope, review documents, or required panel member expertise. Battelle will review the model documentation provided with the SOW and, based on a comparison with Table 2 of the USACE *Protocols for the Certification of Planning Models*, determine if additional information will be required to conduct the model reviews. A plan for the ECO-PCX providing the additional information required will be developed at this kick-off meeting.

Task 2: Work Plan.
Battelle will prepare a draft and final work plan (this document) that describes the process for conducting four separate and consecutive model reviews, including the screening criteria and process for selecting model review panel members, the schedule, charges to model review panel members (including charge questions), the process for conducting the reviews and drafting and finalizing four reports that summarize the results of each model review, communication and meetings with the USACE project team, and quality control. Battelle will also conduct a cursory review of each model to determine the level of effort required for panel members to conduct their reviews.

USACE has provided comments on the draft work plan and draft charge questions. Battelle has consolidated and address all comments in this final work plan, which was submitted within three (3) working days of the receipt of comments.

Task 3: Prepare and Finalize Charge to Reviewers.
Battelle will prepare and finalize the charge to each model review panel based on technical direction received from USACE and guidance provided in Department of the Army, U.S. Army Corps of Engineers EC No. 1105-2-407, *Planning Models Improvement Program: Model Certification*, dated 31 May 2005, and *Protocols for the Certification of Planning Models*, dated July 2007.

The process and evaluation criteria for the review, as outlined in the *Protocols for Certification of Planning Models* (July 2007), may include any or all of the following steps:

1. Panel members determine whether project needs/objectives are clearly identified and whether the model described is meeting those needs/objectives.

2. Panel members evaluate the technical quality of the models (review of model documentation).
    a. Model is based on well-established contemporary theory.
    b. Model is a realistic representation of the actual system.
    c. Analytical requirements of the model are properly identified and the model addresses and properly incorporates the analytical requirements.
    d. Assumptions are clearly identified, valid, and support the analytical requirements.
    e. USACE policies and procedures related to the model are clearly identified, and the model properly incorporates USACE policies and accepted procedures.
    f. Formulas used in the model are correct and model computations are appropriate and done correctly.
3. Panel members evaluate system quality (review by running test data sets or reviewing the results of beta tests).
    a. Rationale for selection of supporting software tool/programming language and hardware platform is adequately described, and supporting software tool/programming language is appropriate for the model.
    b. Supporting software and hardware is readily available.
    c. Programming was done correctly.
    d. Model has been tested and validated, and all critical errors have been corrected.
    e. Data can be readily imported from/into other software analysis tools, if applicable.
4. Panel members evaluate the usability of the model.
    a. Examine the data required by the model and the availability of the required data.
    b. Examine how easily model results are understood.
    c. Evaluate how useful the information in the results is for supporting project objectives.
    d. Evaluate the ability to export results into project reports.
    e. Training is readily available.
    f. User documentation is available, user friendly and complete.
    g. Adequate technical support is available for the model.
    h. Software/hardware platform is available to all or most users.
    i. Model is easily accessible.
    j. Model is transparent and allows for easy verification of calculations and outputs.

Each model review panel member will be provided with a charge that will guide their review of any model documentation, software, and code provided. The charge will include an assessment of the criteria listed above which are relevant to each review and ask panel members to respond to specific charge questions or directives regarding individual sections of the model document, as appropriate.

Battelle prepared a generic draft charge to the model review panels. The draft charge has been finalized based on technical direction received from USACE. The final charge is being submitted to USACE (Appendix A of this document) for final approval and distribution to the model review panel members.

Task 4: Identify Candidate Reviewers.

Screen Candidate Reviewers

Battelle will develop criteria for selecting the candidate reviewers; contact potential reviewers to evaluate technical skills, potential COIs, availability, and hourly rates; and identify up to 24 (12 primary and 12 backup) available potential experts to serve on the model review panels. The selection criteria used to identify candidate reviewers are provided in Appendix B to this work plan. Battelle will also develop a detailed COI screening questionnaire to be included in recruiting communications (Appendix C of this document). USACE will review the questionnaire, suggest changes (if needed), and approve this COI list prior to any potential reviewer receiving it.

To identify potential reviewers, Battelle will review candidates in Battelle's database of peer reviewers, seek recommendations from colleagues, contact former panel members, and conduct targeted internet searches. Preliminary information about the up to 24 potential reviewers, including brief biographical information and their responses to the COI questionnaire, will be provided to USACE as early as possible.

Specifically, the final model review panels will include members with the expertise described in Table 1 below.

Table 1. Number of Required Panel Members

Panel Member Expertise	A. EnviroFish Model	B. Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley	C. Waterfowl Assessment Model	D. HGM Guidebook
Civil Works Planner/Habitat Evaluation Procedures (HEP) Specialist	1	1	1	
Civil Works Planner/HGM Specialist				1
Programming/Spreadsheet Auditor	1			1
Fisheries Biologist	2			
Hydraulic Engineer	1			
Avian Biologist		2		
Waterfowl Biologist			2	
Wetland Ecologist				1
Forester				1
Total Number of Reviewers	**5**	**3**	**3**	**4**

Greater detail on the desired expertise for each of the panel members is presented in Appendix B of this work plan, along with the selection criteria. Each panel member will review one model, with the exception of the civil works planner/HEP specialist (who will review three models) and the programmer/spreadsheet auditor (who will review two models).

Finalize Contracts with Peer Reviewers

Battelle will identify up to 24 potential panel members and select no more than 12 final panel members according to the selection criteria. For each reviewer, Battelle will prepare a tailored scope of work that describes required panel member activities for this project. This scope of work description, along with a request for quotation and a COI inquiry form (Appendix C) will be sent to each selected peer reviewer. Upon receipt of the reviewers' written quotations indicating willingness to participate and the absence of a COI, Battelle will establish contracts with the panel members at agreed-upon rates and hours to ensure/secure participation. Each contract established also includes a non-disclosure statement.

The scope of work for each peer reviewer will consist of:

- Participation in a Battelle kick-off meeting (via teleconference)
- Participation in a USACE kick-off meeting (via teleconference) with the PDT and Battelle
- Participation in a Habitat Evaluation Procedures (HEP) training teleconference (8 panel members)
- Review and assessment of the technical quality, system quality, and usability of the Four Ecological Models and preparation of individual written comments
- Participation in a panel review teleconference to discuss findings and agree on a list of key topics/issues that will be presented in the Draft Model Certification Review Report and form the basis for the model certification review Final Panel Comments
- Preparation of the model certification review Final Panel Comments
- Review of the Draft Model Certification Review Report before it is submitted to USACE
- Review of USACE comments on the Draft Model Certification Review Report and Final Panel Comments
- Participation in a teleconference with USACE to discuss USACE's comments on the Draft Model Certification Review Report and Final Panel Comments
- Revision of the Draft Model Certification Review Report and Final Panel Comments in response to USACE comments
- Review of the Final Model Certification Review Report before it is submitted to USACE
- Provide additional technical support as directed.

Battelle has estimated the level-of-effort required for each panel member for the reviews in Table 2.

Table 2. Estimated Levels-of-Effort (hours) for Panel Members

	Kickoff Meeting	HEP short-course	A. EnviroFish Model	B. Shorebird Model	C. Waterfowl Model	D. HGM Guidebook	Total Hours
CWP/HEP Specialist	3	15	74	29	74		195

	Kickoff Meeting	HEP short-course	A. EnviroFish Model	B. Shorebird Model	C. Waterfowl Model	D. HGM Guidebook	Total Hours
Fisheries Biologists	3	3	74				80
Hydraulic Engineer	3	3	74				80
Spreadsheet Auditor	3		74			74	151
Avian Biologists	3	3		29			35
Waterfowl Biologists	3	3			74		80
CWP/HGM Specialist	3					74	77
Wetland Ecologist	3					74	77
Forester	3					74	77

Note: CWP = Civil Works Planner; HEP = Habitat Evaluation Procedures

The estimated hours listed above include time for the model review and charge question response, teleconferences, preparation of final comments and Draft Model Certification Review Report, report review, responding to USACE comments on the draft report, Final Model Certification Review Report review, and support-related activities.

Task 5 A-D: Conduct Assessment of Model.
A kick-off meeting with Battelle, the model review panel members, representatives from the USACE ECO-PCX, and Model Proponents will be held via teleconference to discuss the model certification requirements and expectations and to facilitate information exchange for each of the model reviews. One kick-off meeting will be conducted and it will cover all four model certification reviews for models A through D.

The description of the model review process in the following paragraphs applies to each of the four models being reviewed. Battelle will provide the panel members with electronic copies of the documentation for the model, software, and model code; *Protocols for Certification of Planning Models;* EC 1105-2-407, *Planning Models Improvement Program: Model Certification*; and other supporting documentation. USACE will provide these documents to Battelle via its FTP site. Battelle will prepare and deliver a memorandum instructing the panel members to undertake the review and outlining the steps and deadlines. Working with USACE, Battelle will respond to any panel member questions or information requests during the review process.

The panel members will complete their review and provide comments to Battelle. After receipt of all individual panel member comments, Battelle will merge all comments into one document and share the document with the panel members. In addition, Battelle will carefully review the comments and identify key issues/topics related to the technical quality, system quality, and usability of the model, as well as the model description and model testing. These key

issues/topics identified in the merged individual comments will be distributed to the panel members.

A panel review teleconference will be convened to ensure the exchange of technical information among the panel members, many of whom will be from diverse scientific backgrounds, and to identify key issues/topics specifically associated with the technical quality, system quality, and usability of the model. The result of the teleconference will be a list of key issues/topics (i.e., findings) that the panel members agree should be presented to USACE in the Draft Model Certification Review Report (Task 7) and as final panel comments. During the teleconference, the specific wording for the final panel comment statement will be agreed upon by all panel members, and final panel comments will be assigned "high," medium," or "low" significance based on the following definitions:

- High: Describes a fundamental problem with the model that could affect the model's ability to serve the intended purpose.
- Medium: Affects the completeness or understanding of the model, model usability, or the level of performance of the model.
- Low: Affects the technical quality of the model documentation but will not affect the performance of the model.

At the end of the teleconference, Battelle will prepare a memorandum to the panel members directing them to prepare specific sections of the Draft Model Certification Review Report (Task 6) based on the findings discussion and the technical quality, system quality, and usability criteria outlined in the *Protocols for Certification of Planning Models*, July 2007. The panel members will also be directed to prepare final panel comments, each of which will include the following four parts: (1) a clear statement of the comment; (2) the basis for the comment; (3) the significance of the comment (high, medium, or low); and (4) recommendations to resolve the comment (including additional research or analysis that may influence the conclusions). The individual comments in response to the charge and the panel review teleconference notes will be used as background information to prepare the final panel comments and the Model Certification Review Report.

Task 6 A-D: Prepare Draft Certification Report.
Four separate Draft Model Certification Review Reports for models A through D will be prepared and submitted. Battelle will prepare each Draft Model Certification Review Report and submit it to USACE for review. The report will assess the degree to which the model meets the technical quality, system quality, and usability criteria outlined in the *Protocols for Certification of Planning Models*, July 2007.

The report will follow the general outline below:

1.0 Introduction

1.1. Model Purpose

1.2. Model Assessment

1.3. Contribution to Planning Effort

1.4. Report Organization

2.0 Model Description

2.1. Model Applicability

2.2. Model Summary

2.3. Model Components

3.0 Model Evaluation

3.1. Assessment Criteria

3.1.1.Technical Quality

3.1.2.System Quality

3.1.3.Usability

3.2. Approach to Model Testing

3.3. Technical Quality Assessment

3.3.1.Review of Theory and External Model Components

3.3.2.Review of Representation of the System

3.3.3.Review of Analytical Requirement

3.3.4.Review of Model Assumptions

3.3.5.Review Ability to Evaluate Risk and Uncertainty

3.3.6.Review Ability to Calculate Benefits for Total Project Life

3.3.7.Review of Model Calculations/Formulas

3.4. System Quality

3.4.1.Review of Supporting Software

3.4.2.Review of Programming Accuracy

3.4.3.Review of Model Testing and Validation

3.5. Usability

3.5.1.Review of Data Availability

3.5.2.Review of Results

3.5.3.Review of Model Documentation

3.6. Model Assessment Summary

4.0 Conclusions

5.0 References

The final panel comments will be included as an appendix to the Draft Model Certification Review Reports. Individual comments will not be included in the Draft Model Certification Review Reports.

The Draft Model Certification Review Reports will be submitted electronically to USACE for review. The ECO-PCX and PMIP will review the Reports and provide comments back to Battelle.

Task 7 A-D: Meeting to Discuss Findings.

As necessary, for each model review (A – D), Battelle and the panel members will meet via teleconference with USACE's Technical Point of Contact, representatives from the ECO-PCX

and CECW-P, and Model Proponents to discuss their initial findings and ask clarifying questions that will aid in determining the information to be included in each of the Model Certification Review Reports.

Task 8 A-D: Prepare Final Certification Report.
For each model review (A – D), Battelle will prepare a Final Model Certification Review Report including a description of the process used to assess the model, assessment of the model based on the criteria outlined in Section 3.a. of *Protocols for Certification of Planning Models* (July 2007) and issues related to model recommendation.

3.0 Quality Control and Quality Assurance

During the review of the Four Ecological Models, there are numerous instances when quality assurance and/or quality control (QA/QC) practices will be implemented to ensure products of the highest quality are being provided to USACE. These QA/QC practices are described below.

Deliverable Review
It is Battelle policy that every deliverable be independently reviewed to ensure that it is accurate, technically sound, has objective interpretation, solid conclusions, satisfying presentation, and meets or exceeds client expectations. The deliverables for this project are listed in Section 4.0 of this work plan. The review may include a technical, editorial, and/or quality assurance component, depending on the document and project requirements. The Project Manager (PM) will determine the type(s) of review appropriate for each deliverable. In addition, per Battelle policy, all deliverables must have a one-over-one review and approval by the appropriate Battelle Manager prior to external distribution.

In addition to general technical, editorial, and/or QA reviews, Battelle will assign at least two people familiar with the project to review the panel members' responses to the charge questions. Because the charge question responses are used to develop the key themes of the panel members' findings, it is important that the responses be reviewed by a second person to ensure that the key themes have been appropriately captured. In addition to the charge question responses, each final panel comment is carefully reviewed by both the PM and the Deputy Project Manager (DPM) to ensure accuracy and thoroughness.

Peer Review Panel Recruitment
As an unbiased panel is critical to the successful completion of the Model Certification Review process, Battelle conducts a thorough peer review panel recruitment process. The first step in this process is the preparation of a COI questionnaire. Each potential panel member must fully complete the COI (see Appendix C for the COI issues identified for the Four Ecological Models reviews). In addition, USACE will provide information on more general COI issues that have been identified by USACE. USACE must approve the final list of potential COI issues before the questionnaire is distributed to potential panel members.

A detailed review is conducted for each candidate panel member. The Battelle recruitment team will present each candidate panel member's technical qualifications and COI screening responses to the Battelle PM and DPM. The candidate's qualifications are compared to the scope of work

and to the pool of potential candidates. If there are any outstanding questions regarding the candidates' responses to the COI screening, the candidate is contacted and the questions resolved prior to submitting the candidate's name to USACE.

Teleconferences

Teleconferences are an important component of conducting a Model Certification Review. They are critical to developing the final panel comments and discussing the final panel comments with USACE. Thus, accurate recording of action items, resolutions, and other information discussed during these teleconferences is critical to the process. To ensure that important information is not missed, Battelle provides at least two note-takers for all teleconferences and kick-off meetings with USACE and/or the panel members. All sets of notes taken by Battelle staff are compared and consolidated after each teleconference to provide one set of official notes. These notes are retained in the project files.

Development of Talking Points for Panel Review Teleconference

After reviewing all the panel members' comments in response to charge questions on the review documents, a talking points memorandum is developed by the DPM prior to the panel review teleconference. This document guides the teleconference and includes the key themes identified from the panel's comments, in addition to specific issues where the reviewers may have disagreed with one another. After drafting the talking points memo, the DPM sends it to at least one member of the Battelle project team to ensure that no important issues were omitted. The talking points are also provided to the panel members prior to the teleconference for review.

4.0 Reporting

Deliverables for the Certification of Four Ecological Models project include the following:

- Draft and final version of the work plan and Model Certification Review Charges
- Final list of up to 24 (primary and backup) selected model review panel members
- Draft and final Model Certification Review Report – EnviroFish Model
- Draft and final Model Certification Review Report – Shorebird Model
- Draft and final Model Certification Review Report – Waterfowl Model
- Draft and final Model Certification Review Report – HGM Guidebook

All draft and final deliverables will be provided to USACE electronically only and in PDF format, with the exception of each Final Model Certification Review Report, which will be sent to the USACE Technical Representative in hard copy (in addition to electronically). The draft work plan and charges were also provided to the USACE in Microsoft Word 2003 format to facilitate their review and allow comments and suggested revisions to be made in track changes.

There are no monthly report requirements for this project.

5.0 Schedule

The due dates for milestones and deliverables in Table 3 below are based on the date Battelle was supplied the final decision regarding the process to follow for conducting these four reviews (September 22, 2009). The asterisks indicate deliverables. All changes to the schedule will be documented and a revised schedule will be submitted to the USACE for approval.

Table 3. Four Ecological Models Certification Review Milestones and Deliverables

TASK	ACTION	DUE DATE
	Receipt of final decision on review process	**9/22/09**
	Review documents available	various
1	USACE/Battelle Kick-off Meeting	09/17/09
	USACE/Battelle/Panel Kick-off Meeting with all panel members	10/28/09
2	*Battelle submits Draft Work Plan to USACE	10/1/09
	USACE provides comments on Draft Work Plan	10/5/09
	Conference Call (if necessary)	TBD
	*Battelle submits Final Work Plan to USACE	10/8/09
3	*Battelle submits Draft Charge (combined with Draft Work Plan – Task 1) to USACE	10/1/09
	USACE provides comments on draft charge	10/5/09
	*Battelle submits Final Charge (combined with Final Work Plan – Task 1) to USACE	10/8/09
	USACE approves Final Charge	10/13/09
4	Battelle provides USACE with conflict of interest (COI) statements for review	9/14/09
	Battelle recruits and screens up to **24** candidate panel members	10/16/09
	*Battelle submits list and summary information of candidate panel members	10/16/09
	USACE provides comments on candidate panel members	10/21/09
	Battelle completes subcontracts for panel members	10/30/09
5A	Battelle provides review documents to panel members	11/2/09
	Panel **A** completes its review	11/20/09
	Battelle collates comments from panel **A**	11/24/09
	Battelle convenes panel review teleconference for panel **A**	12/01/09
	Panel **A** provides final panel comments and report section writing assignments to Battelle	12/11/09
6A	Battelle convenes teleconference with USACE to ask clarifying questions	As needed
7A	*Battelle submits Draft Model Certification Review Report **A** to USACE for review	1/5/10
	USACE provides comments on Draft Model Certification Review Report **A**	1/11/10
	Battelle convenes teleconference to discuss USACE comments on Draft Model Certification Review Report **A**	1/14/10
8A	*Battelle submits Final Model Certification Review Report **A** to USACE	1/22/10
5B	Battelle provides review documents to panel members	11/2/09
	Panel **B** completes its review	1/29/10
	Battelle collates comments from panel **B**	2/2/10

TASK	ACTION	DUE DATE
	Battelle convenes panel review teleconference for panel **B**	2/3/10
	Panel **B** provides final panel comments and report section writing assignments to Battelle	2/15/10
6B	Battelle convenes teleconference with USACE to ask clarifying questions	As needed
7B	*Battelle submits Draft Model Certification Review Report **B** to USACE for review	3/1/10
	USACE provides comments on Draft Model Certification Review Report **B**	3/8/10
	Battelle convenes teleconference to discuss USACE comments on Draft Model Certification Review Report **B**	3/10/10
8B	*Battelle submits Final Model Certification Review Report **B** to USACE	03/17/10
5C	Battelle provides review documents to panel members	11/2/09
	Panel **C** completes its review	1/7/09
	Battelle collates comments from panel **C**	1/11/09
	Battelle convenes panel review teleconference for panel **C**	1/12/09
	Panel **C** provides final panel comments and report section writing assignments to Battelle	1/20/10
6C	Battelle convenes teleconference with USACE to ask clarifying questions	As needed
7C	*Battelle submits Draft Model Certification Review Report **C** to USACE for review	2/3/10
	USACE provides comments on Draft Model Certification Review Report **C**	2/10/10
	Battelle convenes teleconference to discuss USACE comments on Draft Model Certification Review Report **C**	2/15/10
8C	*Battelle submits Final Model Certification Review Report **C** to USACE	2/22/10
5D	Battelle provides review documents to panel members	11/2/09
	Panel **D** completes its review	1/7/09
	Battelle collates comments from panel **D**	1/11/09
	Battelle convenes panel review teleconference for panel **D**	1/12/09
	Panel **D** provides final panel comments and report section writing assignments to Battelle	1/20/10
6D	Battelle convenes teleconference with USACE to ask clarifying questions	As needed
7D	*Battelle submits Draft Model Certification Review Report **D** to USACE for review	2/3/10
	USACE provides comments on Draft Model Certification Review Report **D**	2/10/10
	Battelle convenes teleconference to discuss USACE comments on Draft Model Certification Review Report **D**	2/15/10
8D	*Battelle submits Final Model Certification Review Report **D** to USACE	2/22/10
	Project Closeout	4/30/2010

Note: A indicates tasks for the review of the EnviroFish model, B indicates tasks for the review of the Habitat Model for Migrating Shorebirds in the Upper Mississippi Aluvial Valley, C indicates tasks for the review of the Waterfowl Assessment Methodology, and D indicates tasks for the review of the Delta Region of Arkansas Hydrogeomorphic Methodology Guidebook.
* = deliverable

6.0 Project Organization and Communication

Role and contact information for the key persons who will be working on the Four Ecological Models Review are presented in Table 4 (Battelle staff members), and Table 5 (USACE Project Delivery Team).

Table 4. Battelle Staff for the Four Ecological Models Project IEPR

Name	Project Role	Phone	E-mail
Karen Johnson-Young	Project Manager	(561) 656-6304	johnson-youngk@battelle.org
Amanda Maxemchuk	Deputy Project Manager	(781) 952-5384	maxemchuka@battelle.org
Rachel Sell; Corey Wisneski	Recruiting	(614) 424-3579; (781) 952-5296	sellr@battelle.org; wisneskic@battelle.org
Anne Gregg	Subcontracting Lead	(614) 424-7419	gregga@battelle.org

Table 5. USACE Staff for the Four Ecological Models Project

Name	Project Role	Phone	E-mail
Charles Theiling	Technical Representative/Point of Contact (Rock Island District)	(309) 794-5636	charles.h.theiling@usace.army.mil
Jodi K. Staebell	Alternate Technical Representative/Alternate Point of Contact (Mississippi Valley Division)	(309) 794-5448	jodi.k.staebell@usace.army.mil
Daniel Ward	Alternate Technical Representative/Alternate Point of Contact PDT (Memphis District)	(901) 544-0709	daniel.d.ward@usace.army.mil
Kelly Baerwaldt	Contracting Officer's Representative (Rock Island District)	(309) 794-5285	kelly.l.baerwaldt@usace.army.mil

Communication with USACE

Battelle's Point of Contact (POC) is the Technical Representative for the ECO-PCX. The alternate POC will be copied on all emails to the POC. If the POC is not available (e.g., on vacation), Battelle will contact the alternate POC directly. Communications may include status reports, questions, and/or requests for additional information from the panel.

Communication with the Model Review Panel

Battelle will be the main POC between USACE and model review panel members. Direct contact between the USACE and model review panel members will only occur during teleconferences with a Battelle representative present. All other communications will be directed through Battelle's Project Manager and Deputy Project Manager. The panel will be briefed that they are to have no direct communication with USACE and if they are contacted by USACE, they are to immediately inform Battelle.

7.0 Budget

The approved budget for this project is $392,531.

This page intentionally left blank.

APPENDIX A

Final Charge Guidance and Questions to the Peer Reviewers for the Model Certification Review of *Model Name*[1]

BACKGROUND
Model-specific background will be added.

OBJECTIVE

The objective of this effort is to conduct a review to evaluate the technical approach, system quality, and usability of the ***Model Name***. The ***Model Name*** will be evaluated in accordance with EC 1105-2-407, *Planning Models Improvement Program: Model Certification* (May 2005) and the *Protocols for Certification of Planning Models* (July 2007).

The U.S. Army Corps of Engineers Planning Models Improvement Program (PMIP) was established in 2003 to assess the state of planning tools and models in the U.S. Army Corps of Engineers (USACE) and to make recommendations to assure that high quality methods and tools are available to enable informed decisions on investments in the Nation's water resources infrastructure and natural environment. The main objective of the PMIP is to carry out "a process to review, improve and validate analytical tools and models for USACE Civil Works business programs." The model review for the ***Model Name*** will follow the guidance described in the Department of the Army, U.S. Army Corps of Engineers document entitled *Planning Models Improvement Program: Model Certification* (EC 1105-2-407), dated May 31, 2005, and the Planning Models Improvement Programs document entitled *Protocols for the Certification of Planning Models*, dated July 2007.

MODEL REVIEW

The following outlines the basic steps for the USACE model certification process. These steps are designed to guide the review of models being certified for widespread use and are also used to assess the technical quality and applicability of project-specific models. Model development is a multi-step, iterative process, with the number of steps and iterations being dependent upon the complexity of the model. In general, these steps occur in four fundamental stages.

- Stage 1 (Requirements Stage) involves identifying the need for a specific analytical capability and the options for tools to meet the need.
- Stage 2 (Development Stage) involves the development of software programming code or a spreadsheet and testing by the model developer.
- Stage 3 (Model Testing Stage) involves a beta test of the model by selected users whose objective is to validate the model and ensure that it is usable in real world applications.
- Stage 4 (Implementation Stage) involves providing training, user support, maintenance and continuous evaluation of the model.

[1] Note that all highlighted items in this draft charge will be changed to be specific for the model under review

The certification procedure depends on the stage of model development. The process may include the following steps.

1. Panel members determine whether project needs/objectives are clearly identified and whether the model described is meeting those needs/objectives.
2. Panel members evaluate the technical quality of the models (review of model documentation).
    a. Model is based on well-established contemporary theory.
    b. Model is a realistic representation of the actual system.
    c. Analytical requirement of the model are properly identified and the model addresses and properly incorporates the analytical requirements.
    d. Assumptions are clearly identified, valid, and support the analytical requirements.
    e. USACE policies and procedures related to the model are clearly identified, and the model properly incorporates USACE policies and accepted procedures.
    f. Formulas used in the model are correct and model computations are appropriate and done correctly.
3. Panel members evaluate system quality (review by running test data sets or reviewing the results of beta tests).
    g. Rationale for selection of supporting software tool/programming language and hardware platform is adequately described, and supporting software tool/programming language is appropriate for the model.
    h. Supporting software and hardware is readily available.
    i. Programming was done correctly.
    j. Model has been tested and validated, and all critical errors have been corrected.
    k. Data can be readily imported from/into other software analysis tools, if applicable.
4. Panel members evaluate the usability of the model.
    l. Examine the data required by the model and the availability of the required data.
    m. Examine how easily model results are understood.
    n. Evaluate how useful the information in the results is for supporting project objectives.
    o. Evaluate the ability to export results into project reports.
    p. Training is readily available.
    q. User documentation is available, user friendly and complete.
    r. Adequate technical support is available for the model.
    s. Software/hardware platform is available to all or most users.
    t. Model is easily accessible.
    u. Model is transparent and allows for easy verification of calculations and outputs.

The final deliverable for this effort will be a Model Certification Review Report that Battelle will deliver to USACE. The model review panel members will contribute to the preparation of the draft and final reports, as well as participate in two teleconferences with USACE and the Model Proponents to discuss review panel comments on the method (first teleconference) and USACE comments on the Draft Model Certification Review Report (second teleconference). The general outline for the report will be:

1.0 Introduction
1.1. Model Purpose
1.2. Model Assessment
1.3. Contribution to Planning Effort
1.4. Report Organization
2.0 Model Description
2.1. Model Applicability
2.2. Model Summary
2.3. Model Components
3.0 Model Evaluation
3.1. Assessment Criteria
3.1.1. Technical Quality
3.1.2. System Quality
3.1.3. Usability
3.2. Approach to Model Testing
3.3. Technical Quality Assessment
3.3.1. Review of Theory and External Model Components
3.3.2. Review of Representation of the System
3.3.3. Review of Analytical Requirement
3.3.4. Review of Model Assumptions
3.3.5. Review Ability to Evaluate Risk and Uncertainty
3.3.6. Review Ability to Calculate Benefits for Total Project Life
3.3.7. Review of Model Calculations/Formulas
3.4. System Quality
3.4.1. Review of Supporting Software
3.4.2. Review of Programming Accuracy
3.4.3. Review of Model Testing and Validation
3.5. Usability
3.5.1. Review of Data Availability
3.5.2. Review of Results
3.5.3. Review of Model Documentation
3.6. Model Assessment Summary
4.0 Conclusions
5.0 References

DOCUMENTS PROVIDED

The following is a list of documents and reference materials that will be provided for the review. **The documents and files presented in bold font are those which are to be reviewed.** All other documents are provided for reference.

- **Model Documentation**
- **Software**
- **Model Code**
- Department of the Army, U.S. Army Corps of Engineers *Planning Models Improvement Program: Model Certification* (EC 1105-2-407), dated May 31, 2005
- USACE Planning Models Improvement Programs document entitled: *Protocols for the Certification of Planning Models*, dated July 2007

SCHEDULE

Task	Activity	Due Date	Projected Date
5	*Conduct kick-off conference call with panel members and Model Proponents	Within 3 days of completing contracts	October 28, 2009
	Model review panel members submit comments to Battelle	Within 12 days of kick-off conference call with panel members	*Date*
	Contractor convenes meeting with panel members to discuss initial findings	Within 3 days of receipt of model team comments	*Date*
6	*Convene teleconference with USACE to ask clarifying questions on initial findings	Within 5 days of receipt of model team comments	As needed
	*Submit Draft Model Review Report to USACE for review	Within 14 days of receiving final panel comments and writing assignment from panel members	*Date*
	USACE provide comments on Draft Model Review Report	Within 5 days of receipt of draft report	*Date*
7	Convene a teleconference with USACE to discuss the Draft Review Report	Within 2 days of receipt of USACE comments	*Date*
8	*Submit the Final Model Review Report to the USACE	Within 5 days of review conference call on USACE draft report comments	*Date*

* denotes a deliverable

CHARGE FOR PEER REVIEW

The charge questions and guidelines are based on the model certification criteria discussed in the guidance document *Protocols for Certification of Planning Models* (July 2007) from the USACE

Planning Models Improvement Program. The intent of these questions is to focus your thinking, not to suggest or dictate your answers. We want you to consider several aspects of models during your review, from the inputs to the outputs to the underlying structure of the method.

General Charge Guidance

1. Please answer the scientific and technical questions listed below and conduct a broad overview of the model. Please focus on your areas of expertise and technical knowledge.
2. Evaluate the soundness of model as applicable and relevant to your area of expertise. Comment on whether model explains past events and how model will be validated.
3. Please focus the review on scientific information, including factual inputs, data, the use and soundness of model calculations, assumptions, and results that inform decision makers.
4. Offer opinions as to whether the model parameters and formulas are sufficient to quantify ecosystem function.
5. Panel members may contact each other. However, panel members **should not** contact anyone who is or was involved in the project, prepared the subject documents, developed the model, or was part of the USACE Independent Technical Review.
6. Please contact the Battelle Deputy Project Manager, Amanda Maxemchuk (maxemchuka@battelle.org) and cc: Karen Johnson-Young (johnson-youngk@battelle.org) if you have questions for Battelle or the USACE or need additional information.
7. In case of media contact, notify the Battelle project manager immediately.

Your name will appear as one of the panelists in the peer review. Your comments will be included in the Final Model Certification Review Report, but will remain unattributed. The Final Model Certification Review Report is expected to be released to the public by the USACE at some time in the future.

Please submit your comments in electronic form to Amanda Maxemchuk (maxemchuka@battelle.org) **no later than *Date*.**

MODEL ASSESSMENT CRITERIA

General Questions

1. Are the project needs/objectives clearly identified?

2. Does the model described meet those needs/objectives?

Technical Quality

3. Comment on the overall technical quality of the model.

4. Comment on the temporal and spatial resolution of the model.

5. Is it clear where the model's geographic boundaries fall?

6. Are the limitations of the model clearly defined?
   a. How do the limitations impact the ability of the model to evaluate ecological benefits?
   b. What are the potential impacts to the project?
   c. How can those limitations be overcome?

7. Is the model based on well-established contemporary theory?

8. Is the model a realistic representation of the actual ecosystem?

9. Does the model effectively capture the variables that are most important for the intended use of the model?

10. Comment on the precision and accuracy of the model for evaluating potential outcomes of project alternatives. What factors/variables provide the greatest impact on precision and accuracy?

11. Comment on the sensitivity of the model.

12. Are the analytical requirements of the model properly identified?

13. Does the model address and properly incorporate the analytical requirements?

14. Are the assumptions clearly identified, valid, and do they support the analytical requirements?

15. Comment on the ability of the model to evaluate risk and uncertainty.

16. Comment on the ability of the model to evaluate impacts and benefits for total project life.

17. Comment on the ability of the model to determine adequate compensatory mitigation.

18. Are the formulas used in the models correct and are the model macros and computations appropriate and done correctly?

19. Are USACE policies and procedures related to the model clearly identified, and does the model properly incorporate USACE policies and accepted procedures?

20. Do the models allow the user(s) to make assumptions regarding future global events such as, but not limited to, global climate change and changes to sea level.

System Quality

21. Is the rationale for the selection of the supporting software tool/programming language and hardware platform adequately described?

22. Is the supporting software tool/programming language is appropriate for the model?

23. Was the programming done correctly?

24. Can data be readily imported from/into other software analysis tools?

25. Has the model been sufficiently tested and validated, and have all critical errors been corrected?

26. Are error checks built into the models?

27. Do the models work using both sensible and non-sensible data?

Usability

28. Comment on the model usability.

29. Comment on the availability of the data required by the model.

30. How easily are model results understood?

31. Comment on how useful the information in the results is for supporting project objectives.

32. Comment on the usability of the model for selecting the best project alternative.

33. Is user documentation user friendly, and complete?

34. Are the models transparent and do they allow for easy verification of calculations and outputs?

APPENDIX B

Four Ecological Models Model Certification Review Panels Considerations and Proposed Selection/Exclusion Criteria

According to the documents for the Certification of Four Ecological Models, the overall model review scope includes:

- Two avian biologists (Migrating Shorebird Habitat Suitability Index Model)
- One civil works planner/HEP specialist (EnviroFish, Migrating Shorebird Habitat Suitability Index Model, Waterfowl Assessment Method)
- One civil works planner/HGM specialist (Delta Region of Arkansas HGM Guidebook)
- Two fisheries biologists (EnviroFish)
- One forester (Delta Region of Arkansas HGM Guidebook)
- One hydraulic engineer (EnviroFish)
- One programmer/spreadsheet auditor (EnviroFish, Delta Region of Arkansas HGM Guidebook)
- Two waterfowl biologists (Waterfowl Assessment Method)
- One wetland ecologist (Delta Region of Arkansas HGM Guidebook)

Technical Criteria /Areas of Expertise for Potential Independent External Peer Reviewers

All panel members should have at least 5-10 years of experience and have familiarity with large, complex civil works projects with high public and interagency interests. The panel members should at least have M.S. degrees, although Ph.Ds are preferred.

Technical areas related to **avian biology** (2 experts; Migrating Shorebird Habitat Suitability Index Model):

- Familiarity with methods for evaluating bird habitat suitability and have knowledge of the Lower Mississippi River Valley bird populations, specifically shorebirds.

Technical areas related to **civil works planning and Habitat Evaluation Procedures** (1 expert; EnviroFish, Migrating Shorebird Habitat Suitability Index Model, and Waterfowl Assessment Method reviews):

- Experience in the area of floodplain management including ecosystem restoration, impact analysis, compensatory mitigation and knowledge of Lower Mississippi River Valley ecosystems.
- Experience in the use of HEP.

Technical areas related to **civil works planning and Hydrogeomorphic Models** (1 expert; Delta Region of Arkansas HGM Guidebook):

- Experience in the area of floodplain management including ecosystem restoration, impact analysis, compensatory mitigation and knowledge of Lower Mississippi River Valley ecosystems.
- Experience in the use of Hydrogeomorphic approach for assessing wetland functions.

Technical areas related to **fisheries biology** (2 experts, EnviroFish):

- Familiarity with the methods for evaluating fish habitat suitability and have knowledge of the Lower Mississippi River Valley fisheries.
- Experience working with hydrologic and hydraulic modelers to evaluate floodplain hydraulics is desirable.

Technical areas related to **forestry** (1 expert, Delta Region of Arkansas HGM Guidebook):

- Experience in riverine forest ecology, experience in bottomland hardwood community structure and dynamics within the Lower Mississippi River Valley.
- Familiarity with ecosystem output evaluation, particularly the hydrogeomorphic approach to assessing wetland function, is essential.

Technical areas related to **hydraulic engineering** (1 expert, EnviroFish):

- Experience in estimating the effects of flood protection on floodplain hydrology using the HEC-RAS 1-D Flow and associated DSS (direct storage system) files and conducting ecosystem restoration output evaluations.

Technical areas related to **programmer/spreadsheet auditing** (1 expert, EnviroFish and Delta Region of Arkansas HGM Guidebook):

- Experience testing, debugging and auditing computer programs/spreadsheets to check for accuracy of formulas, cell references, and computer code.
- Must have experience with Java programming language.

Technical areas related to **waterfowl biology** (2 experts, Waterfowl Assessment Method):

- Familiarity with methods for evaluating waterfowl habitat suitability and have knowledge of the Mississippi River Valley migratory waterfowl.

Technical areas related to **wetland ecology** (1 expert, Delta Region of Arkansas HGM Guidebook):

- Experience in wetland ecology of large floodplain rivers, preferably experience in southern bottomland wetlands.
- Familiarity with ecosystem output evaluation, particularly the Hydrogeomorphic approach to assessing wetland function, is essential.

Other considerations:

- Participation in previous USACE technical review panels
- Other technical review panel experience

Reviewer Categories [candidate may fit into more than one category]

- Academic
- Consultant (company-affiliated, *e.g.*, architect-engineer or consulting firm)
- Consultant (independent)
- Non-governmental organization (*e.g.*, public agency)

Potential Exclusion Criteria/Conflicts of Interest

- Involvement by you or your firm[1] in any part of the development, assessment, or review of the following models:
    - EnviroFish Functional Reproductive Habitat Model
    - Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley/Migrating Shorebird Model
    - Waterfowl Assessment Methodology/ Duck Use Days Model
    - A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Forested Wetlands in the Delta Region of Arkansas, Lower Mississippi River Alluvial Valley
- Involvement by your firm[1] in any part of the St. Johns Bayou and New Madrid Floodway Environmental Impact Statement process, including:
    - Final Environmental Impact Statement entitled Mississippi River and Tributaries, Mississippi River Levees (MRL) and Channel Improvement (1976);
    - Final EIS entitled St. Johns Bayou/New Madrid Floodway Project Final EIS (1982);
    - 1998 Mississippi River Mainline Levees Enlargement and Seepage Control EIS
    - Draft Supplemental EIS (1999)
    - Final Supplemental EIS (2000)
    - Revised Supplemental EIS (2002); or,
    - Second Revised Supplemental EIS (2006).
- Any involvement by you or your firm[1] in the conceptual or actual design, construction, or O&M of the St. Johns Bayou and New Madrid Floodway, MO project or the Mississippi River and Tributaries Project.
- Involvement as an expert or provided testimony for the civil action (04-1575) Environmental Defense, et al. v. U.S. Army Corps of Engineers (USACE) et al.
- Involvement as an expert or provided testimony for Water Quality Certification for the St. Johns Bayou and New Madrid Floodway Project (06-0421) Missouri Coalition for the Environment, et al. v. Missouri Department of Natural Resources *et al*.
- Any involvement by you or your firm[1] in any litigation involving the United States of America and the U.S. Army Corps of Engineers in particular
- Any application by you or your firm[1] for a USACE permit of any nature or representation for a client that applied for a USACE permit of any nature within the boundaries of the Memphis or Vicksburg Districts.
- Current employment by the USACE.
- Current or previous employee or affiliation with the interagency mitigation team or the local sponsor, the U.S. Fish and Wildlife Service, Environmental Protection Agency, Missouri Department of Conservation, Missouri Department of Natural Resources, and the St. Johns Levee and Drainage District.
- Any employment as an individual or contractually by a State agency, levee or drainage district, or a city or municipality that had committed to serve as a local sponsor for a USACE project within the boundaries of the Memphis, or Vicksburg Districts.
- Current or previous employment or affiliation with Environmental Defense, National Wildlife Federation, or Missouri Coalition for the Environment (for pay or pro bono).

- Any voluntary service by you or your firm[1] to provide expert opinions or testimony in connection for any party in connection with a federal project.
- Current or future interests in the St. Johns Bayou and New Madrid Floodway Project.
- Involvement with paid or unpaid expert testimony related to the models or document listed above in numbers 1 and 2.
- Current personal involvement with other USACE projects, including whether involvement was to author any manuals or guidance documents for USACE. If yes, provide titles of documents or description of project, dates, and location (USACE district, division, Headquarters, ERDC, etc.), and position/role. Please highlight and discuss in greater detail any projects that are specifically with the Vicksburg District or the Memphis District.
- Current firm[1] involvement with other USACE projects, specifically those projects/contracts that are with the Vicksburg District or the Memphis District. If yes, provide title/description, dates, and location (USACE district, division, Headquarters, ERDC, etc.), and position/role.
- Previous employment by USACE as a direct employee or contractor (either as an individual or through your firm[1]) within the last 10 years, notably if those projects/contracts are with the Vicksburg District or the Memphis District. If yes, provide title/description, dates employed, and place of employment (district, division, Headquarters, ERDC, etc.), and position/role.
- Other USACE affiliation [e.g., scientist employed by USACE (except as described in NAS criteria, see EC 1105-2-410 section 8d)].
- Previous experience conducting technical peer reviews. If yes, please highlight and discuss any technical reviews concerning flood risk management projects, and include the client/agency and duration of review (approximate dates).
- A significant portion (i.e., greater than 50%) of personal or firm[1] revenues within the last 3 years came from USACE contracts.
- A significant portion (i.e., greater than 50%) of personal or firm[1] revenues within the last 3 years came from U.S. Fish and Wildlife Service contracts.
- Any publicly documented statement (including, for example, advocating for or discouraging against) related to the models or document listed above in numbers 1 and 2.
- Any publically documented statement advocating for or against the Mississippi River and Tributaries Project, including the St. Johns Bayou and New Madrid Floodway Project.
- Is there any past, present or future activity, relationship or interest (financial or otherwise) that could make it appear that you would be unable to provide unbiased services on this project? If so, please describe:
- Any other perceived COI not listed, such as:
    - Repeatedly served as USACE technical reviewer
    - Paid or unpaid participation in litigation related to the work of the USACE.
    - Prior repeated service as technical advisor to, or expert witness for, Environmental Defense, National Wildlife Federation, the Missouri Coalition for the Environment, or any other interest group that opposed a USACE Project.
    - Any other perceived COI not listed.

[1] Note: Includes any joint ventures in which your firm is involved.

APPENDIX C

Peer Review Conflict of Interest Inquiry

Dear (Peer Reviewer -- insert name):

You have been requested by the U.S. Army Corps of Engineers (USACE) to serve as an external peer reviewer for the Independent External Peer Review of the Model Certification for Four Ecological Models: EnviroFish, Waterfowl Assessment Methodology (WAM), Migrating Shorebird Habitat Suitability Index Model, and the Delta Region of Arkansas Hydrogeomorphic Methodology. Your participation in this review will be greatly appreciated. However, it is possible that your personal affiliations and involvement in particular activities could pose a conflict of interest or create the appearance that you lack impartiality in your involvement for this peer review. Although your involvement in these activities is not necessarily grounds for exclusion from the peer review, you should consult the contact named below or other appropriate official to discuss these matters. Affiliations or activities that could potentially lead to conflicts of interest might include:

a) current work or arrangements concerning future work in support of industries or other parties that could potentially be affected by developments or other actions based on material presented in the document (or review materials) that you have been asked to review;
b) your personal benefit (or benefit of your employer, spouse or dependent child) from the developments or other actions based on the document (or review materials) you have been asked to review;
c) any previous involvement you have had with the development of the document (or review materials) you have been asked to review;
d) any financial interest held by you (or your employer, spouse or dependent child) that could be affected by your participation in this matter;
e) any financial relationship you have or have had with USACE such as employment, research grants, or cooperative agreements;
f) significant portion (i.e., greater than 50%) of your personal or firm's revenues within the last 3 years came from USACE contracts;
g) you or your firm made a publicly documented statement advocating for or against the subject project;
h) litigation associated with USACE; and
i) past, present or future activity, relationship or interest (financial or otherwise) that could potentially be perceived by a third party, or give the appearance that you would be unable to provide independent unbiased subject matter knowledge, expertise, and/or services on this project.

[1] Note: Includes any joint ventures in which your firm is involved

If you have any concerns over a potential conflict of interest, please contact Mr. Mike Genovese, Battelle (GenoveseM@Battelle.org, (614) 424-4007) to discuss any potential conflict of interest

issues at your earliest convenience, but no later than two (2) days after receiving this request.

If you agree to be on this peer review panel, please check one of the following boxes, sign this form, and fax to Mr. Mike Genovese, Battelle, at (614) 458-4007 no later than two (2) days after receiving this request.

This form does not constitute an authorization to participate in this review; authorization for performance will come from Battelle's Government Subcontracts office.

[ ] I have no known existing or potential conflicts of interest associated with this task.

[ ] I have identified and disclosed in writing all known existing or potential conflicts of interest associated with this task.

_____ _____

Signature *Date* *Printed Name*

Volume 3
Part 6.4

Model Certification Review Report for SJNM Shorebird Model

U.S. Army Corps of Engineers
Memphis District

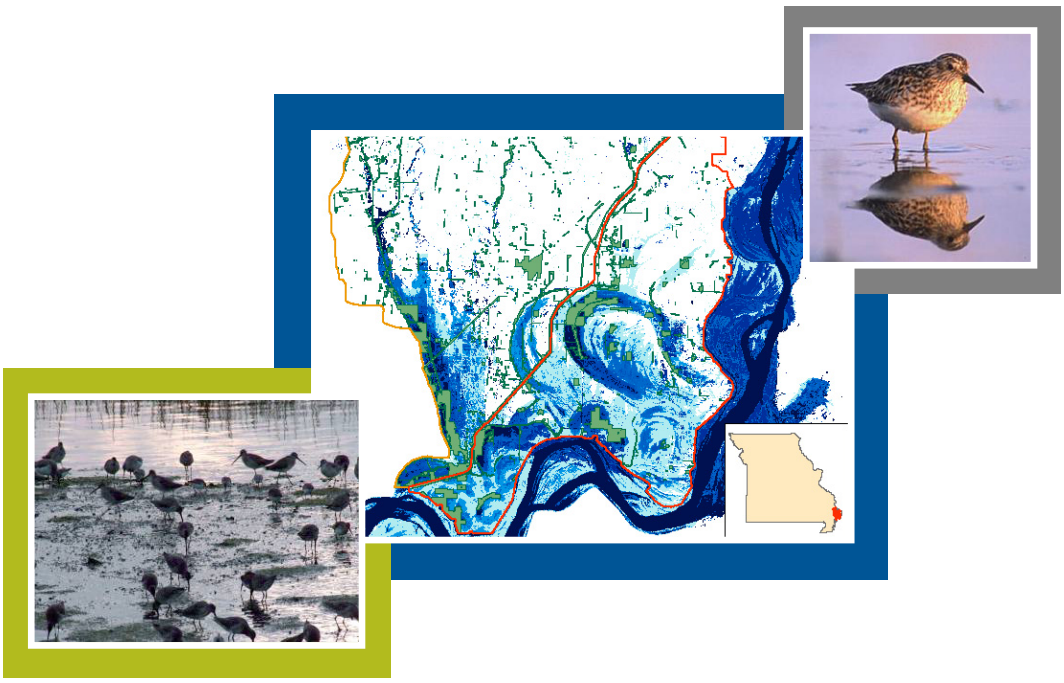
Draft Planning Model Quality Assurance Review Report for the Model Review of the Assessment of Shorebird Habitat within the St. Johns-New Madrid Basins, Missouri (SJNM Shorebird Model)

Prepared by
Battelle Memorial Institute

Prepared for
Department of the Army
U.S. Army Corps of Engineers
Ecosystem Restoration Planning Center of Expertise
Memphis District

Contract No. W912HQ-10-D-002
Task Order: 0008

April 25, 2011



Draft Planning Model Quality Assurance Review Report for the Model Review of the Assessment of Shorebird Habitat within the St. Johns-New Madrid Basins, Missouri (SJNM Shorebird Model)

by

Battelle
505 King Avenue
Columbus, OH 43201

for

Department of the Army
U.S. Army Corps of Engineers
Ecosystem Restoration Planning Center of Expertise
Memphis District

April 25, 2011

Contract No. W912HQ-10-D-002
Task Order: 0008

This page is intentionally left blank.

DRAFT
PLANNING MODEL QUALITY ASSURANCE REVIEW REPORT
for the

Model Review of the Assessment of Shorebird Habitat within the St. Johns-New Madrid Basins, Missouri (SJNM Shorebird Model)

EXECUTIVE SUMMARY

A review of the model for the Assessment of Shorebird Habitat within the St. Johns-New Madrid Basins, Missouri (hereinafter SJNM Shorebird Model) was conducted for the U.S. Army Corps of Engineers (USACE) under Contract Number W912HQ-10-D-002, Task Order 0008 to support the requirements of the Planning Models Improvement Program (PMIP). Established in 2003, the main objective of the PMIP is to carry out "a process to review, improve and validate analytical tools and models for USACE Civil Works business programs" (USACE 2005). Reviews are conducted in accordance with EC 1105-2-407, to ensure that planning models used by USACE are technically and theoretically sound, computationally accurate, and in compliance with USACE planning policy.

As a 501(c)(3) nonprofit science and technology organization with experience in establishing and administering peer review panels for USACE, Battelle was engaged to conduct the review of the SJNM Shorebird Model, which is proposed for use for the St. Johns Bayou and New Madrid Floodway Project. Independent, objective peer review is regarded as a critical element in ensuring the technical quality, system quality, and usability of models and tools used for project planning.

The SJNM Shorebird Model Study Plan was developed to assess the spatial and temporal availability of shallow floodwater habitat in the St. Johns-New Madrid Basins in southeastern Missouri that may be used by migrating shorebirds for foraging. USACE is authorized to implement a flood risk management project in these basins, and the proposed project would complete the levee surrounding the New Madrid Basin and install pumping stations in both the St. Johns and New Madrid Basins. The SJNM Shorebird Model will be used to assess potential impacts to shorebird foraging habitat that may result from implementation of the flood risk management project. The model may also be used for mitigation planning. The model is being developed by Dan Twedt of the U.S. Geological Survey (USGS) Patuxent Wildlife Research Center, in cooperation with the USACE Memphis District.

A panel of four experts (a Habitat Evaluation Procedures [HEP] expert, two avian biologists, and a geospatial analyst) was selected by Battelle and charged with performing a review of the SJNM Shorebird Model. Approximately 118 individual comments were received from the model reviewers in response to 31 charge questions designed to focus the review of the SJNM Shorebird Model. The charge questions were based on the model assessment criteria in the *Protocols for Certification of Planning Models* (USACE 2007). The key findings of the model review regarding the model's technical quality, system quality, and usability are summarized in this report and documented as ten Final Panel Comments presented in Appendix B. The Final

Panel Comments in Appendix B are presented in a five-part format that provides: 1) a clear statement of the issues identified, 2) the relevant model assessment criteria, 3) the basis for the issue, 4) the significance of the issue relative to the performance of the model, and 5) recommendations for resolution.

This draft Planning Model Quality Assurance Review Report for the SJNM Shorebird Model describes the model review process, the selection of model reviewers for the Model Review Panel, and the results of the review. USACE and the model reviewers will discuss the review findings and finalization of this report during a teleconference scheduled for 1:00 – 5:00 pm EDT on May 11, 2011. Once this report has been finalized, the results of the model review as presented in the final report will be taken into consideration for using and possibly revising the SJNM Shorebird Model and model documentation.

During the review of the technical quality, system quality, and usability of the SJNM Shorebird Model, the Model Review Panel determined that the conceptual approach is appropriate for the intended purpose of assessing changes in the availability of suitable shorebird foraging habitat that will result from the St. Johns Bayou and New Madrid Floodway Project. However, some issues were identified regarding the technical quality of the SJNM Shorebird Model and the usability of model outputs. Since models are only approximations of actual systems, all models have limitations. The Model Review Panel has made suggestions regarding how to address the limitations of the SJNM Shorebird Model. Testing and validation of the SJNM Shorebird Model must also be performed to clearly demonstrate its sensitivity, accuracy, and ability to support planning decisions.

In addressing and answering charge questions designed to focus the review of the SJNM Shorebird Model based on the model assessment criteria in the *Protocols for Certification of Planning Models* (USACE 2007), the model reviewers identified the following underlying issues or potential issues with the model.

- Although the model is likely to be able to be used for near-term (5-10 years) future projections, the ability to make projections up to 50 years into the future is limited. This is related to the assumption that land use both upstream and within the project area, and consequently river stage conditions, will not change over time.
- The available geospatial data do not appear to have been used in a way that results in the greatest model accuracy.
- Regarding the model parameters:
    - The model does not include variables for the amount of vegetative cover or vegetation height. Vegetative cover and height strongly influence the suitability of habitat for shorebird foraging, and not including this in the model could lead to an overestimate of available shorebird foraging habitat.
    - The model should weight suitable shorebird habitat for patch size.
    - Qualitative variables need to have quantitative boundaries. This will improve how well model outputs are understood and consistency in application among users.

- The ability of the model to evaluate uncertainty is limited. This is because the response of the model outputs to variation in input parameters and the accuracy of the input parameters has not been quantified.
- The ability to verify and validate the performance of the model is limited. This is because the verification and validation of the model will be based on comparison of the area predicted for shorebird habitat with shallowly inundated area identified in Landsat™ imagery, which has low resolution.
- The model could be strengthened if shorebird use of the habitat was considered during field validation.
- Regarding the model documentation:
  - There is no user documentation for the model.
- If the model is released for more widespread use outside of the project development team (PDT), the model documentation should be improved by providing additional information.

The SJNM Shorebird Model provides a good basis for what could be an effective tool for determining changes in the availability of suitable shorebird foraging habitat at a coarse spatial scale (finer topographic variability is not taken into account). However, the accuracy of the model outputs should be improved for better-informed planning, and the performance of the model needs to be tested and verified before it is applied for decision-making. The Model Review Panel recommends the following actions to improve the technical quality and usability of the SJNM Shorebird Model.

- Estimate the effects of future changes in land use by projecting future changes based on a recent history of land-use changes in the study area, include current and anticipated land use and structural changes upstream when applying historical river-stage data to future conditions, and review and modify the model every 10 years such that the most current changes in river stage and habitat conditions are incorporated.
- Either use the highest-resolution light detection and ranging (LiDAR) data for obtaining the highest model accuracies (preferred), or as an alternative, expand the use of the LiDAR-derived 2-foot contour map from the New Madrid Basin to the St. Johns Basin for obtaining improved model accuracies.
- Conduct an examination of possible methods to distinguish vegetation coverage and heights at a finer scale. If this is not available, provide an explanation of the limitations related to the broad scale definition of vegetation in the model documentation.
- Include a minimum patch size in the definition of suitable shorebird habitat and provide justification for the choice of a minimum patch size.
- Provide quantitative limits for all of the qualitative vegetation variables, including the development of a Suitability Index (SI) value for Conservation Reserve Program (CRP) and set-aside lands.
- Use the model to evaluate ranges of some or all input variables so that the output is a range rather than a single point estimate.

- Consider using higher spatial resolution imagery, such as Sattellite Pour l'Observation de la Terre (SPOT) imagery (10 m pixel size), Quickbird imagery (sub-meter), or SAR imagery (such as TerraSAR-X [1-5 m pixel resolution]) to verify and validate the model.
- Collect data on shorebird use of sites during field validation of the model to confirm shorebird use.
- Expand the SJNM Shorebird Model documentation to:
    - Explain that historic river stages may not represent future river stages and that large scale land-use changes (e.g., changes in agriculture practices) and climate change may result in unforeseen changes to river stage, and include guidelines for how the model will address these changes (e.g., how will changes to inputs be incorporated into the model, what are the minimum levels of change that will require model adjustments, etc.).
    - Emphasize the importance of multiple model runs to assess uncertainty in model outputs.
    - Include an additional section that explicitly details the steps that the users should take for effective application of the model.
    - Provide a clear explanation of the potential impacts from project alternatives on shorebird foraging habitat.
    - Provide a list of terms and their definitions.
    - Include an explanation of the basis for HEP and how the Habitat Suitability Index (HSI) development process was integrated into the development of the SJNM Shorebird Model.
    - Include a description of a validation/modification process that will be applied during the early phases of model application.
    - Provide more information in the existing figures, such as scale and labels.
    - Provide additional figures to help explain the model better.
    - Include the rationale for why 2000 data were chosen for development of the model.
    - Include a complete and comprehensive list of assumptions and limitations in a single location.

This list of actions summarizes the recommendations for resolution in the Final Panel Comments, and more specific detailed recommendations are provided in the Final Panel Comments presented in Appendix B in this report. The level of significance of most of the Final Panel Comments was assigned based on the assumption that the SJNM Shorebird Model is only intended for use by the Project Development Team (PDT) for the St. Johns Bayou and New Madrid Floodway Project, defined to include those who developed the model or know how it was developed; determined and/or understand the methods required to preprocess the data being input to the model and the precision and accuracy required of those data to generate useful model results; served in an advisory role during the development of the SJNM Shorebird Model; and others who served on the teams and without whom the teams would not be complete. If the model is released for general use to a diverse audience, the level of significance of some

comments would be elevated, and all low-significance comments would be assigned medium significance because different users (e.g., public, technical committee and developers) have different levels of understanding, needs and requirements for documentation.

Three issues were identified that need to be addressed for immediate use of the SJNM Shorebird Model by the St. Johns Bayou and New Madrid Floodway Project PDT:

1. The SJNM Shorebird Model needs to consider changes in land use and flood stage.
2. The SJNM Shorebird Model needs to be based on higher resolution geospatial data.
3. The SJNM Shorebird Model needs to be tested and validated to establish its accuracy and determine its sensitivity to variability in model inputs.

Although other issues do not need to be addressed in order for the SJNM Shorebird Model to perform at a very coarse geospatial scale, adopting the recommendations provided would significantly improve the accuracy of the model outputs and the ability to effectively project changes in the availability of suitable shorebird foraging habitat.

This page intentionally left blank

TABLE OF CONTENTS

EXECUTIVE SUMMARY i

1.0 Introduction 1
- 1.1 Model Purpose 1
- 1.2 Model Summary 2
- 1.3 Report Organization 2

2.0 Model evaluation assessment criteria and approach 3
- 2.1 USACE Model Development and Review Process 3
- 2.2 Model Review Approach 5
- 2.3 Approach to Model Testing 8
- 2.4 Assessment Criteria 8

3.0 Technical Quality assessment 9
- 3.1 Review of Theory 9
- 3.2 Review of Representation of the System 9
- 3.3 Review of Analytical Requirements 10
- 3.4 Review of Assumptions 10
- 3.5 Review of Ability to Evaluate Risk and Uncertainty 11
- 3.6 Review of Ability to Calculate Benefits for Total Project Life 11
- 3.7 Review of Calculations/Formulas 12

4.0 System Quality Assessment 12
- 4.1 Review of Supporting Software 13
- 4.2 Review of Programming Accuracy 13
- 4.3 Review of Model Testing and Validation 13

5.0 Usability Assessment 13
- 5.1 Review of User Interface 14
- 5.2 Review of Data Availability 14
- 5.3 Review of Results 14
- 5.4 Review of Documentation 15

6.0 Model Assessment Summary 15

7.0 Conclusions 16

8.0 List of Preparers 19

9.0 References 21

TABLES

Table 1. Experts Selected for the SJNM Shorebird Model Review Panel 19

Appendix A. Charge to the Model Reviewers
Appendix B. Final Panel Comments

Final Panel Comments on the SJNM Shorebird Model

1. Although the model is likely to be able to be used for near-term (5-10 years) future projections, the ability to make projections up to 50 years into the future is limited.....B-3
2. The available geospatial data do not appear to have been used in a way that results in the greatest model accuracy.....B-5
3. The model does not include variables for the amount of vegetative cover and vegetation height.....B-7
4. The model should weight suitable shorebird habitat for patch size.....B-8
5. The ability of the model to evaluate uncertainty is limited. B-9
6. The ability to verify and validate the performance of the model is limited.....B-10
7. Qualitative variables need to have quantitative boundaries.....B-12
8. The model could be strengthened if shorebird use of the habitat was considered during field validation.....B-13
9. There is no user documentation for the model.....B-14
10. If the model is released for more widespread use outside of the model development team, the model documentation should be improved by providing additional information.....B-15

ACRONYMS

COI	Conflict of Interest
CRP	Conservation Reserve Program
DEM	Digital Elevation Map
EC	Engineering Circular
ECO-PCX	Ecosystem Restoration Planning Center of Expertise
ha	Hectare
HEP	Habitat Evaluation Procedures
HSI	Habitat Suitability Index
IEPR	Independent External Peer Review
LiDAR	Light Detection and Ranging
m	Meter
PDT	Project Development Team
PMIP	Planning Models Improvement Program
RMSE	Root Mean Square Error
SAR	Synthetic Aperture Radar
SI	Suitability Index
SJNM	St. Johns and New Madrid
SOW	Statement of Work
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

This page is intentionally left blank.

1.0 INTRODUCTION

A review of the Shorebird Habitat Assessment model within the St. Johns-New Madrid Basins, Missouri (hereinafter SJNM Shorebird Model) was conducted for the U.S. Army Corps of Engineers (USACE) under Contract Number W911NF-07-D-0001, Task Order 0008, Model Certification Support to the Ecosystem Restoration Planning Center of Expertise (ECO-PCX). The objective of the review was to evaluate the technical quality, system quality (limited evaluation), and usability of the SJNM Shorebird Model in accordance with USACE's *Planning Models Improvement Program: Model Certification* (EC 1105-2-407, dated May 31, 2005) and the *Protocols for Certification of Planning Models* (USACE 2007). The USACE Planning Models Improvement Program (PMIP) was established in 2003 to assess the state of USACE planning models and to ensure that high quality methods and tools are available so that informed decisions on investments in the Nation's water resources infrastructure and natural environment can be made. As a 501(c)(3) nonprofit science and technology organization with experience in establishing and administering external peer review panels for USACE, Battelle was engaged to conduct the model review for the SJNM Shorebird Model.

1.1 Model Purpose

USACE planning regulations require that ecosystem impacts and benefits be estimated for proposed project alternatives and that results are included in a Cost Effectiveness and Incremental Cost Analysis to determine the best project for implementation. The SJNM Shorebird Model was designed to evaluate potential impacts to shorebird habitat in the St. Johns and New Madrid basins from implementation of flood risk management projects. The original SJNM Shorebird Model developed in 1998 was abandoned based on comments received during a previous model review regarding the model's ability to effectively project changes in available shorebird habitat, and a new model has been developed with the assistance of members from an independent external peer review (IEPR) panel for the St. Johns Bayou and New Madrid Floodway Project. The new model is being reviewed as a separate and independent model.

The primary goal of this review is to assure the quality of the SJNM Shorebird Model for use by the Project Development Team (PDT) for planning purposes on the St. Johns Bayou and New Madrid Floodway Project. Information provided during the model review will be used by USACE to make any necessary revisions to the SJNM Shorebird Model and/or model documentation for application on the St. Johns Bayou and New Madrid Floodway Project. It is anticipated that the SJNM Shorebird Model may be used for future studies or regulatory actions within the Mississippi Alluvial Valley. Information provided during the model review will be used to assess whether to certify the SJNM Shorebird Model for inclusion in the USACE planning toolbox for broader application under similar circumstances.

The review will focus on the Assessment of Shorebird Habitat within the St. Johns-New Madrid Basins, Missouri, Study Plan (SJNM Shorebird Model Study Plan). The review will not include a technical evaluation of the application of the model on the St. Johns Bayou and New Madrid Floodway Project, as that is the purview of a separate IEPR panel.

1.2 Model Summary

The SJNM Shorebird Model Study Plan was developed to assess the spatial and temporal availability of shallow floodwater habitat in the St. Johns-New Madrid Basins in southeastern Missouri that may be used by migrating shorebirds for foraging. USACE is authorized to implement a flood risk management project in these basins. The proposed project would complete the levee surrounding the New Madrid Basin and install pumping stations in both the St. Johns and New Madrid Basins. The SJNM Shorebird Model will be used to assess potential impacts to shorebird foraging habitat that may result from implementation of the flood risk management project. The model may also be used for mitigation planning. The model is being developed by Dan Twedt, U.S. Geological Survey (USGS) Patuxent Wildlife Research Center, in cooperation with the USACE Memphis District.

1.3 Report Organization

This report presents the approach and the results of the review of the SJNM Shorebird Model and is organized into the following sections:

Section 2.0 Model Evaluation Assessment Criteria and Approach — Describes the model review approach, including the review process and the criteria used to assess technical quality, system quality, and usability.

Section 3.0 Technical Quality Assessment — Describes the key issues identified from the model technical quality assessment.

Section 4.0 System Quality Assessment — Describes the key issues identified from the model system quality assessment.

Section 5.0 Usability Assessment — Describes the key issues identified from the usability assessment.

Section 6.0 Model Assessment Summary — Summarizes the key issues identified during the model review.

Section 7.0 Conclusions — Summarizes the recommendations to resolve the key issues identified during the model review.

Section 8.0 List of Preparers — Contains biographic information on the expert Model Review Panel members selected to perform the review of the model.

Section 9.0 References — Lists the references used for this model assessment and referenced from the model documentation.

Appendix A Contains the final charge guidance and questions to the Model Review Panel to guide the review of the SJNM Shorebird Model.

Appendix B Contains the Final Panel Comment forms that provide the details of the key issues identified by the Model Review Panel during the assessment of the SJNM Shorebird Model.

2.0 MODEL EVALUATION ASSESSMENT CRITERIA AND APPROACH

USACE requires that all planning models be reviewed to ensure that they are technically sound. Models may be certified by USACE either for limited use on a single project or set of projects or for widespread, repeated use across multiple projects within a specified geographic region. The decision whether to certify the model is largely based on results of an independent external peer review (IEPR). Independent, objective peer review is regarded as a critical element in ensuring technical quality, system quality, and usability of the models.

The objective of the review of the SJNM Shorebird Model was to evaluate the technical quality, system quality, and usability of the model, which is proposed for use for the SJNM Assessment, as well as other future studies in the SJNM area. USACE will consider the review findings in determining whether to approve the model for future and/or current regional use.

The main objective of the USACE PMIP is to carry out "a process to review, improve and validate analytical tools and models for USACE Civil Works business programs" (USACE, 2005). Reviews are conducted in accordance with USACE's *Planning Models Improvement Program: Model Certification* (EC 1105-2-407, May 2005) to ensure that models used by USACE are technically and theoretically sound, computationally accurate, and in compliance with USACE planning policy. Model evaluations are conducted following guidance described in the *Protocols for Certification of Planning Models* (USACE 2007).

2.1 USACE Model Development and Review Process

Model development is a multi-step, iterative process, with the number of steps and iterations being dependent upon the complexity of the model. The following basic steps of the USACE model development and certification processes are designed to guide the model review. In general, these steps occur in four fundamental stages:

Stage 1 ***Requirements Stage:*** Identify the need for a specific analytical capability and the options for tools to meet the need.

Stage 2 ***Development Stage:*** Develop software programming code or a spreadsheet model and test it for accuracy.

Stage 3 ***Model Testing Stage:*** A beta of the model is tested by selected users whose objective is to validate the model and ensure that it is usable in real-world applications.

Stage 4 ***Implementation Stage:*** Provide training, user support, maintenance, and continuous evaluation of the model.

The review process depends on the stage of model development. The process may include the following steps.

1. Model reviewers determine whether model needs/objectives are clearly identified and whether the model described is meeting those needs/objectives.

2. Model reviewers evaluate the technical quality of the models (review of model documentation), including whether:
   a. The model is based on well-established contemporary theory.
   b. The model is a realistic representation of the actual system.
   c. Analytical requirements of the model are properly identified and the model addresses and properly incorporates the analytical requirements.
   d. Assumptions are clearly identified, valid, and support the analytical requirements.
   e. USACE policies and procedures related to the model are clearly identified, and the model properly incorporates USACE policies and accepted procedures.
   f. Formulas used in the model are correct and model computations are appropriate and done correctly.
3. Model reviewers evaluate system quality (including review by running test data sets or reviewing the results of beta tests) to determine whether:
   a. The rationale for selection of supporting software tool/programming language and hardware platform is adequately described, and supporting software tool/programming language is appropriate for the model.
   b. The supporting software and hardware are readily available.
   c. The programming was done correctly.
   d. The model has been tested and validated, and all critical errors have been corrected.
   e. Data can be readily imported from/into other software analysis tools, if applicable.
4. Model reviewers evaluate the usability of the model to:
   a. Examine the data required by the model and determine the availability of the required data.
   b. Examine how easily model results are understood.
   c. Evaluate how useful the information in the results is for supporting project objectives.
   d. Evaluate the ability to export results into project reports.
   e. Determine whether training is readily available.
   f. Determine whether user documentation is available, user friendly, and complete.
   g. Determine whether adequate technical support is available for the model.
   h. Determine whether the software/hardware platform is available to all or most users.
   i. Determine whether the model is easily accessible.
   j. Determine whether the model is transparent and allows for easy verification of calculations and outputs.

The SJNM Shorebird Model is currently in the development stage. Consequently, only some of the assessment criteria were evaluated by the model reviewers; other assessment criteria can only be evaluated internally by USACE or were not relevant, including whether USACE policy has been incorporated into the model, and whether the model is easily accessible, training is readily available, and adequate technical support is available. The model review results, which are the subject of this report, are based on a review of the SJNM Shorebird Model Study Plan.

2.2 Model Review Approach

The review process was detailed in the *Final Work Plan for the Model Quality Assurance Review Support to the Ecosystem Planning Center of Expertise for the SJNM Shorebird Model*. The model review process is summarized below and consists of seven tasks:

- Task 1 Participate in Kick-off Teleconference Meeting with USACE
- Task 2 Prepare Work Plan
- Task 3 Identify Candidate Model Reviewers and Select and Finalize Subcontracts with Model Reviewers
- Task 4 Conduct Assessment of Model
- Task 5 Prepare Draft Planning Model Quality Assurance Review Report
- Task 6 Conduct Teleconference Meeting to Discuss Model Review Findings
- Task 7 Prepare Final Planning Model Quality Assurance Review Report.

Battelle participated in a kick-off teleconference meeting with representatives from the USACE ECO-PCX and the model development team (Task 1). The purpose of the meeting was to allow an exchange of information between Battelle and USACE regarding the approach used to conduct the model review, USACE's specific goals and objectives for the model review, the review materials, the expertise required for the review, and the review schedule. Battelle prepared a Work Plan, which included the final review schedule and charge questions and guidance to the Model Review Panel, based on the kick-off teleconference discussions and the USACE Statement of Work (SOW) (Task 2).

Battelle initially contacted the experts who served on the original SJNM Shorebird Model to determine their availability. It was most desirable to have the original model reviewers serve on the Model Review Panel because they were already familiar with the intended application of the model. Of the three original reviewers, only two were available to participate in this review, so another avian biologist needed to be identified. In addition, a geospatial analyst was added to the model review panel because one of the predominant issues identified with the original model had to do with the model's spatial resolution. Battelle identified an additional 28 candidates for the SJNM Shorebird Model Review Panel to fill the two open positions, evaluated their technical expertise, and inquired about potential conflicts of interest (COI). Including the two returning model reviewers, Battelle selected five of the most qualified candidates based on background, years of experience, lack of actual or perceived COI, and confirmed interest and availability (Task 3). Of those five candidates, four were selected as the primary model reviewers for the final Model Review Panel, and one was selected as a backup model reviewer. The remaining candidates were not selected for a variety of reasons, including lack of availability, disclosed COI, or because they did not possess the precise technical expertise required. Information about the candidate model reviewers, including brief biographical information, highest level of education attained, and years of experience, was provided to USACE for feedback. Battelle made the final selection of model reviewers according to the selection criteria described in the Work Plan.

Based on the requirements outlined in the USACE SOW, the final Model Review Panel consisted of the following professionals with the desired relevant experience.

- One expert in ***Habitat Evaluation Procedures (HEP)*** with demonstrated experience in the use and development of HEP. In addition, expertise with HEP application during the planning and evaluation of civil works projects, including impact analysis and mitigation planning. The panel member has a doctorate in environmental science/biology.
- Two experts in ***Avian Biology*** with demonstrated experience in evaluating the habitat suitability for migrating shorebirds and knowledge in migration habitat of shorebirds in large floodplain rivers. Panel members have additional familiarity or experience with HEP and spatial habitat modeling. The panel members have doctorates in wildlife biology.
- One expert in ***Geospatial Analysis*** with demonstrated experience in geospatial topographical analysis, preferably with experience in light detection and ranging (LiDAR) analysis and use of UNET modeled stage data. The panel member has a doctorate in geophysics.

Information on the experts selected for the Model Review Panel is presented in Section 8.0 of this report.

After the model reviewers were under subcontract, Battelle conducted a kick-off teleconference to brief the Model Review Panel on the purpose and approach for the review process. Another kick-off teleconference was convened with Battelle, the Model Review Panel, representatives from the USACE ECO-PCX, and the model development team. This provided the model reviewers an opportunity to be briefed specifically on the model and its intended purpose and to ask questions directly of USACE. The model reviewers were provided with electronic versions of the review documents, along with guidance and a charge (Appendix A) that solicited their comments on specific aspects of the materials that were to be reviewed.

The following document was provided to the model reviewers for the review.

1. Twedt, DJ. 2010, Assessment of Shorebird Habitat within the St. Johns-New Madrid Basins, Missouri. Study Plan 2302-9S270. USGS Patuxent Wildlife Research Center, Vicksburg, MS. 26 pp.

The following additional documents were provided for reference only and were not to be reviewed.

2. Model Documentation for Pre 2010 SJNM Shorebird Model. 18pp.
3. Battelle Memorial Institute. 2010. Final Model Certification Review Report for the Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley (see Appendix B for Final Panel Comments)
4. Battelle Memorial Institute. 2009. Final Independent External Peer Review Report, St. Johns Bayou and New Madrid Floodway, Missouri, Consolidated NEPA Document and Work Plan, Environmental, Economic, and Hydrologic and Hydraulic Review, Phase 1.
5. Battelle Memorial Institute. 2009. Final Panel Comments and Final USACE Evaluator Comments, Final Independent External Peer Review Report, St. Johns Bayou and New Madrid Floodway, Missouri, Consolidated NEPA Document and Work Plan, Environmental, Economic, and Hydrologic and Hydraulic Review, Phase 1.

6. Battelle Memorial Institute. 2010. Addendum to Final Independent External Peer Review Report, St. Johns Bayou and New Madrid Floodway, Missouri Consolidated NEPA Document and Work Plan, Phase 2 Environmental, Economic, and Hydrologic and Hydraulic Review. (See Comments 1, 2 and 15)
7. EC 1105-2-407, Planning - Planning Models Improvement Program: Model Certification, 31 May 2005 http://140.194.76.129/publications/eng-circulars/ec1105-2-407/entire.pdf
8. EC 1105-2-412, Assuring Quality of Planning Models, 30 December 2009. http://inlandwaterways.lrh.usace.army.mil/_kd/Items/actions.cfm?action=Show&item_id=681&destination=ShowItem
9. Almodovar, L., D. Nolton, B. Carlson, J. Walaszek and B. Frechione. 2007. Protocols for the Certification of Planning Models. Planning Models Improvement Program. July 2007 (http://www.usace.army.mil/CECW/PlanningCOP/Documents/models/protocols_cert_7-02-07.pdf)
10. Office of Management and Budget Final Information Quality Bulletin for Peer Review dated 16 December 2004. http://www.whitehouse.gov/sites/default/files/omb/assets/omb/memoranda/fy2005/m05-03.pdf

In addition to these documents, the model reviewers requested specific information on the geospatial data and flood stage data used for the development of the model.

The model reviewers were asked to review the SJNM Shorebird Model using guidance and charge questions provided to them (Appendix A). The charge guidance and questions are based on the model assessment criteria discussed in the *Protocols for Certification of Planning Models* (USACE 2007). The intent of the charge questions was to focus the review on the assessment criteria that are critical for ensuring the technical quality, system quality and usability of planning models. While not strictly prohibited, there was no direct communication between the Model Review Panel and the model development team during the model review process. All communication was through the Battelle Project Manager.

Thirty-one charge questions developed by USACE and reviewed by Battelle were provided to the Model Review Panel in Individual Charge Response Forms to be used during their review. Following completion of the individual reviews of the SJNM Shorebird Model, Individual Charge Response Forms were compiled into a Merged Charge Response Form that contained all of the model review comments. Approximately 118 individual comments were received.

Battelle identified the key issues/concerns with the SJNM Shorebird Model based on the individual review comments received and then conducted a model review teleconference with the Panel to discuss comments regarding the model review assessment criteria, discuss potentially conflicting comments, and reach agreement on the key issues/concerns with the SJNM Shorebird Model identified during the review. The key findings of the model review regarding the models' technical quality, system quality, and usability are documented as Final Panel Comments.

At the conclusion of the model review teleconference, ten Final Panel Comments had been developed to present the key issues/concerns identified during the review of the SJNM Shorebird

Model. Each of the model reviewers was assigned lead responsibility for developing specific Final Panel Comments. The Final Panel Comments are presented in a five-part format that provides: (1) a clear statement of the issues identified, (2) the relevant model assessment criteria, (3) the basis for the comment, (4) the significance of the issue relative to the performance of the model, and (5) recommendations for resolution. Significance levels are defined as follows:

> **High:** Describes a fundamental problem with the model that could affect the model's ability to produce accurate results and serve its intended purpose
>
> **Medium:** Affects the understanding of the model, model usability, or the level of performance of the model
>
> **Low:** Affects the technical quality of the model documentation but will not affect the performance, understanding, usability, or level of performance of the model

Battelle guided the model reviewers on the development of the Final Panel Comments to ensure that the Model Review Panel's viewpoints are clearly represented, appropriate for the review, and not duplicated among Final Panel Comments. The Final Panel Comment statements are presented in the sections of this report that discuss the evaluation of model assessment criteria (Sections 3 through 5). The full five-part Final Panel Comments are presented in Appendix B. The conclusions of the model review, including recommendations for resolution for the key issues identified, are presented in Section 7.0. Of the ten key issues identified in the Final Panel Comments, three were determined to be of high significance, four were determined to be of medium significance, and three were determined to be of low significance. The level of significance was assigned based on the assumption that the SJNM Shorebird Model will currently only be used by the PDT. The number and significance of the review comments may be higher if the model were to be released for broader use outside of the PDT.

Battelle and the Model Review Panel will meet via teleconference with representatives from the ECO-PCX and Model Proponents to discuss the findings of the model review from 1:00 – 5:00 pm EDT on May 11, 2011. During the teleconference, suggested revisions to the draft Planning Model Quality Assurance Review Report will also be discussed. Suggested revisions to the draft report will be considered for preparation of the final Planning Model Quality Assurance Review Report, which will be delivered on May 16, 2011.

2.3 Approach to Model Testing

This review only involved an assessment of the model approach, and no testing of the model was performed for the review.

2.4 Assessment Criteria

In accordance with USACE EC 1105-2-407 (May 2005), the SJNM Shorebird Model was subjected to an IEPR. The review was conducted based on guidance in the *Protocols for Certification of Planning Models* (USACE 2007). As required by USACE (2007), the model was reviewed and assessed for technical quality, system quality, and usability. The review of these three criteria is described in the following sections, which include the Final Panel Comment statements that capture the key issues/concerns identified.

3.0 TECHNICAL QUALITY ASSESSMENT

Analytical tools, including models, used for planning purposes need to be technically sound and based on widely accepted contemporary scientific theory. The potential availability of foraging habitat characterized by the SJNM Shorebird Model must be reasonably represented by the model variables selected, and the correlation of responses of migrating shorebirds with the variables selected must be supported by sound scientific studies. The model calculations must reflect how shorebird habitat quality is expected to change with changes in stage levels due to project actions based on the application of scientific theory. Formulas and calculations that form the mechanics of the model must be accurate and correctly applied, with sound relationships among variables. The model should be able to reflect natural changes as well as the influence of anthropogenic laws, policies, and practices. All model assumptions must be reasonable and should be well-documented. The analytical requirements of the model must be identified, and the model must address these requirements. The model should also produce robust, reproducible results that stand up to rigorous scrutiny in later stages of the plan formulation process.

The technical quality assessment was based on an evaluation of the criteria described in Section 2.1 of this report. The results of the Model Review Panel's assessment of these criteria are summarized in the following sections. The five-part Final Panel Comments are provided in Appendix B.

3.1 Review of Theory

The model reviewers agree that the theoretical basis of the model is well-developed. No issues were identified during the review of the theory behind the model.

3.2 Review of Representation of the System

The model reviewers agree that the SJNM Shorebird Model does a reasonable job of characterizing and projecting available shorebird foraging habitat. However, the model has some limitations that could reduce the accuracy with which it is able to predict available habitat over the life of the project. The following specific issues related to the assessment of the ability of the SJNM Shorebird Model to represent the habitats being modeled were identified (relevant Final Panel Comment numbers are provided in parentheses). The first two issues are of high significance because they have the potential to affect the ability of the SJNM Shorebird Model to produce accurate results and serve its intended purpose. The last two issues are of medium significance, affecting the usability or level of performance of the model.

1. Although the model is likely to be able to be used for near-term (5-10 years) future projections, the ability to make projections up to 50 years into the future is limited (Final Panel Comment 1). This is related to the assumption that land use both upstream and within the project area, and consequently river stage conditions, will not change over time.
2. The available geospatial data do not appear to have been used in a way that results in the greatest model accuracy (Final Panel Comment 2).

3. The model does not include variables for the amount of vegetative cover and vegetation height (Final Panel Comment 3). Vegetation cover and height are equally as important for characterizing available shorebird habitat as river stage.
4. The model should weight suitable shorebird habitat for patch size (Final Panel Comment 4).

3.3 Review of Analytical Requirements

The data input needs for the model are clear, but the availability of shorebird foraging habitat is very sensitive to topographic gradients. The following specific issue related to the assessment of the model's analytical requirements were identified (relevant Final Panel Comment numbers are provided in parentheses). This issue was determined to be of high significance, potentially affecting the model's ability to produce accurate results and serve its intended purpose.

1. The available geospatial data do not appear to have been used in a way that results in the greatest model accuracy (Final Panel Comment 2).

3.4 Review of Assumptions

The SJNM Shorebird Model documentation describes some of the limitations and assumptions of the model. However, the description of the SJNM Shorebird Model limitations and assumptions is incomplete. The following specific issues related to the assessment of model assumptions were identified (relevant Final Panel Comment numbers are provided in parentheses). The first two issues are of high significance, potentially affecting the ability of the SJNM Shorebird Model to produce accurate results and serve its intended purpose. The last three issues are of medium significance, affecting the usability or level of performance of the model.

1. Although the model is likely to be able to be used for near-term (5-10 years) future projections, the ability to make projections up to 50 years into the future is limited (Final Panel Comment 1). This is related to the assumption that land use both upstream and within the project area, and consequently river stage conditions, will not change over time.
2. The available geospatial data do not appear to have been used in a way that results in the greatest model accuracy (Final Panel Comment 2), as it is assumed that relatively coarse spatial resolution data can be used to make finer resolution predictions.
3. The model does not include variables for the amount of vegetative cover and vegetation height (Final Panel Comment 3). It is assumed that the very broad classification of vegetation type is sufficient to determine the availability of shorebird foraging habitat.
4. The model should weight suitable shorebird habitat for patch size (Final Panel Comment 4). Currently, it is assumed that habitat patches of all sizes have equal weight (i.e., are equally suitable for shorebird foraging).
5. Qualitative variables need to have quantitative boundaries (Final Panel Comment 7). The model correctly assumes that vegetative cover types have different suitabilities for shorebirds, but the qualitative descriptions of the general vegetative categories need to be defined quantitatively to provide guidance for correct Suitability Index (SI) determinations.

3.5 Review of Ability to Evaluate Risk and Uncertainty

The SJNM Shorebird Model has very limited ability to evaluate risk and uncertainty because the precision and accuracy of the outputs have not been determined. The following specific issues identified regarding the precision and accuracy of the SJNM Shorebird Model outputs affect the ability of the model to evaluate risk and uncertainty (relevant Final Panel Comment number is provided in parentheses). The first two issues are of high significance, potentially affecting the level of uncertainty in the model outputs and, consequently, the ability of the SJNM Shorebird Model to produce accurate results that can be interpreted with confidence. The remaining issues are of medium significance, affecting the understanding, usability, and level of performance of the model and the uncertainty associated with the model outputs.

1. Although the model is likely to be able to be used for near-term (5-10 years) future projections, the ability to make projections up to 50 years into the future is limited (Final Panel Comment 1). The short-term (5-10 years) changes in surrounding land use and, consequently, river stage conditions that will occur over time have not been studied sufficiently to be quantified, affecting the ability to determine risk and uncertainty.
2. The available geospatial data do not appear to have been used in a way that results in the greatest model accuracy (Final Panel Comment 2). This creates greater uncertainty in the model ouptputs, reducing confidence in management decisions.
3. The model does not include variables for the amount of vegetative cover and vegetation height (Final Panel Comment 3). This increases the uncertainty in the ability of the model to quantify suitable shorebird habitat in a measurable way.
4. In general, the ability of the model to evaluate uncertainty is limited (Final Panel Comment 5). The Shorebird Model is a deterministic model with inputs that result in a single daily estimate of the amount of optimal shorebird habitat in the project area. No sensitivity analysis or measure of model uncertainty has been performed to understand how the model outputs respond to variation in inputs.
5. The ability to verify and validate the performance of the model is limited (Final Panel Comment 6). This is because the verification and validation of the SJNM Shorebird model will be based on comparison of the area predicted for shorebird habitat with shallowly inundated area identified in Landsat™ imagery, which has low resolution.

3.6 Review of Ability to Calculate Benefits for Total Project Life

The life of a project is typically evaluated through 50 years. The model reviewers agree that the SJNM Shorebird Model is not able to accurately project the impacts and benefits of project alternatives over this period of time. The following specific issues related to the assessment of the models' ability to calculate benefits for total project life were identified (relevant Final Panel Comment numbers are provided in parentheses). The first issue is of high significance, potentially affecting the ability of the SJNM Shorebird Model to produce accurate results and serve its intended purpose. The second issue was determined to be of medium significance, affecting the understanding, usability and level of performance of the model.

1. Although the model is likely to be able to be used for near-term (5-10 years) future projections, the ability to make projections up to 50 years into the future is limited (Final Panel Comment 1). This is primarily because there will be changes in land use both

upstream and within the project area, and consequently changes in river stage conditions, that are not accounted for by the model.

2. Qualitative variables need to have quantitative boundaries (Final Panel Comment 7). Otherwise, there will be limited understanding of model outputs and limited accuracy future projections of available shorebird habitat.

3.7 Review of Calculations/Formulas

The issues identified with the SJNM Shorebird Model calculations and formulas are strongly related to the variables selected for the model and how well the calculations can be used to determine and project available shorebird foraging habitat. The following specific issues related to the assessment of the model's calculations and formulas were identified (relevant Final Panel Comment numbers are provided in parentheses). The first issue is of high significance, potentially affecting the ability of the SJNM Shorebird Model to produce accurate results and serve its intended purpose. The other issues are of medium significance, affecting the usability and level of performance of the model.

1. Although the model is likely to be able to be used for near-term (5-10 years) future projections, the ability to make projections up to 50 years into the future is limited (Final Panel Comment 1). This is because the model does not account for changes in land use both upstream and within the project area, and consequently changes in river stage conditions, that will occur over time.
2. The model does not include variables for the amount of vegetative cover and vegetation height (Final Panel Comment 3).
3. The model should weight suitable shorebird habitat for patch size (Final Panel Comment 4).
4. Qualitative variables need to have quantitative boundaries (Final Panel Comment 7).

4.0 SYSTEM QUALITY ASSESSMENT

System quality refers to the quality of the entire system used to develop, use, and support the model, including the software and hardware platform. System quality is generally assessed by testing the hardware and software components, design verification planning for customer acceptance, third party interoperability, compatibility with various hardware and operating systems such as Windows and MacOS, and the development of a problem-tracking database. Most of this is done through USACE internal review and tracking. However, some criteria can be, and have been, evaluated by external peer reviewers. In general, model reviewer evaluation of system quality can include assessing whether supporting software tools/programming language are appropriate for the model, programming is done correctly, software and hardware are available, the model has been tested and validated, and data can be readily imported into other software analysis tools, if applicable.

The system quality assessment for the SJNM Shorebird Model was based on an evaluation of the criteria described in Section 2.1. Most of the assessment criteria are not related to this review because the model is still in the development stage and there is not any software or a model spreadsheet to review. Therefore, the assessment of system quality for this review was limited to

a review of the proposed model testing and validation procedure. The results of the Model Review Panel's assessment of system quality are summarized in the following sections. Full Final Panel Comments are provided in Appendix B.

4.1 Review of Supporting Software

A review of supporting software is not relevant or applicable to the SJNM Shorebird Model review.

4.2 Review of Programming Accuracy

A review of programming accuracy is not relevant or applicable to the SJNM Shorebird Model review.

4.3 Review of Model Testing and Validation

Model testing and validation is key to ensuring that models perform as expected and perform well enough to serve their intended purpose. In the case of the SJNM Shorebird Model, model results would need to accurately and consistently determine or predict the availability of suitable shorebird foraging habitat. The following specific issues regarding model testing and validation were identified (relevant Final Panel Comment numbers are provided in parentheses). The first issue identified is of medium significance, affecting the understanding of the SJNM Shorebird Model performance. The second issue is of low significance, affecting the quality of the testing and validation results.

1. The ability to verify and validate the performance of the model is limited (Final Panel Comment 6). This is because the verification and validation of the model will be based on comparison of the area predicted for shorebird habitat with shallowly inundated area identified in Landsat™ imagery, which has low resolution.
2. The model could be strengthened if shorebird use of the habitat was considered during field validation (Final Panel Comment 8). This has not been proposed as part of the testing and validation process.

5.0 USABILITY ASSESSMENT

Usability refers to how easily model users can access and run the models, interpret model output, and use the model output to support planning decisions. An assessment of model usability includes evaluating the availability of data required to run the models and the ability of the user to learn how to use the model properly and effectively. Model outputs should be easy to interpret, useful for supporting the purpose of the model, easy to export to project reports, and sufficiently transparent to allow for easy verification of calculations and outputs.

The model usability assessment was based on an evaluation of the criteria described in Section 2.1. The SJNM Shorebird Model usability was assessed based on data availability, how easily results are interpreted and understood, and how well the documentation for the SJNM Shorebird Model supports and explains its application. The results of the Model Review Panel's assessment are summarized in the following sections. Full Final Panel Comments are provided in Appendix B.

5.1 Review of User Interface

A review of the user interface is not relevant or applicable to the SJNM Shorebird Model review, as no supporting software or spreadsheets were provided for the review.

5.2 Review of Data Availability

The following specific issues regarding data availability were identified (relevant Final Panel Comment numbers are provided in parentheses). The first issue is of high significance, potentially affecting the ability of the SJNM Shorebird Model to produce accurate results and serve its intended purpose. The second issue is of medium significance, affecting the understanding of the level of performance of the model.

1. The available geospatial data do not appear to have been used in a way that results in the greatest model accuracy (Final Panel Comment 2). The data available could be used to develop a model that produces model outputs with greater accuracy.
2. The ability to verify and validate the performance of the model is limited (Final Panel Comment 6). The verification and validation of the model will be based on comparison of the area predicted for shorebird habitat with shallowly inundated area identified in Landsat™ imagery, which has low spatial resolution. Higher resolution data are available, although at a cost (there is no cost for Landsat imagery), and should be considered to improve verification and validation of the SJNM Shorebird Model.

5.3 Review of Results

The SJNM Shorebird Model produces a measure of available suitable shorebird foraging habitat that is the product of a SI score and area of habitat coverage. Although the rapid assessment approach is desirable for planning projects, the SJNM shorebird habitat assessment approach has its limitations. The following specific issues regarding the results of the models were identified (relevant Final Panel Comment numbers are provided in parentheses). The first two issues are of high significance, potentially affecting the model's ability to produce accurate results and serve its intended purpose. The other issues are of medium significance, affecting the understanding, model usability, or the accuracy of the model results.

1. Although the model is likely to be able to be used for near-term (5-10 years) future projections, the ability to make projections up to 50 years into the future is limited (Final Panel Comment 1). This is because land use both upstream and within the project area, and consequently river stage conditions, will change over time.
2. The available geospatial data do not appear to have been used in a way that results in the greatest model accuracy (Final Panel Comment 2).
3. The model does not include variables for the amount of vegetative cover and vegetation height (Final Panel Comment 3). This limits the ability of the model to accurately determine or project the availability of suitable shorebird foraging habitat, and the availability of suitable habitat may be overestimated.
4. The ability to verify and validate the performance of the model is limited (Final Panel Comment 6). This reduces confidence in the accuracy of results produced.

5. Qualitative variables need to have quantitative boundaries (Final Panel Comment 7). Otherwise, the results produced will not be well-understood, and results could vary across users because of variability in user definition of SI scores.

5.4 Review of Documentation

The model documentation provides a good summary of the theoretical basis for the SJNM Shorebird Model. The model reviewers feel that the SJNM Shorebird Model documentation is currently sufficient for the St. Johns Bayou and New Madrid Floodway Project PDT; however, the documentations will need to be expanded to support planning decisions that are made and if the SJNM Shorebird Model is verified and validated and then released for more widespread use by a broader user audience. The following specific issues regarding the SJNM Shorebird Model documentation were identified (relevant Final Panel Comment numbers are provided in parentheses). These issues are currently of low significance, only affecting the technical quality of the SJNM Shorebird Model documentation. However, they could be of medium significance, affecting the understanding and usability of the model if the model is released for use outside of the PDT.

1. There is no user documentation for the model (Final Panel Comment 9).
2. If the model is released for more widespread use outside of the PDT, the model documentation should be improved by providing additional information (Final Panel Comment 10). Detailed recommendations are provided in the Final Panel Comment form in Appendix B.

6.0 MODEL ASSESSMENT SUMMARY

During the review of the technical quality, system quality, and usability of the SJNM Shorebird Model, the Model Review Panel determined that the conceptual approach is appropriate for the intended purpose of assessing changes in the availability of suitable shorebird foraging habitat that will result from the St. Johns Bayou and New Madrid Floodway Project. However, some issues were identified regarding the technical quality of the SJNM Shorebird Model and the usability of model outputs. Since models are only approximations of actual systems, all models have limitations. The Model Review Panel has made suggestions regarding how to address the limitations of the SJNM Shorebird Model. Testing and validation of the SJNM Shorebird Model must also be performed to clearly demonstrate its sensitivity, accuracy, and ability to support planning decisions.

In addressing and answering charge questions designed to focus the review of the SJNM Shorebird Model based on the model assessment criteria in the *Protocols for Certification of Planning Models* (USACE 2007), the model reviewers identified the following underlying issues or potential issues with the model.

- Although the model is likely to be able to be used for near-term (5-10 years) future projections, the ability to make projections up to 50 years into the future is limited (Final Panel Comment 1). This is related to the assumption that land use both upstream and

within the project area, and consequently river stage conditions, will not change over time.

- The available geospatial data do not appear to have been used in a way that results in the greatest model accuracy (Final Panel Comment 2).
- Regarding the model parameters:
  - The model does not include variables for the amount of vegetative cover and vegetation height (Final Panel Comment 3). Vegetative cover and height strongly influence the suitability of habitat for shorebird foraging, and not including this in the model could lead to an overestimate of available shorebird foraging habitat.
  - The model should weight suitable shorebird habitat for patch size (Final Panel Comment 4).
  - Qualitative variables need to have quantitative boundaries (Final Panel Comment 7). This will improve how well model outputs are understood and consistency between users.
- The ability of the model to evaluate uncertainty is limited (Final Panel Comment 5). This is because the response of the model outputs to variation in input parameters and the accuracy of the input parameters has not been quantified.
- The ability to verify and validate the performance of the model is limited (Final Panel Comment 6). This is because the verification and validation of the model will be based on comparison of the area predicted for shorebird habitat with shallowly inundated area identified in Landsat™ imagery, which has low resolution.
- The model could be strengthened if shorebird use of the habitat was considered during field validation (Final Panel Comment 8).
- Regarding the model documentation:
  - There is no user documentation for the model (Final Panel Comment 9).
  - If the model is released for more widespread use outside of the PDT, the model documentation should be improved by providing additional information (Final Panel Comment 10).

7.0 CONCLUSIONS

The SJNM Shorebird Model provides a good basis for what could be an effective tool for determining changes in the availability of suitable shorebird foraging habitat at a coarse spatial scale (finer topographic variability is not taken into account). However, the accuracy of the model outputs should be improved for better-informed planning, and the performance of the model needs to be tested and verified before it is applied for decision-making. The Model Review Panel recommends the following actions to improve the technical quality and usability of the SJNM Shorebird Model.

- Estimate the effects of future changes in land use by projecting future changes based on a recent history of land-use changes in the study area, include current and anticipated land use and structural changes upstream when applying historical river-stage data to future

conditions, and review and modify the model every 10 years such that the most current changes in river stage and habitat conditions are incorporated (Final Panel Comment 1).

- Either use the highest-resolution LiDAR data for obtaining the highest model accuracies (preferred), or as an alternative, expand the use of the LiDAR-derived 2-foot contour map from the New Madrid Basin to the St. Johns Basin for obtaining improved model accuracies (Final Panel Comment 2).
- Conduct an examination of possible methods to distinguish vegetation coverage and heights at a finer scale. If this is not possible, provide an explanation of the limitations related to the broad scale definition of vegetation in the model documentation (Final Panel Comment 3).
- Include a minimum patch size in the definition of suitable shorebird habitat and provide justification for the choice of a minimum patch size (Final Panel Comment 4).
- Provide quantitative limits for all of the qualitative vegetation variables, including the development of an SI value for Conservation Reserve Program (CRP) and set-aside lands (Final Panel Comment 7).
- Use the model to evaluate ranges of some or all input variables so that the output is a range rather than a single point estimate (Final Panel Comment 5).
- Consider using higher spatial resolution imagery, such as Satellite Pour l'Observation de la Terre (SPOT) imagery (10 m pixel size), Quickbird imagery (sub-meter), or SAR imagery (such as TerraSAR-X [1-5 m pixel resolution]) to verify and validate the model (Final Panel Comment 6).
- Collect data on shorebird use of sites during field validation of the model to confirm shorebird use (Final Panel Comment 8).
- Expand the SJNM Shorebird Model documentation to:
    - Explain that historic river stages may not represent future river stages and that large scale land-use changes (e.g., changes in agriculture practices) and climate change may result in unforeseen changes to river stage, and include guidelines for how the model will address these changes (e.g., how will changes to inputs be incorporated into the model, what are the minimum levels of change that will require model adjustments, etc.). (Final Panel Comment 1).
    - Emphasize the importance of multiple model runs to assess uncertainty in model outputs (Final Panel Comment 5).
    - Include an additional section that explicitly details the steps that the users should take for effective application of the model (Final Panel Comment 9).
    - Provide a clear explanation of the potential impacts from project alternatives on shorebird foraging habitat (Final Panel Comment 10).
    - Provide a list of terms and their definitions (Final Panel Comment 10).
    - Include an explanation of the basis for HEP and how the Habitat Suitability Index (HSI) development process was integrated into the development of the SJNM Shorebird Model (Final Panel Comment 10).

- Include a description of a validation/modification process that will be applied during the early phases of model application (Final Panel Comment 10).
- Provide more information in the existing figures, such as scale and labels (Final Panel Comment 10).
- Provide additional figures to help explain the model better (Final Panel Comment 10).
- Include the rationale for why 2000 data were chosen for development of the model (Final Panel Comment 10).
- Include a complete and comprehensive list of assumptions and limitations in a single location (Final Panel Comment 10).

This list of actions summarizes the recommendations for resolution in the Final Panel Comments, and more specific detailed recommendations are provided in the Final Panel Comments presented in Appendix B in this report. The level of significance of most of the Final Panel Comments was assigned based on the assumption that the SJNM Shorebird Model is only intended for use by the St. Johns Bayou and New Madrid Floodway Project PDT, defined to include those who developed the model or know how it was developed; determined and/or understand the methods required to preprocess the data being input to the model and the precision and accuracy required of those data to generate useful model results; served in an advisory role during the development of the SJNM Shorebird Model; and others who served on the teams and without whom the teams would not be complete. If the model is released for general use to a diverse audience, the level of significance of some comments would be elevated, and all low-significance comments would be assigned medium significance because different users (e.g., public, technical committee and developers) have different levels of understanding, needs and requirements for documentation.

Three issues were identified that need to be addressed for immediate use of the SJNM Shorebird Model by the St. Johns Bayou and New Madrid Floodway Project PDT:

1. The SJNM Shorebird Model needs to consider changes in land use and resulting changes in flood stage conditions.
2. The SJNM Shorebird Model needs to be based on higher resolution geospatial data.
3. The SJNM Shorebird Model needs to be tested and validated to establish its accuracy and determine its sensitivity to variability in model inputs.

Although other issues do not need to be addressed in order for the SJNM Shorebird Model to perform at a very coarse geospatial scale, adopting the recommendations provided would significantly improve the accuracy of the model outputs and the ability to effectively project changes in the availability of suitable shorebird foraging habitat.

8.0 LIST OF PREPARERS

Information on the model reviewers selected for the Model Review Panel is summarized in Table 1. A short biography for each of the reviewers is provided below.

Table 1. Experts Selected for the SJNM Shorebird Model Review Panel

Name	Affiliation	Location	Education	Years of Experience
HEP Specialist				
Richard Stiehl	Independent Consultant	Tucson, AZ	Ph.D. in environmental science/biology	28
Avian Biologist				
Craig Davis	Oklahoma State University	Stillwater, OK	Ph.D. in wildlife sciences	20
Stephen Dinsmore	Iowa State University	Ames, IA	Ph.D. in fishery and wildlife biology	20
Geospatial Analyst				
Shimon Wdowinski	University of Miami	Miami, FL	Ph.D. in geophysics	25

Richard Stiehl (HEP Specialist). Dr. Stiehl earned his Ph.D. in environmental science/biology from Portland State University in 1978 and has over 20 years of experience with HEP, wildlife biology, avian ecology, and habitat and community modeling. He completed his original HEP training in 1981 with the U.S. Fish and Wildlife Service (USFWS) and wrote several sections of the current USFWS HEP Manual as the chief editor. To date, Dr. Stiehl has taught over 30 certified HEP workshops. He was the lead HEP authority at USFWS between 1992 and 2000. Other work with USFWS included revising and/or writing other HEP manuals, rewriting HEP and Habitat Suitability Index (HSI) software, and conducting wildlife research. He continued his HEP leadership role as a private consultant, constructing community HSI models for riparian, desert, and desert wetland habitats. He has developed software to evaluate long-term impacts to desert ecosystems for the Washington Department of Wildlife and the Columbia Basin Fish and Wildlife Agency. Dr. Stiehl has provided HEP expertise to 20 states and many federal agencies, including the USACE, Bureau of Reclamation, Natural Resources Conservation Service, and U.S. Environmental Protection Agency. He has led HEP teams on large, complex projects with high interagency interests, including HEP analyses for shorebird habitat, the impacts of weapons training for the U.S. Air Force in Utah, the Central Utah Project Uinta Basin Replacement Project, HEP software development for the Upper Mississippi River Project, and the Virginia

Department of Transportation SE Expressway Greenbelt Project. Other high profile HEP projects include consulting with General Electric for polychlorinated biphenyls remediation in the Upper Hudson River, NY for post-9/11 communications network evaluation, and the Theodore Roosevelt Conservation Trust for impacts from gas/oil field development in central Wyoming. Dr. Stiehl has experience in the Lower Mississippi River Valley, including being an assistant and associate professor of biology at Southeast Missouri State University (Cape Girardeau, MO) for 10 years and conducting extensive fieldwork in southeastern Missouri on fish and bird populations. Dr. Stiehl also has experience conducting restoration and mitigation analyses for USFWS and tribal lands.

Craig Davis (Avian Biologist). Dr. Davis earned a Ph.D. in wildlife sciences from Texas Tech University in 1996 and has 20 years of experience as an avian biologist. He is an Associate Professor and the Curator of Birds Collection in the Department of Natural Resource Ecology and Management at Oklahoma State University and is involved in research projects focusing on shorebird ecology and wetland habitat assessment. He routinely teaches graduate and undergraduate courses in ornithology, wetland wildlife ecology, wildlife research techniques, and wetland ecology and management. Dr. Davis also teaches a class on HEP and habitat evaluation techniques. The course reviews different HEP approaches as well as the development and application of HSI Models. Dr. Davis has served as a reviewer for the Whooping Crane HSI Model developed by USGS Fort Collins Research Center. Currently, Dr. Davis is serving as a principal investigator to assess landscape-level and climate change influences on shorebird distributions, community structure, and abundances in the central Great Plains. Prior to his position at Oklahoma State, he was the avian ecologist for The Platte River Whooping Crane Trust for four years. He served on the Technical Committee of the Platte River Cooperative Agreement and was involved with developing monitoring protocols and providing recommendations for habitat management for endangered and threatened birds that use the Platte River. Dr. Davis has authored or co-authored more than 20 publications on shorebird and wetland ecology in a wide variety of peer-reviewed journals and is currently co-editing a textbook detailing a variety of new Wetland Research techniques. Since 2003, Dr. Davis has served on the Playa Lakes Joint Venture Shorebird Planning Working Group. He has knowledge of Lower Mississippi River Valley bird populations through his past conservation efforts and as associate editor for Wetlands, for which he has reviewed papers relative to Lower Mississippi River Valley shorebird populations. Dr. Davis is currently a member of the Cooper Ornithological Society, American Ornithologists' Union, Society of Wetland Scientists, The Wildlife Society, and Wilson Ornithological Society.

Stephen Dinsmore (Avian Biologist). Dr. Dinsmore has a M.S. in zoology from North Carolina State University and a Ph.D. in fishery and wildlife biology from Colorado State University, both obtained through his research on the population biology of shorebirds. Currently, Dr. Dinsmore is an associate professor of wildlife ecology for the Department of Natural Resource Ecology and Management at Iowa State University with more than 20 years of experience in the field of avian ecology. In addition to his graduate work, Dr. Dinsmore has assisted with other shorebird migration projects in the Midwest, supervised four graduate students studying shorebird ecology, and taught graduate and undergraduate courses in ornithology, avian biology, and applied wildlife population ecology. Prior to his university appointments, he worked for federal, state, and private organizations. He is familiar with large, complex civil works projects with high public and interagency interests from his involvement in bird surveys for USACE (e.g., the

Saylorville Lake Project, IA) and from previous involvement in other model reviews. Dr. Dinsmore has demonstrated experience in evaluating the habitat suitability for migrating shorebirds. His M.S. degree examined the stopover ecology of shorebirds in North Carolina and included a component dealing with habitat suitability. He has also worked with habitat suitability for Mountain Plovers and other bird species. His knowledge of shorebird migration habitat in large floodplain rivers includes broad familiarity with the shorebird community and habitat use along the Mississippi River and his extensive four-year shorebird surveys in the Mississippi Delta region of northwestern Mississippi. He has a good working knowledge of HEP and teaches this topic in one of his undergraduate classes. He is also familiar with this topic from previous model reviews. He is familiar with spatial habitat modeling and used this approach in both his graduate degrees in shorebird ecology: his M.S. focused on migration/stopover ecology and his doctoral work emphasized population ecology. He has authored or co-authored over 30 peer reviewed journal articles and five books on avian viewing or ecology. Dr. Dinsmore has served as the Associate Editor for the Auk since 2006 and has been a member of the Cooper Ornithological Society since 1993.

Shimon Wdowinski (Geospatial Analyst). Dr. Wdowinski is currently a Research Associate Professor with the Division of Marine Geology and Geophysics in the Rosenstiel School of Marine and Atmospheric Science at University of Miami. He received his Ph.D. in geophysics from Harvard University in 1990 and has M.S. degrees in engineering sciences and geology from Harvard and Hebrew Universities. He has more than 20 years of experience working with geodetic data (global positioning system, InSAR, altimetry, and LiDAR) on a variety of projects and studies that have measured topography and its changes over time. Dr. Wdowinski has extensive experience conducting geospatial topographic analysis of various terrains at various scales and is involved in research projects focused on monitoring post-seismic crustal deformation in Haiti and forest and wetland 3-D vegetation structure, among others. Other topographic analysis experience has included monitoring crustal deformation across the Dead Sea Fault. Dr. Wdowinski has also studied space-based remote sensing of surface water hydrology and sea-level changes in the Everglades. As a result of this work, Dr. Wdowinski is very familiar with large, civil work projects with high public and interagency interest in the Everglades, including the Tamiami Trail Culverts, the Western C-11 water quality treatment and others. Over the past several years, he has been involved with the collection of LiDAR data in the Everglades for topography and vegetation studies. As part of his hydrological research of the Everglades, Dr. Wdowinski used several hydrological models, including MODFLOW, FLO-2D, and UNET, to simulate surface flow in wetlands and channels. The models' results were compared with stage data and space-based InSAR observations. Dr. Wdowinski routinely teaches courses in geophysics, natural disasters, and mathematical methods for geo-scientists. Dr. Wdowinski is currently a member of the Society of Wetland Scientists, American Geophysical Union, and Israel Geological Society.

9.0 REFERENCES

Cobby, D.M., D.C. Mason, and I.J. Davenport. 2001. Image processing of airborne laser altimetry data for improved river modeling. *ISPRS Journal of Photogrammetry and Remote Sensing*, 56(2): 121–138.

Davis, C.A. and J.R. Bidwell. 2008. Response of aquatic invertebrates to vegetation management and agriculture. Wetlands, 28:793-805.

Hodgson, M. E. and P. Bresnahan. 2004. Accuracy of airborne lidar-derived elevation: Empirical assessment and error budget. *ISPRS Journal of Photogrammetry and Remote Sensing*, 70: 331–339.

USACE. 2007. Protocols for Certification of Planning Models Under the Planning Models Improvement Program (PMIP). U.S. Army Corps of Engineers, July 2007.

USACE. 2005. Planning Models Improvement Program (PMIP): Model Certification. U.S. Army Corps of Engineers, Engineering Circular No. 1105-2-407, May 2005.

Zhang, Y. K. and K. E Shilling. 2006. Increasing streamflow and baseflow in Mississippi River since the 1940 s: Effect of land use change. *Journal of Hydrology* 324(4):412-422.

APPENDIX A

Charge to the Model Reviewers

(as submitted to Model Reviewers on March 2, 2011)

This page is intentionally left blank.

Final Charge Guidance and Questions to the Model Reviewers
for the
Model Review of the Assessment of Shorebird Habitat within the St. Johns-New Madrid Basins, Missouri (SJNM Shorebird Model)

BACKGROUND

Planning models are defined as any models and analytical tools that planners use to define water resources management problems and opportunities, to formulate potential alternatives to address the problems and take advantage of the opportunities, to evaluate potential effects of alternatives, and to support decision-making. The U.S. Army Corps of Engineers (USACE) Planning Models Improvement Program (PMIP) was established in 2003 to assess the state of planning models used by USACE and to make recommendations to assure that high quality methods and tools are available to enable informed decisions on investments in the Nation's water resources infrastructure and natural environment. The main objective of the PMIP is to carry out a process to review, improve and validate analytical tools and models for USACE Civil Works business programs.

Use of certified or peer-reviewed approved models for all planning activities is mandatory. Models developed for planning activities must be subjected to a model quality assurance review before being certified or approved by USACE. This policy is applicable to all planning models currently in use, models under development, and new models. District Commanders are responsible for providing high quality, objective, defensible, and consistent planning products. Development of these products requires the use of tested and defensible models. Models may be certified by USACE either for widespread use across projects or approved for limited use on a specific project or set of projects. National certification of planning models for widespread use will result in significant efficiencies in the conduct of planning studies and enhance the capability to produce high quality products.

The appropriate USACE Planning Center of Expertise (PCX) is responsible for model reviews. The goal of review is to establish that USACE planning products are theoretically sound, compliant with USACE policy, computationally accurate, based on reasonable assumptions, and are in compliance with the requirements of the Office of Management and Budget's *Final Information Quality Bulletin for Peer Review* (December 16, 2004). The use of a certified and/or peer reviewed approved model does not constitute technical review of the planning product. Independent technical review of the selection and application of the model and the input data is still the responsibility of the users. If a model is certified or approved, the PCX will work with model developers and managers to ensure that documentation and training in model use are available and that model updates comply with certification/approval requirements.

The primary criterion identified for model quality assurance review is technical soundness. Technical soundness reflects the ability of the model to represent or simulate the processes and/or functions it is intended to represent. The performance metrics for this criterion are related to theory and computational correctness. In terms of the theory, the model should (1) be based on validated and accepted "state of the art" theory; (2) incorporate USACE policies and

requirements; (3) properly incorporate the conceptual theory into the software code; and (4) clearly define the assumptions inherent in the model. In terms of computational correctness, the model should (1) employ proper functions and mathematics to estimate functions and processes represented; and (2) properly estimate and forecast the actual parameters it is intended to estimate and forecast. Other criteria for certification review or model approval review are efficiency, effectiveness, usability and clarity in presentation of results. A certified and/or peer reviewed approved model will stand the tests of technical soundness based on these evaluation criteria.

The Assessment of Shorebird Habitat within the St. Johns-New Madrid Basins, Missouri (SJNM Shorebird Model) Study Plan was developed to assess the spatial and temporal availability of shallow floodwater habitat in the St. Johns-New Madrid Basins in southeastern Missouri that may be used by migrating shorebirds for foraging. USACE is authorized to implement a flood risk management project in these basins. The proposed project would complete the levee surrounding the New Madrid Basin and install pumping stations in both the St. Johns and New Madrid Basins. The SJNM Shorebird Model will be used to assess potential impacts to shorebird foraging habitat that may result from implementation of the flood risk management project. The model may also be used for mitigation planning. The model is being developed by Dan Twedt, U.S. Geological Survey Patuxent Wildlife Research Center, in cooperation with the USACE Memphis District.

The scope of this work is to review the technical quality and usability of the SJNM Shorebird Model and, if appropriate, offer recommendations to improve the model. The model is being considered for approval/certification for use on the SJNM project.

OBJECTIVE

The objective of this work is to conduct a model quality assurance review for the USACE Ecosystem Restoration Planning Center of Expertise (ECO-PCX) to evaluate the technical quality, system quality (limited evaluation), and usability of the SJNM Shorebird Model. The original SJNM Shorebird Model was abandoned based on comments received during a previous model review, and a new model has been developed with the assistance of members from an independent external peer review (IEPR) panel for the SJNM flood risk management project. The new model is being reviewed as a separate and independent model.

The model quality assurance review of the SJNM Shorebird Model will be conducted in accordance with the Department of the Army, USACE guidance entitled *Planning Models Improvement Program: Model Certification* (EC 1105-2-407, dated May 31, 2005) and the *Protocols for Certification of Planning Models* (July 2007). These documents provide information on USACE policy regarding the use of high quality planning tools and the assessment criteria used to evaluate the quality of planning models, respectively. The primary goal of this review is to assure the quality of the SJNM Shorebird Model for use by the SJNM Project Development Team (PDT) for planning purposes on the SJNM flood risk management project. However, additional recommendations for improving the model for more widespread application by a broader user audience are also welcome.

This review will consider the technical quality, system quality (limited evaluation), and usability of the SJNM Shorebird Model. The review will not include a technical evaluation of the application of the model on the SJNM flood risk management project, as that is the purview of a separate IEPR panel. The review will be conducted by subject matter experts (i.e., model reviewers) with extensive experience in U.S. Fish and Wildlife Service (USFWS) Habitat Evaluation Procedures (HEP), avian biology, and geospatial analysis. The model reviewers will be "charged" with responding to specific technical questions as well as providing a broad technical evaluation of the SJNM Shorebird Model. Model reviewers will be asked to provide recommendations for resolving any issues identified. However, they are not responsible for making decisions regarding how to improve the model; the model developers are ultimately responsible for deciding whether to adopt recommendations made by the model reviewers. The review is intended to help USACE identify any errors, deficiencies, or other issues with the model that could limit its ability to meet its intended purpose. The results of this review will be used by USACE to make any necessary revisions to the SJNM Shorebird Model and/or model documentation for application on the SJNM flood risk management project. Although the purpose of this review is to determine whether or not the model can be approved for the limited SJNM application, it is likely that the model could be used for future applications within the Mississippi Alluvial Valley. Information provided during the model review will be used to assess whether to certify the SJNM Shorebird Model for broader application and inclusion in the USACE planning toolbox.

DOCUMENTS PROVIDED

Table 1 is a list of documents and reference materials that will be provided for the review. Only the first document is subject to review. All other materials listed in the table are provided for reference only, and the model reviewers are not required to review these documents. Documents provided for reference only should be read at the reviewer's discretion. When appropriate, the table provides guidance regarding which sections of the reference documents are most relevant to the review of the SJNM Model.

Table 1. Documents provided for the SJNM Shorebird Model Review

For review
1. Twedt, DJ. 2010, Assessment of Shorebird Habitat within the St. Johns-New Madrid Basins, Missouri. Study Plan 2302-9S270. USGS Patuxent Wildlife Research Center, Vicksburg, MS. 26 pp.
For reference only
2. Model Documentation for Pre 2010 SJNM Shorebird Model. 18pp.
3. Battelle Memorial Institute. 2010. Final Model Certification Review Report for the Habitat Model for Migrating Shorebirds in the Upper Mississippi Alluvial Valley (see Appendix B for Final Panel Comments)
4. Battelle Memorial Institute. 2009. Final Independent External Peer Review Report, St. Johns Bayou and New Madrid Floodway, Missouri, Consolidated NEPA Document and Work Plan, Environmental, Economic, and Hydrologic and Hydraulic Review, Phase 1.
5. Battelle Memorial Institute. 2009. Final Panel Comments and Final USACE Evaluator Comments, Final Independent External Peer Review Report, St. Johns Bayou and New Madrid Floodway, Missouri, Consolidated NEPA Document and Work Plan, Environmental, Economic, and Hydrologic and Hydraulic Review, Phase 1.

For reference only
6. Battelle Memorial Institute. 2010. Addendum to Final Independent External Peer Review Report, St. Johns Bayou and New Madrid Floodway, Missouri Consolidated NEPA Document and Work Plan, Phase 2 Environmental, Economic, and Hydrologic and Hydraulic Review. (See Comments 1, 2 and 15)
7. EC 1105-2-407, Planning - Planning Models Improvement Program: Model Certification, 31 May 2005 http://140.194.76.129/publications/eng-circulars/ec1105-2-407/entire.pdf
8. EC 1105-2-412, Assuring Quality of Planning Models, 30 December 2009. http://inlandwaterways.lrh.usace.army.mil/_kd/Items/actions.cfm?action=Show&item_id=681&destination=ShowItem
9. Almodovar, L., D. Nolton, B. Carlson, J. Walaszek and B. Frechione. 2007. Protocols for the Certification of Planning Models. Planning Models Improvement Program. July 2007 (http://www.usace.army.mil/CECW/PlanningCOP/Documents/models/protocols_cert_7-02-07.pdf)
10. Office of Management and Budget Final Information Quality Bulletin for Peer Review dated 16 December 2004. http://www.whitehouse.gov/sites/default/files/omb/assets/omb/memoranda/fy2005/m05-03.pdf

SCHEDULE

TASK	ACTION	DUE DATE
Conduct Model Review	Review documents sent to model reviewers	3/2/2011
	Battelle/Model Review Panel kickoff meeting	3/4/2011
	USACE/Battelle/Model Review Panel kickoff meeting	3/4/2011
	Battelle convenes mid-review teleconference	3/15/2011
	Model Review Panel completes their review	3/25/2011
Prepare Final Panel Comments and Draft Model Review Report	Battelle collates comments from Model Review Panel	3/29/2011
	Battelle convenes model review teleconference	3/30/2011
	Battelle provides Final Panel Comment writing assignment directive to Model Review Panel	3/31/2011
	Model reviewers provide Final Panel Comments to Battelle	4/8/2011
	Battelle provides feedback to model reviewers on Final Panel Comments/model reviewers provide revised Final Panel Comments	4/15/2011
	Battelle provides draft Planning Model Quality Assurance Review Report to Model Review Panel for review	4/20/2011
	Model reviewers provide comments on draft Planning Model Quality Assurance Review Report	4/22/2011
	*Battelle submits draft Planning Model Quality Assurance Review Report to USACE for review	4/27/2011
Prepare Final Model Report	USACE provides comments on draft Planning Model Quality Assurance Review Report and responses to Final Panel Comments in the report	5/11/2011
	Battelle convenes teleconference to discuss USACE responses to Final Panel Comments and comments on the draft Planning Model Quality Assurance Review Report	5/13/2011
	Battelle provides final Planning Model Quality Assurance Review Report to Model Review Panel for review	5/16/2011

TASK	ACTION	DUE DATE
	Model reviewers provide comments on final Planning Model Quality Assurance Review Report	5/17/2011
	*Battelle submits the final Planning Model Quality Assurance Review Report to USACE	5/20/2011

* denotes a deliverable

CHARGE FOR MODEL REVIEW

Input from the model reviewers is being sought to help the USACE Ecosystem Restoration Planning Center of Expertise (ECO-PCX) determine whether the SJNM Model can be described as technically sound relative to its design objectives. In addition to the underlying theoretical, conceptual, and computational aspects of the model, reviewers are asked to comment on aspects of the model that affect its usability and the reliability to produce information that can be effectively used to influence planning decisions.

The charge questions and guidelines below are based on the model assessment criteria in the *Protocols for Certification of Planning Models* (July 2007) from the USACE Planning Models Improvement Program. The intent of these questions is to focus the review on the assessment criteria that need to be evaluated. Accordingly, please provide responses to questions on the scientific and technical topics listed below, but also feel free to offer other relevant comments focusing on your areas of expertise, experience, and technical knowledge as you perform a broad review of the SJNM Shorebird Model.

General Charge Guidance

1. Please answer the scientific and technical questions listed below and conduct a broad overview assessment of the model focusing on your areas of expertise and technical knowledge. **Use the Charge Response Form provided when answering the questions**.
2. Evaluate the soundness of the model as applicable and relevant to your area of expertise. Comment on whether the model reasonably represents the system being modeled and how the model may be validated.
3. Please focus the review on scientific information, including factual inputs, data, the use and soundness of model calculations, assumptions, and results that inform decision makers.
4. Offer opinions as to whether the model parameters and formulas are sufficient to quantify the availability of suitable habitat.
5. Offer suggestions for future improvements that could be considered by USACE but are not necessary for immediate application of the model by the model developers at this time.
6. Panel members may contact each other during the review with questions and information requests, however, the Battelle Project Manager, Amanda Maxemchuk (maxemchuka@battelle.org), and Program Manager, Karen Johnson-Young (johnson-

youngk@battelle.org), should be copied on all correspondence. If determined necessary, communications with USACE or the model proponents will be facilitated by a Battelle representative.

7. In case of media contact, notify the Battelle Program Manager, Karen Johnson-Young (johnson-youngk@battelle.org), immediately.

Your name will appear as one of the members Model Review Panel. Your comments will be included in the final Planning Model Quality Assurance Review Report, but will remain unattributed. The final Planning Model Quality Assurance Review Report is expected to be released to the public by the USACE at some time in the future.

Please submit your comments in electronic form to Amanda Maxemchuk (maxemchuka@battelle.org) **no later than *March 25, 2011*.**

MODEL ASSESSMENT CRITERIA

General Questions

1. Are the model's design objectives and intended uses clearly communicated?
2. To what extent does the model meet the expressed design objectives?
3. To what extent is the model suitable for the expressed intended uses?

Technical Quality

4. Comment on the quality of the model's technical documentation.
5. Comment on the technical quality of the model relative to its expressed design objectives.
6. Comment on the temporal and spatial granularity with which the model is designed to be applied.
7. Comment on the geographic range/applicability of the model.
8. Comment on the degree to which the assumptions and limitations of the model are clearly communicated.
    a. Comment on the degree to which apparent limitations impact the ability of the model to be used for characterization of available shorebird foraging habitat.
    b. Comment on the degree to which apparent limitations impact the ability of the model to be used for planning and forecasting of project-related impacts.
    c. Please provide recommendations for resolving or overcoming identified limitations.
9. Is the model based on well-established contemporary theory?
10. Does the model adequately emulate or otherwise address the suite of critical ecosystem attributes necessary to characterize available shorebird habitat?
11. Does the model effectively allow for reasonable variation in the variables that are critical to the intended uses (i.e., application of the model during planning of water resource and restoration activities)?
12. Comment on the precision and accuracy of the model outputs and identify which variables/factors have the greatest impact on model precision and accuracy.
13. Comment on sensitivities of the model and identify the variables/factors to which the model is most sensitive.
14. Are the input requirements of the model evident to the user (i.e., types of data required as well as accuracy and precision)?
15. Is it evident to the user how the inputs are used by the model?
16. Are the assumptions that are critical to valid application of the SJNM Shorebird Model clearly identified?

17. Comment on the degree to which model assumptions might invalidate the model's use for specific applications.
18. Comment on the degree to which the model facilitates/accommodates uncertainty and risk analyses.
19. Comment on the degree to which the model can be used as a tool to forecast conditions anticipated to occur during the design lifecycle of a water resource and restoration activities project (i.e., from 1 to 50 years).
20. Comment on the degree to which the model delivers information adequate for the purpose of supporting determinations of compensatory mitigation.
21. Comment on the approach for calculating projected changes in available shorebird foraging habitat.
22. Comment on the degree to which the model is configured to accept modified assumptions and inputs regarding future global events such as, but not limited to, global climate change.

System Quality

23. Comment on the proposed approach for model validation and verification.

Usability

24. Comment on the model's ease of use.
25. Comment on the model's practicality and application/input requirements.
26. Comment on the availability of the data required by the model.
27. Comment on how useful the model is for characterization of near-term conditions.
28. Comment on how useful the model is for characterization of future conditions.
29. Comment on the usability of the model for selecting a course/plan of action.
30. Is user documentation user friendly and complete?

Key Issues

31. Please comment on what you think the key issues/concerns are with the SJNM Shorebird Model (if any). Provide clear, concise statements.

APPENDIX B

SJNM Shorebird Model Review Final Panel Comments

This page is intentionally left blank.

Final Panel Comments

The following forms include the Final Panel Comments from the review of the Assessment of Shorebird Habitat within the St. Johns-New Madrid Basins, Missouri (SJNM Shorebird Model) Study Plan. These comments reflect the key issues identified during the assessment of the model review criteria described in the U.S. Army Corps of Engineers (USACE) *Protocols for the Certification of Planning Models*. Each form contains a concise statement of the issue (the comment), the model assessment criteria to which the issue is related, the basis of the comment, the significance of the comment, and recommendations for resolution. Significance levels are defined as follows:

> **High (H):** Describes a fundamental problem with the model that could affect the model's ability to serve its intended purpose
>
> **Medium (M):** Affects the completeness or understanding of the model, model usability, or the level of performance of the model
>
> **Low (L):** Affects the technical quality of the model documentation but will not affect the performance of the model.

The Final Panel Comments are:

1. Although the model is likely to be able to be used for near-term (5-10 years) future projections, the ability to make projections up to 50 years into the future is limited. (H)
2. The available geospatial data do not appear to have been used in a way that results in the greatest model accuracy. (H)
3. The model does not include variables for the amount of vegetative cover and vegetation height. (H)
4. The model should weight suitable shorebird habitat for patch size. (M)
5. The ability of the model to evaluate uncertainty is limited. (M)
6. The ability to verify and validate the performance of the model is limited. (M)
7. Qualitative variables need to have quantitative boundaries. (M)
8. The model could be strengthened if shorebird use of the habitat was considered during field validation. (L)
9. There is no user documentation for the model. (L)
10. If the model is released for more widespread use outside of the project development team (PDT), the model documentation should be improved by providing additional information. (L)

This page is intentionally left blank.

Comment 1:
Although the model is likely to be able to be used for near-term (5-10 years) future projections, the ability to make projections up to 50 years into the future is limited.
Relevant Model Assessment Criteria:
Review of: Model Assumptions Ability to Evaluate Risk and Uncertainty Ability to Calculate Benefits for Total Project Life Model Calculations/Formulas Results
Basis for Comment:
The projected timeline for evaluating the impact of the project on shorebird habitat is 50 years. According to the model documentation, USACE will provide estimates of daily river stages that are likely to occur under post-project conditions. It is not clear how these projected estimates will be determined except that they will be based on historical river stage data (1943-2009). For the near-term (5-10 years post-project), use of historical stage data will be adequate and appropriate for assessing impact on shorebird habitat, but likely will not be sufficient for future projections beyond 10 years. The model currently assumes land use and land cover classes have not changed since 1943 and will remain the same for the life of the project. Furthermore, changes in land use and cover classes upstream are not considered by the model. Zhang and Shilling (2006) indicated that land use change associated with changes in agricultural activities (conversion of perennial vegetation to seasonal row crops) that occurred in the Mississippi River basin during the last 60 years has resulted in increases in both base flow and stream flow. Therefore, this assumption appears to be unrealistic and may affect the accuracy of the model for future projections. Basing future projections on past stochasticity will likely not capture what future river stage conditions will be. For example, changes in land-use patterns and amount of land being managed under different land-use practices upstream of the project may be quite different in the future and could result in river stage levels not encountered during the 1943-2009 time period. Additionally, the model does not consider the effects of land use changes in the project area on the quantity and quality of shorebird habitat. Although future projections in changes in land use in the project area is problematic, applying the rate of recent past changes in land use may provide a logical and defendable forecasting of future changes in land use. A recalibration of the model every 5-10 years such that it takes into consideration more recent changes in river stage that may be a result of recent changes in upstream land-use patterns will allow the model to more accurately portray future impacts on shorebird habitat conditions in the project area.
Significance – High:
By relying exclusively on historic river stage data, future projections of amount of available shorebird habitat may be inaccurate and, consequently, misleading.

Recommendations for Resolution:
1. Estimate the effects of future changes in land use by projecting future changes based on a recent history of land-use changes in the study area. (e.g., If "x" % of the agricultural land has been retired to the Conservation Reserve Program (CRP) in the past 10 years, it may be reasonable to assume that "y" ha will be retired in the next 10 years.) 2. Include current and anticipated land use and structural changes upstream when applying historical river-stage data to future conditions. 3. Review and modify the model every 10 years such that the most current changes in river stage and habitat conditions are incorporated into the model. 4. Explain in the model documentation that historic river stages may not represent future river stages and that large scale land-use changes (e.g., changes in agriculture practices) and climate change may result in unforeseen changes to river stage. Include a discussion of how the model will address these changes.

References:

Zhang, Y. K. and K. E Shilling. 2006. Increasing streamflow and baseflow in Mississippi River since the 1940 s: Effect of land use change.J. Hydro. 324(4):412-422.

Comment 2:
The available geospatial data do not appear to have been used in a way that results in the greatest model accuracy.
Relevant Model Assessment Criteria:
Review of: Representation of the System Analytical Requirement Model Assumptions Ability to Evaluate Risk and Uncertainty Data Availability Results
Basis for Comment:
The model is very sensitive to topographic gradients. In low gradient areas, small stage variations translate to a large shallowly flooded area, whereas in high gradient areas, stage changes translate into small shallowly flooded areas. Therefore, it is important to use reliable topographic datasets, especially in areas with low topographic gradients (i.e., flat topography). The model topographic input is 1-foot elevation contours, which were derived from two datasets with higher contour intervals. The elevation contours for the New Madrid Basin were obtained from a light detection and ranging (LiDAR)-derived map calculated with 2-foot intervals. The elevation contours for the St. Johns Basin were obtained from a mosaic of 24 digital elevation maps (DEMs) that were generated from 7.5 minute quadrangles with 5-foot contour intervals. The 1-foot elevation contour used by the model is an interpolation product of these two lower accuracy elevation datasets. The model then further interpolates the 1-foot contours into 0.1-feet contours in order to calculate the shallowly flooded areas. Thus, the model calculations are based on 0.1-foot elevation contours that were derived from a dual-interpolation of 2- and 5-foot interval datasets. In 2004, an airborne LiDAR survey was conducted in the New Madrid Basin and most of the St. Johns Basin. The LiDAR data acquired by this survey were used to generate the 2-foot contour map of the New Madrid Basin, which is used by the model. These LiDAR data can provide the most accurate elevation dataset for the model. Typical root-mean squared error (RMSE) accuracy values for airborne LiDAR surveys range from a low of 17 to 19 cm in some land cover types (pavement, low grass, and evergreen forests) to a high of 26 cm in other land cover types (deciduous forests) (Cobby et al., 2001; Hodgson and Bresnahan, 2004). Such sub-foot accuracy that is derived directly from the LiDAR data will provide the most accurate topographic dataset and is needed for reliable model calculations.
Significance – High:
Because the model is very sensitive to topographic gradients, the 2- and 5-foot topography datasets used by the model significantly degrade its calculation accuracy compared with calculations that use a DEM derived from the original LiDAR data (elevation accuracy better than 1-foot).

Recommendations for Resolution:
1. Use the original LiDAR data for obtaining the highest model accuracies. a. Generate a DEM from the original LiDAR data, acquired in 2004. Expected uncertainties (RMSE) are about 0.5 foot. b. Use LiDAR-derived DEM (step 1) as an input for the model. c. Eliminate the 0.1-foot interpolation step of the model, as the DEM generation already includes an interpolation (smoothing) of the LiDAR data. 2. Otherwise, expand the use of the LiDAR-derived 2-foot contour map to the St. Johns Basin for obtaining improved model accuracies. This solution is recommended if recommendation 1 is too time consuming and costly. The model procedure of interpolating the LiDAR-derived 2-foot contours, which are also obtained by interpolation, does not take full advantage of the LiDAR dataset. Nevertheless, this procedure still has a good accuracy level that is much better than that of the quadrangles-derived 5-foot contour dataset. Thus, expanding the use of the LiDAR-derived 2-foot contour map to the St. Johns Basin can significantly improve the model's accuracy.

References:

Cobby, D.M., D.C. Mason, and I.J. Davenport. 2001. Image processing of airborne laser altimetry data for improved river modeling. *ISPRS Journal of Photogrammetry and Remote Sensing*, 56(2): 121–138.

Hodgson, M. E. and P. Bresnahan. 2004. Accuracy of airborne lidar-derived elevation: Empirical assessment and error budget. *ISPRS Journal of Photogrammetry and Remote Sensing*, 70: 331–339.

Comment 3:
The model does not include variables for the amount of vegetative cover and vegetation height.
Relevant Model Assessment Criteria:
Review of: Representation of the System Model Assumptions Ability to Evaluate Risk and Uncertainty Model Calculations/Formulas Results
Basis for Comment:
In the Assumptions and Rationale section, it is acknowledged that water depth and vegetation are critical variables that influence shorebird use of foraging habitat. However, water depth is the only variable that is used to differentiate suitable foraging habitat from unsuitable habitat. The amount of vegetation cover and height of vegetation is not considered in the model. Specifically, vegetation is considered at a very broad scale in which grassland and cropland habitats are considered suitable and forest/shrubland habitats are considered unsuitable. Yet, the height of the vegetation or actual coverage of the vegetation is not considered in the model. Without considering the height and coverage of the vegetation, the model may overestimate suitable habitat because, although a site may have a water depth that is characteristic of suitable shorebird habitat, the vegetation height may be too tall for shorebirds to use the habitat. Furthermore, successional changes in plant communities, both within a year and among years, could reduce the quality of foraging habitat. For example, croplands in the spring may provide suitable habitat following fall or spring tilling, but in the summer/fall, the crops may be too tall for the habitat to be suitable. Ideally, field vegetation surveys would be conducted across the project area and throughout the year, as well as over several years to establish average vegetation height and coverage at various points in time that can be used to assign appropriate suitability index (SI) values to reflect suitability of habitat for shorebird foraging. Recognizing that this effort is extremely labor-intensive and may not be feasible, less time consuming alternatives should be explored and used if available. Some LiDAR observations acquired with newer sensors are capable of detecting vegetation height with sub-foot accuracy, although it is uncertain whether the 2004 LiDAR data used for the SJNM study has that capability.
Significance – High:
The broad scale classification of vegetation may result in an overestimation of suitable shorebird habitat.
Recommendations for Resolution:
1. Provide an explanation of the limitations related to the broad scale definition of vegetation in the model documentation. 2. Conduct an examination of possible methods to distinguish vegetation coverage and heights at a finer scale. If a geospatial method (e.g., LiDAR) or higher resolution imagery

is available to further distinguish vegetation height and coverage, it should be used to refine the model.

3. As an alternative, conduct field surveys of potential shorebird habitat to establish cover types and vegetation height during the spring and fall migration periods.

Comment 4:
The model should weight suitable shorebird habitat for patch size.
Relevant Model Assessment Criteria:
Review of: Representation of the System Model Assumptions Model Calculations and Formulas
Basis for Comment:
The model does not consider any thresholds for the minimum size of a habitat patch that is considered suitable for a migratory shorebird. Habitat is mapped at fine resolution (9- square foot pixels), but a single pixel may not truly represent suitable habitat because of its small size and isolation from other patches of suitable habitat. A discussion on the limitations of the model is missing, especially in terms of the resolution of the micro-topography data and broad-scale vegetation classification that help define suitable shorebird habitat. In both of these cases, the amount of suitable shorebird habitat could be overestimated, especially if shorebirds are area-sensitive. Thus, the model should consider area effects of habitat patches (e.g., 100 1-hectare (ha) patches may not have the same habitat value to shorebirds as one 100-ha patch, even though the total areas are equal). The decision to not include patch size may limit this model's use to sites with fewer but larger patches of potential shorebird habitat.
Significance – Medium:
The limitations of the model with respect to the spatial resolution of habitat will likely over-estimate suitable shorebird habitat. Furthermore, the model may label habitat as suitable at spatial scales that are inappropriate (i.e., too small) for use by migratory shorebirds.
Recommendations for Resolution:
1. Include a minimum patch size in the definition of suitable shorebird habitat. 2. Provide a justification for the choice of a minimum patch size.

Comment 5:
The ability of the model to evaluate uncertainty is limited.
Relevant Model Assessment Criteria:
Review of: Ability to Evaluate Risk and Uncertainty
Basis for Comment:
The Shorebird Model is a deterministic model with many inputs that result in a single daily estimate of the amount of optimal shorebird habitat (in ha-days) in the project area. In general, it is difficult to evaluate the model's accuracy because it does not include a sensitivity analysis or any measure of model uncertainty. The two things that contribute most to model uncertainty are habitat patch size and inaccuracies in topographic characterization. There is a need to understand how the model responds to changes in multiple variables and how changing predictions/model inputs affect the model output (i.e., suitable shorebird habitat estimates). Without knowing the sensitivity of the model, it is not clear whether the model can make reasonable predictions to evaluate alternatives. There is also a need to evaluate the contribution of inaccurate topography to the model's uncertainty.
Significance – Medium:
The inability to directly measure model uncertainty may affect the interpretation of model outputs and, ultimately, the application of the model to assess project impacts.
Recommendations for Resolution:
1. Add a statement to the model documentation that emphasizes the importance of multiple model runs to assess uncertainty in model outputs. 2. Use the model to evaluate ranges of some or all input variables so that the output is a range rather than a single point estimate. For example, the model could be run using a) the approach described in the model documentation, and b) as described in the model documentation, but only including habitat that occurs in patches of a minimum size. This would result in two separate estimates of available habitat, which could be compared as a range of possibilities. This could be done for all model inputs.

Comment 6:
The ability to verify and validate the performance of the model is limited.
Relevant Model Assessment Criteria:
Review of: Ability to Evaluate Risk and Uncertainty Model Testing and Validation Data Availability Results
Basis for Comment:
The verification and validation of the model will be based on comparison of the area predicted for shorebird habitat with shallowly inundated area identified in Landsat™ imagery. The proposed method is good, but has the following limitations: • The 30-meter (m) pixel resolution of Landsat imagery can limit the verification/validation procedure, because it is hard to detect the transition from dry to wet land across a single pixel. Typically the transition between wet and dry pixels can be determined over a width of about 2-3 pixels (60-90 m) because the transition area is not well defined, especially in vegetated areas. Such a level of uncertainty can lead to over- or under-estimation of the shallowly flooded area by 5-70%. Based on the USACE elevation map of the New Madrid Basin, high uncertainty levels are expected in intermediate flooding conditions (stage value 280-286 feet), where flooding occurs mostly along long and narrow low elevation features, such abandoned river meanders. In higher stage conditions (> 286 feet), flooding is expected to occur over larger and more equi-dimensional areas and, hence, the uncertainties along flooded area's boundaries represent smaller portion of the total flooded area. Higher spatial resolution imagery would allow a more accurate detection of the transition between flooded and dry areas and, consequently, would provide better constraints for the verification and validation procedure. • The remote sensing analysis might be limited by the available cloud-free imagery. A robust verification/validation analysis should compare the model results with satellite imagery at variable stage (and flooding) conditions. However, availability of Landsat imagery at various flooding conditions might be limited due to cloud cover. Synthetic Aperture Radar (SAR) imagery, which is acquired at all weather conditions and is very sensitive to inundation conditions, can provide an additional source of observations for the verification/validation analysis.
Significance – Medium:
The use of Landsat imagery can limit the verification/validation procedure because of the imagery coarse resolution (30 m pixel) and the need to find sufficient number of cloud-free images with various flooding conditions.

Recommendations for Resolution:
1. Use higher spatial resolution imagery, such as Satellite Pour l'Observation de la Terre (SPOT) imagery (10 m pixel size), or Quickbird imagery (sub-meter). 2. Use SAR imagery, in particular high resolution ones such as TerraSAR-X (1-5 m pixel resolution).

Comment 7:
Qualitative variables need to have quantitative boundaries.
Relevant Model Assessment Criteria:
Review of: Model Assumptions Ability to Calculate Benefits for Total Project Life Model Calculations/Formulas Results
Basis for Comment:
The model attempts to incorporate vegetative variable weighting into the development of cover type SI scores. Although it is clear that forest or shrub cover types are not considered suitable shorebird foraging habitats, the use of qualitative terms (e.g., relatively sparse vegetation, portions of mature crops, very short to relatively tall and rank vegetation) needs to have quantitative descriptors associated with each term to provide guidance to correct SI determinations. Additionally, the model considers grassland cover type as suitable habitat, but discusses CRP or "set-aside" land as having "reduced suitability for shorebirds." The model must provide an SI value from zero to one for all such areas in the St. Johns and New Madrid Basins.
Significance – Medium:
Without quantitative limits associated with qualitative vegetative variables, the resolution of the model will have increased variability, as different users may apply dissimilar definitions to the variables and the value of CRP and set-aside lands for shorebird foraging.
Recommendations for Resolution:
1. Provide quantitative limits for all of the qualitative vegetation variables. Develop an SI value for CRP and set-aside lands.

Comment 8:
The model could be strengthened if shorebird use of the habitat was considered during field validation.
Relevant Model Assessment Criteria:
Review of: Model Testing and Validation
Basis for Comment:
The shorebird migration model correctly states that validation depends only on the presence of suitable shorebird habitat, and not on shorebird use of that habitat. However, the model reviewers agree that the model would be more strongly validated if counts of shorebird use were included in the approach. If field validation of the model is required with respect to flood levels and habitat availability, then this should be done so that shorebirds can be counted simultaneously.
Significance – Low:
The shorebird model can be validated using habitat evaluation procedure (HEP) theory by assessing only potential habitat, although including a measure of shorebird use during habitat field surveys would provide even stronger model validation.
Recommendations for Resolution:
1. Collect data on shorebird use of sites during the proposed field validation of this model.

Comment 9:
There is no user documentation for the model.
Relevant Model Assessment Criteria:
Review of: Model Documentation
Basis for Comment:
Although the model documentation implies how the model should be applied, it does not explicitly describe a step by step application of the model.
Significance – Low:
Without an explicit description of the procedure associated with application of the model, there is a potential for erroneous application by users.
Recommendations for Resolution:
1. Develop and include an additional section in the model documentation that explicitly details the steps that the users should take for effective application of the model.

Comment 10:

If the model is released for more widespread use outside of the model development team, the model documentation should be improved by providing additional information.

Relevant Model Assessment Criteria:

Review of:

Model Documentation

Basis for Comment:

The background information in the model documentation lacks several details including:

1. A clear explanation of the potential impacts from project alternatives on shorebird foraging habitat. This information is important to support the need for model development, as well as the approach.
2. Terms and definitions (e.g., the term 'river stages that are likely to occur' is misleading, as changes in the river stage won't affect the extent of flooded areas after levies will be built. Other terms are also poorly defined.)
3. A brief explanation of how the U.S. Fish and Wildlife Service (USFWS) HEP basis and the Habitat Suitability Index (HSI) development process were integrated into the development of the Shorebird Model. Although the SI scores for the cover types in the project area are arbitrary (per HEP protocol), a more in-depth explanation of the logic of how the SIs for the cover types were developed would provide valuable user documentation.
4. Clear and informative figures:
    a. Information such as scale and labels is missing from some figures. For example, Figure 1 does not show:
        i. Labels for the two basins
        ii. Correct scale
        iii. The location of levees along the Mississippi River
        iv. The location of the levee gap, and
        v. The location of the New Madrid stage station.
    b. Additional figures could help explain the model better, in particular, elevation maps of both basins (e.g., the LiDAR-based USACE elevation map of the New Madrid Basin).
5. A rationale for why 2000 data (Table 2) were chosen for development of the model.
6. Detailed information on assumptions and limitations.
    a. The model should only be applied directly to the SJNM Basin. The model has not been tested or validated and is being applied to a large area over a long time period. The model will likely need modification, and the early phases of model application would provide a good opportunity to test and validate the performance of the model.
    b. The limitations of not having additional vegetation variables (e.g., amount of vegetative cover and vegetation height, type of vegetation) should be acknowledged. Simply noting the presence/absence of vegetative cover will not adequately explain the value of a site to migratory shorebirds. Factors such as vegetation height and patterns of within- and between-year plant succession should also be considered. At

the minimum, an acknowledgment of the importance of finer resolution vegetation characteristics is required. Moreover, there should be an acknowledgment that sites deemed suitable based on appropriate water depths may actually be unsuitable if vegetation is too tall or cover is too expansive at the site.

c. The availability of suitable habitat does not necessarily translate into shorebird abundances. USFWS HEP is very clear in that it describes habitat potential, not species abundance.

d. It is assumed that all water level changes occur due to vertical changes in the river stage. However in reality, such changes occur due to lateral flow. This assumption is valid as long as there are no barriers along the basins. Possible barriers, such as levees and roads, can limit the extent of lateral flow and, hence, model results will not reflect actual conditions precisely.

e. It is assumed that if a habitat is flooded it will have abundant invertebrate populations to meet shorebird foraging needs. Crop fields may actually have low invertebrate numbers because of continuous tilling and herbicide/insecticide applications (Davis and Bidwell, 2008).

7. An explanation that the SJNM Shorebird Model is a simple model that depends on single variable – the water level measured at New Madrid stage station. However, the initialization of the model requires the assemblage of elevation data and land cover information, which might be more complicated and require more expertise. After the elevation and land cover information are assembled into the model, it should be straightforward to use the model.

Significance – Low:

A lack of detailed information on the model description and limitations and assumptions will prevent users from fully understanding the basis and capabilities of the model.

Recommendations for Resolution:

1. Provide a clear explanation of the potential impacts from project alternatives on shorebird foraging habitat.
2. Provide a list of terms and their definitions.
3. Include an explanation of the basis for HEP and how the HSI development process was integrated into the development of the SJNM Shorebird Model.
4. Include a description of a validation/modification process that will be applied during the early phases of model application.
5. Provide more information in the existing figures, such as scale and labels.
6. Provide additional figures to help explain the model better.
7. Include the rationale for why 2000 data were chosen for development of the model.
8. Include a complete and comprehensive list of assumptions and limitations in a single location that includes a discussion of those noted above.
9. Explain clearly that the SJNM Shorebird Model is a simple model and that the initialization of the model requires specific expertise.

References:

Davis, C.A. and J.R. Bidwell. 2008. Response of aquatic invertebrates to vegetation management and agriculture. Wetlands, 28:793-805.