U.S. Department of the Interior
National Park Service

Sequoia and Kings Canyon National Parks
California

Restoration of Native Species in High Elevation Aquatic Ecosystems Plan
and
Final Environmental Impact Statement

Volume 2 • Appendices

June 2016

APPENDIX A: MINIMUM REQUIREMENT ANALYSIS

SEQUOIA AND KINGS CANYON NATIONAL PARKS

MINIMUM REQUIREMENT ANALYSIS
AND WORKSHEET

". . . except as necessary to meet minimum requirements for the administration of the area for the purpose of this Act..."

– The Wilderness Act, 1964

Instructions:
A Minimum Requirement Analysis (MRA) is required for ***all*** administrative actions in wilderness that either propose a Wilderness Act Section 4(c) prohibited use or have an effect on wilderness character (per Director's Order 41). **See the Minimum Requirement Instructions for directions and background materials to assist you with this analysis**. Additional instructions may be found at: http://www.wilderness.net/mrdg/

GENERAL INFORMATION:

Project Title:____ Restoration of High Elevation Aquatic Ecosystems ___

Project Duration:_____With approval of the project (currently EIS is being prepared) it would be a 20-35 year project_____
(For longer projects, review the MRA yearly to determine accuracy. Prepare a new MRA if the project is modified, new prohibited actions are proposed, or at a minimum every 5 years.)

Date Submitted:_____4/4/2013; revised 5/13/2016_____

Project Proponent:___Danny Boiano_____

Contact Information: _____559-565-4273_____

Tracking Number (Office Use Only):_____SEKI-2013-MRA-01_____

Step 1: Determine if any administrative action is necessary.

Description of Situation: What is the situation that may prompt administrative action? What is the reason that you are proposing an action (or actions) in wilderness? Do not describe the action itself. Rather, describe the desired goal or outcome.

The overall goal of this project is to restore clusters of fishless waters in strategic locations across the park to create high elevation ecosystems having more favorable habitat conditions for the persistence of native species (including mountain yellow-legged frogs/MYLFs) and natural ecosystem processes.

Historically, high elevation lakes within SEKI were fishless and provided habitat for a diverse assemblage of native species that developed over thousands of years in a fishless environment. From the 1860s to 1988, nonnative fish including rainbow/golden trout hybrids, brook trout and brown trout were introduced by humans into many fishless waters throughout SEKI. By the early 1900s, MYLFs generally became rare to extirpated in lakes containing nonnative fish, while remaining common to abundant in most fishless lakes (Grinnell and Storer 1924). Surveys completed in 2002 determined that self-sustaining nonnative fish populations had become established in approximately 575 lakes, ponds, and marshes, plus hundreds of miles of connecting streams (after the current project is completed there will be 550 waterbodies containing self-sustaining populations of nonnative fish). All of these waters are located above approximately 8,000 feet in elevation and within SEKI lands designated or managed as wilderness.
The impacts of nonnative trout on high elevation aquatic and adjacent terrestrial ecosystems are well documented and occur at all levels of the food web (Bradford et al. 1998, Knapp and Matthews 2000, Knapp et al. 2001, Matthews et al. 2001, Matthews et al. 2002, Knapp 2005A, Herbst et al. 2009, Pope et al. 2008, Epanchin et al. 2010). Nonnative trout impact native species directly through predation (Vredenburg 2004) and indirectly through competition for food resources (Finlay and Vredenburg 2007). Nonnative trout can disrupt the type and distribution of species, and thus the natural function of aquatic ecosystems. For example, researchers found that the distribution and abundance of MYLFs (Knapp et al. 2005), conspicuous aquatic invertebrates (e.g., mayflies; Bradford et al. 1998) and zooplankton (e.g., Daphnia; Knapp and Sarnelle 2008) were dramatically reduced by the introduction of nonnative trout.

Particularly vulnerable are two species that are integral components of SEKI's high elevation aquatic ecosystems: the MYLFs (*Rana muscosa* and *Rana sierrae*). Nonnative trout prey on MYLFs, compete with them for food, restrict their breeding to marginal, shallow habitat, and fragment remaining populations (Bradford et al. 1993, Knapp and Matthews 2000, Vredenburg 2004, Finlay and Vredenburg 2007). Both species were listed under the California Endangered Species Act in 2012 (CFGC 2012) and the federal Endangered Species Act in 2014 (FWS 2014A).

The following excerpt is from the Federal Register Notice (Federal Register Vol. 78, No. 80, April 25, 2013) Proposed Rule to list the MYLFs as Endangered Species:

> The body of scientific research has demonstrated that introduced trout have negatively impacted mountain yellow-legged frogs over much of the Sierra Nevada (Grinnell and Storer 1924, p. 664; Bradford 1989, pp. 775–778; Bradford et al. 1993, pp. 882–888; Knapp 1994, p. 3; Drost and Fellers 1996, p. 422; Knapp 1996, pp. 13–15; Knapp and Matthews 2000, p. 428; Knapp et al. 2001, p. 401). Fish stocking programs have negative ecological implications because fish eat aquatic flora and fauna, including amphibians and invertebrates (Bahls 1992, p. 191; Erman 1996, p. 992; Matthews et al. 2001, pp. 1135–1136; Pilliod and Peterson 2001, p. 329; Schindler et al. 2001, p. 309; Moyle 2002, p. 58; Epanchin et al. 2010, p. 2406). Finlay and Vredenburg (2007, p. 2187) documented that the same benthic (bottom-dwelling) invertebrate resource base sustains the growth of both frogs and trout, suggesting that competition with trout for prey is an important factor that may contribute to the decline of the mountain yellow-legged frog. Knapp and Matthews (2000, p. 428) surveyed more than 1,700 waterbodies, and concluded that a strong negative correlation exists between introduced trout and mountain yellow-legged frogs (Knapp and Matthews 2000, p. 435).

Consistent with this finding are the results of an analysis of the distribution of mountain yellow-legged frog tadpoles, which indicate that the presence and abundance of this life stage are reduced dramatically in fish-stocked lakes (Knapp et al. 2001, p. 408). Knapp (2005a, pp. 265–279) also compared the distribution of nonnative trout with the distributions of several amphibian and reptile species in 2,239 lakes and ponds in Yosemite National Park, and found that mountain yellow-legged frogs were five times less likely to be detected in waters where trout were present. Even though stocking within the National Park ceased in 1991, more than 50% of waterbodies deeper than 4 m (13 ft) and 75% deeper than 16 m (52 ft) still contained trout populations in 2000–2002 (Knapp 2005a, p. 270). Both trout and mountain yellow-legged frogs utilize deeper waterbodies. Based on the results from Knapp (2005a), the reduced detection of frogs in trout-occupied waters indicates that trout are excluding mountain yellow-legged frogs from some of the best aquatic habitat.

A second factor in the decline of the MYLF is the recent spread of chytridiomycosis, a disease caused by amphibian chytrid fungus (*Batrachochytrium dendrobatidis* or Bd), which has infected and imperiled most remaining MYLF populations (Rachowicz et al. 2006, Vredenburg et al. 2010) in SEKI leading to a more urgent situation that needs to be addressed as soon as possible.

Background

Since 2001, SEKI has been conducting restoration projects in several basins on a limited scale. The primary method has been through the removal of nonnative trout from waterbodies, along with research and monitoring of native species at the removal areas. The results have shown recovery of native species, particularly MYLFs, at the treatment areas. However, recently, chytrid fungus has spread within SEKI and has decimated populations of MYLFs, resulting in increased likelihoods of population die-offs and extirpation of both species. Studies indicate it recently spread into the Sierra Nevada (Rachowicz et al. 2005, Morgan et al. 2007; Vredenburg et al. 2010) and has infected nearly all remaining MYLF populations including those in SEKI and YOSE. Most MYLF populations have severely declined within a few years after becoming infected and some populations have been extirpated. Chytrid fungus has thus been a major factor in accelerating the decline of MYLFs caused by nonnative fish throughout the Sierra Nevada.

MYLFs in the Sierra Nevada only occur in high elevation aquatic ecosystems (above 8,000 feet) which are all located in wilderness. The largest remaining populations of these two species are located within SEKI wilderness. Studies in the past decade determined that MYLF populations have disappeared from approximately 92% of historic localities in the Sierra Nevada, with similarly sized losses in SEKI (Vredenburg et al. 2007). This decline has largely been attributed to the widespread introduction of nonnative fish (Bradford et al. 1994B, Knapp and Matthews 2000) and the recent emergence of disease (Rachowicz et al. 2006). Today the MYLFs are among the world's most critically endangered amphibians; most of the remaining populations are much smaller and more isolated than they were historically (Vredenburg et al. 2007).

The recently completed MYLF Conservation Assessment (Brown et al. 2014) concludes that introduced fish played a major role in the decline of the species likely causing local extirpations, and may have precluded successful recolonization. The Conservation Assessment identifies restoring fishless habitat and developing translocation studies as key conservation actions for recovering the species. The FWS, NPS, USFS and CDFW are currently collaborating on the development of the Mountain Yellow-legged Frog Conservation Strategy (FWS in preparation). The Conservation Strategy is being developed as a tool to guide future conservation strategy and recovery planning for the Sierra Nevada MYLFs. The goal of the Conservation Strategy is to "ensure self-sustaining long-term viability and evolution of mountain yellow legged frog populations in perpetuity that represent their historic geographical range, and genetic and ecological diversity." The multi-agency team developing the strategy has concluded that eradicating introduced fish and developing methods for successful translocations and reintroductions are the primary tools available for recovering MYLFs.

The existence of nonnative trout, and subsequently the spread of the infectious chytrid fungus (Bd) throughout its habitat, has created a dire situation. Other stressors include changing climatic conditions and air pollution. Air pollution may stress the MYLF immune systems. Global climate change has caused

smaller, shallower lakes, which are important habitat because they are fishless, to dry up earlier in the season, thus further impacting the MYLFs, which need 2 to 3 years to successfully grow from tadpole to adult form.

The MYLFs' decline has had cascading negative consequences to high elevation ecosystems across the Sierra Nevada. Because of the historic abundance of MYLFs (Grinnell and Storer 1924), they were important contributors to energy and nutrient cycling in aquatic and adjacent terrestrial ecosystems. Eradicating nonnative fish from high quality MYLF habitat and restoring MYLF populations to locations where they have been extirpated would also restore and protect an integral component of healthy high Sierra native ecosystems (Knapp et al. 2001), which is integral to protecting the natural quality of wilderness character.

Action in wilderness is necessary at this time because it is critical to protect these species and their habitat in order to prevent future impairment to ecosystem processes in high elevation aquatic ecosystems within the SEKI wilderness that would occur as a result of the extirpation of these species in SEKI.

To determine if administrative action is necessary, answer the questions listed in A - F on the following pages by answering Yes or No, and providing an explanation.

A. Are there options outside of wilderness?

Justify why the action is necessary within wilderness.

Yes: ☐ **No:** ☒

Explain:

Over 99% of SEKI's MYLF habitat is located in the wilderness at elevations over 8,000 feet. There have been alternative approaches considered that could occur outside wilderness, including captive rearing programs. Implementing a MYLF captive rearing program for reintroduction into the wild was considered as a restoration tool to supplement nonnative fish eradication and natural recolonization. However, it would be pointless to transplant MYLF into habitat if nonnative fish are not removed in wilderness lakes prior to reintroductions. Frog restoration using only reintroductions would not address the issues with fragmented populations and the availability of high quality fish-free habitat. Also, the reintroductions would have to occur across the MYLF habitat, of which 99% is located in wilderness areas.

This project looks at restoration of natural conditions on a landscape scale as large scale restoration of more complex habitat is critical for native species and ecosystem processes. Since 99% of MYLF habitat is located in wilderness, large scale restoration cannot occur outside of wilderness. Therefore it is necessary to conduct actions within wilderness.

B. Are there valid existing rights or special provisions of wilderness legislation?

Is action necessary to satisfy valid existing rights or a special provision in wilderness legislation (the Wilderness Act of 1964 or subsequent wilderness laws) that allows or requires consideration of the Section 4(c) prohibited uses? Cite law and section.

Yes: ☐ **No:** ☒

Explain:

C. Are there requirements of other legislation?

Is action necessary to meet the requirements of other laws? Cite law and section.

Yes: ☒ **No:** ☐

Explain:
California Wilderness Act of 1984 (Public Law 98-425)
Though not specifically contained within the legislation, conservation is a valid goal of the Sequoia-Kings Canyon Wilderness. The Committee Report (House Report 98-40) accompanying the House version of the 1984 act states that "native wildlife species are an integral and natural component of the character of a wilderness on an interdependent basis with its physical features: soils, water, geology and plants.

Endangered Species Act of 1973 (16 U.S.C. 1531-1544, 87 Stat. 884), as amended – PL 93-205
The Endangered Species Act was enacted to provide a program for the conservation of wildlife and plant species that are threatened or endangered with extinction. The Act provides that federal agencies shall "utilize their authorities in furtherance of the purposes of [the Act] by carrying out programs for the conservation of endangered species and threatened species." 16 U.S.C. Section 1536(a)(1). The Act further requires Federal agencies to ensure that any action authorized, funded or carried out by them is not likely to jeopardize the continued existence of listed species or modify their critical habitat.

In 2012, *R. muscosa* was listed as endangered and *R. sierrae* was listed as threatened under the California Endangered Species Act (CFGC 2012), and in April 2014 both species were listed as endangered (FE) under the federal Endangered Species Act (ESA; FWS 2014A).

Section 7(a)1 of the ESA states that " ... Federal agencies shall, in consultation with and with the assistance of the Secretary, utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered and threatened species ..." Under ESA section 4(f) authority, the Secretary of Interior, through the FWS, is charged with developing and implementing recovery plans for the conservation and survival of threatened and endangered species. By restoring MYLF to its historic range, the project fulfills a necessary component of the Draft Conservation Strategy and facilitates conservation of this species.

The following laws have also informed the NPS's consideration on whether to take action in wilderness:

The Organic Act of the National Park Service (NPS):
"Sec.1. …. The service thus established shall promote and regulate the use of the Federal areas known as national parks, monuments, and reservations hereinafter specified by such means and measures as conform to the fundamental purpose of the said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

The Organic Act directs us "to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

The 1978 Amendment (a.k.a. Redwoods Act) strengthened the protective functions of NPS and influenced recent decisions regarding resource impairment. "…the protection, management, and administration of these areas shall be conducted in the light of the high public value and integrity of the NPS and shall not be exercised in derogation of the values and purposes for which these various areas have been established…"

The National Park Service Omnibus Management Act of 1998

The National Park Service Omnibus Management Act of 1998 directs the Secretary of the Interior "to assure that management of units of the National Park System is enhanced by the availability and utilization of a broad program of the highest quality science and information." It also established the framework for fully integrated natural resource monitoring into the management process of the NPS. Section 5934 of the Act requires the Secretary of the Interior to develop a program of "inventory and monitoring of NPS resources to establish baseline information and to provide information on the long-term trends in the condition of the National Park System resources." The message of the Parks Omnibus Management Act of 1998 was reinforced by Congress in the FY 2000 Appropriations bill.

D. Wilderness Character

Is action necessary to preserve one or more of the qualities of wilderness character including: Untrammeled, Undeveloped, Natural, Outstanding Opportunities for Solitude or Primitive and Unconfined Recreation, or Unique Attributes or Other Features that reflect the character of this wilderness area? (the beneficial and adverse effects on wilderness character are evaluated under Step 3)

Untrammeled: **Yes:** ☐ **No:** ☒

Explain:

Although this action is not necessary to preserve the "Untrammeled" quality of wilderness character, it proposes to correct past intentional human caused manipulation of "the earth and its community of life." This intentional manipulation was the stocking of nonnative trout into the high elevation lakes and streams of Sequoia and Kings Canyon National Parks, which led to changing ecosystem function and the disappearance of MYLF from approximately 92% of historic localities in the Sierra Nevada, with similarly large losses in SEKI (Vredenburg et al. 2007, Bradford et al. 1994B, Knapp and Matthews 2000).

Information excerpted from the Federal Register Notice (Federal Register Vol. 78, No. 80, April 25, 2013):

> Habitat modification due to the introduction of trout to historically fishless areas is documented to have a significant detrimental impact to mountain yellow-legged frog populations. The presence of trout from historical stocking for the creation of a sport fishery in the Sierra Nevada started in the late 19th century (Bahls 1992, p. 185; Pister 2001, p. 280). This anthropogenic activity has community-level effects and constitutes the primary detrimental impact to mountain yellow-legged frog habitat and species viability. Prior to extensive trout planting programs, almost all streams and lakes in the Sierra Nevada at elevations above 1,800 m (6,000 ft) were fishless. Several native fish species occur naturally in aquatic habitats below this elevation in the Sierra Nevada (Knapp 1996, pp. 12– 14; Moyle et al. 1996, p. 354; Moyle 2002, p. 25). Natural barriers prevented fish from colonizing the higher elevation headwaters of the Sierra Nevada watershed (Moyle et al. 1996, p. 354). Another detrimental feature of fish stocking is that fish often persist in waterbodies even after stocking ceases. Lakes larger than 1 ha (2.5 ac) within Sierra Nevada National Parks were estimated to have from 35 to 50% nonnative fish occupancy, only a 29 to 44% decrease since fish stocking was terminated around two decades before the study (Knapp 1996, p. 1).

Undeveloped: **Yes:** ☐ **No:** ☒

Explain:

Natural: **Yes:** ☒ **No:** ☐

Explain:

This project would restore elements of the natural quality of wilderness character by restoring native wildlife and the communities and ecosystems in which they occur. There is the potential for adverse effects on the natural quality of wilderness during the removal of nonnative fish, to varying degrees depending on which alternative is selected. But the overall benefit and long-term effects from removing nonnative fish in treatment areas would improve the natural quality of wilderness on a landscape scale in portions of SEKI.

As mentioned previously under "Description of Situation," the effects of introduced nonnative trout on aquatic ecosystems are well documented.

Perpetuation of natural ecological relationships and processes, and the continued existence of native wildlife populations in largely natural conditions are key components of the natural quality of wilderness character. Experiencing a natural landscape with a full complement of native biodiversity is a key component of the quality of wilderness character. The natural quality of wilderness character in SEKI is being compromised by the extreme and rapid decline of the MYLF. Preventing the frogs from being extirpated in SEKI and restoring their distributions across SEKI's wilderness is necessary to restore and protect the natural quality of wilderness character. In order to help prevent the MYLFs from being extirpated in SEKI, and to restore and protect these qualities of wilderness character, the number and size of viable populations must be substantially increased.

The ecological effects of continuing losses of formerly abundant MYLFs from most of their ranges have been substantial, and recent studies indicate that both species are continuing to decline and are on trajectories toward being extinction (Vredenburg et al. 2010, Knapp et al. 2011). Because important interactions occur between MYLFs, other aquatic and terrestrial species, and key ecosystem processes, the presence of MYLFs in an ecosystem today indicates a system that has retained much of its native species diversity and ecological function, and thus likely has stronger potential for resistance and resiliency to ecosystem stressors and uncertain future conditions (compared to ecosystems lacking MYLFs) (Finlay and Vredenburg 2007, Knapp et al. 2007).

Outstanding Opportunities for Solitude or Primitive and Unconfined Recreation:

Yes: ☒ **No:** ☐

Explain:

Reestablishing a native species in a wilderness area, independent of the means for reaching that goal, enhances the primitive character of the wilderness by restoring the natural sights and sounds of wilderness.

Unique Attributes or Other Features of Value that reflect the character of this wilderness, e.g. Cultural Resources:

Yes: ☐ **No:** ☒

Explain:

E. Public Purposes

Is action necessary to protect one or more of the public purposes for wilderness (as stated in Section 4(b) of the Wilderness Act) of recreational, scenic, scientific, educational, conservation, and historical use?

Recreational: **Yes:** ☒ **No:** ☐

Explain: Experiencing native ecosystems including native wildlife is an integral component of wilderness recreation.

Scenic: **Yes:** ☐ **No:** ☒

Explain:

Scientific: **Yes:** ☒ **No:** ☐

Explain: Intensive field studies on MYLFs have occurred in SEKI, YOSE, Inyo NF and Sierra NF to help managers better understand the effects of nonnative fish, chytrid fungus, pollution and climate change, and ultimately how to mitigate those effects. Actions that have been performed include marking animals for tracking purposes, removing a small percentage of animals from a population for disease studies both in the lab and field, collecting tissue for genetic analyses, and treating animals with antifungal cleansers and probiotics. This project would continue these research activities. The results from these efforts and new data gained will be used to inform future research and science.

The project would help identify presently incomplete information that is needed for effective conservation and management of aquatic ecosystems and help managers and scientists understand aquatic ecosystem functional integrity, biodiversity, and develop the capacity to adapt to unprecedented rates of human-induced change.

Results from the restoration efforts and new knowledge from research studies would be used to refine program methodologies over time and mitigate impacts that have the potential to occur during restoration.

Educational: **Yes:** ☒ **No:** ☐

Explain: The results from the restoration efforts and new data gained will be used to inform both park managers, scientists, other agencies, and the public about aquatic ecosystems in wilderness, and how changing conditions, including human-induced changes, affect these ecosystems.

Conservation: **Yes:** ☒ **No:** ☐

Explain: Conservation is a valid public purpose of wilderness, and this project would fulfill this purpose by conserving and protecting native species, and restoring natural ecosystem functions, resulting in improved conservation of wilderness resources.

The Organic Act directs the NPS "to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

The California Wilderness Act of 1984 (Public Law 98-425) Committee Report (House Report 98-40) accompanying the House version of the 1984 act which established the Sequoia-Kings Canyon Wilderness states that "native wildlife species are an integral and natural component of the character of a wilderness on an interdependent basis with its physical features: soils, water, geology and plants.

Preserving and restoring native wildlife and the communities and ecosystems in which they occur is one of the guiding principles for managing biological resources in national parks per NPS Management Policies 2006 and is among the desired conditions established in SEKI's Final General Management Plan/Final Environmental Impact Statement (GMP; NPS 2007).

The 2007 GMP establishes a vision for what the parks should be, including broadly defined desired future conditions for natural resources:

The following desired conditions are relevant to the conservation of natural resources, including:

- The NPS will maintain all the components and processes of naturally evolving park ecosystems.
- Populations of native plant and animal species function in as natural a condition as possible except where special management considerations are warranted.
- Native species populations that have been severely reduced or extirpated from the park are restored where feasible and sustainable.
- The NPS will, within park boundaries, identify, conserve, and attempt to recover all federally listed threatened, endangered, or special-concern species and their essential habitats. As necessary, the NPS will control visitor access to and use of essential habitats, and may close such areas to entry for other than official purposes. Active management programs (such as monitoring, surveying populations, restorations, exotic species control) will be conducted as necessary to perpetuate, to the extent possible, the natural distribution and abundance of threatened or endangered species, and the ecosystems upon which they depend. Ongoing consultation related to threatened or endangered species will occur with the FWS should any actions take place in the habitat of such species.
- The NPS will strive to protect the full range of genetic types (genotypes) of native plant and animal populations in the parks by perpetuating natural evolutionary processes and minimizing human interference with evolving genetic diversity.
- The NPS will re-establish natural functions and processes in human-disturbed natural systems in the parks unless otherwise directed by Congress. The NPS will restore the biological and physical components of human-disturbed systems as necessary, accelerating both their recovery and the recovery of landscape and community structure and function. The NPS will seek to return human-disturbed areas to conditions and processes representing the ecological zone in which the damaged resources are situated.
- Exotic species will not be introduced into the parks (except under special circumstances).
- The management of populations of exotic plant and animal species, up to and including eradication, will be undertaken whenever such species threaten park resources or public health and wherever control is prudent and feasible.
- The NPS will identify all state and locally listed threatened, endangered, rare, declining, sensitive, or special concern species and their essential habitats that are native to and present in the parks. These species and their essential habitats will be considered in NPS planning and management activities.

Protecting and reestablishing native species in wilderness enhances the primeval character of an ecosystem and serves a critical conservation purpose.

Historical: **Yes:** ☐ **No:** ☒

Explain:

F. Is there other guidance?

Is action necessary to conform to direction contained in agency policy, unit and wilderness management plans, species recovery plans, or agreements with tribal, state and local governments or other federal agencies?

Yes: ☒ **No:** ☐

Explain:

NPS Management Policies (2006)
The policies direct parks to "maintain as parts of the natural ecosystems…all plants and animals native to park ecosystems." This may be accomplished by "preserving and restoring the natural abundances, diversities, dynamics, distributions, habitats, and behaviors of native plant and animal populations and the communities and ecosystems in which they occur… [and] minimizing human impacts on native plants, animals, populations, communities, and ecosystems, and the processes that sustain them" (Section 4.4.1). Native species are defined "as all species that have occurred, now occur, or may occur as a result of natural processes on lands designated as units of the national park system" (Section 4.4.1). In terms of management within wilderness, the policies note that "[w]ithout natural resources, especially indigenous and endemic species, a wilderness experience would not be possible." However, species need to be managed within the context of the whole ecosystem and "management intervention should only be undertaken to the extent necessary to correct past mistakes, the impacts of human use, and influences originating outside of wilderness boundaries" (Section 6.3.7).

The NPS is required to protect and strive to recover all native species that are listed under the ESA and to conduct actions and allocate funding to address endangered and threatened species (Section 4.4.2.3). These actions include control of nonnative species and reestablishment of extirpated populations. State listed species are to be treated in as similar a manner as possible. These policies also direct NPS to cooperate with other agencies and participate in range-wide recovery planning processes.

Section 6.3.7: Natural Resources Management (in wilderness): Management should seek to sustain the natural distribution, numbers, population composition, and interaction of indigenous species. Management intervention should only be undertaken to the extent necessary to correct past mistakes, the impacts of human use, and influences originating outside of wilderness boundaries. Management actions, including the restoration of extirpated native species, the alteration of natural fire regimes, the control of invasive alien species, the management of endangered species, and the protection of air and water quality, should be attempted only when the knowledge and tools exist to accomplish clearly articulated goals.

Section 4.6.5
The Service may intervene to manage individuals or populations of native species only when such intervention will not cause unacceptable impacts to the populations of the species or to other components and processes of the ecosystems that support them (Section 4.4.2). Also management is necessary:

- because a population occurs in an unnaturally high or low concentration as a result of human influences (such as loss of seasonal habitat, the extirpation of predators, the creation of highly productive habitat through agriculture or urban landscapes) and it is not possible to mitigate the effects of the human influences; and
- to protect rare, threatened, or endangered species.

Management Policies 2006, Section 4.4.4, addresses the management of exotic species: Exotic species will not be allowed to displace native species if displacement can be prevented.

Section 4.4.4.2 Removal of Exotic Species Already Present: All exotic plant and animal species that are not maintained to meet an identified park purpose will be managed—up to and including eradication—if (1) control is prudent and feasible, and (2) the exotic species interferes with natural processes and the

perpetuation of natural features, native species or natural habitats, or disrupts the genetic integrity of native species.

This project meets the criteria set in Management Policies Section 4.6.5 because past efforts have shown that nonnative fish can be effectively removed (control is prudent and feasible); as explained previously, nonnative fish have been shown to interfere with natural processes and native species; displacement can be prevented; and the MYLF are federally listed species and are at risk of extinction. Also, the experimental intervention program underway to protect and treat MYLF has not been shown to cause unacceptable impacts to the populations of the species or other components or ecosystem processes.

The Sierra Nevada Mountain Yellow-legged Frog Conservation Assessment
The U.S. Forest Service (USFS) led a multi-agency working group that developed a conservation assessment for the mountain yellow-legged frog in the Sierra Nevada (Brown et al. 2014). The Conservation Assessment concluded that introduced fish played a major role in the decline of the species likely causing local extirpations, and may have precluded successful recolonization. The assessment identified restoring fishless habitat and developing translocation studies as key conservation options for recovering the species.

The Mountain Yellow-legged Frog Conservation Strategy
The FWS, NPS, USFS, and California Department of Fish and Wildlife (CDFW) are currently collaborating on the development of a conservation strategy for the Sierra Nevada yellow-legged frog (*R. sierrae*) and the northern distinct population segment of the mountain yellow-legged frog (*R. muscosa*). The goal of the Conservation Strategy is to "Ensure self-sustaining long-term viability and evolution of mountain yellow legged frog populations in perpetuity that represent their historic geographical range, and genetic and ecological diversity." The multi-agency team developing the strategy has concluded that eradicating introduced fish and developing methods for successful translocations and reintroductions are the primary tools available for recovering the species.

California Endangered Species Act (CESA) (Fish and Game Code Sections 2050-2116)
Under the CESA, the mountain yellow-legged frog (*R. muscosa*) is listed as Endangered and the Sierra Nevada yellow-legged frog (*R. sierrae*) is listed as Threatened. The CDFW recommended listing these species following an extensive review of the species status and threats. CDFW has been actively engaged in conservation of the species for over the past ten years and they have documented along with other agencies including the NPS, and research groups, precipitous range-wide declines. In their status review, CDFW concluded that the introduction of nonnative fishes and disease are the principle drivers of decline. Their management recommendations include continuing to remove nonnative trout from targeted waterbodies to benefit resident MYLF populations and to provide fish free habitat for translocations and reintroductions. They also recommended special focus on research directed at reintroducing MYLFs in a Bd-positive environment.

To determine if an action is necessary in wilderness, review the Step 1 questions in A - F above.
***Note that the answers have varied weight in Step 1:*
Decision: A - D have first priority;
E has second priority;
F has third priority.

Step 1 Decision: Is any administrative action <u>necessary</u> in wilderness?

Is the action "necessary" to ensure wilderness stewardship or preservation? Considerations to help you make this determination: If you do not accomplish the work, would there be unacceptable adverse Effects on wilderness? Would you be going against other laws and/or policies?

Yes: ☒ **No:** ☐

Explain: As discussed in previous sections, the proposed project would allow for the preservation of the natural quality of wilderness, and would fulfill the conservation purpose of wilderness by removing nonnative species and restoring native species and natural ecosystem processes in SEKI. However, the project would also result in a long-term effect on the untrammeled quality of wilderness character during removal and restoration activities, and a short-term effect on the undeveloped quality as a result of using mechanized equipment and the placement of temporary installations.

Numerous studies previously cited have shown that the past trammeling actions (the planting of nonnative fish) in SEKI wilderness have adversely affected the natural quality of wilderness in the long-term, and have imperiled the survival of native species, in particular the MYLFs. If the two species of MYLF become extirpated in SEKI, it could lead to the impairment of the high elevation ecosystems of these parks, which is in direct opposition to the NPS Organic Act.

While the planting of nonnative fish (the past trammeling action) was halted in 1988, the impacts from this action on the natural quality of wilderness continue. Fish often persist in waterbodies even after stocking ceases. Lakes larger than 1 ha (2.5 ac) within Sierra Nevada national parks (YOSE and SEKI) were estimated to have from 35 to 50% nonnative fish occupancy, which is only a 29 to 44% decrease since fish stocking was largely terminated around two decades before the study (Knapp 1996, p. 1). Although stocking no longer occurs in SEKI, nonnative fish had established self-sustaining populations in approximately 575 waterbodies (Knapp 2003) and in hundreds of miles of stream.

Past actions in the wilderness have shown that trammeling actions have been successful in restoring the natural quality of wilderness character. From 1997 to 1999, researchers used gill nets to experimentally eradicate nonnative fish from two park waterbodies, which showed that fish eradication was feasible (Vredenburg 2004). In 2001, SEKI began to implement preliminary (experimental) restoration of MYLFs (NPS 2001). The primary goal was to assess the feasibility of SEKI staff using gill nets and electrofishers to eradicate nonnative fish from low- to moderate-use individual lakes having short associated streams. The purpose of the program was to restore aquatic habitat for native species, with an emphasis on improving the status of imperiled MYLFs. From 2001 to 2013, SEKI removed more than 50,000 fish from targeted lakes and streams (NPS 2015A, NPS unpublished data). By 2013, SEKI had fully eradicated fish from 10 waterbodies, nearly eradicated fish from 9 waterbodies, and began fish eradications in 4 waterbodies (initiated in 2012). These results show that using SEKI staff to eradicate nonnative fish using gill nets and electrofishers is feasible at the local scale of individual or small groups of waterbodies.

To test the mechanism driving the increases in restored MYLF populations, a study compared the change in MYLF density between 1997 and 2005 in 22 fishless control lakes in SEKI and three trout removal lakes, including two of the SEKI restoration lakes and one lake adjacent to the SEKI boundary in the Inyo National Forest (Knapp et al. 2007). The average change in tadpole density in the control lakes and trout removal lakes was +2.3-fold and +35.2-fold, respectively ($P = 0.025$), while the average change in frog density in the control lakes and trout removal lakes was +0.4-fold and +24.9-fold, respectively ($P = 0.0004$). Thus, increases in MYLF frog numbers in trout removal lakes result from fish eradication rather than regionally favorable conditions for population growth. These results show that eradicating nonnative trout is highly beneficial to MYLFs.

Although SEKI has improved MYLF populations in three restoration basins, all remaining MYLF populations are extremely vulnerable to extirpation due to multiple threats and thus are in urgent need of intervention. First, many populations occupy large basins in which multiple large lakes contain nonnative trout and MYLFs are restricted to small and/or shallow ponds. The trout severely limit frog distribution and abundance by excluding them from large amounts of lake habitat, while at the same time restricting them to pond habitat that is highly vulnerable to climate change. These ponds can completely dry up in even relatively short droughts as has already occurred in SEKI (Lacan et al. 2008). When this happens, multiple cohorts of MYLF tadpoles are lost, and populations already suppressed by trout can be quickly extirpated. In addition, shallow ponds can freeze solid during atypical climate patterns as occurred in SEKI during the winter of 2011 to 2012. This event appears to have killed most of the adult MYLFs that remained in one park basin. Eradicating nonnative trout as quickly as possible in such areas will allow MYLF populations to expand (Knapp et al. 2007) and recolonize large lake habitat that is much more protected from climate effects.

Second, all of the recently restored MYLF populations in SEKI were disease-free and primarily being suppressed by trout, allowing them to easily expand following trout removal. However, nearly all remaining MYLF populations in areas feasible for restoration in SEKI are infected with amphibian chytrid fungus. Nearly all of SEKI's infected MYLF populations have experienced severe die-offs, and the remaining remnant populations have very low survival and recruitment from year to year, making them extremely vulnerable to extirpation. In addition to trout removal, these MYLF populations would likely benefit from an emerging disease treatment technique using antifungal agents, designed to increase short-term survival and hopefully long-term recruitment, thus changing the outcome for many frogs from mortality to persistence. Preliminary results of several field trials conducted in SEKI from 2009 to 2015 show promise for future management application, and a large-scale study was initiated in 2015.

In addition, garter snakes were more likely to be found in fish removal waterbodies (0.097) versus fish-containing waterbodies where no removal was conducted (0.038; Figure 4; NPS 2015A). This difference is likely attributable to the presence of increased numbers of MYLFs (which are a primary prey of garter snakes) in fishless waterbodies versus fish-containing waterbodies (Knapp et al. 2007). Snake detections also increased over time, exhibiting a positive linear relationship with the number of years since trout removal began (Upper Bubbs Creek, R2=0.61, P=0.04 and Upper LeConte Canyon, R2= 0.55, P=0.008) (NPS 2012A). These differences are likely attributable to the presence of increased numbers of MYLFs, which are a primary prey of garter snakes, in fishless lakes versus fish-containing lakes (Knapp et al. 2007). Clark's nutcrackers, Brewer's blackbirds and American robins are now seen opportunistically feeding on MYLFs in restored populations (NPS unpublished data). In addition, abundant mayfly hatches are now a common annual occurrence at most trout removal lakes, providing improved forage for gray-crowned rosy finches and several bat species (NPS unpublished data).

This project proposes new long-term trammeling actions (site-specific trammeling would occur over a period of up to 35 years) to address past actions which have adversely affected the natural quality of wilderness character. The new trammeling actions would involve removing all of the nonnative fish from about 15% of the approximately 550 waterbodies (lakes, streams, and marshes) that currently contain nonnative fish. Methods for the removal of the fish are discussed within the alternatives section of this MRA. There would also be trammeling actions associated with future research and restoration of MYLFs. There would be limited short-term effects on undeveloped as a result of the proposed removal actions (i.e. considered actions include the installation of nets, fish traps, use of helicopters, the creation of temporary and permanent stream barriers, and the establishment of temporary crew camps).

When weighing the long-term effects on the untrammeled and undeveloped qualities of wilderness against the ongoing adverse effects on the natural quality of wilderness from the presence of nonnative fish, a number of elements are considered.

First, the ecological and conservation effects of continuing losses of formerly abundant MYLFs from most of their ranges have been substantial, and recent studies indicate that both MYLF species are continuing to decline and are on trajectories toward extinction (Vredenburg et al. 2010, Knapp et al. 2011). Extirpation of these species in SEKI would have a significant adverse effect on the natural quality of wilderness in SEKI because it would remove species which are important to key ecosystem processes.

Second, because important interactions occur between MYLFs, other aquatic and terrestrial species, and key ecosystem processes, the presence of MYLFs indicates an ecosystem that has retained much of its native species diversity and ecological function, which amounts to the preservation of the natural quality of wilderness. Ecosystems with native components, including MYLFs, have been shown to have a stronger potential for resistance and resiliency to ecosystem stressors and uncertain future conditions (compared to ecosystems lacking MYLFs) (Finlay and Vredenburg 2007, Knapp et al. 2007). For these reasons, preserving MYLFs into the foreseeable future would have a long-term beneficial effect on the natural quality of wilderness.

Third, because of the historic abundance of MYLFs (Grinnell and Storer 1924), they were important contributors to energy and nutrient cycling in aquatic and adjacent terrestrial ecosystems. Removing

nonnative fish and restoring MYLF populations to locations where they have been extirpated would restore and protect an integral component of healthy high Sierra native ecosystems (Knapp et al. 2001). Fourth, introduced trout not only contribute to the decline of MYLFs (Bradford et al. 1993, Knapp 1996, Vredenburg V., pers. comm., 2007), they contribute to a general loss of biodiversity in aquatic biota and associated terrestrial fauna. In the northern Sierra Nevada, the long-toed salamander appears to be found primarily in fishless lakes (Bradford and Gordon 1992). Epanchin et al. (2010) found rosy-crowned finch to be more common at lakes without fish than at lakes with fish. This is because introduced fish populations limit mayfly populations on which the finch feeds during mayfly emergence. The mountain garter snake feeds on MYLFs. Matthews et al. (2002) found that mountain garter snake abundance is directly related to frog abundance.

While quantitative data is lacking, the abundance of other alpine/subalpine species are likely to be affected by losses of frog populations. Brewer's blackbirds, Clark's nutcrackers and American robins feed on MYLFs (Jennings and Hayes 1994, NPS unpublished data). While the high elevations of the southern Sierra Nevada seem to provide little natural food for black bears (*Ursus americanus*), they have been observed foraging for MYLFs (Knapp R., pers. comm., 2010). Before frog populations crashed, they may have been an important high elevation food for bears. Additionally, MYLFs are not only prey for a variety of alpine/subalpine vertebrates, they are also a predator. Much of their food is insects, but they feed also on small vertebrates, such as Pacific treefrogs (Pope 1999, Vredenburg V., pers. comm., 2007).

Trout virtually eliminate large-bodied invertebrates from lakes. When Stoddard (1987) surveyed zooplankton in 75 Sierra Nevada lakes, he found fish to be important predictors of species occurrence, with small-bodied species being found in association with fish and large-bodied species occurring only where fish are absent. Likewise, Bradford et al. (1994A, 1998) found large-bodied planktonic microcrustaceans (e.g., *Hesperodiaptomus shoshone* and *Daphnia melanica*) and epibenthic and limnetic macroinvertebrates (e.g., back swimmers, water boatmen, predaceous diving beetles, and larvae of some families of caddis flies and mayflies) to be relatively common in lakes without trout, but rare or absent in lakes with trout.

Herbst et al. (2009) found that the presence of introduced trout in streams resulted in decreased density for 20 invertebrate taxa and increased abundance for 6 taxa. The strongest effects appeared to be on taxa endemic to the Sierra Nevada, which had no coevolutionary history that would have facilitated their development of mechanisms to deal with fish predation. The study found that streams containing introduced trout had significantly more algae density and cover, increased abundance of midges, and reduced density of the most common large invertebrate predator, the stonefly *Doroneuria baumanni*.

Introduced trout are a threat to native trout as well. On the Kern Plateau, introduced brown trout threatened the California golden trout native to the South Fork Kern River. Programs to remove brown trout were necessary to manage the native fishery. In the Little Kern River drainage, the Little Kern golden trout became federally listed as threatened because of genetic introgression from planted rainbow trout. To this day there is an interagency effort to restore both taxa. Likewise, the original genotypes of rainbow trout native to the parks' western drainages are unlikely to have persisted following a century of planting non-indigenous rainbow and golden trout. Many of the fish in those streams show evidence of hybridization with golden trout.

The impacts of trout can be broader than the direct loss of the organisms they eat or displace. Those organisms are important components of the ecosystem. Once removed, their loss will affect the other native organisms on which they fed, as well as the creatures that depended on them for food. Knapp (1996) cites several published examples of these cascading effects.

Fifth, previously approved actions have been successful on a small scale in restoring the natural quality of wilderness character at treatment areas, including increasing MYLF populations and making them more resistant to the chytrid fungus, and in turn increasing other native species in the area that rely upon MYLF for prey or that are adversely affected by the presence of nonnative trout. A few MYLF populations are showing evidence of persistence – surviving and reproducing while continuing to be infected with chytrid fungus (Vredenburg et al. 2010; Knapp R., pers. comm., 2010). All persisting MYLF populations are in fishless areas and had high abundance prior to infection. Eradication of nonnative fish near existing

MYLF populations would allow these populations to expand (Knapp et al. 2007) and should increase their resiliency to chytrid fungus by improving their ability to develop resistance to the disease before being extirpated.

Finally, the continuing decline of MYLF and the high potential for the these species to be extirpated from SEKI should no action be taken would result in a degradation to the high elevation ecosystems as previously described, and could potentially result in an impairment to park resources, because SEKI would lose a key natural component of the wilderness. Impairment is in direct conflict with NPS mandates.

In conclusion, action is necessary because native ecosystems (thus the natural quality of wilderness character) have been degraded from the presence of nonnative trout. The primary species affected are MYLFs, but there are cascading Effects on other native species as well, as previously stated. MYLFs have disappeared from 92% of historic localities in the Sierra Nevada, with similarly large losses in SEKI (Vredenburg et al. 2007) primarily due to the introduction of nonnative trout from 1870 to 1988 (a past trammeling action), while other populations remained strong in areas where fish were not introduced (Knapp and Matthews 2000). Recently, amphibian chytrid fungus invaded the Sierra Nevada and infected most of the MYLF populations in SEKI that were doing well in fishless areas (Vredenburg et al. 2010). Most of the infected populations severely declined, and many were extirpated (NPS unpublished data). Those areas with the highest populations of frogs were able to withstand the outbreak of chytrid fungus.

SEKI is the only park that contains both species of MYLFs, making it a core zone for their restoration, recovery and conservation. Without action, there is a high likelihood that the remaining populations of MYLFs in SEKI will be extirpated, resulting in a permanent adverse effect on the natural quality of wilderness character; the NPS would not meet its conservation mandate, and impairment of high elevation ecosystems would occur. Because the proposed trammeling actions are highly likely to preserve the species, and allow the NPS to meet its mandate, trammeling actions and temporary developments are warranted in this situation.

If you are unable to determine if the action is necessary based on Step 1 information, consult your division chief/supervisor. Researchers consult the Research Permit Coordinator.

Compliance Pathway: Is the action covered under an existing plan, management directive and/or other compliance document (i.e., MD-49, EA, EIS, CE/programmatic CE).

Yes: ☐ **No:** ☒

If yes, provide document name and PEPC reference number:

The National Park Service has prepared a Restoration of Native Species in High Elevation Aquatic Ecosystems Plan and Final Environmental Impact Statement for this project (PEPC 17157).

If no, or you are unsure, contact the Environmental Protection Specialist for instructions.

STEP 2:
Determine the need to develop alternatives.

Does your project propose a Section 4(c) prohibited activity?

Section 4(c) prohibited activities include: the use of mechanical transport and/or motorized equipment and vehicles, the landing of aircraft, and the installation of materials, equipment and/or structures.

***NOTE*:** *Installations include items used to support activities such as communications, water development, stock use, or wildlife management. It includes debris such as old dump sites, plane crash sites, or locations of unexploded ordinance. It includes memorials or other monuments other than those placed during land surveys. It also includes unattended measurement or other device(s) left in place for the purpose of recording environmental data or marking a study plot.*

Yes: ☒ **No:** ☐

If *yes*, proceed to Step 3.

Step 3: Determine the minimum activity.

Please refer to the instructions for additional information on developing alternatives and guidance on identifying effects.

Description of Alternatives

Develop a reasonable range of feasible alternatives. Include a list of alternatives that you considered and ruled out, and the justification for ruling out alternatives (alternatives should not be eliminated simply because of cost or the time involved). You should have at least two alternatives *plus* a "no action" alternative.

For each alternative, describe what the action is, when and where the activity will take place, and what methods and techniques will be used. Include estimates for frequency and duration of activities and actions.

When you are evaluating the effects from each alternative, detail the effects on the qualities of wilderness character and other comparison criteria, including safety. Where mitigation is possible, include mitigation measures. Add additional pages as necessary.

Alternative # __1___ No Action – Status Quo - Continue Current Project until Completed in 2017

*Note: This alternative was previously evaluated in a 2001 Environmental Assessment and approved through a separate minimum requirement analysis.

Description:

Under the "No Action - Status Quo" alternative, the existing high elevation aquatic ecosystem restoration effort initiated in 2001 would be completed, maintained and monitored, but no new fish eradication activities would be initiated. Native species and ecological processes in high elevation

aquatic ecosystems would continue to be monitored and conserved. Research on native species, ecological processes and their stressors would continue in accordance with NPS policy.

Restoration is conducted by NPS staff from the SEKI RMS division. Ongoing high elevation aquatic ecosystem restoration activities include habitat restoration in selected approved waters through removal of nonnative fish, experimental treatments of MYLF populations to mitigate effects of chytrid fungus infection, and experimental reintroductions of MYLFs into fishless waters.

From 1997 to 1999, researchers used gill nets to experimentally eradicate nonnative fish from two park waterbodies. This study showed that fish eradication was feasible (Vredenburg 2004). In February 2001, SEKI released an Environmental Assessment for Preliminary Restoration of Mountain Yellow-legged Frogs (NPS 2001). The document called for SEKI staff to eradicate nonnative fish from low- to moderate-use individual lakes and streams using gill nets and backpack electrofishers. The document was approved with a Finding of No Significant Impact in June 2001. This project has proceeded modestly in order to: 1) determine whether SEKI staff could eradicate fish from park waters, 2) measure benefits to MYLFs and 3) gain the knowledge needed to develop a comprehensive restoration program.

From 2001 to 2011, SEKI staff fully or nearly eradicated nonnative fish from 11 waterbodies (and associated streams); eight were completed but three had insufficient barriers (small non-vertical natural cascades) allowing fish to recolonize the treatment areas. Eradication work in the three waterbodies with insufficient barriers would cease under this alternative.

From 2009 to 2015, nonnative fish eradications were initiated in 12 additional waterbodies (NPS 2009A). Eradications are complete in five of these waterbodies (initiated in 2009), and nearly complete in seven of these waterbodies (initiated in 2009, 2010 and 2012). Eradication work in these seven remaining waterbodies is expected to be completed by 2017.

Under this alternative, monitoring and conservation of native species would continue into the foreseeable future in all 25 waterbodies.

Description of Physical Treatment Methods

Gill Netting

Gill netting is a method of fish collection that is primarily used in lakes, ponds and stream pools. Gill nets are considered an installation because they can be left in place unattended for an extended period, which is a 4(c) prohibited action. The use of gill nets has been proven as an effective method for the removal of fish from small to medium lakes.

Repeated gill netting has been successfully used to completely remove fish from lakes (Knapp and Matthews 1998, Knapp et al. 2007, NPS 2012A). Gill nets are sinking nets designed to effectively capture fish of all sizes. Netting involves placing many sinking nets in a lake, with each net stretched from the shoreline out toward deep water at roughly equal distances between nets. Nets would be approximately 120 ft (36 m) long by 6 ft (1.8 m) deep, and have mesh sizes ranging from 0.4 inches (1 cm) to 1.5 inches (3.8 cm). Nets used to capture young fish that remain very close to shore, would be approximately 60 ft long by 6 ft (1.8 m) deep, and have mesh sizes ranging from 0.4 inches (1 cm) to 0.7 inches (1.7 cm). Gill nets would be deployed using inflatable non-motorized watercraft such as a float tubes, kayaks or rafts.

Nets would be set and pulled during daylight hours to minimize safety hazards and potential handling complications. When a new fish removal site is initiated, nets are frequently cleaned of captured fish and reset (generally every 24 to 48 hrs). By mid-season, capture rates decrease and the length of time that nets are set gradually increases. At the end of the summer field season, several nets are set in deeper water to continue catching fish under winter ice. Summer and over-winter netting continues until all nets set in a lake repeatedly capture zero fish. This method of gill netting typically results in the removal of all fish from a lake by the third or fourth summer, but could be extended to up to seven seasons depending on site conditions.

Electrofishing
Electrofishing is a physical method of fish collection primarily used in streams and occasionally in shallow water at the edges of lakes. Since it is not a mechanized or motorized equipment/use, electrofishing is not considered a 4(c) prohibited action. Electrofishing is a common fishery management technique that has been successfully used to collect fish for approximately 100 years (Cowx and Lamarque 1990). Electrofishing is implemented with a device called an electrofisher, which uses two electrodes to send electric current from a battery into the water. When both electrodes are submerged in the water and the unit is activated, the water completes the circuit and a field of electricity is generated around the electrodes. Fish caught in the field of electricity are stunned, float in the water and are captured using dip nets.

Battery-powered backpack electrofishers are the type of electrofishing units that would be used. A two to three person crew would be deployed, wearing chest waders, wading boots and rubber gloves. One person would operate the electrofisher while the remaining crewmembers would stand on either side of the operator and capture shocked fish using dipnets. Each stream electrofishing session would begin at the downstream boundary of the targeted stream segment and proceed in an upstream direction. This allows stunned fish to drift downstream toward crews and dip nets. Fish removal by electrofishing requires repeated passes through each target stream section until all fish have been eradicated.

Disruption or Covering of Redds
Where redds (fish egg nests) are visible in gravel-bottom areas of streams and shallow lakeshores, they would be disrupted with a shovel or by foot to minimize hatching of fish eggs. Gravel in these areas may then be covered with boulders to eliminate or minimize future fish reproduction in these areas. The disruption of covering of redds is not a 4(c) prohibited action and is moderately successful at removing fish on a small scale.

Fish Traps
Fish traps may be used to augment gill netting and electrofishing efforts when necessary to maintain fish free conditions. If fish traps are used, they would be set in lake inlets and/or outlets to catch fish as they leave the lake to spawn. Fish traps are considered an installation in wilderness because they can be left unattended for an extended period of time, which is a 4(c) prohibited action. Fish traps are moderately successful in capturing fish.

During the first field season, traps would be set during ice-out and removed in the fall. Following the first field season, the effectiveness of having the traps deployed throughout the entire ice-free season would be assessed. If the traps were not effective outside of the spring spawning season, than traps would only be deployed during the spring in subsequent years, otherwise, the traps would be deployed throughout the ice-free season until the site was restored. If the inlet or outlet stream is wider than the trap (1.6 ft / 0.5 m), then mesh arms made out of PVC pipe and aquaculture mesh would be used to construct a funnel between the trap and the stream bank.

Components of the Action		**Activity for this Alternative**
1	Transportation of Personnel to and from the Project Site	Crews hike to and from project sites.
2	Transportation of Equipment to and from the Project Site	Equipment is transported by helicopter or stock* (see conditions that warrant the use of helicopter). Stock would be used for mobilizations and demobilizations of physical treatment sites. Stock would be used for two round trips per site, 1 to 2 sites per year. In general, site mobilizations require 5 animals and demobilizations require 3 to 4 animals plus a packer and riding stock. The maximum yearly stock use is estimated to be 8 to 9 animals per site, requiring only one overnight stay per trip. Therefore, the maximum expected stock

		nights (number of animals multiplied by nights) per year generated by any of the project alternatives are estimated at 16 to 18 nights. • Mobilization: a total of 3-5 flights and 0-2 packstock trips (one mobilization per area) • Demobilization: a total of 3-5 flights and 0-2 packstock trips (one demobilization per area)
3	Establishment of and Use of Crew Camps	Crew size is typically 2 to 3 crewmembers. Crews would camp up to 10 days per site visit and each site would be visited up to 7 times per season. Physical restoration generally takes up to 6 years per lake and up to 10 years per stream and marsh area. Crew camps include a short-term installation of a food and equipment storage locker which would be left in place for the duration of the project work, and removed once the project work is completed.
4	Fish Capture Techniques and Tools	Crews utilize gill nets, fish traps, and battery-powered electrofishers to complete work.
5	Translocation Methods	Frogs to be translocated are either hiked to nearby recipient habitat or transported by helicopter to distant recipient habitat. 'Nearby' habitat generally can be hiked to within 6 hours, posing minor risk to frog survival during transport. 'Distant' habitat cannot be hiked to within 6 hours, which would pose moderate to high risk to frog survival during transport. At the recipient site, all individuals would be released into fishless habitat and monitored for the next several years.
6	Stream barriers	There would be no stream barriers constructed or placed in the streams under this alternative.
7	Condition of Site After Project	Natural conditions would be restored in 25 waterbodies.

*Stock is currently the preferred transport method used to support this project except when one of the following conditions applies:

- Equipment is fragile.
- Cargo is time-dependent or requires stable conditions.
- Cargo is bulky and does not fit well on or over panniers.
- An individual piece of cargo weighs over 150 pounds.
- Stock is not allowed in the area, a waiver for stock use is not authorized by the superintendent, or the area is inaccessible to stock.
- Stock would create unacceptable environmental impacts due to wet trail conditions, and it is impractical to reschedule stock use for a less damaging time.
- Use of stock would cause more environmental impact than a helicopter because the area can only be accessed off trail, or the site is vulnerable to adverse effects.
- Environmental hazards to personnel or animals (e.g., snow or high water crossings) create unsafe conditions for stock use and transport of the material cannot wait until conditions improve.

Exact dates of flights and stock trips could change by 1 to 2 days due to respective Helitack and packer schedules, weather, and/or emergencies at that time.

Actions would continue for two aquatic ecosystem restoration areas until habitat feasible for physical eradication is completed, and would cease for one restoration area where all of the current habitat being restored does not have a definitive fish barrier. The remaining restoration areas include:

Sixty Lake Basin A crew of two biological technicians would work full-time in Sixty Lake Basin from mid June to mid September. During mobilization in early summer, trail conditions (snow, water and logs on trails) make stock use unfeasible and inappropriate. To demobilize Sixty Lake Basin by stock, trail access would be via an unmaintained route. However, stock use in Sixty Lake Basin is prohibited past a certain point to protect fragile amphibian breeding habitat. The camp for the restoration crew is within the stock prohibition area, about one-half mile past the prohibition point. This camp needs to be mobilized and demobilized by a helicopter because the camp is in a stock prohibited area. Work would involve restoring four lakes with a full-time crew that needs to mobilize ~800 Ibs of food/gear per summer using 1 helicopter mobilization flight and 1 helicopter demobilization flight. Four of the six current restoration lakes would be eradicated of fish, and two lakes would be not be eradicated of fish due to the lack of definitive fish barriers. Restoration actions would cease at these two lakes.

Amphitheater Basin A crew of two biological technicians would work full-time in Amphitheater Basin. It would be worked from early July to mid-September - mobilized/demobilized by helicopter. The camp is 2 miles from trail and 2,000 feet higher with a rugged approach not feasible by packstock. Work involves restoring two lakes and one pond with a full-time crew that needs to mobilize ~800 Ibs of food/gear per summer using 1 helicopter mobilization flight and 1 helicopter demobilization flight.

Center Basin
The one current restoration lake would be not be eradicated of fish due to the lack of a definitive fish barrier. Restoration actions would cease at this lake. All gear at the Center Basin camp would be demobilized with one helicopter flight, due the presence of a large metal food/gear storage locker which is too large and bulky to be transported by stock. If the timing coincides with a separate project involving transport of materials needed to mitigate/study an expected frog die-off in the Center Basin area, then the mitigation/study materials would be transported within this restoration flight, thereby eliminating the need for an additional flight in wilderness.

Effects on Wilderness Character:

Untrammeled. The removal of fish is a trammeling action and has a short-term adverse effect on the untrammeled quality of wilderness character. Similarly, translocating frogs into currently unoccupied habitat is a trammeling action which adversely affects this quality. Both would occur at the remaining project sites until site restoration is completed in 2017.

Undeveloped. The project crew camps have a limited short-term adverse effect on the undeveloped quality of wilderness. Since crews are no larger than the average wilderness visitor group, this effect is slight and inconsequential. The use of helicopters for the transport of materials and the translocation of frogs has a short-term adverse effect on the undeveloped quality. The use of gill nets is an installation –netting would continue through 2017 at project sites. Some nets remain in place over the winter months; all are removed after project activities are completed, therefore the effect is limited to the duration of the project. The small crew camps could have food storage lockers in place for several years, and would be a temporary development in wilderness. There would be no permanent change to the undeveloped quality of wilderness under the no action alternative as all developments would be removed after the project completion in 2017.

Natural. The natural ecosystem would be restored in 22 park waterbodies, which is about 4% of the 575 waterbodies that contained nonnative fish prior to the start of the fish removal project. The remaining high elevation waterbodies that contain self-sustaining nonnative trout populations (553 waterbodies plus connecting streams contained in 88 basins) would not be managed to preserve their natural condition and nonnative fish would likely remain into the foreseeable future, adversely affecting the natural quality of wilderness. As a consequence of the presence of nonnative fish, there has been an extensive loss of

native fauna and the proliferation of nonnative fauna. Invertebrate communities have been changed by introduced fish, including a loss of some large species. Some algae communities have been changed from altered invertebrate and vertebrate communities. MYLFs are declining and are at risk of extirpation in SEKI due to loss of habitat from introduced fish, infection by chytrid fungus, and climate change. Gray-crowned rosy finch has significantly less use of lakes that have nonnative fish due to reduced hatch of mayflies and bat species are likely experiencing a similar impact. The impacts on the natural quality of wilderness have been and will continue to be long-term and adverse.

Solitude or Primitive and Unconfined Recreation. The presence of small work crews and equipment could have a negative short-term effect on solitude. However, the work crews are generally small and very similar in appearance to a wilderness visitor's campsite. Also, crews generally camp away from popular camping spots, and most of the work is located away from the primary visitor use areas. Because of these reasons, the impacts are slight and inconsequential.

Other Features of Value. N/A

Effects on safety: Helicopter operations are inherently risky. Prior to considering whether to use helicopters, the previous criteria are considered. An experienced crew would be utilized for helicopter operations. Appropriate training would be provided to all staff working around helicopters.

Effects on other criteria (e.g., special provisions, economics, timing constraints, traditional skills, weather, visitation, etc.): Time of year and weather are considerations when planning project activities, and are considered when determining if a helicopter or stock crew would be utilized to transport equipment to the project site. If it is not possible to use stock to access a camp location due to snow conditions, then a helicopter would be considered for mobilization/ demobilization.

Elements Common to All Action Alternatives:

The following are components of all of the proposed action alternatives that would occur under any of the alternatives. Under each alternative, there would be crew camps established for the project duration. The duration and size of the camp would depend on the alternative selected. Under each alternative, there would be continued ecosystem restoration activities, which would include rebuilding existing populations of MYLFs and reintroducing them into areas previously occupied by frogs, or where nonnative fish removals would be accomplished. Under each alternative, research and monitoring would continue to occur into the future as funding allows. And under each alternative, there would be fish captured and disposed. These elements are evaluated in the following section.

Use of Helicopter and Stock: All fieldwork for the action alternatives would require transport of tools and equipment in and out of the proposed project sites. The type of transport is guided by the Wilderness Act, NPS policies, and the SEKI Wilderness Stewardship Plan (NPS 2015B). This document defines the minimum tool as “the management method (tool) that causes the least amount of impact to the physical resources and experiential qualities (character) of wilderness.”

Stock would only be used for mobilizations and demobilizations of physical treatment sites. Stock would be used for two round trips per site, one to two sites per year. In general, site mobilizations require five animals and demobilizations require three to four animals. Consequently, maximum yearly stock use is estimated to be eight to nine animals per site, requiring only one overnight stay per trip. Therefore, the maximum expected stock nights (number of animals multiplied by nights) per year generated by any of the project alternatives are estimated at 16 to 18 nights. From 2003 to 2012, the yearly average number of stock nights from administrative, commercial, and private use in SEKI is 6,775 nights (NPS 2015B). If this number remains constant, and project stock use utilized the maximum expected stock nights per year (18 nights) for the 25 to 35 year life of the plan, project stock use is only projected to increase park stock use by 0.1% each year. Program managers would require supplemental feed in sensitive meadows. Light (Type 3) helicopters would be utilized if determined to be the minimum tool.

Stock would be the preferred transport method used to support this project except when one of the following conditions applies:

- Equipment is fragile.
- Cargo is time-dependent or requires stable conditions.
- Cargo is bulky and does not fit well in or over panniers.
- An individual piece of cargo weighs over 150 pounds.
- Stock is not allowed in the area, a waiver for stock use is not authorized by the superintendent, or the area is inaccessible to stock.
- Stock would create unacceptable environmental impacts due to wet trail conditions, and it is impractical to reschedule stock use for a less damaging time.
- Use of stock would cause more environmental impact than a helicopter (e.g. by the creation of new trails, by off-trail travel in sensitive environments, etc.).
- Environmental hazards to personnel or animals (e.g., snow or high water crossings) create unsafe conditions for stock use and transport of the material cannot wait until conditions improve.

Whenever any one of those conditions applies, a helicopter would be defined as the minimum tool for transportation of cargo. There could be up to three flights per restoration site per year. Flights would occur at mobilization to deliver supplies, and at demobilization to remove supplies and materials from the project sites. Additional flights could be needed for restoration activities (to transport MYLFs between sites).

Effects of Helicopter and/or Stock Use on Untrammeled: There is no manipulation of the wilderness from the presence and use of helicopters and stock. Therefore there is no effect on the untrammeled quality of wilderness.

Effects of Helicopter and/or Stock Use on Natural: Helicopters affect the natural quality of wilderness by causing disturbance and flight responses in wildlife. The level of disturbance varies depending on the species, and also depending on the habitat. Some animals temporarily leave an area and return when the disruption is gone (when the helicopter departs). Other animals may not return for an extended period (many hours to days) after the disruption ends. Helicopters near habitat may cause some animals to abandon nests or their young. Regardless, there is very little change overall to the natural element of wilderness, and the effects would be short-term, slight, and adverse. Stock can affect the natural quality of wilderness. Moist organic soils become muddier after stock pass through the area, and stock urinate and defecate on trails. Since the stock would only be used during mobilization and demobilization, no stock camps would be established as a result of these actions, and minimum impact techniques would be employed, the effects on natural would be slight and short-term.

Effects of Helicopter and Stock use on Undeveloped: There would be adverse effects on the undeveloped quality of wilderness from the transport of supplies to the sites if helicopters are the chosen method of transport. There could be up to three flights per restoration site per year. Flights would occur at mobilization to deliver supplies, and at demobilization to remove supplies and materials from the project site. Flights would be of short duration and would only be used if stock could not be used to transport supplies to a given project site (e.g. if the trails are not suitable or safe for stock, or if the equipment is too heavy, fragile, or bulky for stock to carry). The adverse effect is temporary, generally only when the helicopter is en route and for 10 to 15 minutes at the landing areas, and would occur in several locations in wilderness each summer. The adverse effect on undeveloped would be short-term and adverse during mobilization and demobilization and would not result in long term adverse effects.

Effects of Helicopter and Stock use on Opportunities for Solitude or Primitive and Unconfined Recreation: The use of helicopters would reduce opportunities for solitude as it would affect the natural soundscape on a short-term basis. If visitors are directed to avoid sites during helicopter drops of equipment, then there would be a temporary reduction in opportunities for unconfined recreation. This would occur for the 10 to 15 minutes required to off load or load equipment, so the adverse effect would be slight and short-term.

Some wilderness users consider pack stock to be an intrusion on their wilderness experience. Backpackers must step off trails for stock strings to pass, stock kick up dust on dry trails, and leave manure and urine. These conditions may be objectionable to some wilderness users, and could reduce

opportunities for solitude on the trails into the project area, and at the project area itself. Again, since this effect would occur only at mobilization and demobilization, the effect would be temporary and slight.

Effects of Helicopter and Stock use on Other Features of Value: There is no effect on this quality from the use of helicopters and stock.

Crew Camps: Crew camps would be required for each selected project area. Crew camps are necessary because the project sites are far from trailheads and this necessitates crews being stationed in the field at project locations for the duration of the project work. Crew camps are similar in size and scale to a wilderness backpacker camp. Crew members bring individual tents and there could be one larger tent used as a work or cooking area. The primary differences between alternatives are the size of the crew, the duration of use and the placement of equipment and/or food storage lockers. Also either a latrine would be dug at the camp, or a portable toilet would be utilized (depending on the location, soil conditions, and site sensitivity).

Food storage and equipment lockers are necessary because a large amount of food is brought into the wilderness for the duration of the project work, more than can be contained in personal portable food storage containers. It is important to protect wildlife from obtaining food from humans. In addition, due to the high elevation of most areas, there are not trees large enough to hang food. Equipment storage is necessary to protect fragile equipment from the weather and site conditions.

Crew camps would be used yearly until the project work is accomplished. Crew camps could be in place up to 10 years per site for physical treatment sites, and 1 to 3 years per site for piscicide treatment sites. Depending on the alternative selected, there could be 1 to 6 crews working at different restoration areas from June or July through September.

Effects of Crew Camps on Untrammeled: There is no manipulation of the wilderness from the presence and use of crew camps. Therefore there is no effect on the untrammeled quality of wilderness.

Effects of Crew Camps on Natural: The effect on the natural quality of wilderness from the presence of crew camps is slight. Small crews staying in one location for several weeks will have an impact on soils in a localized area from trails and compaction around the camp and project area, and could trample vegetation. There could be displacement of wildlife at the camp location, and disturbance from the presence of humans. Crews would be instructed on minimum impact techniques to reduce effects on the natural quality, and would be instructed to avoid areas with sensitive plants. Post project mitigation to rehabilitate the area would be considered and accomplished if warranted.

Effects of Crew Camps on Undeveloped: There would be short term adverse effects on the undeveloped quality of wilderness from the presence of crew camps and associated supplies and transport of supplies. Gear and camping equipment is evident at crew camps. While camping equipment and personal gear is removed at the end of each project or each season, some gear is cached at the camp location in secure equipment containers/lockers for the duration of the project. This results in adverse effects on the undeveloped quality of wilderness character at each project location. However, this effect is not permanent and lasts only for the duration of treatment at each site (2 weeks to 10 years depending on the site and treatment method).

Effects of Crew Camps on Opportunities for Solitude or Primitive and Unconfined Recreation: The presence of crew camps in several locations in the wilderness would reduce opportunities for solitude and primitive and unconfined recreation in the project areas. It is unlikely but still possible that wilderness users could see the crews and/or their camps though the camps would generally be located away from popular trails and destinations and would be sited in areas of low visibility, therefore, the adverse effects would not be noticeable to the average wilderness visitor and short- to long-term (depending on the treatment type selected).

Effects of Crew Camps on Other Features of Value: There is no effect on other features of value from the presence and use of crew camps.

Ecosystem Restoration: The large loss of MYLFs in the Sierra Nevada including the parks has heavily fragmented the populations that remain. Areas in which MYLF populations have disappeared are likely too far from existing populations to be naturally recolonized by migrating frogs. If unaddressed, this situation would make MYLFs much more vulnerable to further losses. The only tool available at this time to reestablish MYLFs in currently vacant, previously occupied basins is to move animals from source populations to these areas (Brown et al. 2014).

Two critical elements of high elevation aquatic ecosystem restoration would include 1) protecting and rebuilding extant populations of MYLFs where opportunities still exist, and 2) reintroducing MYLFs to locations where populations have recently gone extinct. Nonnative fish removal would be a primary step in attempting to restore [a viable, sustainable population of] MYLFs, other native species and natural function to high elevation aquatic ecosystems.

All waters identified for fish eradication would be considered potential reintroduction sites. MYLF restoration actions would be aligned with the nearly-complete Mountain Yellow-legged Frog Conservation Strategy (FWS *in preparation*). Recommended actions include nonnative fish eradication, translocation/reintroduction, antifungal and beneficial bacteria treatment, immunization, headstarting/ captive rearing, and emergency salvage. Before implementation, all MYLF restoration actions would undergo consultation and permitting with the FWS (appendix L). MYLF restoration would be based on the best science available, and protocols would be researched, developed, implemented, monitored, and refined in collaboration with other federal and state agencies (e.g., FWS, USFS, USGS, and CDFW) and academic researchers.

To mitigate the extensive losses of MYLFs populations, a number of individuals would be moved from extant populations to areas where populations recently died out or severely declined. Movement would involve 1) capturing a small percentage (typically <10%) of the individuals in a source population using dipnets; 2) measuring the body condition of each animal (length, weight, sex, chytrid level); 3) inserting a passive integrated transponder (PIT) tag under the skin of each frog larger than 1.25 inches long from snout-to-vent (Matthews and Preisler 2010) to monitor the status of each animal following reintroductions; 4) placing them in aerated containers of water; 5) potentially treating frogs prior to translocation with antifungal drug (e.g., Itraconazole); 6) potentially bioaugmenting naturally occurring bacteria (Janthinobacterium lividum) on frogs; and 7) either hiking them to nearby recipient habitat or transporting them by helicopter to distant recipient habitat.

If determined necessary, MYLFs may be treated with Itraconazole prior to their reintroduction. The treatments would likely occur at the source site. Under current methods, frogs would be held for 7 days in mesh pens (2 m x 2 m x 0.5 m) anchored in the lake. The frogs would be treated once a day by moving them into plastic tubs containing a dilute Itraconazole solution. Animals would be bathed in the treatment solution for 10 minutes per day and then returned to the cages. After 7 days of treatment, animals would be transported to the receiving lake where they could be treated with a bioaugmentation of J. lividum that was collected from the source population and cultured in the laboratory. Under current methods, frogs would be held for 2 days in mesh pens (2 m x 2 m x 0.5 m) anchored in the lake. The frogs would be treated once a day. Up to 50 frogs at a time would be placed in small plastic containers that contain a concentrated solution of J. lividum mixed with lake water. Animals would be kept in the solution for 1 hour per day for two days and then returned to the pens. The frogs would be released into the receiving lake after the second day of treatment.

‘Nearby’ habitat generally can be hiked to within 6 hours, posing minor risk to frog survival during transport. ‘Distant’ habitat cannot be hiked to within 6 hours, which would pose moderate to high risk to frog survival during transport. At the recipient site, all individuals would be released into fishless habitat and monitored for the next several years.

Effects of Restoration of Mountain Yellow-Legged Frogs on Untrammeled: Where reintroductions are used and experimental treatments to species occurs (e.g. antifungal treatments), there would be short-term adverse impacts on the untrammeled quality of wilderness character since there would be an intentional manipulation of a native species in the wilderness. The effects on untrammeled occur only for the duration of restoration activities, resulting in short-term adverse effects on untrammeled; however,

these activities could occur periodically for the life of the project (25 to 35 years)), so at any given time on a landscape /wilderness scale there would be trammeling actions occurring related to these activities.

Effects of Restoration of Mountain Yellow-Legged Frogs on Natural: Restoration of key species (MYLFs) would allow invertebrate, frog, and other wildlife populations to recover to conditions representative of conditions where nonnative fish are not present. There would be short-term adverse effects on the source populations resulting from the removal of a small percentage of MYLFs for reintroductions (in general, no more than 10% of the adult population would be removed for a reintroduction). Based on results from previous reintroductions in YOSE, the source population should rebound quickly; previous removal of approximately 20% of the adult frogs from a source population resulted in a large pulse of recruitment in subsequent years that compensated for the removals. If ecosystem restoration is successful, there would be long-term beneficial effects on the natural quality of wilderness character by restoring two endangered species and thus improving the overall health of the high elevation aquatic ecosystems.

Effects of Restoration of Mountain Yellow-Legged Frogs on Undeveloped: Similar to the crew camps for the proposed restoration work, there would be crew camps associated with ecosystem restoration activities. Crews would stay in backpacker-like camps and would follow minimum impact wilderness practices. The duration of these camps would range from a few days to the entire summer. No equipment or gear would be left on site over the winter. Helicopter may be utilized to deliver gear and supplies to the camps and for restoration purposes if timing is an issue (i.e. moving tadpoles and/or frogs from one site to another quickly) and if determined to be the minimum tool for the project. The effect on undeveloped would be adverse but in a limited area around the restoration sites, and would occur only during project activities.

Effects of Restoration of Mountain Yellow-Legged Frogs on Opportunities for Solitude or Primitive and Unconfined Recreation: There would be short- and long-term adverse effects on solitude from the presence of crews in the wilderness over the duration of the restoration project. As described under "Effects from Crew Camps" it is unlikely but still possible that wilderness users could see the crews and/or their camps though the camps would generally be located away from popular trails and destinations. Generally these crews are small and the average wilderness visitor can not differentiate these crews from other wilderness users.

There would be long-term beneficial effects on primitive recreation related to viewing native wildlife and healthy native ecosystems if restoration efforts are successful.

Effects of Restoration of Mountain Yellow-Legged Frogs on Other Features of Value: This project component would benefit Other Features of Value, particularly the scientific, ecological, and education components.

<u>Monitoring and Continuing Research:</u> These two actions are combined since their effects would be the same. Scientific research is one of the purposes of wilderness. Monitoring is considered part of research. Research is conducted by staff and scientists from public agencies and academic and independent institutions, as managed through SEKI's research permit process. Research findings are written into reports and/or peer-reviewed publications that are used to inform park management and help with decision-making.

Monitoring is conducted by NPS staff from the SEKI Resource Management and Science (RMS) division and the Sierra Nevada Network Inventory and Monitoring program, and by scientists in association with permitted research. High elevation aquatic ecosystem components that are currently monitored include water quality, and populations of amphibian and reptiles associated with restoration and research sites. Any research or monitoring projects that propose 4(c) actions would be evaluated in a separate minimum requirement analysis.

Effects of Monitoring and Continuing Research on Untrammeled: While most monitoring and research activities do not result in an intentional manipulation of natural elements, there are exceptions. Treating wildlife with antifungal drugs and supplementing their immune defenses with naturally co-occurring bacteria are examples of activities that result in a trammel. The effects on untrammeled occur only for the

duration of project activities, resulting in short-term adverse effects on untrammeled; however, these activities could occur periodically for the life of the project (25 to 35 years), so at any given time on a landscape scale there would be trammeling actions occurring related to these activities.

Effects of Monitoring and Continuing Research on Natural: Research would have a short-term adverse effect on the natural quality of wilderness character from the use of antifungal treatments, bioaugmentations, and the removal of individuals from populations. However, in the future, as more information is gained through these programs, there would be long-term beneficial effects on the natural qualities of wilderness as ecosystem restoration is accomplished.

Effects of Monitoring and Continuing Research on Undeveloped: Monitoring would include sampling for invertebrates, and could include the use of samplers and drift nets. These activities require temporary installations, which would result in adverse effects on the undeveloped quality of wilderness in localized areas for the duration of the project work. Antifungal treatments and supplementing naturally occurring bacteria would involve holding animals in small pens for a period of time (currently 8 days). Helicopter and stock may be utilized to deliver gear and supplies to the project site if determined to be the minimum tool for the project. Helicopter use has an adverse effect on undeveloped. The effects on undeveloped would be adverse and short-term at specific project locations, but these effects would occur periodically for the life of the project (25-35 years) resulting in long-term adverse effects.

Effects of Monitoring and Continuing Research on Opportunities for Solitude or Primitive and Unconfined Recreation: Monitoring and research generally involves 2-3 people per project. As stated under “Effects from Crew Camps” the presence of researchers and monitors reduces opportunities for solitude in the project areas during project activities. Monitoring and research can occur throughout the high elevation wilderness of the parks, but generally occur away from the primary visitor use areas, and thus should have no impact on opportunities for primitive and unconfined recreation. Crews are small and no different in appearance than the average wilderness user group. If helicopters are utilized, there would be an effect on solitude as the natural soundscapes would be disrupted. Therefore the impact on solitude is short-term and adverse. Research and monitoring would lead to improved management of natural resources and restoration of native species; therefore, there would be long-term beneficial effects on primitive recreation related to viewing native wildlife and healthy native ecosystems.

Effects of Monitoring and Continuing Research on Other Features of Value: This project component would benefit Other Features of Value, particularly the scientific and education components.

<u>Fish Capture and Disposal:</u> The primary method proven to achieve ecosystem restoration is the removal of nonnative fish from selected waterbodies. With no fish removal, the ecosystems would not be restored, and native species would not be protected. Therefore, the removal of nonnative fish would occur under all alternatives; however, several alternative removal methods are considered within specific alternatives.

For all fish removal activities, removed fish would accumulate and require disposal. Crews would puncture the bladders of all fish captured (to prevent them from floating) and sink them in deep water to the bottom of each restoration lake to dispose of the carcasses.

Effects of Fish Disposal on Untrammeled: The disposal of fish is not an intentional manipulation of the natural element, but is a result of a manipulation (i.e. the removal of nonnative fish from waterbodies). Therefore there would be no effect on untrammeled as a result of the disposal of fish.

Effects of Fish Disposal on Natural: When dead fish are disposed of by puncturing their bladders and sinking them in deep water there would be a short-term effect on the natural quality of wilderness as a result of adding nutrients to the system until the fish biodegrade. There would be short-term adverse impacts to water quality, but the nutrients would ultimately be cycled back into the ecosystem where they originated resulting in a long-term beneficial effect. *Effects of Fish Disposal on Undeveloped:* There would be no effects on undeveloped as a result of fish disposal actions.

Effects of Fish Disposal on Opportunities for Solitude or Primitive and Unconfined Recreation: Fish disposal would have no effect on opportunities for solitude or primitive and unconfined recreation.

Effects of Fish Disposal on Other Features of Value: There is no effect.

Effects on safety from Elements Common to All Alternatives: There are no Effects on safety out of the ordinary. All project work would require the preparation of Job Hazard Analyses.

Effects on other criteria from Elements Common to All Alternatives (e.g., special provisions, economics, timing constraints, traditional skills, weather, visitation, etc.): Actions would need to occur during summer months to allow for travel into the SEKI wilderness when conditions are suitable (little or no snow and ice).

Components of the Action Alternatives

Under each action alternative, the following project components are considered in addition to the elements common to all action alternatives. Components and project elements that have been considered but ruled out are included in the "Alternatives Considered but Dismissed" section of this MRA.

Project Component	Description
Component 1	Transportation of Personnel to the Project Site
Component 2	Transportation of Equipment to the Project Site
Component 3	Establishment of Crew Camps
Component 4	Fish Capture Techniques
Component 5	Translocation Methods
Component 6	Stream barriers
Component 7	Condition of Site After Project

Alternative # __2___ Physical and Piscicide Treatment Preceding Restoration – 4(c) activities – use of gill nets, fish traps, temporary fish barriers, and crew camps (installations); Use of stock and helicopters.

Description:

Both physical (use of gill nets, electrofishers, covering redds, and use of fish traps) and piscicide treatment methods (use of rotenone) would be used for nonnative fish eradication. Waters determined infeasible for physical treatment (see below criteria) would be restored using piscicides.

Basin prescriptions would be developed during years immediately prior to treatment so that information would be current when the treatment begins. The precise areas to be treated by different methods (physical or piscicide) would be developed following a thorough survey of each site. Information needed to develop each prescription would include precise information on the distribution of fish and amphibians, potential need for and proposed location of fish barriers, invertebrate surveys, habitat characteristics (open water, aquatic and riparian vegetation), and basin characteristics (stream flow/gradients, lake size/depth, channel characteristics, connectivity between sites, and unique aquatic environments).

Under alternative 2, physical treatment would be the preferred method. Piscicide treatment, while not a 4(c) prohibited action under the Wilderness Act, would only be used if: 1) a lake is too large or lacks adequate shoreline; 2) a stream is too long, steep, or marshy or has other characteristics that would make physical treatment ineffective for fish eradication; 3) implementation of physical treatment pose an unacceptable safety risk to field crews; or 4) the selected waterbodies exist in basin complexes

that lack natural barriers between most of the individual lakes or are too extensive for physical treatment. The waterbodies proposed for piscicide treatment also include a few small sites located on marshy stream reaches where it would be infeasible to exclude a waterbody from the reach.

Waterbodies that would provide more value in the face of climate change would be considered for piscicide applications (i.e. large, deep, and/or cold waterbodies that can buffer drying and warming trends). Pre- and post-treatment monitoring of the habitat and invertebrate and vertebrate populations would be a component of the use of piscicides.

Based on current knowledge of the proposed fish eradication sites, physical treatment would be used for 52 waterbodies (27 lakes, 24 ponds, 1 marsh; total of 492 acres/ 199 hectares) and approximately 15 miles (24 km) of streams in 17 basins; piscicide treatment would be used for 33 waterbodies (4 lakes, 25 ponds, and 4 marshes; total of 142 acres /57 hectares) and approximately 16 miles (26 km) of stream in 9 basins. In addition, any fish-containing habitat adjacent to treated lakes, ponds and streams identified during fieldwork would also require treatment in order to eradicate fish from each restoration area. These are generally small areas that are not captured in existing maps of proposed project areas. Although the total acreage requiring treatment may change slightly based on site-specific survey information and prescription development, the number of waterbodies and stream miles identified for treatment represents the maximum number of waterbodies to be treated in this alternative.

The physical treatment methods of gill netting, electrofishing, covering redds, and using fish traps are the same as those described under Alternative 1.

For areas where piscicide treatment is proposed, temporary fish barriers (using nets or screens) would be placed in areas where barriers to fish movement are not present. These barriers serve to prevent fish from moving from an untreated area into a treated area. These temporary fish barriers can be used for the piscicide treatment method because treatment can occur quickly in all connected waters. Therefore they only need to be in place until treatment activities are completed.

Stock would be the preferred transport method used to support this project except when the use of helicopters is determined to be the minimum tool as described previously under Elements Common to All Action Alternatives.

Location of Proposed Treatments

Aquatic ecosystem restoration would take place in 55 basins. Nonnative fish would be eradicated from selected waterbodies in 21 basins, including 80 lakes and ponds (602 ac/ 244 ha), 5 fish-containing marshes (32 ac/ 13 ha), approximately 31 miles (50 km) of stream, plus additional connected fish-containing habitat if necessary. These 85 waterbodies represent 15% of the parks' 550 waterbodies known to contain nonnative fish that are candidates for eradication. While the goal of this alternative would be to restore 55 basins over the life of the project (25-35 years), some basins may not be restored because of access limitations or challenges.

Basin	# Lakes	Area (ac)	# Ponds	Area (ac)	Stream (mi)
Physical Treatment					
Barrett	3	42.07	1	0.28	0.87
Blossom	2	9.45	2	2.29	0.64
Brewer	0	0	1	1.60	0.52
Crytes	2	20.62	1	0.87	0.02
Dusy	1	10.58	2	0.60	0.69
East Wright	1	2.63	0	0	0.66
Horseshoe	4	28.96	0	0	0.40
McGee	4	75.31	4	1.19	1.20
Milestone	1	12.80	1	2.07	0.49
Rambaud	0	0	1	0.44	0.25
Slide	1	5.12	1	0.17	1.60
Swamp	0	0	1	1.85	0.28
Tablelands	0	0	1	1.48	1.65
Upper Bubbs	2	21.62	2	1.67	4.32
Upper Evolution	4	228.19	1	0.48	1.20
Upper Kern	0	0	2	2.12	0.38
Vidette	2	16.57	3	0.23	0.39
Subtotal Physical	**27**	**473.91**	**24**	**17.34**	**15.58**
Piscicide Treatment					
Amphitheater	1	58.87	2	1.34	2.16
Crescent	0	0	0	0	1.58
Crytes	0	0	0	0	1.99
Horseshoe	0	0	0	0	2.99
Laurel	0	0	1	0.22	3.09
Sixty Lake	1	13.36	14	14.87	1.00
Upper Bubbs	0	0	0	0	0.93
Upper Evolution	0	0	0	0	0.48
Upper Kern	2	18.32	8	4.17	1.47
Subtotal Piscicide	**4**	**90.56**	**25**	**20.61**	**15.69**
Grand Total	**31**	**564.46**	**49**	**37.95**	**31.27**

Components of the Action		Activity for this Alternative
1	Transportation of Personnel to and from the Project Site	Crews hike to and from project sites.
2	Transportation of Equipment to and from the Project Site	Stock would be used for mobilizations and demobilizations of treatment sites unless conditions warrant the use of helicopters (see conditions described under Elements Common to All Action Alternatives). Stock would be used for two round trips per site, 1 to 2 sites per year. In general, site mobilizations require 5 animals and demobilizations require 3 to 4 animals. The maximum yearly stock use is estimated to be 8 to 9 animals per site, requiring only one overnight stay per trip. Therefore, the maximum number of expected stock nights (number of animals multiplied by nights) per year generated by any of the project alternatives is estimated at 16 to 18 nights. Where stock cannot access sites due to steep terrain or unsuitable/closed trails, work crews would be used to walk-in equipment from the stock drop off point. For heavy or bulky equipment, or when special conditions apply, helicopters would be used to transport materials to the project site. There could be up to three flights per restoration site per year. Flights would occur at mobilization to deliver supplies, and at demobilization to remove supplies and materials from the project site. Flights would be of short duration and would only be used if stock could not be used to transport supplies to a given project site.
3	Establishment of and Use of Crew Camps	Crew size would be 2 to 3 crewmembers at physical treatment sites, and these crews would camp up to 10 days per site visit and each site would be visited up to 7 times per season. Crew size would be 8 to 15 crewmembers at most piscicide worksites, and potentially 16 to 25 crewmembers at one or more of the largest piscicide worksites. Restoration using piscicides would be expected to take 2 to 4 weeks in each of 1 to 3 years per site. Crew camps include a short-term installation of a food and equipment storage locker which would be left in place for the duration of the project work, and removed once the project work is completed.
4	Fish Capture Techniques and Tools	Gill netting, fish traps, electrofishers, disruption of redds, and piscicides (including a small electric pump and motor)
5	Translocation Methods	Frogs to be translocated are either hiked to nearby recipient habitat or transported by helicopter to distant recipient habitat. ‘Nearby’ habitat generally

		can be hiked to within 6 hours, posing minor risk to frog survival during transport. 'Distant' habitat cannot be hiked to within 6 hours, which would pose moderate to high risk to frog survival during transport. At the recipient site, all individuals would be released into fishless habitat and monitored for the next several years.
6	Stream barriers	There may be temporary stream barriers placed in the waters under this alternative. Temporary fish barriers would be installed if needed to protect an invertebrate source population from fish recolonization until fish are eradicated with piscicides. This would include installing temporary nets or screens within streams to prevent fish from swimming upstream. No permanent fish barriers would be installed or created by blasting instream rock.
7	Condition of Site After Project	Aquatic ecosystem restoration would take place in up to 55 basins. Nonnative fish would be eradicated from selected waterbodies in 21 basins, including 80 lakes and ponds (602 ac), 5 fish-containing marshes (32 ac), approximately 31 miles of stream, plus additional connected fish-containing habitat if necessary. These 85 waters represent 15% of the parks' 550 waters known to contain nonnative fish that are candidates for eradication. Invertebrates would be impacted at the piscicide treatment sites until recovery occurs. The recovery of invertebrates (thus the restoration of the natural quality) at the treatment sites could take 5 years or more (Hamilton et al.2009). There would still be self-sustaining nonnative trout populations present in approximately 465 waters plus connecting streams.

Effects on Wilderness Character:

Untrammeled: The project itself constitutes a long-term trammel as it would continue for the next 25 to 35 years across identified areas in the parks' wilderness. There would be site-specific trammeling at up to six treatment sites per year, for several weeks each summer, over a 1 to 7 year period, with some sites treated for up to 10 years.

Under this alternative, there would be short- and long-term adverse effects as a result of trammeling due to the physical and piscicide treatments to remove nonnative fish, netting streams to prevent nonnative fish movement between treated and untreated areas, and pre- and post-invertebrate sampling, which involves the collection of invertebrates from piscicide treatment areas, all of which are intentional manipulations of the wilderness.

Over the life of the project, physical treatment would be used for 52 waterbodies (27 lakes, 24 ponds, 1 marsh; total of 492 acres) and approximately 15 miles (24 km) of streams in 17 basins; piscicide treatment would be used for 33 waterbodies (4 lakes, 25 ponds, 4 marshes; total of 142 acres) and approximately 16 miles (26 km) of streams in 9 basins. In addition, any fish-containing habitat

connected to treated lakes, ponds and stream sections identified during fieldwork would also require treatment in order to eradicate nonnative fish from each restoration area.

For sites that are too large or lack adequate shoreline access, for selected stream channels, where physical treatment has been unsuccessful, or where there is an unacceptable risk to field crews, piscicide treatment would be employed, occurring over 1 to 3 years at each site. Active work by crews would occur primarily during the summer (up to 10 days per site up to 7 times a season). Passive winter netting (i.e. leaving the nets under ice in waterbodies over winter months without the presence of crews) would continue to result in the removal of nonnative fish.

The primary differences between physical and piscicide treatment methods as it relates to the effects on untrammeled is the time it takes to treat a waterbody, and the intensity of the effort. Physical treatment would result in an ongoing trammel of up to 10 years per treatment site, whereas piscicide treatment would result in a trammel for 2 to 4 weeks per summer for up to 3 years per treatment site. However, with piscicide treatment, many more individual nonnative fish are killed in a shorter period of time, and non-target species are also affected and may be killed. These effects are described in detail under the following “Natural” section.

Natural: Under this alternative, there would be approximately 465 waterbodies plus connecting streams that would continue to contain self-sustaining nonnative trout populations, which is a long-term adverse effect on the natural quality of wilderness. The 85 waterbodies proposed for fish removal and restored to natural conditions under this alternative represent 15% of the parks’ 550 waterbodies known to contain nonnative fish that are candidates for eradication.

Aquatic ecosystem restoration would occur over the next 25-35 years in up to 55 basins. Restoration of natural conditions would allow for the recovery of invertebrate, amphibian, reptile, bird, and mammal communities and native species populations to a more natural condition. MYLFs in restoration areas would return to more natural conditions to the extent that chytrid fungus and other stressors (e.g., climate change) can be mitigated.

Effects on MYLF and Yosemite Toads
Most, but not all, of the MYLFs in the treatment areas are expected to be captured and moved out of treatment areas (see Mitigation Measures). Any tadpoles not captured and moved would be affected by piscicide treatments, because tadpoles breathe through gills (rotenone targets gill-breathing organisms) and tadpoles cannot leave the water. CFT Legumine™ application concentrations of 1 ppm (=50 ppb rotenone) in streams and lakes exceed the 24 hr LC50 concentration of 5 ppb rotenone for northern leopard frog tadpoles (*Rana pipiens*; Hamilton 1941), and 30 ppb rotenone for southern leopard frog tadpoles (*Rana sphenocephala*; Chandler and Marking 1982). Since these species are in the same genus as MYLFs (*Rana muscosa* and *Rana sierrae*), MYLF tadpoles are expected to have similar rotenone LC50 concentrations as leopard frog tadpoles.

However, the specific response of tadpoles to rotenone depends on development stage (Hamilton 1941). Younger larvae that are dependent on gill respiration are far more sensitive than older larvae that are near metamorphosis and breathing air. Therefore, the majority of younger MYLF tadpoles exposed to piscicide treatments would be expected to experience mortality, while a small percentage may be affected but would survive. In contrast, it is expected that some older tadpoles would be killed, while some would be affected but would survive.

Adult MYLFs that are not captured and moved would not be expected to be harmed when rotenone is applied at normal piscicidal concentrations (Farringer 1972), because frogs primarily breathe through skin and they can leave the water. Adult amphibian skin may be more of a barrier to rotenone than gills due to skin having a smaller relative surface area and a greater relative distance for rotenone to diffuse across (Fontenot et al. 1994). In addition, CFT Legumine™ application concentrations of 1 ppm (=50 ppb rotenone) in streams and lakes do not exceed the 24 hr LC50 concentration of 240 to 1,580 ppb rotenone for northern leopard frog adults (Farringer 1972). As with tadpoles, MYLF adults are expected to have similar rotenone LC50 concentrations as leopard frog adults. Therefore,

piscicide treatment would not be expected to kill adults, although some adults may be affected (e.g. expending energy on flight responses) but would survive.

Amphibian eggs are thought to be less sensitive to rotenone because their rate of chemical uptake from water is much lower than tadpoles or fish (Ling 2003). In addition, piscicide treatments are expected to be conducted in August or September, after all MYLF eggs would have hatched. Piscicide treatments are therefore expected to have no effect on MYLF eggs.

Due to the distance between treatment sites and extant MYLF populations, MYLFs present in untreated waterbodies adjacent to piscicide treated waterbodies are expected to be able to migrate into the treated areas with no adverse effects shortly (several days) after the treatment is concluded (Pope and Matthews 2001). If any MYLFs arrived within 1 to 2 days after treatment, they likely would all be frogs (not tadpoles), which do not have gills and thus would be expected to not be affected by habitat conditions.

Two stream sections in Upper Evolution are proposed for fish removal using piscicides, and thus there is potential for Yosemite toads to be affected by a piscicide treatment in this treatment area. However, the treatment would be conducted in August or September, after all Yosemite toad adults would have finished breeding and likely moved from aquatic to nearby terrestrial habitat, which is their typical post-breeding behavior (Kagarise Sherman 1980). In addition, many and potentially all tadpoles would have metamorphosed into juvenile toads, which also often move from breeding ponds to adjacent terrestrial habitat. Furthermore, if any individuals are observed in treatment habitat, the “capture-and-move” mitigation as described under the “Mitigation Measures” section of this document would be implemented, which would further reduce the number Yosemite toads that would be affected by the treatment.

Effects on the threatened Little Kern golden trout
This alternative proposes to eradicate fish from Crytes Basin using a combination of physical methods (i.e. gill netting and electrofishing in one lake and one lake/pond complex) and piscicides (rotenone in adjacent streams). The fish population in the lake/pond complex, considered to be a population of federally threatened Little Kern golden trout, would be eradicated and thus adversely affected. However, this population is nonnative, the basin is not in designated critical habitat and is not part of the recovery plan, and recent genetic analysis shows this population is introgressed (not genetically pure).

Although this population is not genetically-pure, it still may have value in that it retains some amount of Little Kern golden trout alleles. If these fish are determined useful as brood stock for management and restoration of Little Kern golden trout within the recovery plan area, SEKI would work with CDFW to live-capture and move as many fish as possible to an appropriate location outside of the project area.

Effects on the endangered Sierra Nevada Bighorn Sheep
This alternative proposes to eradicate fish from both Sixty Lake and Laurel using piscicides (rotenone in lakes/ponds and adjacent streams). In these basins, bighorn sheep are not expected to be present near treatment waterbodies. However, if any sheep are present, it is expected that there would be little effect as sheep have been shown to be habituated to human activity in many locations (including in the Rocky Mountains and in desert habitats (FWS 2007B)). Sheep would be expected to exhibit no more than a slight flight response due to the presence of treatment crews. If individuals are present near crew hiking routes, some individuals may exhibit a flight response, but this would be no different than what would occur when visitors hike through the area.

Although bighorn sheep are not expected to be present near treated waterbodies during the treatment period, there is a slight potential for individuals to come near treatment waterbodies shortly after the treatment period. Although the piscicide would be neutralized with potassium permanganate, a small amount of residue may remain in the surface water (EPA 2007A). However, since terrestrial animals are largely insensitive to rotenone, there is a substantial safety margin between the maximum concentrations needed for treatment and those necessary to harm terrestrial organisms (Ling 2003).

Nevertheless, there are rotenone toxicity data for mammals, but they only analyze effects from consuming fish killed by rotenone. Since bighorn sheep are herbivores and thus do not consume fish or other animals, rotenone toxicity data are not available for bighorn sheep. As a proxy, data for acute dietary exposure to rotenone for humans was utilized, with the exposure acquired through drinking water containing rotenone residues.

The EPA (2007a) determined the estimated drinking water concentration (EDWC) to be 200 ppb, which is the solubility limit of rotenone. Estimated exposure from drinking water considered surface water only because rotenone is not expected to reach groundwater, and the estimate is conservative because it assumes water is consumed immediately after treatment with no breakdown or neutralization prior to consumption. EPA estimated acute dietary exposure to rotenone for humans at 0.0111 mg/kg/day, which is 26% less than the acute population adjusted dose (aPAD) of 0.015 mg/kg/day. Since the EPA is concerned when risk estimates exceed 100% of the aPAD, the EPA concluded that acute dietary risk from rotenone to humans is below the level of concern (see Appendix H for more information). Bighorn sheep are comparable in size to adult humans; adult females (ewes) weigh between 100 and 155 pounds and adult males (rams) can weigh between 120-200 pounds. Since risk to humans from drinking water with rotenone residue is below the EPA level of concern, risk to bighorn sheep from drinking water with rotenone residue is also expected to be below the level of concern, immeasurable, and highly unlikely to occur.

Effects on other vertebrates due to piscicide use would be as follows.

Amphibians (Pacific treefrog)
There is potential for Pacific treefrogs to be affected by piscicide treatments. However, treatments would be conducted in August or September when all Pacific treefrog adults would have finished breeding and likely moved from aquatic to nearby terrestrial habitat, which is their typical post-breeding behavior (Liang 2010). In addition, many and potentially all tadpoles would have metamorphosed into froglets, which also often move from breeding ponds to adjacent terrestrial habitat. Furthermore, if any individuals are observed in treatment habitat, we would implement the same “capture-and-move” mitigation as described in Special-Status Species, which would minimize the number of Pacific treefrogs that would be affected by the treatment. These mitigations include capturing as many individuals as possible and moving them to adjacent untreated waterbodies before piscicide treatments are conducted. If Pacific treefrogs are present in the treatment areas, most, but not all, of them are expected to be captured and moved out of treatment areas.

If any Pacific treefrog tadpoles are not able to be captured and moved, they would be expected to be affected by piscicide treatments. CFT Legumine™ application concentrations of 1 ppm (=50 ppb rotenone) in streams and lakes exceed the 24 hr LC50 concentration of 5 ppb rotenone for northern leopard frog tadpoles (*Rana pipiens*; Hamilton 1941), and 30 ppb rotenone for southern leopard frog tadpoles (*Rana sphenocephala*; Chandler and Marking 1982). Although these species are not in the same genus as the Pacific treefrog, it is probable that Pacific treefrog tadpoles would have similar rotenone LC50 concentrations as leopard frog tadpoles.

The specific response of tadpoles to rotenone depends on development stage (Hamilton 1941). Younger tadpoles that are dependent on gill respiration are far more sensitive than older tadpoles that are near metamorphosis and breathing air. Therefore, younger Pacific treefrog tadpoles exposed to piscicide treatments would be expected to experience mortality, while a small percentage may be affected but would survive. In contrast, some older tadpoles may experience mortality, while some may be affected but would survive.

If any Pacific treefrog adults are not able to be captured and moved, they would not be expected to be harmed when rotenone is applied at normal piscicidal concentrations (Farringer 1972), because adult frogs do not have gills (they primarily breathe through skin). CFT Legumine™ application concentrations of 1 ppm (=50 ppb rotenone) in streams and lakes do not exceed the 24 hr LC50 concentration of 240-1580 ppb rotenone for northern leopard frog adults (Farringer 1972). Similar to tadpoles, it is probable that Pacific treefrog adults have similar rotenone LC50 concentrations as

leopard frog adults. Therefore, Pacific treefrog adults exposed to piscicide treatments would not be expected to experience mortality, and some may be affected but would survive.

Amphibian eggs are thought to be less sensitive to rotenone because their rate of chemical uptake from water is much lower than tadpoles or fish (Ling 2003). In addition, piscicide treatments would be conducted in August or September, after all Pacific treefrog eggs would have hatched. Piscicide treatments are therefore expected to have little effect on Pacific treefrog eggs.

Pacific treefrogs present in untreated waterbodies adjacent to piscicide treatment waterbodies are expected to be able to move into the treatment areas with no adverse effects shortly (several days) after the treatment is concluded (Billman et al. 2012). The eradication of nonnative trout from the piscicide treatment waterbodies would provide a large increase in habitat for Pacific treefrogs occupying these basins, with expected corresponding benefits over time of enhanced survival, growth and reproduction. Overall, piscicide treatments are expected to have minor short-term adverse effects, and long-term beneficial effects on Pacific treefrogs.

Reptiles (Mountain Garter Snake, Sierra Garter Snake)
Although few studies have examined rotenone toxicity to reptiles, Fontenot et al. (1994) conclude the following: freshwater aquatic snakes do not breathe using gills, and it is very unlikely that absorption of rotenone would occur through the thick skin of snakes. However, Haque (1971, as cited in Fontenot et al. 1994) reported the death of one aquatic snake 48 hours after a pond rotenone treatment, while a second snake in the same pond at the same time was swimming in a healthy manner. Although additional studies would clarify the toxicity of rotenone to reptiles, garter snakes are expected to rarely be present in piscicide treatment areas, because they are rarely present in fish-containing lakes in the parks (NPS 2012A). Piscicide treatments are therefore expected to have short-term negligible to minor adverse effects and long-term beneficial effects on reptiles.

Birds (Gray-crowned Rosy Finch, Clark's Nutcracker, Brewer's Blackbird, American Robin, Spotted Sandpiper, Eared Grebe)
The EPA (2007A) concluded that: 1) birds that forage on terrestrial items have little risk of exposure to rotenone residues because rotenone is applied directly to water, and 2) although some birds that forage on fish may opportunistically feed on dead or dying fish in treatment areas, it is unlikely to result in a lethal dose. The EPA based this conclusion on a study (Jarvinen and Ankley 1998) that found 0.22 micrograms per gram (µg/g) of rotenone residue in yellow perch (Perca flavescens) killed by rotenone. Since yellow perch are similar in size to trout, it is probable that trout treated in the parks would also contain similar residues of rotenone.

The average weight of all trout captured in the parks in a survey of high elevation lakes from 1997 to 2002 (Knapp 2003) was 76 g, which, if treated with rotenone would contain approximately 17 µg of rotenone after treatment (76 g × 0.22 µg/g). A juvenile American robin (average weight approximately 55 g at fledging; Howell 1942) would therefore have to consume about 647 trout to reach its reported median lethal dose of 200 mg/kg rotenone (200 mg/kg × 0.055 kg robin = 11 mg = 11,000 µg ÷ 17 µg = 647) (Cutkomp 1943; see Appendix G). Although many of the trout in a treatment area will decompose in deep water and thus not be available for consumption by birds, treated fish that do not sink may be scattered in upland areas and thus have the potential for partial consumption by birds.

Bird species known to occur in the project area that may consume treated fish include Clark's nutcracker, Brewer's blackbird, American robin, and eared grebe. All of these species primarily consume insects, other invertebrates, and seeds, and only opportunistically feed on vertebrates. Nevertheless, if any birds did consume treated fish, their exposure to rotenone is expected to be low due to the small amount of rotenone residue present in treated fish, and the small amount of fish tissue that birds would eat because of their relatively low daily intake of calories. Gray-crowned rosy finch and spotted sandpiper are not expected to consume treated fish because they are only known to consume insects and other invertebrates.

Since all of the bird species consume invertebrates, they are expected to be indirectly affected by the short-term loss of aquatic invertebrates and zooplankton in lakes and streams treated with piscicides.

However, the treatment lakes already have reduced invertebrate and zooplankton assemblages due to the presence of nonnative trout (Knapp et. 2001, Knapp 2005), so the effect is expected to be negligible. In addition, all of the treatment areas have nearby lakes and streams that will not be treated, and thus invertebrate food will be available at natural levels in adjacent habitat. Since birds fly (are highly mobile), they are expected to easily be able to feed more at untreated lakes and streams relative to treatment areas. This effect is expected to largely end in the summer following a treatment (no more than one year), as studies show that invertebrate assemblage abundances typically recover rapidly and approach pre-treatment levels between 9 months and 1 year after piscicide treatment (Binns 1967, Cook and Moore 1969, Hamilton et al. 2009). Further increases of invertebrates and zooplankton are then expected to return to more natural levels over the course of several years following fish removal (Knapp et al. 2001, Knapp 2005, Hamilton et al. 2009), which would have long-term beneficial effect on the bird species.

Mammals (Northern Water Shrew, Coyote, Eight Species of Bats)
Northern water shrews present in a treatment area are not expected to be affected by piscicide treatments because they do not use gills for respiration. In addition, EPA (2007A) concluded that wild mammals are not likely to have significant exposure to rotenone residues because: 1) most dead fish tend to sink and would not be available for terrestrial consumption, and 2) in the event that mammals forage on accessible dead or dying fish, it is unlikely to result in observable acute toxicity.

Although coyotes are known to occur in the project area, restoration crews in the parks from 2001 to 2011 have only rarely observed them. In addition, coyotes are not expected to be present in treatment areas during daylight hours while crews are active, but it is possible they could enter treatment areas during night hours. Coyotes are suspected to have fed on fish caught in gill nets in one shallow treatment lake (NPS unpublished data), where two nets were dragged to shore and fish were gnawed in an area where coyotes were heard. Although coyotes appear to opportunistically feed on fish, coyotes present in a treatment area are not likely to have significant exposure to rotenone residues because: 1) most dead fish tend to sink where they are not available for terrestrial consumption, and 2) in the event that mammals forage on accessible dead or dying fish, it is unlikely to result in observable acute toxicity.

Effects of piscicide treatments on bats are expected to be similar to the bird species, as bats also feed on invertebrates emerging from lakes and streams. The reduction of invertebrates for roughly one year from habitat treated with piscicides would be mitigated by the natural amount of invertebrates emerging from nearby untreated habitat, resulting in short-term negligible to minor adverse effects on the bat species. Conversely, the recovery and substantial increase of invertebrates expected following fish removal in treated habitat is likely to result in long-term beneficial effects on the bat species.

Effects on Invertebrates
Pre- and post-treatment monitoring involving the collection of invertebrates would result in mortality of individuals on a small scale. However this activity would affect individuals and the populations would remain intact.

Effects on the invertebrates due to piscicide use (rotenone) are described in the following analysis, which draws heavily, including excerpted sections, from analyses conducted for these similar recent documents:

- Piscicides and Invertebrates: After 70 Years, Does Anyone Really Know? (Vinson et al. 2010)
- Paiute Cutthroat Restoration Project Draft EIS/EIR (FWS-CDFW 2010)
- Proposed Use of Rotenone to Eradicate Northern Pike in Lake Davis, California Draft EIS/EIR (CDFW 2007)
- Reregistration Eligibility Decision for Rotenone (EPA 2007A)

Based on these analyses and many other studies and projects, many invertebrates present in rotenone treatment areas would be expected to be affected by piscicide use. Effects may include mortality of individuals and variable effects on the composition of invertebrate assemblages, both of which would be unavoidable consequences of rotenone treatment to eradicate nonnative trout.

Rotenone is toxic to many gill-breathing organisms when applied in water because it is readily transmitted across gill surfaces and quickly disrupts cellular aerobic respiration (Finlayson et al. 2000). It therefore prevents fish and certain aquatic invertebrates and zooplankton from extracting oxygen from water, which is essential for respiration and energy production (Singer and Ramsay 1994). Since fish quickly absorb rotenone across gill surfaces, they are extremely sensitive to rotenone treatments. Although sensitivity varies by species, trout are among the most sensitive fishes to rotenone (Marking and Bills 1976), dying within hours at application concentrations below 1 part per million (ppm) in streams (Ling 2003). All project waterbodies proposed for fish eradication only contain brook trout and/or forms of rainbow trout. Although many aquatic invertebrates and zooplankton also use gills and thus are affected by rotenone treatments, they are generally more tolerant of rotenone than trout, as described in the following sections.

Rotenone effects on various aquatic organisms have been reported from controlled toxicity tests that typically measure the LC50 value (median water concentration of active ingredient that kills 50 percent of test animals) over a period of time (typically 24 hrs and/or 96 hrs). A review of many aquatic invertebrate taxa shows a range of sensitivity to rotenone (Table 22; from a variety of sources as summarized by Ling 2003). The table shows a mollusc [96hr LC50 = 7.5 mg/L (ppm) = 7,500 ppb], a snail (24hr LC50 = 6.35 mg/L = 6,350 ppb)], and a freshwater prawn (24hr LC50 = 5.15 mg/L = 5,150 ppb) as the most rotenone-resistant taxa included in this review, while Branchiura (lice; 24hr LC50 = ~0.025 mg/L = 25 ppb), Conchostracan (clam shrimps; 24hr LC50 = ~0.05 mg/L = 50 ppb), and Hydrachnidae (water mites; 96hr LC50 = ~0.05 mg/L = 50 ppb) were the most rotenone-sensitive taxa reported. However, the most sensitive invertebrate taxa are still 7 to 14 times more resistant to rotenone than the most resistant fish taxa in SEKI proposed eradication sites (rainbow trout; 24hr LC50 = 3.5 ppb; Marking and Bills 1976).

Rotenone toxicity reported in several aquatic invertebrate taxa.

Species Guild	Species	Test Endpoint	LC (mg/L)	Reference
Flatworm	*Catenula* sp.	LC_{50} 24h	5.100	Chandler 1982
	Planaria sp.	LC_{50} 24h	<0.500	Hamilton 1941
Annelid worms	Leech	LC_{50} 24h	<0.1	Hamilton 1941
Copepod	*Cyclops* sp.	LC_{100} 72h	<0.100	Meadows 1973
Branchiura	*Argulus* sp.	LC_{50} 24h	~0.025	Hamilton 1941
Cladoceran	*Daphnia pulex*	LC_{50} 24h	0.027	Chandler 1982
	Daphnia pulex	LC_{50} 24h	<0.025	Hamilton 1941
	Diaptomus siciloides	LC_{50} 24h	<0.025	Hamilton 1941
Ostracod	*Cypridopsis* sp.	LC_{50} 24h	0.490	Chandler 1982
Conchostracan	*Estheria* sp.	LC_{50} 24h	~0.050	Hamilton 1941
Freshwater prawn	*Palaemonetes kadiakensis*	LC_{50} 24h	5.150	Chandler 1982
Crayfish	*Cambarus immunis*	LC_{50} 24h	>0.500	Hamilton 1941
Dragonfly naiad	*Macromia* sp.	LC_{50} 24h	4.700	Chandler 1982
Stonefly naiad	*Pteronarcys californica*	LC_{50} 24h	2.900	Sanders and Cope 1968
Backswimmer	*Notonecta* sp.	LC_{50} 24h	3.420	Chandler 1982
	Notonecta sp.	LC_{50} 24h	~0.100	Hamilton 1941
Caddis fly larvae	*Hydropsyche* sp.	LC_{50} 24h	0.605	Chandler 1982
Whirligig beetle	*Gyrinus* sp.	LC_{50} 24h	3.550	Chandler 1982
Water mite	Hydrachnidae	LC_{50} 96h	~0.050	Hamilton 1941
Snail	*Physa pomilia*	LC_{50} 24h	6.350	Chandler 1982
	Oxytrema catenaria	LC_{50} 96h	1.750	Chandler 1982
	Lymnaea stagnalis	LC_{50} 96h	>1.000	Hamilton 1941
Bivalve Mollusc	*Dreissena polymorpha*	LC_{50} 24h	0.219	Waller et al. 1993

	Obliquaria reflexa	LC_{50} 24h	>1.000	Waller et al. 1993
	Elliptio buckleyi	LC_{50} 96h	2.950	Chandler 1982
	Elliptio complanata	LC_{50} 96h	2.000	Chandler 1982
	Corbicula manilensis	LC_{50} 96h	7.500	Chandler 1982
LC = Lethal Concentration				

Another review also shows that susceptibility of individual invertebrates to rotenone varies widely (Vinson and Vinson 2007). They report that 96 hr LC50 rotenone toxicity to benthic macroinvertebrates ranges from 2 to 100,000 ppb, and also varies within and among invertebrate taxonomic groups. Depending on exposure time, mortality can be near 100% at concentrations greater than 50 to 75 ppb rotenone for stream invertebrates and 150 ppb rotenone for lake adult aquatic invertebrate groups such as Heteroptera (true bugs) and Coleoptera (beetles). However, many of the studies reviewed reported results of 96 hr exposure, which is 16 to 24 times longer than the 4 to 6 hr durations planned for each rotenone treatment under this alternative.

Rotenone sensitivity by individual species and life stages appears to depend on body size, morphology and habitats used (Vinson et al. 2010), as well as differing oxygen uptake processes (Engstrom-Heg et al. 1978). Smaller invertebrates appear more sensitive than larger invertebrates, and species that use gills to extract aqueous oxygen are more sensitive than those that obtain oxygen through other means (Vinson et al. 2010). Larvae from the EPT taxa group [Ephemeroptera (mayflies), Plecoptera (stoneflies) and some Trichoptera (caddisflies)] all use gills. They are more sensitive to environmental stressors than other aquatic invertebrate groups, and some EPA taxa were not detected 5 years after a few rotenone treatments such as Mangum and Madrigal (1999), although this project used very high concentrations and durations. Rotenone sensitivity can also vary within the same group. Whelan (2002) reported that while caddisflies had the highest number of species affected by rotenone, many caddisflies were tolerant.

Since the anatomies of many aquatic invertebrate taxa contain gill-like structures, they should theoretically be as susceptible to rotenone as fish or amphibian larvae (Bradbury 1986). In laboratory tests, however, Chandler and Marking (1982) concluded that aquatic invertebrates are generally much more tolerant of rotenone than most fishes and amphibian larval stages. A snail (*Helisoma sp.*) and the Asiatic clam (*Corbicula manilensis*) were the most resistant taxa studied, with 96 hr LC50 concentrations that were 50 times greater than the most resistant fish (black bullhead) studied by Marking and Bills (1976). Another study (Sanders and Cope 1968) measured rotenone effect on subadult stages of a stonefly (*Pteronarcys californica*). They showed 24 hr and 96 hr LC50 concentrations of 2,900 ppb and 380 ppb, respectively, which are an order of magnitude greater than those reported for black bullhead (24 hr LC50 = 33.3 ppb). They also showed that larger, older subadults were less susceptible to given concentrations of rotenone than smaller, younger subadults of the same taxa.

Although results indicate that many aquatic invertebrates are less sensitive to rotenone than fish, acute invertebrate mortality is still expected from a typical rotenone application. Rotenone treatments thus often result in short term (9 month to 1 year) decreases in invertebrate abundance (20–85%; Engstrom-Heg et al. 1978, Darby et al. 2004) and diversity (Binns 1967, Cook and Moore 1969, Engstrom-Heg et al. 1978, Mangum and Madrigal 1999, Whelan 2002).

However, rotenone treatment may not be toxic to all aquatic invertebrates, as CDFW found in tests of benthic macroinvertebrate exposure to CFT Legumine™ and Nusyn-Noxfish (another rotenone formulation). Aquatic invertebrates considered representative of a proposed stream treatment area were collected and exposed to a range of rotenone concentrations that encompassed the planned treatment concentrations of 25 to 50 ppb rotenone. Results showed 4 hr LC50 values ranged from 41 to 274 ppb rotenone and 8 hr LC50 values ranged from 13 to 174 ppb rotenone for various species of caddisflies, mayflies and stoneflies (CDFW unpublished data). Results show that treatment concentrations of 25 to 50 ppb rotenone would have differential effects on these species, including being below the “no observed effect level” (NOEL) for some species.

A comprehensive review of published studies on the effects of rotenone treatment on invertebrate assemblages (Vinson et al. 2010) found that reported recovery varied widely, with several studies reporting few effects and several studies reporting substantial effects. They attributed these differences as resulting from three factors including: 1) rotenone concentration, duration and treatment area, 2) study objectives and sampling intensity, and 3) variation in toxicity among taxa and taxonomic groups. Higher rotenone concentration levels almost always led to greater effects on invertebrates. Although a mean concentration of 25 to 50 ppb rotenone for less than 8 hours has been suggested to achieve full trout mortality while minimizing invertebrate mortality (Finlayson et al. 2010), most fish removal projects used higher dosages, including one with a maximum concentration of 470 ppb rotenone (Binns 1967). Currently, permitting and labeling requirements allow for a maximum concentration of 50 ppb rotenone (Zoëcon 2015).

Differences among invertebrate morphologies and habitats occupied also appear to have considerable influence on the effects of rotenone on invertebrates (Vinson et al. 2010). For example, planktonic invertebrates that occupy open water appear more sensitive than benthic invertebrates that occupy substrate habitat. In addition, smaller invertebrates appear more sensitive than larger invertebrates; and aquatic invertebrates that use gills appear more sensitive than those that acquire oxygen through other means. This last point suggests rotenone may have greater effects in high elevation streams where cold water and high oxygen levels favor usage by small gilled invertebrates often dominated by EPT taxa. However, these taxa are much more benthic than planktonic, which appears to mitigate effects of rotenone. Although studies in mountain streams have generally showed EPT taxa to be more susceptible to rotenone than other taxonomic groups (Binns 1967, Mangum and Madrigal 1999, Whelan 2002, Hamilton et al. 2009), several of these projects (Binns 1967, Mangum and Madrigal 1999, Hamilton et al. 2009) used substantially higher rotenone dosages than legally allowed by the label. Using lower, legally allowed dosages would therefore limit effects of rotenone on macroinvertebrates.

Many studies have assessed aquatic invertebrate recovery from rotenone treatment by measuring how taxa return toward pre-treatment levels. Some studies measured abundance and biomass (Binns 1967, Cook and Moore 1969, Engstrom-Heg et al. 1978), while others measured taxa richness or other diversity indices such as EPT Index (Whelan 2002, Darby et al. 2004). One study (Mangum and Madrigal 1999) primarily measured whether individual taxa present before treatment returned after treatment, however, most studies used a combination of metrics. Note that in SEKI's high elevation streams, return to pre-treatment community composition is not necessarily expected after nonnative trout (year-round predators of invertebrates) are removed. Where there have been major changes in predators, the expectation of return to pre-treatment conditions is misplaced; the approach of comparison to reference streams is more appropriate (e.g. RIVPACS; Hargett et al. 2007) so that variable results can be put into context.

Invertebrate recovery to pre-treatment levels following rotenone treatment has occurred rapidly (<1 year) in some but not all studies (Ling 2003). Recovery time for aquatic invertebrate assemblages have ranged from several months to several years depending on the metrics selected and study length. Assemblage abundances typically return to pre-treatment levels within one year (Binns 1967, Cook and Moore 1969, Beal and Anderson 1993, Mangum and Madrigal 1999, Melaas et al. 2001, Whelan 2002), while diversity and community composition took more than 2 years in some studies (Binns 1967, Whelan 2002). A few individual taxa had not recovered after 5 years in two studies (Mangum and Madrigal 1999, Hamilton et al. 2009), however, both of these studies treated at higher rotenone concentrations than currently recommended. Vinson et al. (2010) attributed these differing results to variation in colonization rates among taxa and amounts of pre- and post-treatment sampling.

Aquatic invertebrate communities tend to recover relatively quickly following rotenone treatment (Ling 2003), with studies showing rapid biomass increases following initial depletions from rotenone treatment (Cook and Moore 1969, Neves 1975). Similarly, Dudgeon (1990) found that stream rotenone treatments caused immediate invertebrate drift, particularly of mayflies, but did not cause significant mortality or a significant reduction in abundance of benthic invertebrates. (Invertebrate drift is when invertebrate larvae in streams are dislodged from substrates and carried downstream by flows.) Nevertheless, varied results of rotenone effect on aquatic invertebrate communities have also been reported, with some showing negligible effects (Demong 2001, Melaas et al. 2001) and others showing longer-term negative effects (Binns 1967, Mangum and Madrigal 1999).

Although aquatic invertebrates are affected by rotenone, certain natural characteristics may mitigate the effects. For example, taxa in the EPT group are typically highly mobile and have short life cycles, and therefore should rapidly repopulate treated areas through dispersal and reproduction (Engstrom-Heg et al. 1978). Further, rotenone exposure to aquatic invertebrates may be reduced by behaviors such as burrowing, associating with vegetation or the ability to trap air bubbles with appendages (CDFW 2007). Moreover, rotenone toxicity to aquatic invertebrates may be moderated by physical and chemical attributes of the treated ecosystem (Melaas et al. 2001).

Only a few studies have conducted 2 or more years of post-treatment sampling to assess aquatic invertebrate assemblage recovery following rotenone treatments (Binns 1967, Mangum and Madrigal 1999, Whelan 2002, Darby et al. 2004, Hamilton et al. 2009).

Binns (1967) reported that rotenone treatment of 435 miles of the Green River, Wyoming had a target concentration of 250 ppb rotenone, but the concentration reached 470 ppb rotenone in some areas. These concentrations are 5 to 9 times higher than the current limit of 50 ppb rotenone for trout removal in streams (EPA 2007A). Two years after treatment the composition of dominant invertebrate groups was different from pre-treatment assemblages and two genera of Ephemeroptera had not reappeared. However, the abundances of Ephemeroptera, Trichoptera and Chironomidae increased during these 2 years after treatment, with larger increases in upstream treatment areas, potentially due to colonization from upstream untreated areas.

Mangum and Madrigal (1999) reported that the entire Strawberry River, Utah received two rotenone treatments within a single year. The treatments were applied at 150 ppb rotenone for 48 hours, which is 3 times the current limit for normal tolerance species of 50 ppb rotenone and at least 6 times longer than currently recommended rotenone durations of less than 8 hours (Finlayson et al. 2010). Total invertebrate abundance recovered within 1 to 36 months among their sample sites, however, community composition had not fully recovered by the end of the study. For example, soon after the treatments they detected 33% of the taxa detected before treatment; 1 year after the treatments they detected 46% of the taxa detected before treatment; and 5 years after the treatments they detected 79% of the pre-treatment taxa. The strong rotenone treatments may have been responsible for the lack of recovery of some taxa after 5 years. Most of the taxa were in the EPT group, although some taxa in each of these groups were present and therefore more resistant and/or resilient to rotenone. In addition, other taxa not present before the treatments were detected after the treatment, showing that a shift in taxonomic composition may have occurred, with new taxa possibly filling niches vacated by those that failed to recover. Potential effects on invertebrate communities from proposed treatments under this alternative, with 25 to 50 ppb rotenone concentrations for less than 8 hours, would be expected to be moderately to substantially lower than those measured in Strawberry River, Utah.

Whelan (2002) reported that Manning Creek, Utah received rotenone treatment in 2 successive years. The treatments were applied at 150 ppb rotenone for 12 to 18 hours, which is 3 times the current limit for normal tolerance species of 50 ppb rotenone and at least 1.5 to 2.25 times longer than currently recommended rotenone durations of less than 8 hours. Invertebrate samples were collected zero, 5 and 7 years before the treatments, and 1 and 3 years after the treatments. About 50% of taxa were detected both before and after the treatments, 21% were detected only before the treatments, and 30% were detected only after the treatments. The taxa found only during the after-treatment surveys were considered rare taxa, and sampling errors in detecting rare taxa contributed to their non-detection in the before-treatment surveys. The most affected group was Trichoptera, in which about 10% of taxa detected before the treatments were not detected 3 years after the treatments.

Darby et al. (2004) and Hamilton et al. (2009) reported that Strawberry Creek, Great Basin National Park (GRBA), Nevada received rotenone treatment, which was applied at 250 ppb rotenone for 1 hour and then 100 ppb rotenone for 7 hours, which is 2 to 5 times the current limit for normal tolerance species of 50 ppb rotenone. Following treatment, the following results were reported.

Total invertebrate abundance:

- declined to 15% of pre-treatment levels after 1 month, then
- recovered to 66% of pre-treatment levels after 2 years;

- recovery after 3 years was not reported

EPT abundance:
- declined to 1% of pre-treatment levels after 1 month, then
- recovered to 44% of pre-treatment levels after 2 years;
- recovery after 3 years was not reported.

Taxa richness:
- declined to 32% of pre-treatment levels after 1 month, then
- recovered to 90% of pre-treatment levels after 2 years, and
- recovered to 96% of pre-treatment levels after 3 years (2 EPT taxa had not recovered).

EPT Taxa richness:
- declined to 14% of pre-treatment levels after 1 month, then
- recovered to 77% of pre-treatment levels after 2 years, and
- recovered to 92% of pre-treatment levels after 3 years (2 EPT taxa had not recovered).

Potential effects on invertebrate communities from proposed treatments under this alternative, with 25 to 50 ppb rotenone concentrations, would be expected to be lower than those measured in GRBA.

Trumbo et al. (2000b) reported that Silver Creek, California received repeated rotenone treatments that were applied at 50 ppb rotenone. Overall invertebrate abundances were not affected but large Plecopterans (stoneflies) were affected. Although study conclusions were limited by little pre-treatment data, there were reductions of 6.6% in the DAT Diversity Index and 8.4% in the Biodiversity Collections Index. Certain taxa were thus affected by rotenone applied at 50 ppb, and short-term shifts in diversity occurred but not to a substantial degree (<10% divergence from baseline levels).

These longer-term studies suggest that invertebrate recovery can occur within as little as 2 months or could take more than 5 years. However, each study assessed recovery differently, making it difficult to compare recovery times. Comparison is also challenged by treatment specifics (such as rotenone concentration); inadequate pre-treatment monitoring (sometimes 1 to 2 sampling events); the highly variable nature of invertebrate assemblages over time and space; lack of adequate control or reference sites; and factors that influence recolonization potential (Vinson et al. 2010).

Niemi et al. (1990) reviewed 150 studies of aquatic ecosystem recovery from disturbance (15 involving rotenone treatments). They reported that: 1) recovery times were slightly quicker for small streams (1st to 3rd order) versus larger rivers (4th to 5th order); and 2) total invertebrate assemblage abundances recovered to 85% of pre-disturbance densities in generally less than 18 months, while recovery of abundances of different invertebrate taxonomic groups and individual taxa varied widely. Recovery abundances were near 80% for Diptera (true flies) after one year, 70% for Ephemeroptera after one year, and about 60% for Trichoptera and Plecoptera after 2 years. Although Coleoptera was not included in enough studies to make a quantified estimate, they predicted that Coleoptera recovered more slowly than Trichoptera and Plecoptera. They concluded that recovery time was well influenced by taxa generation time and dispersal ability, and distance from colonization sources. They also concluded that downstream drift from untreated upstream stream sections was a critical factor influencing stream invertebrate recovery times, following disturbances that did not physically affect habitat (piscicide treatment rather than flood or fire). Since some of the taxa most sensitive to rotenone have winged life stages and short life cycles, they have the potential to rapidly recolonize treated areas through dispersal and egg laying (Engstrom-Heg et al. 1978). They summarized that rates of recovery of aquatic invertebrate assemblages were most influenced by: 1) impact persistence, 2) taxa generation time and dispersal ability, 3) month or season of disturbance, 4) presence of refugia, and 5) distance to recolonization sources.

Distinguishing between the effects of rotenone use, natural disturbance and population variability on aquatic invertebrate assemblages is imprecise. Indeed, the following bullets excerpted from FWS/CDFW (2010) describe how historical data are not easily compared and interpreting their results is complicated by several factors:

- Most studies have not collected adequate baseline (pre-treatment) data to allow comparison with post-treatment data.
- Most studies focused on gross measurements, such as richness or abundance, with little data on the effects of rotenone on individual taxa or post-treatment recovery.
- There were too few studies and to little comparability between studies to make broad statements about the long-term effects of rotenone.
- Sampling effort was often uneven, with more samples taken from treated sites, which affects the likelihood of sampling rare taxa and reduces comparability among sites.
- Some studies have not accounted for the natural variation that occurs in benthic macroinvertebrate communities or historic disturbances that may have affected that area.

Similarly, Vinson et al. (2010) concluded that invertebrate sampling conducted 1 year post-treatment appeared sufficient to detect piscicide effects on assemblage measures (such as total abundance and taxa richness) but not for individual taxa. For individual taxa not detected at 1 year post-treatment, the three longest-term studies conducted to date (Mangum and Madrigal 1999; Whelan 2002; Hamilton et al. 2009) reported that many (but not all) of these taxa were detected 2 to 3 years post-treatment This suggests that 1) sampling may have been inadequate in fully describing the local fauna and (2) aquatic invertebrate assemblages are very diverse and variable over time. Both of these attributes prevent reaching definitive conclusions as to whether natural variation, sampling variation, or piscicides are responsible for differences in taxa measured between pre- and post-treatment samples. Since predators such as nonnative trout affect diversity and composition (e.g., by favoring more defended prey, removing dominants that suppress some taxa, or favoring more numerous but smaller-bodied insects that live in the protected hyporheic zone in streams or sediments in lakes), a more appropriate analysis would be to compare restored streams to nearby fishless streams of the same general elevation, hydrology and substrate type.

Studies show that it is difficult to detect changes in rare taxa and to attribute cause if changes are measured. For example, Whelan (2002) observed that most of the taxa absent after treatment in Manning Creek, Utah were rare in samples before treatment; some taxa detected several years before treatment were not detected immediately prior to treatment; and some taxa not collected in post-treatment samples were actually present via other observations. The author concluded that many of the missing taxa could recover from rotenone treatment because many of these taxa were found following rotenone treatment in Strawberry Creek, Nevada. In addition, Mangum and Madrigal (1999) primarily reported on the presence or absence of taxa following rotenone treatment in Strawberry River, Utah. For the missing taxa, they did not report their abundance in pre-treatment samples or the potential for these taxa to be absent due to other causes such as sampling variation. The comparability of this study is limited, however, because this project applied rotenone at substantially higher concentrations and longer duration than is currently allowed by EPA.

The review by Vinson et al. (2010) concluded that an extensive amount of sampling is necessary to obtain a comprehensive characterization of taxa present in invertebrate assemblages before and after a piscicide treatment. They report that because it is common for stream invertebrate assemblages to contain a large number of rare taxa, there have been no complete inventories of invertebrates of any stream (or body of fresh water). Nevertheless, they cite Strayer (2006) in reporting that stream assemblages can contain hundreds to thousands of species, including over 1,000 species from each of the Danube River, Austria and Breitenbach River, Germany. They report that most studies with periodic sampling over 1 to 2 years commonly detect 50 to 60 taxa in a 0.7 mile (1 km) stream reach. Nevertheless, high elevation streams are not likely to have nearly as much diversity as major river systems at lower elevations.

However, the same location in Logan River, Utah was sampled monthly for 10 years (Vinson et al. 2010), following field (Vinson and Dinger 2008) and laboratory (Vinson and Hawkins 1996) protocols commonly used in piscicide assessment projects. Results showed little variation in the number of invertebrate genera detected each month, but the individual genera within each sample varied widely. A total of 84 genera were detected over the study period, but an average of only 27.5 genera (33% of total) was detected each month. A new genus was detected about every 2 months on average (Figure 14), and the

genera accumulation rate was still increasing steadily after 10 years. Results are similar to two other studies (Needham and Usinger 1956, Resh 1979), suggesting that variation in stream invertebrate assemblages is so high that attempting to quantify the abundances of all but the most common taxa or the assemblage as a whole is likely beyond the scope of most assessment projects.

Vinson et al. (2010) concluded that treatment methods and sampling efforts among existing studies are too variable to allow for definitive conclusions on the effects of rotenone on aquatic invertebrates in general and stream invertebrates in particular. However, lower rotenone concentrations than have generally been used in the past may be able to achieve complete mortality of trout while minimizing effects on invertebrate assemblages (Finlayson et al. 2010). To further reduce rotenone effects and promote invertebrate recolonization, they recommend that upstream and tributary fishless sections be left untreated to serve as invertebrate refugia, and that rotenone should be neutralized to protect downstream colonization sources.

In light of the preceding review of available literature on the effects of rotenone and disturbance on aquatic invertebrates, the following conclusions summarize the potential effects on stream aquatic invertebrates that would be expected from rotenone use in SEKI under this alternative:

- Since rotenone effects may be greater in high elevation streams that are often dominated by small, gilled invertebrates (many EPT taxa) adapted to snowmelt systems, cold water and high oxygen level, short-term effects on aquatic invertebrates would be expected to be high. However, treatments would be applied at 25 to 50 ppb rotenone to minimize invertebrate mortality while still achieving complete mortality of trout. This would improve the ability of invertebrate assemblages to recover, relative to many projects that treated at higher concentrations.
- Since rotenone would be applied in late summer and invertebrate recovery would depend in part on downstream drift of larvae for recolonization, lower fall and winter drift rates and lack of winter reproduction would delay much recovery until the following spring. However, upstream and tributary fishless stream sections are expected to be present in each rotenone treatment basin and would not be treated. In addition, each treatment basin has adjacent fishless stream sections that would also not be treated. These habitats would provide nearby habitat sources for invertebrates to rapidly colonize treatment areas through drift or aerial dispersal of winged life stages.
- Since the proposed rotenone treatment streams have predictable discharge patterns (snowmelt driven) and are presumed to have a relatively low frequency of natural disturbance (little to no fire; smaller and infrequent floods), invertebrate assemblages may be less resistant to rotenone treatment. However, the treatment basins are relatively small (compared to many projects that treated larger basins), which should limit distance to colonization sources and provide for quicker recovery times (versus treating larger basins).
- Common taxa would be expected to quickly recolonize treated areas; rarer taxa may not return for a number of years or indefinitely.

Effects of rotenone on aquatic invertebrates in lakes would be similar to effects on aquatic invertebrates in streams, as described in the preceding section. For effects of rotenone on zooplankton, there is a range of sensitivity to rotenone for two groups of zooplankton, including copepods (72 hr LC100 = <0.1 mg/L = 100 ppb) as the most rotenone-resistant taxa included in this review (Ling 2003), and cladocerans (24 hr LC50 = <0.025 to 0.027 mg/L = 25 to 27 ppb) as the most rotenone-sensitive taxa included. However, these zooplankton taxa are still 7 to 28 times more resistant than the most resistant fish taxa in SEKI proposed eradication sites (rainbow trout: 24 hr LC50 = 3.5 ppb).

Although these results indicate that zooplankton are much less sensitive to rotenone than fish, rotenone is still toxic to zooplankton (Kiser et al. 1963, Anderson 1970, Neves 1975, Beal and Anderson 1993, Melaas et al. 2001) and thus some mortality would be expected from a typical application in lakes or ponds. While many aquatic invertebrates may lessen rotenone exposure by burrowing into sediment, zooplankton typically occupy open-water habitat and thus are exposed to rotenone for the entire time it is active during a treatment (CDFW 2007). As a result, zooplankton taxa such as cladocerans are generally more sensitive than larger benthic invertebrates such as mollusks,

oligochaete worms and chironomid midge larvae (Hamilton 1941, Morrison 1977). However, some zooplankton taxa do have resistant life stages and/or eggs that may facilitate recovery (Kiser et al. 1963).

In lakes, studies have primarily evaluated the effects of rotenone on zooplankton assemblages rather than benthic invertebrates, documenting short-term effects on zooplankton abundance and taxa richness. In a review of published studies on the effects of rotenone on lake invertebrates, Vinson et al. (2010) reported the following results. Almquist (1959) measured that most zooplankton experienced mortality at 25 to 30 ppb rotenone, and that the toxicity of rotenone in lakes varied in response to light, oxygen, alkalinity, temperature and turbidity. Kiser et al. (1963) observed complete mortality of a zooplankton assemblage within 2 days after applying 25 ppb rotenone. Similarly, Beal and Anderson (1993) found no surviving zooplankton 2 days after treatment with 15 ppb rotenone. Finally, Reinertsen et al. (1990) found a substantial reduction in zooplankton abundance after a 25 ppb rotenone treatment. Reductions are generally short-term, with populations of more-resistant taxa such as copepods recovering over periods of 1 to 8 months following treatment (Beal and Anderson 1993, Ling 2003). However, populations of more-sensitive taxa such as cladocerans sometimes needed 3 years to recover in mountain lakes (Anderson 1970).

Although lake studies have reported greater rotenone effects on zooplankton than on benthic invertebrates, studies nevertheless do show short-term effects on benthic invertebrates (Vinson et al. 2010). However, these studies typically showed small differences in total abundance or biomass between pre- and post-treatment samples (Cushing and Olive 1957, Houf and Campbell 1977, Melaas et al. 2001). The greatest effects appear to have been on Chironomidae (midges), which can be the most dominant taxa in invertebrate assemblages.

As introduced above, studies of rotenone effects on zooplankton in lakes most often reported recovery in terms of organism abundance (Vinson et al. 2010). Recovery of zooplankton to pre-treatment abundances ranged from 1 month to 3 years, with rotifer and copepod assemblages appearing to recover more quickly than cladoceran assemblages (Brown and Ball 1943, Anderson 1970, Beal and Anderson 1993).

Several studies have shown rapid and strong recovery of zooplankton assemblages in lakes following rotenone treatment. In Lake Davis, California, overall zooplankton abundance increased to roughly 300% of the pre-rotenone-treatment abundance, and all pre-treatment taxa were present, within 1 year after treatment (CDFW/USFS 2007). In another study, all 42 zooplankton taxa that were extirpated immediately following rotenone treatment returned within 5 months (Kiser et al. 1963). Finally, Melaas et al. (2001) reported complete recovery of prairie wetland zooplankton assemblages within 1 year of treatment.

Studies that assessed recovery of benthic invertebrate assemblages in lakes generally showed no long-term decreases in abundance or taxa richness (Houf and Campbell 1977); no difference in taxa richness within 6 months (Blakely et al. 2005); and no differences between pre- and post-treatment samples within 1 year of treatment (Melaas et al. 2001).

Therefore, while there would be an adverse effect on the natural quality of wilderness from the use of piscicides because of the impacts on native vertebrate and invertebrate populations, these effects would be temporary; in the long-term there would be positive beneficial effects on the natural quality of wilderness character by restoring the natural components of the native high elevation aquatic ecosystems.

Undeveloped: Under this alternative, the undeveloped quality of wilderness would be affected by the presence of the equipment that would be used for the project work, including gill nets, small electric pumps and motors used for piscicide applications, and barrier nets installed across streams and the use of helicopters.

The effects on the undeveloped quality of wilderness character from the installation of gill nets and fish traps would be short-term during project activities, and long-term when gill nets are deployed over

the winter months. There would be up to six crew camps in wilderness per year, generally occupying each site periodically through the summer season for approximately 6 years per lake or pond treatment site, and up to 10 years at treatment sites with long or complex streams.

Crew camps would include temporary installations (food storage and equipment lockers) which could be in place for 6 to 10 years per site at physical treatment sites, and 1 to 3 years per site at piscicide sites. These would be removed after project work is completed at each site.

There could be up to three flights per restoration site per year. Flights would occur at mobilization to deliver supplies, at demobilization to remove supplies and materials from the project site, and to transport frogs to distant reintroduction sites. Flights would be of short duration and would only be used if stock could not be used to transport supplies to a given project site (e.g. if the trails are not suitable or safe for stock, or if the equipment is too heavy, fragile, or bulky for stock to carry) or if translocation sites are longer than a 6 hour hike. The adverse effect is temporary, generally only when the helicopter is en route and for 15 to 30 minutes at the landing areas, and would occur in several locations in wilderness each summer.

Project work would occur in selected areas of the wilderness over the 25 to 35 year life of the project. None of these developments would be permanent, and no permanent improvement or modern human occupation would occur at any of the restoration sites.

Opportunities for Solitude or Primitive and Unconfined Recreation: During any given year throughout the 25 to 35 year project, this alternative results in one to six temporary crew camps in the wilderness. Typically this is expected to be some combination of two to three crews conducting physical restoration concurrent with one or two crews conducting piscicide restoration, with a total of up to four crews in the wilderness at any one time (the crews may move from camp to camp during the field season). The crews implementing physical treatment would involve two to three workers per site. The crews would combine to treat areas with piscicides, and this would involve 8 to 15 people at most piscicide worksites, and potentially 16 to 25 people at one or more of the largest piscicide worksites. Crews would camp up to 10 days per site visit and each site would be visited up to 7 times per season. These larger crews would be slightly more intrusive in frequently used areas, but the larger camps would only be needed for 2 weeks during the actual treatment. Most of the treatment locations are away from popular visitor use areas; however there is still the likelihood that wilderness users could use the same areas, resulting in a short-term adverse effect on opportunities for solitude.

The use of helicopters would reduce opportunities for solitude as it would affect the natural soundscape on a short-term basis. If visitors are directed to avoid sites during helicopter drops of equipment, then there would be a temporary reduction in opportunities for unconfined recreation. This would occur for the 15 to 30 minutes required to off load or load equipment, so the effect would be adverse and short-term.

There would be long term adverse effects on opportunities for primitive recreation (e.g. angling) resulting from reduced angling opportunities at 85 of the parks' waterbodies and 31 miles of streams. But 85% of the 550 lakes and streams containing nonnative fish would continue to provide angling opportunities in the long-term. There would be long-term beneficial effects from the restoration of healthy native ecosystems at treated sites, leading to enhanced opportunities for primitive recreation related to the viewing of native wildlife and natural ecosystems.

If area closures occur due to piscicide treatments, then there would be reduced opportunities for unconfined recreation. These area closures would be limited to the project area, and would be at most for 7 to 14 days per treatment, resulting in short term adverse effects on opportunities for unconfined recreation.

Other Features of Value: No effect.

Effects on safety: Carrying heavy, fragile, and large equipment from stock drop off points to project sites would pose an increased safety risk to project crew members. Helicopter operations are inherently risky.

Prior to considering whether to use helicopters, the previous criteria would be reviewed. This alternative would be less risky to the on-ground crews as they would not be required to carry in the heavy, fragile, and bulky equipment to and from the project area to the stock drop-off location, over trail-less areas with rugged topography.

Due to the remoteness of the proposed project areas, the distance to any downstream human population, and the low likelihood of exposure to visitors during and after treatment, there would be a low risk of human exposure to the piscicides (outside of the crews conducting the treatments), and little threat to the health and safety of wilderness users and the parks' neighbors. Employees would be exposed to piscicides but this risk would be mitigated through proper training and following established protocols.

Effects on other criteria (e.g., special provisions, economics, timing constraints, traditional skills, weather, visitation, etc.): Time of year and weather are considerations when planning project activities, and are considered when determining if a helicopter or stock crew would be utilized to transport equipment to the project site. If it is not possible to use stock to access a camp location, then a helicopter is considered for mobilization/ demobilization. This would allow work at project sites to be started earlier in the season, and extend later into the fall, allowing the project objectives to be met at a quicker rate.

Alternative # __3___ Physical Treatment Preceding Restoration – Including 4(c) activities (*No Piscicide Use)* – installation of gill nets, fish traps, and camp crews; blasting to create barriers; use of helicopters for transportation of equipment

Description:

Alternative 3 would use only physical treatment methods to eradicate nonnative fish, including electrofishing, gillnetting, and disruption or covering of redds. This alternative also includes blasting rock to create vertical fish barriers in restoration areas where existing barriers are ineffective for keeping out nonnative fish. In comparison to alternative 2, excluded from the list of proposed restoration waters are long reaches of stream, most large lakes, and interconnected lake complexes that are too large or too complex for effective physical treatment.

Physical treatment would be used for 52 waterbodies (27 lakes, 24 ponds, 1 marsh; total of 492 acres) and approximately 15 miles (24 km) of stream in 17 basins. In addition, any fish-containing habitat adjacent to treated lakes, ponds and stream sections would also require treatment in order to eradicate fish from each restoration area. Although the total acreage requiring treatment may change slightly based on site-specific survey information and prescription development, the number of waters and stream miles identified for treatment represents the maximum number of waters to be treated in this alternative, and may be reduced as basin prescriptions are completed.

Blasting may be necessary under this alternative in areas where inadequate fish barriers exist. Although the goal of the treatment site selection is to select basins with adequate downstream barriers that prevent fish movement between treated and untreated waters, sometimes a barrier is later (post treatment) found to be inadequate to prevent fish from moving upstream into treated waters.

Location of Proposed Treatments
Aquatic ecosystem restoration would take place in up to 51 basins. Nonnative fish would be eradicated using physical methods from 52 waters in 17 basins, including 51 lakes and ponds (491 ac), 1 known fish-containing marsh area (1 ac), approximately 15 miles of streams, plus additional

connecting fish-containing habitat as necessary. These 52 waters represent 9% of the parks' approximately 550 waters known to contain nonnative fish that are candidates for eradication.

Fishless habitat important for conservation of MYLFs and other native species would be managed in the 17 fish eradication basins, plus up to 34 additional basins where no fish eradication would occur.

Basin	# Lakes	Area (ac)	# Ponds	Area (ac)	Stream (mi)
Physical Treatment Only					
Barrett	3	42.07	1	0.28	0.87
Blossom	2	9.45	2	2.29	0.64
Brewer	0	0.00	1	1.60	0.52
Crytes	2	20.62	1	0.87	0.02
Dusy	1	10.58	2	0.60	0.69
East Wright	1	2.63	0	0.00	0.66
Horseshoe	4	28.96	0	0.00	0.40
McGee	4	75.31	4	1.19	1.20
Milestone	1	12.80	1	2.07	0.49
Rambaud	0	0.00	1	0.44	0.25
Slide	1	5.12	1	0.17	1.60
Swamp	0	0.00	1	1.85	0.28
Tablelands	0	0.00	1	1.48	1.65
Upper Bubbs	2	21.62	2	1.67	4.32
Upper Evolution	4	228.19	1	0.48	1.20
Upper Kern	0	0.00	2	2.12	0.38
Vidette	2	16.57	3	0.23	0.39
Grand Total	**27**	**473.91**	**24**	**17.34**	**15.58**

Components of the Action		Activity for this Alternative
1	Transportation of Personnel to and from the Project Site	Crews hike to and from project sites.
2	Transportation of Equipment to and from the Project Site	Stock or helicopters would be used for mobilizations and demobilizations of physical treatment sites per criteria detailed under Common to All Alternatives. Stock would be used for two round trips per site, 1 to 2 sites per year. In general, site mobilizations require 5 animals and demobilizations require 3 to 4 animals. The maximum yearly stock use is estimated to be 8 to 9 animals per site, requiring only one overnight stay per trip. Therefore, the maximum number of expected stock nights (number of animals multiplied by nights) per year generated by any of the project alternatives is estimated at 16 to 18 nights. A helicopter would be used for transporting

		materials to project areas based on the previously described criteria.
3	Establishment of and Use of Crew Camps	Crew size is typically 2 to 3 crewmembers. Crews would camp up to 10 days per site visit and each site would be visited up to 7 times per season. Physical restoration generally takes 6 years per lake and up to 10 years per stream and marsh area. Crew camps include a short-term installation of food and equipment storage lockers which would be left in place for the duration of the project work, and removed once the project work is completed.
4	Fish Capture Techniques and Tools	Gill nets, electrofishers, fish traps, and disruption of redds
5	Translocation Methods	Frogs to be translocated are either hiked to nearby recipient habitat or transported by helicopter to distant recipient habitat. 'Nearby' habitat generally can be hiked to within 6 hours, posing minor risk to frog survival during transport. 'Distant' habitat cannot be hiked to within 6 hours, which would pose moderate to high risk to frog survival during transport. At the recipient site, all individuals would be released into fishless habitat and monitored for the next several years.
6	Stream barriers	There may be up to five stream barriers constructed under this alternative, created by blasting rock at the downstream end of a cascade to create a vertical waterfall unbreachable by fish. Temporary net stream barriers would not be used since that is only associated with piscicide use.
7	Condition of Site After Project	Natural processes in wilderness would be restored to a more limited extent when compared to Alternative 2, by eliminating impacts being caused by self-sustaining nonnative trout populations in 52 waters and 15 miles of streams, plus connected fish-containing habitat as necessary. However, there would still be self-sustaining nonnative trout populations present in approximately 498 waters plus connecting streams. This alternative represents 9% of the parks' approximately 550 waters known to contain self-sustaining nonnative trout populations. A total of up to 51 basins would be restored to a more natural condition under this alternative. Blasting - Up to five sites would be permanently altered by blasting actions.

Effects on Wilderness Character:

Untrammeled: The trammeling activities associated with alternative 3 include removing nonnative fish by physical methods (gill netting, fish traps, and electrofishing) and blasting a permanent physical barrier in up to five streams – all of which are intentional manipulations of the wilderness. Overall, when compared with alternative 2, there would be fewer treated sites, but because physical treatment requires longer time periods, the trammeling actions would occur for the next 25 to 35 years. Aquatic restoration would occur in up to 51 basins; physical treatment would occur in up to 52 waterbodies

(51 lakes and ponds, 1 marsh; total of 491 acres) and approximately 15 miles of streams contained in 17 basins. Up to five sites would be treated each year for the next 25 to 35 years. Treatment per site could occur for approximately 6 years for lakes and ponds, and up to 10 years for sites with long or complex streams. Active work by crews would occur during the summer, but nets would be set during the winter in select locations in deeper waters to continue to capture fish.

Blasting rock to create vertical fish barriers at five locations is an intentional manipulation of the stream substrate that is meant to control nonnative fish movement. Treatment sites are selected based on the presence of a downstream barrier. However, sometimes the downstream barrier is not effective for preventing nonnative fish from traveling upstream to a previously treated area. If this occurs, and nonnative fish cannot be removed from the downstream areas using physical methods (e.g. gill netting, electrofishing, or fish traps) because if the lake area is too big, too complex, or the streams are too long, then a barrier would need to be created. This barrier would have to prevent nonnative fish from moving upstream, while allowing for the continued flow of water. Blasting is considered the best way to create a barrier as it would involve using natural elements and long-term maintenance would not be required, versus putting in a concrete or human-made structure which would require periodic maintenance, would change the flow of water, and would be a long-term development in the wilderness. Blasting a stream barrier would result in a long-term manipulation of the biophysical environment and would result in a permanent modification/trammel of the stream, resulting in a long-term adverse effect on the untrammeled quality of wilderness character.

Natural: Under this alternative, there would be approximately 498 waterbodies continuing to contain self-sustaining nonnative trout populations, which have a long-term adverse effect on the natural quality of wilderness. Aquatic ecosystem restoration would occur over the next 25-35 years in 51 basins, described as follows. Physical fish eradication treatments would be used for 52 waterbodies (51 lakes and ponds, 1 marsh; total of 492 acres) and approximately 15 miles of streams contained in 17 basins. In comparison to alternative 2, excluded from the list of proposed fish eradication waters are long reaches of stream, most large lakes (which are more resilient to climate change), and interconnected lake complexes that are too large or complex for effective physical treatment. Fishless habitat important for conservation of MYLFs and other native species would be managed in the 17 fish eradication basins, plus up to 34 additional basins where no fish eradication would occur.

The 52 waterbodies to be treated under this alternative represent 9% of the parks' approximately 550 waters known to contain self-sustaining nonnative trout populations that are candidates for fish eradication. A total of up to 51 basins would be restored to a more natural condition under this alternative.

In addition, blasting rock would occur at no more than five individual cascade locations, and would modify the natural rock substrate beneath small sections of streams in these locations, resulting in a long-term adverse effect on the natural quality of wilderness. It is likely in the future that high water events, erosion, and normal geologic processes would remove the evidence of the barriers created by the blasting, however, this would constitute a long-term adverse effect on the natural quality of wilderness.

Undeveloped: Under this alternative, the undeveloped quality of wilderness would be affected by the use of gill nets (installations) during project work. There would be up to five temporary crew camps in wilderness per year, generally occupying each site for several weeks each season for approximately 6 years per site for lakes and ponds, and up to 10 years for sites with long or complex streams. Crew camps would include temporary installations (food storage and equipment lockers). These would be removed after project work is completed at each site. Project work would occur in selected areas of the wilderness over the 25 to 35-year life of the project. The result is a long-term adverse effect on undeveloped. None of the development would be permanent, and no permanent improvement or modern human occupation would occur at any of the restoration sites.

In addition, blasting rock at no more than five individual cascade locations would create permanent scars on rock beneath small sections of streams in these locations. The modification of the rock by blasting would result in a long-term adverse effect on the undeveloped quality of wilderness. It is likely

in the future that high water events, erosion, and normal geologic processes would remove the evidence of the barriers created by blasting, and it is also highly likely that the blasted area would not be noticeable to wilderness visitors as for most of the year it would be under water or snow; regardless of this, it is still considered a long-term adverse effect on the undeveloped quality of wilderness.

Helicopter use would be similar to alternative 2; however, there would be fewer project sites, and therefore reduced adverse effects on the undeveloped quality from the use of a helicopter when compared to alternative 2. There could be up to three flights per restoration site per year. Flights would occur at mobilization to deliver supplies, and at demobilization to remove supplies and materials from the project site. Flights would be of short duration and would only be used if stock could not be used to transport supplies to a given project site (e.g. if the trails are not suitable or safe for stock, or if the equipment is too heavy, fragile, or bulky for stock to carry). The adverse effect is temporary, generally only when the helicopter is en route and for 15 to 30 minutes at the landing areas, and would occur in several locations in wilderness each summer.

Opportunities for Solitude or Primitive and Unconfined Recreation: During any given year throughout the 25 to 35 year project, there would one to five crew camps in wilderness each year. The crews implementing physical treatment would involve two to three workers per site, occupying each site for several weeks each season. Most of the treatment locations are away from popular visitor use areas; however, wilderness users could use the same areas and be adversely affected by the loss of solitude.

There would be long-term adverse effects on opportunities for primitive recreation (e.g. angling) resulting from reduced angling opportunities at 52 of the parks' waterbodies and 15 miles of streams. However, there would be long-term beneficial effects from the restoration of healthy native ecosystems at treated sites, leading to enhanced opportunities for primitive recreation related to the viewing of native wildlife and natural ecosystems.

There would be no area closures associated with this alternative thus no change to opportunities for primitive and unconfined recreation.

Other Features of Value: No effect.

Effects on safety: As stated under alternative 2, helicopter operations are inherently risky. Prior to considering whether to use helicopters, the previously identified criteria would be reviewed. The on-the-ground elements of this alternative are similar to the no action (continuing the current project). There are no Effects on safety out of the ordinary. All project work would require the preparation of Job Hazard Analyses.

Effects on other criteria from Elements Common to All Alternatives (e.g., special provisions, economics, timing constraints, traditional skills, weather, visitation, etc.): Actions would need to occur during summer months to allow for travel into the SEKI wilderness when conditions are appropriate (little or no snow and ice).

Alternative # __4___ Piscicide Treatment Preceding Restoration – with limited 4(c) Actions – Piscicide Use and Helicopter Use for transport of equipment; no physical treatments (no gill nets, electrofishing, or fish traps); limited and short-term installations related to crew camps; and temporary fish barriers (no blasting)

Description:

Properly applied, piscicides can eliminate fish from targeted waters in as few as 1 to 2 days per site, in contrast to physical treatment methods which can take up to 6 years for lakes and up to 10 years

for streams (NPS 2012). Based on initial examination of maps, staff familiarity with the parks, and discussions with experts, piscicide treatment would be used for the next 15 to 20 years in 21 basins, including 85 waterbodies (31 lakes, 49 ponds, and 5 known fish-containing marshes; total of 634 acres), approximately 31 miles of streams, plus additional connected fish-containing habitat as necessary. Although the total acreage requiring treatment may change slightly based on site-specific survey information and prescription development, the number of waters and stream miles identified for treatment represents the maximum number of waters to be treated in this alternative, and may be reduced as basin prescriptions are completed.

Location of Proposed Treatments

Aquatic ecosystem restoration would take place in up to 55 basins. Nonnative fish would be eradicated using piscicide methods from selected waters in 21 basins, including 85 lakes and ponds (602 ac), 5 associated fish-containing marsh areas (32 ac), approximately 31 miles of stream, plus additional connected fish-containing habitat as necessary. These 85 waters represent 15% of the parks' 550 waters known to contain nonnative fish that are candidates for eradication.

Fishless habitat important for conservation of MYLFs and other native species would be managed in the 21 fish eradication basins plus up to 34 additional basins where no fish eradication would occur.

Basin	# Lakes	Area (ac)	# Ponds	Area (ac)	Stream (mi)
Piscicide Treatment Only					
Amphitheater	1	58.87	2	1.34	2.16
Barrett	3	42.07	1	0.28	0.87
Blossom	2	9.45	2	2.29	0.64
Brewer	0	0.00	1	1.60	0.52
Crescent	0	0.00	0	0.00	1.58
Crytes	2	20.62	1	0.87	2.00
Dusy	1	10.58	2	0.60	0.69
East Wright	1	2.63	0	0.00	0.66
Horseshoe	4	28.96	0	0.00	3.39
Laurel	0	0.00	1	0.22	3.09
McGee	4	75.31	4	1.19	1.20
Milestone	1	12.80	1	2.07	0.49
Rambaud	0	0.00	1	0.44	0.25
Sixty Lake	1	13.36	14	14.87	1.00
Slide	1	5.12	1	0.17	1.60
Swamp	0	0.00	1	1.85	0.28
Tablelands	0	0.00	1	1.48	1.65
Upper Bubbs	2	21.62	2	1.67	5.25
Upper Evolution	4	228.19	1	0.48	1.68
Upper Kern	2	18.32	10	6.29	1.85
Vidette	2	16.57	3	0.23	0.39
Grand Total	**31**	**564.46**	**49**	**37.95**	**31.27**

Components of the Action		Activity for this Alternative
1	Transportation of Personnel to and from the Project Site	Crews hike to and from project sites.
2	Transportation of Equipment to and from the Project Site	Because the equipment is fragile and heavy, and includes liquids, all equipment would be transported by helicopter.
3	Establishment of and Use of Crew Camps	Crew size would be 8 to 15 crewmembers at most piscicide worksites, and potentially 16 to 25 crewmembers at one or more of the largest piscicide worksites. Crews would camp up to 10 days per site visit and each site would be visited up to 2 times per season. Restoration using piscicides would be expected to take 2 to 4 weeks in each of 1 to 3 years per site. Since crews would occupy sites for a short period of time, no food storage lockers would be needed, but short-term installation of an equipment locker would be needed to secure piscicide while it is onsite. It would be left in place for the duration of the project work, and removed once the project work is completed.
4	Fish Capture Techniques and Tools	Piscicides only
5	Translocation Methods	Frogs to be translocated are either hiked to nearby recipient habitat or transported by helicopter to distant recipient habitat. 'Nearby' habitat generally can be hiked to within 6 hours, posing minor risk to frog survival during transport. 'Distant' habitat cannot be hiked to within 6 hours, which would pose moderate to high risk to frog survival during transport. At the recipient site, all individuals would be released into fishless habitat and monitored for the next several years.
6	Stream barriers	A temporary fish barrier would be installed if needed to protect an invertebrate source population from fish recolonization until fish are eradicated with piscicides. No permanent barriers would be created.
7	Condition of Site After Project	In 15 to 20 years, project objectives would be accomplished. There would be 80 lakes and ponds, 5 associated marshes, approximately 31 miles of streams, and connected fish-containing habitat (as necessary) restored to natural conditions, which is 15% of the 550 waterbodies known to contain nonnative fish that are candidates for eradication. Invertebrates would be impacted at the piscicide treatment sites until recovery occurs. The recovery of invertebrates (thus the restoration of the natural quality) at the treatment sites could take 5 years or more (Hamilton et al. 2009).

Effects on Wilderness Character:

Untrammeled: Under this alternative, the short-term adverse effects as a result of trammeling due to the use of piscicides to eradicate nonnative fish from 85 lakes and ponds (602 ac), 5 associated fish-

containing marshes (32 ac), approximately 31 miles of streams, plus connected fish-containing habitat as necessary, would create more impacts on untrammeled than the other alternatives.

At any given time during the summer, there could be up to six piscicide projects ongoing, including up to two sites with treatment activities (applying piscicide) and up to four sites with pre- or post-treatment assessment activities (measuring habitat and collecting samples in the summers before and after each treatment). Treatment sites would be occupied for 2 to 4 weeks each year; assessment sites would be occupied for 1 to 2 weeks each year. The actual piscicide treatment would occur over a period of 1 to 2 days.

Because piscicide treatment, if done properly and under the correct environmental conditions, can result in the elimination of nonnative fish from targeted waterbodies in as few as 1 to 2 days, the trammeling actions would be completed sooner than the other action alternatives. Therefore, the fish eradication work would be completed in the wilderness in a shorter period of time (the trammeling actions would stop in 15 to 20 years as opposed to 25 to 35 years as in the other action alternatives). Overall, when considering the scale and timing of this project, the adverse effects on trammeling would be long-term for the duration of the project.

Natural: Under this alternative, there would be 465 waterbodies continuing to contain self-sustaining nonnative fish populations, which is a long-term adverse effect on the natural quality of wilderness character. Piscicide use would be utilized to remove nonnative fish over the next 15 to 20 years in 21 basins, including 80 lakes and ponds (602 ac), 5 associated fish-containing marshes (32 ac), approximately 31 miles of streams, plus connected fish-containing habitat as necessary. Nonnative fish would be removed from 15% of the parks' 550 waterbodies known to contain nonnative fish that are candidates for eradication.

As described in detail under Alternative 2, there would be an adverse effect on the natural quality of wilderness from the use of piscicides (see alternative 2 for a full description of the effects of piscicides). Piscicides would kill most gill breathing organisms in the waters where they are used. The recovery of invertebrates (thus the restoration of the natural quality) at the treatment sites could take up to 5 years or more (Hamilton et al. 2009). However, this alternative would effectively restore the natural quality of wilderness at the treatment sites at a more rapid rate than the other alternatives, resulting in long-term beneficial effects.

Undeveloped: The use of a small electric pump and motor associated with piscicide use creates a short-term adverse effect on the undeveloped quality of wilderness. In addition, there would be a short-term adverse effect from the use of nets as barriers across streams between treatment sites. There would be up to six temporary crew camps in wilderness per year and some of these may have temporary installations (camping equipment). Because the projects would be of short duration, there would be no food storage lockers needed, but equipment lockers would be needed for short-term security of piscicide until it was used during treatments. Treatment sites would be occupied for 2 to 4 weeks in the summer for up to 3 years per site; assessment sites would be occupied for 1 to 2 weeks in the summer for up to 4 years per site.

Project work would occur in selected areas of the wilderness over the 15 to 20 year life of the project, so the overall effect on the undeveloped quality would be long-term. None of the development would be permanent, and no permanent improvement or modern human occupation would occur at any of the restoration sites.

Opportunities for Solitude or Primitive and Unconfined Recreation: Under this alternative, there would be up to six crews each year working in the wilderness, including up to two treatment crews and up to four pre- or post-treatment assessment crews. Each treatment crew would occupy a selected project site for 2 to 4 weeks during treatment activities; each assessment crew would occupy a selected project site for 1 to 2 weeks during assessment activities. Treatment crews would generally involve 8 to 15 people per most sites, and potentially 16 to 25 people at one or more of the largest sites; assessment crews would generally involve 2 to 4 people per site. Most of the treatment

locations are away from popular visitor use areas; however wilderness users could use the same areas and be adversely affected by the loss of solitude.

There would be long-term adverse effects on opportunities for primitive recreation (e.g. angling) resulting from reduced angling opportunities at 85 of the parks' waterbodies and 31 miles of streams. But 85% of the 550 lakes and streams containing nonnative fish would continue to provide angling opportunities in the long-term. There would be long-term beneficial effects from the restoration of healthy native ecosystems at treated sites, leading to enhanced opportunities for primitive recreation related to the viewing of native wildlife and natural ecosystems.

There would be reduced opportunities for unconfined recreation because the treatment areas would be closed to visitors during and for at most 7 to 14 days during and after the piscicide application.

Other Features of Value: No effect.

Effects on safety: The risk from the use of helicopters would be the more than the other alternatives, as there would be more transportation flights required to deliver the piscicides to all the treatment locations. The risk associated with the use of piscicides to project crews would be greater as all the areas would be treated with piscicides. However, overall this alternative results in less exposure to environmental hazards associated with using gill nets and electrofishers (e.g. cold water, slippery rocks and streams, camping and living in high elevation wilderness conditions, etc.). Crews would be spending less time in the waterbodies conducting treatment actions. The fish eradication portion of project implementation period would be reduced to a maximum of 20 years.

Due to the remoteness of the proposed project areas, the distance to any downstream human population, and the low likelihood of exposure to visitors during and after treatment, there would be a low risk of human exposure to the piscicides, and little threat to the health and safety of wilderness users and the parks' neighbors.

Effects on other criteria (e.g., special provisions, economics, timing constraints, traditional skills, weather, visitation, etc.): alternative 4 emphasizes speed in recovering habitat because MYLF populations are declining very rapidly and are at a high risk from extinction. To achieve this speed, only piscicide treatment would be used for nonnative fish eradication.

Mitigation Measures for Action Alternatives (where applicable)

<u>Work Crews (all alternatives)</u>

- All crews would be instructed in and expected to use minimum impact camping practices and wilderness ethics.
- Crew camps will be located where they have minimal impact on opportunities for solitude and primitive and unconfined recreation and the natural qualities of wilderness character. Generally, existing camps frequently used by the public will be avoided, but will be used if adequate naturally hardened sites are not available. Naturally hardened sites have a natural abundance of sand, gravel, or rock and a natural lack of grasses and forbs. Where possible, crew camps would be located at base camps used for previous projects, with minimum potential to disrupt wildlife habitat or habits.
- Crews would be instructed on proper food-storage practices and camps would be inspected to make sure food is properly stored.
- Water for the crews both at work sites and in camp would be taken from a stream or lake that would be accessed by non-sensitive paths. The crews would be instructed to avoid sensitive areas in both the work sites and crew camp areas.
- Gray water would be disposed of over 100 feet from any surface water and would be poured into a small pit through a screen to remove small food particles, which would then be removed from wilderness with other trash.
- Special containers or pit toilets would be used for toilets in all work and camp areas. The containers would be packed or flown out at the end of the field season and disposed of in a sewage treatment facility.

- No motorized equipment would be used in camp. A propane/white gas or battery-powered lantern or headlamp would be used to light the work and cooking area inside the work tent. All other light would be from personal flashlights and headlamps.
- All equipment, clothing, and gear would be checked for debris, cleaned of any visible plant or soil matter, and disinfected with quaternary ammonia following SEKI's disinfection protocol prior to moving to a new site.

Stock Use (all alternatives)

- SEKI's packstock operations would be subject to minimum impact standards and grazing regulations per SEKI's SOPs.
- Packstock (fur and hooves) and equipment would be inspected and cleaned of seeds and dirt, as necessary, before leaving the front country.
- All SEKI grazing restrictions and regulations would be adhered to.

Helicopter Use (for applicable alternatives)

- If a helicopter is determined to be the minimum tool, then a temporary landing zone would be established at the project site. The landing zone should be void of trees and boulders that could pose a threat to helicopter rotors; should be on flat, level surface; minimal exposure to heavy winds; sites with ease of landing (affects load weights that can be delivered); and in proximity to base camp.
- No whitebark or foxtail pines would be cut to accommodate a landing zone.
- A trained helicopter crewmember would be present at the work area to direct air operations, handle cargo and ensure public and employee safety.
- Except in the case of a medical emergency, flights would occur only between 8:00 a.m. and 5:00 p.m. and would follow flight paths to and from the project sites designed to avoid sensitive areas.
- Park staff would inform hikers of possible noise intrusions, when they would occur, and alternative routes visitors could use to avoid the noise.
- Park staff would inform visitors camping near the project sites and landing areas of flights and project activities.
- No helicopter fuel would be stored in wilderness. All helicopter fuel and other supplies not needed on the helicopter during flights would be stored at the frontcountry Ash Mountain Helibase.

Restoration of Mountain Yellow-legged Frogs

- All personnel involved in collection and handling for CMR, translocations, reintroductions, antifungal treatments, and any other methods that involve handling MYLFs would be professional biologists with years of experience with proper handling of endangered amphibians, or–for trained, but less experienced biologists–work under the direct supervision of professionals.
- Handlers would have wet hands when handling any listed amphibian. No adults in amplexus (mating behavior) would be handled during routine monitoring and research activities.
- MYLF handling would be kept to the minimum time necessary for effectively completing conservation actions.
- Expeditious and cautious handling, including proper climate control, would be used during translocations and reintroduction efforts, including transport out of the wilderness, travel time to captive rearing facilities, and transport back to wilderness following captive-rearing.
- All captive-rearing efforts would be undertaken by professional biologists and/or captive rearing facility staff experienced with animal care and disease management techniques.
- Collections would be limited to the minimum number of animals necessary to successfully complete recovery actions and FWS would be consulted to obtain the proper permits.

Vegetation

- Prior to initiating work, project work areas and crew camp sites would be surveyed for the presence of plant species of concern.

- If species of concern are present in work and camp sites, appropriate mitigation measures would be taken, which could include collecting seed or flagging areas during project work to protect the species from onsite activities.
- Equipment and materials would be inspected for soil and plant parts. Dirty materials would be cleaned before being transported to field sites. Equipment and materials that could acquire seeds from surrounding areas would be covered during transport.
- A list and / or map of project areas would be maintained so that sites can subsequently be surveyed for invasive nonnative plants.
- Work crews would inspect their shoes, clothing and equipment for seeds and soil before leaving the front country. Seeds and soil would be removed and placed in bagged garbage.

Wildlife

- Crew camps would be located at least 100 ft (30 m) away from aquatic habitat for MYLFs, Yosemite toads, and Little Kern golden trout, and away from ridgeline habitat for bighorn sheep.
- Stock would be kept at least 100 ft (30 m) away from 1) the core aquatic habitat for MYLFs, Yosemite toads, and Little Kern golden trout; and core terrestrial habitat for bighorn sheep.
- Little Kern golden trout occur in one proposed treatment area (Crytes Basin; NPS unpublished data) included in this plan. This population is not native to Crytes Basin, is not part of the official recovery plan for the species (Christenson 1984), and recent genetic analysis shows that this population is not genetically-pure (Deiner et al. 2010, Erickson et al. 2010). Although this population is not genetically-pure, it still may have value in that it retains some amount of Little Kern golden trout alleles. If this population was determined to be useful as brood stock for management and restoration of Little Kern golden trout within the recovery plan area, SEKI would work with CDFW to live-capture and move as many fish as possible to an appropriate location outside of the project area.
- Prior to any approved helicopter flight, the parks' wildlife biologist would provide a map of known bighorn sheep areas, and the helicopter would avoid flying above or landing in those areas; the final approach to the landing zone would stay below the area of the historic sightings. Flights would be suspended if sheep are observed within ½ mile (0.8 km) of the project area. The landing zone for the helicopter would be located approximately 500 ft (152 m) from any area where sheep have been observed
- All personnel involved in garter snake relocation would be professional biologists with experience with proper handling and marking of snakes, or–for trained, but less experienced biologists–work under the direct supervision of professionals.
- Handling of garter snakes for relocations would be kept to the minimum time necessary for effectively completing each relocation action.

Water Quality

- Equipment and materials would be stored at least 100 ft (30 m) from open water to reduce the likelihood of debris or sediment entering surface water.
- Secondary containment for hazardous materials (e.g. piscicide or white gas) would be incorporated by placing buckets containing a small amount of soil (to minimize splashing of possible spills) under transfers of materials from one container to another. If hazardous materials were nevertheless spilled, they would be cleaned up immediately and would not be allowed to seep deep into the soil or reach open water sources. Absorbent pads would be onsite to absorb pooled hazardous materials. Shovels and bags would be onsite to gather surface soil in the spill area, which would be transported to the frontcountry for remediation.
- Work crews would use appropriate methods for human waste treatment, which is typically a pit toilet, or special containers for removal to the frontcountry.

Soundscapes

- To minimize visitors' exposure to unnatural sounds, project work would typically occur from 8:00 a.m. to 5:30 p.m.
- Crew leaders would ensure that the crew's noise levels do not disturb nearby campers.

- Information may be attached to wilderness permits to advise wilderness users about the need for management action and locations of work activities during their visit to the SEKI wilderness.

Cultural Resources

- Should any unknown cultural resources be encountered during implementation of plan activities, all ground disturbance will be immediately stopped. The parks' archeologist or a qualified representative will examine the area as soon as possible and will follow the requirements of the *National Historic Preservation Act,* and any other applicable cultural resource laws, as needed.

Visitor and Crew Safety

- Crews would be instructed in backcountry safety issues and wilderness communication protocols at the beginning of each field season; they would be provided with radios, and have an established, regular call-in time.
- Crews would abide by the RMS Safety Plan.
- Visitor use could occur in the restoration areas. Any visitors in active restoration areas would be met by a crewmember and kept a safe distance from restoration activities.

The mitigations for specific types of treatment options are described below. These mitigations will be implemented based on the methods selected in the final plan.

Gill Netting (for applicable alternatives)

- While gill-netting, crewmembers wear waterproof chest waders, safety waist belts, personal floatation devices (PFDs), and flip fins to remain warm and dry while using float tubes.
- Crewmembers would be trained to always scan nets for non-target wildlife when walking along shorelines to allow for a captured animal to be detected and released before mortality has occurred.
- Crew members without direct experience with handling non-target wildlife would receive training from an experienced biologist in how to safely remove non-target wildlife from nets.
- The shore ends of nets would be set 3 to 10 ft from shore to provide a buffer for non-target animals to access shoreline habitat. Areas observed to periodically contain many tadpoles and frogs would generally be avoided when placing gill nets.

Electrofishing (for applicable alternatives)

- Crewmembers wear waterproof chest waders and gloves that do not conduct electricity.
- Crewmembers wear wading boots with felt-lined soles that provide improved stability.
- Felt-soled boots used for project work would only be used at project sites. Boots would remain at each project site for the summer, and would be transported out of the project area for the winter, where they would be decontaminated before their next use. This process would eliminate the potential to sustain or transport undesirable nonnative species.
- The output from electrofishers is engineered to specifically target fish so few non-target species would be affected by electrofishing. Nevertheless, during electrofishing crews continually scan the area in front of their progress for non-target wildlife including mountain yellow-legged frogs. If a non-target species is observed, the electrofisher is turned off until the animal leaves the water or the shocking area. If necessary, crews capture and move the animal downstream or to adjacent terrestrial habitat and then proceed with electrofishing.

Disruption of Redds (for applicable alternatives)

- Crewmembers wear wading boots with felt-lined soles that provide improved stability.

Fish Traps (for applicable alternatives)

- While installing and monitoring fish traps, crewmembers wear wading boots with felt-lined soles that provide improved stability, and gloves to protect their hands while working with the traps.

Blasting of Rock to Create Vertical Fish Barriers (for applicable alternatives)

- The NPS would complete site-specific plans for each proposed blasting location, consulting with the SEKI hydrologist for final review. The areas would be surveyed for natural and cultural resources and all applicable state and federal permits would be obtained prior to any stream modification. This surveying and permitting would be completed on a case-by-case basis before blasting activities begin.
- Parks staff involved in blasting activities would wear appropriate PPE (eye, ear and hand protection) and perform their working according to SEKI's blasting procedures. Charges are activated using detonation cord, allowing staff to position themselves safely away from the blast area.

Piscicide Use (for applicable alternatives)

- In piscicide treatment areas with extant amphibian populations (MYLFs, Yosemite toad, Pacific treefrog), mitigations include capturing as many individuals as possible by hand, dipnet, and/or seine and moving them to adjacent untreated fishless waterbodies before piscicide treatments are conducted and while piscicide concentrations dissipate. Most, but not all, of the amphibians in the treatment areas are expected to be captured and moved out of treatment areas.
- If adequate fishless habitat is not present at the head of streams to provide upstream source populations of invertebrates for repopulating treated areas, then a section of stream would be physically treated to remove fish and create an upstream source population. A temporary fish barrier would be installed if needed to protect a source population from fish recolonization until fish are eradicated with piscicides.
- Experienced piscicide applicators would be directly involved in piscicide treatments in SEKI, and all treatments would be managed by applicators certified by CDPR to apply piscicides in state waters. Though not a requirement for federal land managers, this certification would ensure applications are correct and best management practices are applied during treatment activities. All of the restoration crew working with piscicides would be trained in proper use of personal protective equipment, product safety measures, and they would operate under the direction of the certified applicator(s) and in accordance with project safety plans or job hazard analysis.
- Application of rotenone would be carried out in a manner that strictly adheres to practices permitted by the product labeling, including use of personal protective equipment (PPE) for applicators, controlling public access during application, determining the maximum necessary application concentrations, and all other applicable guidelines.
- Rotenone drip stations would be placed in secure and stable locations either on the stream bank or on a stand in the stream channel, and are actively monitored by project staff for the duration of the treatment. The drip nozzles of the stations would be placed very close to the water's surface to reduce the potential for piscicide drift to terrestrial environments. Rotenone applied from backpack sprayers is applied with the spray head very close to the water surface to minimize drift onto terrestrial environments.
- Fish would be collected prior to the treatment process from the project area and placed in net baskets just downstream of drip stations to monitor the effectiveness of the piscicide treatment.
- Rotenone would be neutralized by the careful addition of potassium permanganate to the water at established locations. Fish baskets would also be placed downstream of the neutralization station. Mortality of these fish would alert workers to potential releases of excess chemical in the event of human or equipment error and potential downstream effects.
- Treated fish that do not sink would be removed from treated habitat to reduce short-term nutrient-loading, and scattered or buried in nearby terrestrial areas away from trails and campsites.
- During and after rotenone treatments, water quality would be monitored to assess the effects of treatment on surface waters and bottom sediments. The monitoring would determine that: 1) effective piscicide concentrations of rotenone are applied; 2) sufficient degradation of rotenone has occurred prior to the resumption of public contact; and 3) rotenone toxicity does not occur outside the project area. An analytical laboratory would analyze water samples for

rotenone concentrations as well as for volatile organic compound and semi-volatile organic compound concentrations.

- The parks would also develop and implement a spill contingency plan that addresses chemical transport and use guidelines, as well as spill prevention and containment that adequately protects water quality. The spill contingency plan would be maintained on site.
- Piscicide containers would be securely locked or guarded when taken to the field for use.
- Any piscicide that is spilled would be scooped up (including top layer of soil) with a shovel, placed in a bag designed for product disposal, and transported out of area for disposal as required on the product label.
- Piscicide applications would be communicated to the public using 1) temporary information and warning signs posted on trails near the treatment area, 2) staff stationed on nearby trails, 3) visits to nearby campsites, 4) verbal contacts by the nearest wilderness rangers, 4) staff at local wilderness permit stations, 5) temporary postings to the parks website and 6) information attached to wilderness permits. Any area closures would be included in the annual updates to the Superintendent's compendium.
- Most of the piscicide applications would occur in areas that generally have little visitation. Nevertheless, prior to applications and throughout treatments, public access would be restricted through the use of signs located at trailheads and other strategic places.
- All personnel assisting in the fish removal would use hardened or durable sites for camping and would be familiar with and practice Leave-No-Trace (LNT) principles. A crew of 8 to 15 people is expected to be sufficient to implement most treatments, and a crew of 16 to 25 people may be needed for one or more of the largest piscicide treatments.
- Trails would be used whenever possible to move from one location to another to minimize soil and vegetation disturbance and to prevent establishing new trails. Sensitive plant habitat will be avoided. Treatment activities would be coordinated with wilderness management personnel.
- To incorporate the results of actual piscicide treatments in SEKI to future treatments, we would implement an adaptive management approach, in which intensive monitoring of the initial piscicide treatments is used to better describe the likely impacts of subsequent treatments, and if necessary, to redesign subsequent treatments to further minimize anticipated impacts.

ALTERNATIVES CONSIDERED BUT DISMISSED

<u>"No Action" – No Restoration Program</u>

Under a strictly defined "No Action" alternative, there would be no activities in the wilderness related to the aquatic ecosystem restoration program. All current activities would be halted. There would be no management of the high elevation aquatic ecosystems and no fish removal activities. The reason that this alternative was ruled out was due to the unacceptable adverse impacts to the natural quality of wilderness character. Natural conditions would remain altered by the presence of nonnative fish in 550 nonnative fish-containing lakes, ponds, and marshes, and approximately 31 mi of streams throughout the SEKI wilderness. Many studies conducted in SEKI and elsewhere in the Sierra Nevada have researched the effects that nonnative trout have on native species and ecosystems. These studies consistently document that the widespread introduction and continued presence of nonnative trout has caused substantial impacts to native species and ecosystems. Because nonnative trout are efficient predators and competitors, their introduction results in modifications to native food webs; they prey on large organisms such as amphibians and large-bodied aquatic insects and zooplankton, and altering, depleting or eliminating populations of these animals from naturally fishless habitats. This results in less food being available to native aquatic and terrestrial predators, altering their distribution and abundance in turn. Thus, the presence of nonnative trout has negative, cascading effects on entire ecosystems, and their presence in individual lakes, connecting streams and entire lake basins in SEKI continues to cause negative impacts to native species and ecosystem processes. These impacts are replicated on a landscape scale across much of the parks' high elevations.

It is likely, without any action towards restoration, that the MYLF would be extirpated from the SEKI wilderness, creating a long-term adverse effect on the natural quality of wilderness. Not only have these species been detrimentally affected by nonnative trout, but the amphibian chytrid fungus

(*Batrachochytrium dendrobatidis*) has been discovered in these parks. The fungus causes a highly infectious disease--chytridiomycosis--in many amphibian species. Studies indicate it recently spread into the Sierra Nevada (Rachowicz et al. 2005, Morgan et al. 2007; Vredenburg et al. 2010) and has infected nearly all remaining MYLF populations including those in SEKI and Yosemite National Park (YOSE). Most MYLF populations have severely declined within a few years after becoming infected and many populations have been extirpated. Chytrid fungus has thus been a major factor in accelerating the decline of MYLFs caused by nonnative fish throughout the Sierra Nevada. As a result, in 2014, the FWS listed the two Sierra Nevada populations of MYLFs as endangered species under the ESA (FWS 2014A). Without recovery and restoration actions, two native species would be permanently removed from the SEKI wilderness.

Fish Eradication Using Biological Treatments

An alternative to eradicate nonnative fish using tiger muskies was considered. The tiger muskie is a sterile hybrid-cross between a muskellunge and a northern pike. They have been effective at restructuring size classes of nonnative brook trout from mountain lakes in Idaho. However, they have been generally ineffective at completely eradicating unwanted fish species (IDFG 2010). Further, in a detailed analysis of 250 fish control projects, Meronek et al. (1996) found that stocking certain species of fish to control unwanted fish was the least successful method of fish removal compared to chemical, physical and reservoir drawdowns. Conceptually this technique had potential to be a cost-effective means of eradicating nonnative fish. However, in accordance with NPS Management Policies 2006, new exotic species will not be introduced into parks. In rare situations, an exotic species may be introduced or maintained to meet specific, identified management needs when all feasible and prudent measures to minimize the risk of harm have been taken (Section 4.4.4.1). The state of California also does not support any type of pike introduction. Once the nonnative fish have been eradicated, amphibians and large invertebrates would not be able to return until the predatory tiger muskies were gone. Although tiger muskies might starve after fish have been eradicated, they also might find sufficient natural food to persist. This alternative therefore has the potential to replace one problem (existing nonnative trout) with another (nonnative tiger muskies) and would be out of compliance with NPS Management Policies 2006.

The use of tiger trout, a sterile hybrid-cross between brown trout and brook trout, was also considered for nonnative fish eradication. It was dismissed for the same reasons as above for tiger muskies. For these reasons, biological treatments were dismissed from further consideration.

Frog Restoration Using Only Captive Rearing and Reintroduction

Implementing a MYLF captive rearing program for reintroduction into the wild is being considered as a restoration tool to supplement nonnative fish eradication and natural recolonization. However, this program would not be successful if nonnative fish are not removed prior to reintroductions. Frog restoration using only reintroductions would not address the issues with fragmented populations and the availability of high quality fish-free habitat. Studies have shown that nonnative trout prey on MYLFs (Vredenburg 2004) and suppress MYLF populations (Knapp et al. 2007). Reintroductions are also challenging, even in fish-free waterbodies, and most reintroductions have been unsuccessful in the past. Out of approximately nine recent MYLF reintroductions in SEKI and YOSE (NPS unpublished data), only three have established breeding populations (1 in SEKI, 2 in YOSE). It will take several years to determine if these populations persist or die out. The causes for the low success rate for MYLF reintroductions are not currently known. However, reintroductions have worked in many locations (e.g., Chandler et al. 2015), and may prove to be a vital conservation tool. More research on reintroductions is needed, and studies are currently underway to learn how to conduct reintroductions more successfully. Frog restoration using reintroductions alone was rejected from further consideration because it would not address the presence of self-sustaining populations of nonnative fish and therefore would not meet the plan's objectives of restoring native species diversity and ecological function of selected high elevation aquatic systems and the natural quality of wilderness.

Fish Eradication Using Only Non 4(c) Actions – Angling or Covering Redds

An alternative to eradicate nonnative fish using only angling (by NPS staff and the public) or by covering redds was considered. Removing fish by angling alone is not a proven way to completely

eradicate fish from a waterbody, except possibly at sites where limited fish reproduction occurs within the lake or pond, and no fish reproduction occurs in adjacent streams. In the few locations where this situation exists, every single fish must eventually be attracted to some form of bait, lure or artificial fly, and then successfully caught and landed to shore by anglers. If all of the above criteria are satisfied, it would still take many years of sustained angling to remove all fish. In addition, not all of SEKI's fish containing waters are being proposed for nonnative fish eradication, and thus site restrictions would need to be developed to ensure proposed waters were eradicated but other fish populations were not impacted. The management issues associated with recruiting, training and supervising multiple public anglers, all summer long for many years in a row, dispersed in designated wilderness, fishing only at approved waters, minimizing habitat damage, and protecting health and safety would be overwhelming. Finally, very few of the waters proposed for fish eradication meet all of the rare circumstances necessary for success, and thus restoration at the park scale would not be achievable using this alternative.

Covering or destroying redds is problematic to eradicate nonnative fish. Where redds are visible, destroying them would be possible. They can be broken apart and covered in lakes and streams. However, redds are not always visible. They can be deep in lakes or not clearly visible in streams. Locating redds for fish that spawn in the fall (brook trout) is particularly problematic because it would require crews to be in the high country from October to December (snow season), which would add significant health and safety issues for field crews. Furthermore, brook trout can spawn in marginal habitat that other trout (such as rainbow-golden hybrids) cannot, making their redds even more difficult to eliminate. Any redds that were missed would perpetuate the population.

Fish Eradication using only Gillnets

It is possible to eradicate fish from certain waters using only gill nets, but only if 1) there are no inlet or outlet streams attached to the water or 2) all attached streams are either inaccessible to fish or completely dry each summer. All of the proposed fish eradication basins, however, have waters with attached streams that would prevent successful eradication using only gill nets. Gill nets do not work well in streams since they rapidly collect floating debris or snag on submerged rocks or branches. It is not possible to eradicate fish from streams using only gill nets. At best, gill nets can be used for short periods in calm stream sections such as large pools. In addition, the presence of stream habitat within restoration areas is critical for restoring healthy MYLF populations because these species need streams to migrate between breeding, feeding and over-wintering waters. Limiting restoration to sites where fish can be eradicated using only gill nets would create restored "islands" that are isolated from one another. The waters feasible for this option are too scarce and isolated to facilitate effective restoration at the park scale.

Fish Eradication by Temporarily Drying Stream Segments or Small Waters

Theoretically, this method would be an effective way to eradicate fish from smaller portions of habitat and destroy any redds. However, drying of streams would only have the potential to eradicate fish from the affected stream habitats, and it would allow fish to remain in adjacent lakes. Logistically, it would be extremely difficult to channel all of the water from one natural fish barrier to a point below the next downstream barrier, or to siphon all of the water out of a lake or pond faster than it could be replaced by water flowing from upstream areas. Partial drying of very small waterbodies may facilitate fish eradication using gill nets, but it is unlikely to eradicate fish by itself. Drying of anything larger than small waterbodies is not feasible, and all of the fish eradication basins in consideration include larger waterbodies. In addition, a break in the piping would be a disaster as huge quantities of water would flow over and erode upland areas. It would require potentially large temporary structures built in streams to divert the water and numerous equipment and personnel to move the pipe or conduit. Additionally, this method would unnecessarily eliminate (at least temporarily) fauna that are resistant to rotenone. This alternative could have extensive environmental impacts and be extremely impractical to implement. This option would not meet the wilderness management requirement of causing the least amount of impact to the physical resources and experiential qualities (character) of wilderness or using the least intrusive tools. Therefore, it has been dismissed from further consideration.

Fish Eradication Using the Piscicide Antimycin A

There is another piscicide (antimycin A) that has been used to eradicate fish in national parks and other lands outside of California. However, antimycin A is not registered for use in California. NPS management decisions attempt to adhere to state regulations when a feasible option (rotenone) exists. In addition, antimycin A currently is not being manufactured and thus is not available for purchase. Therefore, this alternative has been dismissed from further consideration at this time. If antimycin A or any other piscicide becomes available for use in California, NPS staff would assess the appropriateness of its use in SEKI to accomplish the purpose and goals of this plan. This assessment would include opportunities for public review and involvement, and would comply with existing laws, policies, and plans.

Complete Eradication of Nonnative Fish (restoring the Natural) from All High Elevation Waters in Wilderness

Complete eradication of nonnative fish populations from all high elevation waters in SEKI is neither practical nor feasible to be considered in this Restoration Plan/FEIS. At this time it is known that nonnative fish are present in approximately 550 lakes and ponds in SEKI that are candidates for eradication, and there may be additional populations in unmapped ponds and large stream pools that are far from all previously surveyed waters. In addition, there are many hundreds of miles of stream in which nonnative fish are present, ranging from the high elevation basins downstream to the low elevation unglaciated areas where native fish are also present. It is extremely unlikely that nonnative fish populations could be successfully eradicated from such an extensive and remote amount of habitat. If it was possible, it would be extremely difficult and expensive, and likely would take 50 to 100 years or more to complete, which is outside the duration of most or all plans under NEPA. Finally, complete eradication of nonnative fish from all high elevation waters would eliminate all high elevation angling opportunities in SEKI, which is not the intention of this restoration plan. Therefore, this alternative has been dismissed from further consideration.

Treating MYLF for Amphibian Chytrid Fungus without Fish Removal

The FWS, NPS, USFS, and the CDFW are currently collaborating on the development of a conservation strategy for the Sierra Nevada yellow-legged frog (*R. sierrae*) and the northern distinct population segment of the mountain yellow-legged frog (*R. muscosa*). The goal of the Conservation Strategy is to "Ensure self-sustaining long-term viability and evolution of mountain yellow-legged frog populations in perpetuity that represent their historic geographical range, and genetic and ecological diversity." The multi-agency team developing the strategy has concluded that eradicating introduced fish and developing methods for successful translocations are the primary tools available for recovering the species. To survive, MYLFs must be protected in fishless habitats with long-term viability (i.e., interconnected habitats, including larger, deeper waterbodies that are necessary for successful overwintering and more resistant to climate change). While treatment for amphibian chytrid fungus is being explored, the methods and techniques have only begun to be field tested, and there is no evidence that the methods would be successful in restoring frog populations in the long-term without accompanying actions, including habitat restoration and translocations/reintroductions. Moreover, this alternative would not result in the removal of nonnative fish from targeted areas and therefore would not meet the plan's objectives of restoring native species diversity and ecological function of selected high elevation aquatic systems and the natural quality of wilderness.

Addressing other Known Stressors to MYLF and their habitat

Stop Stock Use in MYLF Habitat: Riding stock and packstock use (including horses, mules, burros, and llamas) is permitted in SEKI wilderness. An extensive amount of long-term and ongoing monitoring data has been collected for MYLF populations in SEKI and YOSE, which has made it possible to quantify impacts from stock use. The vast majority of populations in SEKI and YOSE have received no to negligible impacts from stock use. In populations where impacts were detected (Sixty Lake Basin in SEKI), stock use is prohibited. In populations where impacts had reasonable potential to occur (upper LeConte Canyon in SEKI and Kerrick Meadow in YOSE), stock use is regulated to prevent such impacts. In addition, stock are adaptively managed in all areas of SEKI and YOSE, with many areas closed to stock entirely or limited to day use due to inadequate trail access and/or to protect sensitive habitat. Numerous studies have documented that the two primary stressors to MYLF are nonnative fish (Bradford et al. 1993, Knapp and Matthews 2000, Vredenburg 2004, Finlay and Vredenburg 2007, FWS 2014A)

and amphibian chytrid fungus (Rachowicz et al. 2006, Vredenburg et al. 2010A, FWS 2014A). Without removing nonnative fish from MYLF habitat, and implementing the restoration MYLF program, solely closing areas to stock use would not result in the restoration of MYLF or high elevation aquatic ecosystems.

Halt recreational activities in MYLF habitat: Reducing recreational activities in MYLF habitat would not meet the plan's objectives of restoring native species diversity or MYLF populations. As discussed above, nonnative trout and disease pose the highest risk to the conservation of the MYLF in SEKI. Second, recreational use, such as hiking and backpacking, is a negligible risk factor for MYLF conservation (FWS 2014A). While recreational activities occur adjacent to many populations, there is evidence that the risk to nearly all proposed critical habitat in SEKI is slight to none. For example, in SEKI, a high-use trail allows hikers annually numbering in the thousands to come into close contact with several MYLF populations, whose habitat is immediately adjacent to the trail. Repeated surveys show that these populations have grown substantially over the last decade (Knapp R., unpublished data), indicating that hiking/backpacking is typically not a risk factor for critical habitat in SEKI.

Halt Livestock Grazing and Timber Harvest in MYLF Habitat: Neither is a permitted use in SEKI thus there would be no effect from this action.

<u>No use of Helicopters for Transport of Equipment</u>
The NPS considered not allowing the use of helicopters for project work, and using stock and humans to transport all equipment to the project site, or to a drop off point near the project site. There would likely be delays in project work. Project work would be limited to areas where snowmelt has occurred and conditions allow for stock transport, or project work would be delayed until access is safe and conditions allow for stock use. In addition – as much of the equipment is heavy, large, and/or fragile – it would be difficult and sometimes infeasible for humans to transport it by carrying it from stock drop-off points to project sites. There are safety concerns which would rule it out this option. Without the use of helicopters, it would be challenging and potentially dangerous for stock and/or crew members to carry heavy, bulky, and sometimes heavy liquid containers over steep rough terrain. Many of the project sites are in areas without trails and in high elevation environs where access is challenging. Therefore, some of the project work would not be possible, and the overall goals of this project would not be accomplished.

<u>Using Drought Conditions to Facilitate the Exclusive Use of Physical Fish Removal Methods</u>
A comment was received during public review of the Restoration Plan/DEIS suggesting we use the 2012-2015 drought conditions to facilitate the exclusive use of physical fish removal methods. Episodic events such as droughts or low water years could potentially, temporarily, make physical methods somewhat more feasible for fish eradication. However, predicting, planning, and relying on such events is not a viable alternative for completing fish eradications and recovering MYLFs in SEKI. It is not feasible or prudent to design a long-term restoration plan that is dependent on a particular weather pattern to be successful. Based on previous successful physical restoration work, physical methods can take between 3 and 10 years, depending on the site. In order for this method to be successful, SEKI would have to 1) wait for at least three years of drought and hope that aquatic habitats would shrink enough to allow for eradication using physical methods; and 2) be ready with a crew to start that site in the first year of the drought. It is not feasible from a management perspective to schedule crews in this way because once restoration at a site begins, it needs to be consistently worked until eradication is achieved, and before moving to a new site. In addition, even if crews were available to start a new site in a drought year, there is no way to predict that the subsequent years would also bring the drought conditions needed for eradication using physical methods. The current 2015-2016 winter was wetter than the recent drought years – near the long-term average for precipitation in the southern Sierra Nevada. This demonstrates how highly variable weather cannot be relied upon to underpin a particular implementation strategy. Using drought conditions to facilitate extensive use of physical fish removal methods is not a feasible alternative.

The current 2015-2016 winter was wetter than the recent drought years - near the long-term average for precipitation in the southern Sierra Nevada. This demonstrates how highly variable weather cannot be relied upon to underpin a particular implementation strategy. Using drought conditions to facilitate the exclusive use of physical fish removal methods is not a feasible alternative.

Comparison of Alternatives

It may be useful to compare each alternative's positive and negative impacts to each of the criteria in tabular form, keeping in mind the law's mandate to "preserve wilderness character." Rate each alternative on a scale of +3 to -3 with +3 being 'high positive impact' and -3 being 'high negative impact' and 0 being 'no impact' or 'undeterminable.'

This table is used for comparison purposes only. It serves to provide a summary of the effects of the alternatives when looking at the combined actions and how these actions would effect the different qualities of wilderness character. A more detailed description of the effects of the alternatives to each quality of wilderness character is found in the previous section.

-3	**-2**	**-1**	**0**	**1**	**2**	**3**
High Negative Impact	Moderate Negative Impact	Low Negative Impact	No Impact/ Undeterminable	Low Positive Impact	Moderate Positive Impact	High Positive Impact

WILDERNESS CHARACTER	short-term	long-term	short-term	long-term	short-term	long-term	short-term	long-term
	Alt. 1	Alt. 1	Alt. 2	Alt. 2	Alt. 3	Alt. 3	Alt. 4	Alt. 4
Untrammeled								
Physical Methods	-2	0	-2	-2	-2	-2	0	0
Piscicide Use	0	0	-3	-3	0	0	-3	-3
Translocations	-1	0	-1	-1	-1	-1	-1	-1
Stream Barriers	0	0	-1	0	-3	-3	-1	0
Undeveloped								
Installations	-1	0	-1	-1	-1	-1	-1	-1
Helicopter Use	-2	0	-2	-2	-2	-2	-2	-2
Natural								
Effects on Native Species	+1	-3	-3	+/-3	-2	+/-2	-3	+/-3
Ability to Accomplish Restoration of Native Ecosystem	0	-3	+3	+3	+1	+1	+3	+3
Solitude or Primitive and Unconfined Recreation								
Effects on Solitude	0	0	-1	-1	0	0	-1	-1
Effects on Primitive and Unconfined Recreation – Fishing Opps.	0	0	-1	-1	-1	-1	-1	-1
Effects on Primitive and	0	0	-1	0	0	0	-1	0

Unconfined Recreation – Area Closures								
Effects on Primitive and Unconfined Recreation – Restoring Opps. to view Native Ecosystems	-1	-2	+1	+3	+1	+2	+1	+3
Other Features of Value	0	0	0	0	0	0	0	0
TOTAL	**-6**	**-8**	**-12**	**-5**	**-10**	**-7**	**-9**	**-3**

SAFETY	short-term	long-term	short-term	long-term	short-term	long-term	short-term	long-term
	Alt. 1	Alt. 1	Alt. 2	Alt. 2	Alt. 3	Alt. 3	Alt. 4	Alt. 4

Safety Criterion
Occasionally, safety concerns can dictate choosing one alternative which degrades wilderness character (or other criteria) more than an otherwise preferable alternative. In that case, describe the positive and negative impacts in terms of risks to the public and workers for each alternative, but avoid pre-selecting an alternative based on the safety criteria in this section.

Documentation of Safety Concerns
To support the evaluation of alternatives, provide an analysis, reference, or documentation and avoid assumptions about risks and the potential for accidents. This documentation can take the form of agency accident-rate data tracking occurrences and severity; a project-specific job hazard analysis; research literature; or other specific agency guidelines.

The current program (Alternative A) uses a helicopter to transport heavy, fragile, or large equipment that cannot be safely carried by stock and/or crew members. This has proven to be necessary to support the operations as otherwise, crew members would have to carry heavy equipment over rough primarily trail-less terrain from the stock drop-off points. In addition, alternatives that propose the use of piscicides would involve carrying liquid materials in large (30 to 55 gallon) containers – which pose additional risks and cannot be safely carried by crew members as they are heavy and awkward – consider carrying a 30 gallon jug across rough uneven terrain and rocky areas.

For these reasons, the alternatives that propose the transport of equipment and materials to project sites utilizing only stock and crew members have not been analyzed.

OTHER CRITERIA SUMMARY	short-term	long-term	short-term	long-term	short-term	long-term	short-term	long-term
	Alt. A	Alt. A	Alt. B	Alt. B	Alt. C	Alt. C	No Action	No Action
N/A								
TOTAL								

Step 2 Decision: What is the Minimum Activity?

Usually the alternative that results in the least overall adverse effect to the wilderness character will be the preferred alternative. However, there may be other considerations. If you do not select the alternative with the least overall adverse effect, provide the rationale below. Note: When selecting the preferred alternative the potential disruption of wilderness character and resources will be considered before, and given significantly more weight than, economic efficiency and convenience. If a compromise of wilderness character or resources is unavoidable, only those actions that preserve wilderness character and/or have localized, short-term acceptable adverse impacts will be allowed.

Selected Alternative: Alternative 2 – Using both Physical and Piscicides for Restoration of High Elevation Aquatic Ecosystems

Rationale for selecting this alternative (including safety criterion, if appropriate):

The no action alternative, though it has the least effect on the untrammeled and undeveloped qualities of wilderness character, has not been selected as it would not accomplish high elevation ecosystem restoration because of its limited scale and scope, and could lead to impairment of park resources if MYLFs are extirpated in the parks, and lead to an irreversible degradation of the natural quality of wilderness character.

The three action alternatives all have varying degrees of adverse effects on wilderness character. All result in long-term adverse effects on wilderness character from extensive trammeling. All result in short and long-term effects on the undeveloped quality of wilderness character from the use of mechanized equipment and motorized transport, and from installations such as gill nets, fish traps, and crew camps. All affect the natural quality to varying degrees, with piscicide use having the highest short and long-term adverse effects from treatment actions, but accomplishing restoration in a shorter period of time than the physical methods, thus reducing the trammeling actions overall and improving the natural quality of wilderness character in the long term.

Alternative 4, using solely piscicide to remove nonnative fish, was determined to be the least impacting on wilderness character, and would have faster results (a shorter time period to complete the projects, thus reduced trammeling actions than physical removals), however, the adverse effects on the natural quality of wilderness based on the effects on non-target species makes this alternative less appealing than alternative 2. In addition, past work has shown that piscicides are not needed in all locations and physical treatment can accomplish restoration, albeit in a longer time period (6-10 years per site using physical methods v. 1-3 years per site using piscicides).

Alternative 3, using solely physical methods, would not allow for the treatment of larger, deeper, and more complex systems, while alternative 2, using a combination of physical treatment and piscicides, would allow for the work to be accomplished in larger, deeper, and more complex systems, which is vital for the long-term survival of MYLF in changing climatic conditions.

Alternative 3 is also less appealing because it would include blasting stream barriers, which would be a permanent trammel and development in wilderness.

The long-term disruption of wilderness character (up to 35 years) to accomplish restoration efforts in high elevation ecosystems has been determined necessary to protect the wilderness character in the long term, particularly the natural quality of wilderness character. MYLF are facing extinction. Nonnative trout have been shown to be a major cause of their decline, with amphibian chytrid fungus outbreaks exponentially increasing their potential for demise. With the numerous mandates previously stated for the conservation and preservation of native species, and the mandate to protect the natural quality of wilderness character, the long-term trammeling actions are justified because the long-term ecosystem-

wide benefits that would result (thus improving the natural quality of wilderness character in the long-term) from implementing this alternative outweigh the disruption to wilderness character.

Therefore, in consideration of the above information, Alternative 2 is recommended as the preferred alternative.

Cumulative Effects:
Do you know of any other projects in the vicinity of your project location(s) (past, present, or future) that have the potential to impact wilderness character?

Yes: ☒ **No:** ☐

If yes, please describe.

Resource management, research and monitoring activities occur in the parks' wilderness areas. Examples of ongoing and future planned activities include wildlife monitoring, lake sampling, air quality monitoring, exotic plant removal, resource rehabilitation and revegetation, and snow surveys. Each activity is evaluated on a case-by-case basis through the minimum requirement analysis process. When external research projects are proposed, the proposed activity is evaluated through the NPS research permitting process which also requires a minimum requirement analysis. Equipment and tools used for these projects are chosen based on the minimum requirement / minimum tool analysis, and could include non-motorized and motorized tools.

Restoration actions and studies for the conservation of native species in high elevation ecosystems of the southern Sierra Nevada have taken place in recent decades, including but not limited to MYLFs, Little Kern golden trout, California golden trout, Kern River rainbow trout and Sierra Nevada bighorn sheep. Actions include nonnative fish eradication, intensive field studies, population monitoring, reestablishment of populations in historic habitat, establishment of populations in isolated habitat, and creation or current development of a recovery plan, conservation assessment and/or conservation strategy.

There are more than 800 miles (1,287 km) of trails located within designated or potential/proposed wilderness of the parks. There are approximately 15 trail bridges in wilderness within Kings Canyon and 22 trail bridges in Sequoia. Approximately 85% of the parks' trails receive some level of maintenance each year, when conditions allow. In the high elevations, most trail work occurs during the summer. Wilderness trail maintenance activities include: maintaining, repairing, and rebuilding damaged/deteriorated walls, trail tread, drainage structures, signs, and other structural elements; rebuilding and repairing trail bridges including decking, railings, approaches, abutments, and stringers; removing or blasting fallen trees and rocks and debris from the trail corridor; repairing sections where erosion and other landscape processes have compromised trail integrity; creating barriers to discourage trail shortcutting, trail widening, and use of social trails; and, restoring landscape damage from abandoned trail segments. Maintenance crews may also mitigate hazard trees in designated camp areas. Trail crews frequently use stock (horse and mule) support for delivering supplies and equipment. On occasion, when determined the minimum tool, helicopters are used to support trail maintenance activities. At any given time there could be up to ten trail crews within the wilderness, ranging from 1 to 3 crew members up to 20 crew members, during summer months.

Helicopter flights may be used for law enforcement, SAR operations and fire suppression activities. In addition, selective helicopter flights may be determined to meet the minimum requirements for administering the area as wilderness, and to be the minimum tool for selected project work within SEKI. The types of projects where helicopter use has been considered the minimum tool include snow surveys, trail maintenance (delivery of equipment, materials and supplies), restoration/rehabilitation activities, exotic plant removal, wildlife surveys, scientific investigations, mobilizing/demobilizing wilderness ranger stations and radio repeater maintenance. As the projects are analyzed on a case-by-case basis, helicopter operations vary by project and by year. Flights can occur at any time in the year, but they are generally scheduled to minimize conflicts with wilderness users.

Provide information on Wilderness Act Section 4(c) uses proposed in this alternative:

4(c) Prohibition	Frequency and/or Quantity	Duration
mechanical transport	There could be up to three flights per restoration site per year to mobilize and demobilize the project equipment. There could be up to six flights per treatment area for the translocation of frogs. Flights would occur at mobilization to deliver supplies, and at demobilization to remove supplies and materials from the project site.	Several hours per flight.
motorized equipment	Motorized pumps would be used periodically at piscicide treatment sites.	4 to 8 hours per day for 1 to 3 days per site
motor vehicles	N/A	N/A
motorboats	An electric motor would be used to periodically propel a raft at piscicide treatment sites that contain large lakes.	2 to 4 hours per day for 1 to 3 days per site.
landing of aircraft	There would be up 3-6 landings at each restoration site per year and 3-6 landings per year for frog translocations.	Short-term to load and off load supplies and equipment.
structure(s)/installation(s)	Each restoration crew camp site would have 1 to 2 food/equipment storage lockers (3 to 6 would be in the wilderness at any one time) Number and location of nets and fish traps will be reported at the end of each field season.	3 to 10 years per site depending on success of treatments
temporary road	N/A	N/A

Additional mitigation, monitoring and reporting requirements *(Reviewers provide input)*:

Follow-Up Form Required: **Yes:** ☒ **No:** ☐

Mitigation was included above. A yearly report will be completed and provided to the Wilderness Office that includes a detailed list of all 4(c) prohibited actions, including flight times/flight lines, landing locations and durations, number of food storage/equipment lockers and locations, number and locations of nets and fish traps, etc.

Prepared by:

Danny Boiano Name	Aquatic Ecologist Position	4/4/2013; 5/16/2016 Date

Review and Comments

Name/Position	Comments	Date
Wilderness Coordinator	Reviewed and commented. A. Steiner G. Fauth	5/2/2013 6/3/2013
Environmental Protection Specialist	Updated. N. Hendricks	4/18/2013; 2/12/2016 5/19/2016
Other reviewer as appropriate		

Approvals	Print Name	Signature	Date
Recommended:	Division Chief		
Approved:	Superintendent:		

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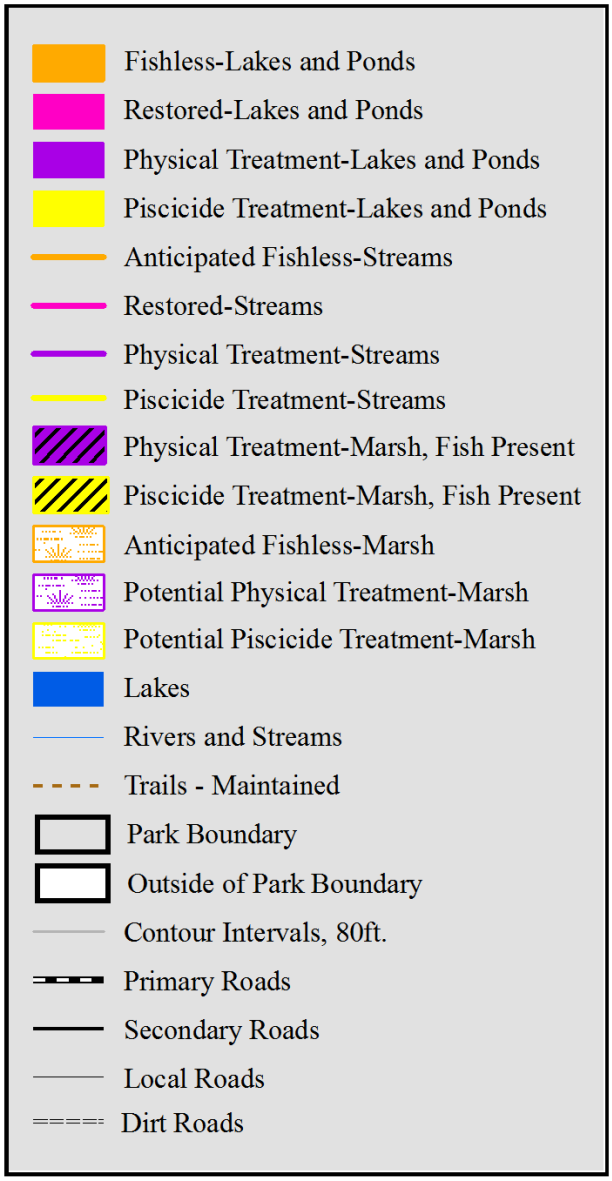
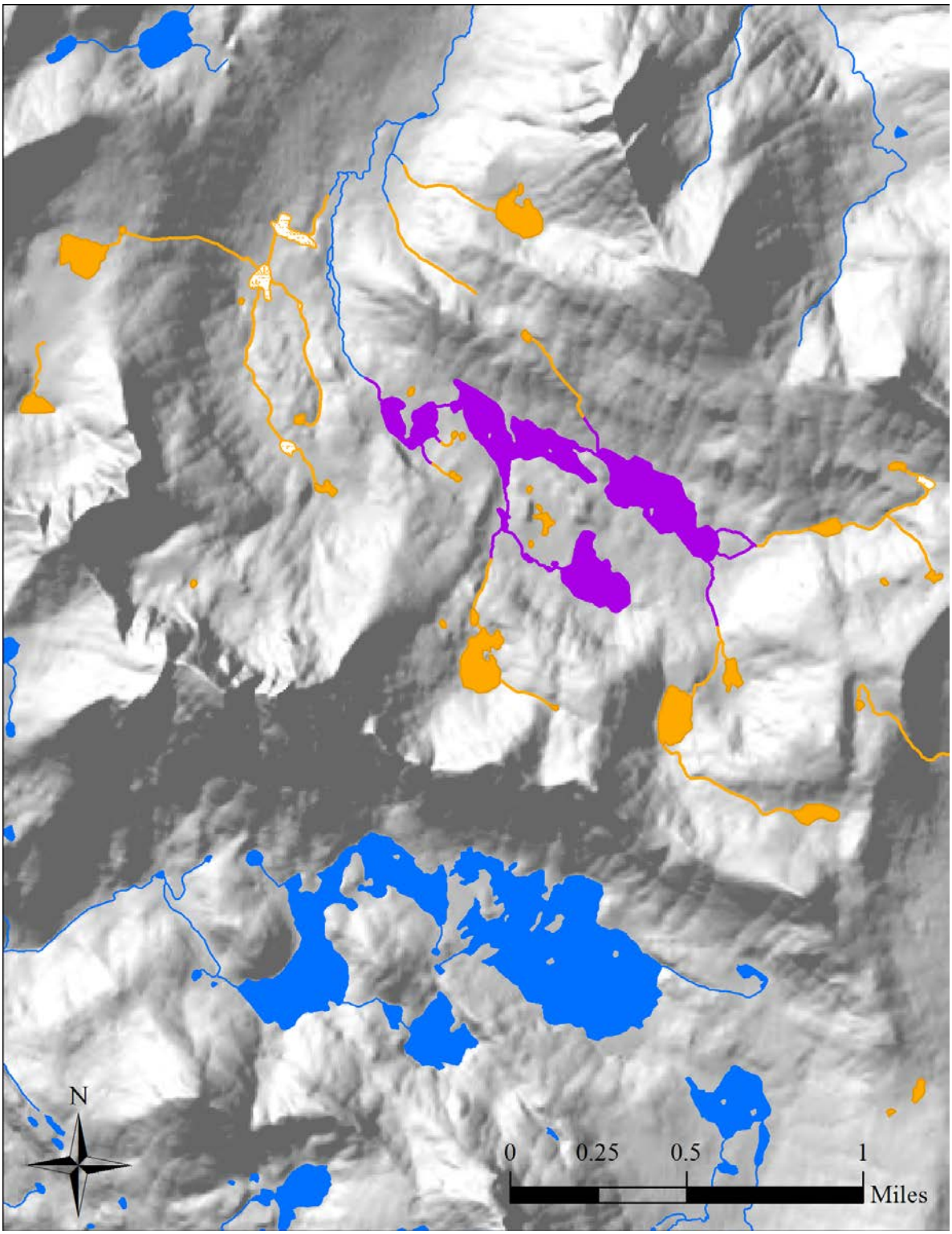
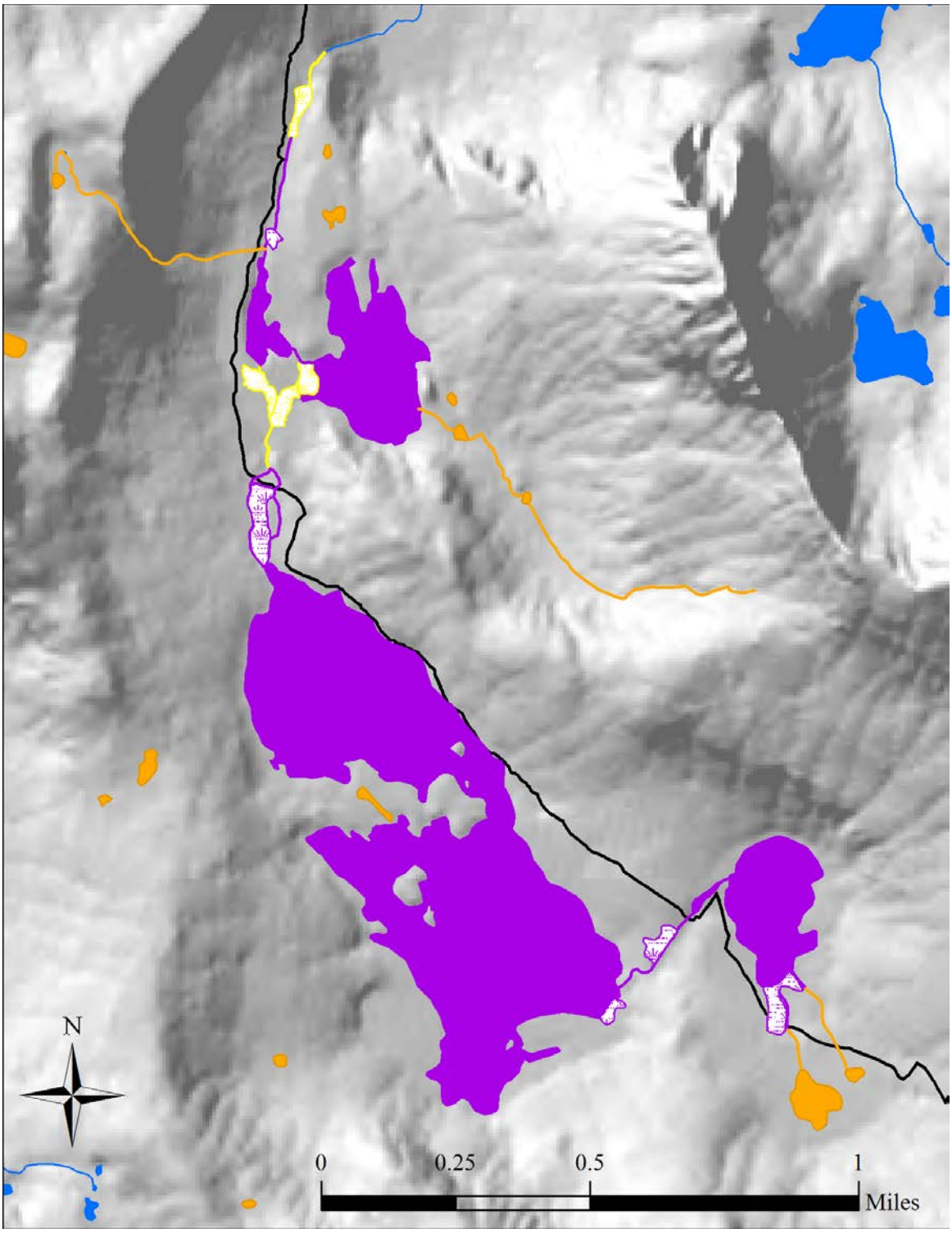
APPENDIX B: INDIVIDUAL FISH ERADICATION BASIN MAPS

This appendix provides a detailed map for each of the 21 treatment basins included in Alternative B, plus restored basins (fish eradication completed or in-progress). Three basins (Amphitheater, Sixty Lake, and Upper Bubbs) contain waterbodies with fish eradication in-progress and additional waterbodies proposed for fish eradication. Alternative B includes 85 waterbodies proposed for fish eradication, which is the maximum number of waterbodies that would be treated under any alternative in this plan. Each map shows the number and acreage of lakes and ponds, and miles of stream, that would be restored per treatment method in that particular basin. Treatment methods include: (1) Restored (fish eradication waters completed or in-progress using physical treatment); (2) Physical (proposed fish eradication waters using physical treatment); and (3) Piscicide (proposed fish eradication waters using piscicide treatment). Basin maps are ordered from north, starting in Kings Canyon National Park, to south, ending in Sequoia National Park. The legend below describes the symbology used on each map.

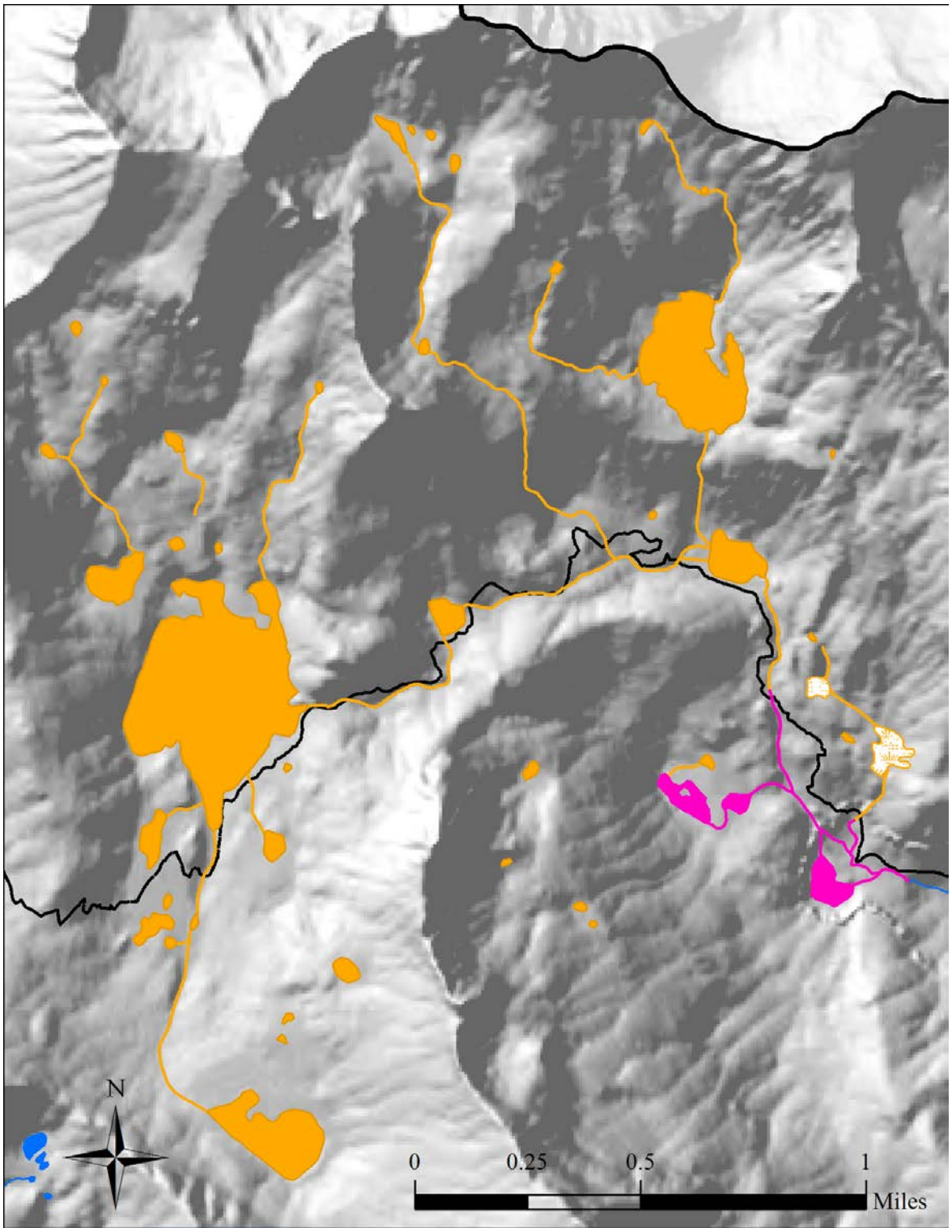




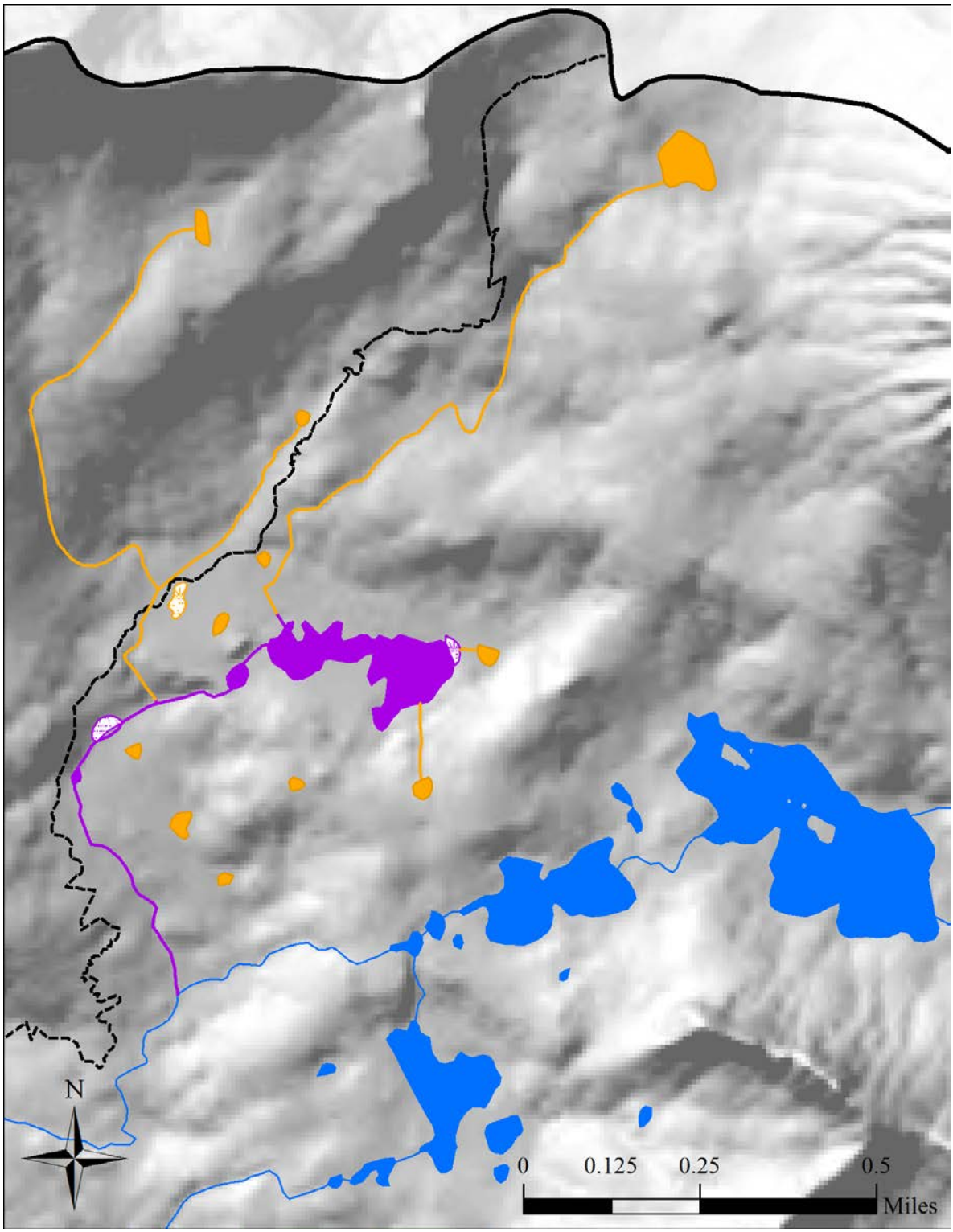
McGee					
Treatment	**# Lakes**	**(ac.)**	**# Ponds**	**(ac.)**	**Stream (mi.)**
physical	4	75.3	4	1.2	1.2
Total	**4**	**75.3**	**4**	**1.2**	**1.2**



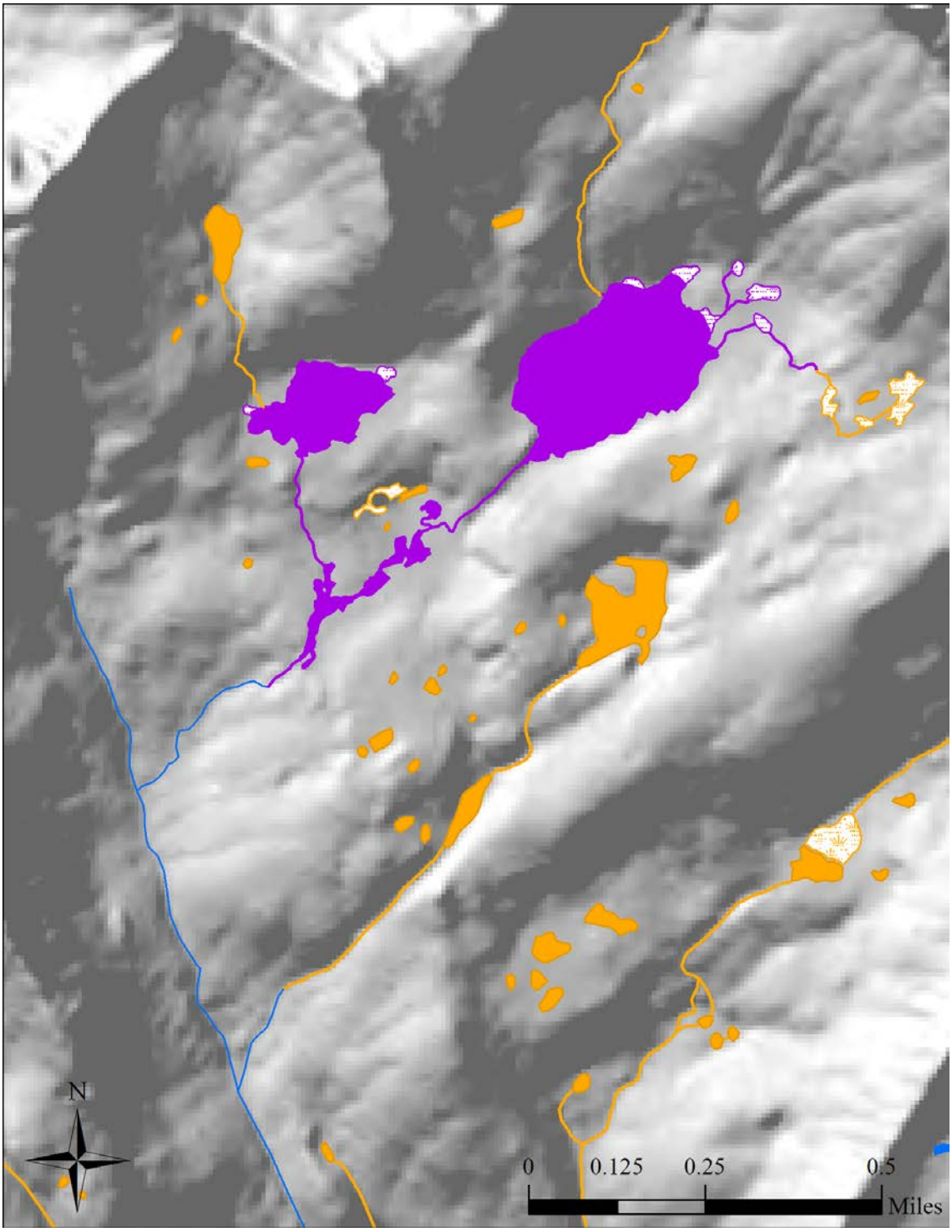
Upper Evolution					
Treatment	**# Lakes**	**(ac.)**	**# Ponds**	**(ac.)**	**Stream (mi.)**
physical	4	228.2	1	0.5	1.2
piscicide	0	0.0	0	0.0	0.5
Total	**4**	**228.2**	**1**	**0.5**	**1.7**



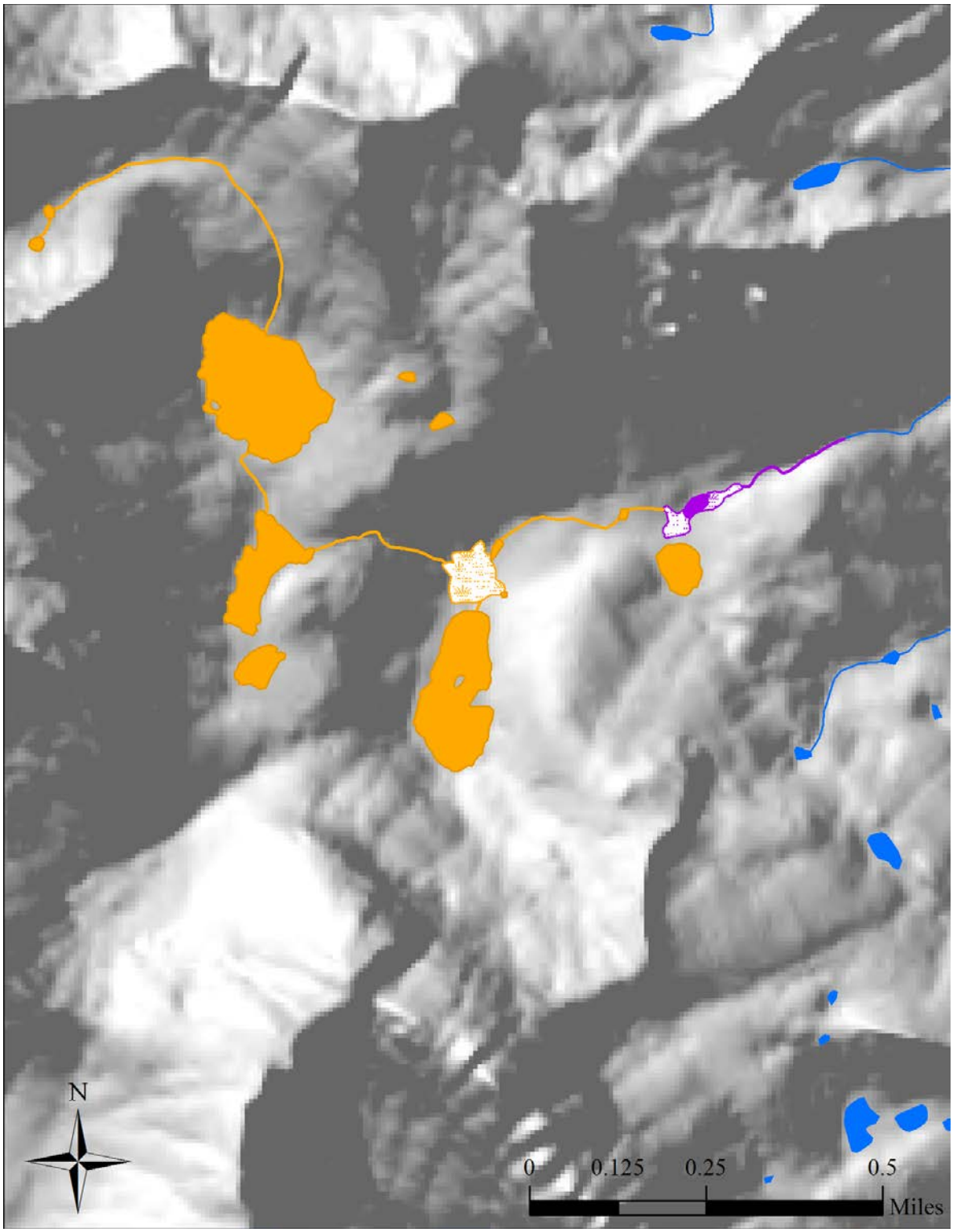
LeConte Canyon					
Treatment	**# Lakes**	**(ac.)**	**# Ponds**	**(ac.)**	**Stream (mi.)**
restored	2	7.3	1	1.3	1.0
Total	**2**	**7.3**	**1**	**1.3**	**1.0**



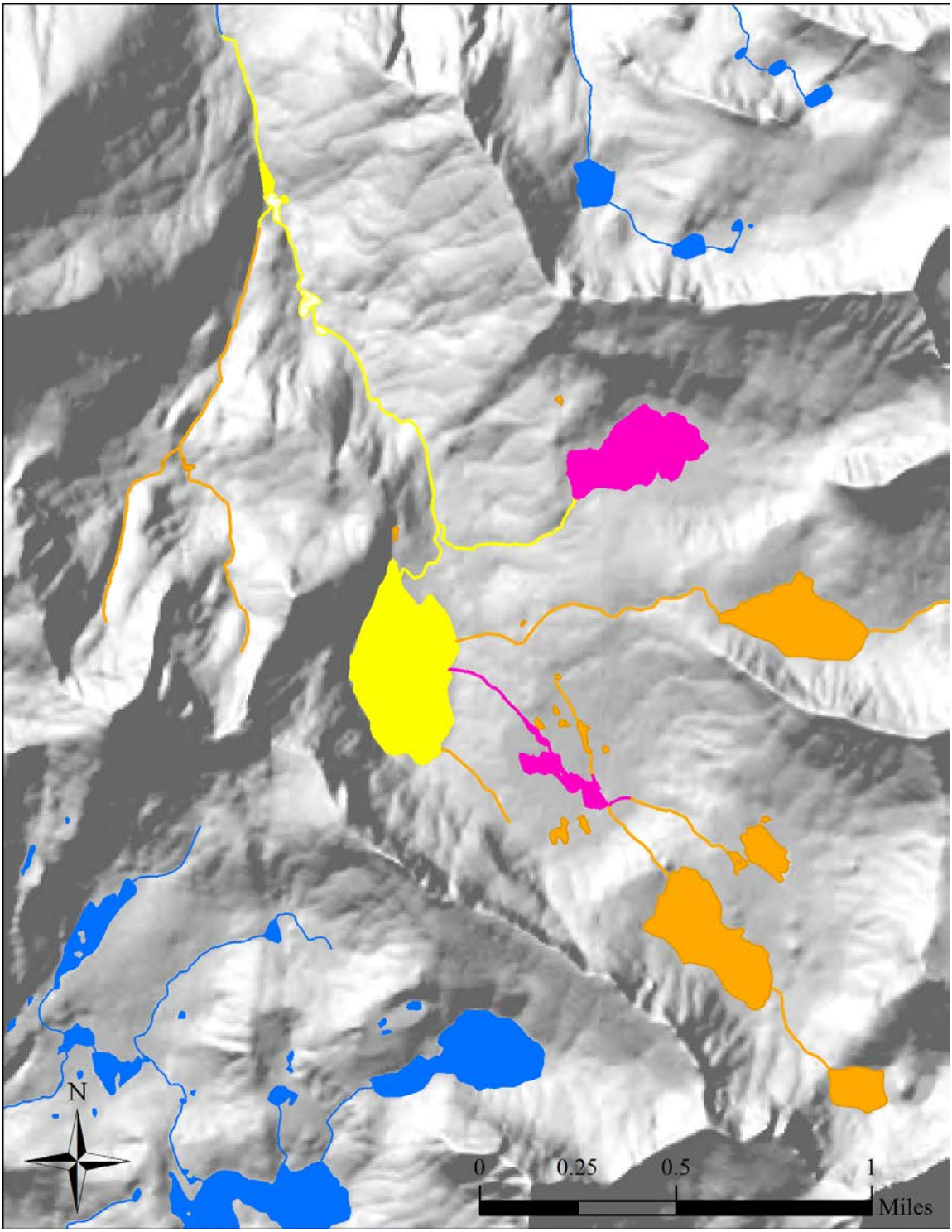
Dusy **Treatment**	**# Lakes**	**(ac.)**	**# Ponds**	**(ac.)**	**Stream (mi.)**
physical	1	10.6	2	0.6	0.7
Total	**1**	**10.6**	**2**	**0.6**	**0.7**



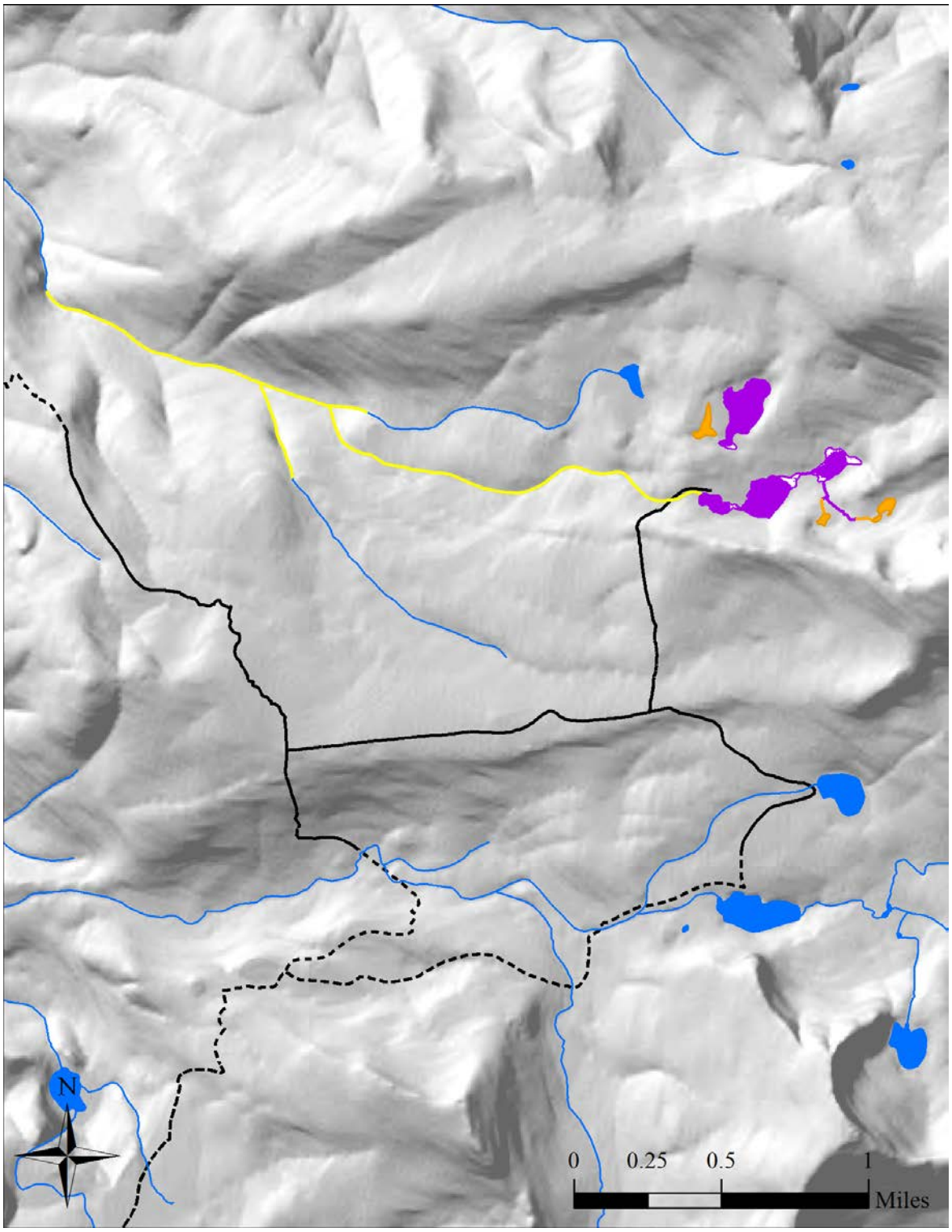
Barrett **Treatment**	**# Lakes**	**(ac.)**	**# Ponds**	**(ac.)**	**Stream (mi.)**
physical	3	42.1	1	0.3	0.9
Total	**3**	**42.1**	**1**	**0.3**	**0.9**



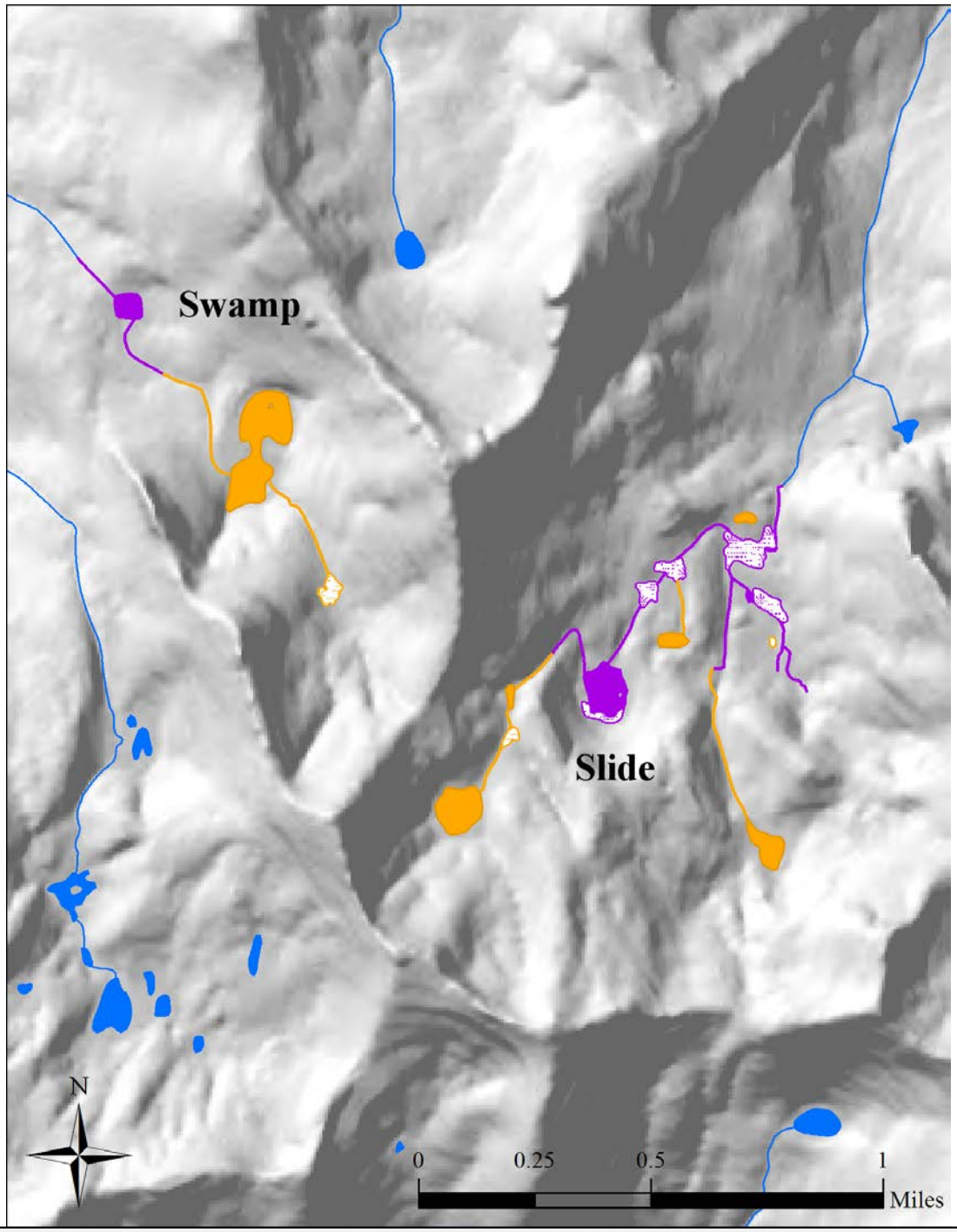
Rambaud					
Treatment	**# Lakes**	**(ac.)**	**# Ponds**	**(ac.)**	**Stream (mi.)**
physical	0	0.0	1	0.4	0.3
Total	**0**	**0.0**	**1**	**0.4**	**0.3**



Amphitheater					
Treatment	**# Lakes**	**(ac.)**	**# Ponds**	**(ac.)**	**Stream (mi.)**
piscicide	1	58.9	2	1.3	2.2
restored	2	36.8	1	0.7	0.3
Total	**3**	**95.7**	**3**	**2.0**	**2.5**

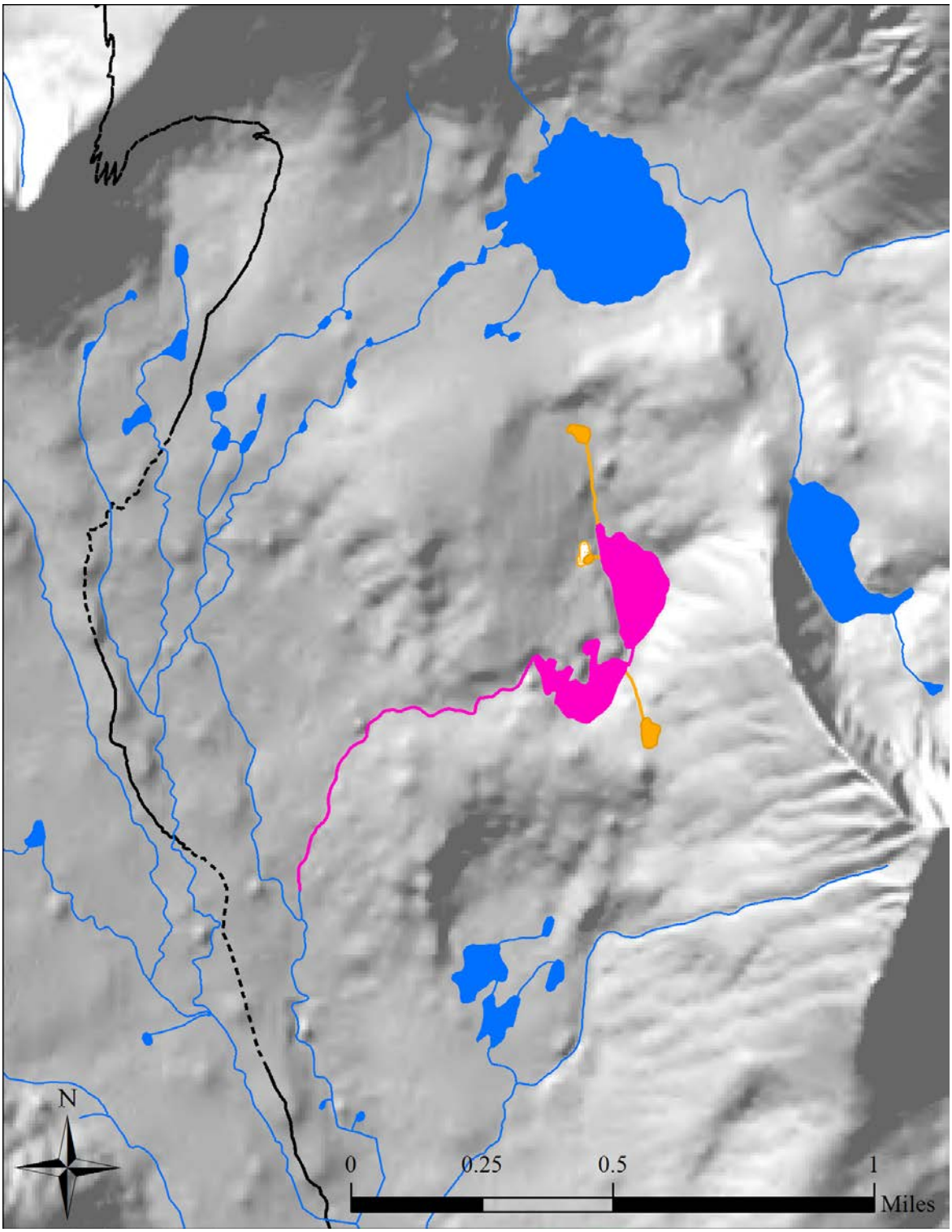


Horseshoe **Treatment**	**# Lakes**	**(ac.)**	**# Ponds**	**(ac.)**	**Stream (mi.)**
physical	4	29.0	0	0.0	0.4
piscicide	0	0	0	0	3.0
Total	**4**	**29.0**	**0**	**0**	**3.4**

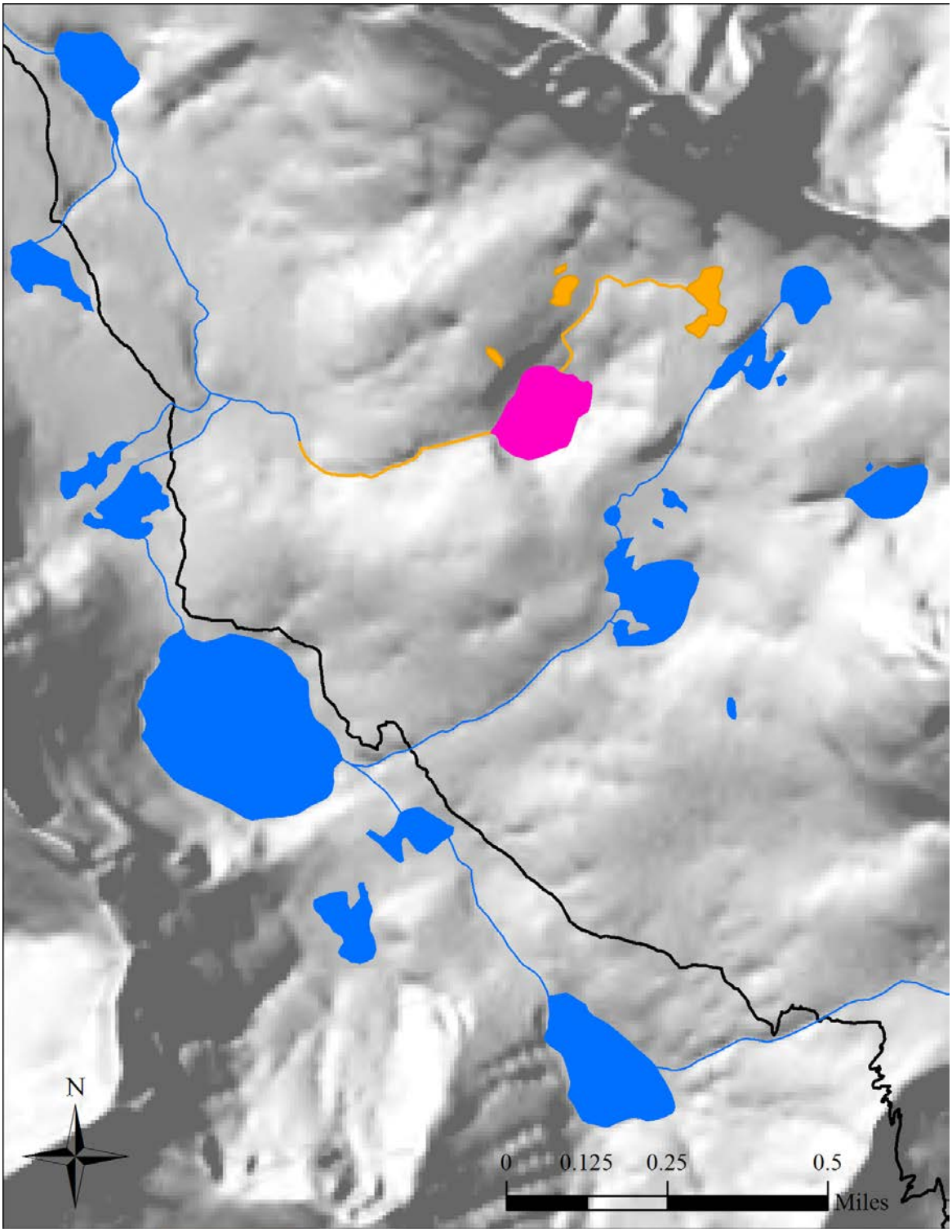


Slide					
Treatment	**# Lakes**	**(ac.)**	**# Ponds**	**(ac.)**	**Stream (mi.)**
physical	1	5.1	1	0.2	1.6
Total	**1**	**5.1**	**1**	**0.2**	**1.6**

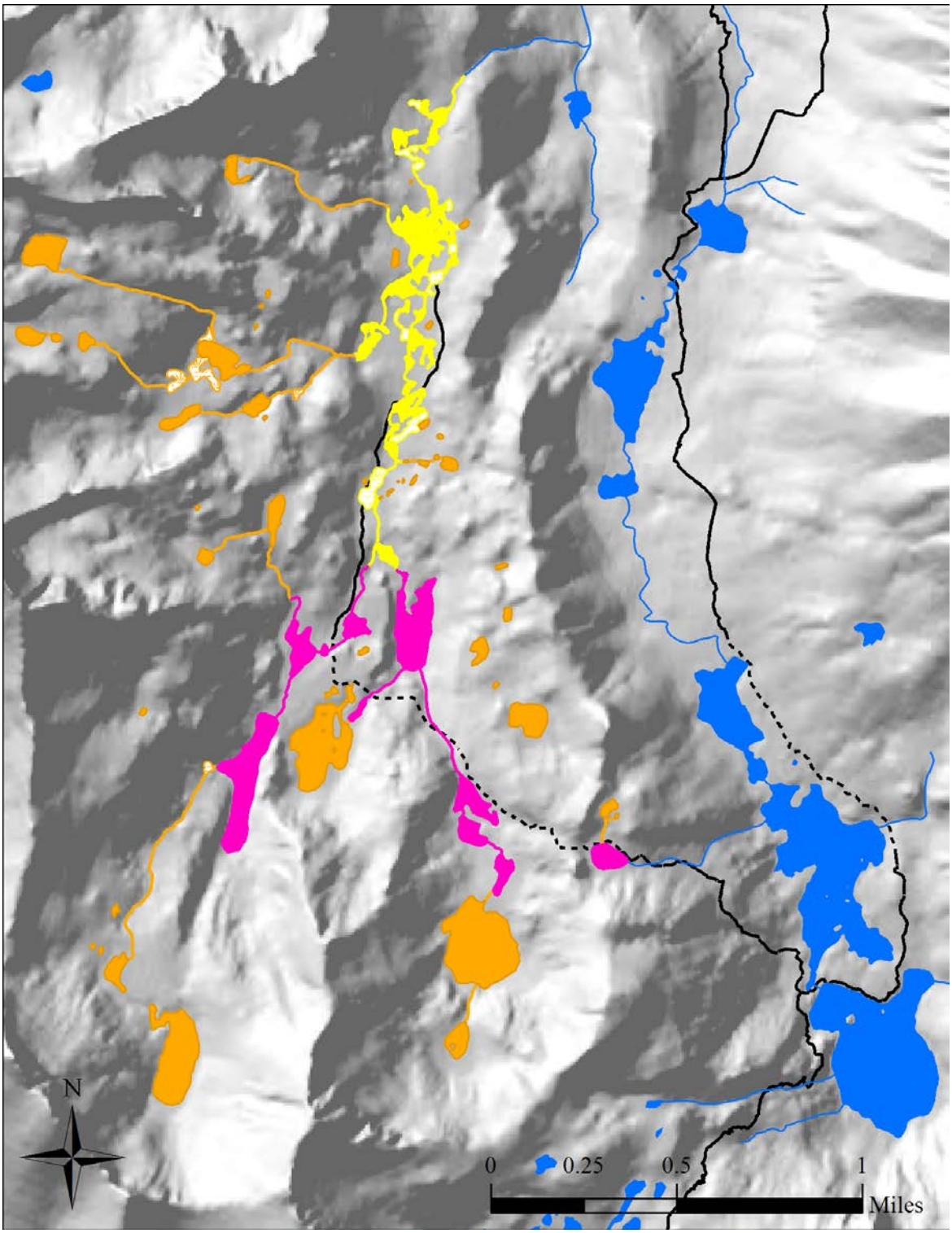
Swamp					
Treatment	**# Lakes**	**(ac.)**	**# Ponds**	**(ac.)**	**Stream (mi.)**
physical	0	0.0	1	1.8	0.3
Total	**0**	**0.0**	**1**	**1.8**	**0.3**



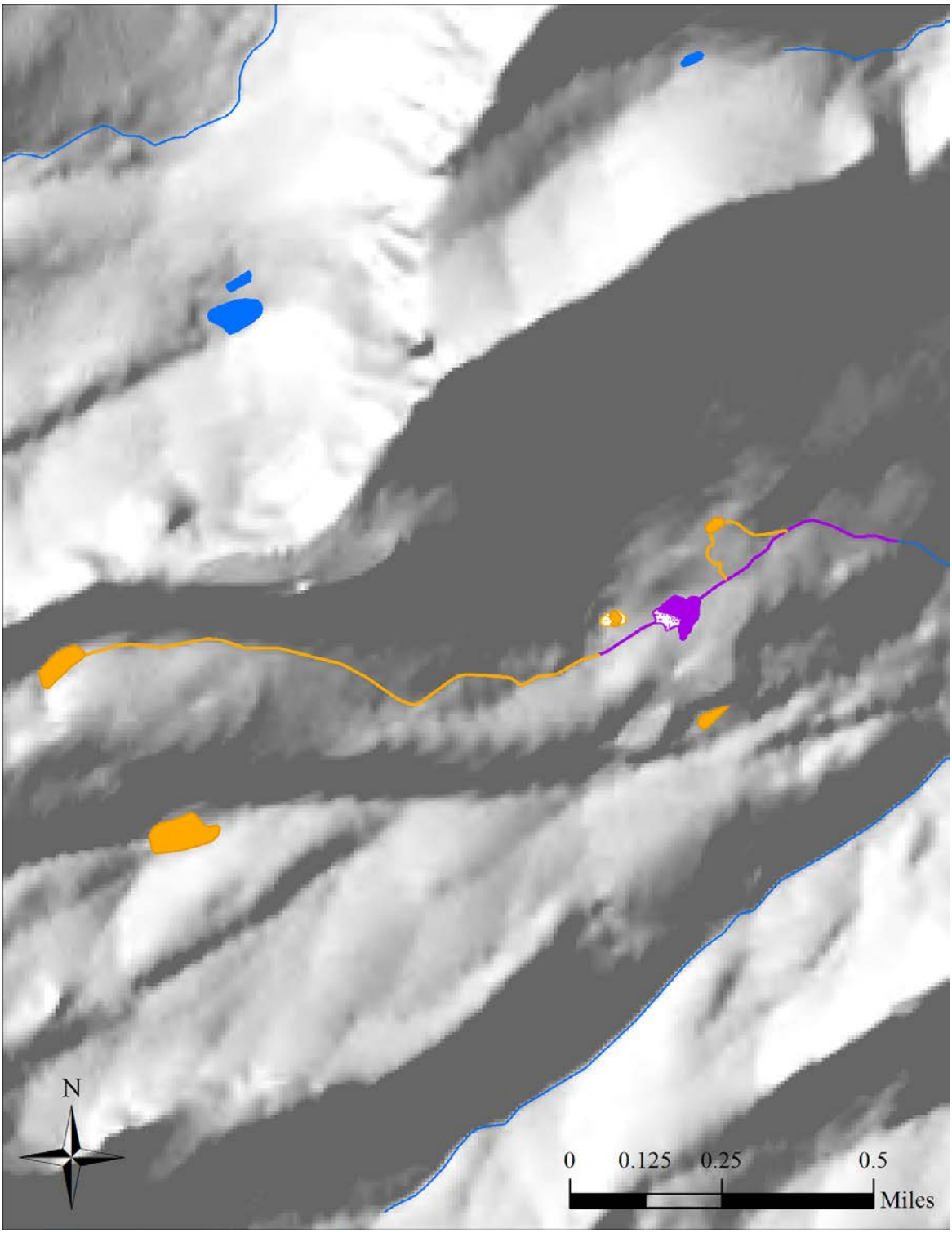
Upper Basin					
Treatment	**# Lakes**	**(ac.)**	**# Ponds**	**(ac.)**	**Stream (mi.)**
restored	2	19.5	0	0.0	0.8
Total	**2**	**19.5**	**0**	**0.0**	**0.8**



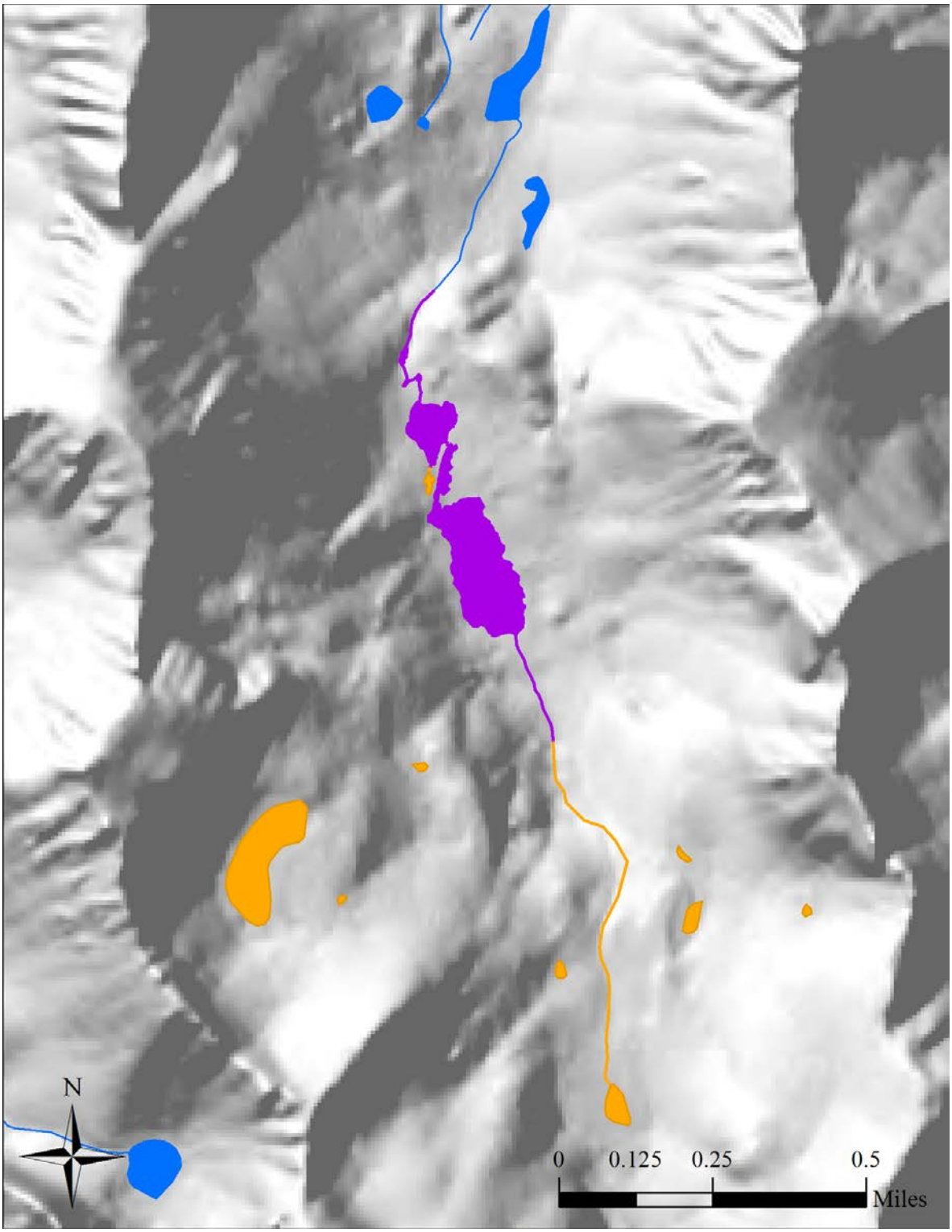
Pinchot					
Treatment	**# Lakes**	**(ac.)**	**# Ponds**	**(ac.)**	**Stream (mi.)**
restored	1	9.4	0	0.0	0.0
Total	**1**	**9.4**	**0**	**0.0**	**0.0**



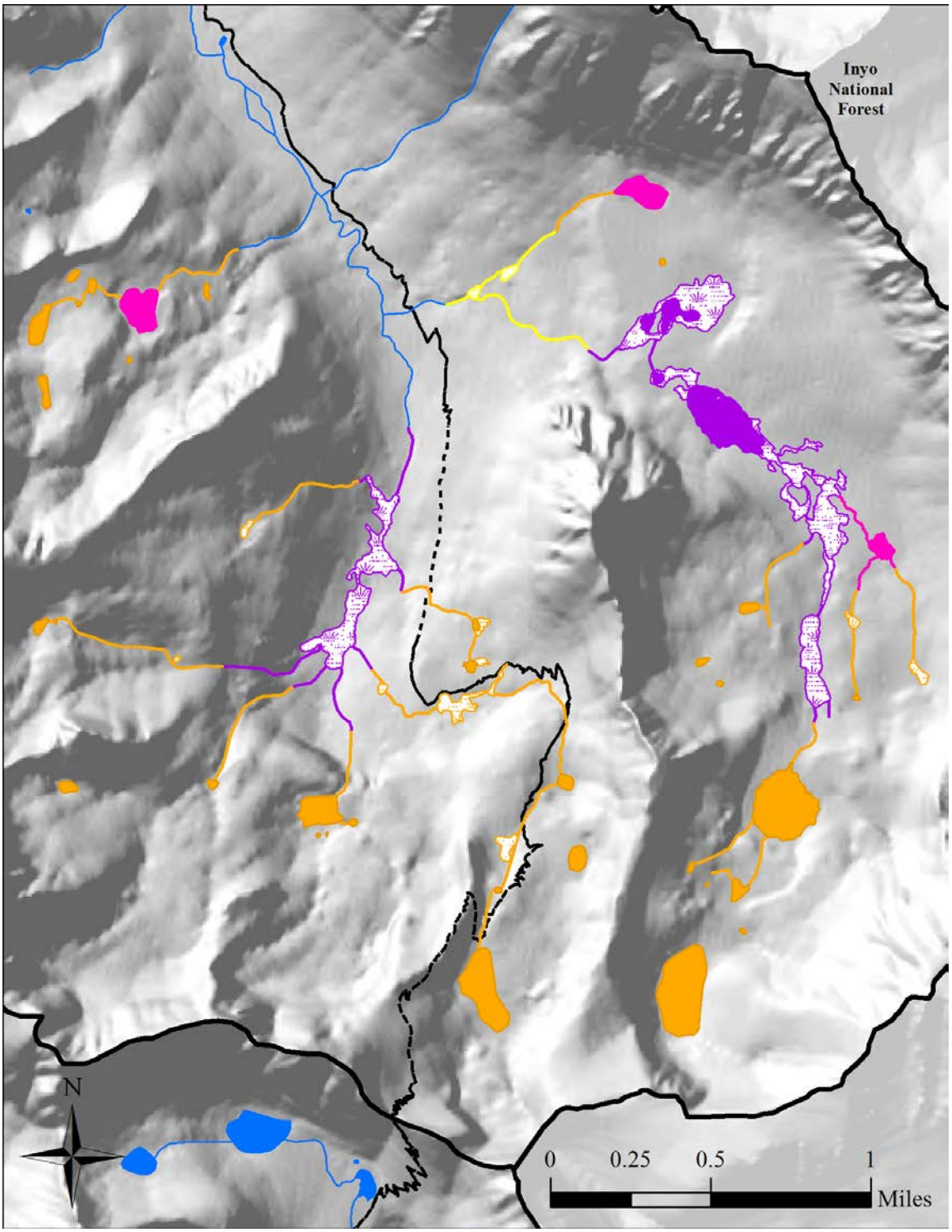
Sixty Lake					
Treatment	**# Lakes**	**(ac.)**	**# Ponds**	**(ac.)**	**Stream (mi.)**
restored	5	36.5	6	7.7	1.0
piscicide	1	13.4	14	14.9	1.0
Total	**6**	**49.8**	**20**	**22.6**	**2.0**



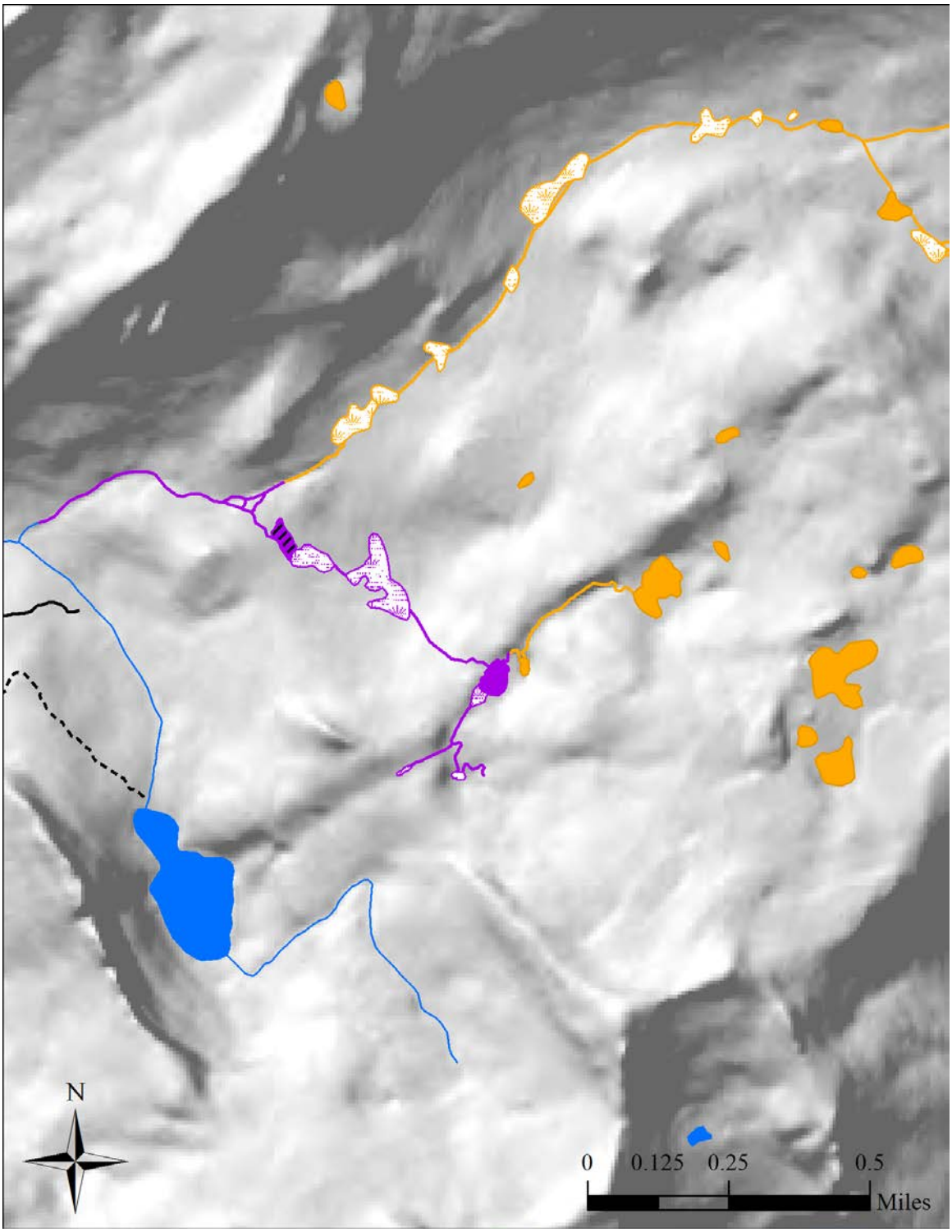
Brewer **Treatment**	**# Lakes**	**(ac.)**	**# Ponds**	**(ac.)**	**Stream (mi.)**
physical	0	0.0	1	1.6	0.5
Total	**0**	**0.0**	**1**	**1.6**	**0.5**



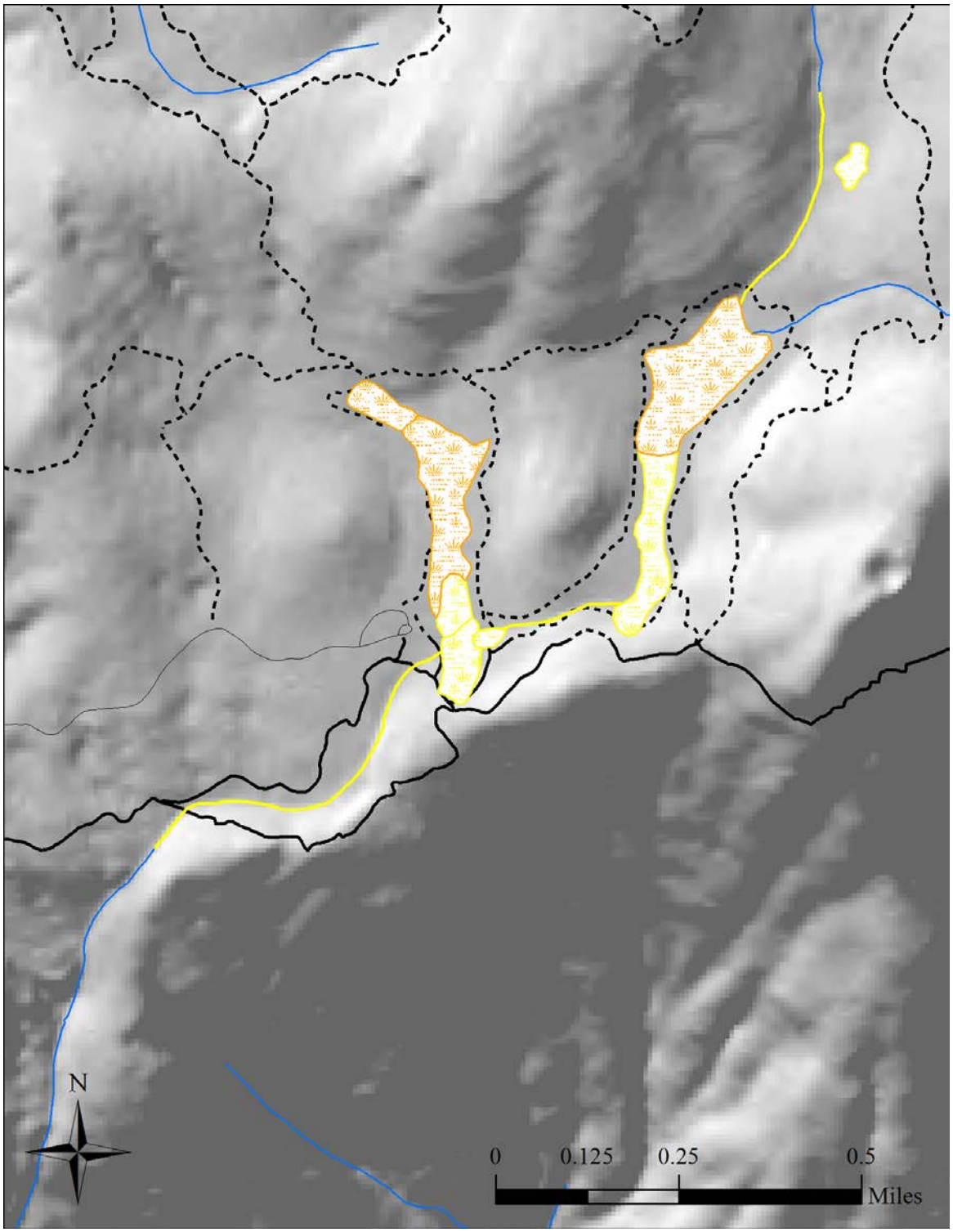
Vidette					
Treatment	**# Lakes**	**(ac.)**	**# Ponds**	**(ac.)**	**Stream (mi.)**
physical	2	16.6	3	0.2	0.4
Total	**2**	**16.6**	**3**	**0.2**	**0.4**



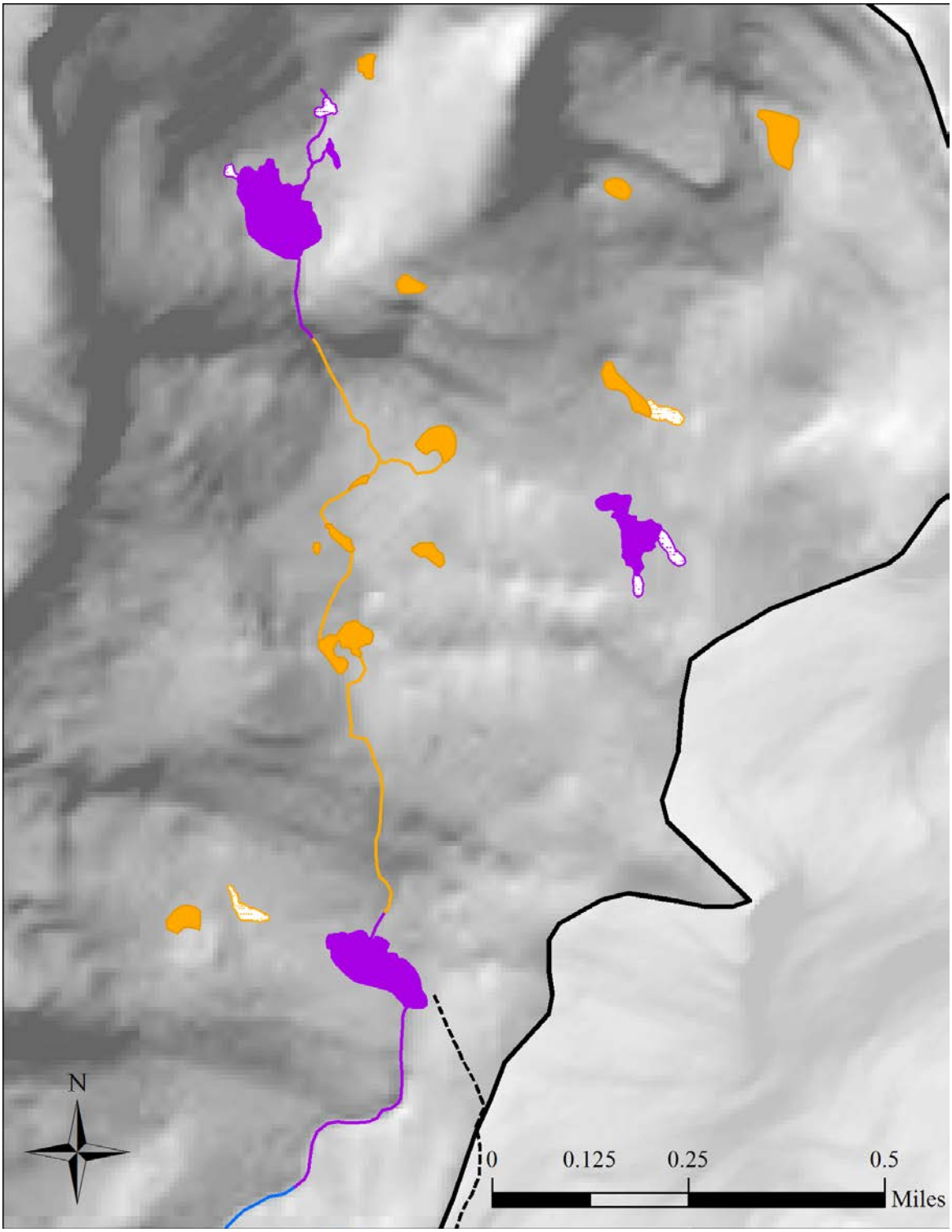
Upper Bubbs Creek					
Treatment	**# Lakes**	**(ac.)**	**# Ponds**	**(ac.)**	**Stream (mi.)**
restored	3	16.2	0	0.0	0.4
physical	2	21.6	2	1.7	4.3
piscicide	0	0.0	0	0.0	0.9
Total	**5**	**37.9**	**2**	**1.7**	**5.6**



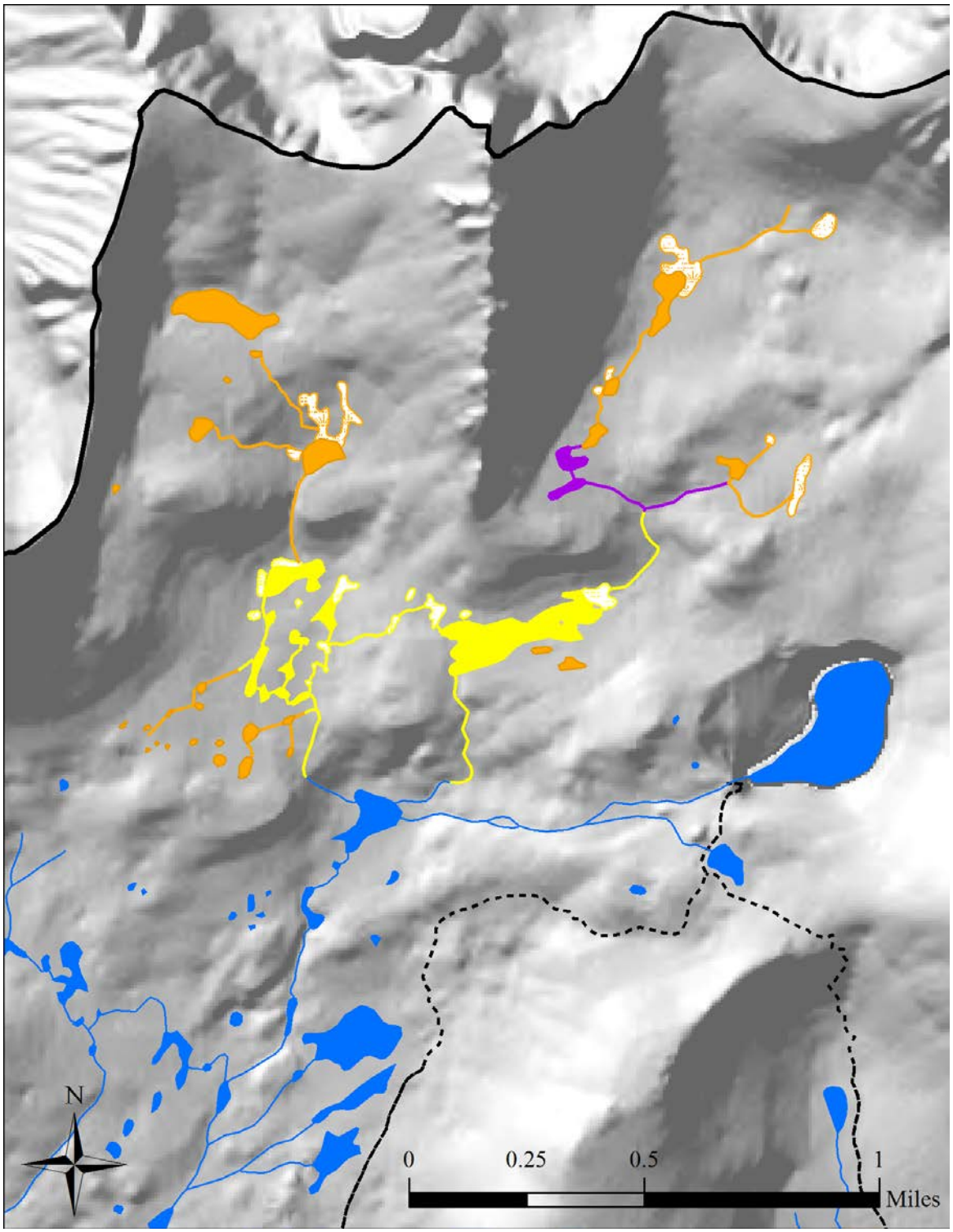
Tablelands					
Treatment	**# Lakes**	**(ac.)**	**# Ponds**	**(ac.)**	**Stream (mi.)**
physical	0	0.0	1	1.5	1.7
Total	**0**	**0.0**	**1**	**1.5**	**1.7**



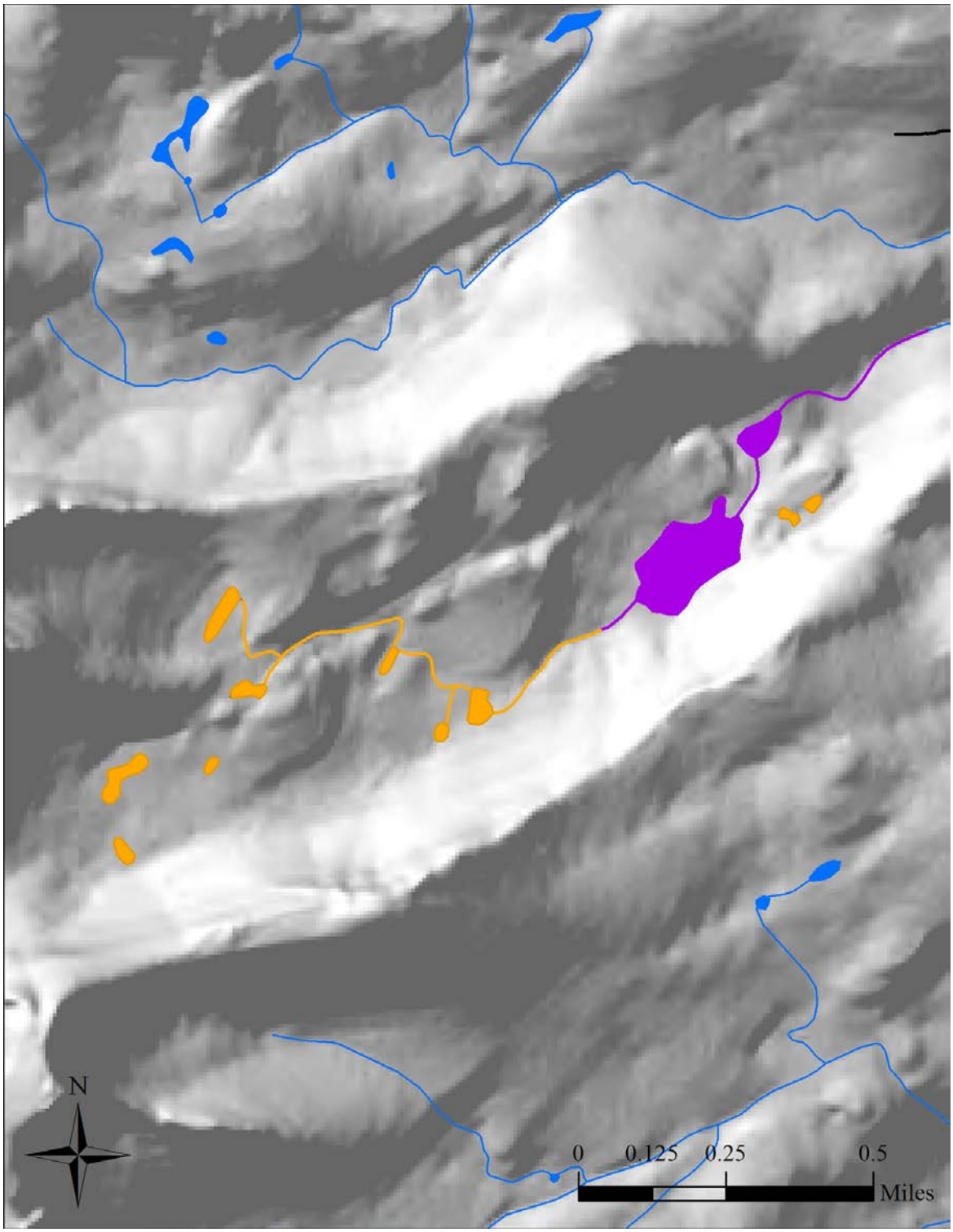
Crescent **Treatment**	**# Lakes**	**(ac.)**	**# Ponds**	**(ac.)**	**Stream (mi.)**
piscicide	0	0.0	0	0.0	1.6
Total	**0**	**0.0**	**0**	**0.0**	**1.6**



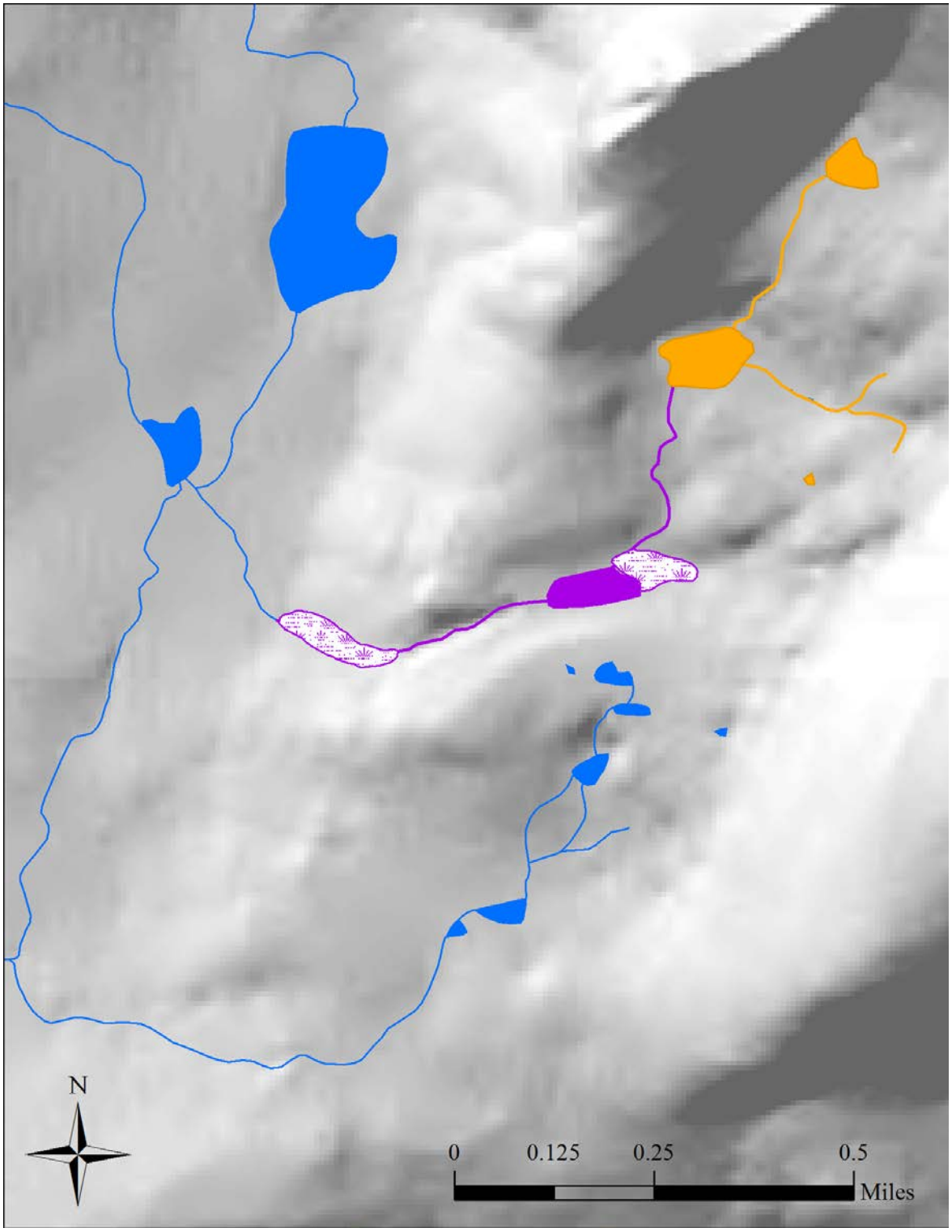
Blossom **Treatment**	**# Lakes**	**(ac.)**	**# Ponds**	**(ac.)**	**Stream (mi.)**
physical	2	9.4	2	2.3	0.6
Total	**2**	**9.4**	**2**	**2.3**	**0.6**



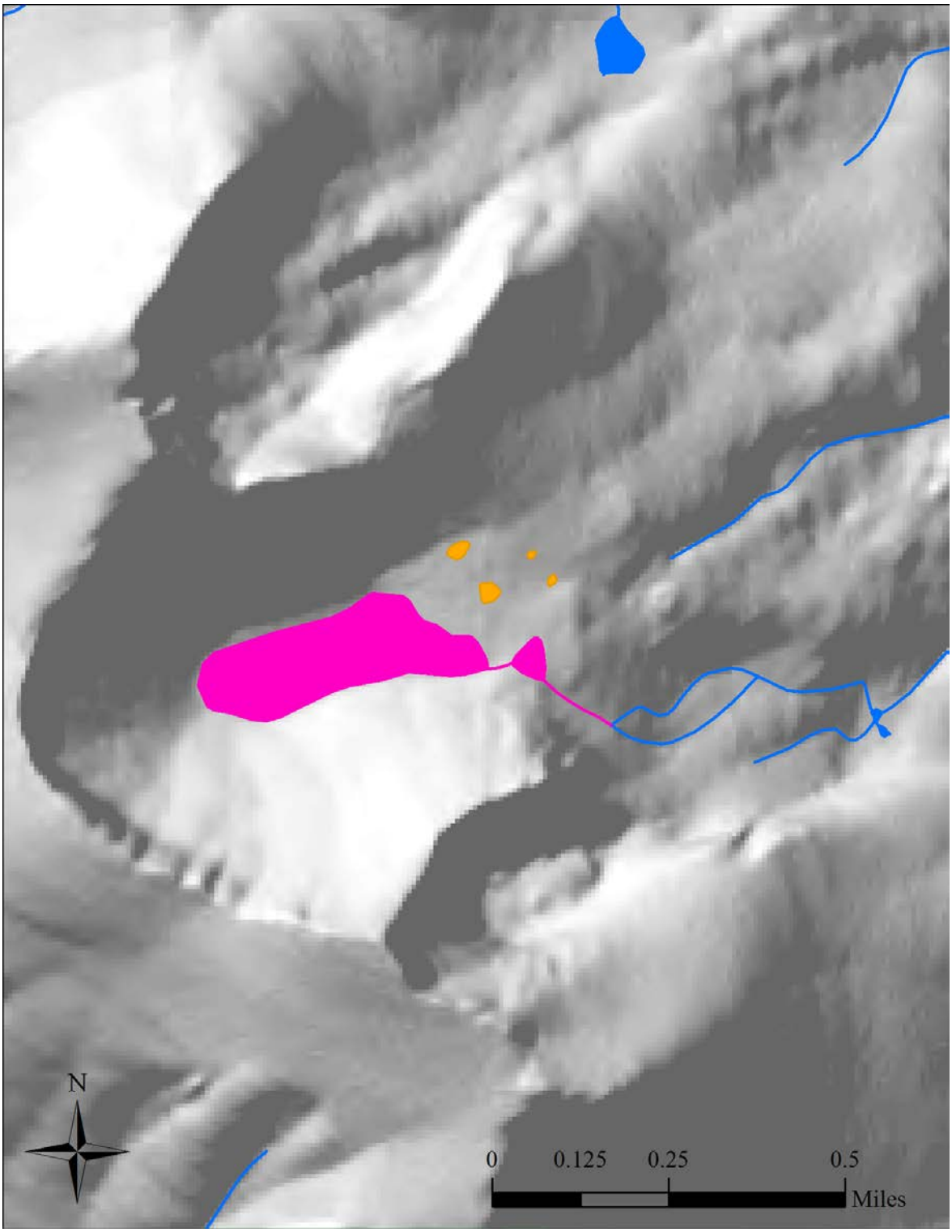
Upper Kern					
Treatment	**# Lakes**	**(ac.)**	**# Ponds**	**(ac.)**	**Stream (mi.)**
physical	0	0.0	2	2.1	0.4
piscicide	2	18.3	8	4.2	1.5
Total	**2**	**18.3**	**10**	**6.3**	**1.9**



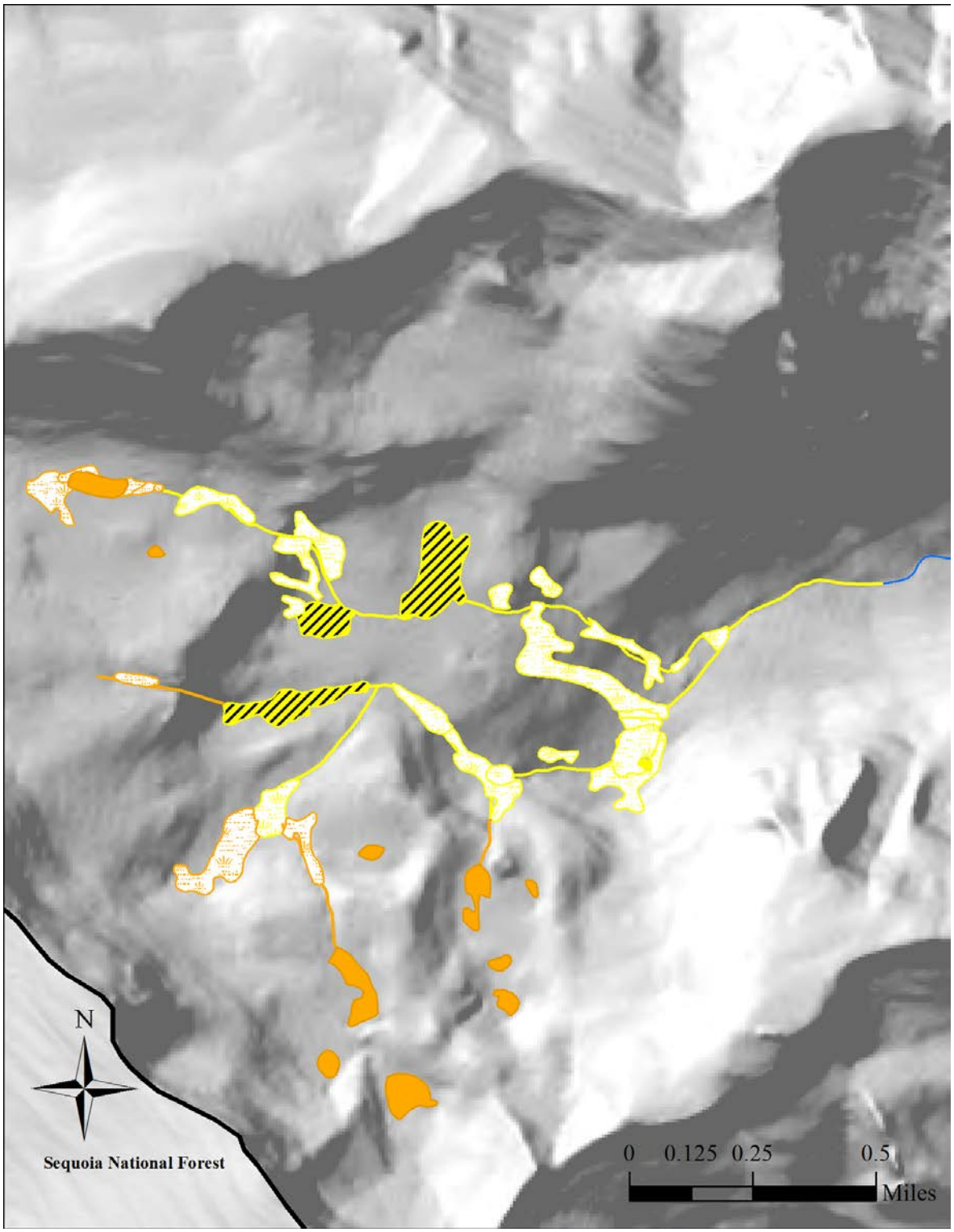
Milestone **Treatment**	**# Lakes**	**(ac.)**	**# Ponds**	**(ac.)**	**Stream (mi.)**
physical	1	12.8	1	2.1	0.5
Total	**1**	**12.8**	**1**	**2.1**	**0.5**



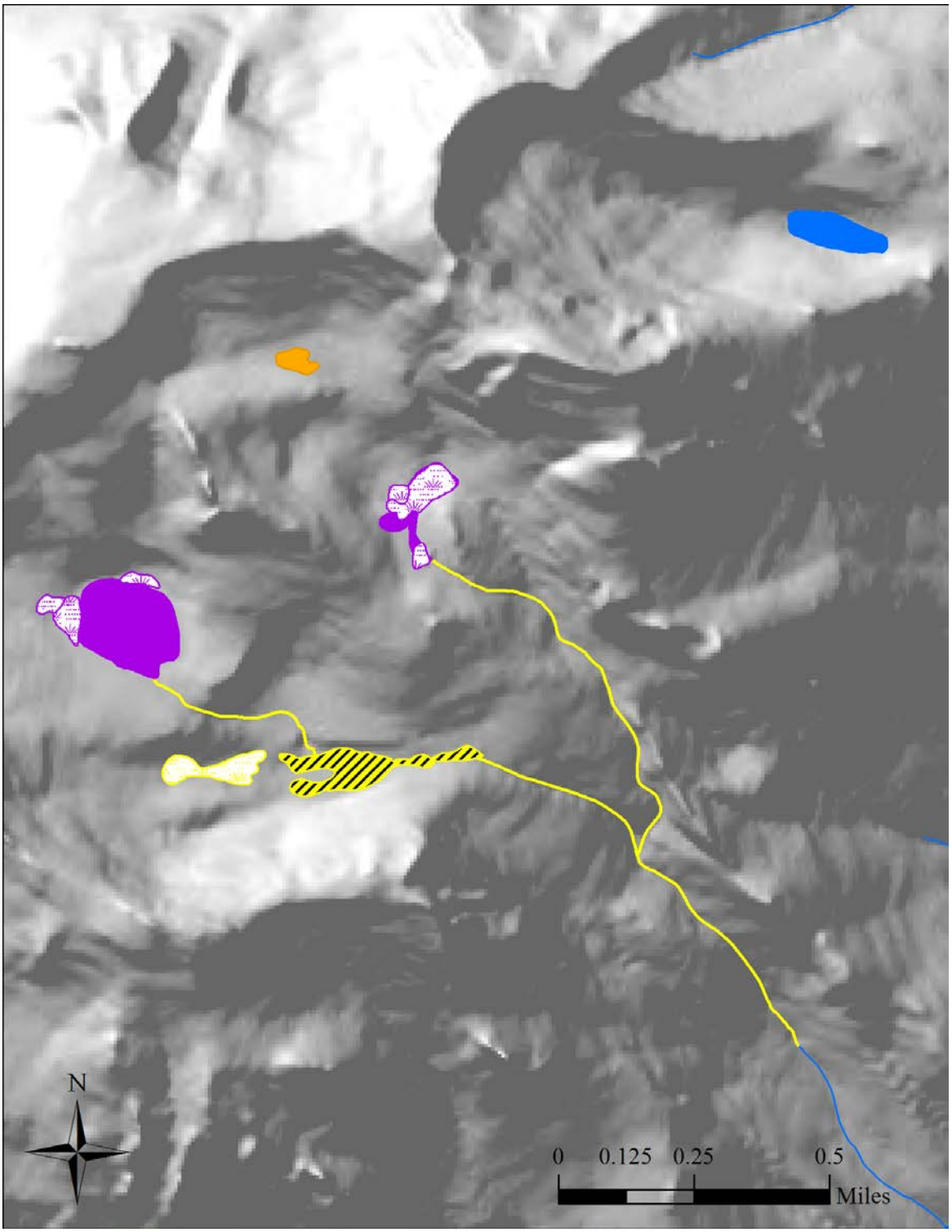
East Wright					
Treatment	**# Lakes**	**(ac.)**	**# Ponds**	**(ac.)**	**Stream (mi.)**
physical	1	2.6	0	0.0	0.7
Total	**1**	**2.6**	**0**	**0.0**	**0.7**



Kern Point					
Treatment	**# Lakes**	**(ac.)**	**# Ponds**	**(ac.)**	**Stream (mi.)**
restored	1	25.2	1	1.2	0.1
Total	**1**	**25.2**	**1**	**1.2**	**0.1**



Laurel					
Treatment	**# Lakes**	**(ac.)**	**# Ponds**	**(ac.)**	**Stream (mi.)**
piscicide	0	0.0	1	0.2	3.1
Total	**0**	**0.0**	**1**	**0.2**	**3.1**



Crytes **Treatment**	**# Lakes**	**(ac.)**	**# Ponds**	**(ac.)**	**Stream (mi.)**
physical	2	20.6	1	0.9	0.0
piscicide	0	0.0	0	0.0	2.0
Total	**2**	**20.6**	**1**	**0.9**	**2.0**

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APPENDIX C: EFFECTS OF NONNATIVE FISH SPECIES

Impacts of Nonnative Fish on High Elevation Ecosystems

Nonnative fish have been widely introduced to naturally fishless, mountain ecosystems throughout western North America, commonly resulting in negative ecological effects to these systems (Anderson 1971, Bahls 1992, Knapp 1996). In SEKI, high elevation waterbodies were naturally inhabited by a diverse assemblage of aquatic species that developed over thousands of years in a fishless environment. Fish were naturally restricted in distribution by waterfalls and cascades to low or middle elevation waterbodies depending on the drainage (Christenson 1977). The stocking of various nonnative trout species into SEKI's fishless high elevation waterbodies began in the 1860s (Knapp 1996) before Sequoia National Park was established.

Many studies have been conducted on the impacts of introduced trout on native biota in the high Sierra Nevada, including SEKI. Important contributions to our understanding of this issue come from landscape analyses with large sample sizes that correlate the presence of introduced trout with the absence or near-absence of native biota, such as amphibians and large invertebrates (Knapp 1996, Knapp and Matthews 2000, Matthews et al. 2001, Matthews et al. 2002, Knapp 2005A).

In the Sierra Nevada, studies show that nonnative trout negatively impact entire food webs, including native fish, amphibians, aquatic invertebrates, zooplankton, algae, and birds. The impacts of nonnative trout on high-elevation aquatic and adjacent terrestrial ecosystems are well documented and occur at all levels of the food web (Bradford et al. 1998, Matthews et al. 2002, Knapp and Sarnelle 2008, Pope et al. 2008, Herbst et al. 2009, Epanchin et al. 2010). Nonnative fish impact native species directly through predation and indirectly through competition for food resources. Nonnative fish can disrupt the type and distribution of species, and the natural function of aquatic ecosystems. For example, researchers found that the distribution and abundance of mountain yellow-legged frogs (MYLFs; *Rana muscosa* and *R. sierrae*), conspicuous aquatic invertebrates (e.g., mayflies), and zooplankton (e.g., *Daphnia*) were dramatically reduced by the introduction of fish (Knapp et al. 2001). There is no hard boundary between aquatic and terrestrial ecosystems. For example, leaves may drop into a lake and provide food for aquatic insect larvae. When the insects emerge as adults, they may be eaten by frogs, birds, or bats. When nonnative fish consume the insect larvae or frogs, they in turn impact snakes, birds, and bats. Consequently, the impacts of nonnative fish disrupt the flow of energy and nutrients within and between aquatic and terrestrial ecosystems (Knapp 1996, Finlay and Vredenburg 2007).

Nonnative trout directly impact native amphibians by preying on eggs, tadpoles, and frogs and competing with frogs for food, thereby reducing or eliminating reproduction (Vredenburg 2004). MYLFs are especially vulnerable to the impacts from nonnative trout (Bradford et al. 1993, Knapp and Matthews 2000, Vredenburg 2004, Knapp 2005A, Knapp et al. 2007). Trout and MYLFs both require deep, permanent lakes, which do not freeze solid in the winter or dry out even in drought years (Grinnell and Storer 1924, Hayes and Jennings 1986, Bradford 1989, Bradford et al. 1993, Bradford et al. 1994B, Knapp 1996, Knapp and Matthews 2000, Knapp 2005A). Nonnative trout typically cause large reductions in distribution and abundance of local MYLF populations (Knapp et al. 2001), ultimately resulting in extirpation in many locations (Bradford et al. 1994B; Knapp 1996, Knapp and Matthews 2000, Knapp 2005A). In turn, the presence of nonnative trout in lakes and streams across SEKI's landscape has fragmented the remaining MYLF populations and drastically reduced their ability to re-establish populations that have been extirpated (Bradford et al. 1993). The remaining isolated frog populations are at much greater risk of extirpation (Bradford et al. 1993; Lacan et al. 2008).

The widespread introduction of nonnative trout is therefore a major factor in the disappearance of MYLF populations from approximately 92% of historic localities in the Sierra Nevada (Vredenburg et al. 2007). Due to this steep decline, the populations of both species of MYLFs in the Sierra Nevada have been listed as federally endangered under the Endangered Species Act (FWS 2014). In 2012, the Sierra Nevada population of the southern species (*Rana muscosa*) was state-listed as endangered and the northern population (*Rana sierrae*) was state listed as threatened under the California Endangered Species Act (CFGC 2012).

Surveys conducted between 1997 and 2002 of all lakes, ponds, and marshes (waterbodies) in SEKI showed that frogs and fish rarely coexist (Knapp 2003). These surveys detected nonnative trout at 575 waterbodies. Although nonnative trout were present in 18% of all waterbodies surveyed (575 of 3,244), they were present in 33% of lakes [2.5 acres (1 hectare) or larger], and 50% of lake surface area at least 3 meters deep, which are crucial for the long-term survival of MYLFs. MYLFs were also present in 18% of all waterbodies surveyed (569 of 3,244), but they were only detected with nonnative trout in 4% of waterbodies (135 of 3,244). Of these 135 waterbodies, MYLF adults and/or subadults were present in 122 waterbodies (4% of 3,244), whereas MYLF tadpoles and/or egg masses (evidence of breeding) were only present in 67 waterbodies (2% of 3,244). These results show that although adult and/or subadult MYLFs may occasionally be observed with trout, MYLF tadpoles and egg masses are more susceptible to fish predation and thus are rarely observed with trout.

Nonnative trout occupy an estimated hundreds of miles of high elevation (6,000 to 12,000 ft /1,800 to 3,700 m) stream and river habitat in SEKI, and only small portions of headwater stream habitats are in a naturally fishless state (Knapp 2003). The presence of trout reduces the chance that MYLFs will occupy these streams, and precludes movement by this species between most remaining populations. Given the current distribution of trout and the scarcity of extant frog populations, it is difficult for MYLFs to move between existing populations, and these remaining isolated populations (Bradford et al. 1993) are consequently more vulnerable to extirpation from random events, such as prolonged drought, severe winters (Bradford 1983), or disease outbreaks. Continued loss of MYLF populations will further isolate populations and make MYLFs more vulnerable to extirpation from entire watersheds (Bradford 1989, Bradford et al. 1993, Lacan et al. 2008).

Nonnative fish indirectly impact native predators such as the mountain garter snake (*Thamnophis elegans elegans*), which primarily preys on amphibians, including MYLFs. These snakes are now less common at fish-containing versus fishless lakes in the high Sierra, likely because amphibians are rarely available as food at fish-containing lakes (Matthews et al. 2002). In addition, nonnative fish directly impact large aquatic invertebrates (Bradford et al. 1998, Knapp et al. 2001) and zooplankton (Stoddard 1987, Knapp et al. 2001) by severely reducing or eliminating them in lakes, and thus indirectly impact wildlife that rely on these organisms for food. This causes trophic cascades in aquatic food webs that extend into terrestrial environments (Finlay and Vredenburg 2007). For example, the gray-crowned rosy finch (*Leucosticte tephrocotis*), a high elevation Sierran bird that feeds extensively on adult mayflies emerging from lakes during the breeding season, is now less common at fish-containing lakes than fishless lakes (Epanchin et al. 2010). This difference is the result of nonnative fish feeding on mayfly larvae, severely reducing or eliminating mayfly emergence from lakes, resulting in a substantial loss of food for gray-crowned rosy finches.

Nonnative fish impact native fish in low-to-mid elevation Sierran streams through hybridization, predation, and competition (Moyle 2002). Because nonnative fish have been introduced to all of the Sierran streams containing native fish, the entire native fish assemblage has declined, including several subspecies of trout and several non-trout species. Some of these fish have declined throughout their range and the following have been given protected status by the FWS. Listed as threatened under the Endangered Species Act are the Little Kern golden trout (*Oncorhynchus mykiss whitei*; FWS 1978),

Paiute cutthroat trout (*Oncorhynchus clarki seleneris*; FWS 1975), and Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*; FWS 1975). The California golden trout (*Oncorhynchus mykiss aguabonita*) has been petitioned for listing (FWS 2002A), and the pure form of Kern River rainbow trout (*Oncorhynchus mykiss gilberti*) has become extremely rare (Erickson et al. 2010).

Collectively, these processes result in a negative effect by nonnative fish on native species and high elevation aquatic and terrestrial ecosystems in the Sierra Nevada. However, these negative effects appear to largely disappear after nonnative fish are actively eradicated or die out naturally from these systems (Knapp et al. 2001, Vredenburg 2004, Knapp et al. 2005, 2007). Although nonnative trout stocking was terminated in SEKI in 1988, recent research indicates that approximately 70% of previously-stocked lakes in SEKI have sufficient habitat to sustain trout populations in the absence of stocking (Zardus et al. 1977, Armstrong and Knapp 2004). Since trout typically live 6 to 7 years (Behnke 2002), and have been aged to 24 years in one high Sierra lake (Reimers 1979), all natural disappearances of nonnative trout in SEKI's high elevation waterbodies have likely already occurred. The remaining trout-containing waterbodies in SEKI's high elevations therefore contain self-sustaining fish populations that will continue to cause negative effects to these ecosystems unless they are eradicated by human intervention.

Past Aquatic Management in High Elevation Waterbodies in SEKI

Nonnative fish stocking into high Sierra waterbodies was largely conducted by various sporting groups (Knapp 1996). After 1890 and the establishment of Sequoia National Park, U.S. Army staff were dispatched to manage the new park lands, during which they conducted extensive fish stocking (Christenson 1977). Easily accessible waterbodies were stocked with fish using packstock. After the NPS was created in 1916, NPS staff continued to conduct fish stocking in park waterbodies, and the California Fish and Game Commission began coordinating these efforts. By the 1940s, fish stocking in park waterbodies was almost entirely managed by the California Department of Fish and Game (CDFW) (Knapp 1996), with permission from the NPS. Under CDFW management, nonnative fish were systematically stocked using aircraft to plant fish in remote lakes. From the 1940s to the 1970s, most large waterbodies in SEKI were stocked with nonnative fish at least once, and many were stocked repeatedly.

In the 1960s, the NPS began to apply a Servicewide policy of science-based management. The "Leopold Report" (Leopold et al. 1963) assessed various NPS resources management policies and among many findings concluded that (1) fish stocking into naturally fishless habitat was not congruent with NPS management policies and (2) indiscriminate stocking of nonnative fish into naturally fishless waterbodies may be causing negative ecological effects. The report recommended that the NPS should reevaluate its fish stocking policy and investigate whether nonnative fish stocking was impacting native species.

In the 1970s, SEKI began phasing out nonnative fish stocking while conducting a study of nonnative trout in 137 SEKI lakes (Zardus et al. 1977) to determine how those populations might respond to an absence of stocking. The study found that fish in 97 (72%) of the 137 lakes were likely able to sustain their populations in the absence of stocking. The study also recorded observations of other biota, reporting MYLFs swimming in open water in two (1.5%) of the 137 lakes, and stating: "In lakes with large populations of fish, tadpoles are observed only in shallow or protected waters, or are not present at all." In addition, in 1975 the NPS adopted a policy in which naturally fishless waters will no longer be stocked with fish (NPS 1975). As a result, the NPS proposed to terminate the authorization for CDFW to continue stocking nonnative fish in SEKI lakes. Instead, a compromise was reached in which CDFW was allowed to continue stocking fish in no more than seven lakes per year in SEKI, intermittently selected from a total of 16 high use lakes. This practice continued until 1988 when the NPS terminated all fish stocking in SEKI lakes. Although stocking no longer occurs in SEKI, nonnative fish had established self-sustaining populations in approximately 575 waterbodies (Knapp 2003) and in hundreds of miles of stream.

In the 1980s and 1990s, while additional studies were investigating landscape-scale effects of nonnative fish introductions in SEKI and the high Sierra Nevada (Bradford 1989; Bradford et al. 1993, 1998), researchers and NPS staff observed that amphibians, particularly MYLFs, appeared to be declining. Several studies ensued to quantify the MYLF decline and attempted to determine its causal factors. The primary conclusions from these studies were that (1) lake acidity levels were not elevated and thus did not appear to be a contributing factor to MYLF decline (Bradford et al. 1994A), and (2) MYLFs were much less likely to occur in lakes with nonnative fish versus fishless lakes (Bradford et al. 1994B, Knapp and Matthews 2000). To further investigate the effects of nonnative fish, researchers studied the response of MYLFs and other native species (e.g., aquatic invertebrates and zooplankton) when nonnative fish disappeared from historically fishless lakes due to stocking termination or experimental eradication. Results showed that native species quickly recovered toward pre-disturbance levels following the return of lakes to a fishless condition (Knapp et al. 2001, 2005, 2007; Vredenburg 2004; Knapp and Sarnelle 2008).

Recent Aquatic Management Actions in SEKI

From 1997 to 1999, researchers used gill nets to experimentally eradicate nonnative fish from two park waterbodies, which showed that fish eradication was feasible (Vredenburg 2004). In 2001, SEKI began to implement preliminary (experimental) restoration of MYLFs (NPS 2001). The primary goal was to assess the feasibility of SEKI staff using gill nets and electrofishers to eradicate nonnative fish from low- to moderate-use individual lakes having short associated streams. The purpose of the program was to restore aquatic habitat for native species, with an emphasis on improving the status of imperiled MYLFs. From 2001-2013, SEKI removed nearly 50,201 fish from targeted lakes and streams (Figure 2 in Chapter 1; also NPS 2015A). By 2015, fish were fully eradicated from 15 lakes and nearly eradicated from 10 lakes, which are expected for completion by 2017.

In nine of the lakes eradicated of fish, MYLFs remained disease-free three years after trout removal. Average tadpole density in these nine lakes increased by 13-fold (from 0.8 to 10.1 per 10 m of shoreline; $P = 0.008$), while average frog density increased by 14-fold (from 0.8 to 11.1 per 10 m of shoreline; $P = 0.004$) (Figure 3 in Chapter 1; also NPS 2011A). One lake showed an overall 49-fold increase from 0.9 to 43.9 individuals per 10 m of shoreline (NPS 2011A). Several of these MYLF populations are now among the largest in the entire range of MYLFs.

To test the mechanism driving the increases in restored MYLF populations, a study compared the change in MYLF density between 1997 and 2005 in 22 fishless control lakes in SEKI and three trout removal lakes, including two of the SEKI restoration lakes and one lake adjacent to the SEKI boundary in the Inyo National Forest (Knapp et al. 2007). The average change in *tadpole* density in the control lakes and trout removal lakes was +2.3-fold and +35.2-fold, respectively ($P = 0.025$), while the average change in *frog* density in the control lakes and trout removal lakes was +0.4-fold and +24.9-fold, respectively ($P = 0.0004$). Thus, increases in MYLF frog numbers in trout removal lakes result from fish eradication rather than regionally favorable conditions for population growth. These results show that eradicating nonnative trout is highly beneficial to MYLFs.

In addition, monitoring efforts have detected significantly more garter snakes per survey in trout removal lakes (0.15) versus fish-containing lakes (0.02; P=0.014; Figure 4; 2012A). Garter snakes were thus 10 times more likely to be found in fish removal lakes versus fish-containing control lakes where no removal was conducted. Snake detections also increased over time, exhibiting a positive linear relationship with the number of years since trout removal began (Upper Bubbs Creek, R^2=0.55, P=0.09 and Upper LeConte Canyon, R^2= 0.49, P=0.02) (NPS 2011A). These differences are likely attributable to the presence of increased numbers of MYLFs, which are a primary prey of garter snakes, in fishless lakes versus fish-containing lakes (Knapp et al. 2007).

Clark's nutcrackers, Brewer's blackbirds and American robins are now seen opportunistically feeding on MYLFs in restored populations (NPS unpublished data). In addition, abundant mayfly hatches are now a common annual occurrence at most trout removal lakes, providing improved forage for gray-crowned rosy finches and several bat species (NPS unpublished data).

These results show that nonnative trout eradication provides ecological benefits extending beyond frog restoration. Nonnative trout eradication in high Sierra aquatic ecosystems is feasible and beneficial to MYLFs and other native species at the local scale of individual or small groups of waterbodies. Nonnative trout eradications in SEKI are complete in 15 waterbodies and nearly complete in 10 waterbodies. Restoration at the landscape scale focusing on entire basins or larger groups of waterbodies and connecting streams, however, would provide even greater benefit to native species and ecosystems. Nonnative fish eradication in multiple waterbodies and the streams that connect these habitats would enable MYLFs and other native aquatic organisms to naturally disperse between waterbodies, improving ecosystem health, and increasing resistance and resilience to other stressors and uncertain future conditions.

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APPENDIX D: PUBLIC SCOPING MATERIALS 2007 AND 2009

The following scoping notice and press release were produced and used during public scoping activities conducted for this project in 2007 and 2009.

SCOPING NOTICE

Restoration of Mountain Yellow-legged Frogs and High Elevation Lakes and Streams Environmental Analysis

National Park Service – Sequoia and Kings Canyon National Parks
January 2007

SCOPING NOTICE

The National Park Service is conducting an environmental analysis for proposed restoration of mountain yellow-legged frogs and high elevation lakes and streams at several areas within Sequoia and Kings Canyon National Parks in California. If you would like more information than is presented in this notice, please contact Wendy Koelfgen, NEPA Specialist, at wendy_koelfgen@nps.gov or (559) 565-3102.

BACKGROUND

The mountain yellow-legged frog (MYLF) is a species that only occurs in the high Sierra Nevada and the mountains of southern California (Fig 1). It is an important species whose presence or absence affects the natural ecology of Sierra Nevada lakes and associated shoreline environments.

Bad News – The frog has disappeared from about 92% of its historic sites in the Sierra Nevada and is a candidate for federal listing as "endangered" under the Endangered Species Act. The frog's existence is threatened by cumulative impacts from trout populations that were introduced to naturally fishless habitats, and a new pathogen, chytrid fungus. The MYLF is declining rapidly and could become extinct within a decade.

Good News – Hope is not lost. Scientists in Sequoia & Kings Canyon National Parks (SEKI) have seen significant frog population expansions after experimentally removing trout in six lakes beginning in 2001 (Fig. 2). Although chytrid fungus could impact these populations, there is some evidence of chytrid resistance emerging in sites that had large frog populations prior to infection.

Within the MYLF range, only a few other restoration efforts are in progress. The California Department of Fish and Game has a program restoring about a dozen lakes, and Yosemite National Park is considering restoration of a few lakes in the future. A park-wide restoration program in Sequoia and Kings Canyon National Parks may be very important for recovery of the species.

WE NEED YOUR HELP

Over the next several months, a National Park Service (NPS) interdisciplinary planning team will conduct the environmental analysis for a long-term project to restore MYLFs and high elevation lakes and streams in SEKI, based on the successful experimental work over the last several years.

As part of the NEPA process, the NPS would like to hear from you. Do you have any comments, recommendations, issues, or concerns about the project? Your participation is important for our success and the future of the MYLF and high elevation lakes and streams.

Figure 1. Adult and larval mountain yellow-legged frogs.

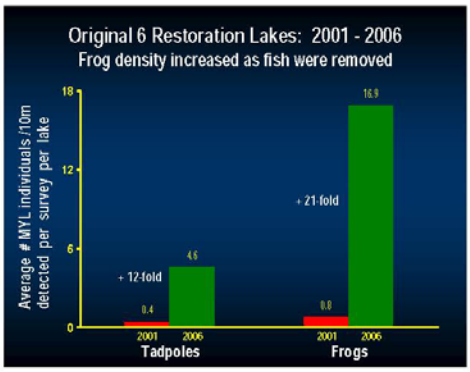

Figure 2. Change from 2001 to 2006 in average density of mountain yellow-legged tadpoles and frogs measured per survey per lake in six restoration lakes in Sequoia and Kings Canyon National Parks in which introduced trout were removed beginning in 2001.

NPS MANAGEMENT POLICIES

The environmental analysis will adhere to guidance provided in the National Environmental Policy Act (NEPA) and NPS Management Policies 2006. The latter document provides guidance for management of all aspects of NPS units, including general principles for managing biological resources (section 4.4.1). In this section, it states that "the NPS will maintain as parts of the natural ecosystems of parks all plants and animals native to park ecosystems" and "will successfully maintain native plants and animals by:

1) preserving and restoring the natural abundances, diversities, dynamics, distributions, habitats, and behaviors of native plant and animal populations and the communities and ecosystems in which they occur;

2) restoring native plant and animal populations in parks when they have been extirpated (gone locally extinct) by past human-caused actions; and

3) minimizing human impacts on native plants, animals, populations, communities, and ecosystems, and the processes that sustain them."

In addition, NPS Management Policies 2006 states in section 4.4.1.1 that the NPS will:

"prevent the introduction of exotic species into units of the national park system, and remove, when possible, or otherwise contain individuals or populations of these species that have already become established in parks."

PURPOSE AND NEED

The **purpose** of this project is to preserve and restore populations of MYLFs and other native animals in high elevation lakes and streams at select sites in SEKI. This project will enhance protection for these native animal populations from the direct and indirect effects caused by the presence of introduced trout in naturally fishless habitats.

Introduced trout occur in approximately 570 lakes and ponds in SEKI. Their presence compromises reproduction by MYLFs, eliminates large aquatic invertebrates and zooplankton, and reduces the food available to other wildlife. In turn, the presence of introduced trout in lakes and streams across SEKI's landscape has fragmented the remaining MYLF populations and drastically reduced the frog's ability to re-establish populations that go extinct.

This project will create clusters of fishless habitat in several areas across SEKI. This will create more favorable conditions for the persistence of MYLFs, native animal populations, and natural ecosystem processes. This also will create new opportunities for visitors to experience the wildlife of pristine wilderness lakes and streams, while continuing to provide ample opportunities for recreational fishing,

The **need** for this project is to:

- Prevent further loss of ecological function provided by MYLFs;
- Prevent further loss of genetic diversity in MYLFs;
- Help maintain geographic distribution of MYLFs;
- Restore naturally functioning aquatic ecosystems within restoration areas.

PROPOSED ACTION

The NPS proposes to remove introduced trout populations from additional lakes and adjacent streams in Sequoia & Kings Canyon National Parks (SEKI). The restoration areas will be chosen using the best available scientific studies.

There are approximately 570 lakes and ponds that contain introduced trout in these parks, and SEKI is considering removing introduced trout from 5-15% of these sites. This equates to roughly 30-85 lakes and ponds in which introduced trout would be removed to restore MYLFs and aquatic ecosystems.

Looking at this from another perspective, 85-95% of introduced trout populations would remain in these parks and continue to allow for recreational fishing opportunities in approximately 485-540 lakes and ponds.

Managers estimate that restoration of 30-85 lakes and ponds would take approximately 15-30 years and would:

- Create small clusters of connected fishless lakes and streams in several areas in SEKI;
- Allow MYLF and other native animal populations to expand;
- Improve connectivity between remaining MYLF populations;
- Preserve genetic diversity in MYLFs;
- Continue to provide ample opportunities for recreational fishing across SEKI.

The current methodology of physically removing fish using gill nets and electrofishers takes one crew about five seasons to fully remove trout from three lakes. This works out to an average of less than one lake restored per crew per year. To increase the rate of restoration in both lakes and streams, SEKI is evaluating alternatives that remove introduced trout using both physical and chemical means.

PRELIMINARY ALTERNATIVES

An internal scoping was conducted to develop preliminary alternatives. All possible alternatives are being considered and analyzed to determine whether they meet the project purpose and need. The following preliminary alternatives are being considered for evaluation by the NEPA process:

- **Alternative 1 - No Removal of Introduced Trout to Restore MYLFs (No Action Alternative)**
  This alternative involves no removal of introduced trout to restore MYLFs and high elevation lakes and streams. Negative effects by introduced trout on MYLF and other native animal populations would continue to occur at their current level, with the MYLF remaining in jeopardy of going extinct.

- **Alternative 2 – Integrated Physical and Chemical Treatment (Proposed Action)**
  This alternative involves physically removing introduced trout using gill nets and electrofishers from sites where this method is feasible, and chemically removing introduced trout using piscicides from sites where physical removal is not feasible. It also includes reintroducing MYLFs to sites where they have been extirpated using the closest genetic forms available, and continuing to encourage research on MYLFs, chytrid fungus and its management, and the ecological functioning of high mountain lakes and streams.

- **Alternative 3 – Physical Treatment Only**
  This alternative involves physically removing introduced trout using gill nets and electrofishers from sites where this method is feasible, and no chemical removal of introduced trout. It includes reintroducing MYLFs to sites where they have been extirpated and encouraging the research described above. This alternative reduces the amount of habitat that can be restored but eliminates impacts from fish piscicides. Restoration of large deep lakes and sites with extensive stream systems would not be possible with this alternative.

- **Alternative 4 – Chemical Treatment Only**
  This alternative involves chemically removing introduced trout using piscicides from selected sites, and no physical removal of introduced trout. It includes reintroducing MYLFs to sites where they have been extirpated and encouraging the research described above. This alternative maximizes the amount of habitat that can be restored annually but the piscicides cause temporary environmental impacts of their own, particularly to stream invertebrates. This alternative is being considered only because the MYLF is declining rapidly.

ALTERNATIVES CONSIDERED BUT REJECTED

Biological Treatments – Use of sterile predatory fish to remove introduced trout populations is not acceptable due to high risks of 1) introducing exotic species to national parks and 2) unlimited feeding by these predatory fish on MYLFs and other native animals. This action also would involve excessive cost and complex regulatory permitting.

Captive Breeding & Reintroduction of MYLFs – Remove MYLFs from some populations to breed them in captivity, and then reintroduce individuals back into SEKI lakes and ponds. This action was dismissed due to the failure of existing efforts to successfully breed MYLFs in captivity in southern California, and due to the excessive costs needed to 1) develop facilities, 2) transport animals in and out of high elevation Wilderness, and 3) research and resolve the complex issues associated with captive breeding of sensitive amphibian species.

PRELIMINARY RESOURCE CONSIDERATIONS

Resource considerations which will be evaluated for each alternative include:

- Wildlife
- Vegetation
- Air quality
- Water Quality
- Geologic Resources
- Wilderness
- Health and Safety
- Scenic Resources
- Natural Soundscapes
- Recreation
- Archeological Resources

NEPA PROCESS AND TIMELINE

The overall planning process is anticipated to extend over a period of approximately 8 months. Project milestones include:

Project Initiation:	Oct 2006
Public Scoping:	Jan 2007
Analysis & Consultation:	Feb 2007
Document Preparation:	Mar 2007
Public Review:	Apr 2007
Final Decision Document:	Jun 2007

PUBLIC PARTICIPATION

We want your comments! Anyone interested in this planning effort is encouraged to visit: http://parkplanning.nps.gov/parkHome.cfm?parkId=342 which will contain information on current project activities.
Before including your address, phone number, e-mail address, or other personal identifying information in your comment, you should be aware that your entire comment – including your personal identifying information – may be made publicly available at any time. While you can ask us in your comment to withhold your personal identifying information from public review, we cannot guarantee that we will be able to do so. Anonymous comments may not be considered.
Comments can be emailed to: **SEKI_Superintendent@nps.gov**, or you may return the attached comment form to:

National Park Service
Sequoia and Kings Canyon National Parks
47050 Generals Highway
Three Rivers, California 93271
Attn: Compliance Office

WHAT'S NEXT?

Once we have received and reviewed the scoping comments, we will begin revising and analyzing the alternatives. The next step will be writing the analysis, available for review in spring 2007.

Thank you for your interest in Sequoia and Kings Canyon National Parks and your participation in the restoration of mountain yellow-legged frogs and high elevation lakes and streams.

Scoping Comment Form
Sequoia and Kings Canyon National Parks, California
Restoration of Mountain Yellow-legged Frogs and High Elevation Lakes and Streams
Environmental Analysis

Please respond to the following questions and **return this form by February 6, 2007**. You may attach additional pages if needed. Also, include your name, mailing address and email address (if applicable) in the space provided below. Thank you again for your interest in Sequoia and Kings Canyon National Parks' Aquatic Resources Program.

Before including your address, phone number, e-mail address, or other personal identifying information in your comment, you should be aware that your entire comment – including your personal identifying information – may be made publicly available at any time. While you can ask us in your comment to withhold your personal identifying information from public review, we cannot guarantee that we will be able to do so. Anonymous comments may not be considered.

What issues would you like to see addressed?

_____
_____
_____
_____
_____

What alternatives or restoration strategies would you like to see addressed?

_____
_____
_____
_____
_____
_____

Do you have additional information, concerns, or other comments about the proposal?

_____
_____
_____
_____
_____

Please check the box if you would like to remain on the mailing list to receive additional information concerning this proposal.

Name: _____ **E-Mail:** _____

Street/Box #:_____

City, State, Zip Code:_____

Mail To: **OR** **Email To:**

Sequoia and Kings Canyon National Parks
Attn: Compliance Office
47050 Generals Highway
Three Rivers, CA 93271

SEKI_Superintendent@nps.gov

SEQUOIA AND KINGS CANYON NATIONAL PARKS
Attn: Compliance Office
47050 Generals Highway
Three Rivers, California 93271

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Restoration of Mountain Yellow-legged Frogs and High Elevation Lakes and Streams Environmental Analysis

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47050 Generals Highway
Three Rivers, California 93271

National Park Service
U.S. Department of the Interior

Office of the Superintendent
47050 Generals Highway
Three Rivers, CA 93271-9651

(559) 565-3131 phone
(559) 565-3730 fax
http://www.nps.gov/seki

Sequoia and Kings Canyon National Parks
News Release

For Immediate Release – October 7, 2009
Contact Adrienne Freeman: (559) 565-3131

Sequoia and Kings Canyon National Park will be preparing an environmental impact statement (EIS) for a plan to restore high elevation aquatic ecosystems and mountain yellow-legged frogs within their historic range in the parks. A notice of intent to prepare an EIS was published today in the Federal Register provides more information on the proposal.

There are approximately 560 lakes and ponds within the parks that contain introduced trout, and removal of these non-native species from up to 15% of these sites will be considered. This project is needed to preserve and restore aquatic ecosystems and populations of native species, including mountain yellow-legged frogs in high elevation lakes and streams, creating new opportunities for visitors to experience native wildlife yet also maintaining recreational fishing opportunities.

Initially public scoping was conducted in early 2007, and it was anticipated an environmental assessment (EA) would be prepared to analyze the project. During that time, the parks received comments from over 30 different sources. As staff began the environmental analysis and re-examined information provided by the public, it became clear that the project had the potential for significant impacts on the human environment. There was a level of controversy associated with the proposal, potential for uncertainty and both adverse and beneficial consequences, and unique and unforeseeable environmental impacts. For these reasons, in early 2009 the Superintendent determined that an EIS would be prepared. An EIS is a more comprehensive document that is prepared when a federal action may result in a significant impact on the human environment.

All scoping comments received to date are included in the official administrative record; the Scoping Summary Report includes all comments and information obtained to date and is available on-line at *http://parkplanning.nps.gov/seki*. It is not necessary for previous letters to be resubmitted; however if prior respondents have new issues or information they wish to bring forward then new letters should be submitted. The public can submit comments on the project until November 21, 2009, online at: http:/parkplanning.nps.gov/seki, by email at SEKI_Planning@nps.gov, or by writing:

Superintendent
Aquatic Ecosystem Restoration
Sequoia and Kings Canyon National Parks
47050 Generals Highway
Three Rivers, CA 93271

Before including your address, phone number, e-mail address, or other personal identifying information in your comment, you should be aware that your entire comment - including your personal identifying information - may be made publicly available at any time. While you can ask us in your comment to withhold your personal identifying information from public review, we cannot guarantee that we will be able to do so.

-- NPS --

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APPENDIX E: PUBLIC COMMENT CONCERN / RESPONSE REPORT

INTRODUCTION

The National Park Service (NPS), Sequoia and Kings Canyon National Parks (SEKI) has prepared a plan and final environmental impact statement for the Restoration of Native Species in High Elevation Aquatic Ecosystems (Restoration Plan/FEIS) in Sequoia and Kings Canyon National Parks (SEKI).

The purpose of the Restoration Plan/FEIS is to guide management actions by the NPS to restore and conserve native species diversity and ecological function to selected high elevation aquatic ecosystems that have been adversely impacted by human activities, and to increase the resistance and resilience of these species and ecosystems to human induced environmental modifications, such as nonnative fish, disease and unprecedented climate change.

Action is needed at this time:

- because nonnative fish have severely reduced native biological diversity and disrupted ecological function;
- to prevent the extirpation of two species of mountain yellow-legged frogs (*Rana muscosa* and *Rana sierrae;* MYLF) in the parks and to restore MYLF populations to many locations in the parks where they have been extirpated;
- to further the NPS's mission and policy directives to conserve native animals, plants and processes found in SEKI's aquatic ecosystems;
- because large scale restoration of more complex habitat (areas containing large lakes or clusters of many lakes with many and/or large connecting stream sections) is critical for native species and ecosystem recovery;
- to increase the resistance and resilience of native high elevation aquatic species and ecosystems to human induced environmental change; and
- to enhance and preserve the natural quality of wilderness character.

As an implementation level plan, the Restoration Plan/FEIS provides detailed guidance on a variety of issues including, but not limited to: nonnative trout eradication, using both physical methods and piscicide use; basin selection; fish disposal; site assessments; active frog restoration methods including translocations / reintroductions and antifungal treatments; monitoring and continuing research; use of helicopters, stock, and crew camps; and, adaptive management.

This public comment concern/response report provides a summary of the public comments received during the public review of the Restoration of Native Species in High Elevation Aquatic Ecosystems Plan and Draft Environmental Impact Statement (Restoration Plan/DEIS) and includes responses to the comments. Although the public outreach process attempts to solicit and capture the full range of public concerns regarding the proposal, this report only reflects input from people who chose to submit public comments. This report, therefore, does not necessarily represent the sentiments of the entire public. The NPS focuses on the content of the comment rather than the number of times a comment was received. This report is intended to be a summary of the comments received, rather than a statistical analysis.

PUBLIC COMMENT PROCESS SUMMARY

On September 26, 2013, SEKI released the draft Restoration Plan/DEIS to the public; federal, state, and local agencies; tribes; and organizations for a 60-day public review period. In October 2013, due to an extended shutdown of the federal government, and the unavailability of federal systems that allowed the review of the draft plan, the public review period was extended to December 17, 2013.

The parks' staff presented elements of the Restoration Plan/DEIS at one agency/tribal meeting on November 19, 2013 at the Sierra National Forest, Bass Lake Ranger District in North Fork, CA; and at the following three public meetings. Total attendance at the public meetings was 39. The public meeting schedule was as follows:

- November 19, 2013: University of California-Merced, Fresno Center, Fresno, CA
- November 20, 2013: Three Rivers Arts Center, Three Rivers, CA
- November 21, 2013: Eastern Sierra Tri-county Fairgrounds, Bishop, CA

The public were able to submit their comments on the project using any of the following methods:

- Electronically through the NPS Planning, Environment, and Public Comment (PEPC) website
- By submitting written comments in person at the public meetings or by hand delivery to the park
- By mailing comments to the NPS
- By emailing comments to the NPS

NATURE OF COMMENTS RECEIVED

During the scoping period, 123 pieces of correspondence were received. Many comments were related to (1) piscicide use, (2) methods for fish removal, and (3) active frog restoration. All correspondences were entered into the NPS PEPC website. Comments that were not related to the Restoration Plan/DEIS for SEKI were coded as outside of the scope of analysis and are not included in this report.

All substantive comments that were within the scope of the Restoration Plan/DEIS, regardless of their topic, were carefully read and analyzed. Similar comments were grouped into "concern statements," and these concern statements with NPS responses are provided in this report. Most concern statements include a representative *quote*, which is verbatim text from public comments, whereas other responses include a representative *comment*, which summarizes the topic of concern, but are not direct quotes. The supporting quotes have not been edited; therefore spelling and grammar errors are not corrected. These supporting quotes are followed by information as to whether the comment author was an individual, or representing an agency, organization, or tribe. The full text of all correspondences received during the public review of the Restoration Plan/DEIS can be found on the PEPC website at: http://parkplanning.nps.gov/aquatics under "Public Documents."

PUBLIC CONCERNS AND NPS RESPONSES

CHAPTER 1 – PURPOSE AND NEED FOR ACTION

Concern 1: *The NPS needs to better explain the justification for the use of piscicides instead of the continued use of physical methods.*

Representative Quotes:
The DEIS fails to demonstrate that chemical treatments are necessary for achieving the overarching objective of the plan, which is to establish a network of fishless habitats for the benefit of frogs and other aquatic species. [Recreation Group, #110]

The document lacks the most crucial of all analyses, and that is whether it is truly necessary to apply chemical treatments to achieve the objective of establishing a network of refugia for mountain yellow-legged frogs. [Unaffiliated Individual, #112]

Response: In general, piscicides would be used where there is evidence (based on habitat assessments and previous fish removal efforts) that the water volume is too great or habitat is too complex for physical removal methods to be effective or efficient. The Restoration Plan/FEIS includes information explaining the reasoning behind the proposed use of piscicides (chapter 1, Background). To clarify, SEKI has proposed piscicide use in a subset of the proposed fish eradication areas. Park staff have been conducting fish removals in SEKI for approximately 15 years, and have learned from these efforts what habitat types are feasible using physical methods. The Restoration Plan/FEIS reflects this knowledge and directly factors into which methods are proposed at each site. Depending on the habitat, fish eradication can be achieved in many lakes and streams using gill nets and electrofishers (Restoration Plan/FEIS, chapter 1, Purpose and Need for a Plan). However, in other areas, the use of piscicides is necessary, and the more complex habitats needing piscicide treatment are important to the long-term success of restoring MYLF populations. Several additional alternatives were considered but dismissed in the Restoration Plan/FEIS (chapter 2). Additionally, genetic manipulation such as daughterless technology, which attempts to modify fish genes to eventually eliminate all females from a population, is in the early stages of development, is not a proven method (Britton et al. 2011), and even with this technology, fish are long-lived and could still persist for some time. Thus, it is not considered in the Restoration Plan/FEIS.

There are several factors that determine which type of treatment is necessary to accomplish fish eradication, and they relate to the feasibility of treatment methods, the probability of success, and the safety of crews conducting the work. The success of physical eradication methods in streams is primarily influenced by the length, size, and/or complexity of the treatment area. In lakes, physical eradication methods are effective for small to medium-sized lakes having accessible shorelines and no or relatively short or simple outlet streams before reaching a fish barrier. Simply applying more time using physical methods to a longer stream or a large, complex lake does not necessarily allow the park to meet eradication goals (e.g., Meyer et al. 2006). Depending on the habitat configuration, it can be very difficult to capture fish in streams and to determine if all fish have been captured, due to factors such as multiple braided channels, boulder crevices, undercut banks, woody debris, vegetation, and bubble curtains. In addition, (1) the typically low electrical conductivities of high Sierra streams allow fish to more easily swim away from electrofisher fields, and (2) electrofishing frequently misses the smaller fish size classes (Meyer et al. 2006), which then are given the chance to grow and breed in the absence of competition from the fish that are caught via electrofishing. Combine these difficulties with the need to capture all fish to achieve eradication, and it becomes apparent how the probability of success is diminished as length, size, and/or complexity of habitat increases.

Further, the high elevation, snowmelt-driven habitats in this plan typically have high water flows in June and July, leaving limited periods of lower flows in August and September when electrofishing is most safe and effective. This small window of time to electrofish, plus the considerable time necessary for gill netting, is too short of a period to allow for eradication to be achieved. In addition, in long stretches of stream with no barriers, fish have ample room to escape. Although block nets may theoretically limit fish dispersal, they are not feasible for this plan. Sites are remote and staffed by small crews with multiple duties, so crews would not be able to remove net debris (small branches, bark, caddisfly cases, heavy algae accumulation, etc.) frequently enough to keep nets from blowing out or becoming a wall of debris that can no longer catch fish.

With this information in mind, site assessments were conducted at each proposed removal site to determine which methods would be appropriate for achieving fish eradication. The results of those visits revealed that several sites would not be feasible using physical methods, due to having a large distance to the barrier (e.g., Amphitheater), or having excessive complexity (e.g., upper Evolution); these sites were proposed for piscicide treatment in the Restoration Plan/FEIS. Site assessments and further analysis determined that (1) two habitats proposed for physical eradication methods in the DEIS *may* only be feasible with piscicides (the outlet stream of Horseshoe, and part of the inlet stream in upper Bubbs); (2) two habitats proposed for piscicide use in the DEIS could achieve meaningful restoration using only physical methods (Barrett and Slide) by reducing the size of the treatment area; and, (3) one habitat proposed for piscicide use in the DEIS can be removed as a proposed fish eradication site (Moose Lake area of Tablelands) due to an abundance of nearby fishless habitat that can sufficiently support MYLF recovery in this park area. The Restoration Plan/FEIS has been updated to reflect these changes (chapter 2 and appendix B).

The Restoration Plan/FEIS proposes to use physical eradication even in selected stream locations where fish removal may be challenging because the probability for success is high. Physical removal methods are proposed for portions of McGee, upper Evolution, Barrett, upper Bubbs, Tablelands, Blossom, and Milestone. Although removing fish with physical methods would take several years, using physical methods has a high probability of success. In all areas proposed for piscicide eradication, park staff have determined that physical methods are not feasible and using physical methods has a low probability of success. The sites remain proposed for restoration because they have fish barriers which make them excellent restoration sites, and because they are important for creating fishless networks of critical MYLF habitats that have surface water connectivity, which is crucial for MYLFs to build and maintain self-sustaining populations that are resilient to environmental stressors. Although it was stated in the DEIS that piscicide treatment would be the preferred treatment method in a situation where time was critical for preventing the impending extirpation of a MYLF population, the final plan proposes physical treatments everywhere feasible and proposes piscicide treatments only where physical treatments were determined infeasible. After reevaluating the restoration areas, some large lakes and long stream sections proposed for piscicide treatment in the DEIS were either (1) excluded from the Restoration Plan/FEIS because restoring those areas would not be critical for the long-term recovery of native species (e.g., Moose Lake portion of Tablelands), or (2) the proposed methods were converted to physical treatment because site assessments revealed physical restoration methods would be feasible (e.g., Slide).

Some of the basins proposed for piscicide treatment can be eradicated of fish using a hybrid approach, in which the more logistically challenging and time-consuming route of physical fish eradication in the upper part of the basin is used in combination with piscicides to complete the treatment in the lower basin. Because the upper parts of basins typically have smaller streams and lower flows than the lower parts, physical methods (using an electrofisher) can accomplish fish removal from the inlet streams, but piscicides would need to be used to eradicate fish from the typically larger, longer and/or more complex outlet streams (see example in Restoration Plan/FEIS, appendix B). Piscicide treatments would be

conducted every 1-3 years (i.e., each year a different basin would be treated), which would allow all basins proposed for piscicide use to be completed within 15-20 years. Each treatment would take place over a 5-10 day period.

The use of piscicides allows the restoration of a larger number of viable sites across the landscape and enables greater connectivity among restored habitats. Research on other species of amphibians has documented the importance of maintaining genetic diversity in isolated populations to increase the probability of persistence in the presence of disease and other negative effects of habitat change (Savage et al. 2015). In fragmented landscapes, where populations are small, genetic diversity is lower and populations have less potential to adapt to change (Johansson et al. 2007), such as exposure to emergent pathogens (Pearson and Garner 2005). Piscicides would help restore sites with increased connectivity and thus potential for greater genetic diversity, as well as larger lakes and more complex basins that have a greater potential to be resilient to impacts of warming climate.

Concern 2: *The NPS needs to provide additional information on the overall project objectives and how success will be measured.*

Representative Quote:
The DEIS alone does not provide the necessary information on factors that evaluate successful eradication objectives for physical or chemical treatments. [California Department of Fish and Wildlife, #117]

Response: The Restoration Plan/FEIS explicitly states the overall project objectives (chapter 1, Objectives of the Restoration Program), which includes policies within which the objectives are grounded. The level to which each alternative is expected to meet each project objective is provided in the Alternatives Comparison Table (chapter 2, Table 15). Project success would be measured by how well the project objectives are achieved upon completion of the plan's implementation.

In general, if nonnative fish are eradicated from any of the proposed fish eradication areas, it would restore high elevation aquatic ecosystem habitat, creating more favorable conditions for native species populations to persist and be more resilient to human induced changes to environmental conditions. Quantitative measures of success would include the percentage of water bodies restored to fishless condition and the number of restored frog populations. If active frog restoration actions help stabilize and recover endangered MYLFs in SEKI, it would help ensure the self-sustaining, long-term viability and evolution of MYLF populations within portions of their present and historic geographic range within the parks, and help maintain the genetic and ecological diversity of these species. The plan's implementation would organically stimulate development of research priorities and studies to investigate them. The adaptive management component as described in the Restoration Plan/FEIS (chapter 2, Elements Common to All Action Alternatives) would allow the refinement of project methodologies over time. Nonnative fish eradication and native species restoration and conservation would restore and protect natural processes in wilderness. Restoring the most habitat and native species populations possible over the plan duration, while allowing fish to remain in hundreds of waterbodies, would provide an appropriate range of visitor experiences and recreational opportunities at wilderness lakes and streams concurrent with minimizing the degradations that have occurred to the biological integrity of high elevation aquatic ecosystems. The Restoration Plan/FEIS does not state a restoration success threshold above which would equate project success and below which would equate project failure. Rather, if the project actions are implemented, it is highly likely to achieve a net gain in restored habitat, restored native species populations, and fulfillment of the remaining objectives, which would constitute a successful project.

Concern 3: *The plan should include a discussion of how the plan would influence the long-term ecological and evolutional processes that are necessary for species persistence.*

Representative Quotes:
Specifically, the DEIS contains no discussion of the broader vision of how the plan would influence the long-term ecological and evolutionary processes that are necessary for species persistence. [Recreation Group, #110]

The preferred alternative of using both physical and chemical fish eradication methods will allow SEKI to restore a more diverse set of aquatic habitats than would be possible using only physical methods. This more diverse array of restored habitats should allow the persistence of a much more spatially-representative set of mountain yellow-legged frog populations (and populations of other aquatic species) in SEKI than would be the case under the "no action" alternative. [University of California, #35]

Response: The Restoration Plan/FEIS contains background information and the purpose and need for this project, including how the plan would restore multiple high elevation aquatic ecosystems across the parks and substantially contribute to "long-term ecological and evolutionary processes that are necessary for species persistence." It would take a great amount of detail to describe how this project would influence long-term ecological and evolutionary processes; however, the Restoration Plan/FEIS includes much of this information (chapter 1, Background). See also the last paragraph of the response to Concern 1 for discussion of the importance of restoration on habitat connectivity and genetic diversity.

Concern 4: *The DEIS should provide a sufficient explanation and rationale for how the removal of nonnative fish from high-elevation water bodies, with toxins, will guarantee the MYLF population will survive, combat the chytrid fungus, achieve better defenses against climate change, and develop networks throughout the park.*

Representative Quote:
The rationale that the Park Service employs to justify use of chemical poisons in backcountry lakes, ponds, and streams is fundamentally flawed and severely overstates the supposed need to resort to chemical treatments. [Recreation Group, #110]

Response: The survival of endangered species, including the MYLFs, cannot be guaranteed. However, the Restoration Plan/FEIS presents several years of analysis that illustrate a thorough understanding of the (1) status of nonnative fish and endangered MYLFs in SEKI, (2) feasibility of fish eradication across SEKI's lake basins, and (3) active frog restoration techniques (e.g., translocations and reintroductions) available to complement fish eradication in achieving MYLF recovery. SEKI believes the proposed plan has an appropriately large spatial design to restore aquatic ecosystem structure and function and recover MYLFs at the scale of the parks. The key is to have in each conservation area fishless habitats that are large, diverse and connected to support self-sustaining MYLF populations [U.S. Fish and Wildlife Service (FWS) *in preparation*], and other native species, over time.

Fish eradication would (1) increase the size and connectivity of fish-free habitat, which would better withstand drying and warming expected under climate change; (2) allow existing MYLF populations to increase in size and better withstand chytrid fungus (briefly, greater population size equates to greater genetic diversity such that some frogs may have genes that enable them to withstand amphibian chytrid fungus, survive, and perpetuate the population in the midst of a new environmental stressor); and (3) provide restored habitat for re-establishing MYLF populations that completely died off due to fish and/or disease. As stated in the Restoration Plan/FEIS, piscicide treatment is the key tool that would allow fish to

be eradicated in the basins where physical treatment is infeasible (see Concern 1, and chapter 1 and appendices C and J of the Restoration Plan/FEIS).

The specific water bodies targeted for piscicide treatment have evidence of current or previous MYLF presence, and thus possess the habitat requirements for MYLFs if nonnative fish were not present. However, several sites are not feasible for eradication using physical methods only (see Concern 1). Time is critical to these populations, which are in rapid decline. Even in habitats that are relatively simple compared to those at SEKI, successful restoration using physical methods can still take years of intense labor (Pacas and Taylor 2015). Piscicides are the only reliable tool available today to achieve fish eradication in these areas. Some of the targeted piscicide basins are critical for restoration because they are occupied by one of the few remaining MYLF populations or were occupied by MYLFs that recently died out. Restoring these populations to a healthier condition via fish eradication is the best chance to conserve them long-term. Their current state of being suppressed and fragmented by fish makes it more difficult for them to survive. For the few proposed piscicide basins in which MYLFs have already died out, fish eradication would allow populations to be re-established, filling in some of the large gaps in the species' range made by their decline.

The Restoration Plan/FEIS proposed action (alternative B) is designed to allow a much larger amount and diverse set of critical MYLF habitat to be restored than would be possible using only physical methods. This would allow a much more spatially-representative set of MYLF (and other native species) populations to persist in SEKI than would be the case under alternatives A or C. The restored MYLF populations would be larger, more genetically diverse, and more broadly distributed, in larger lakes or lake complexes connected by streams that are more climatically stable (Ryan et al. 2014). This would create populations of MYLFs more resistant and resilient to current and future threats than the small and fragmented populations that dominate SEKI today using only physical methods. Importantly, the larger restored populations would become source populations for translocations to allow for MYLF recovery in other areas. Therefore, piscicide use is critical to achieving the plan's primary objective of restoring aquatic habitats of sufficient size to allow the recovery of ecosystem structure and function at a park-wide scale.

Concern 5: *The NPS needs to better explain the translocation program and how it would benefit MYLF restoration.*

Representative Quote:
The DEIS fails to adequately disclose the high degree of uncertainty associated with the translocation of MYLFs to habitats from which fish are eradicated. [Recreation Group, #110]

Response: The DEIS provided background information on this topic in chapter 1, Purpose and Need for the Plan, and chapter 2, Elements Common to All Action Alternatives. The Restoration Plan/FEIS provides updates of these sections to better explain the translocation program and how it would benefit MYLFs. Some of the updated information is provided below.

MYLFs were afforded endangered status largely because (1) they have been eliminated from over 90% of their historic range, and (2) most remaining populations are small due to nonnative fish and disease, and fragmented and isolated by fish-containing habitat both within and between lake basins. Because MYLF populations have been extirpated from many basins, if translocations are not conducted, then there is no chance to re-establish extirpated populations and reclaim high quality fishless habitat that exists in many areas. While migration corridors are important to establish and maintain as fishless habitat, this is primarily effective at the within-basin scale, not at the park-wide scale. Natural recolonization is unlikely given the vast distances between occupied basins, and would still be of low probability even if frogs were

in all historically-occupied basins given the vastness of the landscape. Re-establishing populations through translocation in key fishless locations can contribute toward recovery of the species. In addition, several of the proposed fish eradication basins recently lost all of their MYLFs. These areas contain suitable habitat because they were recently occupied by frogs. Fish eradication followed by translocations in these areas would further contribute to recovery.

In this plan prioritization is being given to reintroducing MYLFs into fishless areas that were previously occupied by MYLFs but they have since died out or declined. SEKI is large enough and there are several hundred waterbodies with records of recent MYLF presence in which to conduct translocations or reintroductions over the timeframe of this plan. In addition, augmenting small, chytrid-infected (i.e., vulnerable) MYLF populations with genetically-similar animals moved from larger persistent populations is another action that would contribute to the overall recovery of the MYLF species.

While translocations have had mixed success including some failed attempts, the important implication for management is that some translocations have been successful in re-establishing populations to locations where they completely died-off. Four populations in YOSE have been re-established using similar methods; and two recently translocated populations in SEKI show promise to become self-sustaining. Carefully coordinated and executed studies that closely monitor success of translocated frogs as well as source populations allows us to gain new information that would contribute to the success of the next effort. Success would be based on the on the ability of source populations to sustain frog abundance levels, and by documenting successful breeding and recruitment in re-established populations.

CHAPTER 1 – PURPOSE AND NEED – Guiding Policies, Regulations, and Laws

NEPA, APA

Concern 6: *The Restoration Plan/DEIS violates the National Environmental Policy Act and the Administrative Procedures Act.*

Representative Quotes:
NPS did not rigorously explore alternatives, it did not objectively evaluate alternatives, and it did not adequately explain why proposed alternatives were eliminated. 40 C.F.R. 1502.14(a). [Non-governmental Organization, #123]

Failure to provide site-specific analysis, or even ecosystem analysis, for any of the waterbodies NPS proposes to poison, is a violation of NEPA. [Non-governmental Organization, #123]

The DEIS is not compliant with NEPA for its failure to evaluate the cumulative effects of these projects. [Non-governmental Organization, #123]

The DEIS' conclusions that there are no known rare or endemic macroinvertebrate species in the project area (for the unstated reason that no one has looked for them) and that there will be significant adverse effects and possible significant cumulative effects to such rare and endemic species does not comport with NEPA or CEQA's mandates that agencies take a hard look at the impacts of a project and provide sufficient disclosure and analysis to the public and to allow for truly informed decision-making. [Non-governmental Organization, #123]

The DEIS does not adequately identify the impacts or environmental effects of scattering and burying dead fish containing rotenone on the high-altitude environment, on the species that live nearby or that may feed on the poisoned fish carcasses, the claimed breakdown of rotenone and the toxicant's other

ingredients in the particular and varied environments in SEKI where NPS proposes to conduct the activities, and the DEIS does not adequately analyze the effects and impacts. Failure to do so violates the agency's obligations under NEPA, and the APA, 5 U.S.C. 551 et seq. [Non-governmental Organization, #123]

Response: With public input, the NPS developed and considered a range of alternatives – a total of 11 potential action alternatives and the no action alternative were originally identified for the plan. Of these, eight action alternatives were dismissed from further consideration for reasons described in detail in chapter 2. Three action alternatives and the no action alternative were carried forward for further analysis.

The Restoration Plan/FEIS provides a comprehensive discussion of the impacts from the four alternatives, including direct and indirect short-and long-term effects of the projects on water resources, rare and endemic species including invertebrates, and impacts from the disposal of treated fish. The document deals extensively with rotenone toxicity and its half-life; the sinking of nearly all fish carcasses in deep water minimizes exposure to other organisms. The NPS also considers other past, present, and future foreseeable projects in the area and on adjacent lands that could potentially affect similar resources, as is required in the cumulative effects analysis. In addition, site-specific surveys are included as an important component of this plan, both in evaluating sites for treatment alternatives, and for monitoring effects of selected treatments.

Concern 7: *The NPS does not meet the requirements under NEPA in regard to the proposed mitigation measures.*

Representative Quote:
However, the DEIS does not clearly indicate how the requirements of CEQA (California Code of Regulations, title 14, section 15000 et seq.) are met. For example, because NEPA does not require separate discussion of mitigation measures or growth inducing impacts, these points of analysis may need to be added, supplemented, or identified before the EIS can be used as an EIR. [Central Valley Regional Water Quality Control Board, #103]

Response: CEQA applies to state agencies in California and to federal agencies when state permits are required, as in this circumstance. As a federal agency, the NPS complies with NEPA which requires federal agencies to evaluate the impacts of major federal actions on the human environment, and with CEQA because it meets the requirements of California Code of Regulations title 14, section 15000 et seq.

The Council on Environmental Quality (CEQ) regulations indicate that mitigation measures can be integrated into EIS alternatives, stating, "Many Federal agencies and applicants include mitigation measures as integral components of a proposed project's design. Agencies also consider mitigation measures as alternatives when developing Environmental Assessments (EA) and Environmental Impact Statements (EIS)" 40 Code of Federal Regulations (CFR) § 1502.14(g), 1502.16(h). The Department of the Interior's NEPA regulations provide similar guidance (43 CFR § 46.130).

Reasonable mitigation measures were developed during the planning process with the input of subject matter experts and resource specialists. The parks also reviewed and considered the effectiveness of mitigation measures that had been used in similar projects on other federal and state lands and incorporated measures used in previous projects as appropriate. Mitigation measures were included as a component of the proposed action and treatment methods (i.e. project design) described in the Restoration Plan/FEIS. In addition, each site specific treatment plan would integrate the mitigation measures and a monitoring protocol as described in chapter 2, Mitigation Measures Common to All Alternatives.

Wilderness Act

Concern 8: *The plan does not adequately disclose the effects on wilderness.*

Representative Quotes:
Both physical and toxicant methods of nonnative fish removal will require substantial crew support to implement. The crew will include people, stock, helicopters (e.g., DEIS at 41, 44-45). The impacts that these crews, stock and helicopters will have direct and indirect environmental impacts on the application sites, and the DEIS has not adequately considered these impacts. (e.g. crews will leave their gear onsite over the winter months, DEIS at 45). [Non-governmental Organization, #123]

The use of chemicals that are highly toxic to all gill-breathing organisms is antithetical to the most fundamental goal of the Wilderness Act, which is to preserve and protect ecosystems in their natural condition. [Recreation Group, #110]

Response: The Restoration Plan/FEIS (chapter 4 and appendix A) provides a thorough analysis of how each alternative would affect the five qualities of wilderness character: untrammeled, natural, undeveloped, providing outstanding opportunities for solitude or primitive and unconfined recreation, and other features of value. As part of the planning process, the NPS prepared a minimum requirement analysis (MRA; appendix A). A key part of the MRA was to determine whether administrative action by the NPS is needed to restore native aquatic ecosystems, and if action is needed, to identify the minimum tools necessary to implement that action.

Through this process, the NPS determined that the project is necessary in wilderness to restore and preserve the natural character of wilderness (i.e. native ecosystems and native wildlife). The MRA considered several alternative methods to accomplish project objectives, and determined that a combination of helicopter and stock use is the minimum tool (appendix A). The use of chemicals (i.e. piscicides), although not specifically prohibited by the Wilderness Act, was considered in the MRA. While the use of chemicals results in short-term adverse effects on the untrammeled quality of wilderness character, as discussed in the Restoration Plan/FEIS (chapter 4), these adverse effects are considered acceptable and moreover are outweighed by the long-term beneficial effects that would result from the recovery of the high elevation native ecosystems to their natural condition (i.e. fishless), thus improving the natural quality of wilderness character that is adversely affected by the presence of fish.

The proposed project (including the limited use of piscicides in select locations) meets both the purposes of the Wilderness Act and the NPS Organic Act because it would result in long-term beneficial effects on the natural quality of wilderness character, and restore the native ecosystems of Sequoia and Kings Canyon National Parks.

NPS Organic Act and NPS Management Policies

Concern 9: *The proposed action goes against NPS preservation mandates and policies.*

Representative Quotes:
I can't imagine how this could benefit the whole ecosystem from all the invertebrates, other amphibians, insects, birds, and the life forms higher up on the food chain that would also be eating or drinking from poisoned waters. It would destroy the very wilderness character you are mandated to give the very highest protections to over any lands in the US. [Unaffiliated Individual, #115]

Is the Park Service really willing to run the risk of extirpating species it does not know are present? That seems a far cry from the Park Service's mandate to "preserve and protect" the natural communities of wilderness ecosystems. [Unaffiliated Individual, #112]

Response: Chapter 1 of the Restoration Plan/FEIS contains a discussion of applicable laws and policies and their relationship to the proposed restoration project. Among them, Section 4.4.4.2 of NPS *Management Policies 2006* recognizes that eradication of exotic plant and animal species is appropriate if (1) control is prudent and feasible, and (2) the exotic species interferes with natural processes and the perpetuation of natural features, native species or natural habitats. *Management Policies 2006* also allow for the use of pesticides when necessary and when other options to remove invasive species are not acceptable or feasible. During the planning process, NPS evaluated a wide range of alternative methods to remove nonnative trout. NPS retained for consideration those action alternatives that would further the purpose and need for the plan and that were consistent with applicable laws and policies. The NPS also developed and incorporated a number of mitigation measures and best management practices into the preferred alternative, as well as adaptive management techniques.

With regard to the potential extirpation of endemic species, the chance is remote that the number and extent of proposed rotenone treatments would extirpate anything but local populations of fishes. Untreated headwater streams would be present in most, if not all, basins, and not all waters in a basin would be treated with rotenone. Therefore, there would be refugia for other endemics, if present. In addition, common taxa would be expected to quickly recolonize treated areas; rarer taxa may not be detected for a number of years or indefinitely. If a rare taxon is not detected after treatment, there would be low confidence in concluding whether it were extirpated from the treatment area or present but not detected due to its rarity. If a treatment did cause the loss of a taxon from a treatment area, the same taxon would be expected to be present at other park sites and thus not be extirpated from the parks. An impact that would not be expected to threaten the continued existence of a species in the parks is defined as a moderate impact (see chapter 4, Table 22).

Concern 10: Trout have been occupying habitat in the parks for hundreds of years and should be considered native.

Representative Quotes:
The 'Non' native trout have been in these lakes and stream for over 100 years and as far as I am concerned are as 'Native' and precious to my wilderness experience and most others that I know. [Unaffiliated Individual, #1]

Response: As explained in the Restoration Plan/FEIS in chapter 1, Background, all trout are nonnative to all of the proposed restoration areas, which constitute up to 15% of nonnative fish-containing waterbodies in SEKI. Trout are considered nonnative because they were deliberately introduced by humans and, across western North American mountainous landscapes, they have significant negative ecological consequences for the entire ecosystems (Anderson 1971, Bahls 1992, Knapp 1996; see also appendix C for more detailed information). Per NPS *Management Policies 2006*, exotic (commonly referred to as nonnative) species are those species that occupy or could occupy park lands directly or indirectly as the result of deliberate or accidental human activities. Exotic species are also commonly referred to as nonnative, alien, or invasive species. Because an exotic species did not evolve in concert with the species native to the place, the exotic species is not a natural component of the natural ecosystem at that place (section 4.4.1.3), regardless of how long that species has been there. In addition, under this plan nonnative trout would continue to exist in 85% of the fish-containing waterbodies in SEKI.

California Proposition 65

Concern 11: *The EIS must explain how their proposed actions do not violate Proposition. 65.*

Representative Quote:
This proposal violates California Proposition 65 because the proposed chemicals are known to cause cancer or reproductive toxicity. Federal or state agencies involved in this project may be exempt, but their contractors may not be. [Conservation/Preservation, #124]

Response: Neither rotenone or antimycin A are on the State of California Environmental Protection Agency list of chemicals known to the state to cause cancer or reproductive toxicity. Proposition 65 is not relevant to the proposed project.

California Porter-Cologne Water Quality Act

Concern 12: *The NPS must consider the Porter-Cologne Water Quality Act goals in the EIS.*

Representative Quotes:
The Restoration Plan/DEIS should indicate that the designated beneficial uses of the water bodies in the project area, as identified in the Central Valley Water Board's Water Quality Control Plan for the Tulare Lake Basin (Second Edition, revised January 2004) and Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (Fourth Edition, revised October 2011) include municipal and domestic water supply, agricultural supply, hydropower generation, water contact recreation; non-water contact recreation; warm freshwater habitat; cold freshwater habitat; wildlife habitat; rare, threatened, or endangered species habitat; spawning, reproduction, and/or early development habitat; and freshwater replenishment. [Central Valley Regional Water Quality Control Board, #103]

This project would violate the no discharge without a NPDES permit requirements of Clean Water Act and the Porter-Cologne Water Quality Act. The NPS would need to obtain a NPDES permit for the discharge of aquatic pesticides to waters of the U.S. [Non-governmental Organization, #123]

Response: The Porter-Cologne Water Quality Act established a statewide program for the control of the quality of all waters of the state of California. The principles, guidelines, and objectives of the state water quality control are aligned with those of the Clean Water Act and Sequoia and Kings Canyon National Parks – that beneficial uses are to be protected, and impairment of water quality is to be avoided. As described in the Restoration Plan/FEIS (chapter 3, Water Quality), the State of California considers the surface water of the parks to be beneficial for wildlife and as freshwater habitat, contact and non-contact recreation, freshwater replenishment, and municipal and domestic water supply as indicated in the California Water Quality Control Board's Central Valley Regional Water Quality Control Plans for the Tulare Lake Basin (CRWQCB 2015A)and the Sacramento and San Joaquin River Basins (CRWQCB 2015A) and the Sacramento and San Joaquin River Basins (CRWQCB 2015B).

The effect on water quality was evaluated in the Restoration Plan/FEIS (chapter 4). Prior to implementation, the NPS would obtain the appropriate permits from the State and the U.S. Army Corps of Engineers, including a NPDES permit for discharges from piscicide applications.

Clean Water Act

Concern 13: The NPS must consider the effects on water quality and must not violate the Clean Water Act.

Representative Quote:
The NPS must consider the antidegradation policy (40 CFR section 131.12) in the DEIS and must described how any degradation of the high quality waters in the project area is consistent with maximum benefit to the people of the State and is necessary to accommodate important economic or social development. The DEIS should also indicate how the discharge will not unreasonably affect beneficial uses of the affected water bodies. [Non-governmental Organization, #123]

Response: The Restoration Plan/FEIS describes the methodology for analyzing impacts (chapter 4, Water Quality) including the consideration of the antidegradation policy. The antidegradation policy is only one portion of a water quality standard. Part of this policy (40 CFR 131.12(a)(2)) strives to maintain water quality at existing levels if it is already better than the minimum criteria. Antidegradation should not be interpreted to mean that "no degradation" can or would occur, as even in the most pristine waters, degradation may be allowed for certain pollutants as long as it is temporary and short-term. Each alternative was examined to determine its effect on surface water (lakes, ponds, streams and runoff). Analysis focused on common biotic and abiotic water quality measurements that could be impacted by project actions. These include changes in hydrology, water chemistry, turbidity, and microbial communities. None of the alternatives would result in a degradation of the high quality waters in the project area, alter economic or social development, or unreasonably affect beneficial uses of the affected water bodies (see Restoration Plan/FEIS, chapter 4, Water Quality).

California Environmental Quality Act (CEQA)

Concern 14: *The NPS must prepare a document that complies with the requirements of the California Environmental Quality Act (CEQA).*

Representative Quote:
Supplemental information may be required in the final EIS to satisfy CEQA requirements, including, but not limited to a consideration of environmental impacts pursuant to California Code of Regulations, title 14, section 15126. [Central Valley Regional Water Quality Control Board, #103]

Response: The Restoration Plan/FEIS is a NEPA/CEQA compliant document. It discusses significant environmental effects on the proposed project (chapter 4) and includes significant environmental effects which cannot be avoided (chapter 4, Adverse Impacts that could not be avoided) and significant irreversible environmental changes which would be involved in the proposed project should it be implemented (chapter 4, Irreversible or Irretrievable Commitment of Resources). Mitigation measures are detailed in chapter 2 (Mitigation Measures Common to All Alternatives), as are alternatives to the proposed project. There is not potential for growth-inducing impact resulting from the proposed project. The project occurs in wilderness and there is no potential for population growth or economic growth in the parks' wilderness as a result of project implementation.

Endangered Species Act (ESA)/California Endangered Species Act (CESA)

Concern 15: *The NPS must analyze the effects to listed species such as the MYLF and Yosemite Toad in the EIS, and consult with the US Fish and Wildlife Service, per Section 7 of the Endangered Species Act, and must comply with the California Endangered Species Act.*

Representative Comments:
The NPS must analyze the effects to listed species such as the MYLF and Yosemite Toad in the EIS, and consult with the US Fish and Wildlife Service, per Section 7 of the Endangered Species Act. [Non-governmental Organization, #123]

Actions carried out by non-federal employees may result in the "take" of any species listed as threatened or endangered under the California Endangered Species Act (CESA), thus the California Department of Fish and Wildlife may need to issue an Incidental Take Permit (ITP) (Fish and Game Code Section 2080 et seq.), and consultation with CDFW is warranted. [California Department of Fish and Wildlife, #117]

Response: In February 2016, SEKI prepared a Biological Assessment per Section 7 of the Endangered Species Act to analyze the effects of the Restoration Plan/FEIS on listed species. The FWS responded to the NPS on May 25, 2016 with a Biological Opinion, included in appendix L. The FWS concurred that the Restoration Plan as proposed may affect, but is not likely to adversely affect the Sierra Nevada bighorn sheep, nor adversely affect its critical habitat. The FWS found that the proposed project is not likely to adversely affect critical habitat for the little Kern golden trout. The Service's biological opinion is that the SEKI Restoration Plan, as proposed, is not likely to jeopardize the continued existence of the Sierra Nevada yellow-legged frog, northern DPS of the mountain yellow-legged frog, Yosemite toad, and Little Kern golden trout.

It is the Service's biological opinion that the SEIKI Restoration Plan, as proposed, is not likely to destroy or adversely modify proposed critical habitat for the MYLF or Yosemite toad. The Service reached this conclusion because the project-related effects to the proposed and designated critical habitat, when added to the environmental baseline and analyzed in consideration of all potential cumulative effects, will enhance the value of the affected key components, or PCEs, to provide for the conservation of these species based on the following: (1) effects to essential physical or biological features will be temporary; (2) these actions will not destroy any essential physical or biological features of the habitat; and (3) the Restoration Plan will enhance proposed critical habitat via removing predatory fish. The effects to Sierra Nevada yellow-legged frog and northern DPS of the mountain yellow-legged frog proposed critical habitat are small and discrete, relative to the entire area designated, short in duration, and are expected over time to appreciably enhance the value of the critical habitat for the conservation of the Sierra Nevada yellow-legged frog, northern DPS of the mountain yellow-legged frog, and the Yosemite toad. This information is included in the Restoration Plan/FEIS in chapter 4, Special-Status Species and in appendix L.

The NPS is not required to obtain an incidental take permit from the California Department of Fish and Wildlife (CDFW). However, CDFW reviewed and provided comments on the proposal and all substantive comments from CDFW were considered, and the plan updated where appropriate.

Resource Conservation and Recovery Act Of 1976 (RCRA)

Concern 16: *The NPS must consider the RCRA as part of the project because burying and scattering of dead fish constitutes a disposal because fish and poison may enter the environment, resulting in a substantial endangerment to human health and the environment.*

Representative Quote: *The DEIS Alternative B proposes disposal of killed fish by transporting rotenone and neutralizer-laden fish away from the water body, and disposing of the dead fish by scattering and burying them in nearby terrestrial areas away from trails and campsites. DEIS at 59. The Commenters believe that the dead fish, and the poison remaining in their carcasses, are 'solid waste' within the meaning of RCRA, that the NPS's action of burying and scattering would constitute 'disposal' as fish and*

the poison in them may enter the environment, and that leaving fish with poison in them may constitute and imminent and substantial endangerment to health, or to the environment. [Non-governmental Organization, #123]

Response: The Resource Conservation and Recovery Act of 1976 (RCRA) does not apply in this situation. RCRA gives the Environmental Protection Agency the authority to control and manage hazardous waste. Per the RCRA, section 1004 (5), the term ‘‘hazardous waste’’ means a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may—(A) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.

Per this definition, the disposal of dead fish as a result of project implementation does not constitute a hazardous waste. The concentration of rotenone that may be contained in fish tissue at the time of death would be so low that hundreds of fish would have to be consumed by humans or other animals to even have a chance at having a negative effect (Restoration Plan/FEIS, chapter 4, Vertebrates). This level of accumulation does not meet the RCRA definition of a hazardous waste. This conclusion is consistent with the product label for CFT Legumine™, which does not require treated fish to be removed from the habitat (Zoecon 2015). Similarly, trout collected from high elevation lakes in SEKI have been found to have low mercury (Hg) levels, which are well below levels of concerns for human consumption (Eagles-Smith et al. 2014). Although certain semi-volatile organic compounds have been found in fish in SEKI, the contaminant levels were below the EPA threshold for recreational fish consumption (Flanagan Pritz et al. 2014). Additionally, rotenone has a low tendency to bioaccumulate in fish (Gingerich 1986, EPA 2007A).

Since most lake systems in the high Sierra are oligotrophic (nutrient lacking), the best ecological option is to return nutrients contained in fish back to the aquatic ecosystem directly. Thus, floating fish would have their swim bladders punctured so they sink to the substrate of deep lakes. In addition, from a practical standpoint, burying potentially thousands of dead fish in shallow, high elevation soils would be very difficult to achieve, and could potentially act as a significant attractant for scavengers.

Wild and Scenic Rivers Act (WSRA)

Concern 17: *The NPS violates the WSRA because it does not make adequate provisions in the plan to prevent rotenone from entering wild and scenic rivers.*

Representative Quote:
However, "[t]he furthest downstream points in the two streams proposed for piscicide treatments are approximately 650 feet and 820 feet & upstream of the wild and scenic river boundary." (DEIS at 182). NPS does not make adequate provisions to prevent rotenone from entering wild and scenic areas. [Conservation/Preservation, #124]

Response: None of the proposed restoration sites are within designated or eligible wild and scenic rivers segments. All of the sites proposed for piscicide use, except one, are far from designated wild and scenic rivers or river segments. One site in Upper Kern basin that is proposed for piscicide treatment is near the headwaters of the North Fork of the Kern River, which is designated as “Wild” under the WSRA. The furthest downstream points in the two streams proposed for piscicide treatment are approximately 200 meters and 250 meters upstream of the wild and scenic river boundary. While no work would occur directly within designated sections of these rivers, proposed fish eradication basins would be located within the watersheds feeding these rivers.

Through treatment methods and project mitigation, the potential for rotenone to enter wild and scenic rivers is low. Rotenone would be neutralized by the careful addition of potassium permanganate to the water at established locations downstream from the treatment sites. Fish baskets would also be placed downstream of the neutralization station. Mortality of these fish would alert workers to potential releases of excess chemical in the event of human or equipment error and potential downstream effects. If this occurs, potassium permanganate levels would be increased to neutralize the excess rotenone, from the typical concentration of 3 ppm to no more than the maximum concentration of 5 ppm as described in this plan. In addition, users downstream would be alerted.

During and after rotenone treatments, water quality would be monitored to assess the effects of treatment on surface waters and bottom sediments. The monitoring would determine that: (1) effective piscicide concentrations of rotenone are applied; (2) sufficient degradation of rotenone has occurred prior to the resumption of public contact; and (3) rotenone toxicity does not occur outside the project area. An analytical laboratory would analyze water samples for rotenone and rotenolone concentrations as well as for volatile organic compound and semi-volatile organic compound concentrations. The parks would also develop and implement a spill contingency plan that addresses chemical transport and use guidelines, as well as spill prevention and containment that adequately protects water quality. The spill contingency plan would be maintained on site.

The analysis in chapter 4 of the Restoration Plan/FEIS concluded that the project would not degrade river values or water quality for any of the wild and scenic rivers located in fish eradication basins. In addition, the Wild and Scenic Rivers Act does not prohibit the use of piscicides.

CHAPTER 2 – ALTERNATIVES

Concern 18: *The NPS should provide detailed treatment plans describing the methods of applications, locations, numbers of treatments required at each site, and timing.*

Representative Quote:
The DEIS indicates that SEKI will develop site specific treatment plans during the years immediately prior to treatment, and that the precise areas to be treated by different methods will be developed following thorough surveys of each site. It is unclear what information will be included in these future treatment plans, and it is unclear what type of surveys will occur the years prior to and the year of treatments. The Department recommends that SEKI include additional language thoroughly describing the content of future site-specific Treatment Plans. [California Department of Fish and Wildlife, #117]

Response: All site assessments, which show treatment locations, have been completed. A site assessment example is included as appendix I in the Restoration Plan/FEIS. Treatment application methods are provided in the Restoration Plan/FEIS (chapter 2, alternative B). More detailed treatment protocols are also provided (appendix N), including an estimated implementation timeline. A second type of site assessment for proposed piscicide treatment areas would occur immediately prior to treatment, rather than be incorporated into this plan, because it would measure characteristics that change from year-to-year (such as stream flow and piscicide travel times), which are important for planning the specifics of a given treatment area. The results of these fine-scale assessments would be communicated to stakeholders using methods described in a project communication strategy, which is provided in the Restoration Plan/FEIS.

Concern 19: *The NPS needs to complete site assessments prior to making a final decision on which sites would be included in the physical and piscicide treatment plans.*

Representative Quote:
To better describe the actual conditions at each of the proposed fish eradication sites I would encourage SEKI to finish all site assessments during summer 2014 and include those assessments in the final EIS. [University of California, #35]

Response: All site assessments have been completed and an example has been included in appendix I in the Restoration Plan/FEIS.

There are two different types of site assessments, each with different purposes. The first type, which has been completed, was to determine which areas were or were not feasible for each type of restoration method (i.e., physical methods or piscicides). These site assessments also included information on the distribution of fish and amphibians, the location and reliability of waterfalls/cascades to act as fish barriers, lake size/depth, and spatial arrangement and connectivity of aquatic habitats in the area.

The second type, which has not occurred yet, requires more detailed information about the sites (i.e., more precise information on the distribution of amphibians, invertebrate surveys in the first two to three treatment sites, and certain habitat characteristics. The second type of site assessment is required to determine a specific treatment plan but not required to determine treatment feasibility. The second site assessment would help develop the specific treatment plan (e.g., how many piscicide metering stations and sprayers would be needed for stream and peripheral treatment areas, how much product would be needed to treat all of the aquatic habitat, and the quantity of potassium permanganate needed to neutralize piscicides along the outflow of the treatment area). The second type of assessment would occur immediately prior to treatment, rather than be incorporated into the Restoration Plan/FEIS, because it would measure characteristics that change from year-to-year, which are important for planning the specifics of a given treatment.

Concern 20: *The NPS needs to provide additional information about the selection of the proposed sites, including details on habitat features, barriers to fish passage, and fish presence/absence, and how the numbers of lakes/basins to be treated was derived.*

Representative Quote:
The DEIS asserts (pg. 41) that waterbodies were selected from across the parks to ensure the proposed sites would restore and conserve native species, genetic diversity and ecosystem processes in areas encompassing the geographic and elevational diversity contained within the parks. However, it provides no further information on how this was assessed. [Recreation Group, #110]

Response: Detailed habitat, fish population, and MYLF population data has been derived from an extensive number of lake surveys, studies, and restoration actions conducted by collaborating researchers and SEKI staff since 1997. These data were used to consider and select basins for proposed fish eradication by deriving (1) the location of existing or recently-died-out populations of endangered MYLFs that could benefit from fish eradication, (2) genetic diversity of MYLFs across the parks, (3) where eradication is likely feasible, and (4) how many sites could be completed in a 25-35 year time frame. Park staff then conducted site assessments to confirm feasibility, including whether restoration can be achieved with physical methods, or if piscicides are necessary. Whether a lake is too large to be feasible for physical eradication is determined from a combination factors, such as lake volume; maximum depth; shoreline accessibility; fish population structure and density; amount and locations of fish spawning habitat; and the size and complexity of tributaries. The determination is made by experienced staff and consulting with collaborators. This process gave us detailed information from which to develop and propose a park-scale plan heavily based on science and local experience.

Basin selection criteria are shown in the Restoration Plan/FEIS (chapter 2, table 7, and Elements Common to All Action Alternatives, Basin Selection). Alternative B describes the development of site-specific treatment plans.

Concern 21: *The NPS should provide information on how waterbodies selected for rotenone or physical treatment can withstand climate change.*

Representative Quotes:
The DEIS does not explain how the waterbodies selected for rotenone treatment relate to establishing MYLF populations that can withstand climate change or fungal infections. [Non-governmental Organization, #123]

Will climate change make it a futile effort? According to a recent article that I read, frog populations are experiencing a dramatic decline throughout the world. [Unaffiliated Individual, #100]

Response: The Restoration Plan/FEIS provides information on climate change (chapter 1, chapter 2, and appendix B). To summarize, fish eradication would substantially increase the size (surface area and volume) and connectivity of fish free aquatic habitat in each of the proposed fish eradication basins. These larger and deeper habitats would better withstand drying and warming expected under climate change as compared to the current fishless habitat in each basin that in many cases is small and shallow. Therefore, native species such as endangered MYLFs in each basin would have access to additional suitable habitat that would have a much better chance of persisting (not drying up) in the face of climate change. Improving habitat size and connectivity benefits additional native species in these basins and also improves genetic diversity (connecting disparate populations), contributing to more effective disease resistance.

Concern 22: *The NPS has not provided sufficient evidence that connectivity would be achieved in the specific lakes and streams proposed for treatment.*

Representative Quotes:
There is passing mention of the need to establish "whole basins" that are fishless, as well as to build connectivity among populations. However, there is no substantive, spatially explicit analysis of how that would be accomplished by the Plan. [Unaffiliated Individual, #112]

You need to concretely demonstrate that connectivity would in fact be achieved for the specific lakes and streams proposed for treatment. . . Justification needs to be provided on a site-specific basis. [Unaffiliated Individual, #112]

Response: As explained in the Restoration Plan/FEIS (chapter 2, Elements Common to All Action Alternatives) and in alternative B, the proposed action would result in a restored network of aquatic habitats for MYLFs and other native species that have improved connectivity at the basin scale.

Fish eradication substantially improves habitat suitability for native species by removing a major environmental stressor - predation and competition for food by nonnative fish. The high lake basins in SEKI consist of collections of lakes, ponds, and wetlands connected by streams. In basins occupied by nonnative fish, the fish typically occupy larger lake and stream habitats while endangered MYLFs are typically restricted to small and shallow pond and wetland habitats, which are vulnerable to drying expected under climate change projections (Lacan et al. 2008). Fish eradication removes the habitat fragmentation caused by nonnative fish, thereby substantially improving connectivity of suitable habitat between waterbodies.

The proposed treatment sites were included in the Restoration Plan/FEIS because they are important for creating fishless networks of critical MYLF habitats that have surface water connectivity, which is crucial for MYLFs to build and maintain self-sustaining populations that are resilient to environmental stressors (Pittman et al. 2014). As an example of fish eradication providing resilience for MYLF populations experiencing an outbreak of amphibian chytrid fungus, consider one of SEKI's long-term restoration areas, Sixty Lake Basin. By the early 2000s, fish were eradicated from three lakes. The MYLF populations in these three lakes were disease-free for approximately five years, during which time the frog populations increased substantially. The populations then became infected with amphibian chytrid fungus, and experienced die-offs. One lake, with no stream connectivity to other lakes, completely lost its MYLF population. The other two lakes, both with stream connectivity in a multi-lake complex, continue to have small, persisting MYLF populations. Observed patterns of chytrid-caused die-offs suggest that the MYLF populations in the two restoration lakes still containing MYLFs could have completely died out if fish eradication had not taken place (R. Knapp, unpublished data). Eradication provided several critical years during which MYLF populations were able to expand before they became infected.

Restoring MYLF populations to a healthier condition via fish eradication is the best chance to conserve them long-term. Left in their current state of being suppressed and fragmented by fish makes survival much more difficult. For the few proposed basins in which MYLFs have already died out, fish eradication would allow populations to be re-established, filling in some of the large gaps in the species' range made by their decline.

Concern 23: *The NPS needs to provide more details on how fish disposal will occur.*

Representative Quotes:
Give more detailed information on how the dead fish will be dealt with (the DEIS notes they will be sunk to the bottom of water bodies or buried, but this does not adequately identify or assess the risks of this proposal). [Non-governmental Organization, #123]

As written, it is unclear whether SEKI's proposed use of rotenone will adhere to the EPA guidelines for this piscicide. For example, rotenone users are encouraged to collect and bury dead fish (bullet #2). However, in numerous places in the DEIS it is stated that fish will be collected and either buried or scattered. [University of California, #35]

Response: The Restoration Plan/FEIS provides a description of fish disposal methods (chapter 2, Elements Common to All Action Alternatives) which has been modified slightly from the DEIS. Fish carcasses would be left in deeper waterbodies proposed for restoration (i.e., carcasses would remain in larger waterbodies, or they would be moved from small, shallow waterbodies to nearby larger waterbodies). Since most lake systems in the high Sierra are oligotrophic (nutrient lacking), the better ecological option is to return nutrients contained in fish back to the aquatic ecosystem directly. Thus, floating fish would have their swim bladders punctured so they sink to the substrate. In addition, from a practical standpoint, burying potentially thousands of dead fish in shallow, high elevation soils would be very difficult to achieve, and could potentially act as a significant attractant for scavengers.

Also, nonnative fish are essentially composed of nutrients that would otherwise be available to native biota within the same waterbody. Thus, returning the carcasses of fish to the waterbody from which they are removed (or to one nearby) is the most consistent approach with the NPS policy of maintaining and conserving native species.

Concern 24: *The NPS needs to provide additional details on how marshes will be treated.*

Representative Quotes:
One of the many troubling parts of this DEIS is its lack of description of the "marshes" NPS proposes to poison. There is no public record of EIS's or EA's that document or describe how a marsh would be poisoned. The DEIS merely states NPS may use a boat or raft; in other words, it sounds like NPS proposes to treat a marsh as if it were a lake or pond. [Non-governmental Organization, #123]

It is extraordinarily difficult to chemically spray every single pocket of water where a small fish may be residing. Further, rotenone quickly adsorbs to both emergent vegetation and sediment, reducing its effectiveness in ponds, marshes, and other wetland habitats. Consequently, achieving 100% fish eradication in these more complex habitats will likely take multiple treatments, probably over many years. [Recreation Group, #110]

Response: A more-complete definition of "marsh" habitats proposed for piscicide treatment in alternatives B and D is included in the Restoration Plan/FEIS. The marsh areas constitute a small proportion of the areas proposed for piscicide treatment. Many areas highlighted as marsh are ephemeral habitats that dry yearly. Large portions of the areas highlighted by yellow marsh labels in the maps included in appendix B of the Restoration Plan/FEIS would not require treatment because they would either be dry or unsuitable for fish occupancy. Additionally, many locations listed as marsh are essentially small, shallow ponds, rather than what many people think of as traditional marshes found at lower elevations. For example, one traditional definition of a marsh is "*a frequently or continually inundated wetland characterized by emergent herbaceous vegetation adapted to saturated soil conditions*" (Mitsch and Gosselink 2007, pg. 32). Areas labeled as marshes in the Restoration Plan/FEIS, apart from being consistently saturated and containing varying amounts of vegetation, are effectively small, shallow, open ponds, or small order stream widenings with some vegetation. Therefore, the term marsh is largely a misnomer in the context of the habitats highlighted in the Restoration Plan/FEIS, and probably better labeled as "ephemeral wetland habitats." These areas are referred to as marshes to remain concise; however, it is understandable that this has led to some confusion about the proposed areas.

Concern 25: *The NPS needs to provide a better justification as to why currently fishless lakes would not be used in the translocation program.*

Representative Quotes:
The Park Service fails to provide information on currently fishless lakes and streams that currently provide potential refuge for MYLFs and other aquatic species. Again, this information is critical for making an informed decision about how the proposed treatment lakes fit into the broader scheme of restoration. [Recreation Group, #110]

Has the Department evaluated placing MYLF in these fishless basins and are the doing so? If not, why not? [Unaffiliated Individual, #52]

Additionally, there are hundreds of fishless lakes in the Sierra where the frog could be introduced... maybe try these first before gill-netting self-sustaining trout lakes. [Unaffiliated Individual, #46]

Restrict frog transplantation projects to the many lakes in the Sierra that are already devoid of fish. [Unaffiliated Individual, #75]

Response: Currently fishless lakes would be used extensively in proposed translocation and reintroduction efforts. For example, fishless waterbodies in which MYLFs are extant (or recently extirpated) would be considered for MYLF conservation actions. However, fishless lakes would not be used exclusively, in part because nonnative fish occupy a disproportionate number of large, deep,

perennial lakes when compared with all available lakes in SEKI. MYLF populations require these larger, more persistent waterbodies to sustain populations in the long term. Therefore, fish eradication is needed to allow native species to recolonize numerous quality habitats from which they have been excluded by nonnative fish for decades.

Moving MYLFs into currently fishless basins where there are no records of MYLF occupancy is not recommended in the Restoration Plan/FEIS. The reasons include:

1. The MYLF populations of imminent conservation priority are those persisting in the presence of amphibian chytrid fungus. All persistent MYLF populations are small and many would not be able to sustain take from adult translocations until populations are larger. In most cases, MYLF populations could not expand until provided with additional habitat through fish eradication. Given that these populations are small and threatened with imminent extirpation, translocations and reintroductions should be focused on moving the available MYLFs into large, fishless habitats in which there are previous records of MYLF occupancy.

2. It is unnecessarily risky to attempt moving the small number of MYLFs available for translocations and reintroductions into areas not known to have contained MYLF populations in the past. There could be numerous factors that have naturally prevented unoccupied fishless areas from sustaining MYLF populations, including habitat unsuitability. The more reasonable approach is to utilize habitats in which MYLFs have been known to occur because these areas are currently suitable for MYLFs (or have been in the recent past).

3. Collaboration with captive rearing facilities is needed to increase survival of young frogs in infected populations, and to reduce infection intensities in adult frogs in large populations that become infected. This is an intricate process that involves collections, transportation, husbandry, antifungal treatments, reintroduction to the wild, and time needed for long-term survival and reproduction to ultimately achieve recovery. Current capacity at captive-rearing facilities is extremely limited, and SEKI is one part of a larger range of MYLFs that has declined by >90%. Therefore, SEKI MYLF populations would need to compete with populations from other regions for assistance from captive-rearing facilities. Captive-rearing facilities would be used when available, but the Restoration Plan/FEIS cannot rely exclusively on translocations and reintroductions. Additionally, literature shows that reintroductions and translocations can be successful, but they typically need repeated infusions before becoming self-sustaining (Dodd 2005, Griffiths and Pavajeau 2008). Although worth the efforts, additional reintroduction and translocation efforts would add to the complexity, time, and outside support needed for success.

4. Nonnative fish have caused severe effects across the parks' high elevation landscape. Eradicating fish has been shown to provide substantial ecosystem benefits. NPS mission and policies guide us to conduct this work when and where feasible. Restoring several fishless basins for native species is justified by policy, regardless of MYLF population status.

Over the 25-35 year timeframe of this plan, there is no to little need to consider additional fishless waters where there is no documentation of frogs occurring because there are sufficient numbers of fishless waters available where frogs occur or were known to occur.

Concern 26: *The NPS needs to be willing to research and use additional methods such as fyke nets, in addition to the methods proposed in the plan, and as an alternative to piscicide treatment.*

Representative Quotes:
Electrofishing alone will not result in extirpation of nonnative fish from streams, although downstream electrofishing into fyke nets can vastly increase capture rates…[Unaffiliated Individual, #39]

*Most of the proposed treatment lakes in SEKI have either golden and rainbow trout in them. Because these species must spawn in running waters, eradication should be possible through a combination of gill netting within the lakes, and trapping (fyke nets, minnow traps) or electrofishing in the inlet or outlet stream*s. [Unaffiliated Individual, #112]

Response: For a description of why piscicide treatment is needed, see the response to Concern 1. This response also describes why physical methods, which would include using devices such as fyke nets, would not be feasible for eradicating fish from the proposed piscicide treatment areas. Fyke nets are usually set in open water along the shoreline of lakes and use wings to direct fish into a fyke or box. In lakes, a fyke net is most effective for use with species of fish that favor cover associated with shoreline and not open water pelagic species such as trout (Lake 2013). Thus, fyke nets would not be effective in Sierra Nevada lakes where the trout are found in open water. Other types of traps (such as wire boxes that can trap fish at the mouth of inlet and outlet streams) are labor-intensive and need to be serviced daily during spawning season. While they would capture some of the trout that migrate out of lakes to spawn, they would not eliminate the trout population.

Concern 27: *The NPS needs to incorporate adaptive management into this project which includes an assessment of the impacts of piscicides on resident aquatic fauna, further research on contaminants, and be willing to modify the project as additional information warrants.*

Representative Quotes:
There remains uncertainty as to the actual impacts of rotenone treatments in SEKI. These uncertainties could be better accommodated using an adaptive management approach, in which intensive monitoring of the initial rotenone treatments is used to better describe the likely impacts of subsequent treatments and if necessary to redesign subsequent treatments to further minimize these anticipated impacts. This adaptive management framework should be described explicitly for impacts to water quality, stream ecosystems, and lake ecosystems. [University of California, #35]

The DEIS would be improved if it developed more substantively the adaptive management framework for rotenone-based fish removals. [University of California, #35]

Response: Monitoring surveys and studies would be conducted to assess how resident aquatic fauna responds to piscicide treatment, in particular MYLFs, Pacific treefrogs, and garter snakes, as well as invertebrates in at least the first two to three treatments. Results would be evaluated over time to determine if plan modifications are warranted. As described in the Restoration Plan/FEIS (chapter 2, Elements Common to All Action Alternatives), the NPS would continue to research and use newly proven and reliable methods in addition to those proposed in the plan. The Restoration Plan/FEIS is science-based and proposes to continue using research to improve management responses to achieve aquatic ecosystem recovery. As new technologies and/or reliable techniques emerge, SEKI would research and consider them for incorporation into the plan.

Concern 28: *The NPS needs to provide information on site selection and how the sites proposed for treatment have been considered for the effects to anglers.*

Representative Quote: *It is unclear what, if any, evaluations were conducted within SEKI to survey angling use/effort at project sites. Some of the waters proposed for trout removal are near or adjacent to*

major trails and although they may not be destination fisheries, they likely provide supplemental food for backpacking anglers. With limited effort, the Department found references in recent angling publications (Beck, S. 2000, Trout Fishing the John Muir Trail. Frank Amato Publishing, Portland, OR) specifying some of the proposed treatment waters as quality fisheries. There does not seem to be an assessment of the effect to specific fisheries, but rather a statement that a large percentage of waters will still be available to anglers without regard to the quality or level of use for specific waters. [California Department of Fish and Wildlife, #117]

Response: Effects to anglers are analyzed in the Restoration Plan (chapter 4, Environmental Consequences). A vast majority of quality angling opportunities in SEKI would still be available, even if all sites proposed for aquatic restoration are approved. There are approximately 549 waterbodies containing nonnative trout and up to 85 (about 15% of fish-containing waterbodies) are proposed for fish eradication in the Restoration Plan/FEIS.

As discussed in public scoping in 2010, numerous high-quality and high-use recreational angling areas were excluded from the proposed restoration plan. Information was compiled on angling areas from public scoping, angler interviews, published and online literature on fishing, and NPS staff observations and reports. A majority of the known highest quality angling sites in the parks are excluded from this plan.

Angling is an important part of the recreational experience for many visitors. The work proposed in this plan maintains a large and diverse array of angling areas throughout the parks. It is inevitable that every location proposed for nonnative fish eradication will be the preferred destination for a subset of people who seek out angling opportunities. However, as discussed in the Restoration Plan/FEIS (chapter 1, Purpose and Need for the Plan), the NPS has a responsibility to preserve and protect native species. NPS management policies recognize that resource conservation takes precedence over visitor recreation. The policy dictates, “Congress, recognizing that the enjoyment by future generations of the national parks can be ensured only if the superb quality of park resources and values is left unimpaired, has provided that when there is a conflict between conserving resources and values and providing for enjoyment of them, conservation is to be predominant” (NPS 2006A, Section 1.4.3).

Actions proposed in the Restoration Plan/FEIS maintain a balance between protecting and enhancing habitat for native species, and preserving numerous recreational opportunities for nonnative fish angling. (Refer the Restoration Plan/FEIS, chapter 2, Elements Common to All Action Alternatives).

Concern 29: *The NPS needs to include a communications plan in the EIS to explain how they would inform the public and partners about the selected treatment schedule and activities.*

Representative Quotes:
Once the restoration plan is finalized and adopted, the bodies of water targeted for fish removal should be: (1) Listed online on the Seki website well before start of removal operations, perhaps as a link on the "Wilderness" section of the site. (2) Locations of the fish removal sites should be given to those acquiring or reserving a wilderness permit, for such information will be useful for backpackers in weighing alternatives for their trips. This will reduce the number of unpleasant "surprises" for wilderness hiker-anglers and help keep the restoration efforts in the public favor. [Unaffiliated Individual, #91]

Present the schedule of poisoning by year and specify frequency of poisoning each habitat per year. [Non-governmental Organization, #123]

There needs to be an obvious public communication plan attached to any of the alternatives chosen, with approach (physical or Piscicide treatment) so the recreational user can make plans to avoid a treatment area if desired. This is a matter of public transparency on what is happening, where it's happening and when. [Unaffiliated Individual, #108]

Response: The Restoration Plan/FEIS includes a communication strategy to guide outreach efforts shortly before and during each piscicide treatment. This information would be available during treatment periods through a variety for formats, including notices provided to visitors at wilderness permit stations, and notices on the parks' website. The information provided would be the specific areas affected (including lakes and streams, especially stream sections near downstream trail crossings) and length of closures (e.g., at least 72 hours after treatment has been completed). Additional information regarding communications is discussed in Concern 30 of this report.

Concern 30: *The NPS needs to include in the plan increased efforts to educate the public about the restoration project, including the threats amphibians face and the importance of protecting remaining amphibian populations.*

Representative Quote:
The NPS could create publications with pictures of native and non-native fish along with area-specific fishing regulations to educate visitors. [Unaffiliated Individual, #26]

I also encourage the National Park Service to increase its efforts to educate the public about the threats amphibians face and the importance of protecting remaining amphibian populations. [Unaffiliated Individual, #76]

Response: Education and public engagement are essential components for facilitating public support for native species conservation and management activities aimed to protect park resources. SEKI has developed a number of products to educate visitors about MYLFs and aquatic ecosystems including web pages and videos, and various public presentations and will continue to work with agencies and partners to develop educational materials and programs.

CONSIDERED BUT DISMISSED

Concern 31: *The NPS should consider utilizing fishermen for fish removal activities as part of the restoration effort.*

Representative Quote:
I propose that the NPS should launch a public trout-removal campaign, and call for fisherman to act in solidarity with their beloved national parks. [Unaffiliated Individual, #89]

Response: This idea was considered but dismissed from further analysis because of the reasons described in the Restoration Plan/FEIS (chapter 2, Alternatives Considered But Dismissed from Detailed Analysis). To elaborate, this is an understandable idea, but one that is not feasible for achieving fish eradication, because every single fish needs to be removed from the treatment area in order to achieve project objectives. In 15 lakes eradicated of fish in SEKI from 1997 to 2014, it has taken an average of three to four full years (summer and winter) of continuous gill netting using many nets per lake, plus simultaneous repeated electrofishing of all connected stream habitat throughout the summer, to achieve eradication. This work was largely produced by a team of two to three full-time summer technicians at each eradication basin. A public fishing campaign in an eradication basin might temporarily reduce the number of fish in targeted lakes and streams, but would not remove all fish. In addition, due to the remote

locations and high elevations of the proposed lakes (many of the proposed lakes are 15 miles or more from the nearest trailhead, at 11,000 feet or more, and require on- and off-trail passes to reach them) the park would be unlikely to recruit a sufficient number of volunteers to carry out the campaign. In addition, coordinating volunteers would greatly increase the logistical burden of this project. Therefore, this idea was dismissed from further analysis.

Concern 32: *The NPS should consider using drought conditions to eliminate the need for piscicide use.*

Representative Quote:
The difficulties in treating complex wetland habitats can be alleviated somewhat with strategic planning. The spatial extent of wetlands varies considerably among years as a function of total precipitation during the winter. In drought years, many marshy areas effectively dry up, and fish are forced to move back to the stream channel, where they can be more easily captured using physical methods. . .This is a viable alternative to the use of chemical treatments, and should have been considered in the DEIS. [Recreation Group, #110]

Response: Some feedback was received during public review of the DEIS suggesting that the NPS use current drought conditions to facilitate the exclusive use of physical fish removal methods. Episodic events such as droughts or low water years could potentially make physical methods somewhat more feasible for fish eradication. However, predicting, planning, and relying on such events is not a viable alternative for recovering MYLFs. It is not feasible or prudent to design a long-term restoration plan that is dependent on a particular weather pattern to be successful. Based on previous successful physical restoration work, physical methods can take from 3-10 years, depending on the site. Therefore, a three-year drought would be the minimum necessary, with the hope it dries aquatic habitats enough to potentially eradicate fish using physical methods. In addition, a crew would have to be ready to start project work in that location in the first year of the drought. Crews cannot be funded or scheduled in this manner. Once restoration is initiated at a site, that site must be consistently worked until eradication is achieved, and then a new site can be started. In addition, there is no way to predict that the subsequent years would also bring the drought conditions needed for eradication using physical methods. This idea was not considered in the DEIS because it is not a viable alternative; however, it was included in the DEIS as a potential additional action alternative, and was dismissed from further consideration.

CHAPTER 3 – AFFECTED ENVIRONMENT

Concern 33: *The NPS does not provide enough information on mountain yellow-legged frog natural history and demographics to allow for informed decisions.*

Representative Quote:
The document fails to disclose any information on the current distribution and abundance of MYLFs within SEKI. This makes it impossible for the reader to evaluate (1) the potential adverse influence of proposed treatments on existing frog populations, (2) whether recolonization of treated habitats is likely through natural dispersal processes or will require translocation of frogs from other populations, and (3) whether the removal of fish will significantly improve connectivity in habitats within and among basins. [Recreation Group, #110]

Response: A wealth of research has been conducted on MYLFs in SEKI. The Restoration Plan/FEIS discusses MYLF natural history and demographics throughout the document, including information on their natural history, inter-species interactions, and demographics (chapter 1, Purpose and Need for the Plan and Background; chapter 4, Special Status Species; and appendix J). All recommendations regarding the proposed treatments on existing frog populations were formulated under the guidance of professional

researchers, are aligned with the MYLF Conservation Strategy (a multi-agency document that is the foundation for a species' recovery plan (FWS *in preparation*), and would be approved by the U.S. Fish and Wildlife Service (FWS) per Section 7 of the Endangered Species Act).

Concern 34: *The NPS should disclose that the real cause of MYLF decline is disease caused by amphibian chytrid fungus (Bd), or a combination of disease and environmental contaminants*

Representative Quotes:
I don't think there is enough proof that fish are the main reason for the frog decline. [Unaffiliated Individual, #68]

What scientific studies have proven that the frog decline in the Sierra is due to fish predation? [Unaffiliated Individual, #84]

Wasting tax payer dollars destroying non-native trout in pristine mountain lakes with the excuse that they have caused the demise of the yellow legged frog when studies have shown that it is a worldwide fungus. [Unaffiliated Individual, #31]

Response: Chapter 1 and appendices C and J in the Restoration Plan/FEIS provide extensive information on causes for the MYLF decline.

Systematically collected evidence unequivocally shows that nonnative trout are a primary reason for MYLF declines (Bradford et al. 1994B, Knapp and Matthews 2000a, Vredenburg 2004, Finlay and Vredenburg 2007). In the specific instances when frogs are persisting in the same basin with fish, it is because the frogs have access to fishless habitat. Examples of fishless habitat include the shallow edges of lakes where there are boulder crevices inaccessible to fish, or small side pools separated from the main waterbody by shallow and/or thickly vegetated channels through which fish cannot pass. Conditions like this exist in small portions of many fish-containing basins. However, nearly all quality habitat in the main waterbodies are occupied by fish, and therefore unsuitable for amphibians. Nonnative fish have also been found to negatively impact the entire aquatic ecosystem, including zooplankton, macroinvertebrates, snakes, and birds (Knapp 1996, Knapp et al. 2001, Matthews et al. 2002, Knapp et al. 2005, Finlay and Vredenburg 2007, Epanchin et al. 2010).

Amphibian chytrid fungus is also a major factor in frog declines worldwide, including MYLF populations in SEKI. Amphibian chytrid fungus exacerbated the effects of nonnative fish, resulting in further MYLF declines and local extirpations. Some MYLF populations in SEKI have persisted with amphibian chytrid fungus and others that have been extirpated. Research has shown that although infected with amphibian chytrid fungus, some frogs can survive, and some populations can persist (or even increase) while chytridiomycosis is present (Jani and Briggs 2014, Knapp unpublished data; see also Briggs et al. 2010, and Knapp et al. 2011). In SEKI, the chance of persistence for populations infected with amphibian chytrid fungus is low, since many more infected populations have been extirpated than have persisted. However, a data set that describes the spread of amphibian chytrid fungus across SEKI from 1999 to 2012 was used to analyze the fate of 186 MYLF populations in SEKI (Knapp, *in preparation*). Several factors were assessed to examine their influence on whether a population was still present at least 4 years after a die-off. The population size at the time of the die-off was the most important predictor. That is, the larger the population, the better its chance of persisting with amphibian chytrid fungus. (The only other slightly significant predictor was snow depth during the previous winter—expressed as the difference from the long-term average—which had a negative effect. That is, bigger snow years had a slight negative effect on frog populations.) This result, based on a large data set, suggests that nonnative fish eradication near MYLF populations is vital for population persistence. Not only does eradicating them allow frog

populations to increase in size, but it also increases the probability that MYLF populations would persist in the presence of amphibian chytrid fungus.

Contaminants have been suggested as leading to—or exacerbating—MYLF population declines, however, recent research did not find a negative association between pesticides and the MYLF decline in SEKI (Bradford et al. 2011). Rather, the pattern of decline was more consistent with the pattern of amphibian chytrid fungal infection as it spread through populations in the parks. In addition, other research examined the effects of four insecticides alone, or as a mixture, on the development and metamorphosis of Pacific treefrogs in the presence or absence of amphibian chytrid fungus (Kleinhenz et al. 2012). Results "did not support the prediction that effects of [amphibian chytrid fungus] would be greater in the presence of expected environmental concentrations of insecticide(s), but it did show that [amphibian chytrid fungus] had negative effects on responses at metamorphosis that could reduce the quality of juveniles recruited into the population." Specifically, amphibian chytrid fungus slowed down the metamorphic response by lengthening the larval period and slowing down the time of tail resorption.

Therefore, primarily due to nonnative fish and amphibian chytrid fungus, the MYLF populations across the Sierra are in peril. Add probable climate effects over time, and extinction is a distinct possibility unless intervention occurs and is effective. Amphibian chytrid fungus has proven more difficult to mitigate than fish, but it is likely effectiveness would improve over time via continued research and adaptive management. As a result, fish eradication in strategic locations is a primary restoration tool being recommended by the MYLF Conservation Strategy and the Restoration Plan/FEIS.

Concern 35: *The NPS should provide information on past restoration efforts and the result of these efforts.*

Representative Quote:
The DEIS discloses that past attempts to transfer frogs have, with few exceptions, been unsuccessful. The document fails to discuss the implications of this in terms of the overall recovery effort. [Recreation Group, #110]

Response: Information on past and ongoing restoration efforts within and outside of SEKI is provided in the Restoration Plan/FEIS (chapter 4, Cumulative Effects) which has been updated based on the most recent work.

To summarize, there are several strategies that have been used in the region for the translocation/ reintroduction of MYLFs. Frogs for translocations/reintroductions have been provided by 1) collecting eggs, tadpoles, and/or juvenile frogs from targeted diseased populations, growing them to adulthood in a captive-rearing facility to get them past the juvenile survival bottleneck, immunizing them to develop disease resistance (Murphy et al. 2011, McMahon et al. 2014), and reintroducing them to the same location from which they were collected; 2) direct translocation into previously occupied habitats using adult frogs from one, or several (to increase genetic diversity and improve the potential for disease resistance) "persistent" populations within the same clade that are surviving with disease, and have enough abundance to withstand a small take (Knapp et al. 2011); or, 3) collecting adults from a nearby, genetically-similar, and currently large population that is not yet diseased, immunizing them to develop disease resistance, and then translocating them to previously occupied habitats where frogs were extirpated due to a combination of fish and disease impacts. (Knapp unpublished data). All of these scenarios have been attempted for MYLF recovery in the Sierra Nevada and southern California. While there have been some unsuccessful attempts (Fellers et al. 2007, Knapp et al. 2011, FWS 2012), there have also been several successful attempts thus far (Knapp et al. 2011, FWS 2012, Knapp unpublished data). In YOSE, four populations have been re-established for 2-8 years, and in SEKI, three populations

have been re-established for 2 years. Therefore, it is promising that relatively reliable frog translocation/reintroduction methods would be developed. Even if these methods are not 100% successful, every population re-established or augmented would be a net gain and would be critically important for the long-term restoration, recovery, and conservation of both MYLF species.

There are many records of individual waterbodies, and collectively basins, which have been occupied by MYLFs (Jennings and Hayes 1994, Knapp 2003, Vredenburg et al. 2007). The basins proposed for restoration in the Restoration Plan/FEIS meet habitat requirements of the MYLFs. All of the basins support (or supported) MYLF populations of varying sizes. Helping to expand existing populations (and re-establishing populations that completely died out) provides the best chance for long-term MYLF recovery. Recovering frogs in many of these basins would vastly improve the status of the two species, allowing MYLFs to persist over the long term, and, if successful, ultimately be removed from the endangered species list.

SEKI has several MYLF populations that are not yet infected with chytridiomycosis. Most of them are large, including the largest populations of *Rana muscosa* and *Rana sierrae* in the range of each species. When amphibian chytrid fungus inevitably spreads to these populations, there would most likely be a severe die-off in which most or all adult frogs do not survive. Before these large populations become infected, SEKI is working closely with researchers to determine the effectiveness of translocations using frogs from these populations. In 2013 SEKI permitted researchers to collect adult frogs from an uninfected MYLF population that had increased to a large, sustainable level following fish eradication. The frogs were transported to a lab and exposed to amphibian chytrid fungus to induce infection and attempt to activate an immune response. Once infected, they were cleared of the disease with an antifungal treatment, and reintroduced to the wild. Treated frogs were released, in equal numbers, to three lakes in three basins, including two lakes associated with recent fish eradication. Preliminary results to date are encouraging. Monitoring trips in 2014 found frogs in each lake; all appeared large and healthy, and several had migrated to adjacent waters - another sign of successful acclimation. Further, tadpoles were detected in two lakes, demonstrating that successful breeding had occurred. If successful frog breeding continues to occur, and at least one MYLF population can be re-established, then the efforts would be deemed successful and have implications for future restoration progress in additional areas identified in the plan.

In 2015 tadpoles and recently metamorphosed frogs were collected from two infected MYLF populations in SEKI to rear them to adulthood and immunize them in zoos, before reintroducing them to the locations from which they were collected. This will hopefully add a substantial number of resistant adults to these populations, which can then breed for years and increase the chance for the population as a whole to develop persistence instead of being extirpated. All of these individuals are expected to reach adulthood in time for immunization and reintroduction in 2016 and 2017. Results will be studied closely to incorporate findings into future restoration work.

Concern 36: *The NPS should disclose the probability of large scale success of restoration in light of the current demise of the MYLF from chytrid fungus.*

Representative Quotes:
While you describe treatments for the chytrid fungus in mylf there appears to be no evaluation of the probability of large scale success of the treatment and the creation of long term viable populations of mylf. It appears that the odds of the operation being a success but the patient dying anyway is quite high. [Unaffiliated Individual, #41]

Can you promise/certify that your actions will work and will not have adverse effects on the living things within SEKI that drink water from the lakes and streams? Will the use of a piscicide in over 38 lakes and some 27 miles of streams have no side effects on anything but the trout, and is the cost of such efforts without knowing the absolute probability of success worth the risk? [Unaffiliated Individual, #52]

Response: Chapter 1 of the Restoration Plan/FEIS describes the success of completed fish eradications in SEKI and elsewhere in the Sierra Nevada. The Restoration Plan/FEIS also describes results to date of frog antifungal treatment, translocation/reintroduction, immunization, and captive-rearing; as well as evidence of population adaptation to amphibian chytrid fungus in the Sierra Nevada (chapter 1, Background). Given there have been successes in each restoration category, and the expectation that management effectiveness would improve over time with continued research and experience, the probability of large scale success of restoration in SEKI is moderate to high.
There is a large amount of science upon which this plan is based, including dozens of studies in the Sierra Nevada and many in SEKI, going back several decades (see the references cited in chapters 1-4 and appendices C and J). Habitat restoration via nonnative fish eradication, along with current efforts and studies to develop reliable active frog restoration techniques including antifungal treatment, translocation / reintroduction, immunization, and head-starting, are crucial for restoring aquatic ecosystems and recovering MYLFs over the long-term.

The MYLF Conservation Strategy (FWS *in preparation*), which will be the foundation for a MYLF Recovery Plan, is recommending a toolbox approach that addresses the primary threats to MYLFs. First, nonnative fish eradication would restore large critical habitats, that can withstand drying and warming expected under climate change, to their previously fishless condition, which would increase amounts of suitable MYLF habitat and improve connectivity between lakes, ponds, marshes and streams within treatment basins. Restored habitat can allow existing MYLF populations to expand (Knapp et al. 2007) or provide high quality habitat for recently lost populations to be re-established using translocations / reintroductions (Knapp et al. 2011, FWS 2012). The latter is necessary because nearly all lake basins in SEKI are isolated from each other by steep, high and dry slopes and ridgelines, and separated by nonnative-fish-containing streams (Bradford et al. 1993), and thus frogs from the few remaining MYLF populations are not able to replenish populations that have completely died-off. Second, most of the remaining MYLF populations are hindered by recent onset of disease (chytridiomycosis) in which few adult frogs naturally survived the disease outbreak. In the ensuing years, very few offspring from those few surviving adults are able to survive from juvenile frog to adulthood - until the population as a whole can gradually adapt to the disease and produce resistant individuals. These populations are highly vulnerable to dwindling to zero if the adults die before the population can stabilize and recover through increased recruitment. Therefore, these populations would benefit by receiving an infusion of disease resistant adult frogs. Third, MYLF populations in many basins have completely died-off, primarily due to nonnative fish and/or disease, and reintroductions are needed in order to re-establish MYLF populations in these basins. Together, the toolbox approach of fish eradication combined with several active frog restoration techniques would provide the best chance for recovering endangered MYLFs over the long-term. In addition, most non-target species populations are expected ultimately to benefit as a result of fish removal.

For more information on potential non-target effects of piscicide, see responses to Concerns 38, 39, and 40, and chapter 4 of the Restoration Plan/FEIS. For detailed descriptions of the methods summarized in this response, see chapter 2, Elements Common to all Action Alternatives.

Concern 37: *The plan needs to provide additional information on the past stocking program in SEKI.*

Representative Quote:
The Plan notes stocking occurred until 1988. Would it be possible for you to expand on that or provide a record of stocking history of SEKI (or direct me to the information)? [Unaffiliated Individual, #52]

Response: There is no book or report that summarizes all of the nonnative fish stocking that occurred in the parks between the mid-1800s and late 1980s. There are several references that provide a history and/or analyze the status of nonnative fish in the high Sierra (e.g., Christenson 1977, Knapp 1996, Moyle 2002). Early stocking in SEKI was done by various citizens, later stocking was done by early park managers, and stocking from about the 1920s until 1988 was done by the state of California under authorization from SEKI. While many stocking records exist, the records are not 100% complete or meticulous. SEKI terminated nearly all stocking in the mid-1970s, while periodically stocking approximately 16 popular fishing lakes until 1988, when all stocking was terminated.

CHAPTER 4 – ENVIRONMENTAL CONSEQUENCES

EFFECTS OF PISCICIDE USE

Concern 38: *The NPS has not fully disclosed the long-term effects on benthic macroinvertebrates from the application of piscicides.*

Representative Quote:
These poisons cause long-term impacts on aquatic and terrestrial food webs, on aquatic animal communities, and may lead to extinction of some native, aquatic, non-target species. [Unaffiliated Individual, #51]

Response: The effects of rotenone (CFT Legumine™) on the invertebrates that occur in SEKI's high elevation aquatic ecosystems are collectively analyzed in detail in the Restoration Plan/FEIS (chapter 4, Wildlife; and appendix G, Ecological Risk Assessment).

There is abundant evidence that invertebrate abundance and taxa richness recovers following piscicide treatments. Recovery time can range from a few months to several years and depends upon factors such as physical environments, season of year, and how treatments are conducted (Binns 1967, Cook and Moore 1969, Beal and Anderson 1993, Mangum and Madrigal 1999, Melaas et al. 2001, Whelan 2002, Finlayson et al. 2010B). Full ecosystem function is expected to return within 1-3 years, with the native aquatic invertebrate community resembling what is typically found in native fishless habitat, which is the historic condition of all project areas.

Extirpation of highly specialized species that are restricted to narrow localized habitats could occur if treatments were applied to isolated habitats that promote endemism. However, the treatment areas are not isolated; they are in habitats connected to or near untreated source populations. Therefore, the potential for complete elimination of a species that could not recolonize via drift or aerial migration would be extremely rare, and recolonization would occur relatively quickly. Endemism is expected to be fairly uncommon in SEKI's high elevation lakes and streams (Ward 1994), in part because of (1) the similarity of these habitats within a particular mountain range, and (2) many native taxa in these habitats are aquatic insects that have an aerial stage that can disperse widely among drainages.

Concern 39: *The NPS must fully disclose the effects of the use of piscicides on water quality, including the short and long-term effects on water clarity and color, information on the breakdown of the rotenone and other ingredients, and information on the effects to water quality from the use of potassium permanganate.*

The NPS must fully disclose the persistence of rotenone in lake and stream sediments.

Representative Quotes:
The DEIS does acknowledge that rotenone has half-life of 20 days in cold water. (DEIS at 217), that it completely degrades within 1-8 weeks (DEIS at 217) and has half-life of 7.8 to 15 days (Id.). Twenty days duration where the poison is still exposing wildlife, humans, and environmental resources to a toxicant is not a short amount of time. [Non-governmental Organization, #123]

Rotenone and its derivatives are discussed in the document, but potassium permanganate application needs to be included, too. Perhaps it is in the document but I could not find such justification in a prominent place. Such justification needs to be much more visible, since potassium permanganate must be co-applied with rotenone. [Unaffiliated Individual, #91]

How persistent will rotenone be in lake and stream sediments? Will it return to the water when those sediments are disturbed by people and animal packers crossing streams and being in shallow lake water? Will seasonal flooding disturb the sediments also? [Unaffiliated Individual, #84]

Response: The Restoration Plan/FEIS (chapter 4 and appendix G) provides a thorough analysis of how each alternative would affect water quality including rotenone persistence.

The available evidence indicates that rotenone:

- would likely be well below any human or wildlife health risk within days of the treatment (EPA 2007A, Brown and Zale 2012, NOCA 2013);
- would likely break down to undetectable levels within 2 months in most areas (Finlayson et al. 2014), partially because rotenone naturally degrades rapidly after just two days, and partially because the montane stream systems being considered are often turbulent and well-mixed, which helps increase the breakdown and dissipation of rotenone (Finlayson et al. 2010A). Although rotenone may persist in lakes for a longer duration, the longest rotenone is expected to be detectable in a lake is 160 days (EPA 2007A, Vasquez et al. 2012); and
- has not been detected in repeated groundwater sampling efforts (Finlayson et al. 2001, CADHS 2007, Finlayson et al. 2014), which alleviates drinking water concerns. These projects sampled surface and groundwater for rotenone after lake and stream treatments for trout removal in California and Oregon (Finlayson et al. 2001, 2014) and pike removal from a California reservoir (CADHS 2007). These lake and stream projects are comparable to the proposed use of rotenone in SEKI, except that they occurred in less remote areas and wells were available for sampling groundwater.

In addition, potassium permanganate ($KMnO_4$) neutralization stations would be used in system outlets to further reduce water quality impacts by detoxifying rotenone. Should rotenone ingredients get past a neutralization station, they are expected to dissipate and degrade in the environment, likely faster than within the treatment area (Brown and Zale 2012). This is because the original concentration being applied within the treatment area immediately starts getting diluted the further it moves downstream. By the time it leaves the treatment area, it would be at a lower concentration than within the treatment area and should degrade more quickly. The rate at which dilution occurs varies depending on hydrology, including yearly and seasonal conditions that determine how much groundwater and headwaters contribute to the stream.

Potassium permanganate itself would also likely have an adverse impact on aquatic organisms from the neutralization station to 30 minutes of travel time downstream of the station (Marking and Bills 1975, Hobbs et al. 2006). This area is considered part of the affected treatment area for the project, and fish as well as non-target organisms would be monitored in this area. Potassium permanganate does not travel long distances downstream and is not persistent in the environment because it is quickly reduced through

natural processes (FWS 2010). While potassium permanganate could be toxic to terrestrial organisms at high concentrations, the chemical is routinely used to treat potable water supplies for oxidizing contaminants, colors, and odors (Tucker and Boyd 1977, Chen and Yeh 2005; Dash et al. 2009). Levels of potassium permanganate in treated waters for this project would be below concentrations of potassium permanganate used to remove oxidizing agents in potable water.

Concern 40: *The NPS needs to better explain the effects of rotenone on human health, specifically links to Parkinson's disease and the link to hormone disruption and other human health concerns.*

Representative Quotes:
Protections from exposure to rotenone and its ingredients, however, are not well-identified or analyzed. Thus the protections for the public provided in the DEIS do not appear well developed and the direct effects of applying rotenone are not adequately analyzed. [Non-governmental Organization, #123]

The DEIS ignores all recent findings regarding the connection between rotenone and Parkinson's disease. [Unaffiliated Individual, #98]

Response: The Restoration Plan/FEIS (chapter 4 and appendix H) provides a thorough analysis of how piscicide use would affect human health.

- The general public would have almost no risk of coming into contact with undiluted rotenone due to secure storage, transportation, and labeling practices required by the product label. Exposure to diluted rotenone in treated water is possible but unlikely because project areas would be closed for at least 72 hours following piscicide treatments (Restoration Plan/FEIS, chapter 4, Visitor Experience and Recreation). The use of press releases, notification via the SEKI website, information distributed with wilderness permits, and signs (located at trailheads, ranger stations, and other strategic places in the treatment area) would aid in public awareness. In addition, field crews would search for visitors in the area and notify them of the treatment. Since many of the treatment sites are away from popular visitor use areas, these areas generally have little visitation.

  If, despite these precautions, the public does come into contact with diluted rotenone, there remains little cause for concern over substantial human health effects. In a review of incidents of human exposure to rotenone for all previously registered uses (piscicidal, agricultural, and residential), the EPA (2007A) found that eye irritation was the most commonly reported symptom. Also common were dermal irritation, throat irritation, nausea, and coughing. Less common, but more severe, symptoms (including headache, dizziness, peripheral neuropathy, numbness, and tremor) have occasionally been reported (EPA 2007A). However, chemical concentrations to which individuals may have been exposed in these reported incidents were unknown. Additionally, no causal link can be established between the symptoms reported and the application of rotenone. Reports involving individuals who handled rotenone for the now cancelled agricultural and residential uses may not have been using appropriate personal protective equipment and were likely using higher rotenone concentrations than those to which members of the public could be exposed during piscicide treatments. The EPA (2007A) also noted that "No fatalities or systemic poisonings were reported in relation to ordinary use." The few incidents involving poisoning or death were via accidental (e.g., De Wilde et al. 1986) or intentional (e.g., Wood et al. 2005) ingestion of concentrated rotenone.

- The only human receptors at any measurable risk would be the crew members applying the piscicide. However, those involved in rotenone applications for fish management are required to wear personal protective equipment, including respirators, coveralls, gloves, and goggles, which effectively eliminates potential routes of significant exposure. In addition, ambient air samples near treatment sites showed no rotenone above the detection limit.

Regarding Parkinson's disease (PD) specifically:

- Studies that have suggested a link between PD and rotenone (e.g., Betarbet et al. 2000, Cannon et al. 2009) have been based on laboratory exposure situations under experimental conditions that would not occur in a fisheries management application. As Finlayson et al. (2012, pg. 473) describe: "Collectively, the toxicology and epidemiological studies present no clear evidence that rotenone is causally linked to PD. Even if there were clear evidence, it would have little impact on the current and proposed use of rotenone in fish management. This is because the toxicology studies demonstrating PD-like effects were conducted using routes of exposure (e.g., intraperitoneal or intravenous injection or oral dosing with solvents) and exposure regimes (e.g., weeks to months) not germane to potential human exposure associated with fishery uses." As demonstrated previously, human exposure to rotenone would be already quite limited (particularly for the general public) and exposure routes such as intraperitoneal or intravenous injection or oral dosing with solvents are not possible in the wilderness environment (project area), therefore the NPS finds no evidence to warrant concern about the piscicidal application of rotenone and PD.

Concern 41: *The NPS should disclose the broader effects of rotenone, such as the effects on other vertebrates, wildlife such as birds, and the food web.*

The NPS needs to provide information on how the use of rotenone would affect the MYLF, particularly tadpoles.

Representative Quotes:
NPS failed to adequately identify and analyze the direct effects of rotenone on aquatic ecosystems. [Non-governmental Organization, #123]

Analyze the food web effects of poisoning on terrestrial as well as aquatic communities. Include birds, amphibians, reptiles, mammals, and terrestrial invertebrates that depend on emerging insects for food as well as those that depend on aquatic invertebrate forms for food. [Non-governmental Organization, #123]

Response: The Restoration Plan/FEIS (chapter 4 and appendix G) provides a thorough analysis of how piscicide use would affect the wildlife communities that occur in SEKI's high elevation aquatic ecosystems, including MYLFs, birds, and other vertebrates. This information is summarized below.

Numerous studies show that rotenone applied at concentrations recommended for use in fisheries management (Finlayson et al. 2010A) have little to no long-term effects on the ecosystem (Melaas et al. 2001, Ling 2003, Finlayson et al. 2010B, Vinson et al. 2010, Billman et al. 2012). This is due to a combination of the extremely low concentrations at which rotenone is required to be applied (EPA 2007A) and its unstable nature once applied (Ling 2003), in which it does not persist in the environment (chapter 4, Water Quality; also Vasquez et al. 2012). Rotenone rapidly degrades in the environment, metabolizes in vertebrates, and does not bioaccumulate like fat soluble pollutants (e.g., DDT, PCBs, etc.; Fukami et al. 1969, Gingerich 1986, Ling 2003). Rotenone should be undetectable in the first samples obtained the following summer after treatment. In addition, rotenone use is highly regulated by the EPA, in which it is restricted to fish eradication projects with specific label requirements to be followed during applications (EPA 2007A, Finlayson et al. 2010A). Therefore, when proper procedures are followed, there is little risk for rotenone use to have effects beyond its intended application, due to its limited persistence and limited duration of effects.

Rotenone applications affect all gill-breathing aquatic organisms, including fish, larval invertebrates, zooplankton, and larval amphibians (tadpoles). Because nonnative trout prevent successful MYLF and Pacific treefrog breeding in nearly all locations where they have been established, the vast majority of fish-containing areas that would be treated with piscicides are not expected to contain any tadpoles. Because nonnative fish have occupied the proposed treatment water bodies for decades, MYLFs of all life stages are rarely documented in the areas proposed for piscicide treatment (Vredenburg 2004). If amphibian breeding does successfully occur in a treatment area, most if not all Pacific treefrog and Yosemite toad tadpoles would have already metamorphosed into frogs, many MYLF tadpoles would have metamorphosed, and as many as possible of those that were still tadpoles would be collected for movement out of the treatment area.

Concern 42: *The NPS needs to include information in the plan about the potential for unforeseen consequences, such as needing to treat areas multiple times and with higher rotenone concentrations than anticipated.*

Representative Quotes:
It has been the experience of the Department that single chemical treatments in streams are rarely successful in eradicating all fish and that it is necessary to conduct at least two back-to-back chemical treatments of the same stream reach followed by monitoring. The DEIS is not clear regarding specific areas receiving single or multiple treatments. [California Department of Fish and Wildlife, #117]

There is no conceivable way to achieve uniform concentrations of rotenone in lakes due to the manner in which it is applied and the inability to control the mixing of water. Instead, treated lakes are likely to experience considerable heterogeneity in rotenone concentrations, with some localized areas exceeding the prescribed concentration by many-fold, while other areas never attain lethal concentrations (this is one of several reasons why single treatments often fail to eliminate 100% of targeted fish). [Recreation Group, #110]

Several repeated applications would have to occur in complex locations. In complex habitats aquatic macrophytes and emergent vegetation that typify wetlands and some stream and lake margins, rotenone quickly adsorbs to plants and sediments, effectively lowering the dissolved concentrations in water. [Non-governmental Organization, #123]

Evidence suggests that effective rotenone use requires multiple treatments over multiple years. Consequently, both the ecological and aesthetic impacts would be much more severe than the DEIS suggests. [Unaffiliated Individual, #81]

Response: The Restoration Plan/FEIS discusses the use and effects of piscicide application in numerous places throughout the document and in appendices G and H. While the DEIS stated that piscicide treatments could take up to two years (i.e., a second treatment could occur), the Restoration Plan/FEIS has been updated to reflect that up to three treatments could potentially occur (chapter 2, alternative B, and appendix N). Most sites would require one or two treatments, but unforeseen circumstances could make some sites take up to three treatments.

Goals of piscicide use in fisheries management projects have been diverse, ranging from restructuring fish communities to complete eradication of unwanted fish. Achieving complete eradication may not have been the goal of some past piscicide projects and is a major reason why some projects have involved multiple treatments. The goal of SEKI's proposed piscicide use is to achieve complete fish eradication using the fewest number of treatments.

While none of the action alternatives, including alternative B, are guaranteed to meet project objectives, complete fish eradication using piscicides is expected to be achieved. While some of the proposed treatment areas in SEKI are small (e.g., the outlet stream of Center Basin) and one treatment would likely eradicate all fish in these areas, the Restoration Plan/FEIS clarifies a second or third treatment may be necessary in more complex areas such as lower Sixty Lake Basin.

Complete fish eradication in the time allotted can be achieved because successful treatments by the NPS are much more common in recent years than in the past. For example, from 1938-1986, the NPS conducted piscicide treatments in 22 sites and failed to eradicate fish in nine of these sites (41%); whereas from 1987-2014, the NPS conducted piscicide treatments in 25 sites and failed to eradicate fish in only two of these sites (8%, both in 1987; NPS data). Of the 23 successful piscicide treatments, 15 were completed in one treatment, seven were completed in two treatments (with one of these seven being treated a third time for extra precaution), and one required three treatments (a large area that included many stream miles with complex woody debris). The recent piscicide treatments in which one application eradicated all fish occurred in North Cascades (Rawhouser A., pers. comm., 2016), Yellowstone (Bigelow P., pers. comm., 2015), Great Smoky Mountains (Kulp M., pers. comm., 2015), and Great Basin National Parks (Hamilton et al. 2009). These areas have remained free of the targeted species for up to 15 years following treatment (the earliest of these treatments was in 2000). Identification of sufficient fish barriers is important for preventing fish recolonization. All of these sites are in mountain parks similar to SEKI, but North Cascades is the most similar, with remote wilderness sites and complex habitat. North Cascades successfully eradicated fish after one treatment at three sites from 2009 to 2014. Project managers in numerous National Parks have learned from past mistakes and improved methods to help achieve fish eradication in one or two treatments. Methods used in successful treatments would be incorporated into proposed piscicide treatments in SEKI.

In general, habitat complexity and physical conditions specific to the site help determine the number of rotenone treatments needed. The general protocol would be to treat habitat once in mid/late summer, monitor in September, and monitor again the following early/mid-summer. If live fish are found, a second treatment would be conducted in mid-late summer. If no live fish are found, then a second treatment would not be necessary.

Regarding reports of higher rotenone concentrations than anticipated encountered during some treatments outside SEKI and the potential for them to be duplicated at SEKI, such circumstances are the exception rather than the rule. Based on lessons learned from reviewing both successful and unsuccessful treatments, a number of steps would be implemented to ensure that the proposed action, if chosen, is effective and safe, including but not limited to: (1) treating streams to upper most limits of fish distribution to ensure that there no nonnative fish remain within the treatment area; (2) implementing treatments after all juvenile fish have emerged from stream gravels as rotenone is less effective on eggs; (3) treating a site twice if necessary due to habitat complexity; (4) staffing neutralization stations continuously to ensure there are no equipment malfunctions and that water quality monitoring is conducted; (5) using field colorimeters to monitor potassium permanganate concentrations during treatments (Parmenter and Fujimura 1994); and (6) using current methods and continuous monitoring to monitor concentrations of residual potassium permanganate at the downstream boundary of project areas (30-minute flow time below neutralization station) (Fujimura 2006).

Concern 43: *The NPS needs to provide information on the monitoring plan and how monitoring information will be utilized to adapt future restoration treatments.*

Representative Quote:

I would like a full description of how monitoring information will be utilized to adapt future restoration treatments. [Unaffiliated Individual, #44]

Response: A more complete monitoring and adaptive management framework for piscicide-based fish removals is included in the Restoration Plan/FEIS (appendix N). Intensive monitoring of the initial piscicide treatments would be used to better describe the impacts of subsequent treatments, and if necessary subsequent treatments would be redesigned to further minimize effects.

The framework addresses effects on water quality and stream and lake ecosystems as follows. A more-complete protocol for assessing potential impacts of piscicide treatments on water quality is included in the Restoration Plan/FEIS. Briefly, all water quality testing required as part of permitting to apply piscicides would be met.

The first two to three piscicide treatments would include baseline and post-treatment surveys for stream benthic macroinvertebrates (BMI) and lake zooplankton and BMI to assess potential effects. As described in the Restoration Plan/FEIS, effects are expected to be similar to impacts typically observed in the numerous piscicide treatments that have been conducted in North America in the last 75 years; that is, short-term major adverse effects and long-term moderate adverse effects due to piscicides (Vinson et al. 2010), and long-term beneficial effects due to fish eradication (chapter 4, Wildlife; Knapp et al. 2001). If results from the first two to three treatments are as expected, then BMI and zooplankton surveys would probably not be included in the remaining piscicide treatments.

Concern 44: *The NPS needs to provide information on how the chemicals and inert ingredients in piscicides interact with atmospherically deposited environmental contaminants.*

Representative Quote:
The DEIS underestimates the true impacts of rotenone on aquatic life because it does not account for preexisting toxins, which work synergistically or cumulatively with rotenone to weaken the natural defense systems of organisms. [Non-governmental Organization, #123]

Response: The Restoration Plan/FEIS (appendix G) provides information on the formulation of CFT Legumine™, including all inactive ingredients. Although the DEIS did not provide the percentage that each chemical is present in the formulation, the following text from Vasquez et al. (2012, pg. 1032) provides the percentages for the five chemicals that make up nearly 94% of the formulation: *"The rotenone formulation CFT Legumine is comprised of five major constituents possessing the following average concentrations: rotenone (5.12%), rotenolone (0.718%), methyl pyrrolidone (MP; 9.8%), diethylene glycol monethyl ether (DEGEE; 61.1%), and Fennedefo 99 (17.1%) (McMillin and Finlayson 2008). Rotenolone is a degradation product of rotenone, whereas MP, DEGEE, and Fennedefo 99 are used as solvents and surfactants to aid in the dissolution of rotenone. Rotenone is the active ingredient of CFT Legumine."*

If an alternative piscicide was considered in the future, subsequent environmental compliance would be completed and would include a risk assessment to analyze the environmental consequences (including human health and safety) expected from using the new piscicide; this information would be available for public review.

The neutralization agent is potassium permanganate ($KMnO_4$). As described in the Restoration Plan/FEIS (appendix N), the typical target concentration for neutralizing a piscicide treatment in SEKI is expected to be 3 parts per million $KMnO_4$. See also the response to Concern 39.

Deguelin is a metabolite of the CFT Legumine™ formula. At low concentrations, such as those that would be expected following the breakdown of rotenone after field applications, deguelin has been found to have limited negative effects (Takatsuki et al. 1969, Gerhauser et al. 1997, Kim et al. 2008, Ito et al. 2010, Garcia et al. 2012). However, very high concentrations injected intravenously into rats led to Parkinson's-like symptoms (Caboni et al. 2004). This suggests, like most compounds, that concentration and exposure pathway lead to a broad spectrum of potential biological effects. That is, injecting high concentrations of a chemical directly into the blood stream can have greater adverse effects than being exposed to low concentrations via more common exposure pathways such as skin contact, drinking, or inhaling.

There is no scientific evidence for interactions—either neutral or negative—between atmospherically deposited contaminants and rotenone (or its derivatives). Environmental contaminants have the potential to cause harm to wildlife, especially if combined with other stressors such as disease, competition, and predation. Several studies in the Sierra Nevada have focused on the sublethal effects of contaminants on amphibians (Davidson 2004, Fellers et al. 2004, Sparling and Fellers 2009, Sparling et al. 2014). Laboratory studies have shown certain pesticides can be harmful to amphibians (Sparling and Fellers 2009, 2007), although not all pesticides have produced a negative effect (Davidson et al. 2007). In SEKI, contaminants have been detected in sediment, water, and amphibian tissues (LeNoir et al. 1999, Fellers et al. 2004, Landers et al. 2008). Although there is potential for sublethal effects on amphibians, atmospherically deposited contaminants in the higher elevations of SEKI (where all but one of the proposed restoration sites in which piscicides have been proposed in the Restoration Plan/FEIS are located) have been repeatedly detected only at extremely low concentrations (if at all), below levels at which toxic effects are detectable (LeNoir et al. 1999, Fellers et al. 2004, Bradford et al. 2010). Samples from which higher levels of pesticides have been detected in water, sediment, and tissues were collected at the western edge of the parks (closest to agricultural activity in the Central Valley) or at much lower elevations (LeNoir et al. 1999, Bradford et al. 2010). Additionally, the evidence for correlation between amphibian declines in the Sierra Nevada and pesticide use is based on modeling prevailing wind patterns and presence/absence of amphibians at historically occupied sites (Davidson 2004, Davidson and Knapp 2007). Further analysis has shown little evidence between pesticides use and amphibian declines in the high elevation sites proposed in the Restoration Plan/FEIS (Bradford et al. 2011). However, there is unequivocal evidence for the direct negative impacts on amphibians caused by nonnative fish (Restoration Plan/FEIS, appendix C and Bradford et al. 1993, Vredenburg 2004, Knapp et al. 2007) and disease (Vredenburg et al. 2010A, Bradford et al. 2011).

The information summarized above shows very low concentrations of contaminants detected at high elevations, low concentrations of rotenone and its derivatives applied to eradicate nonnative fish, and strong evidence of direct impacts from fish and disease. Therefore, the long-term benefits to aquatic ecosystems by removing nonnative fish from specific locations using rotenone greatly outweigh the short-term impacts, including possible (but unlikely given current evidence) interactions of rotenone and its derivatives with the extremely low levels of environmental contaminants found in some high elevation locations in SEKI.

EFFECTS ON MYLFs

Concern 45: *The NPS needs to explain the potential impacts on source populations of MYLF used for the translocation program.*

Representative Quotes:
The DEIS fails to adequately disclose the high degree of uncertainty associated with the translocation of MYLFs to habitats from which fish are eradicated. [Recreation Group, #110]

The DEIS fails to disclose the potential impacts of removing frogs from extant populations for the purpose of recolonizing treated areas. Because the Park Service has not provided population estimates for extant MYLF populations, it is impossible to determine the consequences to population viability of removing frogs from these source populations. Small populations are at increased risk of extinction through both demographic and genetic processes. For demographic risks, population levels that will likely lead to persistence depend on natural variation in key vital rates (i.e., births and death rates), so defining minimum viable population sizes is difficult. [Recreation Group, #110]

The DEIS has no discussion of how many frogs would be translocated to new habitats or what this means in terms of the likelihood of successful colonization. As noted, the genetic risks associated with small population size are significant. Consequently, populations that (1) are founded with a small number of translocated individuals and (2) are isolated from sources of colonizers that could potentially infuse new genetic diversity into the population may be highly susceptible to extinction through genetic effects. [Recreation Group, #110]

Response: The effects on MYLF source populations have been evaluated in the Restoration Plan/FEIS (chapter 4 and appendix L). A biological opinion per section 7 of the Endangered Species Act was issued by the FWS on May 25, 2016 (appendix L, FWS Consultations). The provided the determination that the proposed project would not jeopardize the existence of MYLFs and would support recovery efforts of this endangered species.

For each source population, the number of individuals removed at one time would be dependent on the estimated population size. SEKI would use available population data and site-specific experience to propose high-priority actions to the MYLF recovery team. The information would be reviewed by the team, decided by consensus using professional judgment, and would ultimately have to be endorsed by FWS (as the enforcing agency of the ESA) before the action could be implemented. Although there is a chance that a take event could result in reduced population abundance for longer than a one year period, generally limiting translocations to larger source populations would safely provide enough animals to augment a small population or reestablish a population that recently died out, while also providing a fair amount of genetic diversity. However, most of the remaining frog populations are small primarily due to effects from nonnative trout and disease; many populations only have access to small and shallow habitat at risk to drying and warming; and nearly all populations are isolated from each other by long distances of fish-containing habitat. This is an extremely vulnerable situation; and the best chance to recover MYLFs is through a combination of reclaiming habitat via fish eradication, translocations to help increase the size and number of extant populations, and disease treatments to increase frog survival.

Translocations are a critical piece of the strategy. The Restoration Plan/FEIS (chapter 2, Restoration of MYLFs), states that: "MYLF restoration would be based on the best science available, and protocols would be researched, developed, implemented, monitored, and refined in collaboration with other federal and state agencies (e.g., FWS, USFS, USGS, and CDFW) and academic researchers. The approach to reintroductions, including preserving genetic diversity, treating frogs for chytrid fungus, and identifying source populations, would be developed with guidance from the 'Mountain Yellow-legged Frog Conservation Strategy,' which is currently being developed by a multi-agency team led by FWS…"

In addition, all actions proposed in this plan that have the potential to affect federally endangered MYLFs, including translocation protocols, would be approved by the FWS in accordance with section 7 of the Endangered Species Act. Therefore, this plan would be heavily research-based, vetted, and the adaptive management component would ensure that protocols are improved over time, or abandoned if not working.

The Restoration Plan/FEIS considers recent research that modeled potential MYLF population responses to disease (chytridiomycosis) over time (Briggs et al. 2010). This research demonstrates that MYLFs have very high reproductive rates, which sometimes leads to overcrowding in large populations that can reduce frog condition and growth. One MYLF population in YOSE that likely has persisted with disease for at least 15-20 years has recovered to a large size. Although the population as a whole is disease-tolerant, many individuals have low disease resistance. In addition, the population is limited by density-dependence. Together, these forces impact a moderate percentage of the frogs in the population, as indicated in annual surveys of this site that repeatedly observe many frogs in poor condition and many in good condition (Knapp unpublished data). This population is large enough for it to have been safely used as a donor population for several translocations, which helps relieve some of the density-dependent pressure on this population. Survey data showed that survival and recruitment increased in the years following translocations (Knapp unpublished data). Therefore, modest frog removals (of generally a small percentage of the population) sometimes have a positive effect on population viability.

Ongoing monitoring, often annually, allows a strong understanding of population distribution, abundance and trends of frog populations and their disease loads. Very small frog populations are not able to safely sustain take, and thus translocations are limited to larger populations, except for emergency situations such as disease outbreaks and severe drought, when salvage would be appropriate to save animals before the population completely dies-off or habitat dries up.

EFFECTS ON WILDERNESS CHARACTER

Concern 46: *The NPS does not adequately evaluate the effects that large work crews, camp areas, the use of helicopters, and the use of stock, will have on wilderness visitors and wilderness character (opportunities for solitude, and undeveloped qualities of wilderness character).*

The NPS does not adequately describe the effects that area closure related to the proposed project would have on opportunities for primitive and unconfined recreation in wilderness.

Representative Quotes:
Crews needed to support chemical treatments are substantially larger (8 to 15 people), meaning greater spatial extent of on the ground impacts (including creation of new hardened campsites that are slow to heal), greater human waste disposal problems, more intrusive fish disposal methods (scattering of fish on the ground), and greater intrusion on wilderness solitude (much like the impacts of large trail crews). [Recreation Group, #110]

Application of chemicals for fish eradication requires excessive use of the trails by stock and equipment, involves closures of areas to backpackers, and sometimes these procedures must be repeated because they are not sufficiently effective the first or second or third time around. [Unaffiliated Individual, #120]

Response: The effects on wilderness character have been evaluated in the Restoration Plan/FEIS (chapter 4 and appendix A). Regardless of the alternative selected, direct impacts from crews and treatment actions are considered minimal. Any impacts from treatment activities, including the presence of work crews, camp areas, helicopters, and stock would be isolated, short-term, and dependent upon the type and timing of the treatments.

If piscicide treatments are approved, there would be some additional effects on wilderness visitors, including short-term restrictions (at least 72 hours) from the immediate area treated with CFT

Legumine™, but again, this impact is minimal. This information is included in the Restoration Plan/FEIS, (chapter 4, Visitor Experience and Recreation).

Through the minimum analysis process conducted as part of the Restoration Plan/FEIS (appendix A), helicopters and stock have been determined to be the minimum tools necessary for accomplishing aquatic restoration goals; these equipment transport options are only used when the loads are too heavy or bulky to be carried in, or where time is of the essence (e.g. translocation timing related to moving live frogs).

EFFECTS FROM STOCK USE

Concern 47: *The plan should provide information on any new restrictions or changes to stock use in the parks as a result of implementing any of the alternatives.*

Representative Quote:
The High Sierra Unit is very much interested in ensuring that none of these alternatives results in a detrimental impact to stock use in Sequoia and Kings Canyon National Parks ('SEKl'). [Unaffiliated Individual, #122]

Response: There would be no new restrictions or changes to stock use in the parks as a result of implementing any of the alternatives. The NPS and FWS (FWS 2014, pgs. 24270-24271) have limited concern about stock use impacts on MYLF populations. Stock use is considered a low magnitude threat to MYLFs, and any threats have been found to be localized (e.g., limiting stock access to certain breeding areas to eliminate potential for effect on vulnerable populations). Like other recreational activities, stock use has historically been a threat of low significance for MYLFs and is projected to remain of limited concern for MYLF conservation. In the future, if new restrictions or changes to stock use are proposed for the protection of MYLF, separate compliance would be completed and would include public review.

EFFECTS ON SOCIOECONOMICS

Concern 48: *The plan needs to disclose the potential effects on the economy of neighboring communities and counties, in particular the socioeconomic effects on Inyo County.*

Representative Quote:
We are concerned regarding the impacts to important components of our local society, culture, history, and economy associated with recreational fishing in the Sierra Nevada. [County Government, #50]

This issue was addressed in the Restoration Plan/FEIS (chapter 1, Issues and Impact Topics, Impact Topics Dismissed from Further Analysis). To elaborate briefly here, even in the most ambitious alternative, angling would remain a prevalent recreation opportunity throughout the parks. Since most of the proposed fish removal waterbodies are outside of high-use areas, and many are relatively small compared with most other fish-containing lakes, social and economic effects on neighboring communities would be negligible.

APPENDIX F: SENSITIVE SPECIES LISTS

This appendix includes lists of vertebrates and invertebrates that are indicated as federally and/or state listed species, or special-status species, that are known to occur or may potentially occur within SEKI (Tables F-1 and F-2). This appendix also provides an analysis of the potential for the proposed actions to measurably affect the state and federally listed vertebrates and other sensitive vertebrates that are known to occur or may potentially occur in the project area (Table F-3). There are no federally listed plant species within SEKI; sensitive plant species are not listed as there would be no to negligible effects on plants.

Table F-1. Federal and state listed vertebrates and other sensitive vertebrates that are known to occur or may potentially occur in SEKI.

Binomial Name	Common Name	T&E Listed	Sensitive
Fish			
Lavinia symmetricus	California roach		BLMS, CS
Mylopharodon conocephalus	Hardhead		CS, FS
Oncorhynchus mykiss aguabonita	California Golden Trout		CS, FS
Oncorhynchus mykiss gilberti	Kern Rainbow Trout		CS, FS
Oncorhynchus mykiss whitei	Little Kern Golden Trout	FT	
Amphibians			
Anaxyrus [*Bufo*] *canorus*	Yosemite Toad	FT	CS, FS
Hydromantes platycephalus	Mount Lyell Salamander		CS
Rana muscosa	Southern Mountain Yellow-legged Frog	CE, FE	CS, FS
Rana sierrae	Sierra Nevada Yellow-legged Frog	CT, FE	CS, FS
Reptiles			
Anniella pulchra	California legless lizard		CS, FS
Emys marmorata	Western pond turtle		BLMS, CS, FS
Phrynosoma blainvillii	Blainville's horned lizard		BLMS, CC, CS
Birds			
Accipiter cooperii	Cooper's Hawk		CWL
Accipiter gentilis	Northern Goshawk		BLMS, CS, DFS, FS
Accipiter striatus	Sharp-shinned Hawk		CWL
Aquila chrysaetos	Golden Eagle		BLMS, CP, CWL, DFS
Asio flammeus	Short-eared Owl		CS
Asio otus	Long-eared Owl		CS
Buteo regalis	Ferruginous hawk		CWL
Buteo swainsoni	Swainson's hawk	CT	BLMS
Chaetura vauxi	Vaux's Swift		CS
Circus cyaneus	Northern Harrier		CS
Cypseloides niger	Black Swift		CS
Dendroica petechia	Yellow Warbler		CS
Elanus leucurus	White-tailed kite		BLMS, CP
Empidonax traillii	Willow Flycatcher	CE	FS
Eremophila alpestris	Horned lark		CWL
Falco columbarius	Merlin		CWL
Falco mexicanus	Prairie Falcon		CWL
Falco peregrinus	Peregrine Falcon	Delisted	CP, DFS

Binomial Name	Common Name	T&E Listed	Sensitive
Gynmogyps californianus	California Condor*	CE, FE	CP, DFS
Haliaeetus leucocephalus	Bald Eagle	CE	BLMS, CP, DFS, FS
Histrionicus histrionicus	Harlequin duck		CS
Larus californicus	California gull		CWL
Pandion haliaetus	Osprey		CWL, DFS
Progne subis	Purple martin		CS
Strix nebulosa	Great Gray Owl	CE	DFS, FS
Strix occidentalis	Spotted Owl	FT	BLMS, CC, CS, FS
Mammals			
Antrozous pallidus	Pallid Bat		BLMS, CS, FS
Aplodontia rufa californica	Mountain Beaver		CS
Corynorhinus townsendii	Townsend's Big-eared Bat		BLMS, CC, CS, FS
Euderma maculatum	Spotted Bat		BLMS, CS
Eumops perotis	Western Mastiff Bat		BLMS, CS
Gulo gulo	Wolverine	CT	CP, FS
Lasiurus blossevillii	Western red bat		CS
Lepus townsendii	White-tailed Jack Rabbit		CS
Martes caurina [*americana*] *sierrae*	Sierra Marten		FS
Pekania [*Martes*] *pennanti*	Fisher (west coast DPS)		BLMS, CC, CS, FS
Myotis ciliolabrum	Small-footed Myotis		BLMS
Myotis evotis	Long-eared Myotis		BLMS
Myotis thysanodes	Fringed Myotis		BMLS, FS
Myotis yumanensis	Yuma Myotis		BLMS
Ovis canadensis	Bighorn Sheep	CE, FE	BLMS, CP, FS
Taxidea taxus	American badger		CS
Vulpes vulpes necator	Red Fox	CT	FS

FE = Federal Endangered, FT = Federal Threatened, FPT = Fed. Proposed Threatened, CC = California Candidate Sp., CE = California Endangered, CT = California Threatened, CP = California Protected, CS = California Special Concern, CWL = California Watch List, FS = Forest Service Sensitive, BLMS = BLM Sensitive, * extirpated

Table F-2. Federal and state listed invertebrates and other sensitive invertebrates that are known to occur or may potentially occur in SEKI, however, none are known to occur in the project area.

Binomial Name	Common Name	Fed Status	State Status
Branchinecta lynchi	vernal pool fairy shrimp	Threatened	None
Branchinecta mesovallensis	midvalley fairy shrimp	None	None
Linderiella occidentalis	California linderiella	None	None
Lepidurus packardi	vernal pool tadpole shrimp	Endangered	None
Bowmanasellus sequoiae	An isopod	None	None
Calasellus longus	An isopod	None	None
Cicindela tranquebarica ssp.	San Joaquin Tiger Beetle	None	None
Desmocerus californicus dimorphus	valley elderberry longhorn beetle	Threatened	None
Coelus gracilis	San Joaquin dune beetle	None	None
Lytta hoppingi	Hopping's blister beetle	None	None
Lytta moesta	moestan blister beetle	None	None
Lytta molesta	molestan blister beetle	None	None
Lytta morrisoni	Morrison's blister beetle	None	None
Hydroporus hirsutus	wooly hydroporus diving beetle	None	None

Binomial Name	Common Name	Fed Status	State Status
Aegialia concinna	Ciervo aegilian scarab beetle	None	None
Efferia antiochi	Antioch efferian robberfly	None	None
Metapogon hurdi	Hurd's metapogon robberfly	None	None
Oravelia pege	Dry Creek cliff strider bug	None	None
Eucerceris ruficeps	redheaded sphecid wasp	None	None
Andrena macswaini	An andrenid bee	None	None
Chrysis tularensis	A cuckoo wasp	None	None
Cryptochia denningi	Denning's cryptic caddisfly	None	None
Parapsyche extensa	King's Creek parapsyche caddisfly	None	None
Talanites moodyae	Moody's gnaphosid spider	None	None
Calicina dimorphica	A harvestman	None	None
Calicina macula	A harvestman	None	None
Calicina mesaensis	Table Mountain harvestman	None	None
Calicina piedra	Piedra harvestman	None	None
Calicina cloughensis	Clough Cave harvestman	None	None
Ammonitella yatesii	tight coin (=Yates' snail)	None	None
Helminthoglypta callistoderma	Kern shoulderband	None	None

Analysis of Special Status Animal Species

The table below provides an analysis of the federal and state listed and sensitive vertebrates listed above. Those species that likely would not be measurably affected by the proposed actions were dismissed from further analysis. Those species that have the potential to be measurably affected by the proposed actions were evaluated under Special-Status Species or Wildlife-Vertebrates in Chapter 4. There are no known invertebrates of concern in the project area.

Federal Agencies
FE = Endangered
FT = Threatened
FPT =Proposed Threatened
FS = Forest Service Sensitive
BLMS = Bureau of Land Management Sensitive

California State Agencies
CE = Endangered
CT = Threatened
CC = Candidate
CS = Special Concern
CP = Protected
CWL = Watch List
DFS = Department of Forestry Sensitive

Table F-3. An analysis of the potential for proposed actions to measurably affect the federal and state listed vertebrates and other sensitive vertebrates that are known to occur or may potentially occur in SEKI.

Common Name	Latin Name	T&E Listed		Other Status		Found in project area?	Analysis	Result
		Federal	State	Federal	State			
Fish								
California roach	*Lavinia symmetricus*	-	-	BLMS	CS	No	This taxon is not found in project area.	Dismissed
Hardhead	*Mylopharodon conocephalus*	-	-	FS	CS	No	This taxon is not found in project area.	Dismissed
California golden trout	*Oncorhynchus mykiss aguabonita*	-	-	FS	CS	Yes	This taxon is found in the project area, however, it is nonnative in these habitats, and is nonnative in the parks. Its native range is completely within Sequoia National Forest. Many populations have been transplanted into the project area - to naturally fishless, high elevation waters. However, most are likely hybridized with rainbow and hatchery golden trout (Cordes et al. 2006). There is low potential for pure or nearly pure California golden trout to be present in lakes proposed for fish eradication. If any lakes approved for eradication contain California golden trout populations with genetic value, the parks would work with California Fish and Game staff to transplant these fish out of the treatment areas before they are treated.	Dismissed
Kern rainbow trout	*Oncorhynchus mykiss gilberti*	-	-	FS	CS	Yes	This taxon is found in the project area, however, it is nonnative in these habitats. Its native range is restricted to the mainstem Kern River, the upper portion of which is within Sequoia National Park, at elevations from approximately 6,000 to 8,000 ft (1,800 to 2,400	Dismissed

Common Name	Latin Name	T&E Listed		Other Status		Found in project area?	Analysis	Result
		Federal	State	Federal	State			
							m). Some populations have been transplanted into the project area - to naturally fishless, high elevation waters. However, most are hybridized with rainbow and golden trout (Erickson et al. 2010). There is low potential for pure or nearly pure Kern rainbow trout to be present in lakes proposed for fish eradication. If any lakes approved for eradication contain Kern rainbow trout populations with genetic value, the parks would work with California Fish and Game staff to transplant these fish out of the treatment areas before they are treated.	
Little Kern golden trout	*Oncorhynchus mykiss whitei*	FT	-	-	-	Yes	This taxon is found in the project area, however, it is nonnative in these habitats. Its native range is restricted to the Little Kern River, the upper portion of which is within Sequoia National Park, at elevations from approximately 8,000 to 8,500 ft (2,400 to 2,600 m). One population has been transplanted into the project area – to naturally fishless, high elevation waters. However, it hybridized with rainbow and golden trout (Erickson et al. 2010). There is low potential for pure or nearly pure Little Kern golden trout to be present in lakes proposed for fish eradication. If any lakes approved for eradication contain Little Kern golden trout populations with genetic value, the parks would work with California Fish and Game staff to transplant some of these fish out of the treatment areas before they are treated. Nevertheless, since the proposed actions could have a measurable effect on Little Kern golden trout in at least one treatment area, this taxon is being evaluated under Special-Status Species in Chapter 4.	Evaluated
Amphibians								
Yosemite toad	*Anaxyrus* [*Bufo*] *canorus*	FT	-	FS	CS	Yes	This taxon, currently proposed for federal listing as threatened, may have meadow habitat in some areas affected by crew activity. The potential habitat is in the northern-most portions of the proposed restoration project area and is generally not associated with lakes or streams within proposed treatment areas. A study being conducted by the USGS in SEKI from 2010 to 2011 detected toads in 42 meadows of several hundred surveyed, which included	Evaluated

Common Name	Latin Name	T&E Listed		Other Status		Found in project area?	Analysis	Result
		Federal	State	Federal	State			
							most of the range of Yosemite toads in SEKI (USGS unpublished data). If a proposed restoration area would be near toad habitat, crews would survey the area before beginning work. If toads are found during the pre-surveys, then mitigation would be implemented to minimize effects to this species. Since most work would be outside toad habitat and pre-surveys would be done before work in possible habitat, the proposed actions would not have a measurable impact in most treatment areas. Nevertheless, since the proposed actions could have a measurable effect on Yosemite toads in at least two treatment areas, this taxon is being evaluated under Special-Status Species in Chapter 4.	
Mount Lyell salamander	*Hydromantes platycephalus*	-	-	-	CS	Yes	This taxon is primarily found in seeps, and spray zones of flowing water and waterfalls, under rocks with moisture, near melting snow banks, and under low growing plants. They are found within many treatment basins. There would be potential for piscicide treatments to harm individuals that occupy habitat near larger flowing water that would be treated. However, most habitat for this species is outside of treatment waters given that this taxon is not truly aquatic. Therefore, this taxon has been dismissed from further analysis.	Dismissed
Mountain yellow-legged frog (Sierra Nevada DPS[1])	*Rana muscosa*	FE	CE	FS	CS	Yes	This taxon is federally listed as endangered and is state listed as endangered. It would be measurably affected by many of the proposed actions and therefore is being evaluated under Special-Status Species in Chapter 4.	Evaluated
Sierra Nevada yellow-legged frog	*Rana sierrae*	FE	CT	FS	CS	Yes	This taxon is federally listed as endangered and is state listed as threatened. It would be measurably affected by many of the proposed actions and therefore is being evaluated under Special-Status Species in Chapter 4.	Evaluated
Reptiles								
California legless lizard	*Anniella pulchra*	-	-	FS	CS	No	This taxon is not found in the project area.	Dismissed
Western pond turtle	*Emys marmorata*	-	-	BLMS, FS	CS	No	This taxon is not found in the project area.	Dismissed

Common Name	Latin Name	T&E Listed		Other Status		Found in project area?	Analysis	Result
		Federal	State	Federal	State			
Coast horned lizard	*Phrynosoma blainvillii*	-	-	BLMS, FS	CC, CS	No	This taxon is not found in the project area.	Dismissed
Birds								
Cooper's hawk	*Accipiter cooperii*	-	-	-	CWL	Yes	Primary habitat includes forested areas adjacent to, but not within the treatment habitat. There would be no likelihood of adverse effects on small birds and mammals, which are primary prey items for this taxon. Though project base camps could have a slight effect on nesting and foraging behavior, there is no potential for measurable effects. Therefore, this taxon has been dismissed from further analysis.	Dismissed
Northern goshawk	*Accipiter gentilis*	-	-	BLMS, FS	CS, DFS	Yes	Primary habitat includes open, forested areas adjacent to clearings and wetlands. This habitat is associated with only a small portion of the treatment basins. There is no likelihood for adverse effects on grouse, rabbits, and squirrels, which are primary prey items for this taxon. Though project base camps could have a slight effect on nesting and foraging behavior, there is no potential for measurable effects. Therefore, this taxon has been dismissed from further analysis.	Dismissed
Sharp-shinned hawk	*Accipiter striatus*	-	-	-	CWL	Yes	Primary habitat includes forested areas adjacent to, but not within the treatment habitat. There could be a slight potential for effects on small bird related to nesting and foraging behavior, which are primary prey items for this taxon. Though project base camps could have a slight effect on nesting and foraging behavior, there is no potential for measurable effects. Therefore, this taxon has been dismissed from further analysis.	Dismissed
Golden eagle	*Aquila chrysaetos*	-	-	BLMS	CP, CWL, DFS	Yes	Primary habitat includes open landscapes, which are found within many treatment basins. There would be no likelihood for adverse effects on small mammals, which are primary prey items for this taxon. Though project base camps could have a slight effect on nesting and foraging behavior, there is no potential for measurable effects. Therefore, this taxon has been dismissed from further analysis.	Dismissed

Common Name	Latin Name	T&E Listed		Other Status		Found in project area?	Analysis	Result
		Federal	State	Federal	State			
Short-eared owl	*Asio flammeus*	-	-	-	CS	Yes	It is rare for this taxon to occur in the project area. Primary habitat includes grassy fields and marshes, which are found within some of the treatment basins. There would be a negligible impact on small mammals, which are primary prey items for this taxon. Though project base camps could have a slight effect on nesting and foraging behavior, there is no potential for measurable effects. Therefore, this taxon has been dismissed from further analysis.	Dismissed
Long-eared owl	*Asio otus*	-	-	-	CS	Yes	It is rare for this taxon to occur in the project area. Primary habitat includes dense forest stands, which are not associated with the treatment basins. There would be a negligible impact on small mammals, which are primary prey items for this taxon. Though project base camps could have a slight effect on nesting and foraging behavior, there is no potential for measurable effects. Therefore, this taxon has been dismissed from further analysis.	Dismissed
Ferruginous hawk	*Buteo regalis*	-	-	-	CWL	Yes	Primary habitat includes open treeless landscapes, which are found within many treatment basins. There would be a negligible impact on small mammals, which are primary prey items of this taxon. Though project base camps could have a slight effect on nesting and foraging behavior, there is no potential for measurable effects. Therefore, this taxon has been dismissed from further analysis	Dismissed
Swainson's hawk	*Buteo swainsoni*	-	CT	BLMS	-	No	This taxon is not found in project area.	Dismissed
Vaux's swift	*Chaetura vauxi*	-	-	-	CS	Yes	It is rare for this taxon to occur in the project area. Primary habitat includes large, hollow trees for nesting and open land and water for foraging. Prey items include both terrestrial and emergent aquatic insects. There may be a minor short term impact to aquatic prey items at piscicide treatment areas. However, the habitat impacted in the short term by these treatments is minor compared to the foraging habitat available outside of treatment basins. Though project base camps could have a slight effect on nesting and foraging behavior, there is no potential for measurable effects. Therefore, this taxon has been dismissed from further analysis.	Dismissed
Northern harrier	*Circus cyaneus*	-	-	-	CS	Yes	Primary habitat includes grassy fields and marshes, which are found within some of the treatment basins. There would be a	Dismissed

Common Name	Latin Name	T&E Listed		Other Status		Found in project area?	Analysis	Result
		Federal	State	Federal	State			
							negligible impact on small mammals, which are primary prey items for this taxon. Though project base camps could have a slight effect on nesting and foraging behavior, there is no potential for measurable effects. Therefore, this taxon has been dismissed from further analysis.	
Black swift	*Cypseloides niger*	-	-	-	CS	Yes	Primary nesting habitat includes cliffs and cliff ledges and open land and water for foraging. Prey items include both terrestrial and emergent aquatic insects. However, the habitat impacted in the short term by these treatments is minor compared to the foraging habitat available outside of treatment basins. Though project base camps could have a slight effect on nesting and foraging behavior, there is no potential for measurable effects. Therefore, this taxon has been dismissed from further analysis.	Dismissed
Yellow warbler	*Setophaga petechia*	-	-	-	CS	Yes	Primary habitat includes wet, brushy habitat. Prey items include both terrestrial and emergent aquatic insects. There may be a minor short term impact to aquatic prey items at piscicide treatment areas. However, the habitat impacted in the short term by these treatments is minor compared to the foraging habitat available outside of treatment basins. Though project base camps could have a slight effect on nesting and foraging behavior, there is no potential for measurable effects. Therefore, this taxon has been dismissed from further analysis.	Dismissed
White-tailed kite	*Elanus leucurus*	-	-	BLMS	CP	Yes	It would be very uncommon for this taxon to occur in a project area. Primary habitat includes grassy fields and marshes, which are found within some of the treatment basins. There could be a slight impact on small rodents, which are primary prey items for this taxon. Though project base camps could have a slight effect on nesting and foraging behavior, there is no potential for measurable effects. Therefore, this taxon has been dismissed from further analysis.	Dismissed
Willow flycatcher	*Empidonax traillii*	-	CE	FS	-	Yes	Primary habitat includes wet, brushy willow thicket habitat. Prey items include flying insects. This taxon is typically found at elevations lower than all treatment basins. Should they occur in a	Dismissed

Common Name	Latin Name	T&E Listed		Other Status		Found in project area?	Analysis	Result
		Federal	State	Federal	State			
							treatment basin, there may be a minor short term impact to aquatic prey items at piscicide treatment areas. The habitat impacted in the short term by these treatments is minor compared to the foraging habitat available outside of treatment basins. Though project base camps could have a slight effect on nesting and foraging behavior, there is no potential for measurable effects. Therefore, this taxon has been dismissed from further analysis.	
Horned lark	*Eremophila alpestris*	-	-	-	CWL	Yes	Primary habitat includes barren, open areas, which are found within many treatment basins. There would be no impact on seeds and terrestrial insects, which are primary prey items for this taxon. Though project base camps could have a slight effect on nesting and foraging behavior, there is no potential for measurable effects. Therefore, this taxon has been dismissed from further analysis.	Dismissed
Merlin	*Falco columbarius*	-	-	-	CWL	Yes	Primary habitat includes open landscapes, which are found within many treatment basins. There would be a negligible impact on small birds, which are primary prey items of this taxon. Though project base camps could have a slight effect on nesting and foraging behavior, there is no potential for measurable effects. Therefore, this taxon has been dismissed from further analysis.	Dismissed
Prairie falcon	*Falco mexicanus*	-	-	-	CWL	Yes	Primary habitat includes cliff ledges for nesting and open landscapes for feeding. This habitat is found within many treatment basins. There would be a negligible impact on small mammals and birds, which are primary prey items of this taxon. Though project base camps could have a slight effect on nesting and foraging behavior, there is no potential for measurable effects. Therefore, this taxon has been dismissed from further analysis.	Dismissed
Peregrine falcon	*Falco peregrinus*	Delisted	Delisted	-	CP, DFS	Yes	Primary habitat includes cliff ledges for nesting and open landscapes away from water for feeding. This habitat is found within many treatment basins. There would be a negligible impact on small birds, which are primary prey items of this taxon. Though project base camps could have a slight effect on nesting and foraging behavior, there is no potential for measurable effects. Therefore, this taxon has been dismissed from further analysis.	Dismissed

Common Name	Latin Name	T&E Listed		Other Status		Found in project area?	Analysis	Result
		Federal	State	Federal	State			
California condor	*Gymnogyps californianus*	FE	CE	-	CP, DFS	No	This taxon historically occurred in the parks, but it was considered an extirpated species in SEKI after the last recorded observation occurred in 1981. From 2013 to 2015, three observations occurred of individuals flying (conducting exploratory movements) over the parks (Gammons D, pers. comm., 2016). Due to the rarity of the California condor, and its occasional brief visits to SEKI, project implementation and staff presence would have no likelihood of adverse effects to the California condor. Therefore, this taxon has been dismissed from further analysis.	Dismissed
Bald eagle	*Haliaeetus leucocephalus*	Delisted	CE	BLMS, FS	CP, DFS	Yes	Primary habitat includes large nesting trees near rivers and lakes. This habitat is found within some treatment basins. There would be a negligible impact on small mammals and waterfowl, which are prey items of this taxon. Bald eagles also feed on fish. Eradication of this prey item is considered negligible since all fish are nonnative to the treatment basins. This prey source was historically unavailable to bald eagles prior to fish introductions into high elevation SEKI lakes and streams. This taxon is highly mobile so if there are bald eagles present at treatment basins, they can easily move to nearby areas that would still contain fish. Though project base camps could have a slight effect on nesting and foraging behavior, there is no potential for measurable effects. Therefore, this taxon has been dismissed from further analysis.	Dismissed
Harlequin duck	*Histrionicus histrionicus*	-	-	-	CS	No	This taxon is not found in project area	Dismissed
California gull	*Larus californicus*	-	-	-	CWL	Yes	Primary habitat includes lakes, ponds, rivers and areas of human habitation. In their natural aquatic habitat, this taxon feeds on small mammals, insects, and fish. There would be a negligible impact on small mammals. There may be a minor short term impact to aquatic prey items at piscicide treatment areas. However, the habitat impacted in the short term by these treatments is minor compared to the foraging habitat available outside of treatment basins. Eradication of fish is considered negligible since all fish are nonnative to the treatment basins. This prey source was historically unavailable to California gulls prior to fish introductions into high	Dismissed

Common Name	Latin Name	T&E Listed		Other Status		Found in project area?	Analysis	Result
		Federal	State	Federal	State			
							elevation SEKI lakes and streams. This taxon is highly mobile so if there are individuals present at treatment basins, they can easily move to nearby areas that would still contain fish. Though project base camps could have a slight effect on nesting and foraging behavior, there is no potential for measurable effects. Therefore, this taxon has been dismissed.	
Osprey	*Pandion haliaetus*	-	-	-	CWL, DFS	Yes	Primary habitat includes large nesting trees near open water. This habitat is found within some treatment basins. Osprey feed almost exclusively on fish. Eradication of this prey item is considered negligible since all fish are nonnative to the treatment basins. This prey source was historically unavailable to osprey prior to fish introductions into high elevation SEKI lakes and streams. This taxon is highly mobile so if there is osprey present at treatment basins, they can easily move to nearby areas that would still contain fish. Though project base camps could have a slight effect on nesting and foraging behavior, there is no potential for measurable effects. Therefore, this taxon has been dismissed from further analysis.	Dismissed
Purple martin	*Progne subis*	-	-	-	CS	No	This taxon is not found in project area.	Dismissed
Great gray owl	*Strix nebulosa*	-	SE	FS	DFS	No	This taxon is not found in project area.	Dismissed
Spotted owl	*Strix occidentalis*	FT	-	BLMS, FS	CC, CS	No	This taxon is not found in project area.	Dismissed
Mammals								
Pallid bat	*Antrozous pallidus*	-	-	BLMS, FS	CS	Yes	It would be very uncommon for this taxon to occur in a project area. This taxon is most commonly found at lower elevation sites in blue oak savannah in Sequoia National Park and ponderosa pine forests in Cedar Grove, Kings Canyon National Park. This taxon is rarely found up to 6,600 ft (2,000 m) in elevation and is likely to occur downstream of treatment basins. Though project base camps could have a slight effect on roosting and foraging behavior, there is no potential for measureable effects. Therefore, this taxon has been dismissed from further analysis.	Dismissed

Common Name	Latin Name	T&E Listed		Other Status		Found in project area?	Analysis	Result
		Federal	State	Federal	State			
Sierra Nevada mountain beaver	*Aplodontia rufa californica*	-	-	-	CS	Yes	It would be very uncommon for this taxon to occur in a project area. There have been occasional sightings at high elevations, but most occurrences have been at lower elevations outside the project area. This taxon feeds exclusively on vegetation, which would not be impacted by the project. Though project base camps could have a slight effect on behavior, there is no potential for measurable effects. Therefore, this taxon has been dismissed from further analysis.	Dismissed
Townsend's big-eared bat	*Corynorhinus townsendii*	-	-	BLMS, FS	CC, CS	No	This taxon is not found in project area.	Dismissed
Spotted bat	*Euderma maculatum*	-	-	BLMS	CS	Yes	This taxon is most commonly found at low elevation sites in Sequoia National Park. It is found less frequently in high elevation areas of both parks. Most known records occur outside of all treatment basins. In addition, this taxon nests on cliff ledges and forages over wet and dry meadows. There would be a slight impact to these areas by project treatments. Though project base camps could have a slight effect on roosting and foraging behavior, there is no potential for measurable effects. However, Pierson and Rainey (2009) reported this species as captured or recorded in the project area, and spotted bats either feed over aquatic habitats or are generalists feeders, making it possible for them to occur over treated habitat and therefore potentially be affected by proposed actions.	Evaluated
Western mastiff bat	*Eumops perotis*	-	-	BLMS	CS	Yes	This taxon roosts at low elevation rock outcrops in SEKI. It would travel to high elevation areas only to forage above meadows, lakes and other open areas. There may be a minor short term impact to emergent aquatic prey items at piscicide treatment areas. However, the habitat impacted in the short term by these treatments is small when compared to the foraging habitat available outside of treatment basins. Though project base camps could have a slight effect on roosting and foraging behavior, there is no potential for measurable effects. Nevertheless, Pierson and Rainey (2009) reported this species as captured or recorded in the project area,	Evaluated

Common Name	Latin Name	T&E Listed		Other Status		Found in project area?	Analysis	Result
		Federal	State	Federal	State			
							and western mastiff bats either feed over aquatic habitats or are generalists feeders, making it possible for them to occur over treated habitat and therefore potentially be affected by proposed actions.	
Wolverine	*Gulo gulo*	-	CT	FS	CP	Yes	It would be very uncommon for this taxon to occur in the project area. Primary habitat includes most vegetation zones at middle to high elevations. There would be a negligible impact on small and large mammals, which are primary prey items for this taxon. Due to the rarity of the wolverine, and suspected low population density or extirpation in SEKI, project implementation and staff presence is expected to have no potential for adverse effects on the wolverine. Therefore, this taxon has been dismissed from further analysis.	Dismissed
Western red bat	*Lasiurus blossevillii*	-	-	-	CS	Yes	This taxon is typically found in low elevation cottonwood and willow riparian habitats. It is found predominantly below 7,900 ft (2,400 m) in elevation. There have been a few detections above this elevation, including at elevations that could potentially overlap with the treatment basins. However, because it is highly unlikely to occur at project treatment basins, this taxon has been dismissed from further analysis.	Dismissed
White-tailed jack rabbit	*Lepus townsendii*	-	-	-	CS	No	This taxon is not found in project area.	Dismissed
Sierra Marten	*Martes caurina* [*americana*] *sierrae*	-	-	FS	-	Yes	This taxon is found in all elevations of SEKI. Marten typically occupy forested areas, which are occasionally found within or nearby treatment basins. There would be a negligible impact on small mammals, birds, and terrestrial insects, which are primary prey items for this taxon. Though project base camps could have a slight effect on behavior since project implementation would take place in open, exposed, aquatic habitats rather than upland forested habitats. However, there is no potential for measurable effects. Therefore, this taxon has been dismissed from further analysis.	Dismissed

Common Name	Latin Name	T&E Listed		Other Status		Found in project area?	Analysis	Result
		Federal	State	Federal	State			
Fisher (west coast DPS)	*Pekania* [*Martes*] *pennanti*	-	-	BLMS, FS	CC, CS	Yes	There is the potential that the habitat for this taxon occurs near proposed restoration areas. However, since nearly all of the proposed restoration areas occur at higher elevations than its habitat, it is highly unlikely that crew presence would disturb the animal. Primary habitat includes most vegetation zones in very complex forests at low to middle elevations. There would be a negligible impact on small mammals, which are primary prey items for this taxon. Due to the unlikely presence of the taxon and the negligible impacts from human action, this taxon has been dismissed from further analysis.	Dismissed
Small-footed myotis	*Myotis ciliobrum*	-	-	BLMS	-	Yes	This taxon has been detected in low frequencies throughout SEKI. It has been found at a wide elevation range in SEKI, occurring in foothill and alpine habitat. It forages on aquatic and terrestrial insects. There may be a minor short term impact to emergent aquatic prey items at piscicide treatment areas. However, the habitat impacted in the short term by these treatments is minor compared to the foraging habitat available outside of treatment basins. In addition, short-term, low impact project base camps would have negligible impacts on roosting and foraging behavior. Therefore, this taxon has been dismissed from being evaluated as a special-status species. However, Pierson and Rainey (2009) reported this species as captured or recorded in the project area, and small-footed myotis either feed over aquatic habitats or are generalists feeders, making it possible for them to occur over treated habitat and therefore potentially be affected by proposed actions. Therefore, this taxon is being evaluated under Wildlife-Vertebrates in Chapter 4.	Evaluated
Long-eared myotis	*Myotis evotis*	-	-	BLMS	-	Yes	This taxon is associated with mixed deciduous and coniferous forests. Prey items primarily include large terrestrial insects captured in the forest understory. This taxon is found in middle to high elevation habitats. Although this taxon is likely found near or within treatment basins, there would be a minor impact to their primary life history requirements since all treatments would take	Dismissed

Common Name	Latin Name	T&E Listed		Other Status		Found in project area?	Analysis	Result
		Federal	State	Federal	State			
							place in aquatic habitats. Though project base camps could have a slight effect on roosting and foraging behavior, there is no potential for measurable effects. Therefore, this taxon has been dismissed from further analysis.	
Fringed myotis	*Myotis thysanodes*	-	-	BLMS, FS	-	Yes	This taxon is associated with mixed deciduous and coniferous forests, Douglas fir forest, and giant Sequoia habitat. In SEKI, they appear to be limited by elevation, ranging from 3,300 to 6,600 ft (1,000 to 2,000 m). The only treatment basin that this taxon could occur in is Crescent Meadow. However, their diet predominantly consists of terrestrial insects. There may be a minor short term impact on emergent aquatic prey items during a Crescent Meadow piscicide treatment. However, the habitat impacted in the short term by these treatments is minor compared to the foraging habitat available outside of the Crescent Meadow treatment area. Therefore, this taxon has been dismissed from further analysis.	Dismissed
Yuma myotis	*Myotis yumanensis*	-	-	BLMS	-	Yes	This taxon is a habitat generalist, found from low elevation blue oak forests to high elevation lodgepole pine forests. It is predominately found from 3,300 to 8,200 ft (1,000 to 2,500 m) in elevation, but it can occasionally occur over 9,900 ft (3,000 m). This taxon feeds primarily on emergent aquatic insects. There may be short term minor impacts to emergent aquatic prey items at piscicide treatment areas. However, the habitat impacted in the short term by these treatments is minor compared to the foraging habitat available outside of treatment basins. In addition, short-term, low impact project base camps would have negligible impacts on roosting and foraging behavior. Therefore, this taxon has been dismissed from being evaluated as a special-status species. However, Pierson and Rainey (2009) reported this species as captured or recorded in the project area, and small-footed myotis either feed over aquatic habitats or are generalists feeders, making it possible for them to occur over treated habitat and therefore potentially be affected by proposed actions.	Evaluated

Common Name	Latin Name	T&E Listed		Other Status		Found in project area?	Analysis	Result
		Federal	State	Federal	State			
							Therefore, this taxon is being evaluated under Wildlife-Vertebrates in Chapter 4.	
Sierra Nevada bighorn sheep	*Ovis canadensis sierrae*	FE	CE	BLMS, FS	CP	Yes	This taxon is listed under the Endangered Species Act as endangered. Scattered portions of SEKI's high elevations have been designated as critical habitat for the Sierra Nevada bighorn sheep. One of the proposed treatment sites would be in the lower portion of Sixty Lake Basin. Bighorn sheep habitat is located in the upper portion of the basin where sheep have recently been observed. The proposed treatment site involves approximately seven lakes, connective ponds and streams in the lower end of the basin. In areas of the park where sheep and visitors frequently occur in the same general area, such as Upper Soldier Meadow, sheep show a high tolerance for human presence. Based on elevation preferences of the sheep and tolerance for people, the presence of crews in the Sixty Lake Basin restoration area is therefore not expected to measurably impact sheep activity, movement or use. Another proposed treatment site would be Laurel Basin, where restoration action would largely occur in stream habitat, and one pond. There has not been bighorn sheep activity observed in the area in the recent past; however, there may be the potential for sheep reintroductions in the future. Restoration activities can be scheduled so that any treatment activities are completed prior to any future reintroduction of bighorn sheep. If piscicides are used as part of the treatment options, studies indicate that effects to water quality and vegetation would be short-term (EPA 2007A; see Appendix G). Based on minor overlap between bighorn sheep and the proposed treatment areas, plus the above information and mitigations, the proposed actions would likely not have a measurable impact on bighorn sheep in most of the proposed treatment areas. Nevertheless, since the proposed actions could have a measurable effect on bighorn sheep in at least 1 to 2 treatment areas, this taxon is being evaluated under Special-Status Species in Chapter 4.	Evaluated

Common Name	Latin Name	T&E Listed		Other Status		Found in project area?	Analysis	Result
		Federal	State	Federal	State			
American badger	*Taxidea taxus*	-	-	-	CS	Yes	This taxon is found in all elevations of SEKI, though it has been observed more often at lower and middle elevations. American badgers typically occupy drier open areas such as meadows and grasslands These habitats are occasionally found within or nearby treatment basins. There would be a negligible impact on small mammals, which are primary prey items for this taxon. Though project base camps could have a slight effect on behavior since project implementation would take place aquatic habitats rather than upland habitats, there is not potential for measurable effects. Therefore, this taxon has been dismissed from further analysis.	Dismissed
Sierra Nevada red fox	*Vulpes vulpes necator*	-	CT	FS	-	No	This taxon is not found in project area.	Dismissed

[1] DPS = Distinct Population Segment – a separated and unique subspecies population
[2] The Sierra Nevada population of *Rana muscosa* was designated as a federal candidate in 2003 and again in 2007. The taxonomy for a portion of the range changed to *Rana sierrae* in 2007. In 2012, the Sierra Nevada population of *Rana muscosa* was state listed as endangered and *Rana sierrae* was state listed as threatened. In April 2013, the populations of both species in the Sierra Nevada were proposed for federal listing as endangered. In April 2014, the populations of both species in the Sierra Nevada were federally listed as endangered.

Source: California Dept. of Fish and Wildlife, California Natural Diversity Database: 1) State & Federally Listed Endangered & Threatened Animals of California, January 2016; and 2) Special Animals List, January 2016. FWS IPaC Trust Resource Report, web accessed February 2016. https://ecos.fws.gov/ipac/

APPENDIX G: BACKGROUND INFORMATION AND EFFECTS OF ROTENONE ON ECOLOGICAL HEALTH

Rotenone and Antimycin A Regulatory History

Rotenone and antimycin A were first registered as piscicides with the US Environmental Protection Agency (EPA) in 1947 and 1960, respectively (EPA 2007A, 2007B). In 1988, the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) was amended to facilitate reregistration of products with active ingredients registered prior to November 1, 1984. The reregistration process thoroughly reviews the data on which a pesticide's registration is based, with a purpose to "reassess the potential hazards arising from the currently registered uses of a pesticide, to determine the need for additional data on health and environmental effects, and to determine whether or not the pesticide meets the "no unreasonable adverse effects" criteria of FIFRA."

In 2007, following comprehensive ecological and human health risk assessments conducted by the EPA, both rotenone and antimycin A were declared eligible for reregistration as restricted-use pesticides, but only for piscicidal use (EPA 2007A, 2007B). All other past EPA-registered uses for rotenone, including livestock, residential, home owner, domestic pet, and others, were voluntarily cancelled by the three current manufacturers of commercial rotenone products (Prentiss Incorporated, Foreign Domestic Chemicals Corporation, and Tifa International LLC).

Following these decisions, a specific formulation of rotenone, CFT Legumine™, was reregistered by the California Department of Pesticide Regulation (CDPR) for applications targeting fish in California waters (CDPR 2007). CFT Legumine™ is the newest formulation of rotenone, designed to be more benign relative to ecological and human health than older formulations. Antimycin A, however, is not currently registered by CDPR for use in California, due to the inability of the manufacturer to generate health and safety data required by the state (Finlayson B., pers. comm., 2007). The remainder of this section therefore summarizes what is known about rotenone and analyzes piscicidal use of CFT Legumine™ as a management tool.

Rotenone Origin and Use

Rotenone is a natural toxin derived from the roots of several leguminous plants, including *Derris* spp., *Lonchocarpus* spp., and *Tephrosia* spp., which are primarily found in Southeast Asia, South America, and East Africa, respectively (EPA 2007A). Rotenone is highly toxic to fish and other aquatic life, but substantially less toxic to birds and mammals (Durkin 2008).Therefore, rotenone has been used by humans for centuries to capture fish for food, and for more than 150 years as a commercial insecticide (Ling 2003). Published literature on rotenone is extensive and long-ranging, with 475 papers on insecticide use known in 1932 (Roark 1932). Since 1990, more than 1,000 papers with rotenone in the title have been published (Web of Science Core Collection, accessed February 2016), with recent interest focusing on biochemical, neurological, and possible anticancer properties (Ling 2003). Since rotenone is now considered one of the most environmentally benign piscicides available (Ling 2003), it has been used extensively to manage and research fish populations for more than 70 years, with the majority of piscicide applications in North America involving the use of rotenone (McClay 2005). To address recent public concern about piscicidal use of rotenone, a stewardship program was established by the American Fisheries Society to develop safe rotenone practices and encourage good planning and public involvement in future rotenone programs (AFS 2000).

The empirical formula and chemical name for rotenone are $C_{23}H_{22}O_6$ and (2R,6aS,12aS)-1,2,6,6a,12,12a-hexahydro-2-isopropenyl-8,9-dimethoxychromeno[3,4-b]furo[2,3-h]chromen-6-one, respectively. The

chemical structure of rotenone is shown in Figure G-1 (from Ling 2003), and its CAS number, a unique numerical identifier assigned by the Chemical Abstracts Service, is 83-79-4.

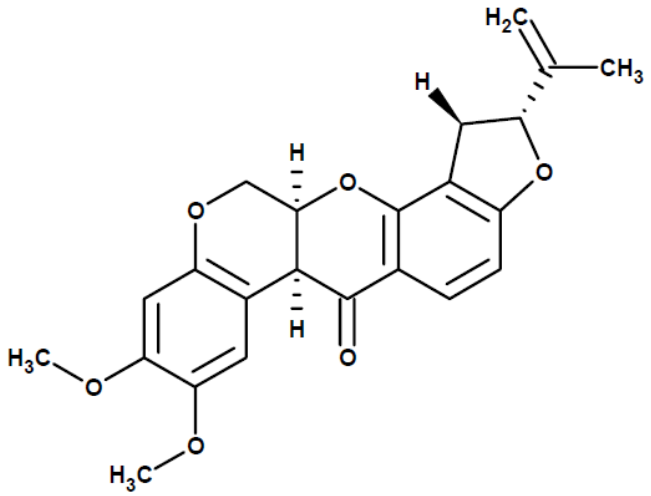

Figure G-1. Chemical structure of rotenone (from Ling 2003).

Rotenone stuns and eventually poisons fish by disrupting cellular aerobic respiration. First, rotenone blocks mitochondrial electron transport at complex I, resulting in a severance of oxidative phosphorylation (Singer and Ramsay 1994). This blocks oxygen uptake, greatly reduces cellular energy production, and increases partial pressure of oxygen (pO_2) in blood. In turn, increases in cellular anaerobic metabolism and lactic acid production cause blood acidosis (Fajt and Grizzle 1998), and fatality ultimately results from tissue anoxia (Ling 2003). Because fish quickly absorb rotenone across gill surfaces, they are extremely sensitive to rotenone poisoning. Although sensitivity varies by taxa, many taxa including trout die within hours at concentrations below 1 part per million (ppm; Ling 2003).

Ingredients in CFT Legumine™

Laboratory analyses done on CFT Legumine™ batches used in a recent rotenone treatment in Lake Davis, California (CDFW 2007) show the active ingredient rotenone as 5% of the formulation. Additional main ingredients as described on the label and determined in this analysis were: methyl pyrrolidone, diethylene glycol ethyl ether, fatty acid esters, and polyethylene glycols. These additives are necessary to make rotenone soluble in water. Several trace compounds were also detected, including naphthalene, substituted benzenes, and hexanol.

EPA (2007A) is limiting CFT Legumine™ applications to a rate of 1 ppm in flowing water and 4 ppm in standing water. At a CFT Legumine™ application rate of 1 ppm, the rotenone itself is initially present at 50 parts per billion (ppb; 1 ppm x 5% rotenone = 0.05 ppm = 50 ppb). For context, a ppb is equal to one part of a substance to a billion parts of water, or "one billionth." An example would be one billionth of Interstate 80 between New York and San Francisco (about 3,000 mi / 4,800 km) is less than ¼ inch (CDFW 2007). The trace compounds are initially present at a few ppb at the greatest, and many are not detectable in the water immediately after the rotenone is applied (CDFW 2007).

Rotenone Environmental Fate and Persistence

Rotenone mixtures, including CFT Legumine™, are chemically unstable when exposed to light, heat, and air, degrading rapidly into water-soluble, non-toxic components (Ling 2003). When applied in water, the EPA (2007A) concluded that rotenone 1) generally degrades quickly through abiotic (hydrolytic and

photolytic) mechanisms, 2) is mobile in soil and sediment, and 3) has limited volatility due to its low vapor pressure and Henry's Law constant, and therefore is not persistent in the environment and has relatively low potential for bioaccumulating in aquatic organisms. Although the EPA (2007A) did not analyze rotenone degradation through biotic mechanisms due to limited data availability, Bettoli and Maceina (1996) stated that rotenone applications can be detoxified by abundant vegetation through adsorption. Similarly, all of the compounds identified in CFT Legumine™ (rotenone and additives) are rapidly biodegraded, hydrolyzed and/or degraded by sunlight, and thus are not persistent and would not bioaccumulate in the environment (CDFW 2007).

Rotenone degradation varies depending on water temperature, however, with half-lives ranging from a few hours in summer to a few weeks in winter (Ling 2003). Summer rotenone applications should therefore strive to treat entire project areas as simultaneously as possible, or rapid breakdown may allow fish to survive and migrate back into previously treated areas. In addition, rotenone products must be stored sealed in a cool dark place or will lose much of their toxicity within weeks (Cheng et al. 1972). If rotenone products end up detoxifying in storage, the breakdown products become comparatively non-toxic, similar to degradation in the field (Marking and Bills 1976).

Rotenone Degradates and Product Additives

The EPA (2007A) also determined that rotenone degradates, including rotenoloids, occur in plants from which rotenone is derived, and thus also occur in varying amounts in manufactured rotenone formulations. The EPA concluded that rotenone degradates such as rotenoloids are structurally similar to rotenone and thus are not more toxic.

Some rotenone formulations, including CFT Legumine™, use solvents and emulsifiers to extract rotenone from derris root (EPA 2007A) and/or improve product dispersion and penetration of thermal stratifications in water (Almquist 1959). The full list of identified chemical constituents of CFT Legumine™ is listed in Table G-5. In particular, CFT Legumine™ primarily contains the following degradates and additives (Environ 2007):

1. Rotenolone (0.718%)
2. 1-Methyl-2-pyrrolidinone (or N-Methylpyrrolidone; hereafter NMP) (9.8%)
3. Diethylene glycol monoethyl ether (Diethylene glycol ethyl ether; hereafter DGEE) (61.1%)
4. Fennedefo 99™ [17.1%; Fennedefo primarily contains a fatty acid ester mixture (Environ 2007)]

Approximately 93% of CFT Legumine™ by weight consists of NMP and DGEE (CDFW 2007). Both are highly soluble in water, would not adsorb to sediments, and would readily volatilize or undergo hydrolysis or direct photolysis (NLM 2006). Both chemicals are therefore expected to be broken down and removed from water by aerobic biodegradation and from air by reaction with photochemically-produced hydroxyl radicals (NLM 2006). The remaining carrier chemicals include naphthalene, methylnaphthalene and a few alkylated benzenes, which comprise less than one percent of CFT Legumine™ and are not expected to alter its overall fate and transport (CDFW 2007). CFT Legumine™ does not use the synergist piperonyl butoxide, which increases the toxicity of rotenone formulations, and therefore CFT Legumine™ has comparatively less environmental impact than rotenone formulations containing piperonyl butoxide.

NMP has low toxicity and thus is often used as a solvent, including in pharmaceuticals for oral ingestion. Toxicology data indicate that the no observable effect level (NOEL) in rats is 6,000 to 18,000 ppm and in mice is 2,500 ppm (NLM 2013). With a standard safety factor of 1,000, this translates to a safe reference dose concentration of 2.5 to 6 ppm, or approximately 25 times greater than NMP concentrations in typical field applications of CFT Legumine™. NMP is readily transformed and excreted from biological organisms, and thus does not bioaccumulate. The half-life of NMP in biological organisms is 3 to 7 hours.

In aquatic systems, NMP is not expected to bind to soils and thus biodegrades readily. For example, 210 ppm of NMP in aquatic systems biodegrades to greater than 98% within 24 hours (NLM 2013).

The other primary component used in CFT Legumine™ is DGEE. In rats and mice given DGEE in drinking water over 2 years, slight to no effects were noted at high doses, including 10,000 ppm in rats and 50,000 ppm in mice (NLM 2013). These levels are nearly 90,000 times greater than DGEE concentrations expected in a typical field application of CFT Legumine™. Additional toxicology data indicate even high concentrations of DGEE have relatively low toxicity (NLM 2013). DGEE is excreted readily through metabolic activity and thus does not bioaccumulate. Although DGEE in aquatic systems is not quickly broken down, 400 ppm DGEE was observed to degrade to greater than 90% after 28 days (NLM 2013).

NMP and DGEE would be expected to dissipate more slowly relative to the active ingredient rotenone because they would be at much higher initial concentrations. Although both are water soluble and would not readily dissipate through volatilization, both are also biodegradable, which is the primary mechanism through which they would dissipate.

The remaining components of CFT-Legumine™ include minute quantities of naphthalene, methylnaphthalene and various alkylbenzenes. In typical field applications of CFT Legumine™, the concentrations of these compounds are in the parts per trillion (ppt), and far below either drinking water standards or safe reference doses established by the EPA. From a health safety standpoint, the application concentrations of naphthalene (350 ppt) and methylnaphthalene (140 ppt) are of little concern, as they are 100 to 1,000 times lower than the safe lifetime doses determined by the EPA.

To summarize, when solvent components of CFT Legumine™ are diluted to the low concentrations expected in typical field applications, they are substantially below the safe concentrations established for drinking water contaminants by the EPA.

Although these additives may result in the presence of chemical odors and pose risks to ecological and human health, the EPA has addressed risks of concern from these additives through numerous mitigation measures, including requiring applicators to use respiratory personal protective equipment and by reducing the maximum allowable treatment concentrations to 50 ppb in flowing water and 200 ppb in standing water (EPA 2007A). The EPA concluded that these mitigations would allow periodic piscicidal use of formulations containing rotenone and additives to continue to provide benefits to society while minimizing risks to human and ecological health.

Neutralization with Potassium Permanganate ($KMnO_4$)

In reregistering rotenone for continued piscicidal use, the EPA (2007A) is requiring that all rotenone applications be deactivated or neutralized using potassium permanganate ($KMnO_4$), to ensure that rotenone toxicity does not spread downstream or linger in a treated area after project goals have been achieved. $KMnO_4$ is a strong oxidizing agent used: 1) in many industries and laboratories, 2) to disinfect water to a potable state, 3) to treat fish for parasites, and 4) to neutralize water following a rotenone application, at a ratio 2 to 4 parts $KMnO_4$ to 1 part rotenone (CDFW 2007). $KMnO_4$ eliminates the respiratory toxicity of rotenone by oxidizing it. In the process, $KMnO_4$ is reduced to potassium (K; an essential electrolyte) and manganese dioxide (MnO_2), which is generally insoluble and similar to the MnO_2 found in the earth's crust (Howe et al. 2004).

The main component of $KMnO_4$ with potential toxicity is manganese, the availability of which in water is largely controlled by pH. At pHs above approximately 5.5, colloidal manganese hydroxides typically form in water, and such colloidal forms are generally not bioavailable (CDFW 2007). Therefore, when

$KMnO_4$ is applied to water to neutralize rotenone, at least two-thirds of it would be reduced, it would not persist in the environment, and it poses little risk to human health.

The ecological toxicity of KMnO4 varies by aquatic taxa, but due to the volume of KMnO4 required to deactivate rotenone, it may be hazardous to aquatic vertebrates, eliciting toxicity at concentrations as low as 1 to 2 ppm (EPA 2006B). KMnO4 is more toxic to rainbow trout at lower versus higher water temperature (Marking and Bills 1976), and more toxic in hard versus soft water due to the potential for MnO2 to precipitate on fish gills (CDFW 2007). KMnO4 is toxic to zooplankton, as represented by *Daphnia spp.*, at concentrations from 84 to 3,500 ppb (EPA 2006B), however, it is less toxic to *Daphnia spp.* than rotenone, which is toxic at concentrations as low as 25 to 27 ppb (see Table G-2).

Rotenone Risk Assessments for Ecological Health

General Overview

The EPA recently conducted an assessment to make a reregistration eligibility determination (RED) for rotenone based on 1) required data generated by acceptable studies following current guidelines, and 2) published scientific literature (EPA 2007A). In 1988, the EPA initiated the reregistration process for rotenone by issuing the "Registration Standard" and associated data call-ins (DCI). DCIs were also issued in 1995 to require a foliar residue dissipation study, and dermal and inhalation passive dosimetry studies; and in 2004 to require a sub-chronic (28-day) inhalation neurotoxicity study, to further investigate independent studies of intravenous rotenone injections in animals at very high doses that led to Parkinson's disease-like symptoms. Although, in 2004, there were registered uses for dust rotenone products that were of concern for inhalation exposure in areas inhabited by humans, all non-piscicidal (agricultural, residential and food) uses were voluntarily cancelled by rotenone manufacturers in 2006, and the EPA subsequently waived the requirement for this study. However, since the EPA could not quantitatively assess potential neurotoxicity at doses to which rotenone users could be exposed, an additional 10x database uncertainty factor - in addition to the inter-species (10x) uncertainty factor and intra-species (10x) uncertainty factor - was applied to the human health risk assessment to protect against potential human health effects, and thus the target margin of exposure (MOE) is 1,000.

In March 2007, the EPA concluded that "currently registered piscicidal (fish-kill) uses of rotenone are eligible for reregistration provided the requirements for reregistration identified in the RED are implemented" (EPA 2007A). The following use profile was excerpted from the RED for rotenone:

Type of Pesticide: Piscicide.

Summary of Use: Rotenone is applied directly to water to manage fish populations in lakes, ponds, reservoirs, rivers, streams, and in aquaculture. The piscicide can be applied to an entire waterbody to achieve a "complete kill" or to a portion of a waterbody to achieve a "partial kill." Complete kills are used to eliminate all fish in the treatment area; partial kills are used to reduce or sample fish populations in the treatment area.

Target Organisms: Undesired fish species.

Mode of Action: Rotenone acts through uncoupling oxidative phosphorylation within cell mitochondria by blocking electron transport at complex I.

Tolerances: No tolerance exists for the piscicidal uses of rotenone.

Use Classification: Rotenone products are classified as Restricted Use Pesticides due to acute inhalation, acute oral, and aquatic toxicity.

Formulations: Liquid.

Methods of Application: Applications are made with helicopters and boats in lakes, reservoirs, and ponds (boats would likely be used in this project); with direct metering into moving water such as streams; and with hand-held equipment such as backpack sprayers in difficult-to-reach aquatic areas.

Use Rates: Labels evaluated in this RED allow rotenone to be applied to achieve treatment concentrations up to 50 ppb in streams/rivers and up to 250 ppb in lakes/reservoirs/ponds.

Application Timing: Rotenone may be applied at any time of year. Fish management program applications typically occur during warm months because the compound degrades more rapidly in warm water than cold water. Aquaculture applications typically occur during the spring prior to stocking.

Annual Usage: Annual usage data for piscicidal applications are not available.

Ecological Risk Assessment

To estimate potential ecological risk from rotenone, the EPA calculated risk quotients (RQ) by dividing acute and chronic estimated environmental concentrations (EEC) by ecotoxicity values (LC50, EC50) taken from published studies for various taxa, and comparing RQs to levels of concern (LOC; EPA 2007A). There is presumed risk of concern when a RQ exceeds a LOC, with higher RQs suggesting greater potential risk than lower RQs. Risk characterization then provides additional information on potential adverse effects and their possible impacts, by considering the environmental fate of applied chemicals and their degradates, potentially at risk organisms, and the nature of observed effects. Toxicities and risk assessments to various biota follow.

Fish

Rotenone effects on various aquatic organisms have been reported from controlled toxicity tests that typically measure the LC50 value (median water concentration of active ingredient that kills 50 percent of test animals) over a period of time (typically 24 hrs and/or 96 hrs). Rotenone toxicity data for several fish taxa (Table G-1, from Marking and Bills 1976, as presented in CDFW 2007) show the most resistant taxa as black bullhead (*Ictalurus melas*), channel catfish (*I. punctatus*), and fathead minnow (*Pimephales promelas*), with 24hr LC50 rotenone concentrations of 33.3 µg/L, 20 µg/L, and 20 µg/L, respectively. In contrast, salmonids (trout, salmon and char) were among the most sensitive taxa tested, with 24hr LC50 rotenone concentrations ranging from 1.4 to 3.6 µg/L, respectively. (All proposed fish eradication sites in SEKI only contain brook trout (*Salvelinus fontinalis*) and/or forms or rainbow trout (*Oncorhynchus mykiss spp.*), which have 24hr LC50 rotenone concentrations of 2.4 µg/L and 3.5 µg/L, respectively.)

However, these tests were conducted with laboratory water, which lacks organic materials typically present in natural water. Natural organics bind to some of the rotenone applied in a treatment, thereby increasing the total amount of rotenone needing to be applied so enough free rotenone is available to fully toxify fish (CDFW 2007). As a result, applications of commercial rotenone formulations from 1 to 3 mg/L (ppm), which result in active ingredient (rotenone) concentrations from 50 to 150 µg/L (ppb), are necessary to eliminate all fish in a treatment area (Ling 2003). In summary, trout are acutely sensitive to rotenone, quickly absorbing it through the gills and typically dying within hours at application concentrations as low as 1 ppm (Ling 2003).

The EPA (2007A) used rainbow trout to estimate toxicity, exposure, and risk to freshwater fish. Rotenone is expected to eliminate fish at labeled application rates of 200 ppb for standing water and 50 ppb for flowing water. (Since the maximum solubility concentration for rotenone is 200 ppb, it is considered that 200 ppb and 50 ppb are the maximum potential exposure, and therefore EEC, for exposed aquatic organisms in standing and flowing water, respectively.) The RQ equation (EEC/LC50 = RQ) confirms

this expectation in both lakes (200/1.94 = 103.1) and streams (50/1.94 = 25.8). Since these RQs exceed the acute risk level of concern (LOC = 0.5) when rotenone is used at labeled application rates, rotenone is likely to cause the intended effect of acute mortality for freshwater fish in the treatment area.

Table G-1. Fish toxicity of Noxfish®, containing 5% rotenone, in standardized laboratory tests at 12°C water temperature.

Species	Lethal Concentration of Noxfish®		Lethal Concentration of Rotenone (x 0.05)	
	LC_{50} 24h. (µg/L)	LC_{50} 96h. (µg/L)	LC_{50} 24h. (µg/L)	LC_{50} 96h. (µg/L)
Northern Pike	44.9	33.0	2.3	1.7
Atlantic salmon	35.0	21.5	1.8	1.1
Brook trout	47.0	44.3	2.4	2.2
Chinook salmon	49.0	36.9	2.5	1.9
Coho salmon	71.6	62.0	3.6	3.1
Lake trout	26.9	26.9	1.4	1.4
Rainbow trout	68.9	46.0	3.5	2.3
Goldfish	---	497.0	---	24.9
Common carp	84.0	50.0	4.2	2.5
Fathead minnow	400.0	142.0	20	7.1
Channel catfish	400.0	164.0	20	8.2
Black bullhead	665.0	389.0	33.3	19.5
Smallmouth bass	93.2	79.0	4.7	4.0
Largemouth bass	200.0	142.0	10	7.1
Green sunfish	218.0	141.0	10.9	7.1
Bluegill sunfish	149.0	141.0	7.5	7.1
Yellow perch	92.0	70.0	4.6	3.5
Longnose sucker	67.2	57.0	3.4	2.9
White sucker	71.9	68.0	3.6	3.4
Bowfin	57.5	30.0	2.9	1.5

Source: CDFW 2007, Appendix J (via Marking and Bills 1976)

The RQs shown above also exceed the chronic risk level of concern (LOC = 1). Chronic effects may therefore occur if freshwater fish survive acute exposure. Based on rotenone environmental fate and labeled application rates in standing and flowing water, freshwater fish may be affected for less than two weeks in warm water and up to approximately 160 days in cold water, where rotenone is relatively more persistent.

Aquatic Invertebrates

The effects of rotenone on aquatic invertebrates are discussed extensively in the Restoration Plan/FEIS in Chapter 4, Wildlife, Invertebrates, Alternative B. Plans for monitoring invertebrates are discussed in Appendix O: Piscicide Treatment Protocols. A summary of rotenone effects on invertebrates is briefly summarized here, but consult the main document for more detailed information on this topic.

Similar to fish, a review of many aquatic invertebrate taxa shows a range of sensitivity to rotenone (Table G-2, from a variety of sources, as summarized by Ling 2003), perhaps based on differing oxygen requirements (CDFW 2007). Table G-2 shows a mollusc (96hr LC50 = 7,500 µg/L), a snail (24hr LC50 = 6,350 µg/L), and a freshwater prawn (24hr LC50 = 5,150 µg/L) as the most rotenone-resistant taxa included in this review, while Branchiura (lice; 24hr LC50 =

~25 µg/L), Conchostracan (clam shrimps; 24hr LC50 = ~50 µg/L), and Hydrachnidae (water mites; 96hr LC50 = ~50 µg/L) were the most rotenone-sensitive taxa reported.

Table G-2. Rotenone toxicity reported in some aquatic invertebrates.

Species Guild	Test Species	Test Endpoint	Lethal Concentration (mg/L)
Flatworm	*Catenula* sp.	LC_{50} 24h	5.1
	Planaria sp.	LC_{50} 24h	<0.5
Annelid worms	Leech	LC_{50} 48 h	<0.100
Copepod	*Cyclops* sp.	LC_{10}0 72h	<0.100
Branchiura	*Argulus* sp.	LC_{50} 24h	~0.025
Cladoceran	*Daphnia pulex*	LC_{50} 24h	0.027
	D. pulex	LC_{50} 24h	<0.025
	Diaptomus siciloides	LC_{50} 24h	<0.025
Conchostracan	*Estheria* sp.	LC_{50} 24h	~0.050
Freshwater prawn	*Palaemonetes kadiakensis*	LC_{50} 24h	5.15
Crayfish	*Cambarus immunis*	LC_{50} 72h	>0.500
Dragonfly naiad	Macromia sp.	LC_{50} 24h	4.7
Stonefly naiad	*Pteronarcys californica*	LC_{50} 24h	2.9
Backswimmer	*Notoncta* sp.	LC_{50} 24h	3.42
	Notonecta sp.	LC_{50} 24h	~0.100
Caddis fly larvae	*Hydropsychye* sp.	LC_{50} 96h	0.605
Whirligig	*Gyrinus* sp.	LC_{50} 24h	3.55
Water mite	Hydrachnidae	LC_{50} 96h	~0.050
Snail	*Physa pomilia*	LC_{50} 24h	6.35
	Oxytrema catenaria	LC_{50} 96h	1.75
	Lymnaea stagnalis	LC_{50} 96h	>1.0
Bivalve Mollusc	*Dreissena polymorpha*	LC_{50} 48h	0.219
	Obliquaria reflexa	LC_{50} 48h	>1.0
	Elliptio buckleyi	LC_{50} 96h	2.95
	Elliptio complanata	LC_{50} 96h	2
	Corbicula manilensis	LC_{50} 96 h	7.5
Ostracod	*Cypridopsis* sp.	LC_{50} 24h	0.490

Source: CDFW 2007, Appendix J (via Ling 2003)

However, these most sensitive invertebrate taxa are 7 to 14 times more resistant than the most resistant fish taxa in SEKI proposed eradication sites (rainbow trout: 24hr LC50 = 3.5 µg/L). Since the anatomies of many aquatic invertebrate taxa contain gill-like structures, they should theoretically be as susceptible to rotenone as fish or amphibian larvae (Bradbury 1986). In laboratory tests, however, Chandler and Marking (1982) concluded that aquatic invertebrates are generally much more tolerant of rotenone than most fishes and amphibian larval stages. A snail (*Helisoma sp.*) and the Asiatic clam (*Corbicula manilensis*) were the most resistant taxa studied, with 96hr LC50 concentrations that were 50 times greater than the most resistant fish (black bullhead) studied by Marking and Bills (1976). Another study (Sanders and Cope 1968) measured rotenone effect on subadult stages of a stonefly (*Pteronarcys californica*). They showed 24hr and 96hr LC50 concentrations of 2,900 µg/L and 380 µg/L, respectively, which are an order of magnitude greater than those reported for black bullhead. They also showed that

larger, older subadults were less susceptible to given concentrations of rotenone than smaller, younger subadults of the same taxa. Although these results indicate that aquatic invertebrates are much less sensitive to rotenone than fish, acute invertebrate mortality is still expected from a typical rotenone application.

Aquatic invertebrate communities, however, tend to recover relatively quickly following rotenone treatment (Ling 2003), with studies showing rapid biomass increases following initial depletions from rotenone treatment (Neves 1975, Cook and Moore 1969). Similarly, Dudgeon (1990) found that stream rotenone treatments caused immediate invertebrate drift, particularly of mayflies, but did not cause significant mortality or a significant reduction in abundance of benthic invertebrates. Nevertheless, varied results of rotenone effect on aquatic invertebrate communities have also been reported, with some showing negligible effects (Demong 2001, Melaas et al. 2001) and others showing longer-term negative effects (Binns 1967, Mangum and Madrigal 1999).

A study of a rotenone treatment in Strawberry River, Utah (Mangum and Madrigal 1999) showed that up to 33% of benthic invertebrate taxa were never affected, 46% had recovered after one year, and 21% were still missing after five years. Most of the taxa that failed to recover were in the EPT group [Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies)], although some taxa in each of these groups were still present and therefore resistant to rotenone. In addition, other taxa not present before the treatment were also detected and possibly filling vacated niches.

However, it is important to note that the Strawberry treatment targeted eradication of Utah chubs (*Gila atraria*), which are in the same family and functionally similar to fathead minnows – one of the most-resistant fish taxa reviewed by Marking and Bills (1976; Table G-1). Therefore, assuming that Utah chubs are significantly more resistant to rotenone than trout, this treatment was applied at a concentration significantly greater than is necessary to eliminate trout taxa, and significantly greater than is currently allowed following the reregistration of rotenone for piscicidal use (EPA 2007A).

In addition, taxa in the EPT group are typically highly mobile and have short life cycles, and therefore should rapidly repopulate treated areas through dispersal and reproduction (Engstrom-Heg et al. 1978). Further, rotenone exposure to aquatic invertebrates may be reduced by behaviors such as burrowing, associating with vegetation or the ability to trap air bubbles with appendages (CDFW 2007). Moreover, rotenone toxicity to aquatic invertebrates such as freshwater shrimp may be moderated by physical and chemical attributes of the treated ecosystem (Melass et al. 2001).

Zooplankton
Table G-2 shows a range of sensitivity to rotenone for two groups of zooplankton, including copepods (72hr LC100 = <100 µg/L) as the most rotenone-resistant taxa included in this review, and cladocerans (24hr LC50 = <25 to 27 µg/L) as the most rotenone-sensitive taxa reported. However, these zooplankton taxa are still 7 to 28 times more resistant than the most resistant fish taxa in SEKI proposed eradication sites (rainbow trout: 24hr LC50 = 3.5 µg/L).

Although these results indicate that zooplankton are much less sensitive to rotenone than fish, rotenone is still toxic to zooplankton (Kiser et al. 1963, Anderson 1970, Neves 1975, Beal and Anderson 1993, Melaas et al. 2001) and thus mortality is expected from a typical application in standing waters. Reductions are generally short-term, however, with populations of more-resistant taxa such as copepods recovering over periods of 1 to 8 months following treatment (Beal and Anderson 1993, Ling 2003), and populations of more-sensitive taxa such as cladocerans sometimes needing three years to recover in mountain lakes (Anderson 1970).

While many benthic invertebrates may lessen rotenone exposure by burrowing into sediment, zooplankton typically occupy open-water habitat and thus are exposed to rotenone for the entire time it is active during a treatment (CDFW 2007). As a result, zooplankton taxa such as cladocerans are generally more sensitive than larger benthic invertebrates such as mollusks, oligochaete worms and chironomid midge larvae (Hamilton 1941, Morrison 1977). However, some zooplankton taxa have resistant life stages and/or eggs that may facilitate recovery (Kiser et al. 1963).

The EPA (2007A) used cladocerans (Daphnids) to estimate toxicity, exposure, and risk to zooplankton. Rotenone is expected to eliminate many zooplankton at labeled application rates of 200 ppb for standing water and 50 ppb for flowing water. The RQ equation (EEC/LD50 = RQ) confirms this expectation in both lakes (200/3.7 = 54.1) and streams 50/3.7 = 13.5). Since these RQs exceed the acute risk level of concern (LOC = 0.5), when rotenone is used at labeled application rates, rotenone is likely to cause acute mortality for many zooplankton in the treatment area.

The RQs shown above also exceed the chronic risk level of concern (LOC = 1). Chronic effects may occur if zooplankton survive acute exposure. Based on rotenone environmental fate and labeled application rates in standing and flowing water, sensitive species may be affected for less than two weeks in warm water and up to approximately 160 days in cold water, where rotenone is relatively more persistent.

Amphibians
Table G-3 (from a variety of sources, as summarized by CDFW 2007) and Chandler and Marking (1982) show a range of rotenone sensitivity values for amphibians, including northern leopard frog (*Rana pipiens*) adults (24hr LC50 = 240 to 1580 µg/L; 96hr LC50 = 240 to 920 µg/L) as the most rotenone-resistant group reported, and gilled larvae of various taxa (24hr LC50 = 5 to 580 µg/L; 96hr LC50 = 25 to 500 µg/L) as the most rotenone-sensitive group. However, even gilled larvae as the most sensitive amphibian group are still 1.4 to 165 times more resistant than the most resistant fish taxa in SEKI proposed eradication sites (rainbow trout: 24hr LC50 = 3.5 µg/L). Amphibian adults are therefore much less sensitive to rotenone than fish, and gilled larval amphibians have rotenone sensitivities similar to the most-resistant fish taxa.

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Table G-3. Rotenone toxicity to various amphibians in lakes.

Species	Stage	Temp °C	24 hours LC_{50} (µg/L)	96 hours LC_{50} (µg/L)	Original Reference
N. Leopard frog (*Lithobates pipiens*)	Juvenile/adult	—	10	—	Haag 1931
	Tadpole	—	5	—	Hamilton 1941
	Adult	12	240	240	Farringer 1972
	Adult	12	1200	290	Farringer 1972
	Adult	12	1460	920	Farringer 1972
	Adult	12	1580	640	Farringer 1972
Tiger salamander (*Ambystoma tigrinum*)	Larvae	—	5	—	Hamilton 1941
S. Leopard frog (*Lithobates sphenocephalus*)	Tadpole	15-17	30	25	Chandler and Marking 1982

Source: CDFW 2007, Appendix J.

The difference in rotenone sensitivity between adult and gilled larval amphibians may be due to anatomical differences in which adults primarily breathe through skin while larvae breathe through gills. Adult amphibian skin may be more of a barrier to rotenone than gills due to skin having a smaller relative surface area and a greater relative distance for rotenone to diffuse across (Fontenot et al. 1994). Amphibian adults should therefore not be harmed when rotenone is applied in accordance with labeled instructions (at required piscicidal concentrations) (Farringer 1972), and the response of gilled larval amphibians depends on development stage (Hamilton 1941). Younger larvae that are dependent on gill respiration are far more sensitive than older larvae that are near metamorphosis and breathing air, indicating that rotenone is more readily absorbed across gills than skin. In addition, amphibian eggs are less sensitive to rotenone than fish because their rate of chemical uptake from water is much lower (Ling 2003).

At labeled rotenone application rates, some effects on amphibians are therefore expected, but significant losses would be unlikely, especially if treatments are scheduled in late summer after amphibian eggs have hatched and larvae of most amphibian taxa have metamorphosed. Indeed, these conclusions are similar to results of a rotenone application in spring of 1974 to eradicate exotic African clawed frogs (*Xenopus laevis*) in California, in which all *X. laevis* tadpoles were killed but adults were unaffected and able to reproduce later that spring (McCoid and Bettoli 1996).

Terrestrial Biota

Since terrestrial biota is largely insensitive to rotenone compared to aquatic organisms, there is a significant safety margin between maximum treatment concentrations and those needed to harm to terrestrial organisms (Ling 2003). Acute rotenone toxicities to various mammals and birds are shown in Table G-4 (from a variety of sources, as adapted from CDFW 2007).

Table G-4. Rotenone toxicity to various mammals and birds.

Animal Group	Toxicology Test	Median Lethal Concentration	Reference(s)
Mammals			
Human	Lethal dose (quantity consumed estimated: case report- 3 y.o. child)	40mg/kg	De Wilde et al. 1986
	Commonly cited *estimated* lethal dose	300 – 500 mg/kg	Durkin 2008
Rat	Acute LD_{50} oral	39.5 mg/kg (female)	USEPA 1988
	Acute LD_{50} oral	102 mg/kg (male)	USEPA 1988
	Chronic NOAEL TRV	7.5 mg/kg	Marking 1988
	Chronic LOAEL TRV	37.5 mg/kg	Marking 1988
Mouse	Acute LD_{50} oral	350 mg/kg	Kidd and James 1991
Guinea Pig	Acute LD_{50} oral	50 – 200 mg/kg	Cutkomp 1943
Rabbit	Acute LD_{50} oral	3,000 mg/kg	Cutkomp 1943
Dog	Chronic NOAEL TRV	0.4 mg/kg/day	Marking 1988
	Chronic LOAEL TRV	2 mg/kg/day	Marking 1988
Birds			
American robin (nestling)	Acute LD_{50} oral	200 mg/kg	Cutkomp 1943
Quail	Acute LD_{50} oral	1882 mg/kg	Unknown reference
Mallard duck	Acute LD_{50} oral	2200 mg/kg	USEPA 1988

Source: Adapted from CDFW 2007, Appendix J.

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Reptiles
Few studies have examined rotenone toxicity to reptiles, however, Fontenot et al. (1994) reports that acute toxicity to green anole lizards (*Anolis carolinensis*) were considered during pre-registration of piscicides including rotenone. Aquatic turtle taxa with specialized mechanisms such as buccopharyngeal respiration (*Apalone spinifera, Kinosternon minor*) or modified skin and cloaca to enhance respiration (*Trachemys scripta, K. odoratum*) may be more sensitive to rotenone than more terrestrial turtle taxa. In addition, Carr (1952), and Dundee and Rossman (1989) hypothesized that soft-shelled turtles (*Apalone* spp.) may be sensitive to rotenone but did not provide scientific data to support this. These conclusions are similar to one study of a rotenone treatment in Lake Conroe in Texas that reported aquatic turtles (*K. subrubrum*) to be sensitive to rotenone, with at least 60 dead or dying individuals observed around the lake shoreline 24 to 48 hours after treatment (McCoid and Bettoli 1996).

Since freshwater aquatic snakes do not use aquatic respiration, it is very unlikely that absorption of rotenone would occur through the thick skin of snakes (Fontenot et al. 1994). However, Fotentot et al. 1994 reported the death of one aquatic snake 48 hours after a pond rotenone treatment, while a second snake in the same pond at the same time was swimming in a healthy manner. Additional studies would therefore clarify the toxicity of rotenone to reptiles.

Birds
The EPA (2007A) concluded that: 1) birds that forage on terrestrial items have little risk of exposure to rotenone residues because rotenone is applied directly to water, and 2) although some birds that forage on fish may opportunistically feed on dead or dying fish in treatment areas, it is unlikely to result in a lethal dose. EPA based this conclusion on a study (Jarvinen and Ankley 1998) that found only 0.22 µg/g of rotenone residue in yellow perch (*Perca flavescens*; similar in size to trout) killed by rotenone. A 68 g perch would therefore contain about 15 µg of rotenone, and a 1,000 g bird would have to consume about 274,000 perch to reach the avian subacute LC50 of 4,110 mg/kg. In addition, trout in a treatment area would have their swim bladders punctured so they sink to the lake bottom and thus not be available for consumption by birds.

Mammals
The EPA (2007A) also concluded that: 1) wild mammals are not likely to have significant exposure to rotenone residues because dead fish tend to sink where they are not available for terrestrial consumption, and 2) in the unlikely event that mammals could forage on dead or dying fish, it is unlikely to result in observable acute toxicity. As stated above, a 68 g perch would contain about 15 µg of rotenone. A medium-sized (350 g) mammal with a daily food intake of 18.8 g would receive 4.1 µg of rotenone if it foraged its entire daily ration from a perch in a treatment area. This is far below the median lethal dose of rotenone (39.5 mg/kg * 0.350 kg = 13.8 mg = 13,800 µg) for similarly sized mammals. Likewise, a large-sized (1,000 g) mammal with a daily food intake of 34 g would receive 7.5 µg of rotenone if it foraged its entire daily ration from a perch in a treatment area. This is far below the median lethal dose of rotenone adjusted for body weight (30.4 mg/kg * 1 kg = 30.4 mg = 30,400 µg) for similarly sized mammals.

Terrestrial Invertebrates and Plants
Although the EPA does not currently estimate RQs for terrestrial insects, a contact study on honey bees classified technical grade rotenone as practically non-toxic on an acute exposure basis to non-target terrestrial insects (EPA 2007A). Moreover, it is presumed that terrestrial insects that forage on terrestrial items have little exposure to rotenone residues because rotenone is applied directly to water.

Although no data were submitted to assess the risk of rotenone exposure to terrestrial plants, the EPA (2007A) concluded that rotenone exposure to terrestrial plants is unlikely given the protocols by which rotenone is applied.

Water

CFT Legumine™ formulations contain, in addition to the active ingredient rotenone, a variety of additional chemicals that facilitate solubility and dispersal. Table G-5 (as presented in CDFW 2007) lists the chemicals present and calculated treatment concentrations for CDFW's treatment of Davis Lake in 2007. The chemicals and concentrations from the Davis Lake treatment are expected to be very similar to those expected in piscicide treatments proposed under alternatives B or D.

The rate and manner in which natural physical processes affect the breakdown or persistence of a chemical in the environment is chemical specific. All of these chemicals have characteristics that make them break down rapidly in the environment, and they are not expected to be present in environmental media for extended periods of time. Using currently available sampling and analytical tools and following EPA protocols, rotenone and many of the other compounds in the formulations proposed would not be detectable in water, sediment, or air after just a few days to weeks following the proposed treatments. Maximum conservative estimates in sediment for rotenone are assumed to persist for no longer than 45 days, and likely significantly less (CDFW 2007).

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Table G-5. Reported chemical composition, field concentration, persistence and toxicity of CFT Legumine™.

Ingredient	Conc. in Treatment[1] (µg/l)	Half-Life[2]	Water Pollution Factors	Aquatic Toxicity Metrics	Toxicity of Other Receptors
rotenone	42.1	Hydrolysis: 3.2 days @ pH 7, 2 days @ pH 9 Aqueous photolysis: 21 hr (1 cm), 191 days 1 m well mixed Entire Pond System (water + sediment): 20 days @ 5°C, 1.5 days @ 25-27°C Air Photooxidation: 0.05 days Soil: 3 days			LD_{50} Mice (i.p.): 2.8 mg/kg rats (oral): 132 mg/kg-bw; (i.v.): 6 mg/kg human: Ingestion or inhalation of large doses may lead to: numbness of oral muscosa, respiratory paralysis at lethal doses, tremor, trachypnea, nausea, vomiting. Chronic exposure may produce fatty changes to liver and kidney. More toxic when inhaled than ingested. Skin irritation from direct contact.
rotenolone	5.2				Oral LD_{50} mice: rotenolone I: 4.1 mg/kg rotenolone II: 25 mg/kg
1-methyl-2-pyrrolidinone	87.8	Air Photooxidation: 5 hrs Soil: 4 days in clay 8.7 in loam 11.5 in sand		NOEL=5 g/l in bacteria, algae (*Scenedesmus*), & protozoa (*Colpoda*)	
diethylene glycol monoethyl ether	581.1	Air Photooxidation: 12 hrs	BOD: 20 NEN 3235-5.4 COD: 1.85 NEN 3235-3.3	24 hr LC_{50}: >5,000 mg/l (goldfish, static) 96 hr LC_{50}: >10,000 mg/l (*Menidia beryllina*, static)	Oral LD_{50} (single dose): rat = 8.69-9.74 g/kg guinea pig = 3.67=4.97 g/kg cat = 1 ml/kg (lethal) rat NOEL: 0.49 g/kg (repeat oral dose) rabbit, cat, guinea pig, mouse: inhalation – no injury w/ 12 day exposure to saturated vapor

Ingredient	Conc. in Treatment[1] (µg/l)	Half-Life[2]	Water Pollution Factors	Aquatic Toxicity Metrics	Toxicity of Other Receptors
1,3,5-trimethylbenzene	0.004	Aqueaceous Volitilization: est. 3 hrs for model river, 4 hrs for model lake & 5 days for model pond (includes sediment adsorption) Air Photooxidation: 7 hrs	BOD: 3% of Theoretical Oxygen Demand (ThOD) COD: 110% of ThOD	96hr median threshold limit = 13 mg/l (goldfish, flow-through)	
sec-butylbenzene	0.004	Aqueaceous Volitilization: est. 3.4 hrs for model river, 4.6 hrs for model lake & 88 days for model pond (includes sediment adsorption) Air Photooxidation: 1.9 days			Eye irritation reactivity (EIR) in humans @ 1.8
1-butlybenzene (n-butylbenzene)[3]	0.005-0.0236-0.078	Aqueaceous Volitilization: est. 3.5 hrs for model river, 4.6 hrs for model lake & 16 days for model pond (includes sediment adsorption) Air Photooxidation: 1.8 days	ThOD: 3.22		EIR: 6.4 (humans)
4-isopropyltoluene	0.005	Aqueaceous Volitilization: est. 1 hr for model river, 5 hrs for model lake & 30 days for model pond (includes sediment adsorption) Air Photooxidation:1 day			
methylnaphthalene	0.136	Aqueaceous Volitilization: est. 5.5 hr for model river, 5.3 hrs for model lake & 78 days for model pond (includes sediment adsorption) Air Photooxidation: 7.4 hrs		24, 48, 72, 96-hr LC_{50} = 39, 9, 9, 9 mg/l in FHM (static); 48 hr LC_{50} in brown trout yearlings =8.4 mg/l (static); BCF: 20 to 130 in coho salman muscle, depending on length of exposure	
naphthalene	0.255-0.341	Aqueaceous Volitilization: est. 3 hr for model river and 5 days			

Ingredient	Conc. in Treatment[1] (µg/l)	Half-Life[2]	Water Pollution Factors	Aquatic Toxicity Metrics	Toxicity of Other Receptors
		for model lake Aqueous photolysis: 71 hrs Aqueous Biodegration: 0.8-43 days Sediment: Degradation rates in sediments are 8-20 times higher than in the above water column. Biodegradation half lives ranged from 2.4 weeks in sediments chronically exposed to petroleum hydrocarbons to 4.4 weeks in sediments from a pristine environment. Soil Biodegration: 2-18 days Air Photooxidation: 18 hrs			
1-hexanol	3.6		BOD: 28% of ThOD; COD: 94% of ThOD		LD_{50} orally in rats 4.59 g/kg. Toxicity threshold (cell multiplication inhibition test): bacteria (*Pseudomonas putida*): 62 mg/l; algae: *Microcystis aeruginosa*): 12 mg/l; green algae (*Scenedesmus quadricauda*): 30 mg/l; protozoa (*Entosiphon sulcatum*): 75 mg/l; protozoa: (*Uronema parduczi* Chatton-Lwoff: 93 mg/l
1,2,4,5-tetramethylbenzene	0.369	Aqueaceous Volitilization: est. 3.5 hr for model river and 4.6 days for model lake			
1,2,4-trimethlybenzene	0.0307				
1,4-diethylbenzene	0.453	Aqueaceous Volitilization: est. 3.5 hr for model river and 4.6 days for model lake			

Ingredient	Conc. in Treatment[1] (µg/l)	Half-Life[2]	Water Pollution Factors	Aquatic Toxicity Metrics	Toxicity of Other Receptors
total c_4 substitued benzenes	2.586				
total c_5 substitued benzenes	0.796				
triethylene glycol[3]	0.220-0.266		BOD5: 0.03 NEN 3235-5.4, 1.4% of ThOD; BOD10: 0.50 std.dil.sew.; 10 days: 3.7% ThOD; 15 days: 11.5% of ThOD; 20 days: 17% of ThOD; COD: 1.57 NEN 3235-5.3	LC_{50}/96-hr values for fish are between 10 and 100 mg/l. Therefore, this material is expected to be slightly toxic to aquatic wildlife.	LD50 Oral mice, rats (g/kg): 21, 15-22; Toxicity threshold (cell multiplication inhibition test) in mg/ml: bacteria (*Pseudomonas putida*): 320; algae: *Microcystis aeruginosa*): 3,600; protozoa (*Entosiphon sulcatum*). Goldfish: 24-hr LC_{50}=>5,000 mg/l; guppy: 7 d LC_{50}: 62,600 ppm. Single oral doses LD_{50}: Guinea pig: 14.6 g/kg; 7.9 ml/kg. Rat (repeated oral dose): no effect@3-4 g/kg/day, 2 years, 5-8 g/kg/day, 30 days; Human: very low acute and chronic toxicity
tetraethylene glycol[3]	1.060-1.194		BOD10: 0.50 std.dil.sew.		Rats: single oral LD_{50}: 32.8 g/kg, and 28.9 ml/kg=1; Rabbit: skin LD_{50} >20,000 mg/kg
pentaethylene glycol[3]	2.00-2.471				
hexaethylene glycol[3]	3.600-4.386				Oral rat LD_{50}: 32,000 mg/kg-1; Oral guinea pig: 20,000 mg/kg-1
trichloroethylene	0.0073				
tetrachloroethylene	0.0128				
toluene	0.1667				
xylene-m/p	0.0029				
Total fatty acid esters, resin acids and neutrals[3, 4]	164.115				
Representative Rosin Acids					
abietic acid					LC_{50} values to crustaceans: 6.2 mg/l=96 hr, Nitocra spinipes; LC_{50} values in fish: 0.56 mg/l=96 hr,

Ingredient	Conc. in Treatment[1] (µg/l)	Half-Life[2]	Water Pollution Factors	Aquatic Toxicity Metrics	Toxicity of Other Receptors
					Oncorhynchus kisutch (i.e., coho salmon); 0.7 mg/l=96 hr, *Salmo gairdneri;* 0.41 mg/l=96 hr, Oncorhynchus kisutch.
beta-pinene					
isopimaric acid					LC50=0.4 mg/l for rainbow trout for isopimaric acid in lodgepole pine sapwood (Wang, Z. et al. Jan.1995, Applied & Env. Microbiol.).
Fatty Acids					
tall oil				Fish: Semistatic; 96 hourexposure; NOEC >=1000mg/L Invertebrates: (Crustacea); 48 hour exposure; NOEC >=1000mg/L Plants: (Algae); 72 hour exposure; NOEC >=1000mg/L	Oral: LD_{50}, Rat @ 74000 mg/kg bw (Oleic) LD_{50} Rat @>3200 mg/kg bw (linoleic) LD_{50}, Rat @ 7600 mg/kg bw (Rosin) Skin: Rabbit, Slight Irritant Eye: Rabbit, Slight irritant
oleic acid (112-80-1) <tall oil partition>				Fish: Fathead Minnow: LC_{50} = 205 mg/L; 96 Hr.;	LD_{50}/LC_{50}: Draize test, rabbit, eye: 100 mg Mild; Oral, mouse: LD50

Ingredient	Conc. in Treatment[1] (µg/l)	Half-Life[2]	Water Pollution Factors	Aquatic Toxicity Metrics	Toxicity of Other Receptors
				Static condition	= 28 gm/kg; Oral, rat: LD50 = 25 gm/kg; Human Skin Draize 15 mg/3D intermittent; REACTION: Moderate.
linoleic acid (60-33-3) <tall oil partition>			COD: 8.38% of ThOD BOD: 71% of ThOD	Invertebrate toxicity:EC_{50} (duration unspecified) purple sea urchin 0.28-1.07 mg/kg inhibited fertilisation (Cherr, G.N. et al. Environ.Toxicol.Chem. 1987, 6(7), 561-569).	Oral, mouse: LD_{50} = >50 gm/kg
Linolenic (463-40-1) <tall oil partition>					
Rotenone Neutralization Compound					
potassium permanganate	4 mg/l max			96-hr LC_{50}: 3.6 mg/l (goldfish) 0.75 mg/l (channel catfish) 96-hr LD_{50}: 2.7-3.6 mg/l (bluegill)	Oral LD50 (single dose): Guinea pig: 810 mg/kg Mouse: 750 mg/kg Rat: 750 mg/kg

Adapted from CDFW 2007, Appendix J, Table J-15.

[1] Calculation based on application of 1 ppm

[2] River model assumes depth = 1 m, flow velocity = 1 m/sec, & wind velocity = 3 m/sec. Model lake assumes depth = 1 m, flow velocity = 0.05 m/sec, & wind velocity = 0.5 m/sec. Do not consider sediment particulate adsorption.

[3] Components of Fennodefo 99™ which is 17.1% of CFT Legumine™ formulation.

APPENDIX H: HUMAN HEALTH RISK ASSESSMENT

Toxicity Profile

The Environmental Protection Agency (EPA; 2007A) estimated the degree to which rotenone could cause adverse health effects in humans, and the level or dose at which those effects would occur, evaluating acute, short and intermediate term, and chronic effects. The EPA concluded that "rotenone has high acute toxicity via the oral and inhalation routes of exposure (Category I) and low acute toxicity via the dermal route of exposure (Category IV)," and that "rotenone is not an eye or skin irritant nor is it a skin sensitizer." Based on a structure activity relationship and human dermal information, dermal absorption of rotenone was estimated at 10%, while a default factor of 100% was used for inhalation absorption. Table H-1 (excerpted from the EPA 2007A), shows the acute toxicity profile for rotenone.

Table H-1. Acute toxicity profile for rotenone.

Guideline Number	Study Title	MRID	Results	Toxicity Category
870.1100	Acute oral [rat]	00145496	LD_{50} = 102 mg/kg (M) LD_{50} = 39.5 mg/kg (F)	I
870.1200	Acute dermal [rabbit]	43907501	LD_{50} > 5000 mg/kg	IV
870.1300	Acute inhalation [rat]	42153701	LC_{50} = 0.0212 mg/L (combined) LC_{50} = 0.0235 mg/L (M) LC_{50} =0.0194 mg/L (F)	I
870.2400	Acute eye irritation [rabbit]	42076203	PIS = 3.3 at 1 hr., cleared less than 24 hours	IV
870.2500	Acute dermal irritation [rabbit]	42076204	PIS = 0.08 at 1 hr which decreased to 0 at 72 hours	IV
870.2600	Skin sensitization [guinea pig]	42153702	Not a dermal sensitizer	N/A

(*Source: Table 3, EPA 2007A, pg. 11.*)
LD_{50} = Median Lethal Dose; PIS = primary irritation score

The EPA (2007A) used the toxicological endpoints summarized in Table H-2 as part of the human health risk assessment for rotenone. The EPA (2007A) found that available information on rotenone toxicity supported reregistration. However, their assessment of toxicity from multiple types of exposure (e.g., dietary, dermal, and recreational) was highly conservative, based on "a potentially critical effect (neurotoxicity) at doses to which rotenone users," (i.e., those applying rotenone for fish eradication), "could be exposed." Therefore, the EPA placed a cumulative 1,000x uncertainty factor, which includes a 10x database uncertainty factor (to account for limitations in available rotenone data), a 10x uncertainty factor for intra-species variation, and a 10x uncertainty factor for inter-species variation (i.e., since rotenone has only been tested on certain organisms). In effect, this means that the no observed adverse effect level (NOAEL) in rodent species, the mammalian organisms on which rotenone exposure has been studied, involved substantially higher rotenone concentrations than the hypothetical NOAEL for humans determined by the EPA (2007A).

Another way of calculating exposure risk of a substance involves estimating a margin of exposure (MOE), "which is the magnitude by which the NOAEL of the critical toxic effect exceeds the estimated exposure dose (EED), where both are expressed in the same units: MOE = NOAEL (experimental dose) / EED (human dose)" (EPA 1993). For example, in a study where mice were exposed to rotenone, the NOAEL was 15 mg/kg/day (EPA 2007A). However, since this NOAEL concentration cannot be

extrapolated directly to humans, the 1,000x uncertainty factor was applied, in which 15 mg/kg/day is divided by 1,000 to reach a 0.015 mg/kg/day dietary acute population adjusted dose (aPAD; Table H-2), which, in this case, is the human acute EED. Therefore, the estimated human NOAEL of 15 mg/kg/day divided by the 0.015 mg/kg/day EED = a MOE of 1000. In this case, the uncertainty factor is equivalent to the MOE.

Dietary Risk

To estimate acute dietary exposure to rotenone for humans, the EPA (2007A) considered residues in drinking water and food from piscicidal use in fish management. The estimated drinking water concentration (EDWC) was determined to be 200 ppb, which is the solubility limit of rotenone. Estimated exposure from drinking water considered surface water only because rotenone is not expected to reach groundwater (CDHS 2007), and the estimate is conservative because it assumes water is consumed immediately after treatment with no breakdown or water treatment prior to consumption. Rotenone exposure from food may occur if humans consume fish that survive a treatment, although this type of exposure is unlikely, given the remoteness of locations proposed for treatment, closure of the treatment area during application, and high susceptibility of fish to minute concentrations of rotenone. The EPA estimated acute dietary exposure to rotenone is 0.01117 mg/kg/day, which is 26% less than the aPAD of 0.015 mg/kg/day. Since the EPA is concerned when risk estimates exceed 100% of the aPAD, the EPA concluded that acute dietary risk from rotenone is below the level of concern.

Additionally, the EPA (2007A) determined that the chronic dietary risk assessment would only consider "drinking water for the general population and various population subgroups. The chronic assessment only considered drinking water because chronic exposure from food (consumption of treated fish) is not expected based on rotenone's generally rapid degradation and low propensity to bioaccumulate in fish." For chronic exposures, the EPA determined the drinking water level of concern (DWLOC) at 40 ppb, which is based on the most potentially sensitive subgroup of infants and children. The low DWLOC also assumed that rotenone could reach drinking water intakes, of which there are none in the proposed treatment areas in the Restoration Plan/FEIS. The EPA also discusses that, under normal use (i.e., per label requirements), piscicides dissipate via aqueous photolysis and hydrolysis, and are readily deactivated with potassium permanganate ($KMnO_4$). Finally, the EPA discusses it is likely that drinking water treatment by chlorination, ozonation, or charcoal filtering would deactivate rotenone. Based on the "Thus, the Agency expects no chronic exposures to rotenone in situations where water is either treated with potassium permanganate for deactivation purposes or is subject to an oxidative drinking water treatment regimen." (EPA 2007A, pg. 15).

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Table H-2. Rotenone Toxicological Endpoints.

Exposure Scenario	Dose Used in Risk Assessment, Uncertainty Factor (UF)	Level of Concern for Risk Assessment	Study and Toxicological Effects
Acute Dietary (females 13-49)	NOAEL = 15 mg/kg/day UF = 1000 aRfD = 15 mg/kg/day / 1000 = 0.015 mg/kg/day	Acute PAD = 0.015 mg/kg/day	Developmental toxicity study in mouse (MRID 00141707, 00145049) LOAEL = 24 mg/kg/day based on increased resorptions
Acute Dietary (all populations)	An appropriate endpoint attributable to a single dose was not identified in the available studies, including the developmental toxicity studies.		
Chronic Dietary (all populations)	NOAEL = 0.375 mg/kg/day UF = 1000 cRfD = 0.375 mg/kg/day / 1000 = 0.0004 mg/kg/day	Chronic PAD = 0/0004 mg/kg/day	Chronic/onogenicity study in rat (MRID 00156739, 41657101) LOAEL = 1.9 mg/kg/day based on decreased body weight and food consumption in both males and females
Incidental Oral Short-term (1-30 days) Intermediate-term (1-6 months)	NOAEL = 0.5 mg/kg/day	Residential MOE = 1000	Reproductive toxicity study in rat (MRID 00141408) LOAEL = 2.4/3.0 mg/kg/day [M/F] based on decreased parental (male and female) body weight and body weight gain
Dermal Short-, Intermediate- , and Long-Term	NOAEL = 0.5 mg/kg/day 10% dermal absorption factor	Residential MOE = 1000 Worker MOE = 1000	Reproductive toxicity study in rat (MRID 00141408) LOAEL = 2.4/3.0 mg/kg/day
Inhalation Short-term (1-30 days) Intermediate-term (1-6 months)	NOAEL = 0.5 mg/kg/day 100% inhalation absorption factor	Residential MOE = 1000 Worker MOE = 1000	[M/F] based on decreased parental (male and female) body weight and body weight gain
Canter (oral, dermal, inhalation)	Classification: No evidence of carcinogenicity		

(*Source: Table 4, EPA 2007A, pg. 12.*)
UF = uncertainty factor; NOAEL = no observed adverse effect level; LOAEL = lowest observed adverse effect level; aPAD = acute population adjusted does; cPAD = chronic population adjusted dose; RfD = reference dose; MOE = margin of exposure; N/A= Not Applicable

Dermal, Incidental Oral, and Inhalation Risk

Recreational Risk

Although rotenone can be applied in public and private waters, it is only permitted for sale to certified applicators (EPA 2007A, Finlayson et al. 2010A). Further, although treatment areas are closed to the public during application, they may be exposed by later recreating in water that was previously treated. The EPA therefore estimated recreational exposure and risk, but only from swimming (dermal and incidental ingestion) because other recreational activities would likely result in significantly less exposure. Recreational risks were calculated through the MOE. MOEs $\geq$1,000 indicate that recreational exposure risks to rotenone would not exceed the EPA's level of concern (LOC) for dermal, incidental oral, and inhalation risk.

For short-term risks to adult swimmers on the same day as a 200 ppb application of rotenone, EPA (2007A) determined the dermal and incidental oral MOEs to be 1,600 and 7,000, respectively, neither of which exceeds the EPA LOC of 1,000. However, for short-term risks to toddler swimmers on the same day as a 200 ppb application of rotenone, the EPA (2007A) determined the dermal, incidental oral, and combined non-dietary MOEs to be 970, 850, and 450, respectively, all of which exceed the EPA LOC of 1,000. The EPA therefore estimated it would take three days in 25ºC water for rotenone concentrations to decrease below the LOC (for MOE = 1,000, rotenone concentration = 90 ppb). The EPA is therefore requiring that swimmers not enter rotenone treated areas until exposures are below the LOC.

Occupational Risk
Workers may be exposed while mixing, loading, or applying rotenone, or when entering previously treated areas. The EPA (2007A) initially estimated handler risks using a long sleeve shirt, long pants, shoes, socks, no gloves, and no respirator. If these estimates exceed the EPA's LOC, they then estimated how personal protective equipment (PPE; such as additional clothing, chemical-resistant gloves, respirator) and management controls such as enclosed cabs, closed mixing/loading systems, and water-soluble packaging) would lower exposure.

The EPA (2007A) used the following scenarios to assess risk to occupational handlers for short-term (1 to 30 days) and intermediate-term (1 to 6 months) exposure: mixer/loader, applicator, and mixer/loader/applicator. Exposures were estimated based on application of liquids and wettable powders via helicopter, boat, backpack, and drip bars. The EPA (2007A) used the Pesticide Handlers Exposure Database (PHED) Version 1.1 (August 1998) to estimate handler exposure, but considers these estimates to be conservative due to several factors.

The EPA (2007A) used rotenone's historic maximum labeled concentration (250 ppb; 0.68 lb. ai/A-ft) and solubility limit (200 ppb; 0.54 lb. ai/A-ft) to estimate occupational handler exposure in standing water, as summarized in Table H-3. Because many risks exceed the EPA LOC (MOEs < 1,000), the EPA is requiring the maximum labeled treatment concentration to be reduced from 250 ppb to 200 ppb, the use of additional PPE including respirators, and other mitigation measures to reduce occupational exposure.

The EPA (2007A) did not assess risk for occupational activities after rotenone applications because any dermal exposure from collecting dead fish and inhalation exposure from volatilization are expected to be minimal.

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Table H-3. Rotenone occupational handler risks at 250 ppb and 200 ppb application rates.

Exposure Scenario	Crop or Target	Application Rate[1]	Area Treated Daily (acres)	Combined MOEs[2]							
				Baseline	G + NR	G,DL + NR	G+ 80%R	G,DL+ 80%R	G + 90%R	G,DL+ 90% R	Eng Cont
Mixing/Loading Liquid Concentrates for Helicopter Applications (1a)	Lakes	0.68	10	3.5	290	350	410	530	430	570	1100
	Lakes	0.68	5	7.1	590	710	810	1100	850	1100	2200
	Lakes	0.54	10	4.5	370	450	510	670	540	710	1400
	Lakes	0.54	5	8.9	740	890	1000	1300	1100	1400	2700
Mixing/Loading Liquid Concentrates for Boat Applications (1b)	Lakes	0.68	100	0.35	29	35	41	53	43	57	110
	Lakes	0.68	50	0.71	59	71	81	110	85	110	220
	Lakes	0.54	100	0.45	37	45	51	67	54	71	140
	Lakes	0.54	50	0.89	74	89	100	130	110	140	270
Mixing/Loading Wettable Powders for Boat Applications (2a)	Lakes	0.68	100	0.25	1.7	1.8	4	4.8	4.8	6	84
	Lakes	0.68	50	0.5	3.4	3.7	8	9.5	9.7	12	170
	Lakes	0.54	100	0.31	2.2	2.3	5.1	6	6.1	7.5	110
	Lakes	0.54	50	0.63	4.3	4.6	10	12	12	15	210
Applying Sprays via Helicopter (3)	Lakes	0.68	10	ND	ND	ND	ND	ND	ND	ND	1800
	Lakes	0.68	5	ND	ND	ND	ND	ND	ND	ND	3600
	Lakes	0.54	10	ND	ND	ND	ND	ND	ND	ND	2300
	Lakes	0.54	5	ND	ND	ND	ND	ND	ND	ND	4600
Applying Sprays via Boat Over-surface Boom Equipment (4)	Lakes	0.68	100	48	48	56	66	82	70	88	130
	Lakes	0.68	50	96	96	110	130	160	140	180	380
	Lakes	0.54	100	61	61	70	84	100	88	110	240
	Lakes	0.54	50	120	120	140	170	210	180	220	480
Mixing/Loading/Applying Liquids with a Backpack Sprayer (using PHED liquid low pressure handwand data (5)	Lakes	0.68	2	0.51	71	77	110	120	110	130	NF
	Lakes	0.54	2	0.51	71	77	110	120	110	130	NF
	Streams	0.000016 lb ai/ft3	10,560 ft long	10	1400	1500	2100	2400	2300	2600	NF
	Streams	0.000013 lb ai/ft3	10,560 ft long	13	1700	1900	2600	3000	2800	3200	NF
Mixing/Loading/Applying Liquids with Closed System Aspirators (PHED: missing/ loading liquid – closed system) (6)	Lakes	0.68	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	110
	Lakes	0.68	5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	220
	Lakes	0.54	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	140
	Lakes	0.54	5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	270
Mixing/Loading/Applying Liquids with Drip Bars (PHED: mixing/loading liquid) (7)	Streams	0.000016 lb ai/ft3	10,560 ft long	360	30000	36000	41000	53000	43000	57000	110000
	Streams	0.000013 lb ai/ft3	10,560 ft long	440	36000	44000	50000	66000	53000	70000	140000
Mixing/Loading/Applying Wettable Powders with a Backpack Sprayer (using PHED wettable powder low pressure handwand data) (8)	Lakes	0.68	2	ND	2.6	3	4.8	6.1	5.3	7.1	NF
	Lakes	0.54	2	ND	2.6	3	4.8	6.1	5.3	7.1	NF
	Streams	0.000016 lb ai/ft3	10,560 ft long	ND	53	60	96	120	110	140	NF
	Streams	0.000013 lb ai/ft3	10,560 ft long	ND	65	74	120	150	130	170	NF
Mixing/Loading/Applying Wettable Powders with Closed System Aspirators (PHED: mixing/loading liquid closed system) (9)	Lakes	0.68	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	84
	Lakes	0.68	5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	170
	Lakes	0.54	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	110
	Lakes	0.54	5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	210
Mixing/Loading/Applying Wettable Powders with Drip Bars (PHED: mixing/loading liquid) (10)	Streams	0.000016 lb ai/ft3	10,560 ft long	250	1700	1800	4000	4800	4900	6000	85000
	Streams	0.000013 lb ai/ft3	10,560 ft long	310	2100	2300	5000	5900	6000	7400	100000
Mixing/Loading/Applying Wettable Powders via Powder/Sand/Gelatin Paste (11)	Seeps and Springs	There are currently no data to assess this scenario. EPA believes this scenario would result in minimal exposure due to the amount of rotenone used and the fact that this paste is typically mixed in either a lab under a fume hood or by an individual wearing a respirator.									

(*Source: Table 9, EPA 2007A, pgs. 19-20.*)
[1]Lb ai/A-ft unless otherwise noted
[2]G = Gloves; DL= Double Layer (baseline clothing + gloves); NR = No Respirator; R = Respirator; Eng Cont = Engineering Controls; ND = No Data; N/A = Not Applicable; NF = Not Feasible

Rotenone and Parkinson's Disease
Rotenone has been shown to cause symptoms similar to Parkinson's Disease (PD) in animal studies (Betarbet et al. 2000, 2002). Multiple laboratory studies have shown that rotenone is capable of causing damage to nerve cells, including the production of neurotoxic symptoms, in rodents (Cannon et al. 2009). However, most studies in which animal models were used to induce PD-like symptoms have utilized methods of rotenone exposure (e.g., intravenous, intraperitoneal, or directly onto brain tissue), doses (e.g., 2.75-3.0 mg/kg/day, Cannon et al. 2009; 30-100 mg/kg/day, Inden et al. 2011), and exposure durations (e.g., weeks to months) that are dissimilar to the manner in which humans – especially anyone not directly involved in the application process – could be exposed to rotenone during applications for fish eradication (Finlayson et al. 2012). Conversely, one animal study found that chronic rotenone inhalation (i.e., injecting 2.5 mg/kg of rotenone dissolved in saline solution directly into the sinuses of young rats once per day for 30 days) did not result in any PD-like symptoms (Rojo et al. 2007). Two other studies found that chronic oral administration of rotenone to mice caused neurodegeneration and PD-like effects (Inden et al. 2007, 2011). However, the doses that caused these effects ranged between 10 and 100 mg/kg/day, and the duration of the direct oral dosing lasted between 28 and 56 days (Inden et al. 2007, 2011). Therefore, the concentrations of rotenone that resulted in these effects were dramatically higher than the extremely low concentrations of rotenone to which people could potentially be exposed from fisheries management practices (Finlayson et al. 2012).

The other evidence associating rotenone use with PD comes from numerous case-control studies, in which indirect evidence (e.g., self-reporting of pesticide use/exposure and medical history) has shown a possible correlation between rotenone and increased risk of PD (Gorell et al. 1998, Kamel et al. 2006, Tanner et al. 2011, Liew et al. 2014). However, numerous confounding factors prevent inferring any type of causal relationship with rotenone exposure and PD (Finlayson et al. 2012). For example, study participants received potential exposure to numerous other pesticides, specific levels of exposure for all pesticides were unknown, and the biases resulting from the self-reporting of the individuals willing and able to participate (Brown et al. 2006, Tanner et al. 2011, Finlayson et al. 2012). On the latter point, self-reporting leads to large variability in the reliability and accuracy of the data provided (Brown et al. 2006). For example, participants have widely differing ability to remember (or even know) many details regarding the type of pesticides used, levels of exposure, and methods of exposure, all of which can lead to substantial recall bias that severely limits the ability to draw conclusions or make comparisons between studies (Brown et al. 2006, Finlayson et al. 2012).

Some concerns have also been raised regarding other degradation products derived from cubé resins (plant-based rotenoid pesticides), such as deguelin. At lower concentrations, there is some evidence deguelin can be used to deter cancer in humans (Kim et al. 2008). However, high concentrations injected intravenously into rats led to PD-like symptoms (Caboni et al. 2004). Overall, the studies investigating links between rotenone and PD suggest the following conclusion: when organisms are exposed to chemical compounds administered at concentrations substantially exceeding those allowed, and/or via exposure pathways not allowed, a broad spectrum of deleterious effects may result.

Finlayson et al. 2012 provide the following conclusion concerning the potential relationship between PD and rotenone use for fish eradication:

> "*Collectively, the toxicology and epidemiological studies present no clear evidence that rotenone is causally linked to PD. Even if there were clear evidence, it would have little impact on the current and proposed use of rotenone in fish management. This is because the toxicology studies demonstrating PD-like effects were conducted using routes of exposure (e.g., intraperitoneal or intravenous injection or oral dosing with solvents) and exposure regimes (e.g., weeks to months) not germane to potential human exposure associated with fishery uses. The epidemiological studies on pesticide use by farmers*

> *assessed historical application scenarios that paid little or no attention to personal hygiene, safety, and safety equipment. For the applicator, the use of required PPE will significantly reduce, if not eliminate, exposure. For the general public, restricted access to the treatment area until rotenone subsides to safe levels and the use of potassium permanganate to detoxify water leaving the treatment area will greatly minimize exposure. Although everyone is at some risk of developing PD, the risk of developing PD-like symptoms as a result of rotenone exposure from use in fisheries management is negligible because with recommended care, rotenone exposure has been effectively eliminated."* – pg. 473

In summary, in evaluating this potential risk, the NPS finds no evidence to suggest a connection between the piscicidal application of rotenone and PD.

Risk Characterization

Summary- Conclusion

In summary, rotenone is chemically unstable and rapidly breaks down in the environment to yield water-soluble, non-toxic byproducts. The bodies of vertebrates receiving a sub-lethal dose of rotenone metabolize it to non-toxic excretable substances. Rotenone is not considered to be carcinogenic, and recent experimental findings linking rotenone with Parkinson's disease are not a cause for concern when using EPA-required protocols.

The Re-registration Eligibility Determination for Rotenone (EPA 2007A), therefore, concluded that "currently registered uses of rotenone will not pose unreasonable risks or adverse effects to humans or the environment if the requirements for re-registration outlined in this document are implemented." The EPA also concluded the following: "Provided that registrants comply with the requirements of this RED, the EPA believes that rotenone will not present risks inconsistent with FIFRA and that rotenone's benefits to society, including enhanced recreational areas and control of nonnative and invasive species, outweigh the remaining risks." The EPA further concluded that "continued registration of both liquid and wettable powder rotenone products, subject to the requirements of this RED, would provide benefit to society in controlling invasive or unwanted fish species."

Human Health and Ecological Risk

In the comprehensive assessments conducted as part of the rotenone re-registration process, EPA (2007A) concluded that most risks from rotenone are below the EPA level of concern (LOC). However, they also identified potential actions that could pose unreasonable risks or adverse effects to human or ecological health if left unmitigated. As a result, the EPA is requiring registrants and users of rotenone to implement the following risk mitigation measures, which were amended from EPA (2007A) and the CFT Legumine™ product label (Zoëcon 2015):

1. Deactivate with potassium permanganate to ensure that rotenone effects will not spread beyond the treatment area.

2. The maximum labeled application concentration will be 50 ppb for species with normal sensitivity/tolerance to rotenone.

3. Require additional personal protective equipment, including air-purifying respirators, protective clothing (coveralls, gloves), and eye protection (splash goggles or face shields).

4. The Certified Applicator or designee under his/her direct supervision ensures concentrations of rotenone at drinking water intakes are below EPA's LOC (40 ppb).

5. Placard treatment areas to prohibit 1) recreational access during treatment, 2) swimming for at least three days following treatment, and 3) consumption of dead fish taken from the treatment area.

6. Ensure rotenone products are mixed/loaded in closed systems (except for backpack sprayers with liquid formulations).

7. Apply rotenone below the water's surface (except for aerial and backpack sprayer applications).

8. Limit the use of backpack sprayers to only liquid formulations.

9. Prohibit rotenone from being applied to estuarine/marine environments.

10. Registrants will update product labels to require these measures.

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APPENDIX I: SITE ASSESSMENT PROTOCOL AND EXAMPLE

The following pages provide the protocol that was used for conducting site assessments for nonnative fish eradication areas proposed in the Sequoia and Kings Canyon National Parks Restoration of Native Species in High Elevation Aquatic Ecosystem Plan / Final Environmental Impact Statement (Restoration Plan/FEIS), and a sample site assessment.

Between 2008 and 2015, full site assessments and reports were completed for all 21 proposed fish eradication basins in the Restoration Plan/FEIS. In totality, these site assessment reports comprise over 200 pages of information. As all of these site assessment reports contain the same type of information and format, it would be redundant to include all of them in this document. Therefore, one site assessment report is included as an example of the type and detail of information that has been collected and assessed for each proposed fish eradication site. In addition, site assessment reports contain sensitive and/or protected locality information for special-status species. Specific locality information regarding special-status species has been redacted from the site assessment report included in this appendix.

Site assessments were undertaken by field crews to determine the feasibility of restoring high elevation lakes and streams to their natural fishless state. The components of a site assessment include: assessing fish distribution; quantifying and marking strategic barriers; surveying for MYLF distribution; providing input for the restoration techniques exclusive to the site; assessing accessibility and safety; finding a low-impact, long-term base camps; and, establishing a safe helicopter landing zone or stock drop-point.

Proposed restoration sites were thoroughly evaluated prior to including in the preferred alternative. One to two employees visited each site and collected detailed information to formulate strategies that consider all aspects of the area. Some of the pertinent information was quantified; qualitative observations were also relied upon. Along with additional resources (e.g., data from cooperators and local knowledge), the results of site assessments will be used to formulate prescriptions for future restoration work.

Two site assessment factors of concern were received in public comments for the Restoration Plan/DEIS (NPS 2013A): (1) determining feasibility of complete fish eradication using the proposed methods, and (2) ensuring that stream barriers are definitively not passable by fish. SEKI personnel have over two decades of combined experience in removing fish using physical methods. Therefore, there is confidence in the on-site assessments regarding the feasibility of fish removal where physical methods are proposed. Sites in which piscicide application has been proposed would receive additional scrutiny from both SEKI staff and individuals experienced in piscicide treatments. Before the initiation of any new fish eradication work, all barriers at approved sites would be reassessed to ensure there is consensus that the selected barrier is impassable by fish.

Mountain Yellow-legged Frog Restoration Project: Site Assessment Protocol
Sequoia and Kings Canyon National Parks

Danny Boiano, Aquatic Ecologist, (559) 565-4273, danny_boiano@nps.gov
Erik Meyer, Lead Physical Sciences Technician, (559) 565-3127, erik_meyer@nps.gov
Isaac Chellman, Lead Aquatic Technician, (559) 565-4274, isaac_chellman@nps.gov
Sequoia and Kings Canyon National Parks, 47050 Generals Highway, Three Rivers, CA 93271

Introduction/Overview
Site assessments will be conducted by field crews to evaluate the feasibility of restoring high elevation lakes and streams to their natural fishless state. The components of a site assessment include: assessing fish distribution, quantifying and marking strategic barriers, surveying for mountain yellow-legged frog distribution, providing input for the restoration techniques exclusive to the site, assessing access and safety, finding a site appropriate for a low impact long-term base camp, and establishing a safe helicopter landing zone and/or a drop-off point for stock.

Proposed restoration sites need to be thoroughly evaluated prior to including in the restoration plan. For each site, one to two employees will visit the site and collect detailed information and formulate strategies that consider all aspects of the area. Some of the pertinent information will be quantified, but qualitative observations are also used. Along with additional resources (e.g., Knapp lake project, local knowledge), the results of these site assessments will inform prescriptions for future restoration work.

All field data are recorded into standardized data sheets (attached). Before each site visit, crews will be equipped with several relevant GIS-generated maps. All lakes will be referred to in their five digit "Knapp Lake ID." All references to lakes use these unique IDs. Additionally, maps will be used for drawing unique features that do not show up on standard maps (e.g., braids, wetlands, cliffs, etc.) or cannot be fully explained on the data sheets.

The following is the information, definitions, and instructions for the site assessments, and the standardized data sheets.

Restoration Lakes
Prior to the site visit, potential restoration lakes would be identified. It is necessary to meticulously assess each of these lakes so we can fully understand lake-specific issues.

Lake ID: Record the five digit Knapp ID of the waterbody being assessed. Lake IDs are shown on field maps.

Fish Species: Record the four letter abbreviation of the fish species present at the waterbody being assessed. Record ONSP for rainbow x golden trout hybrids (*Oncorhynchus spp.*); ONMY for rainbow trout (*Oncorhynchus mykiss)*; SAFO for brook trout (*Salvelinus fontinalis*); UNKN for unknown identification.

YOY: Record Yes or No for presence of young of the year (larval) trout.

Spawning Habitat: Record Yes or No if lentic fish spawning habitat exists. If yes, attempt to quantify area in m^2.

Density: Record visual fish densities as Low, Medium or High. This category is subjective. If you only detect adult fish of similar sizes, record as Low. If all life stages are present, well represented and abundant, record as High. Fish densities in between these perimeters can be recorded as Medium.

Estimated Nets: Estimate the number of nets that are necessary to reach eradication. Our typical formula for effective coverage is 1 net per 40 m of shoreline. State whether nets should be added or reduced based on this formula.

Comments: Provide a detailed analysis of the lake. Include all unique features, including feasibility, potential pitfalls, etc. Refer to the site map when necessary. Include photograph numbers of all pictures of the lake.

Barrier Assessment
Streams are incredibly important to investigate thoroughly during site assessments, specifically in terms of habitat complexity, fish distributions, basic hydrology, and presence/absence of barriers. Determining whether barriers to fish movement are present along stream channels in proposed restoration areas is critical to the success of fish removal efforts. Fish can regain access to restoration sites if definitive downstream barriers are not present. If a feature thought to be a barrier is actually surmountable by fish, all restoration work would be compromised.

Features that may act as a barrier depend on the habitat specific to a site. Small order streams may not require large barriers to actually prevent fish passage. However, in terms of smaller features, there is no set rule on what may actually be a fish barrier in all circumstances. Certain habitat features may look like barriers, but their effectiveness in preventing upstream fish movement is indeterminate. Such features may include small drops, low gradient sections of sheet flow over bedrock, or rock piles.

In proposed restoration areas, experienced fisheries biologists should assess a proposed barrier to make an initial determination on whether the feature actually constitutes a barrier to fish passage. Some features are clearly complete barriers (e.g., tall, vertical waterfalls around which water cannot skirt during high flows). However, in most instances, determining whether a proposed barrier blocks fish passage during any flow condition is very difficult. In these cases, additional assessment would likely be necessary.

Two possible methods to further investigate the effectiveness of a barrier include, 1) setting up a trail camera to monitor the barrier under different flow conditions and 2) capturing 100 (or more) trout downstream of the proposed barrier and then monitoring the area upstream with angling, electrofishing, and/or gill netting to see if any marked fish are present above the barrier over the next couple of years. Clearly, these additional monitoring methods would involve substantial time and effort. Additionally, marking trout and monitoring for their presence above a barrier would need to begin at least two years prior to starting any proposed upstream fish eradication at the site in question. However, the additional endeavor would be well worth pursing, since careful monitoring would help ensure that eradication efforts would not be compromised by fish returning to the restoration area.

Features that can be definitively determined as conclusive barriers through visual inspection alone are uncommon. However, they mainly include:

- **Vertical waterfalls** (≥3 m high; Figures 1a-1c). This feature is the easiest to confirm as definitively insurmountable. Trout in most parts of the high Sierra Nevada are <20 cm (NPS 2015) and cannot negotiate vertical features more than 1–2 m high. Plunge pools present beneath the barrier face provide more ability for trout to leap over smaller drops. However, if a vertical barrier is more than several meters high, trout would not be able to leap upstream.

The following features–***if found along a steep gradient***–may be impassible by fish:

- **Sheet flow over bedrock** (Figure 2). These features are more subjective, but stream reaches with long sections of very steep gradient flowing over smooth bedrock may not be surmountable by fish.
- **Piles of dense talus** (Figures 3a and 3b). Many streams in the Sierra Nevada contain talus slopes through which streams flow. If the talus is loosely piled, fish may be able to access areas upstream. However, in many cases, talus is densely piled on steep slopes, and water may only percolate through rock interstices. If the talus pile is large and well-consolidated, fish would not be able to pass through.
- **Slot channels through bedrock** (Figures 4a and 4b). High angle slots carved into bedrock can prevent all upstream fish movement.
- **Long sections of stream with multiple drops** (Figures 5a and 5b). Even if no individual drop seems unquestionably insurmountable by fish, many high elevation streams in the Sierra Nevada flow at steep angles over long sections (e.g., tens to hundreds of meters) with multiple 1-2 meter drops and rock piles. Many of these very steep reaches can prevent upstream fish movement.

Restoration Streams
Prior to the site visit, potential restoration streams would be identified. Each section would be labeled by a unique letter (i.e. A, B, C, etc.). Typically, sections would be labeled as follows: Section A includes Lake 12345 outlet stream to downstream fish barrier or Section B includes Lake 12345 inlet to first upstream confluence.

Section: Unique stream section label provided on field maps. Stream sections would be labeled as A, B, C, etc.

Fish Species: Record the 4 letter abbreviation of the fish species present at the waterbody being assessed. Record ONSP for rainbow x golden trout hybrids (*Oncorhynchus spp.*); ONMY for rainbow trout (*Oncorhynchus mykiss)*; SAFO for eastern brook trout (*Salvelinus fontinalis*) UNKN for unknown identification.

YOY: Record Yes or No for presence of young of the year (larval) trout.

Spawning Habitat: Record if lotic spawning habitat exists. If yes, attempt to quantify area in m^2.

Upstream Barrier: If the recorded stream section would be used as a barrier or this stream section ends at the furthest upstream fish distribution, provide the UTM coordinates in datum NAD 83. Upstream fish distribution is important to quantify because it allows us to estimate the amount of potential stream habitat to be restored.

Downstream Barrier: If the recorded stream section would be used as a barrier to fish recolonization into the restoration area, provide the UTM coordinates in datum NAD 83. Downstream fish distribution is important to quantify because it allows us to estimate the amount of potential stream habitat to be restored.

Comments: Provide a detailed analysis of the stream. Include all unique features, including feasibility, potential pitfalls, and restoration technique (i.e., physical or piscicides). Refer to the site map when necessary. Include photograph numbers of all pictures of the stream. If a barrier is marked, take a picture and provide the picture number.

Amphibian Surveys
We would be conducting amphibian surveys at select lakes in the proposed site to assess pre restoration frog distribution. The crew should attempt to officially (protocol) or opportunistically (quick searches) survey each lake that is to be restored. If conducting an official survey, follow the amphibian monitoring protocol below for required fields. If opportunistic amphibian observations were recorded, include this information in the Frog Surveys section of the data sheet.

Lake ID: Record the 5 digit Knapp ID of the waterbody being surveyed. Lake ID's are shown on field maps.

Air temperature and time: Just before you begin surveying AND right after you end surveying, measure the air temperature at the lake shore at 1 m above the lake surface. Record each temperature in Celsius.

Water temperature and time: Just before you begin surveying AND right after you end surveying, measure the water temperature approximately 0.5 m out from shore and 10 cm under the water surface. Record each temperature in Celsius.

Weather and Wind: Just before you begin surveying AND right after you end surveying, define cloud cover as clear (0-4 % cloud cover), partly cloudy (5-49 % cloud cover), mostly cloudy (50-95%), overcast (96-100 %), rain or snow. Define wind as none, light (0-4 mph; small ripples on water surface), moderate (5-10 mph; waves on water surface, but no whitecaps) or heavy (> 10 mph; whitecap waves on water surface).

Survey start time and end time: Record the times at which the survey began and ended. The start time is the time the amphibian survey began, not the time you arrived at the site. Record time as 24 hr time.

Total survey duration: Record the total time spent searching for amphibians. Do not include time spent surmounting lake-side obstacles (e.g., cliffs), identifying specimens, or recording notes. If two people survey the same site by walking in opposite directions around the lake perimeter, the total survey duration should include the time spent surveying by each person (e.g., record as 15 min + 18 min = 33 min).

Visual fish survey: During the amphibian survey, look carefully in the waterbody for fish swimming in water or rising on the surface. Record whether fish were detected or not detected.

Amphibian detections: To conduct a survey, walk **slowly** around the perimeter of the site, counting the number of adults, subadults, larvae, and egg masses you find of each amphibian and reptile species. Species abbreviations are:

RAMU (*Rana muscosa*, southern mountain yellow-legged frog); **BUCA** (*Bufo canorus*, Yosemite toad);
RASI (*Rana sierrae*, Sierra Nevada yellow-legged frog); **BUBO** (*Bufo boreas*, western toad);
PSRE (*Pseudacris regilla*, Pacific tree frog);
THEL (*Thamnophis elegans elegans*, mountain garter snake); **THCO** (*Thamnophis couchii*, Sierra garter snake)

Use the following description as a guide for identifying egg masses.

RAMU Laid in globular and often flattened clumps, 1-3 inches in diameter, attached to boulders; banks of ponds, lakes, and streams; or stems of vegetation; **individual eggs are solid black and 1-2 mm in diameter**.
HYRE Laid in loose, irregular clusters of 9-80 eggs (often 20-25), 0.5-1 inch in diameter, attached to plant stems, sticks, or other debris in shallow, quiet water of ponds, lake borders, and streams.
BUCA Laid in beadlike strings and clusters, often covered with silt, in the shallows of meadow pools. You can see indentations in the string between each egg.
BUBO Laid in tangled strings of 1-3 rows (typically 2), often entwined in vegetation along edges of ponds, lakes, and streams. Eggs are enclosed in a tube, so you cannot see indentations in the string between each egg.

Comments: Record any interesting observations made during the survey (e.g., tadpoles found only in shallow lagoon on NW side of lake; the sole RAMU adult detected was large – approx. 7.0 cm snout-vent length; several Brewer's blackbirds were feeding at different shoreline areas – likely predating on abundance of RAMU larvae at this site).

Operations
Many of the prospective restoration sites would be occupied by crews for several summer field seasons. A long term restoration camp requires a suitable camp location, permanent accessible drinking water and gear access via helicopter or stock. If there are multiple locations for each operation-related feature, include all and identify each in the order of suitability.

Feature: Identify all features relevant for restoration operations. These include, but are not limited to camp site, helicopter landing zone (LZ), stock drop-off location, human refuse (i.e. boomer) and drinking water collection.

UTM E: UTM easting of the feature location, in NAD 83.
UTM N: UTM northing of the feature location, in NAD 83.

Comments: Include all relevant comments regarding the feature location. Example: This camp location is within 150 meters from a permanent water source. It is located in a stand of pine trees to block up canyon wind and out of view from the hiking trail.

Site Comments
Use the site comments box to address any additional information that wasn't covered in the previous sections. Also, use this area to continue comments that exceed the allowed space in the previous sections.

Please be specific and always refer to the 5 digit Lake IDs and stream section letters when referring to restoration areas.

This section should be used to discuss all safety hazards at the site. Additionally, describe in detail the hiking route to the site. Often, these areas require considerable off-trail hiking. It is necessary to document the safest and most effective route to each site. In addition to this description, please trace the route on the site map.

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Figure 1a. Vertical rock face barrier.

Figure 1b. Another example of a tall, high gradient waterfall barrier at low flow.

Figure 1c. Large waterfall barrier. Although the entire waterfall is not vertical, this waterfall contains an initial 3 meter vertical drop, followed by a steep cascade. (Note: without a person in this image, the perspective is difficult to judge, but this is waterfall is very tall [~7 m high] and steep.)

Figure 2. Example of sheet flow. This particular feature may not be a definitive barrier at high flows. However, if this type of feature is at a high gradient and flows over several meters, fish are not able to move upstream.

Figure 3a. Dense talus barrier between two lakes. Large, dense talus piles like this one are definitive fish barriers.

Figure 3b. There is actually a stream flowing underneath this talus slope. However, densely conglomerated talus through which a stream percolates prevents any upstream fish movement.

Figure 4a. A steep "slot canyon" barrier flowing through bedrock.

Figure 4b. A small (~3 m) slot barrier through bedrock. This slot barrier also contains lodged boulders that act as a shelf, which provides additional assurance that upstream fish movement is completely restricted.

Figure 5a. A long stretch of outlet stream at the lower end of a basin. Although there are no vertical drops larger than 1 or 2 meters in this section, the combination of many smaller vertical faces, steep gradients, and rock piles would prevent upstream fish movement.

Figure 5b. High angle slot canyon barrier full of large talus. This particular barrier is not vertical in most areas, but it is very steep and contains several small vertical sections. The combination of steep gradient, rock piles, and drops prevent any upstream fish movement.

Restoration Lakes

Lake ID	Fish Spp.	YOY?	Spawn Hab.	Density	Est. Nets	Comments (Restoration technique, unique features, complexity, issues, etc.)

Lake ID: *5 digit Knapp code*; **Fish spp.:** *ONSP, ONMY, SAFO, UNKN;* **YOY?:** *young of year present, Yes or No;* **Spawn Hab.:** *Presence and estimated area of lentic spawning habitat;* **Density:** *density of fish, low, medium or high;* **Est. Nets:** *estimate # of nets to eradicate fish;* **Comments:** *detailed analysis of the features of the lake, photo #'s*

Restoration Streams

Section	Fish Spp.	YOY?	Spawn Hab.	Upstream Barrier	Downstream Barrier	Comments (Restoration technique, unique features, complexity, issues, etc.)
				E: N:	E: N:	
				E: N:	E: N:	
				E: N:	E: N:	
				E: N:	E: N:	
				E: N:	E: N:	

Section: *Ex. A, B, C, etc. as labeled on site map;* **Fish spp.:** *ONSP, ONMY, SAFO, UNKN;* **YOY?:** *young of year present, Yes or No;* **Spawn Hab.:** *Presence and estimated area of lotic spawning habitat;* **Upstream Barrier:** *UTM of furthest upstream fish distribution;* **Downstream Barrier:** *UTM of definitive downstream fish barrier;* **Comments:** *detailed analysis of the features of this stream section, including its connectivity to the restoration lakes*

Frog Surveys

Lake ID	Start				End				Start Time	End Time	Total	Spp.	Life Stage					Fish?	Comments:
	Air	H_20	Weather	Wind	Air	H_20	Weather	Wind					A	SA	LL	ML	SL		

Lake ID: *5 digit Knapp code*; **Temperature:** *Air and H_20 in Celsius;* **Weather:** *Clear, partly cloudy, mostly cloudy, overcast, rain or snow;* **Wind:** *none, light, moderate or heavy;* **Start and End Time:** *24 hour time;* **Total:** *total survey duration;* **Spp.:** *species encountered, RAMU, RASI, PSRE, BUCA, BUBO, THEL, THCO;* **Life Stage:** *A=adult, SA=subadult, LL=large larvae, ML=medium larvae, SL=small larvae;* **Fish ?:** *presence, Yes or No;* **Comments:** *general observations during the survey, photo #'s*

Operations

Feature	UTM E	UTM N	Comments

Feature: *Camp, LZ, spring, etc.;* **UTM E:** *Easting;* **UTM N:** *Northing;* **Comments:** *detailed description of the feature, photo #'s*

Site Comments

Enter all additional relevant information unique to this restoration site in the above area. Please be specific.

Mountain Yellow-legged Frog Restoration Project: UPPER EVOLUTION SITE ASSESSMENT
Sequoia and Kings Canyon National Parks
November 22, 2013

Isaac Chellman, Lead Biological Science Technician, (559) 565-4274, isaac_chellman@nps.gov
Erik Meyer, Lead Physical Sciences Technician, (559) 565-3127, erik_meyer@nps.gov
Danny Boiano, Aquatic Ecologist, (559) 565-4273, danny_boiano@nps.gov
Sequoia and Kings Canyon National Parks, 47050 Generals Highway, Three Rivers, CA 93271

Introduction

This report combines field work conducted during summers 2010 and 2012, the combined efforts of which create a complete site assessment for the proposed Upper Evolution basin restoration area (Map 1). On August 8th, 2010 and August 17-18, 2012, we conducted a site assessment of Upper Evolution basin to evaluate the feasibility of restoring six water bodies and adjacent inlet and outlet streams to their natural fishless state. In 2010, only three lakes were assessed because a lightning storm occurred during the visit. However, a full assessment was completed during the subsequent visit in 2012. We used the five digit lake ID's from the Knapp lake assessment project for nomenclature (Map 2). Our goals for site assessments include: assess fish distribution; quantify and mark strategic fish barriers; survey for mountain yellow-legged frog (MYLF) distribution; provide input for the restoration techniques exclusive to the site; assess accessibility and safety; find a low impact, long-term base camp; and establish a safe helicopter landing zone. The following text outlines the results of the Upper Evolution site assessment.

Proposed Site

The Upper Evolution site is located in the headwaters of the South Fork San Joaquin River (Map 1). This site is located in Evolution Basin, just north of Muir Pass and South of Evolution Valley. Proposed restoration work would occur from 3390 to 3535 m elevation. There are four fish containing lakes, one pond, and approximately 2.7 km of fish-containing stream habitat. This number may be misleading, however, because there are some braided sections of stream excluded from the GIS stream layer used to calculate distances. The stream distances also do not take into account drying habitat, which could greatly reduce the stream length that is treated. Most of the currently fishless habitat in Upper Evolution is either high in the basin, or composed of small, shallow ponds surrounded by large, fish-containing water bodies (Map 2).

Proposed Methods

To restore the Upper Evolution site, we would employ a combined "physical" fish-removal techniques with chemical treatment in a subset of stream sections (Map 2). This includes using methods of fish removal such as gill netting and electrofishing in the lakes, ponds, and several stream sections. The remaining fish-containing stream sections for which physical methods are not feasible would be treated using a chemical piscicide.

Proposed Lakes

Fish Removal-Lakes 10091, 11870, 10090, 10069, and 10511, plus adjacent streams and marsh habitat

Lake 10091 (Lake McDermand) is 21.4 acres with a shoreline perimeter of 1328 m, a max depth of 8.0 m and an elevation of 3520 m (Table 1; Map 2). This lake contains a moderately dense population of rainbow X golden trout hybrids (*Oncorhynchus* spp.). The trout population is self-sustaining, with abundant spawning habitat around the shallow littoral zone of the lake. All inlets either dry up or contain a very small amount of water. Barriers are denoted on the prescription map (Map 2), but no fish were observed occupying these stream segments during the site assessment. The main inlets are shallow, braided, and enter into a meadow area before they reach the lake. At this interface, there is ample

spawning habitat, with several redds observed. The southern part of the lake consists of a shallow shelf. Fish were not observed frequently here. They were observed in higher densities in the deeper, northern part of the lake (Map 2). The outlet stream travels 30 m downstream until it reaches Lake 11870.

Lake 11870 is 0.5 acres with a shoreline perimeter of 261 m, a max depth of 1.5 m, and an elevation of 3520 m (Table 1; Map 2). This lake contains a low density population of rainbow X golden trout hybrids. The stream connecting this lake and Lake 10091 is low gradient, primarily lentic habitat with nothing restricting fish travel between lakes. The outlet stream travels 70 m before it gets to an area of talus subsurface flow (Map 2). Trout were not observed from Lake 11870 to this barrier, however, trout were observed at low densities below this barrier. It was noted that the subsurface talus area probably blocked fish travel upstream. Below the barrier, the stream travels 275 m of low gradient, shallow flow until it reaches Lake 10090.

Lake 10090 (Wanda Lake) is 173.9 acres with a shoreline perimeter of 7498 m, a max depth of 30 m, and an elevation of 3483 m (Table 1; Map 2). The inlet stream is described above. This lake contains extremely low densities of rainbow X golden trout hybrids. Although very large, Lake 10090 does not appear to have a reproducing fish population. It should be noted that we believe trout are not traveling from Lake 10090 to upstream waters. Rather, we think fish are occasionally traveling downstream during high flow events. Gill nets set during the initial survey visit for the lake assessment project in 1997 resulted in zero captures. Subsequent visual surveys by NPS staff and researchers have only observed a few fish during 3 out of 12 surveys. The last year any fish were seen in this lake was 2010, during which time only a few trout were observed near the inlet. Occasional trout have also been observed in the inlet, below the talus barrier. However, no fish were observed during visual surveys of the entire lake perimeter in August 2012.

The outlet stream of Lake 10090 is low gradient, braided, and flows over a homogenous cobble substrate. The outlet is 1.2 km long and contains two channels beginning at the margin of Lake 10090. The two braids join several hundred meters downstream prior to entering Lake 10069. The two stream segments, from the edge of Lake 10090 to where they rejoin, are fairly uniform: there is one primary channel flowing over rocky substrate of various sizes. Both segments contain several small barriers, each of which alone likely block fish passage during most of the year. The combination of relatively steep gradient and numerous smaller barriers in each channel likely block fish completely.

Approximately 250 m prior to entering Lake 10069, the stream bed widens into a complex, low gradient assemblage of dense boulders and cobble (Photos 1 and 2). Electrofishing efforts would be incredibly difficult, if not impossible, in this stream segment (Map 2, in yellow). Electrofishing would be more feasible in the upper section of the Lake 10090 outlet, where the stream diverges into two braids (Map 2, in purple). No fish were observed in any portion of this stream segment (including both channels) during surveys on August 18, 2012. However, it was a dry summer and flows were very low. For example, in the wide, shallow stream section upstream of Lake 10069 (Photo 2), most water was flowing subsurface, so fish would be unlikely to swim upstream from Lake 10069. Despite these considerations, given the fact that there is no single large, definitive barrier present along the stream segment between Lakes 10069 and 10090, we cannot definitively rule out the possibility of fish passage.

Lake 10069 is 28.5 acres with a shoreline perimeter of 2136 m, a max depth of 12.0 m, and an elevation of 3443 m (Table 1; Map 2). This lake contains low to moderate densities of rainbow X golden trout hybrids. A majority of fish observed were large (upper 10-20, lower 20-30 cm size classes). The trout population is self-sustaining, with spawning habitat available along many areas of the shallow littoral zone of the lake. The inlet stream is described above. The 80 m, low gradient outlet stream contains no barriers and a heterogeneous mix of boulder and cobble (Photo 3). Several trout were observed in the outlet stream during surveys.

The complex network of marshy stream habitat due west of Lake 10069 would be logistically difficulty if physical methods were attempted (Photo 4). The stream network is far too shallow, complex, and full of dense rocky substrate for electrofishing. Therefore, we are proposing the use of piscicides, which could greatly ease efforts to remove fish in this area. Although the habitat appears poor for trout, we observed trout in a few small, isolated pools. Given that we observed trout in cut off pools when this area was almost completely dry, it is likely that trout use this stream network more extensively earlier in the season. The stream network probably dries completely by late September during most years.

There is a very small pond south of Lake 10511 into which a secondary channel of the inlet to Lake 10069 flows (Photo 5). This pond and associated marshy habitat contain moderate densities of rainbow X golden trout hybrids. Although it is likely trout could be easily removed from the pond using a combination of gill net fragments and electrofishing, we are proposing piscicide use for removing fish in this area. We chose piscicides because this small pond is directly connected to the wide, complex section of the inlet to Lake 10069 (Photos 1 and 2), and in close proximity to the complex stream network described above (Photo 4).

Lake 10511 is 4.4 acres with a shoreline perimeter of 898 m, a max depth of 8.0 m, and an elevation of 3442 m (Table 1; Map 2). This lake contains a moderate density of rainbow X golden trout hybrids. There were various size classes of fish, including YOY, +1, and adult trout. The trout population is self-sustaining, with abundant spawning habitat available along the shallow littoral zone of the lake. There is a small pond displayed on some topographic maps just north of the main lake. However, there is no pond at this location; west of the stream channel there is some marshy habitat, which mostly dries by late summer. The inlet stream is described above. The outlet stream flows for ~400 m before widening into a shallow, complex network of mixed cobble (Photo 6). Due to the complex habitat configuration, electrofishing would not be a feasible alternative in this stream section. The outlet stream splits into a few channels ~650 m downstream from Lake 10511, after which all channels descend down a steep waterfall barrier. This barrier is definitive, so all fish passage upstream from Sapphire Lake is completely blocked. Only a few trout were observed in the outlet stream.

Table 1. Lake descriptions for all proposed lakes in the Upper Evolution restoration site.

Lake ID	Area (ac)	Perimeter (m)	Max Depth (m)	Elevation (m)
10091	21.4	1328.0	8	3517
11870	0.5	261.1	1.5	3517
10090†	173.9	7498.1	30	3483
10069*	28.5	2136.3	12	3443
10511*	4.4	898.2	8	3442

†Lake 10090 was visited in both August 2010 and 2012.
* Lakes assessed during second site assessment trip in August 2012.

Complete eradication of trout can be achieved with a deployment of 35-40 gill nets in Lake 10091, and two nets in Lake 11870. It is unknown how many nets would be needed in Lake 10090. We would likely start by setting nets in the inlets, outlets, and select areas along the lake. Based on catch intensity, we would adjust net placement and abundance. 40-45 nets would be placed in Lake 10069 and 10 nets would be set in Lake 10511. In addition, there is a maximum of 1.9 km of electrofishing and 0.77 km of piscicide application if we chose to restore all proposed stream habitat. However, this is likely an overestimate, since many parts of the stream (especially where there are wide, shallow stretches of dense cobble) are not suitable for trout occupancy.

Frog Response
During the site assessment in 2010, a mountain yellow-legged frog survey was conducted at Lake 10091. No other official surveys were conducted in 2010 due to nearby thunderstorms.

In 2012, we conducted MYLF surveys at the remaining lakes in the proposed treatment area.

Additional Information

Accessibility
Crews would likely access this site from the North Lake Trailhead. Take the trail toward Lamarck Lakes, branching off the main trail to the south soon before reaching Upper Lamarck Lake. Follow the unmaintained trail to the south and west, over a ridgeline and up the valley northeast of Mt. Lamarck. The trail would lead up and over Lamarck Col. A detailed description of the route can be found in Secor (2009; Pg. 308). Descend down the faint trail along the scree slope south of Lamarck Col, heading southwest into Darwin Canyon. Approach the second lake to the west and follow along the northern shoreline of the Darwin Canyon lakes. Once out of Darwin Canyon, head south along a faint unmaintained trail, keeping just to the east of the small pond on Darwin Bench. The unmaintained trail heads southwest, just east of the Darwin Bench outlet stream. Descend the trail until reaching the Pacific Crest Trail (PCT). Once on the PCT, head southeast past Evolution Lakes and into Upper Evolution basin (Map 3).

If snow conditions make the route over Lamarck Col a safety hazard, entering from the South Lake trailhead provides an alternate route into Upper Evolution basin. After reaching Bishop Pass, the head down to LeConte Canyon, north to Muir Pass, and then down to Lake 10091. South of this lake, head counterclockwise off trail until you get to the camp area. An alternative camp area is located on the area of dry land between Lakes 10069 and 10511 (an additional 3 km; Map 2).

Base Camp
When looking for a base camp, we prioritize sites with granite slabs, decomposed granite substrate absent of vegetation, or previously impacted camps. These areas must be out of the colonization route mountain yellow-legged frogs take from the source pond to the restoration lakes. In considering visitor wilderness experience, we attempt to blend into the surrounding environment. This involves using trees for camouflage and staying away from developed trails. Our camp sites should be in close proximity to water for camp supply. We look for sites that provide efficient access to all restoration lakes.

The base camp for this site could be located on either the eastern shoreline of Lake 10091 or south of Lake 10511 (Map 2). Both areas are flat, with decomposed granite substrate, and sparse vegetation (i.e., no trees). The location adjacent to Lake 10091 is next to a spring that can be utilized for camp and drinking water purposes. It is out of view of the PCT. The only downside is that it is a very barren area, with potentially dangerous exposure to lightning. This entire basin is similarly exposed.

The other proposed camping area is also exposed and more visible from the PCT. However, it is very difficult to find a flat area with adequate camping for several people that is not at least partially in view of the trail, since the trail passes through the entire basin where most of the flat areas are located, and there are no trees. There were some small potential camping areas on the northwest side of Lake 10069, but we could not readily determine if they would be dry during a more typical year (2012 was one of the driest summers on record).

Landing Zone and Stock Support
There are several factors to consider when looking for a good landing zone. First, the general area should be void of trees and boulders that could pose a threat to helicopter rotors. Second, the landing zone should

be on a flat, level surface. Lastly, we look to minimize exposed areas that may leave the helicopter subject to heavy winds. To maximize safety and performance of the mobilization, we choose sites with in-ground effect. The landing zone chosen near Lake 10091 exhibits all of the above conditions (Map 2). The landing zone is also in close proximity to the chosen base camp. Stock support may not be feasible due to the remoteness and lack of grazing opportunities in this location.

There are two additional landing site options southwest of Lakes 10069 and 10511. Both sites meet the safety criteria listed in the description above. Additionally, both landing sites are close to the other proposed camping site between Lakes 10069 and 10511.

Safety Hazards
The following safety hazards exist at this site: gill netting, electrofishing, piscicide application, exposure to extreme weather, lightning, dehydration, hypothermia, heat-related illnesses, exhaustion, altitude sickness, and hiking related injuries.

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Photo 1. Wide, low gradient section of inlet just upstream of Lake 10069 (in background). Facing east.

Photo 2. Wide, low gradient section of inlet stream above Lake 10069. Facing southwest and upstream toward lake 10090.

Photo 3. Stream segment between Lakes 10069 and 10511. Facing east.

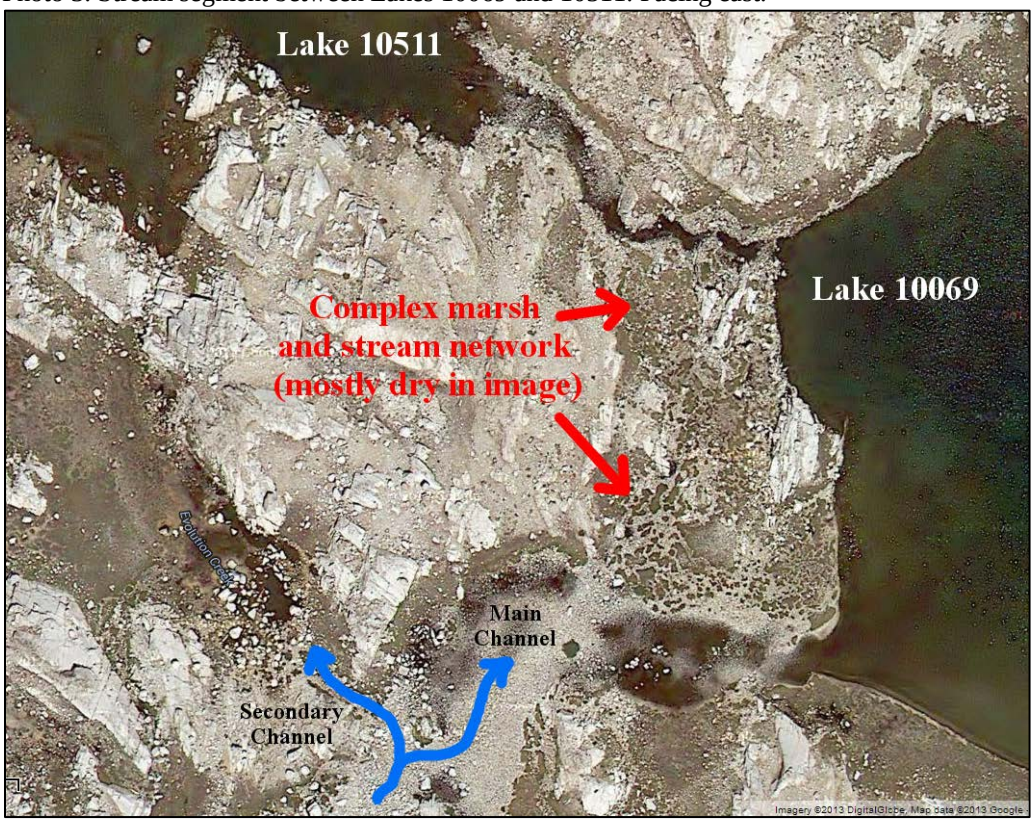
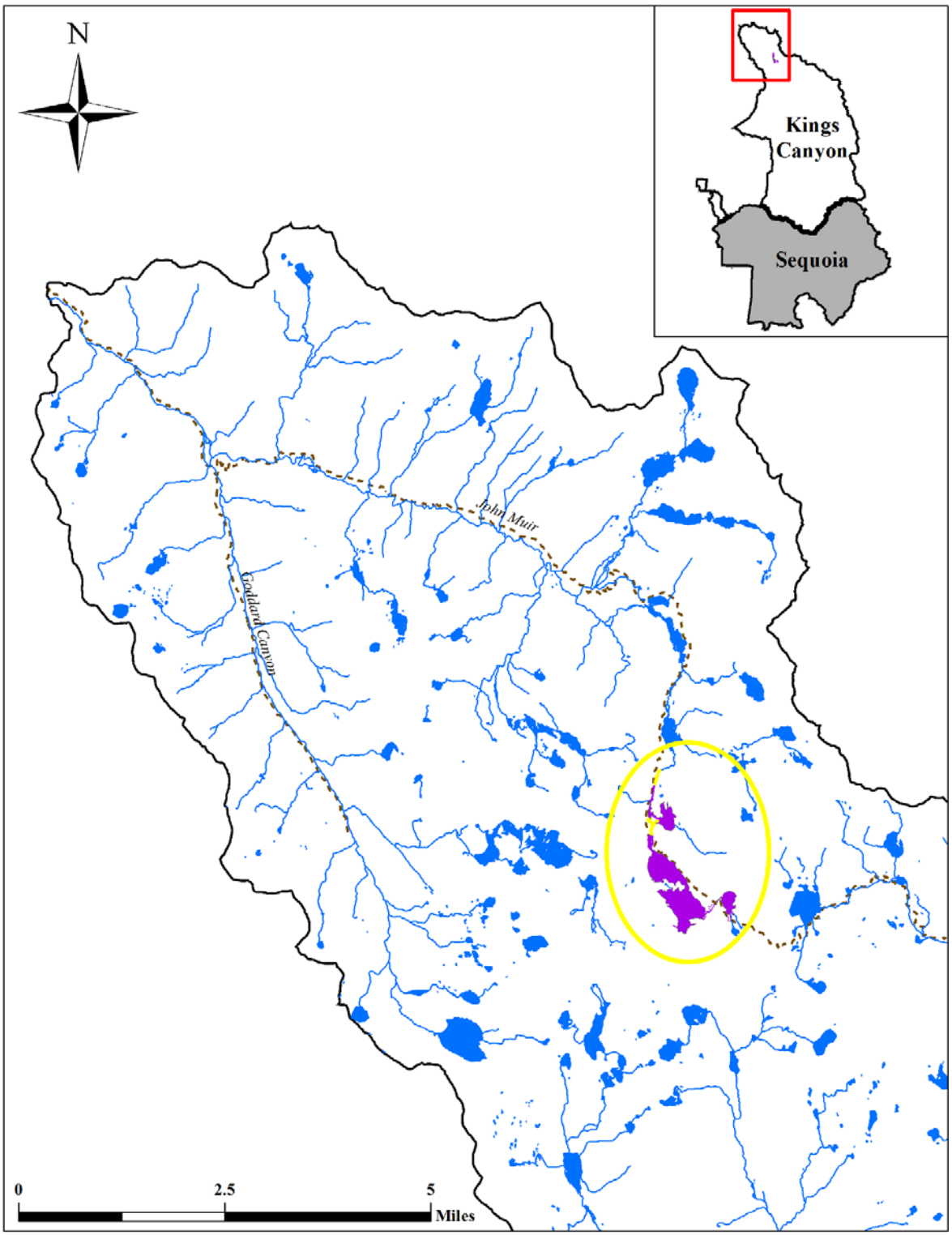


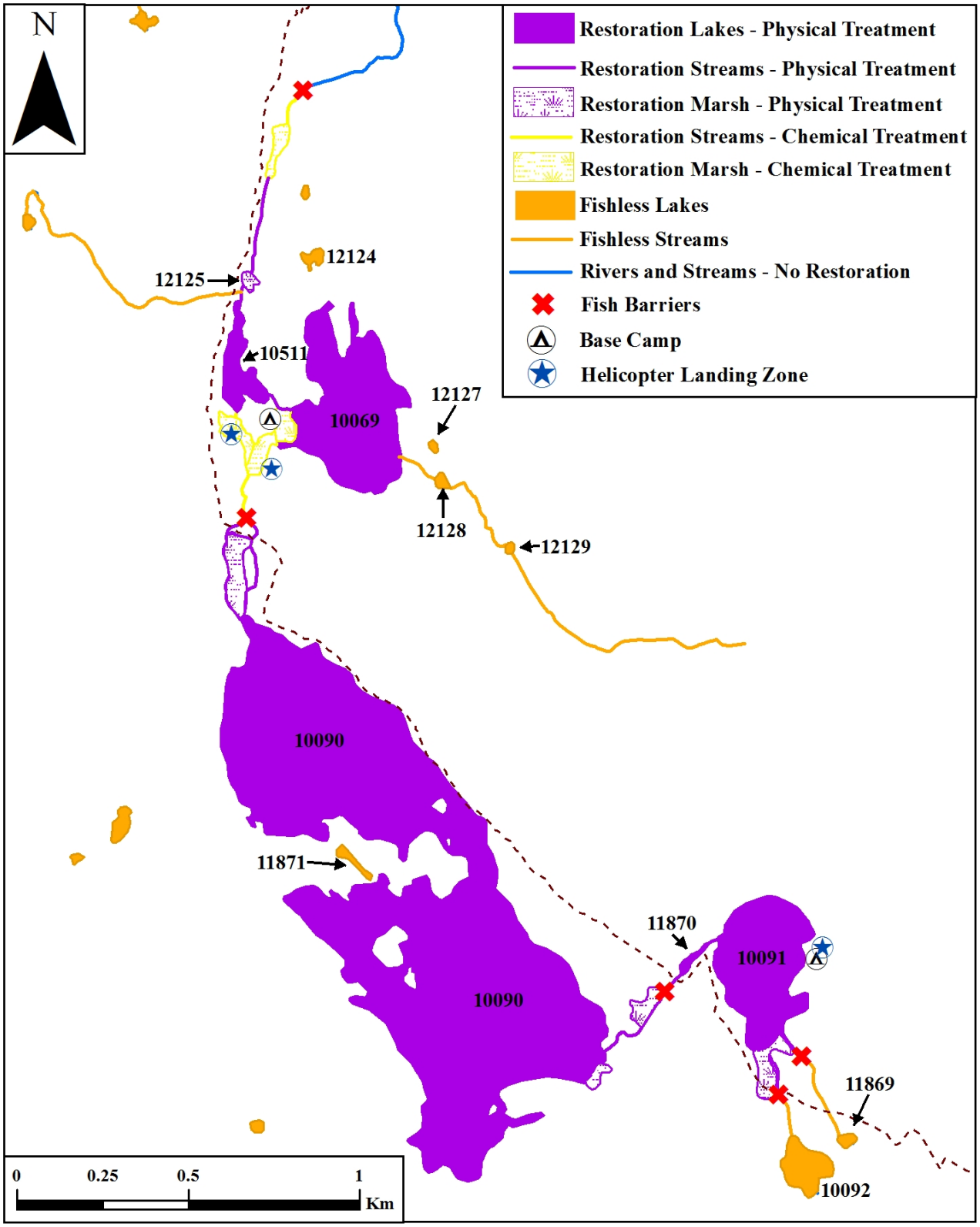
Photo 4. Aerial image showing the complex stream network west of Lake 10069. This area was mostly dry during the site visit in August 2012, but did contain isolated pools with fish. Also shown are the main and secondary channels of the inlet to Lake 10069, inlet to Lake 10511 (see also Photo 3), and small pond and marshy area south of Lake 10511 (see also Photo 5).

Photo 5. Small pond and marshy area south of Lake 10511 and west of Lake 10069. Facing south.

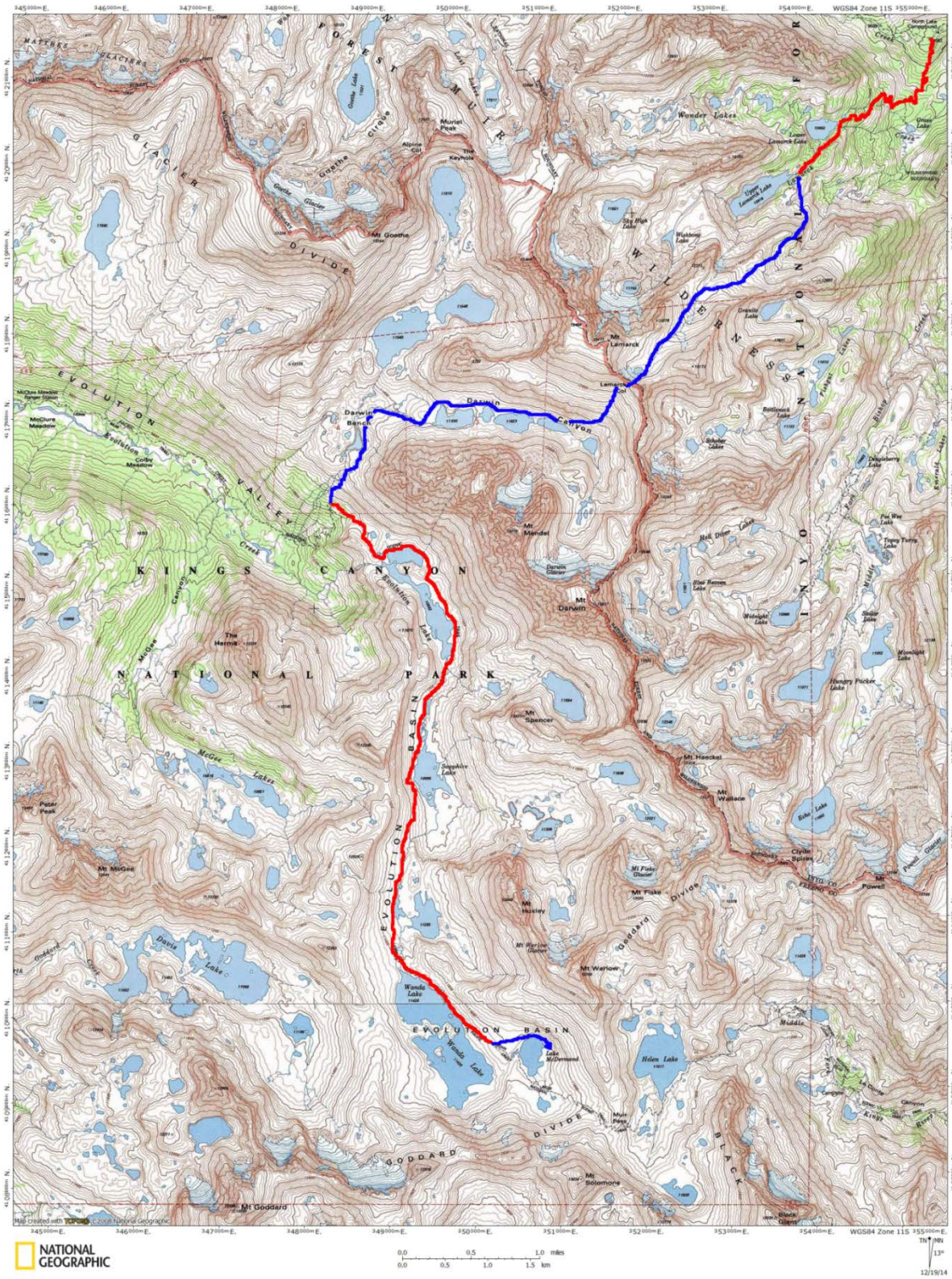
Photo 6. Widening in channel approximately 400 m downstream of Lake 10511. Facing north.



Map 1. Location of Upper Evolution proposed restoration site in Kings Canyon National Park, CA.



Map 2. Proposed restoration site in Upper Evolution, Kings National Park, CA.



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Map 3. Suggested route into Upper Evolution Basin via Lamarck Col. Established trails are highlighted in red. Unmaintained or off trail portions of the route are shown in blue.

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APPENDIX J: LIFE HISTORY OF MOUNTAIN YELLOW-LEGGED FROGS

Description

Mountain yellow-legged frogs (MYLFs) are a native amphibian species complex that includes two species (Vredenburg et al. 2007): the Sierra Nevada yellow-legged frog (*Rana sierrae*) and the mountain yellow legged-frog (*Rana muscosa*). Both species are federally listed as endangered (FWS 2014), while *R. sierrae* is state listed as threatened and *R. muscosa* is state listed as endangered (CFGC 2012). The two species are difficult to distinguish visually within SEKI, although some phenotypic differences have been established between the two species (Vredenburg et al. 2007, pgs. 370-371). *R. sierrae* (Figure J-1, A and B) have relatively shorter legs when compared with *R. muscosa* (Figure J-1, C and D), and the two species have different calls. However, visual differences are slight, both species only call when underwater, and there is considerable color and pattern variation within both species (NPS aquatics staff, pers. obs., Stebbins and McGinnis 2012). The typical way to differentiate between the two species involves a priori knowledge of which species is present within the geographic area being surveyed based on genetic sampling.

Adults are a moderate-sized frog that varies from about 1.5 to 3 inches (40 to 80 mm) snout to vent length (SVL). In general, dorsal color has varying mixes of olive-green, brown, and black. Color varies from mottled to spotted, and they may appear anywhere from drab to colorful. The ventral color is white to yellowish-beige. The underside of legs often contains a yellowish wash. The venter and underside of the upper thighs may also have a bright reddish-orange coloration. Larvae (tadpoles) are very dark (nearly black) during their first year. Older larvae are slightly lighter and resemble large ripe olives with tails (Figure J-1, E; Stebbins and McGinnis 2012).

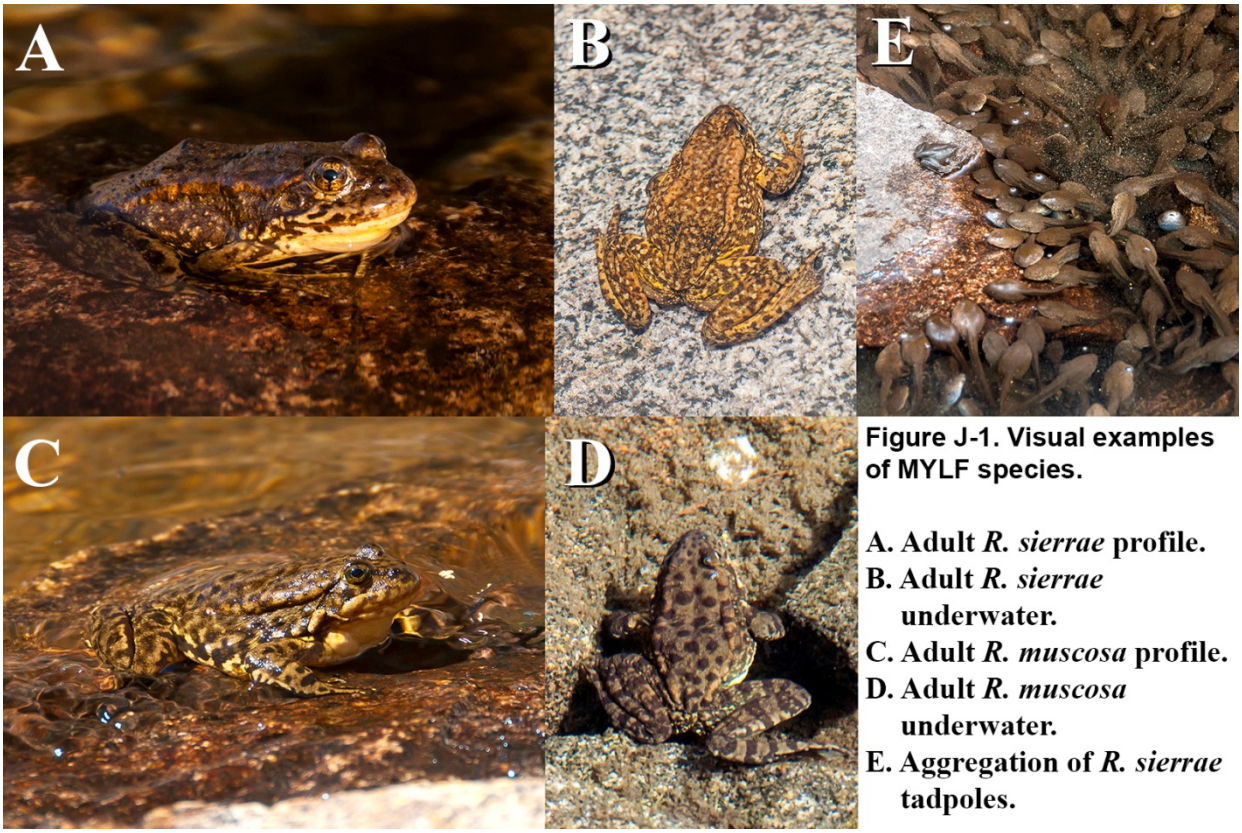

Figure J-1. Visual examples of MYLF species.

A. Adult *R. sierrae* profile.
B. Adult *R. sierrae* underwater.
C. Adult *R. muscosa* profile.
D. Adult *R. muscosa* underwater.
E. Aggregation of *R. sierrae* tadpoles.

Biology

MYLFs live high in the Sierra Nevada, occupying lakes, ponds, tarns, wet meadows, and streams (Mullally and Cunningham 1956). Though they have been reported between 4,495 ft (1,370 m; Zweifel 1955) to over 11,975 ft (3,650 m; Mullally and Cunningham 1956), MYLFs are normally encountered at the higher end of their elevational range. Historic, and some extant, populations exist in the mountains of southern California (San Gabriel, San Bernardino, San Jacinto, and Mt. Palomar), living at lower elevations from 1,214 ft (370 m) to over 7,500 ft (2,286 m; Zweifel 1955; Jennings and Hayes 1994). The historic records show that they ranged down to 6,400 ft (1,950 m) in Sequoia and Kings Canyon National Parks (SEKI), occupying montane meadows such as Round Meadow in Giant Forest and meadows at Grant Grove (Vredenburg et al. 2007, Vredenburg unpublished data). It is presumed that MYLFs ranged downstream to the upper limits of the natural distribution of trout prior to fish planting. In some drainages, this could have been below 5,000 ft (1,500 m). Known records and the likely historic distribution are shown in Figure J-2.

Within SEKI, the range of *R. sierrae* is generally bordered by ridges that divide the Middle and South Forks of the Kings River and ranges from Mather Pass, west to the Monarch Divide, and north to the northern boundary of the parks; while the range of *R. muscosa* is generally bordered by the crest of Sierra Nevada with the ridges that divide the Middle and South Forks of the Kings River, and ranges from Mather Pass, west to the Monarch Divide, and south to the southern boundary of the parks (Vredenburg et al. 2007).

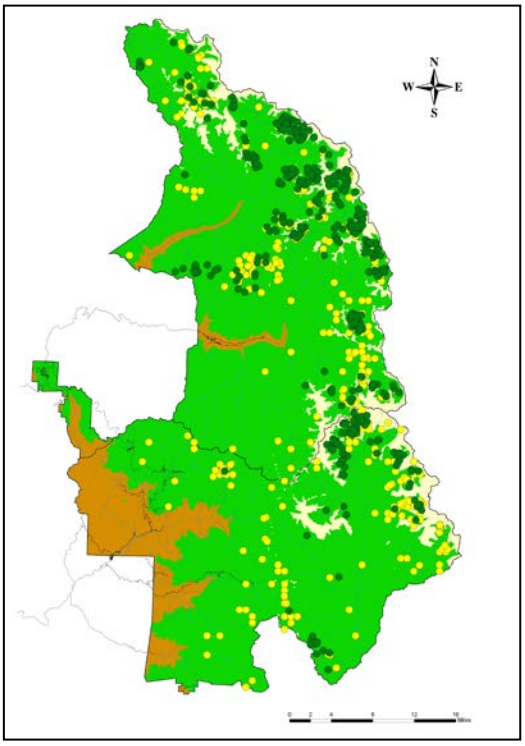

Figure J-1. Estimated historic distribution of MYLFs.

The estimated historic distribution is in green. Yellow dots mark historic records, and dark green dots mark observations since 1997. Brown areas are lower elevations than they were known to occur though the frogs range may have extended farther downstream prior to the planting of fish above their pristine distribution. The beige areas were generally too high to be inhabited.

MYLFs were once the most common frog and large tadpole seen within their range. Given their diurnal nature and historic large numbers, MYLFs were very conspicuous to early travelers. Seeing tens to hundreds of MYLFs leap into the water is an impressive sight for wilderness travelers. Though once common, they were rarely heard, since MYLFs call primarily under water (Stebbins and McGinnis 2012). Most frog calling in the high Sierra is produced by a more diminutive frog found throughout their range, the Pacific treefrog (*Pseudacris regilla*; Recuero et al. 2006). Adult MYLFs eat beetles, flies, ants, bees, wasps, bugs (Jennings and Hayes 1994), and treefrogs (Pope and Matthews 2002). Their predators include mountain garter snakes (*Thamnophis elegans elegans*), Brewer's blackbirds (*Euphagus cyanocephalus*), coyotes (*Canis latrans*), and introduced fish (Jennings and Hayes 1994). Additionally, there are observations of MYLFs being eaten by Sierra garter snakes (*Thamnophis couchii*), Clark's nutcrackers (*Nucifraga columbiana*), and American robins (*Turdus migratorius*) (NPS unpublished data), and also black bears (*Ursus americanus*) (Knapp R., pers. comm., 2010).

Breeding and egg-laying is coincident with late snowmelt and usually occurs in late May or June, but can occur later in summer, depending on conditions and elevation. Egg masses are normally laid in shallow water, especially in tiny springs and streams adjacent to lakes and ponds (Vredenburg V., pers. comm., 2007). Because the growth period is limited to summer and early fall, it can take up to three summers (possibly four) for larvae to metamorphose into adults. During the summer, larvae congregate in shallow waters, where the warmer temperatures facilitate their development (Figure J-1). Sometimes hundreds of larvae can be seen within a few square feet of warm, shallow water (Bradford 1984).

Both adults and larvae must be able to survive the winter. Larvae can survive the loss of oxygen when shallow lakes freeze to the bottom, but adults are much more susceptible to winter kill (Bradford 1983). Adults must have deep lakes or other refugia from anoxic conditions caused by winter ice.

Significance

MYLFs are subalpine/alpine predators of both aquatic and terrestrial invertebrates, as well as some vertebrates like the Pacific treefrog (Pope and Matthews 2002). In turn, they are a major source of food to larger alpine predators like the mountain garter snake. The loss of MYLFs is likely to have a measurable impact on the natural functioning of the lakes and streams within their historic range. Their loss could change the abundance of some other species with which they interact. This has been demonstrated for the mountain garter snake (Matthews et al. 2002).

Ecological Issues

Decline of mountain yellow-legged frogs

Populations of MYLFs have declined precipitously from their historic abundance, and they are in danger of becoming extinct. Drost and Fellers (1996) found that MYLFs have disappeared from eighty-six percent of the sites where Grinnell and Storer (1924) found them in 1915. Surveys by Bradford et al. (1994B) in SEKI during 1989-1990 failed to find MYLFs in 48% of the sites where they were found between 1955 through 1979. Within the Tablelands portion of the Kaweah drainage, MYLFs declined 96% between the late 1970s and 1989 (Bradford et al. 1994B). During the summers of 1997, 2000, 2001, and 2002, Roland Knapp and his field crews surveyed virtually all lentic sites in SEKI, and found MYLFs at 547 of the 3,639 sites surveyed. Repeat surveys in 2004 and 2005 showed that the frogs had gone extinct at 42% of the frog populations surveyed 3 to 8 years earlier (Knapp 2005B). Many of the sites that remain consist of small numbers of individuals that are vulnerable to extirpation (Knapp R., pers. comm., 2010).

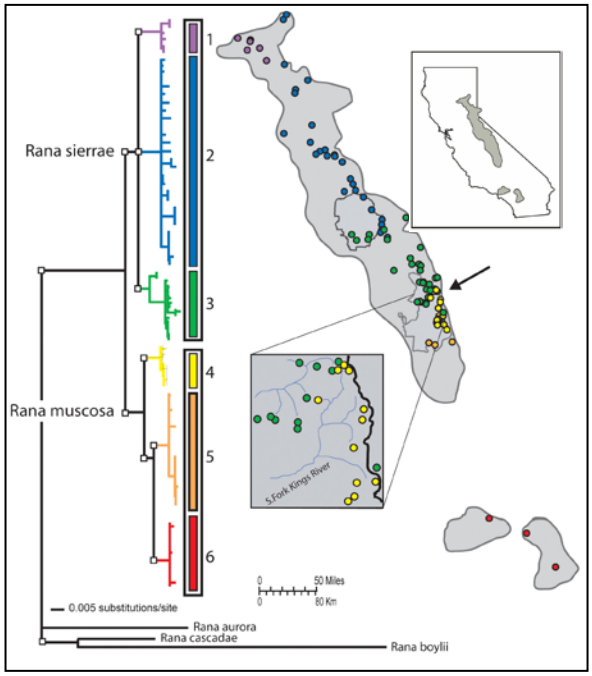

Figure J-2. Historic range of mountain yellow-legged frogs and collection locations used for genetic analyses.

From Vredenburg et al. (2007)**.** Historic range (grey) and collection locations (dots) used for genetic analyses. Bayes phylogram shows two major clades (*Rana muscosa*, *Rana sierrae*) and six minor clades (1–6) identified from the mitochondrial DNA analysis. The contact zone (arrow) between the species is located between the Middle and South Forks of the Kings River (inset).

Resurveys of historic localities throughout the ranges of MYLFs show dramatic declines (Vredenburg et al. 2007). Both species are imperiled: the Sierra Nevada yellow-legged

frog has been extirpated from 92.5% of its historic range, and the southern mountain yellow-legged frog has been extirpated from 96.2% of its historic range (Vredenburg et al. 2007).

Need to Preserve Yellow-legged Frog Genetic Diversity
In addition to the two species within the MYLF complex, each of the two species has three distinct genotypes or minor clades (Figure J-3; Vredenburg et al. 2007), and there is evidence that genetic diversity exists even within individual basins (Vredenburg V., pers. comm., 2007). Additionally, the critically endangered populations of southern mountain yellow-legged frogs in the San Gabriel, San Bernardino, and San Jacinto mountains, each show distinct population structure, which suggests a high level of genetic isolation (Schoville et al. 2011). There has likely been isolation in these populations since the Pleistocene, and the authors recommended that each of the three respective populations be managed as separate conservation units (Schoville et al. 2011). Preserving this diversity is one of the goals of this conservation effort and is consistent with NPS *Management Policies 2006*, which states: "*The Service will strive to protect the full range of genetic types (genotypes) of native plant and animal populations in the parks by perpetuating natural evolutionary processes and minimizing human interference with evolving genetic diversity*" (section 4.4.1.2).

Of the two species and six minor clades in the MYLF complex, SEKI includes the range of the southern minor clade (Number 3 in Fig. 3) of the Sierra Nevada yellow-legged frog and the two most northern minor clades (Numbers 4 and 5 in Fig. 3) of the mountain yellow-legged frog. Much of this genetic diversity is being lost due to the rapid decline of these species. Where genotypes are completely lost, the restoration effort would be limited to the nearest genetic matches to restore the ecological function the frogs provided. Again, this is consistent with NPS *Management Policies 2006*, which states: *"The restoration of native plants and animals will be accomplished using organisms taken from populations as closely related genetically and ecologically as possible to park populations, preferably from similar habitats in adjacent or local areas"* (section 4.4.1.2).

Known Causes of the Decline
Introduced trout are a major factor contributing to the declines of MYLFs (Bradford et al. 1993, Knapp 1996, Knapp and Matthews 2000, Vredenburg 2004, Knapp et al. 2007). Introduced predators are not a problem unique to MYLFs. Declines in a variety of western of frogs have been attributed, in part, to the introduction of predators like bullfrogs, bass and sunfish, catfish, mosquito fish, and red swamp crawfish (Cowles and Bogert 1936, Dumas 1966, Moyle 1973, Hammerson 1982, Hayes and Jennings 1986, Corn 1994, Jennings and Hayes 1994).

Fish are not native to most of the upper elevations of the Sierra Nevada. Pleistocene glaciation and steep topography created barriers to fish moving upstream (Christenson 1977, Moyle et al. 1996). West of the Sierra crest, most native fish (primarily coastal rainbow trout) occurred in streams below 4,900 ft (1,500 m), but may have reached 7,200 ft (2,200 m) in streams in the Kings watershed (Moyle et al. 1996). South of the glaciation, golden trout ranged in streams up to 9,800 ft (3,000 m; Moyle et al. 1996). In the eastern watersheds of the Sierra Nevada, Lahontan cutthroat trout also ranged in streams up to 9,800 ft (3,000 m; Moyle 2002). When settlers of European ancestry first came to the high country, virtually all of the waters in the lake basins, which are perched above the high gradient streams, were naturally fishless.

Planting fish in natural areas of the Sierra Nevada began in 1861 and became widespread in the 1870s (Christenson 1977). The first *recorded* stocking of fish in SEKI was in 1970 (Christenson 1977). Initially, planting was done by stock users, anglers, and anyone else that wanted to move fish into fishless waterbodies. By 1912, the California Department of Fish and Game had become involved in planting fish. In general, brown trout (*Salmo trutta*) were planted at the lower elevations, rainbow trout (*Oncorhynchus mykiss*) at the mid elevations, and golden trout (*Oncorhynchus mykiss aguabonita*) in the high Sierra. Brook trout (*Salvelinus fontinalis*) were later added to the species planted in the mid-elevations, and

cutthroat trout (*Oncorhynchus clarki* subsp.) to the high elevations (NPS 1989). In the early days, fish planting was completed primarily with pack stock, but aircraft began to be used in 1940 (NPS 1989). This increased the efficiency of fish planting efforts and increased access to new planting locations. Since 1988, fish planting was been banned within SEKI.

Most lakes within the parks are relatively oligotrophic (having low biological productivity) because they are primarily in granitic basins at high elevations. In many lakes, nutrients and prey are initially abundant enough to sustain fish populations, but productivity declines over time as fish consume resources (Purkett 1951, Reimers 1958). In some situations, fish become stunted, or their populations decline to where they are in equilibrium with the lake (Pister 1977). Populations of brook trout planted in oligotrophic lakes are particularly prone to becoming stunted (Reimers 1979). The general low productivity of Sierran waterbodies led to an effort to enhance trout food. In 1919, the Department of Fish Culture introduced an amphipod (*Hyalella azteca*) and an alga (*Nitella* sp.) to Rae Lakes to enhance the fish food supply (NPS 1989). Today, these introduced organisms persist, and *Hyalella* is quite abundant in these waters.

Some trout species generally sustain themselves at a level that maintains healthy looking fish. A survey of 137 lakes in SEKI showed that 84 lakes (61%) were definitely self-sustaining, 13 (10%) were probably self-sustaining, 16 (12%) showed little evidence of fish reproduction, six (4%) were not producing any new fish, and 18 (13%) were fishless (Zardus et al. 1977). Armstrong and Knapp (2004) resurveyed all lakes in which there had been direct evidence of trout reproduction from the Zardus et al. (1977) study. Armstrong and Knapp (2004) found reproducing nonnative fish populations in 57 of the 84 resurveyed lakes (68%). Given that at least 20 years had passed since any stocking had occurred in the resurveyed lakes, Armstrong and Knapp (2004) concluded that sufficient natural reproduction was occurring to maintain numerous nonnative trout populations in the long term.

Nearly a century ago, Grinnell and Storer (1924) reported the loss of MYLF following the introduction of nonnative trout. Fish stocking intensity reached its peak following the adoption of airplane stocking in the late 1940s. Dramatic MYLF declines were sometimes not reported until years following initial stocking (Bradford 1989, Drost and Fellers 1996). However, lack of immediate reporting is not surprising, given that many MYLF populations experienced relatively slow declines over time from reduced recruitment in the presence of nonnative fish predators (Knapp and Matthews 2000). Additionally, the remoteness of many sites containing MYLFs (and corresponding difficulty of access) can result in declines not being documented for many years. Therefore, MYLF have been declining primary due to fish stocking between the late 19th and late 20th centuries. More recently, amphibian chytrid fungus (*Batrachochytrium dendrobatidis*, often abbreviated *Bd*; discussed below) has spread through most remaining frog populations in SEKI and intensified long-term declines (Vredenburg et al. 2010A).

Within MYLF habitat, not all waterbodies provide ideal habitat. Ponds that may be good for feeding may not be the best sites for breeding or over-wintering. Matthews and Pope (1999) documented seasonal movement between ponds. In addition to seasonal movements, recruitment may be high at some locations, while other waterbodies maintain their populations through immigration from more productive sites. Before fish were introduced, there was connectivity, and thus potential for successful movement, between the ponds. Frogs could freely migrate between ponds to achieve their seasonal needs, and ponds that lost frogs could be recolonized from nearby locations. The isolation of frog populations has been exacerbated by the effects of both introduced fish and amphibian chytrid fungus.

Because trout and MYLFs are largely mutually exclusive (Bradford 1989, Bradford et al. 1993, Knapp 1996), the introduction of trout fragments the historic connectivity of MYLF habitat. Dense populations of predatory fish impede seasonal movements and occupy many deep water over-wintering sites formerly used by MYLFs. Frog populations have subsequently become fragmented and isolated. Then, if the MYLF population of a smaller waterbody is wiped out by a catastrophic event like drought, disease, or

winter-kill, often there are no adjacent source sites for recolonization. The addition of environmental stressors, such as amphibian chytrid fungus and climate change, may have increased the frequency of local catastrophic events (Blaustein et al. 2011). Not only do populations become more isolated with the loss of connectivity, but with isolation, there is likely to be increased inbreeding and possible loss of genetic viability. Amphibian populations have been shown to have natural fluctuations (Pechmann et al. 1991), but without connectivity, the means to recover from an inherent drop in numbers would be more limited. What might have been a downward fluctuation 200 years ago could today, in the absence of connectivity, result in extirpation. As isolated populations disappear, the distance between potential sources has increased. Thus, as isolation and environmental stressors continued to increase in magnitude, it is likely that the rate of frog declines will also increase.

Amphibian chytrid fungus has compounded the effects of nonnative fish on MYLFs, causing serious losses in many populations throughout their ranges. Amphibian chytrid fungal infection can result in chytridiomycosis, a disease that causes catastrophic disruption to the skin of infected adult frogs (Voyles et al. 2009, Rosenblum et al. 2012). Both species of MYLFs share the same pathological response to amphibian chytrid fungal infection, including electrolyte imbalance, compromised ability to osmoregulate, and cascading effects on other organ systems. Many of these perturbations appear to be directly linked to physical disruption of the epidermis (Rosenblum et al. 2012).

Studies demonstrate that amphibian chytrid fungus recently spread through the Sierra Nevada (Morgan et al. 2007, Vredenburg et al. 2010A, Voyles et al. 2012) and has infected nearly all MYLF populations, including those in SEKI. Most MYLF populations crash within a few years after becoming infected, and many populations have been extirpated. Amphibian chytrid fungus has thus been a major factor in accelerating the decline of MYLFs already well underway following the introduction of nonnative trout (Knapp et al. 2011).

MYLF populations that persist following chytridiomycosis outbreaks have very low survival and recruitment from year to year, making them extremely vulnerable to extirpation. In addition to trout removal, these MYLF populations would likely benefit from an emerging disease treatment technique using antifungal agents, designed to significantly increase short-term survival, and hopefully long-term recruitment. The first phase involves treating frogs with itraconazole (an antifungal drug) to reduce their infection levels; and a second possible phase involves augmenting the concentration of a common bacterium (*Janthinobacterium lividum*) on the skin of frogs that has protective anti-fungal properties. Combined, the regimen appears to allow development of an immune response on treated frogs, thus changing the outcome for many frogs from mortality to persistence. Preliminary results of several field trials conducted in SEKI from 2009 to 2012 have shown promise for future management application. Immediately following the discovery of a large scale chytridiomycosis die-off in northern Kings Canyon National Park, a larger-scale study was initiated in August 2015 to determine if anti-fungal treatments are a viable option for reducing amphibian chytrid fungal infection intensities, facilitating MYLF adult survival following chytridiomycosis outbreak, and help frogs develop an immune response to the disease (Knapp et al. unpublished data). Follow-up surveys are planned for the summer of 2016 to determine if there was survival among the frogs treated with anti-fungal drugs.

Potential Contributing Factors

For over two decades, scientists have been noting the dramatic world-wide decline of amphibians (Blaustein and Wake 1990, Stuart et al. 2004, Wake and Vredenburg 2008). Many different hypotheses have been developed to explain the losses, and in many cases there are local data to support one or more potential causal agents, but often there is not enough data to suggest that any given hypothesis fully explains the worldwide decline. The list of commonly cited possible explanations for amphibian declines includes: disease, habitat loss, pesticides, climate change, introduced predators/competitors, acid deposition, increased UV-B radiation (as a consequence of the thinning stratospheric ozone layer), and

various combinations of all these factors (Collins and Storfer 2003). Scientific articles and popular media often refer to amphibians as indicator species or "coal miners' canaries" and warn that amphibian losses are an early warning for humans (Kerby et al. 2010).

Climate change has recently begun to affect MYLFs by drying and/or freezing small, shallow ponds to which MYLF populations are restricted in many basins because nonnative trout occupy all adjacent lakes (Lacan et al. 2008). These ponds can completely dry up in even relatively short droughts, an event that has already occurred in Dusy Basin (Lacan et al. 2008). When this happens, multiple year-classes of MYLF tadpoles are lost, and populations already suppressed by trout can be quickly extirpated. In addition, shallow ponds can freeze solid during atypical climate patterns, which also occurred in Dusy Basin during the winter of 2011 to 2012. This event appears to have killed most of the adult MYLFs that remained in that area of Dusy Basin. Quickly eradicating nonnative trout would allow MYLF populations to expand (Knapp et al. 2007) and recolonize large lake habitat that is much more resistant to the effects of climate change.

Changes in the climate of the Sierra Nevada could affect MYLFs in a variety of ways (Lacan et al. 2008). Snow pack depletion could reduce the availability of shallow ponds or the connectivity of deep lakes. The broad historic elevation range of the MYLFs suggests that climate projections may be tolerable for the species if adequate aquatic habitat persists, but it is not known what indirect effects climate change may cause to the species. How climate change may affect amphibians worldwide is still mostly unknown (Davidson et al. 2002, Carey and Alexander 2003, Lips et al. 2008, Rohr et al. 2008, Blaustein et al. 2010).

Pesticides may also be contributing to the loss of MYLFs (Sparling et al. 2001, Davidson et al. 2002, Davidson 2004, Fellers et al. 2004, Davidson and Knapp 2007) and other California amphibians (Sparling et al. 2001, Davidson et al. 2002, Davidson 2004). However, not all recent studies have found an association between pesticides and amphibian decline in the high elevation regions of the Sierra Nevada (Bradford et al. 2011). Still, the southern and central Sierra Nevada are downwind of one of the most intensely cultivated areas on earth (Cory et al. 1970). Fresno and Tulare Counties used over 43 million pounds of pesticide active ingredients in 2010 (CDPR 2011). Combined with Kings and Kern Counties, nearly 76 million pounds (CDPR 2011) of pesticide active ingredient were used in agricultural areas upwind of the southern Sierra Nevada in 2010 alone.

A variety of pesticides have been found in the parks' water and in the tissues of amphibians and fish. Measurable quantities of organophosphate pesticides were measured in the Sierra Nevada at 6,300 ft with increasing concentrations at lower elevations (Zabik and Seiber 1993). Datta et al. (1998) found polychlorinated biphenyl (PCBs) and dichlorodiphenyldichloroethylene (DDE) in trout in the Kaweah drainage. Pacific treefrog tadpoles contained PCBs, chlorpyrifos, chlorthalonil, and a chloronitrile fungicide. In the late 1960s, Cory et al. (1970) found DDE residues in MYLFs, with the heaviest concentrations being in the southern and central Sierra Nevada. Angerman et al. (2002) found PCB concentrations in Pacific treefrogs to range from 244 ng/g (wet weight) at low elevations to 1.6 ng/g on the eastern slopes of the Sierra Nevada. Likewise, toxaphene in Pacific treefrogs varied from 1.5 ng/g to 15.6 ng/g. The data suggested that rain-shadows may reduce tissue concentrations.

The pesticide drift into these parks includes organophosphorous pesticides. They are highly toxic to amphibians because they deactivate acetylcholinesterase, the enzyme that breaks down acetylcholine. This results in a repeated and uncontrolled firing of neural signals across synapses, causing the animals to die, usually from asphyxiation. Metabolism of organophosphorus pesticides in the liver, plus breakdown by certain bacteria and other environmental conditions, creates oxons that increase the toxicity of the pesticide. Sparling and Fellers (2007) calculated the LC50 (the concentration that kills half of the test animals) for the three most commonly used organophosphorus pesticides in California's Central Valley,

chlorpyrifos, malathion, and diazinon, using larval foothill yellow-legged frogs (*Rana boylii*). Median lethal concentrations were 3.005 mg/l for chlorpyrifos with a 24 hr exposure, 2.14 mg/l for malathion with a 96 hr exposure, and 7.488 mg/l for diazinon with a 96 hr exposure. The oxons of these chemicals were 10 to 100 times more lethal with maloxon showing an LC50 of 0.023 mg/l and diazoxon being 0.760 mg/l. Cloroxon could not be calculated because all the test animals died at the lowest concentration, so cloroxon exceeds being 100 times more toxic than its parental compound.

The LC50 concentrations for *R.* boylii are well above reported southern Sierra Nevada high elevation pesticide concentrations (Zabik and Seiber 1993, McConnell et al. 1998, LeNoir et al. 1999, Fellers et al. 2004), which are normally reported in nanograms (values that are one millionth of a milligram) and sometimes in pictograms (one billionth of a milligram). However, when Davidson (2004) compared extant frog populations with historic pesticide use, he found a significant inverse relationship between pesticide application and amphibian populations for four species of frogs, including MYLFs. This relationship was strongest for the cholinesterase inhibiting pesticides. The low concentrations of pesticides found in the southern Sierra suggest that pesticide effects are sublethal. While those sublethal effects have not been identified, one possibility is reduced immunity.

Pesticide depression of immunity has been demonstrated in some frogs. Gilbertson et al. (2003) demonstrated immunosuppression on the northern leopard frog (*Lithobates pipiens*) using malathion, and Davidson et al. (2007) on the foothill yellow-legged frog using carbaryl. A landscape-scale study by Davidson and Knapp (2007) looked simultaneously at correlations between pesticide use, prevailing wind patterns, and predation by introduced fish. The study found that both stressors caused significant loss of MYLFs, but the landscape-scale correlation with pesticide application was stronger than the effect from introduced fish. However, this association was not based on actual measurement of pesticide concentrations in the field, or within animal tissues (Davidson and Knapp 2007).

A more recent study investigated potential effects of pesticide exposure in MYLFs at 14 high elevation sites in SEKI (Bradford et al. 2011). In this study, the authors measured concentrations of nine different pesticide compounds (only those compounds–of an original 46 pesticides and metabolites targeted for measurement–that were detected >30% of the time in sediment and tadpoles) that were detected in air and sediment samples, plus cholinesterase (ChE) levels (which are used as an indicator of organophosphorus and carbamate exposure) measured in whole Pacific treefrog tadpoles (Bradford et al. 2011). The study concluded that the results *"do not support the hypothesis that pesticides have contributed to the population declines of* R. muscosa *and* R. sierrae *in the alpine zone of the southern Sierra Nevada. In particular, no association was found between any pesticide-related metric and population declines. By contrast, the amphibian disease chytridiomycosis has been demonstrated in other studies as the cause for dramatic population declines of many populations of these species in recent years. Moreover, linear distance from the Valley was strongly related to frog population status in the present study, a finding that is consistent with the apparent pattern of spread of chytridiomycosis."* (Bradford et al. 2011, pg. 690).

Bradford et al. (2011) concluded that there is evidence for lethal and sublethal effects of pesticides for other species of amphibian residing in lower elevations and downwind locations closer to where pesticides are being applied (Davidson 2004, Sparling and Fellers 2009). For example, using the Pacific treefrog as a sentinel species, Sparling et al. (2001) demonstrated that cholinesterase activity was significantly more suppressed on the downwind side of the Central Valley in the Sierra Nevada foothills (~1500 m elevation) than upwind along the coast or north of the Valley.

In addition to declines, there is another phenomenon that concerns scientists. In some areas, frogs are developing deformities that range from missing to extra limbs (Lannoo 2008). This has been attributed to some of the same processes believed to be effecting declines (e.g., UV-B radiation; Ankley 1997), but natural causes like trematodes have also been identified (Sessions 1997). Deformities were not believed to

be an issue in the Sierra Nevada until Pacific treefrogs with unnaturally shortened femurs (brachymelia) were found in Sequoia and Yosemite National Parks (Cowman et al. 2002).

Air pollutants may also be cause for concern. Jennings (1996) reported a conversation with T. Cahill stating that studies by the Crocker Nuclear Laboratory have noticed that the pattern of recent frog extinctions in the southern Sierra Nevada corresponds to the patterns of highest concentrations of exhaust pollutants from automobiles. Nitrates and nitrites are associated with automobile pollution. Marco et al. (1999) found that *Rana pretiosa* and *Ambystoma gracile* larvae were sensitive to nitrite and nitrate levels allowable in Environmental Protection Agency (EPA) established drinking water concentrations for these chemicals. The effects increased with both concentration and time.

Another indirect effect of air pollution is the thinning of stratospheric ozone as a consequence of chlorofluorocarbons, resulting in increased ultraviolet radiation, especially the UV-B region of the spectrum. Blaustein et al. (1994B, 1995, and 1997) attributed the decline of several amphibians to UV-B radiation. However, other investigators have failed to find negative effects of UV-B on amphibians (Grant and Licht 1995, Ovaska et al. 1997, Corn 1998, Vredenburg 2002, Vredenburg et al. 2010B). Exposing embryonic stages to ultraviolet radiation does reduce survival for some species (Worrest and Kimeldorf 1975, 1976; Blaustein et al. 1994B, 1995, 1997; Grant and Licht 1995; Hayes et al. 1996) and can cause developmental malformations (e.g., extra or missing limbs) in a laboratory situation (Ankley et al. 1998). However, what can be done in a laboratory does not necessarily resemble what happens in nature. In a natural environment, larvae have the ability to avoid UV-B radiation by shielding themselves under vegetation, in rock crevices, and under mud and detritus. There is no published evidence, to date, that UV-B radiation has caused declines of MYLFs. However, the limited information currently available does not mean that MYLFs are insensitive to changes in ambient UV-B levels.

Diseases other than amphibian chytrid fungus have also been implicated in some amphibian population declines, including ranaviruses and red leg syndrome (Densmore and Green 2007). Red leg syndrome (bacterial dermatosepticemia) may have contributed to losses of several species of toads and larval tiger salamanders in the western United States (Collins et al. 1988, Worthylake and Hovingh 1989, Carey 1993, Kagarise Sherman and Morton 1993). Both Bradford (1991) and Knapp (pers. comm., 2010) reported red leg syndrome to cause losses of MYLFs. They reported red-leg syndrome as localized cases and not likely to cause widespread declines. Red leg syndrome is often a consequence of immune systems being weakened by stress (Corn 1994). In 2001, a major die-off from a ranavirus was reported in Upper Basin in Kings Canyon National Parks (Knapp R., pers. comm., 2010). Mao et al. (1999) demonstrated that Iridoviridae (the virus family that includes *Ranavirus*) could be transmitted from introduced trout to amphibians.

The waters of SEKI are subject to acidic deposition (Melack et al. 1989). Acid deposition is a potential source of stress on frog populations. Tome and Pough (1982) looked at 14 species of amphibians, and found that when pH drops to 4 or less, mortality during embryonic development is over 50%. This increased to 85% with pH between 3.7 to 3.9. Acidic deposition has been suspect as a contributing cause to amphibian declines in a variety of places (Harte and Hoffman 1989, Wyman 1990, Blaustein and Wake 1990, Carey 1993), and episodic acidification does occur in these parks in basins with low acid neutralizing capacity (Melack et al. 1989, Stoddard 1995). Bradford et al. (1992) found that *Rana muscosa* embryos and hatchlings were not sensitive to pH values recorded in high-elevation Sierra Nevada lakes. From an analysis of pH at 235 potential breeding sites, Bradford et al. (1994A) concluded that acidic deposition is not a likely cause of amphibian declines in the Sierra Nevada. However, Bradford et al. (1998) reported that MYLF tadpoles were absent in acidic lakes (pH <6) in the vicinity of Mt. Pinchot (Bradford et al. 1998). When nine lakes and ponds in the Middle Fork Kaweah drainage were surveyed in 1993, eight of nine field pH measurements were below six (NPS unpublished data). The one

high pH of 8.1 was from a pond in marble, a rock that neutralizes acidity. Given a lack of any observations for many years, MYLFs are assumed to be extirpated from the Kaweah drainage.

Direct habitat destruction is one of the leading factors responsible for amphibian declines (Lehtinen et al. 1999, Davidson et al. 2002, Cushman et al 2006, Gallant et al. 2007, Sodhi et al. 2008). Some amphibian losses can be attributed to the conversion of wetlands to urban or agricultural use (Corn 1994). Other alterations are subtler. Jennings (1996) noted that: "*aquatic habitats of the Sierra Nevada have been greatly altered through dams, diversions, channelizations, siltation, livestock grazing, timber harvest, placer mining, and many other factors.*" Although certainly a factor in MYLF declines outside of protected areas, habitat loss and alterations appear to be an unlikely factor in the loss of MYLFs in SEKI because they occupy high-elevations sites far removed from human engineering projects. Many of the historic populations occurred in remote basins that infrequently see human use. Most populations are within designated wilderness where they, and their habitat, are fully protected.

Not all amphibian declines are the result of direct or indirect human activities. Fluctuations have been reported in amphibian populations (Pechmann et al. 1991, Pechmann and Wilbur 1994). It is important to distinguish between natural events and loses attributable to anthropogenic effects. In many cases, a combination of causes may be contributing to amphibian losses (Collins and Storfer 2003, Blaustein et al. 2011). As stated above, chytridiomycosis and predation by introduced fish are the primary causes of decline of MYLF species. However, other causes may have contributed to amphibian declines in the Sierra, and some factors not previously considered may also be contributing.

Loss of Aquatic and Terrestrial Biodiversity
Introduced trout not only contribute to the decline of MYLFs (Bradford et al. 1993, Knapp and Matthews 2000), they contribute to a general loss of biodiversity in aquatic biota and associated terrestrial fauna (Knapp et al. 2001, Knapp et al. 2005, Knapp and Sarnelle 2008, Epanchin et al. 2010). For example, long-toed salamander (*Ambystoma macrodactylum*) populations are greatly reduced when fish are present, and fish can occasionally completely exclude long-toed salamanders from breeding sites (Lannoo 2005, pg. 620). Epanchin et al. (2010) found gray-crowned rosy finch to be more common at lakes without fish than at lakes with fish. This is because introduced fish populations limit mayfly populations on which the finches feed during mayfly emergence.

While quantitative data is lacking, the abundance of other alpine/subalpine species are likely to be affected by losses of MYLF populations. Both Brewer's blackbirds and Clark's nutcrackers feed on MYLFs (Jennings and Hayes 1994, NPS unpublished data). Black bears (*Ursus americanus*) have also been observed foraging for MYLFs (Knapp R., pers. comm., 2010). MYLFs may have been an important high elevation food for bears prior to nonnative trout and disease caused declines. Mountain garter snakes feeds on MYLFs (Jennings et al. 1992), and Matthews et al. (2002) found that mountain garter snake abundance is directly related to frog abundance. Additionally, MYLFs have historically been important predatory species in the high elevations of the Sierra Nevada. Most of their prey consists of insects (Finlay and Vredenburg 2007), but they feed also on small vertebrates, such as Pacific treefrogs (Pope 1999, Pope and Matthews 2002).

Trout virtually eliminate large-bodied invertebrates from lakes. When Stoddard (1987) surveyed zooplankton in 75 Sierra Nevada lakes, he found fish to be important predictors of zooplankton species occurrence, with small-bodied species being found in association with fish and large-bodied species occurring only where fish were absent. Likewise, Bradford et al. (1998) found large-bodied planktonic microcrustaceans (e.g., *Hesperodiaptomus shoshone* and *Daphnia middendorffiana*) and epibenthic and limnetic macroinvertebrates (e.g., back swimmers, water boatmen, predaceous diving beetles, and larvae of some families of caddis flies and mayflies) to be relatively common in lakes without trout, but rare or absent in lakes with trout.

Herbst et al. (2009) found that the presence of introduced trout in streams resulted in decreased density for 20 invertebrate taxa and increased abundance for six taxa. The strongest effects appeared to be on taxa endemic to the Sierra Nevada, which have no coevolutionary history that would have facilitated the development of mechanisms to deal with fish predation. The study found that streams containing introduced trout had significantly more algae density and cover, increased abundance of midges, and reduced density of the most common large invertebrate predator, the stonefly *Doroneuria baumanni*.

Introduced trout are also a threat to native trout. On the Kern Plateau, introduced brown trout threatened the golden trout native to the South Fork Kern River. Programs to remove brown trout were necessary to manage the native fishery. In the Little Kern River drainage, the Little Kern golden trout became federally listed as threatened because of genetic introgression from planted rainbow trout (FWS 1978). Today, there remains an interagency effort to restore the Little Kern golden trout. Likewise, the original genotypes of rainbow trout native to the Parks' western drainages are unlikely to have persisted following a century of planting non-indigenous rainbow and golden trout (Christenson 1977). Many of the fish in those streams show evidence of hybridization with golden trout (Gall et al. 1976)

The impacts of trout can be broader than the direct loss of the organisms they consume or displace. The native organisms preyed on by nonnative trout are important, interconnected components of the ecosystem. Once removed, their loss affects the other native organisms on which they feed, and the native predators that depend on the trout-consumed native species. Knapp (1996) cites several published examples of these cascading effects.

Alone or in combination, both the introduction of trout and the decline of MYLFs threaten the natural biodiversity of the southern Sierra Nevada. Even if the frog were to go extinct for reasons beyond our control, the removal of nonnative trout would benefit restoration of more natural assemblages of invertebrates and go a long way toward restoring alpine/subalpine community structure and biodiversity to a more natural condition.

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APPENDIX K: WILD AND SCENIC RIVERS ACT ANALYSIS INCLUDING SECTION 7(A) DETERMINATION

Background

The *National Wild and Scenic Rivers Act of 1968* (WSRA; 16 USC § 1271 et seq.) establishes the national wild and scenic rivers systems to preserve and protect selected rivers, or segments of rivers, in their free-flowing condition. Section 1(b) of the WSRA states that "certain selected rivers of the Nation which, with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values, shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations."

Of the major watersheds within Sequoia and Kings Canyon National Parks (SEKI or parks) – the North Fork of the Kern River (28.9 miles) and the Middle and South Forks of the Kings River (53.6 miles) are designated as "wild," which means rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted. A short segment of the South Fork of the Kings River (7.6 miles) is designated as "recreational," which means rivers or sections of rivers that are readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past.

The 2007 *Final General Management Plan/Final Environmental Impact Statement* (GMP) for SEKI establishes a vision for what the parks should be, including broadly defined desired future conditions for natural and cultural resources and visitor experiences, and includes a comprehensive river management plan for rivers within SEKI that have been designated by Congress as components of the national wild and scenic rivers system. The GMP reiterated the goals and objectives of the 1999 *Natural and Cultural Resources Plan* (RMP).

The GMP broadly established desired conditions for various natural resources. Many desired conditions are relevant to this *Restoration of Native Species in High Elevation Aquatic Ecosystems Plan / Final Environmental Impact Statement* (Restoration Plan/FEIS), including:

> Populations of native plant and animal species function in as natural a condition as possible except where special management considerations are warranted.
>
> Native species populations that have been severely reduced or extirpated from the park are restored where feasible and sustainable.
>
> The National Park Service (NPS) will strive to protect the full range of genetic types (genotypes) of native plant and animal populations in the parks by perpetuating natural evolutionary processes and minimizing human interference with evolving genetic diversity.
>
> Exotic species will not be introduced into the parks (except under special circumstances).
>
> The management of populations of exotic plant and animal species, up to and including eradication, will be undertaken whenever such species threaten park resources or public health and wherever control is prudent and feasible.
>
> The NPS will maintain all the components and processes of naturally evolving park ecosystems.
>
> The NPS will re-establish natural functions and processes in human-disturbed natural systems in the parks unless otherwise directed by Congress. The NPS will restore the biological and physical components of human-disturbed systems as necessary, accelerating both their recovery and the

recovery of landscape and community structure and function. The NPS will seek to return human-disturbed areas to conditions and processes representing the ecological zone in which the damaged resources are situated.

The NPS will, within park boundaries, identify, conserve, and attempt to recover all federally listed threatened, endangered, or special-concern species and their essential habitats. As necessary, the NPS will control visitor access to and use of essential habitats, and may close such areas to entry for other than official purposes. Active management programs (such as monitoring, surveying populations, restorations, exotic species control) will be conducted as necessary to perpetuate, to the extent possible, the natural distribution and abundance of threatened or endangered species, and the ecosystems upon which they depend. Ongoing consultation related to threatened or endangered species will occur with the U.S. Fish and Wildlife Service (FWS) should any actions take place in the habitat of such species.

The NPS will identify all state and locally listed threatened, endangered, rare, declining, sensitive, or special concern species and their essential habitats that are native to and present in the parks. These species and their essential habitats will be considered in NPS planning and management activities.

The natural and beneficial values of wetlands are preserved and enhanced.

The NPS will avoid, whenever possible, the pollution of park waters by human activities occurring within and outside parks.

NPS and NPS-permitted programs and facilities are maintained and operated to avoid pollution of surface and ground waters.

Protection of stream features will primarily be accomplished by avoiding impacts to watershed and riparian vegetation, and by allowing natural fluvial processes to proceed unimpeded.

Wild and Scenic Rivers within Sequoia and Kings Canyon National Parks

Most of the parks' major watersheds include sections of river designated or eligible for designation under the WSRA. The goal of designating a river as wild and scenic is to preserve its free-flowing condition, water quality, and outstandingly remarkable values for the benefit and enjoyment of present and future generations. Outstandingly remarkable values may include scenic, recreational, geologic, fish and wildlife, historic, cultural or other similar values and individual segments may be designated as wild, scenic, or recreational. The classification of a river segment indicates the level of development on the shorelines, the level of development in the watershed, and the accessibility by road or trail. Wild river areas are those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted. These represent vestiges of primitive America. Scenic river areas are those rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads. Recreational river areas are those rivers or sections of rivers that are readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past.

On November 3, 1987, the entire park segments of the Middle Fork and South Fork of the Kings River (61 mi) were added to the wild and scenic river system, with 53.6 miles classified as wild and the lowest 7.6 miles of the South Fork Kings River within the park classified as recreational. The entire park segment of the North Fork of the Kern River (29 mi) was added to the wild and scenic river system and was classified as wild on November 24, 1987.

Table K-1. Designated and Eligible Wild and Scenic Rivers with SEKI

River	Designation	Mileage
North Fork of the Kern River	Wild	28.9 miles
Middle Fork of the Kings River	Wild	29.5 miles
South Fork of the Kings River – Upper Segment	Wild	24.1 miles
South Fork of the Kings River – Lower Segment	Recreational	7.6 miles
South Fork of the San Joaquin River	Eligible - Wild	11.4 miles
East Fork of the Kaweah – Upper Segment	Eligible – Wild	1.0 mile
East Fork of the Kaweah – Middle Segment	Eligible – Recreational	5.2 miles
East Fork of the Kaweah – Lower Segment	Eligible – Wild	8.0 miles
Marble Fork of the Kaweah – Upper Segment	Eligible - Wild	4.1 miles
Marble Fork of the Kaweah – Lower Segment	Eligible – Recreational	11.2 miles
Middle Fork of the Kaweah – Upper Segment	Eligible - Wild	10.9 miles
Middle Fork of the Kaweah – Lower Segment	Eligible - Recreational	7.6 miles
South Fork of the Kaweah	Eligible – Wild	11.4 miles

<u>Designated or Eligible Wild and Scenic Rivers Potentially Affected by Proposed Project Work</u>
While none of the proposed project work would be conducted directly in the corridor / river bed of a designated or proposed wild and scenic river, actions are proposed in tributaries to a Wild and Scenic River corridor. Proposed fish eradication basins that are watersheds and/or tributaries feeding Wild and Scenic rivers include:

- Dusy, Rambaud, Barrett, Amphitheater, Horseshoe, Slide, and Swamp for the *Middle Fork of the Kings River*.

  Dusy, Rambaud, Barrett, Swamp, and Slide basins would utilize only physical treatment methods, and Horseshoe would utilize physical followed by piscicide methods. Amphitheater would utilize piscicide methods.

- Sixty Lake, Brewer, Vidette, and Upper Bubbs Creek for the *South Fork of the Kings River*

  Sixty Lake would utilize piscicide methods and Upper Bubbs Creek would utilize physical followed by piscicide methods. Vidette would utilize only physical methods.

- Upper Kern, East Wright, Milestone, Laurel, and Crytes for the *North Fork of the Kern River*.

  The Upper Kern would utilize physical methods and may also use piscicide methods if a fish barrier is confirmed downstream of the treatment area. East Wright and Milestone would utilize physical methods only, and Crytes would utilize physical methods followed by piscicide use. Laurel would utilize piscicide methods.

None of the proposed restoration sites are within the designated segments of these rivers, and all of the treatment sites except one are at least 1 mile from the listed river. None of the restoration activities would occur within the designated segments of any wild and scenic rivers.

One site proposed for piscicide treatment is near the headwaters of the North Fork of the Kern River, with the downstream edge of the treatment area approximately 650 feet from the designated wild and scenic river. Therefore, this evaluation was completed to address this treatment area and its potential effects on the North Fork of the Kern River.

Wild and Scenic Rivers Section 7(a) Evaluations

When Congress enacted the WSRA in 1968, it sought to prevent decades of damming, dredging, and diversion from spreading to some of the nation's most spectacular waterways. Section 7(a) of the act specifies restrictions on hydro and water resource development projects and directs the managing agency to specify a process that will be followed in determining whether or not a proposed water resources project is appropriate.

Why is Free Flow Important to a River System?

- Free-flowing rivers disperse valuable nutrients in adjacent meadows and stream habitats during flood events.
- Aquatic species require varied habitat created by a dynamic river system.
- Constriction and hardening of river channels, as caused by levees, riprap, and bridges, can alter the river's energy and natural course, causing it to erode its banks and damage valuable habitat, particularly during flood events.

Examples of water resources projects include, but are not limited to, dams, water diversion projects, fisheries habitat and watershed restoration/enhancement projects, bridge and other roadway construction/reconstruction projects, bank stabilization projects, channelization projects, levee construction, recreation facilities such as boat ramps and fishing piers, and activities that require a section 404 permit from the U.S. Army Corps of Engineers (USACE). The Restoration Plan/FEIS includes projects with the purpose of habitat restoration and/ or enhancing a particular outstandingly remarkable value.

<u>Standards</u>
The need for a section 7(a) review is determined by the standards shown in Figure K-1.

Figure K-1. Standards to determine the need for a WSRA Section 7(a) analysis.

IF	IF
The project is proposed in the *bed or banks* of a designated river or congressionally authorized study river	The project is proposed in the bed *or banks of a river below, above, or on a stream tributary* to a designated river or congressionally authorized study river
AND	**AND**
The project is proposed by a federal agency or it requires some type of federal assistance such as a permit, license, grant, or loan	The project is proposed by a federal agency or it requires some type of federal assistance such as a permit, license, grant, or loan
	AND
	The project is likely to result in effects within a designated river or congressionally authorized study river
THEN	**THEN**
When both of the above conditions exist, a determination is required under section 7.	When all of the above conditions exist, a determination is required under section 7.

Federally Assisted Projects on Wild and Scenic Rivers

The law prohibits any federally assisted water resources project that would have a "direct and adverse effect" on the values for which a river was added to the wild and scenic rivers system. For actions described in the Restoration Plan/FEIS, the NPS is responsible for making the final determination as to whether a proposed water resources project would have a direct and adverse impact on river values. The agency coordinates its evaluation process with other agencies that are required to review and comment on the project. Depending on the type and location of the project, such agencies might include the FWS, the U.S. Environmental Protection Agency, the U.S. Forest Service, the Bureau of Land Management, and the USACE. Review of WSRA section 7(a) projects are also coordinated with other environmental review processes, such as those required by the National Environmental Policy Act (NEPA) and the National Historic Preservation Act, as appropriate. Potential water resources projects that are found to have a direct and adverse effect on the values of a designated river must be either redesigned and resubmitted for a subsequent section 7(a) determination, abandoned, or reported to the Secretary of the Interior and the United States Congress, in accordance with the act. Since the proposed project does not involve construction, and none of the proposed or alternative work elements would occur within the bed or banks of a wild and scenic river, there would be no direct effects on the values present in the wild and scenic river.

Federally Assisted Projects Below, Above, or on Tributaries of a Wild and Scenic River

For federally assisted projects below, above, or on tributaries of a wild and scenic river, the river-administering agency evaluates non-hydroelectric project proposals under an 'invade the area or unreasonably diminish' standard. Typical projects that meet this definition are water resources projects visible from the designated river, such as dams, and upstream diversion structures because they have the potential to affect scenic, recreational, and fish and wildlife values in the designated river.

Because actions are proposed under the Restoration Plan/FEIS that are above or on the tributaries of wild and scenic rivers, a determination needs to be made if the scenic, recreational, and fish and wildlife values in the designated rivers would be affected.

The Purpose of the Section 7(a) Determination

The purpose of this determination is to evaluate the potential of the actions described in the Restoration Plan/FEIS to either invade or diminish the scenic, recreational, fish, or wildlife values of the wild and scenic river.

Authority

The authority for this determination is found in section 7(a) of the WSRA. Section 7(a) states that:

> No department or agency of the United States shall assist by loan, grant, license or otherwise in the construction of any water resources project that would have a direct and adverse effect on the values for which such river was established, as determined by the Secretary charged with its administration. Nothing contained in the foregoing sentence, however, shall preclude licensing of, or assistance to, developments below or above a wild, scenic or recreational river area or on any stream tributary thereto which will not invade the area or unreasonably diminish the scenic, recreation, and fish and wildlife values present in the area on the date of designation of a river as a component of the national wild and scenic rivers system.

While the WSRA does not prohibit development along a river corridor, it does prohibit activities that would interfere with the free-flowing condition of the river or degrade the values for which it was designated wild and scenic. The WSRA specifies guidelines for the determination of appropriate actions in the bed and banks of the river and either below, above, or on a tributary to a wild and scenic river.

As the designated river manager for the wild and scenic river segments located within the boundaries of SEKI, the NPS must carry out a determination of effects on all proposed water resources projects.

Section 7(a) Determination Process

The description of the WSRA section 7(a) determination process contained in this section is adapted from a technical report by the Interagency Council (IWSRCC 2004). In conformance with the guidance contained in that report, the NPS will undertake the following steps as part of its section 7(a) determination process for nonemergency projects:

- Describe the purpose and need of the proposed project and its location, duration, magnitude, and relationship to past and future management activities.
- Analyze the potential impacts of the proposed project on the values for which the river was designated wild and scenic. This analysis will follow the guidelines provided by the Wild and Scenic Rivers Act, section 7(a) Technical Report of the Interagency Council (2004), and other applicable guidance.
- Define the likely duration of the projected impacts.
- Assess the effects of the projected impacts on the achievement or timing of achievement of the management objectives of the Restoration Plan/FEIS (based on WSRA).
- Use this analysis to make a WSRA section 7(a) determination. This determination will document the effects of the proposed activity, including any direct and adverse effects on the values for which the river was designated as wild and scenic.
- Redesign and resubmit any water resources projects found to have a direct and adverse effect on the values of this designated river for a subsequent section 7(a) determination. In the event that a project cannot be redesigned to avoid direct and adverse effects on the values for which the river was designated, the NPS will either abandon the project or advise the Secretary of the Interior in writing and report to Congress in writing in accordance with section 7(a) of the act.
- Follow WSRA section 7(a) procedures to determine if projects above or below the designated river or on its tributary streams would invade the area or unreasonably diminish the scenic, recreational, and fish and wildlife values present in the designated corridor.

The Purpose of the Proposed Project

The purpose of the Restoration Plan/FEIS is to guide management actions by the NPS to restore and conserve native species diversity and ecological function to selected high elevation aquatic ecosystems that have been adversely impacted by human activities including the introduction of nonnative fish, and to increase the resistance and resilience of these species and ecosystems to human induced environmental modifications such as disease and unprecedented climate change. The overall goal of the Restoration Plan/FEIS is to restore clusters of waterbodies to a fishless state in strategic locations across SEKI to create high elevation ecosystems having more favorable habitat conditions for the persistence of native species and ecosystem processes.

The Restoration Plan/FEIS presents a range of alternative management actions to restore and conserve native species diversity and ecological function to selected high elevation aquatic ecosystems in SEKI that have been disturbed by human activities, particularly the stocking of nonnative trout. The Restoration Plan/FEIS describes the no action alternative and three action alternatives that are being considered during this planning effort, and presents an analysis of the impacts of the alternatives on the natural, cultural and physical resources in SEKI. The alternatives represent a range of reasonable and feasible options for addressing the goals and objectives of the plan and the issues and concerns raised by parks staff, other government agencies, and members of the public during the plan's scoping process. Upon

conclusion of the Restoration Plan/FEIS planning effort, one of the four alternatives would become the Restoration of Native Species in High Elevation Aquatic Ecosystems Plan and guide future restoration management actions for a period of 25 to 35 years, with an internal evaluation of management effectiveness scheduled every 5 to 10 years.

Description of the Proposed Actions and Alternatives

The four management alternatives are summarized below. Alternative B is the management preferred alternative.

Alternative A: No Action
Under the "No Action" alternative, the existing high elevation aquatic ecosystem restoration effort for 25 waterbodies would be completed, maintained and monitored, but no new fish eradication activities would be initiated. Native species and ecological processes in high elevation aquatic ecosystems would continue to be monitored. Research on native species, ecological processes and their stressors would continue in accordance with NPS policy. After all treatments are completed, self-sustaining nonnative trout populations would continue to exist in 550 waterbodies (252 lakes, 235 ponds, 63 marshes) and hundreds of miles of stream.

Alternative B: Prescription Treatment (Physical and Piscicide) Preceding Restoration
Under this alternative, a prescription (detailed plan of action) for restoration would be developed for each proposed restoration area based on the criteria for basin selection, pre-treatment surveys, habitat size, basin topography, wilderness values, visitor use and field crew safety. Prescriptions would consider the actual distribution of fish, results of amphibian surveys and whether any unique habitats were detected (such as springs). Physical treatment (gill netting, electrofishing, disturbing redds and/or temporarily covering redds with boulders) would be utilized. Piscicide treatment methods would be considered for waterbodies determined infeasible for physical treatment.

Based on current knowledge of the proposed fish eradication sites, physical treatment would be applied in 52 waterbodies (27 lakes, 24 ponds, 1 marsh; total of 492 ac/199 ha) and approximately 15 miles (25 km) of streams in 17 basins, and piscicide treatment would be applied in 33 waterbodies (4 lakes, 25 ponds, and 4 marshes; total of 142 ac/57 ha) and approximately 16 miles (25 km) of streams in 9 basins. In addition, any unsurveyed habitat adjacent to treated lakes, ponds, marshes and streams found to contain nonnative fish would also require treatment in order to eradicate fish from the geographic area. Although the total acreage requiring treatment may change slightly based on site-specific survey information and prescription development, the number of waterbodies and stream miles identified for treatment represents the maximum number of waterbodies to be treated in this alternative. After all treatments are completed, self-sustaining nonnative trout populations would continue to exist in 465 waterbodies (221 lakes, 186 ponds, 58 marshes) and hundreds of miles of stream.

Alternative C: Physical Treatment Preceding Restoration
Alternative C would use physical treatment methods only to eradicate nonnative fish by gill netting, electrofishing, disturbing and/or covering redds, and blasting rock to create vertical fish barriers. In comparison to alternative B, excluded from the list of proposed restoration waterbodies are long reaches of stream, several large lakes, and interconnected lake complexes that are too large for effective physical treatment. Under this alternative, a prescription for restoration would be developed for each proposed restoration area based on the criteria for basin selection, pre-treatment surveys, habitat size, basin topography, wilderness values, visitor use, field crew safety, and the actual distribution of fish and amphibians.

Physical treatment methods would be applied in 52 waterbodies (27 lakes, 24 ponds, and 1 marsh; total of 492 ac/199 ha) and approximately 15 miles (25 km) of streams contained in 17 basins. In addition, any unsurveyed habitat adjacent to treated lakes, ponds, marshes and streams found to contain nonnative fish would be treated to eradicate fish from the entire scope of the restoration area. Although the total acreage requiring treatment may change slightly based on site-specific survey information and prescription development, the number of waterbodies and stream miles identified for treatment represents the maximum number of waterbodies to be treated in this alternative. After all treatments are completed, self-sustaining nonnative trout populations would continue to exist in 498 waterbodies (225 lakes, 211 ponds, 62 marshes) and hundreds of miles of stream.

Alternative D: Piscicide Treatment Preceding Restoration
Alternative D emphasizes speed in recovering habitat because mountain yellow-legged frogs (MYLF; *Rana muscosa* and *Rana sierrae*) populations are declining rapidly. To achieve this speed, only piscicide treatment would be used for nonnative fish eradication. Properly applied, piscicides can eliminate fish from targeted waterbodies in 1 to 3 years, in contrast to physical treatment methods which can take up to 6 years for lakes and up to 10 years for streams. A prescription for treatment would be developed as described in alternative B. Based on initial examination of maps, staff familiarity with the park, and discussions with scientists, piscicide treatment would be used for 85 waterbodies (31 lakes, 49 ponds, and 5 marshes; total of 634 ac/257 ha), approximately 31 miles (50 km) of streams, and connected fish-containing habitat as necessary. Although the total acreage requiring treatment may change slightly based on site-specific survey information and prescription development, the number of waterbodies and stream miles identified for treatment represents the maximum number of waterbodies to be treated in this alternative. After all treatments are completed, self-sustaining nonnative trout populations would continue to exist in 465 waterbodies (221 lakes, 186 ponds, 58 marshes) and hundreds of miles of stream.

In addition, there are a number of activities described as common to all action alternatives. These include the development of criteria for the selection of basins for restoration; the development of criteria for selection of crew camp locations; ecosystem restoration and management, including protection and rebuilding extant populations of MYLFs where opportunities still exist and reintroducing MYLFs to locations where populations have recently gone extinct; monitoring restoration work and ecosystem responses; continuing research; and fish disposal methods.

Methodology for Analyzing Impacts

The impact analysis evaluates how each alternative would affect outstandingly remarkable values for designated wild and scenic rivers within or near the proposed project areas and determines if the project would “invade the area or unreasonably diminish” the standards for which the wild and scenic river was designated.

The initial question to be addressed is whether or not the proposed project invades the designated river. The term ‘invade’ is defined as “encroachment or intrusion upon.” If the proposed project does not invade the designated river, the next question to be answered, relative to the standard in section 7(a), is whether or not the proposed project would “unreasonably diminish” any of the specified values. Given that the standard implies that some diminution of values may be determined reasonable, there are two questions to consider:

1. Does the proposed project cause diminution of the scenic, recreation, and fish and wildlife values of the designated river as present at the date of designation?

2. If there is diminution, is it unreasonable? This would suggest an evaluation of the magnitude of the loss. Factors to be considered include:

- whether the value contributed to the designation of the river (i.e., an outstandingly remarkable value)
- the current condition and trends of the resource (If diminution is determined unreasonable, measures might be recommended to reduce adverse effects to within acceptable levels.)

Since no project work would occur directly in any wild and scenic river segment, there would be no direct encroachment or intrusion upon the river. Therefore, the evaluation is based on project work proposed in tributaries or watersheds that could potentially feed wild and scenic rivers (either designated or suitable). The rivers that could be affected by one or more of the alternatives include the Middle Fork and South Fork of the Kings River, and the North Fork of the Kern River (Figure K-2).

Description of Designated River Segments and Outstandingly Remarkable Values for Potentially Affected Wild and Scenic Rivers

Outstandingly Remarkable Values

Outstandingly remarkable values are the river-related and dependent values that make the river segment unique and worthy of special protection, and they form the basis for the river's designation as part of the wild and scenic rivers system. The values include scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values or features. A feature must be judged to be unique, rare, or exemplary to the extent that it stands out as among the best on a regional or national basis. River and affiliated land management practices are to concentrate on protecting these values.

Middle Fork and South Fork of the Kings River

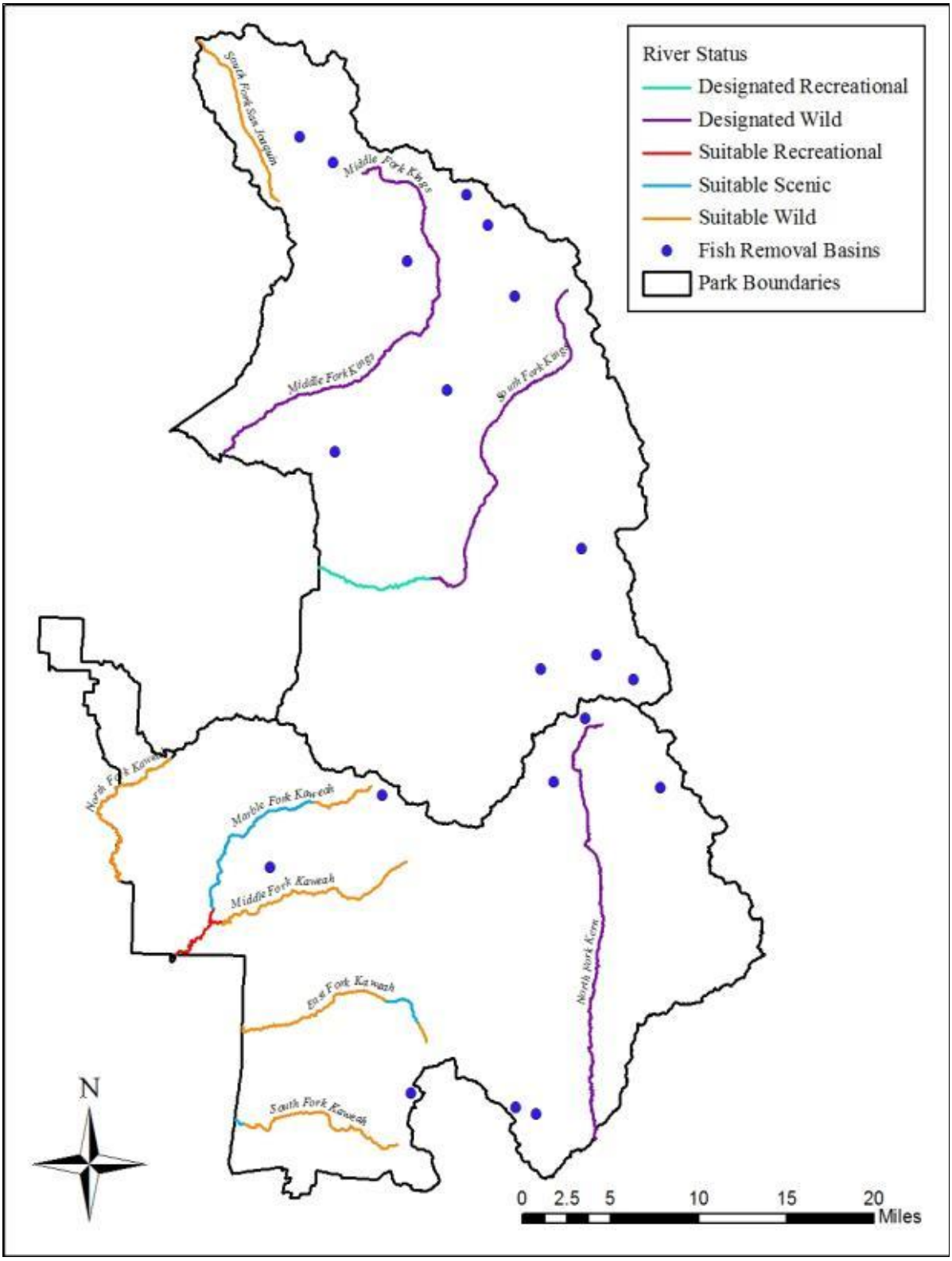
The Kings River is the largest free-flowing river in the Sierra Nevada. Approximately 88.8 river miles of the Middle Fork, South Fork, and main stem of the Kings River were added to the national wild and scenic rivers system on November 3, 1987 (PL 100-150). The designated reaches include:

- the Middle Fork from its headwaters at Lake Helen between Muir Pass and Black Giant Mountain to its confluence with the main stem (29.5 miles)
- the South Fork from its headwaters at Lake 11599 to its confluence with the main stem (31.7 miles)
- the main stem of the Kings River from the confluence of the Middle Fork and the South Fork to the point at elevation 1,595 feet above mean sea level (this portion is outside the park and is managed by the U.S. Forest Service)

These reaches encompass the entire Middle and South Forks, which are largely in Kings Canyon National Park. The NPS manages the 61.2 miles of the Middle and South Forks within Kings Canyon National Park and the U.S. Forest Service the remaining 27.6 miles. The portions of the Middle and South Forks managed by the NPS begin in glacial lakes above timberline and flow through deep, steep-sided canyons, over falls and cataracts, and eventually become an outstanding whitewater rafting river in Sequoia National Forest. Both the Middle and South Forks flow through extensive and spectacular glacial canyons. All of the Middle Fork is within designated wilderness, as is the upper portion (24.1 miles) of the South Fork.

The lower 7.6-mile portion of the South Fork canyon is known as the Kings Canyon, giving the park its name. The Kings Canyon, including the Cedar Grove developed area, is the only segment of the Kings River accessible by motor vehicle.

Figure K-2 Locations of proposed fish eradication basins in relation to Designated and Suitable Wild and Scenic Rivers in SEKI.



Outstandingly Remarkable Values for the Middle and South Fork of the Kings River:

- Middle Fork of the Kings River (29.5 miles within Kings Canyon National Park) — Wild. This free-flowing river segment is wholly in designated wilderness. It is accessible only by trail and is primitive in nature, qualifying it for wild classification.
- South Fork of the Kings River (the upper 24.1 miles within Kings Canyon National Park) — Wild. This free-flowing river segment is wholly in designated wilderness. It is accessible only by trail and is primitive in nature, qualifying it for wild classification.
- South Fork of the Kings River (the lower 7.6 miles within Kings Canyon National Park) — Recreational. Lodging, campgrounds, and other amenities for park visitors are located in or near the river corridor. The river corridor also contains a road that runs parallel to the river, and three road bridges cross the river, thus qualifying it for recreational classification.

Proposed fish eradication basins that contain portions of these rivers or are watersheds feeding these rivers include:

- Dusy, Rambaud, Barrett, Amphitheater, Horseshoe, Slide and Swamp for the *Middle Fork of the Kings River*;
- Sixty Lake, Brewer, Vidette and Upper Bubbs Creek for the *South Fork of the Kings River*.

<u>North Fork of the Kern River</u>

The North Fork of the Kern River was added to the national wild and scenic rivers system on November 24, 1987 (PL 100-174). This 78.5- mile segment extends from its headwaters at the 12,000-foot contour just south of Harrison Pass Lake below the Kings-Kern Divide and off the west slopes of Mount Whitney in Sequoia National Park to the Tulare-Kern county line. The NPS manages the upper 28.9 miles of the North Fork within Sequoia National Park, and the U.S. Forest Service manages the remainder of the river, which flows almost entirely through national forest land, including the Golden Trout Wilderness. The upper river portion is free flowing for over 61 miles, the longest stretch of free-flowing river in the Sierra Nevada, and it is classified as wild. The lower 17.5-mile stretch managed by the U.S. Forest Service is classified as recreational due to road accessibility and minor impoundments.

Outstandingly Remarkable Values for the North Fork of the Kern River:

- North Fork of the Kern River (the entire 28.9 miles within Sequoia National Park) — Wild. This free-flowing river segment is wholly in designated wilderness. It is accessible only by trail and is primitive in nature, qualifying it for wild classification.

Proposed fish eradication basins that contain portions of these rivers or are watersheds feeding these rivers include:

- Upper Kern, East Wright, Milestone, Laurel, and Crytes for the *North Fork of the Kern River*.

Does the Proposed Project "Invade" the Wild and Scenic Rivers?

None of the proposed restoration sites are within the designated segments of these rivers. All of the sites proposed for piscicide use, except one, are far from designated wild and scenic rivers or river segments. The site in Upper Kern basin is proposed for piscicide treatment and is near the headwaters of the North Fork of the Kern River, which is designated as "Wild" under the WSRA. The furthest downstream points in the two streams proposed for piscicide treatment are approximately 200 meters and 250 meters upstream of the wild and scenic river boundary. While no work would occur directly within designated sections of these rivers, proposed fish eradication basins would be located within the watersheds feeding these rivers.

None of the alternatives would affect the free-flowing character of any designated wild and scenic river. Outstandingly remarkable values which could be affected by project activities include scenic, recreational

fish, and wildlife. Impacts are evaluated in general terms of whether they would be beneficial or adverse to these outstandingly remarkable values. Beneficial impacts would result from actions that protect and enhance these values, while adverse impacts would result from actions that reduce those values. The duration of the impact considers whether the impact would be temporary and/or associated with transitional types of activities or if the impact would occur over a longer period and alter the outstandingly remarkable river values.

Because none of the project work would occur within a wild and scenic river corridor, the flow chart in Figure K-3 was used to determine if a section 7(a) determination is warranted. Because the project has the potential to affect recreation, fish, and wildlife values present in the wild and scenic river, a section 7(a) determination is included using the following methodologies in Table K-2.

Table K-2. Wild and Scenic Rivers Impact and Intensity Descriptions

Impact Intensity	Intensity Description
Negligible	Impacts would not be detectable to most visitors and would have no discernible effect on a river's outstandingly remarkable values.
Minor	Impacts would be slightly detectable to some visitors but are not expected to have an overall effect on a river's outstandingly remarkable values.
Moderate	Impacts would be clearly detectable by many visitors and could have an appreciable effect on a river's outstandingly remarkable values.
Major	Impacts would have a substantial and noticeable effect to most visitors or the river's outstandingly remarkable values.

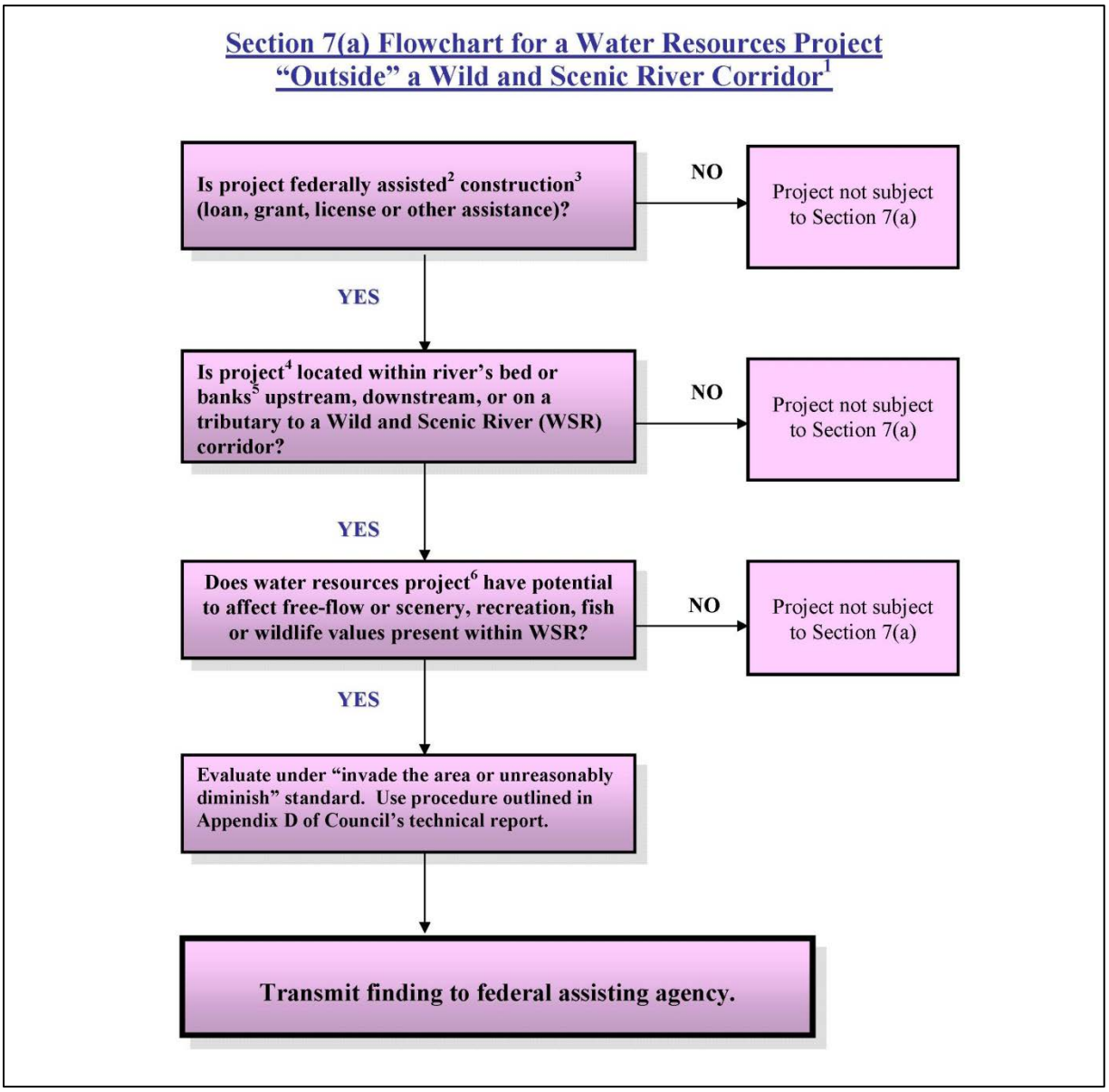
Short-term—Impacts occur during project work; Long-term—Impacts are ongoing after project work is completed.

Impact Analysis of Outstandingly Remarkable Values Under Each Alternative

Impacts of Elements Common to All Alternatives

Impacts on Outstandingly Remarkable Values (Scenic, Recreational, Fish and Wildlife): Crew camps, helicopter use, restoration of mountain yellow-legged frogs, monitoring, research, and fish disposal would have no direct effects on designated ORV because none of these activities would occur within designated river segments. Stock use would pass through river corridors. These trips would be minimal but sometimes would involve overnight stays. In upper basin areas upstream from wild and scenic rivers, there would be no on scenic values because crews working and camping in project areas would not be visible from a wild and scenic river or its banks. Recreational, fish, and wildlife values in areas of upstream of wild and scenic river segments would be changed as ecosystems are restored, primarily due to an increase in opportunities to view native wildlife; and these changes would have the potential to spread into the designated wild and scenic river segments in the future. This would result in beneficial effects to the recreation, fish, and wildlife ORV.

Figure K-3 Flowchart for a water resources project "outside" a wild and scenic river corridor.



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[1] **A wild and scenic river (WSR)** means a river and the adjacent area within the boundaries of a component of the National Wild and Scenic Rivers System pursuant to section 3(a) or 2(a)(ii) of the Wild and Scenic Rivers Act (WSRA). **Outside** the corridor means a project located upstream, downstream or on a tributary to a WSR.

[2] **Assistance** means loan, grant, license, or other assistance in the construction of any water resources project.

[3] **Construction** means any action carried on with Federal assistance affecting the free-flowing characteristics of a WSR.

[4] **Water resources project** means any federally assisted construction that would affect free-flowing characteristic, as defined in Section 16(b) of the WSRA (see footnote 5), or affect the scenic, recreational, fish or wildlife values within the WSR. Projects that typically meet this definition are dams, diversion structures and projects that can be seen from the WSR because they have the potential to affect these characteristics and values in the WSR. This definition also includes licenses and exemptions of hydropower projects under Part I of the Federal Power Act, as amended (41 Stat. 1063; 16 U.S.C. 791a et seq.), assuming a nexus as describe in footnote 6.

[5] **Bed or banks** is an interpretation of Section 16(b) of the WSRA, which defines free-flowing, in part, as "existing or flowing in natural condition without impoundment, diversion, straightening, riprapping, or other modification of the waterway." Generally the applicability of Section 7(a) is limited to the area within the ordinary high water mark (OHWM) of the river. OHWM is defined in 33 CFR Part 328.3(e) as "…that line on the shore established by fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas."

[6] Requires a **nexus** between the proposed upstream, downstream or tributary project and the WSR or such project is not a water resources project for purposes of a Section 7(a) determination. Projects that have the potential to affect *free-flow, or scenery, recreation, fish or wildlife values* of the WSR are dams, upstream diversion structures and projects that can be seen from the WSR as they have the potential to affect these characteristics and values in the WSR.

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Impacts of Alternative A: No action

Impacts on Outstandingly Remarkable Values: The impacts associated with the current program are the physical removal of nonnative fish prior to restoration. There would be no work within the designated segments of wild and scenic rivers and therefore no direct effects resulting from this alternative on the outstandingly remarkable river values. However, continuing the ongoing restoration program would result in some changes to seven basins which feed, wholly or partially, the three rivers designated under the WSRA. There would be long-term beneficial effects on native fish and wildlife populations (see the following sections in the Restoration Plan/FEIS: Impacts to Special Status Species, Wildlife, and Visitor Experience and Recreational Opportunities). These effects, such as increased chances of wildlife viewing, could cascade down the basins, indirectly enhancing certain attributes of the recreation, fish, and wildlife ORV inside designated sections of the wild and scenic rivers.

Cumulative Effects: The 2007 GMP established a vision for the management of wild and scenic rivers within SEKI, and identified river protection measures that are employed for projects within the river boundaries (extending 0.25 mile on each side of the designated river sections), tributaries and the overall watershed. This project meets the goals established by the GMP and adheres to the river protection measures. The project areas are remote and the outstandingly remarkable values are protected in parks' wilderness areas. No past, ongoing, and future proposed actions are degrading the outstandingly remarkable values of designated wild and scenic rivers within the parks, thus there are no cumulative effects.

Conclusion: There would be long-term beneficial effects on recreation, fish, and wildlife ORV.

Impacts of Alternative B: Prescription Treatment Preceding Restoration (Preferred Alternative)

Impacts on Outstandingly Remarkable Values: The impacts associated with physical treatment would be the same as alternative A only expanded to include additional sites in Dusy, Rambaud, Barrett, Amphitheater, Horseshoe, Slide and Swamp, which are upstream from the Middle Fork of the Kings River; Sixty Lake, Brewer, Vidette and Upper Bubbs Basins, which are upstream from the South Fork of the Kings River; and Upper Kern, Milestone, East Wright, Laurel and Crytes, which are upstream from the North Fork of the Kern River. All of these treatment sites are outside the designated portions of these wild and scenic rivers. In addition, this alternative involves the proposed use of piscicides in selected treatment sites. All of the sites proposed for piscicide use, except one, are far from designated wild and scenic rivers or river segments. The site in Upper Kern basin is proposed for piscicide treatment and is near the headwaters of the North Fork of the Kern River, which is designated as Wild under the WSRA. The furthest downstream points in the two streams proposed for piscicide treatment are approximately 650 ft and 820 ft (200 m and 250 m) upstream of the wild and scenic river boundary.

The treatment with piscicides could result in short-term adverse effects to the recreation, fish and wildlife ORV. However, because the furthest downstream treatment site is 650 ft (200 m) upstream of the wild and scenic river boundary, these effects are unlikely to occur. Yearly treatments would involve less than 3 miles (4.8 km) of stream and generally no more than three lakes. Some years there may be no piscicide treatments in this area. Piscicides would cause mortality to all gill breathing organisms in the treatment site, which would have major adverse effects to the fish and gill-breathing wildlife upstream of the designated wild and scenic river segment. However, this effect would be short-term as native wildlife populations are expected to recover, based on similar work at other areas (see Restoration Plan/FEIS for citations).

Given the mobility of some wildlife species benefitting from aquatic restoration, the beneficial effects of this alternative are likely to extend within the designated wild and scenic river boundaries – and be

beneficial for the recreation, fish, and wildlife ORV. Effects of piscicide use on water quality are discussed in the water quality impact topic in chapter 4.

Cumulative Effects: In the long-term, outstandingly remarkable values would continue to be protected in the parks' wild and scenic rivers. The project areas are remote and the outstandingly remarkable values are protected in parks' wilderness areas. No past, ongoing, and future proposed actions are degrading the outstandingly remarkable values of designated wild and scenic rivers within the parks, thus there are no cumulative effects.

Conclusion: There would be long-term beneficial effects on the recreation, fish, and wildlife ORV.

Impacts of Alternative C: Physical Treatment Preceding Restoration

Impacts on Outstandingly Remarkable Values: The impacts associated with physical treatment would be the same as alternative B. In upper basin areas upstream of designated wild and scenic river segments, there would be decreased angling opportunities in the short and long term, and increased recreational opportunities associated with viewing native wildlife in the long-term. Within the designated wild and scenic river segments, there would be long-term beneficial effects to the recreation, fish, and wildlife ORV as native wildlife is restored by implementing this alternative.

Cumulative Effects: The cumulative effects would be the same as alternative B.

Conclusion: In the long-term there would be beneficial effects to recreational values associated with native wildlife viewing, and beneficial effects to wildlife within and adjacent to wild and scenic rivers.

Impacts of Alternative D: Piscicide Treatment Preceding Restoration

Impacts on Outstandingly Remarkable Values: This alternative would be similar to alternative B, only more areas would be treated with piscicides and work would occur over a shorter period of time. All of the sites except one are far from designated wild and scenic rivers or river segments. One site (Upper Kern Basin) proposed for piscicide treatment is near the headwaters of the North Fork of the Kern River. The furthest downstream points in the two streams proposed for piscicide treatment are approximately 650 ft and 820 ft (200 m and 250 m) upstream of the wild and scenic river boundary. The North Fork of the Kern River is designated as Wild under the WSRA. As explained in alternative B, there would be long-term adverse effects on recreational opportunities related to decreased recreation (fishing) in upper basin areas upstream of the designated wild and scenic rivers, and long-term beneficial effects on the recreation, fish, and wildlife ORV within the designated wild and scenic river segments.

Cumulative Effects: The cumulative effects to outstandingly remarkable values would be the same as alternative B.

Conclusion: There would be long-term beneficial effects on native wildlife populations. The cumulative effects would be short-term, negligible and adverse and would occur outside of the designated wild and scenic river boundaries, but long-term and beneficial cumulative effects would occur within the designated wild and scenic river boundaries.

Does the proposed project unreasonably diminish the scenic, recreational, and fish and wildlife values present in the area as of the date of designation?

The Restoration Plan/FEIS includes actions to improve native wildlife habitat within the watershed and/or tributaries of the Middle and South Fork of the Kings River, and the North Fork of the Kern River. The proposed actions would remove nonnative trout from lakes, streams, and marshes that are upstream of the designated river corridors using a variety of methods, including physical removal methods and piscicides.

There would be no direct effects to the wild and scenic river corridors. In addition, the proposed project would enhance the other recreation, fish, and wildlife values present in the area due to the restoration of native species that would occur as a result of the project work.

Section 7(a) Determination

Using the Restoration Plan/FEIS as the basis for the section 7(a) determination and implementing specific mitigation measures outlined in Chapter 2 of the plan, the NPS has determined that the proposed projects would not invade the Wild and Scenic Middle and South Forks of the Kings River, and the North Fork of the Kern River, or unreasonably diminish the scenic, recreational, fish, and wildlife values present in the area as of the date of designation.

Recommended by Woody Smeck, SEKI Superintendent Date

Approved by Laura Joss, NPS Pacific West Regional Director Date

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APPENDIX L: U.S. FISH AND WILDLIFE SERVICE CONSULTATIONS

The Endangered Species Act of 1973, as amended (16 USC 1531 et seq.), requires all federal agencies to consult with the U.S. Fish and Wildlife Service (FWS) to ensure that any action authorized, funded, or carried out by the agency does not jeopardize the continued existence of listed species or critical habitat. The National Park Service (NPS) reviewed the special-status species lists on the FWS website in 2006, 2009, 2012, and again on February 10, 2016 (see appendix F) and park biologists determine which species has the potential to be affected by the proposed project.

The NPS initiated several discussions with various FWS staff by phone, email, and in-person communications to (1) describe this project and its potential relationships to special-status species; (2) become educated on the consultation process and timeline; and (3) determine an appropriate consultation structure. The phone and email communications occurred intermittently from approximately 2011 to March 2016. In-person communications occurred during team meetings for the mountain yellow-legged frog (MYLF) Conservation Strategy, and at several research and management meetings for MYLFs and the Yosemite toad. The NPS submitted a biological assessment (BA) to evaluate the proposal to the FWS on February 24, 2016. The BA provided an analysis of the effects from the proposed project to the following listed species: the northern distinct population segment of the mountain yellow-legged frog, the Sierra Nevada yellow-legged frog, the Yosemite toad, the Little Kern golden trout, and the Sierra Nevada bighorn sheep. The BA also provided an analysis of the effects to proposed or designated critical habitat for these species.

The FWS responded to the NPS on May 25, 2016 with a Biological Opinion, included in this appendix. The FWS concurred that the Restoration Plan as proposed may affect, but is not likely to adversely affect the Sierra Nevada bighorn sheep, nor adversely affect its critical habitat. The FWS found that the proposed project is not likely to adversely affect critical habitat for the little Kern golden trout. The Service's biological opinion is that the SEKI Restoration Plan, as proposed, is not likely to jeopardize the continued existence of the Sierra Nevada yellow-legged frog, northern DPS of the mountain yellow-legged frog, Yosemite toad, and Little Kern golden trout.

It is the Service's biological opinion that the SEIKI Restoration Plan, as proposed, is not likely to destroy or adversely modify proposed critical habitat for the MYLF or Yosemite toad. The Service reached this conclusion because the project-related effects to the proposed and designated critical habitat, when added to the environmental baseline and analyzed in consideration of all potential cumulative effects, will enhance the value of the affected key components, or PCEs, to provide for the conservation of these species based on the following: (1) effects to essential physical or biological features will be temporary; (2) these actions will not destroy any essential physical or biological features of the habitat; and (3) the Restoration Plan will enhance proposed critical habitat via removing predatory fish. The effects to Sierra Nevada yellow-legged frog and northern DPS of the mountain yellow-legged frog proposed critical habitat are small and discrete, relative to the entire area designated, short in duration, and are expected over time to appreciably enhance the value of the critical habitat for the conservation of the Sierra Nevada yellow-legged frog, northern DPS of the mountain yellow-legged frog, and the Yosemite toad.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Suite W-2605
Sacramento, California 95825-1846

In Reply Refer to:
08ESMF00-2016-
F-1174

MAY 25 2016

Memorandum

To: Park Superintendant, Sequoia and Kings Canyon National Park, Three Rivers, California

From: Field Supervisor, Sacramento Fish and Wildlife Office, Sacramento, California

Subject: Formal Consultation and Formal Conference on the Restoration of Native Species in High Elevation Aquatic Ecosystems Plan, Sequoia and Kings Canyon National Park, Three Rivers, California

This is in response to National Park Service's February 24, 2016, request for formal consultation with the U.S. Fish and Wildlife Service (Service). At issue are the potential effects of the Restoration of Native Species in High Elevation Aquatic Ecosystems Plan, Sequoia and Kings Canyon National Park (SEKI) on the endangered Sierra Nevada bighorn sheep (*Ovis canadensis sierrae*) and its critical habitat, endangered northern Distinct Population Segment (DPS) of the mountain yellow-legged frog *(Rana muscosa),* endangered Sierra Nevada yellow-legged frog *(Rana sierrae),* threatened Yosemite toad (*Anaxyrus canorus*) and their proposed critical habitat, and the threatened Little Kern golden trout (*Oncorhynchus mykiss whitei*) and its critical habitat. This biological opinion and biological conference is issued under the authority of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.).* (Act).

The Federal action on which we are consulting is the implementation of the preferred alternative B of the Restoration of Native Species in High Elevation Aquatic Ecosystems Plan Final Environmental Impact Statement (Restoration Plan). This alternative proposes to return strategically-located waterbodies to their naturally fishless state in locations across SEKI, and thereby restore favorable conditions for the persistence of native species and ecosystem processes in high elevation lake and stream communities.

Pursuant to 50 CFR §402.12(j), you submitted a biological assessment, along with subsequent information, for our review, and requested concurrence with your determinations on the effects on listed species. Your determinations are the proposed project may affect, likely to adversely affect the Sierra Nevada yellow-legged frog, northern DPS of the mountain yellow-legged frog, Little Kern golden trout, and the Yosemite toad; and that the proposed project may affect, not likely to adversely affect the Sierra Nevada bighorn sheep. You further made the determination that the project will not adversely affect proposed critical habitat for the Sierra Nevada yellow-legged frog, northern DPS of the mountain yellow-legged frog, Yosemite toad, and critical habitat for the Little Kern golden trout and Sierra Nevada bighorn sheep.

Park Superintendent

In considering your request, we based our evaluation on the following: (1) letter from the National Park Service to the Service dated February 24, 2016, and attached biological assessment (NPS 2016a); (2) Restoration of Native Species in High Elevation Aquatic Ecosystems Plan and Final Environmental Impact Statement, Appendix B (NPS 2016b) ; (3) Restoration of High Elevation Aquatic Ecosystems in Sequoia and Kings Canyon National Park s 2012 Field Season Summary (NPS 2013); (3) Mountain Yellow-legged Frog Conservation Assessment for the Sierra Nevada Mountains of California, USA (USFS 2014); (4) Administrative Draft, Interagency Conservation Strategy for Mountain Yellow-Legged Frogs in the Sierra Nevada (Service in preparation); and (5) other information available to the Service.

Many of the published peer-reviewed papers and unpublished reports on the Sierra Nevada yellow-legged frog and the mountain yellow-legged frog were issued prior to the analysis and taxonomic reclassification by Vredenburg *et al.* (2007). These two taxa have been elevated from subspecies to species, and other changes in their systematics and taxonomy; possess similar morphology, behavior, biological and ecological characteristics; and within this biological opinion when the information applies to both animals, they will be collectively referred to as "mountain yellow-legged frog."

Based on the information you provided and also available to us, we concur with your determination that the proposed project is not likely to adversely affect the endangered Sierra Nevada bighorn, nor adversely affect its critical habitat. We concur that the proposed activities will not result in harassment, injury, death, or harm because this species likely will move away from National Park Service staff conducting the activities of their own volition. The proposed activities will not result in loss or damage to the primary constituent elements of this species' critical habitat. We find that the proposed project is not likely to adversely affect critical habitat for the Little Kern golden trout because project activities are not proposed within the Little Kern River drainage and it is outside of aquatic features that comprise critical habitat for this species (50 CFR 17.95 – Little Kern River and all streams tributary to Little Kern River above barrier falls 1 mile below the mouth of Trout Meadows Creek). We do not concur the project will not adversely affect proposed critical habitat for the Sierra Nevada yellow-legged frog, northern DPS of the mountain yellow-legged frog, Yosemite toad.

Our evaluation of this action on the mountain yellow-legged frogs, Yosemite toad, and Little Kern golden trout; and proposed critical habitat for the Sierra Nevada yellow-legged frog, northern DPS of the mountain yellow-legged frog, and Yosemite toad; and Little Kern golden trout, is contained within this biological and conference opinion.

Consultation History

January 21, 2016	Telephone conversation with SEKI to clarify approach towards final permitting and consultation requirements for FEIS and ROD.
February 24, 2016	SEKI initiated formal consultation on the project in a letter dated February 24, 2016.
March 17, 2016	The Service and SEKI met to discuss elements of the project and timeline.

Park Superintendent

April 15, 2016	Email correspondence from SEKI clarifying that the project description includes Yosemite toad monitoring; and also amending the request for May Affect, Not Likely to Adversely Affect concurrence in the biological assessment for Little Kern golden trout and Yosemite toad to May Affect, Likely to Adversely Affect to accommodate take associated with exotic fish eradication.
April 22-25, 2016	Email correspondence between SEKI and the Service clarifying incidental take of mountain yellow-legged frogs and Yosemite toad for fish eradication activities.
May 26, 2016	Electronic mail clarification for not likely to adversely affect determinations and findings.

Description of the Action

Sequoia National Park, established in 1890, and Kings Canyon National Park, established in 1940, are administered as a single unit that rises from the low western foothills at 1,370 ft to the summit of Mount Whitney at approximately 14,494 ft. SEKI protects 865,964 acres along the western slope of the Sierra Nevada mountain range in east-central California. Two wilderness areas are located within SEKI, including the Sequoia-Kings Canyon Wilderness and John Krebs Wilderness, which encompass approximately 97% of the parks. The entirety of SEKI is within Tulare and Fresno counties. Drivable access is by California State Routes 180 and 198, which within SEKI is known as the Generals Highway.

SEKI is developing a long-term, park-wide Restoration Plan/FEIS (Plan) to guide management actions to restore and conserve native species diversity and ecological function at selected high elevation aquatic ecosystems that have been adversely impacted by human activities. This project is intended to increase the amount, distribution, and connectivity of high quality habitat for the endangered mountain yellow-legged frogs. Increasing the amount, distribution and connectivity of high quality mountain yellow-legged frog habitat by eradicating non-native trout is a primary tool available for restoring ecosystems to conditions capable of supporting robust frog metapopulations. This project focuses upon non-native fish eradication and other restoration and monitoring activities. The project includes a mix of fish eradication using both physical and chemical methods (piscicides), active habitat restoration using a variety of methods to help stabilize and recover mountain yellow-legged frogs across the Park, and monitoring efforts to measure frog distribution, abundance, population, and disease status.

Since 2001, SEKI has been conducting the Preliminary Restoration of Mountain Yellow-legged Frogs project in selected high elevation basins within SEKI (NPS 2001, 2009a, 2015a). These activities are nearing completion, and were covered through prior Service formal consultation (FFOSESMF00-2014-F-0421). This action expands the areal and temporal coverage of SEKI aquatic restoration activities, and broadens the scope of the activities to include the use of rotenone(a piscicide) to complete fish eradication in those water bodies where physical eradication is infeasible.

Park Superintendent

Frog monitoring and restoration activities associated within the larger management plan include: visual encounter surveys, capture-mark-recapture surveys, translocation and reintroduction, antifungal and beneficial bacterial treatments, captive rearing, salvaging drought-threatened populations, and continued research associated with disease intervention methodologies. This plan will be implemented over a period of 25 to 35 years (2016-2051), with an internal evaluation of management effectiveness every five to ten years. SEKI is proposing to eradicate non-native trout and monitor the three listed amphibians

Project Activities

Mountain Yellow-legged Frog Restoration

The strategy incorporated into this Plan for high elevation aquatic ecosystem restoration is to both protect and rebuild extant populations of mountain yellow-legged frogs where opportunities still exist, and to reintroduce the species to many locations where populations have recently been extirpated. Non-native fish removal is a primary step in restoring mountain yellow-legged frogs as higher trophic level predators in these high elevation aquatic ecosystems, thereby restoring native community dynamics. All lake basins identified for fish eradication or known to have historic or current occupancy by the endangered amphibians are considered potential restoration sites for this species.

The proposed restoration areas within SEKI were selected for: 1) geographic and elevational representation of the historic distribution of mountain yellow-legged frogs, 2) the known genetic diversity of mountain yellow-legged frogs, 3) areas of potential high-quality habitat, and 4) known persistent mountain yellow-legged frog populations that may be important to future restoration. Mountain yellow-legged frog restoration actions will be aligned with the nearly-complete Interagency Mountain Yellow-legged Frog Conservation Strategy for the Sierra Nevada (Strategy) (Service *et al.* in preparation). Recommended actions in the Strategy include: non-native fish eradication, translocation/reintroduction, antifungal and beneficial bacteria treatment, immunization, head-starting/captive rearing, and emergency salvage.

The restoration activities will take place in a total of 55 basins. These 55 basins include up to 21 basins in which non-native fish will be eradicated from at least one waterbody, plus 34 additional basins where no fish will be eradicated, including four basins with fish eradications completed under the existing approved plan. All of the 55 restoration basins contain differing numbers of lakes, ponds, streams and associated wetlands that are already fishless. Restoring connectivity of fishless habitat between multiple waterbodies will improve dispersal between frog breeding, feeding and over-wintering habitat where occupied mountain yellow-legged frog habitat is nearby. In locations with high quality but unoccupied mountain yellow-legged frog habitat, or areas where restoration sites are geographically isolated from existing frog populations, physical reintroductions ("translocating" or transporting frogs from one site to another) will occur.

The high elevation aquatic ecosystems in the Park ranging from 6,000 to 12,000 feet targeted for physical restoration include: 21 lake basins where physical and chemical fish eradication will be applied—including 80 lakes and ponds (totaling 602 acres); five fish-containing marshes (totaling 32 acres), and approximately 31 miles of stream. Broader project related activities include continued monitoring, disease intervention, translocations/salvage/captive rearing, and related research that span a total of 55 lake basins within the Park.

Park Superintendent

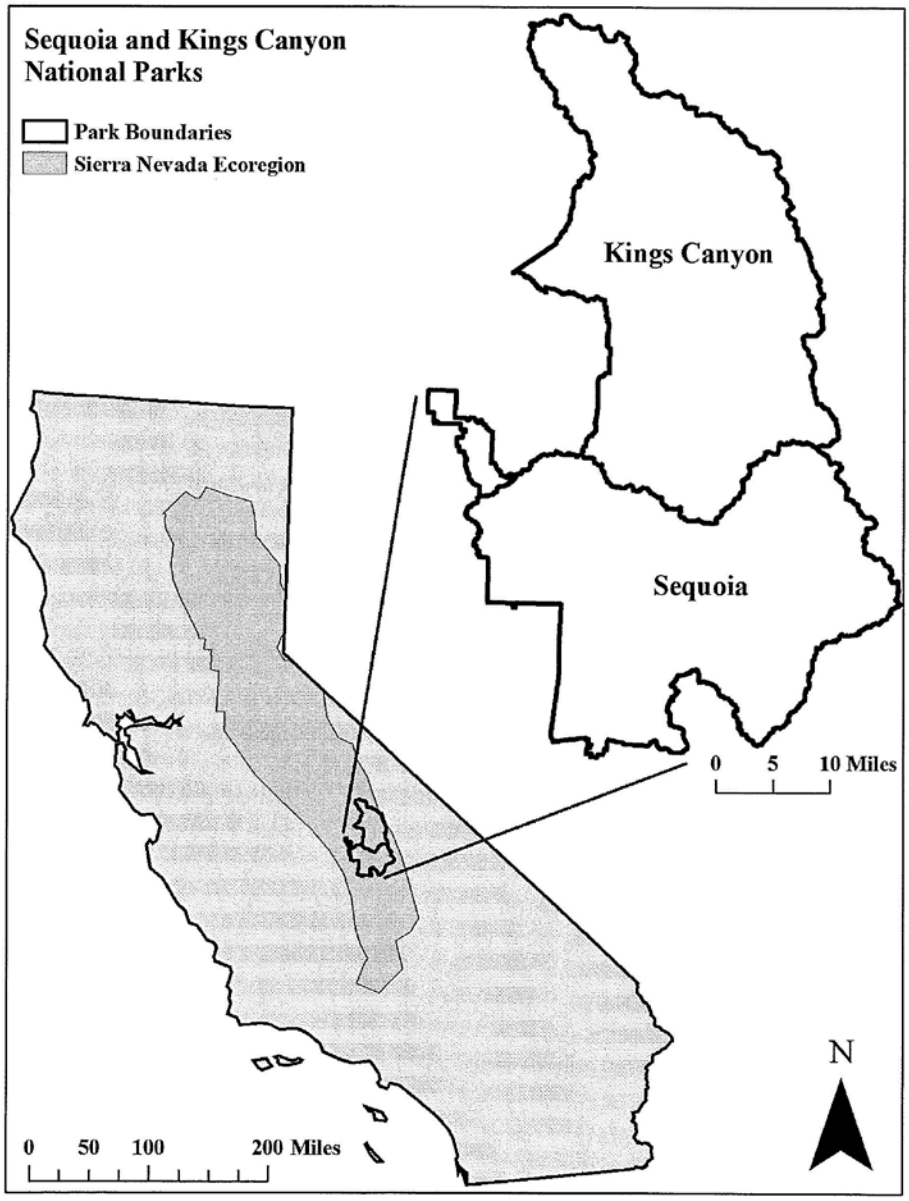

Figure 1. State perspective map of Sequoia and Kings Canyon National Parks.

Park Superintendent

The following activities will be conducted at a total of 55 basins across the Park:

1. Continuing restoration and monitoring, including:

    a. Handling up to 3,000 eggs or tadpoles and 2,000 (male and female) adults or post-metamorphic sub-adults per year;

    b. Performing capture-mark-recapture (and release at or near point of capture);

    c. Collecting and/or translocating eggs, tadpoles and adults from SEKI to captive rearing facilities (e.g., San Francisco Zoo) or directly to approved locations within SEKI;

    d. Transporting live reared frogs from captive rearing facilities to SEKI;

2. Capturing adults with dip-nets and handling tadpoles, adults, and subadults (≥38 mm), weighing, measuring, and marking using passive integrated transponders (PIT tags, ≥38 mm), visual implant elastomer (VIE), radio-transmitters, toe clips (if needed for genetic material, or as a last resort for marking subadults where VIE and PIT tags are not feasible);

    a. Clearing frogs of disease infection using antifungal treatments (e.g., itraconazole);

    b. Performing bioaugmentation treatments on frogs to shield them from infection;

    c. Conducting emergency salvage at populations threatened by drought and/or warming;

    d. Conducting garter snake relocation at reintroduction/translocation sites to increase probability of population establishment.

3. A subset of 21 lake basins are identified for physical restoration, including:

    a. Non-native fish eradication using physical methods in 17 basins, specifically:

        i. 27 lakes

        ii. 24 ponds

        iii. one marsh (collectively, 492 acres)

        iv. 15 miles of streams

    b. Non-native fish eradication using piscicides in 9 basins, specifically:

        i. four lakes

        ii. 25 ponds

        iii. four marshes (collectively, 142 acres)

Park Superintendent

iv. 16 miles of streams

Monitoring of the short- and long-term outcomes of restoration work will document mountain yellow-legged frog and ecosystem responses to restoration efforts. The analysis of the biological data will provide further insight regarding beneficial effects from non-native fish and restoration methods, managing genetic diversity within species populations, interactions between stressors, and discovery of issues yet unknown. The knowledge gained through monitoring will be incorporated into adaptive management activities and also will add to understanding of the continuing threats to high elevation ecosystems from non-native species, air pollution, climate change, new pathogens and other environmental stressors.

SEKI staff use visual encounter surveys (VES) to monitor the distribution, relative abundance, and age structure of mountain yellow-legged frog populations over time (Crump and Scott 1994). This technique involves one or two crew members walking around the shoreline of lakes, ponds, marshes, and streams, and sometimes through heavily-vegetated shallow aquatic habitat, and recording 1) the number of amphibian and reptile individuals detected by species and life stage; 2) the health of each individual (alive, morbid, dead); 3) presence/absence of fish and their redds, and 4) air and water temperature, wind and weather conditions; and 5) interesting observations. VES will be conducted at all mountain yellow-legged frog sites, as well as treatment (fish eradication) and control (fish-containing and historically fishless) lakes in each fish eradication basin.

VES generally do not involve handling animals unless species identification is uncertain. In very rare instances, an individual may need to be handled to confirm identification. In some surveys, up to 20 post-metamorphic frogs per waterbody may be captured using dipnets and temporarily handled to collect skin samples (sterile swabs) using standard methods (Hyatt *et al.* 2007) for assessing the presence and infection intensity of *Batrachochytrium dendrobatidis* (Bd), and to record information about the individual frog (size, sex, behavior). Disease monitoring could provide opportunities to treat animals just before and/or during a die-off to increase frog survival.

Although useful for general monitoring purposes, VESs are well-known to produce underestimates of true population size (Mazerolle *et al.* 2007). Capture-mark-recapture (CMR) surveys account for detection probability and result in larger and more accurate estimates of population size (Williams *et al.* 2002). These data can be used to more accurately determine what percentage of the population can be responsibly collected for recovery efforts. To conduct CMR surveys, surveyors capture adult and juvenile mountain yellow-legged frogs that have a snout-to-vent length greater than or equal to 1.5 inches (38 mm) from lakes using dip nets. Each individual will be sexed, weighed, and swabbed to determine amphibian Bd infection levels. To mark each frog, an 8 millimeter passive integrated transponder (PIT) tag will be inserted under the surface of the dorsal skin. To insert PIT tags, a tiny incision is made just behind the head on the dorsal surface of the mountain yellow-legged frog and the PIT tag is inserted and moved to behind the pelvic girdle (Briggs *et al.* 2010). This assures that the PIT tag remains on the dorsal surface, but cannot move above the pelvic girdle. CMR surveys depend on each animal having a unique identifying feature, and because it is difficult to distinguish individual mountain yellow-legged frogs based on color patterns or other morphological features, PIT tags are a necessary tool. Each PIT tag contains a unique alphanumeric code and can be read with hand-held readers. Every time a mountain yellow-legged frog is recaptured, the surveyor can correctly identify each individual.

Park Superintendent

In all action alternatives, fish eradication sites will be monitored to determine that complete fish eradication has been achieved. For physical fish removal methods, initial confirmation of fish eradication will be determined using the methods employed since 2001 in SEKI. This method involves conducting gill-netting and electrofishing until winter, the following summer, and a second winter with no fish captures. If no fish are captured during this period, active fish removal efforts cease. For piscicide applications, the entire treatment area will be surveyed for any live fish using visual searches, gill-netting and electrofishing in the days/months immediately following treatment and during the subsequent summer.

For all treatment methods, post fish eradication monitoring will occur from two to five years to confirm the continued absence of fish. A small number of gill nets, deployed anywhere between one day and one month, may be used along with visual surveys to confirm fish absence. If fish are discovered in a restored site, eradication crews will return for follow-up fish removal efforts. Feedback from this monitoring will inform park managers and researchers about the results of fish eradication efforts, and be incorporated into future management activities.

Use of environmental DNA (eDNA), in which water samples are collected from aquatic environments to detect species, is an emerging technique that may prove useful as an additional method for confirming fish eradication (Pilliod et al. 2013; Keskin 2014; Turner et al. 2015). This method involves amplifying small fragments of DNA from water samples using species-specific DNA primers, which allow for the detection of species from quantities of DNA present in the environment (Wilcox et al. 2013). Research into this method shows potential as a non-invasive monitoring tool (Takahara et al. 2012, Wilcox et al. 2013). Research is currently ongoing to determine the feasibility of eDNA methods for detecting low density fish populations, or confirming eradication, in high elevation aquatic ecosystems in SEKI (NPS 2016a). If eDNA methods prove useful for confirming non-native trout absence in restored waterbodies, this method may be incorporated into monitoring of fish eradication sites.

Research Activities

Continuing research is expected to be critically important for long-term conservation of the special-status species, especially for the mountain yellow-legged frog. In particular, solutions to mitigate the effect of amphibian chytrid fungus on this species are very much needed. Three areas of potential promise include refining methods to 1) bathe mountain yellow-legged frogs in an anti-fungal solution (e.g., itraconazole) to reduce amphibian chytrid levels on frog skin, 2) augmenting naturally occurring bacteria to frog skin (e.g., Janthobacterium lividum) to increase natural protection from amphibian chytrid fungus, and 3) re-establishing mountain yellow-legged frog populations where they historically occurred or are dwindling toward extinction due to Bd. SEKI intends to continue research activities involving chytrid disease intervention and the possible use of probiotics in addition to chemical treatments to protect dying populations during the epizootic phase of infection in currently Bd naïve lakes.

Itraconazole is an anti-fungal compound that has been used extensively to clear amphibian chytrid fungus from amphibians, typically in a laboratory setting. In recent field experiments in SEKI it was used to clear or substantially reduce amphibian chytrid fungus loads on mountain yellow-legged frogs in three populations in the parks (Knapp 2010, 2011, 2012). In each population as many mountain yellow-legged frogs as possible are captured, held in temporary enclosures, and bathed in a low-concentration solution of itraconazole for ten minutes a day for seven consecutive days.

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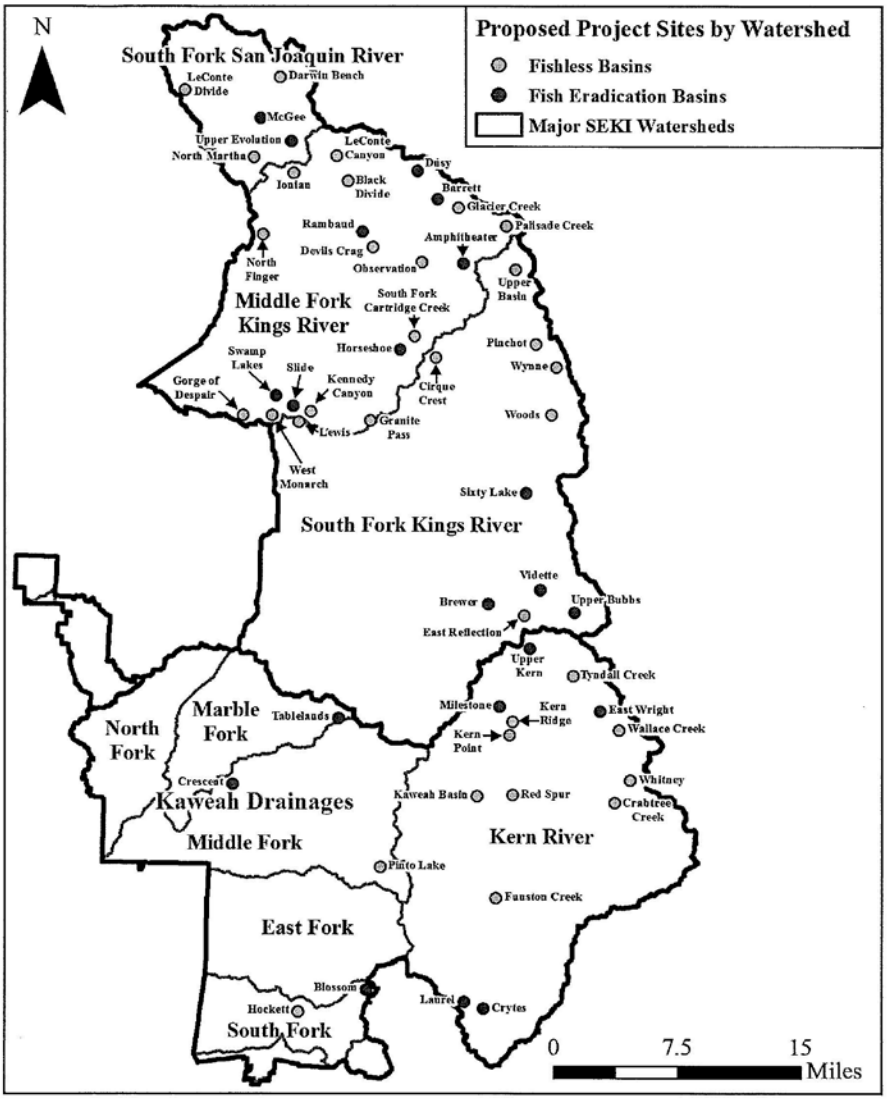


Figure 2. Locations of proposed aquatic ecosystem restoration sites. Orange dots indicate fishless conservation waterbodies, blue dots indicate proposed fish eradication waterbodies, all of which (except Crescent) also contain fishless conservation waterbodies.

Park Superintendent

San Joaquin/Kings MYLF Clade	Kings/Kern MYLF Clade	Southern Kern MYLF Clade	Unknown MYLF Clade
Physical Treatment	**Physical Treatment**	**Physical Treatment**	**Physical Treatment**
Barrett	Brewer	Crytes*	Blossom
Dusy	East Wright		Tablelands
Horseshoe*	Milestone	**Piscicide Treatment**	
McGee	Upper Bubbs*	Laurel	**Piscicide Treatment**
Rambaud	Upper Kern*		Crescent
Slide	Vidette	**Frog Restoration**	
Swamp Lakes		Funston Creek	**Frog Restoration**
Upper Evolution*	**Piscicide Treatment**		Hockett
	Sixty Lake		Pinto Lake
Piscicide Treatment			
Amphitheater	**Frog Restoration**		
	Cirque Crest		
Frog Restoration	Crabtree Creek		
Black Divide	East Lake Reflection		
Darwin Bench	Ionian		
Devils Crag	Kaweah Basin		
Glacier Creek	Kern Point		
Gorge of Despair	Kern Ridge		
Granite Pass	Lewis Lake		
Kennedy Canyon	North Finger Peak		
LeConte Canyon	North Martha		
LeConte Divide	Pinchot		
Observation	Red Spur		
Palisade Creek	Tyndall Creek		
South Fork Cartridge Creek	Upper Basin		
West Monarch	Wallace Creek		
	Whitney		
	Woods		
	Wynne		
Rana sierrae ←→	*Rana muscosa*		
* = *Basins in which fish eradication will be performed physically and with piscicides.*			

Table 1. List of 55 basins included in preferred Alternative B of the Restoration Plan/FEIS, grouped by mountain yellow-legged frog species and clade, and method of fish eradication or frog restoration

The bacterium J. lividum has strong anti-fungal properties and is found naturally on the skin of several amphibians including the mountain yellow-legged frog in the Sierra Nevada. This bacterium produces the anti- amphibian chytrid metabolite violacein and may help to protect frogs from fungal diseases including chytridiomycosis. In SEKI during 2010, a field trial was conducted in which recently infected adult mountain yellow-legged frogs were treated with J. lividum to increase the concentration of this bacterium on their skin. The treatment was conducted over one or two days by bathing frogs in a concentrated J. lividum solution for one hour each day (Knapp 2010). Subsequent monitoring showed much higher survival through the end of summer compared to individuals that were not treated.

Occupied basins will be monitored as much as possible over time, and waterbodies from which mountain yellow-legged frogs appear to have recently died out will be monitored as capacity allows, which will help assess natural recolonization rates. When a waterbody is monitored, SEKI expects to conduct one visit per year and crews will be onsite for one day

during each visit. Mountain yellow-legged frogs in sites with Bd-positive populations are generally not swabbed for Bd-monitoring, whereas animals in sites with Bd-negative populations are annually swabbed in an attempt to detect the onset of expected infection and population die-offs, which will provide the opportunity to conduct antifungal and/or bacterial treatments to increase frog survival. SEKI currently has seven remaining basins in which Bd-negative mountain yellow-legged frogs occur (Dusy, Rambaud, Upper Bubbs [Center, Spur and Forester], Vidette, South Milestone, Kern Point, and Crabtree). A maximum of approximately 30 waterbodies are currently occupied by the amphibian in these seven basins. The average number of mountain yellow-legged frogs that will be captured and swabbed for Bd monitoring at these sites in one year will be ten frogs per waterbody per visit (Table 2).

Bd-monitoring will also be conducted at frog translocation/reintroduction sites, CMR study sites, and Bd treatment sites (Table 2). The maximum number of lakes at which translocations/ reintroductions may occur in one year is estimated at five lakes, and three visits swabbing an average of 20 frogs per lake could occur. The maximum number of lakes at which CMR studies may occur in one year is estimated at ten lakes (two basins, five lakes each), and three visits swabbing an average of ten frogs per lake could occur. The maximum number of lakes at which Bd treatments may occur in one year is estimated at five lakes, and two visits swabbing an average of 100 frogs per lake could occur. Swabbing may result in an annual maximum of 1900 swabs collected by SEKI staff for Bd monitoring for the duration this project (Table 2).

PIT-tagging also will be conducted at Bd treatment sites, mountain yellow-legged frog translocation/reintroduction sites, and CMR study sites as part of recovery actions (Table 7). The maximum number of sites at which Bd treatments may occur in one year is estimated at five lakes, and one visit PIT-tagging an average of 100 frogs per lake could occur. The maximum number of lakes at which translocations/reintroductions may occur in one year is estimated at five lakes, and one visit PIT-tagging an average of 40 frogs per lake could occur. The maximum number of lakes at

Table 2. Mountain yellow-legged frogs that may be handled and swabbed for Bd monitoring each year by SEKI staff during this project.

Site	# Annual swab visits	Maximum # lakes	# Swabs/visit/lake	Total
7 Bd-negative basins	1	30	10	300
Translocations / reintroductions	3	5	20	300
CMR studies	3	10	10	300
Bd treatments	2	5	100	1000
Total annual maximum	3	45	100	1900

Table 3. Mountain yellow-legged frogs that may be PIT-tagged for recovery actions each year by SEKI staff during this project.

Site	# Annual Tag visits	Maximum # lakes	# Tags/visit/lake	Total
Bd treatments	1	5	100	500
Translocations /	1	5	40	200

reintroductions				
CMR studies	3	10	10	300
Total annual maximum	3	20	100	1000

which CMR studies may occur in one year is estimated at ten lakes (two basins, five lakes each), and three visits PIT-tagging an average of ten frogs per lake could occur. Implementation of the PIT-tagging described above will result in an annual maximum of 1000 PIT-tags that may be inserted into frogs by SEKI staff during this project (Table 3).

Translocation/Reintroduction

To restore depopulated lakes after the extensive historic losses of mountain yellow-legged frog populations, a number of individuals will be moved from extant populations to areas where populations recently died out or severely declined. Movement will involve 1) capturing a small percentage (typically <10%) of the individuals in a source population using dipnets; 2) measuring the body condition of each animal (length, weight, sex, amphibian Bd level); 3) inserting a PIT tag under the skin of each frog larger than 1.5 inches (38 mm) long from snout-to-vent (Matthews and Preisler 2010) to monitor the status of each animal following reintroductions; 4) placing them in wetted containers with air holes; 5) potentially treating frogs prior to translocation with antifungal drug (e.g., itraconazole); 6) potential bioaugmentation with naturally occurring bacteria, *Janthinobacterium lividum*; and, 7) either carrying them to nearby recipient habitat or transporting them by helicopter to distant recipient habitat.

Whether frogs are given antifungal and/or bacterial treatments will depend on: 1) if preliminary results suggesting these agents are beneficial are confirmed by further study, to be completed by 2017, and 2) a targeted population is severely affected by amphibian chytrid fungus and thus needs treatment to increase survival. "Nearby" habitat generally can be hiked to within 6 hours, posing minor risk to frog survival during transport. "Distant" habitat cannot be hiked to within 6 hours, which will pose moderate to high risk to frog survival during transport. At the recipient site, all individuals will be released into fishless habitat and monitored for the next several years.

Itraconazole (Sporonox®) is an antifungal compound that has been used to clear *Batrachochytrium dendrobatidis* (Bd, or chytrid fungus) from infected amphibians, typically in a laboratory setting. Whether antifungal treatments are conducted in the field or in a laboratory (i.e., at a zoo), the solution ratio is 0.15 milliliter (3 drops) of itraconazole to 1 liter of water. After that is mixed, the frogs (usually adults and/or juveniles) are placed in the solution for ten minutes and positioned such that they are mostly submerged in the solution but can still hold their heads above to breathe. The frogs are then moved to a holding pen so that they can be treated again, once per day, for 6 to 10 days. If mountain yellow-legged frogs were treated in the field, the treatments will likely occur at the source site. Under current methods, frogs will be held in mesh pens (2 meter × 2 meter × 0.5 meter) anchored in the lake that allow the frogs to both swim in the water and bask on the shoreline. Animals will be treated once a day by moving 20 to 50 frogs at a time into plastic tubs containing the itraconazole solution. They will be bathed in the treatment solution for ten minutes per day and then returned to the pen. After full treatment is completed, animals will be transported to the receiving lake. If deemed necessary, the animals also may be treated with *J. lividum* collected from the source population and cultured in the laboratory. At the receiving lake, frogs will be held for two days in mesh pens anchored in the lake. Up to 50 frogs at a time will each be placed in small

plastic containers that contain a concentrated solution of *J. lividum* mixed with lake water. Animals will be kept in the solution for one hour per day for two days and then returned to the pens between the two treatment sessions. The frogs will be released into the receiving lake after the second day of treatment. Currently, although bioaugmentation is not frequently utilized in the parks, this form of treatment is a potentially useful tool that may be implemented more in the future (Harris *et al.* 2009). These methods and their efficacy are still in development and could change over the course of this plan.

Captive Rearing

Bd-infected mountain yellow-legged frog populations in SEKI typically have few adults that are persisting and breeding, and an abundance of tadpoles and recently metamorphosed juveniles that experience very low survival with few animals reaching adulthood. While these populations may adapt to amphibian chytrid fungus in the field, captive rearing can help increase the chance for them to persist and recover by allowing more animals to survive the high mortality phase (post-metamorphosis) by allowing animals to be immunized and "head-started." Captive rearing will generally involve collection of adults from uninfected sites, and eggs, tadpoles, and/or juveniles from infected sites, for transport to a facility such as a zoo. In uninfected sites, it is generally permissible to collect up to 10% of adults for captive rearing. In infected sites, a larger percentage of eggs, tadpoles, and/or juveniles may be permissible for collection because few, if any, of these individuals will reach adulthood without some kind of intervention (e.g., antifungal treatment and immunization). Once collected, mountain yellow-legged frogs are kept cool (i.e., to ensure they remain well below their thermal maximum temperature), and transported immediately, by foot, helicopter, and/or vehicle, to minimize stress. At the zoo, the animals are first cleared of the chytrid infection, then raised to adulthood, re-infected with amphibian chytrid fungus, and then cleared again to elicit an adaptive immune response. At this point, Bd-free but no longer naïve frogs can be returned to either their source location, or introduced to a different site depending on conservation needs.

Salvaging Drought-threatened Populations

Although small ponds are not optimal habitat for mountain yellow-legged frogs, the widespread presence of non-native fish in larger, more suitable lake habitat has increased the importance of such marginal habitats. However, the same factor that generally makes these sites incapable of sustaining fish populations, also makes them less suitable for frogs—namely small ponds tend to be shallower and more susceptible to complete drying during summer. Mountain yellow-legged frogs require two to four years of permanent water for tadpoles to complete metamorphosis and reach adulthood. Thus, the potential complete drying of these smaller ponds can cause high local mortality across multiple frog cohorts (Lacan *et al.* 2008). When combined with the severely reduced breeding and recruitment success in larger lakes that contain non-native fish, the drying of these small ponds has the potential to result in extirpation of mountain yellow-legged frog populations simply as the result of stochastic environmental events. Salvaging populations can serve as a tool against potential extirpation. In such cases, frogs at any life stage may be collected and transported to a captive location using the same protocol described above. In captivity, mountain yellow-legged frogs can be kept until habitat conditions become suitable again and then released, or can be used to establish a captive breeding program. By establishing a captive breeding program, more animals can be produced and any life stage can be released into wild sites

Park Superintendent

Garter Snake Relocation

Garter snake predation has compromised the success of at least two mountain yellow-legged frog reintroductions in SEKI and Yosemite (Knapp unpubl. data). Given the relatively small numbers of mountain yellow-legged frog individuals anticipated to be available for translocations and reintroductions, all garter snakes detected will be relocated away from these sites for one to two years following reintroduction. This will give small mountain yellow-legged frog populations a chance to successfully breed, increase in abundance and stabilize enough so that they can persist amid natural snake predation. Snakes detected during monitoring will be captured, marked, and moved by foot to a site within the same basin that does not have frogs and is at least one mile away.

Gear Transport

Field crews hike to project areas on foot, backpacking in lightweight equipment and personal supplies. The bulk of project tools, equipment and supplies require transport, including one mobilization trip per restoration basin at the beginning of each summer, and one demobilization trip per restoration basin at the end of each summer. The type of gear transport is guided by the Wilderness Act, NPS policies, and the SEKI Wilderness Stewardship Plan (NPS 2015c). This document defines the minimum tool as "the management method (tool) that causes the least amount of impact to the physical resources and experiential qualities (character) of wilderness."

Packstock are the preferred transport method used to support this project except when one or more of the following conditions applies:

1. Equipment is fragile.
2. Cargo is time-dependent or requires stable conditions
3. Cargo is bulky and does not fit well on or over panniers.
4. An individual piece of cargo weighs over 150 pounds.
5. Stock is not allowed in the area, a waiver for stock use is not authorized by the superintendent, or the area is inaccessible to stock.
6. Stock will create unacceptable environmental impacts due to wet trail conditions, and it is impractical to reschedule stock use for a less damaging time.
7. Use of stock will cause more environmental impact than a helicopter (e.g., by the creation of new trails, by off-trail travel in sensitive environments, etc.).
8. Environmental hazards to personnel or animals (e.g., snow or high water crossings) create unsafe conditions for stock use and transport of the material cannot wait until conditions improve.

When one of these conditions applies, a helicopter is defined as the minimum tool for gear transport. Light (Type 3) helicopters are utilized.

Park Superintendent

When packstock are used for gear transport, mobilization trips typically require 5-7 animals and demobilization trips typically require 3-4 animals. Packers abide by all park regulations, including those governing off-trail travel, low-impact camping, and stock grazing. In general, stock will enter a site on day one, spend the night at a suitable site enroute back to the trailhead, and reach the trailhead the following day. If the overnight location is a sensitive meadow, then supplemental feed is required to minimize grazing impacts. If the restoration site is close enough to a trailhead, the packer can go in and out on the same day without having to stay overnight.

Crews and Crew Camps

Crew camps are required for each restoration basin. Crew camps are similar in size and scale to a wilderness backpacker camp. Crew members bring individual tents and there could be one larger tent used as a work or cooking area. The primary differences are the duration of use and the placement of equipment and/or food storage lockers. Also, either a pit is dug at the camp for use as a latrine, or a portable toilet is used (depending on the location, soil conditions, and site sensitivity). Crews follow "Leave No Trace" wilderness practices to minimize impacts to wilderness character. Crew camps are used yearly until the project work is accomplished. There typically are one to three crews working at different restoration basins from June or July through September. Timing depends on weather and snowpack conditions. Crew size is typically two to three crewmembers per restoration basin, but there could be as many as 8 crew members at a site during mobilization trips depending on the size and complexity of the site. Crews camp up to ten days per site visit and each site is visited up to 7 times per season. Camp locations are selected to prefer available granite slabs or decomposed granite substrate generally absent of vegetation, out of mountain yellow-legged frog migration routes; and at sites more than 30 meters from water.

Yosemite Toad Monitoring

The threatened Yosemite toad occurs in SEKI. The NPS intends to develop capacity to monitor this animal and hopefully to recover it in SEKI, once restoration actions are identified and recommended by the species recovery team. In the interim, general population monitoring across the toad's range is necessary to improve our understanding of population fluctuations (e.g., local extinction and recolonization processes) and provide data to proactively plan management and conservation strategies (Jennings and Hayes 1994; Brown *et al.* 2012). For 2016, SEKI has secured funding to conduct one summer of Yosemite toad (and mountain yellow-legged frog) monitoring in relation to effects from drought. Funding has also been secured for one summer of monitoring on national forests adjacent to SEKI. Joint NPS and USFS protocols are in development, but VES is likely to be utilized, and Bd swabs may be collected.

Table 4. Yosemite toads that may be swabbed for recovery actions each year by SEKI staff during this project.Site

	# Annual swab visits	Maximum # meadows	# Swabs/visit/meadow	Total
SEKI wide	2 (max per meadow per summer)	35	10	700

Park Superintendent

Exotic Fish Removal

Gill Netting

Gill netting is a method of fish capture primarily used in lakes, ponds and stream pools. Repeated gill netting has been successfully used to eradicate fish from many lakes in the high Sierra (Knapp and Matthews 1998; Knapp *et al.* 2007; NPS 2015a). Gill nets are sinking nets designed to effectively capture fish of all sizes. Netting involves placing many nets in a lake, with each net stretched fromthe shoreline out toward deep water at roughly equal distances between nets. Standard nets are 36 meters long by 1.8 meters deep, and have mesh sizes ranging from 1-3.8 centimeters. Nets used to capture young fish that remain very close to shore, are 18 m long by 1.8 m deep, and have mesh sizes ranging from 1-1.7 cm. Gill nets are deployed using inflatable non-motorized float tubes.

Nets are set and pulled during daylight hours to minimize safety hazards and potential handling complications. When a new fish removal site is initiated, nets are frequently cleaned of captured fish and reset, generally every 24 to 48 hrs. By mid-season, capture rates decrease and the length of time that nets are set gradually increases. At the end of the summer field season, several nets are set in deeper water to continue catching fish under winter ice. Summer and over-winter netting continues until all nets set in a lake repeatedly capture zero fish. This method of gill netting typically results in the removal of all fish from a lake by the third or fourth summer, but could take longer depending on site conditions. Once a site is thought to be fishless, gill-netting is continued for two winters and the summer in-between. If no fish are caught during this confirmation phase, the site is considered eradicated of fish and gill-netting is terminated.

Electrofishing

Electrofishing is a physical method of fish collection primarily used in streams and occasionally in shallow water at the edges of lakes. It is a common fishery management technique that has been successfully used to collect fish for approximately 100 years (Cowx and Lamarque 1990). Electrofishing is implemented with a device called an "electrofisher," which uses two electrodes to send electric current from a battery through the water. When both electrodes are submerged in the water and the unit is activated, the water completes the circuit and a field of electricity is generated around the electrodes. Fish caught in the field of electricity are stunned, float in the water, and are then captured using dipnets.

A two to three person electrofishing crew is deployed, wearing chest waders, wading boots and rubber gloves. One person operates the electrofisher while the remaining crewmembers stand on either side of the operator and capture shocked fish using dipnets. Each stream electrofishing session begins at the downstream boundary of the targeted stream segment and proceeds in an upstream direction. This allows stunned fish to drift downstream toward dipnet crews. Fish removal by electrofishing requires repeated passes through each target stream section until fish have been eradicated.

Disruption or Covering of Fish Redds

Where redds (fish egg nests) are visible in gravel-bottom areas of streams and shallow lake shores, they are disrupted with a shovel or by foot to minimize hatching of fish eggs. Gravels in these areas

are then sometimes temporarily covered with boulders to eliminate or minimize future fish spawning habitat until eradication is achieved. Redds in high Sierra streams are typically small, measuring <0.25 m^2 in surface area. Although this method is described here, it is very seldom used.

Fish Traps

Fish traps (Figure 3) may be used to augment gill netting and electrofishing efforts, when necessary, to maintain fish free conditions. If fish traps are used, they will be set in lake inlets and/or outlets to catch fish as they leave the lake to spawn. During the first field season, traps will be set during ice-out and removed in the fall. Following the first field season, the effectiveness of having the traps deployed throughout the entire ice-free season will be assessed. If the traps were not effective outside of the spring spawning season, then traps will only be deployed during the spring in subsequent years. Otherwise, the traps will be deployed throughout the ice-free season until the site was restored. If the inlet or outlet stream is wider than the trap (0.5 m) than mesh arms made out of PVC pipe and aquaculture mesh will be used to construct a funnel between the trap and the stream bank.

Piscicide Treatment

A piscicide is a chemical substance toxic to fish whose intended function is to eliminate undesirable fish from a body of water (CDFW 2007). The Prentox CFT Legumine™ formulation of rotenone is currently registered in the state of California for use in aquatic environments for the purpose of fish removal (CDPR 2016) and was declared eligible for reregistration as restricted-use piscicides by the U.S. Environmental Protection Agency (EPA 2007a, 2007b). Piscicide treatments in this Plan follow guidance and standard operating procedures documented in Planning and Standard Operating Procedures for the Use of Rotenone in Fish Management (Finlayson *et al.* 2010) and project plans in NOCA (NPS 2015b) and Silver King Creek, California (Service 2010).

Piscicide application will be carried out in a manner that strictly adheres to practices permitted by the product labeling, including determining the maximum necessary application concentrations, and all other applicable guidelines. Experienced piscicide applicators will be directly involved in piscicicde treatments in SEKI, and all treatments will be managed by applicators certified by the state of California to apply piscicides in state waters. Applications will be conducted with an intention of eradicating all fish at treatment sites with as few treatments as possible. Fish eradication will likely be accomplished after one or two treatments at each site. Several treatments have recently been conducted in other national parks in which one application eradicated all fish. A third treatment may be necessary in the most complex areas, including Sixty Lake, Upper Kern and Laurel. Complex habitats increase the chances that rotenone concentrations will not reach levels lethal to fish in all areas (Finlayson *et al.* 2010). This rotenone SOP recommends spacing out treatments in time (usually so they occur over the course of multiple years) to allow fish eggs sufficient time to hatch and fry to be vulnerable to rotenone exposure.

The general protocol will be to treat habitat once in mid-late summer, monitor in September, and monitor again in the following early-midsummer. If live fish are found, a second treatment will be conducted. If no live fish are found, then a second treatment will not be necessary. Some of the proposed treatment areas in SEKI are small (e.g., one outlet stream of Upper Bubbs) and one treatment has a good probability of eradicating all fish in these areas. Other proposed treatment areas are larger (e.g., lower watershed of Sixty Lake), and while one treatment may eradicate all fish

Park Superintendent

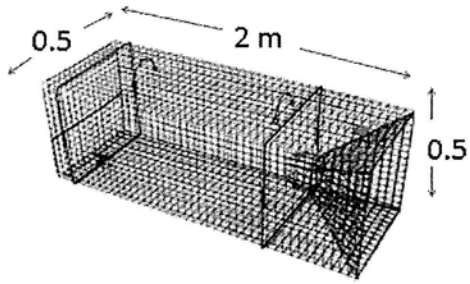
in these areas, additional treatment(s) may be necessary. If fish eradication is unsuccessful after three treatment years (initial year plus two reapplication years) at a particular site, then piscicide use will be abandoned at that site.

Table 5. Basins and waterbodies proposed for non-native fish eradication under Alternative B. Five associated marshes, including one in Crytes and four in Laurel are not included

Basin	# Lakes	Area (ac)	# Ponds	Area (ac)	Stream (mi)
Physical Treatment					
Barrett	3	42.07	1	0.28	0.87
Blossom	2	9.45	2	2.29	0.64
Brewer	0	0	1	1.60	0.52
Crytes	2	20.62	1	0.87	0.02
Dusy	1	10.58	2	0.60	0.69
East Wright	1	2.63	0	0	0.66
Horseshoe	4	28.96	0	0	0.40
McGee	4	75.31	4	1.19	1.20
Milestone	1	12.80	1	2.07	0.49
Rambaud	0	0	1	0.44	0.25
Slide	1	5.12	1	0.17	1.60
Swamp	0	0	1	1.85	0.28
Tablelands	0	0	1	1.48	1.65
Upper Bubbs	2	21.62	2	1.67	4.32
Upper Evolution	4	228.19	1	0.48	1.20
Upper Kern	0	0	2	2.12	0.38
Vidette	2	16.57	3	0.23	0.39
Subtotal Physical	**27**	**473.91**	**24**	**17.34**	**15.58**
Piscicide Treatment					
Amphitheater	1	58.87	2	1.34	2.16
Crescent	0	0	0	0	1.58
Crytes	0	0	0	0	1.99
Horseshoe	0	0	0	0	2.99
Laurel	0	0	1	0.22	3.09
Sixty Lake	1	13.36	14	14.87	1.00
Upper Bubbs	0	0	0	0	0.93
Upper Evolution	0	0	0	0	0.48
Upper Kern	2	18.32	8	4.17	1.47
Subtotal Piscicide	**4**	**90.56**	**25**	**20.61**	**15.69**
Grand Total	**31**	**564.46**	**49**	**37.95**	**31.27**

Park Superintendent

.Figure 3. Fish traps may be used in some lake inlets and/or outlets to catch fish as they migrate to spawning areas.



Each individual piscicide treatment will require up to ten working days (approximately 1½ weeks) including mobilization, application, neutralization, and demobilization. A crew of 8 to 15 people is needed to implement most of the piscicide treatments due to the greater size, complexity, and number of tasks compared to physical treatments. A crew of more than 15 people may be needed to implement one or more of the largest piscicide treatments, including Sixty Lake, Upper Kern and Laurel. Personnel experienced in piscicide treatments from other NPS units and/or CDFW will lead the first one to two treatments, after which SEKI personnel are expected to be sufficiently trained to lead the remaining treatments.

Anticipated take associated with fish eradication (both physical and chemical) is enumerated in Tables 5-7 for mountain yellow-legged frogs and Yosemite toad.

Table 6. Sierra Nevada yellow-legged frogs that may be incidentally taken due to fish eradication actions each year by SEKI staff during this project.

Fish Eradication Method	Adults/subadults annual average	Tadpoles annual average	Egg masses annual average	10 year total by lifestage
Physical	8	8	2	80/80/20
Piscicide	25	200	0	50/400/0[1]

Table 7. Northern DPS mountain yellow-legged frogs that may be incidentally lost to fish eradication actions each year by SEKI staff during this project.

Fish Eradication Method	Adults/subadults annual average	Tadpoles annual average	Egg masses annual average	10 year total by lifestage
Physical	8	8	2	80/80/20
Piscicide	25	200	0	75/600/0[2]

1 Ten year cumulative incidental take figure is based on three treatment sites total, maximum two treatments first ten years.
2 Ten year cumulative incidental take figure is based on six treatment sites total, maximum three treatments first ten years.

Table 8. Yosemite toads that may be incidentally lost to fish eradication actions each year by SEKI staff during this project.

Fish Eradication Method	Adults/subadults annual average	Tadpoles annual average	Egg masses annual average	10 year total by lifestage
Physical	3	3	2	30/30/20
Piscicide	10	200	0	10/200/0[3]

Fish Disposal

Most lake systems in the high Sierra are oligotrophic, or nutrient lacking. Therefore, allowing nutrients present in fish populations to be released directly to the aquatic ecosystem through decomposition is an important step for retaining limited nutrients and will be a long-term benefit to the restoration areas. At sites where fish will be removed using physical methods, on a daily basis, crews will puncture the swim bladders of all individuals captured to prevent them from floating, and sink them in deep water to the bottom of each restoration lake. Crews will dispose of stream fish taken by electrofishing by puncturing their swim bladders and sinking them in deep water to the bottom of the nearest restoration lake. This method has been used with no observable adverse ecosystem effects in 13 project years (NPS 2015a; NPS unpubl. data). At sites where high density fish populations will be eradicated using piscicides, dead fish may float to the surface in potentially large numbers. Large fish kills resulting from piscicides will remain in larger waterbodies, or carcasses will be moved from small, shallow waterbodies to nearby larger waterbodies. In cases where myriad fish are killed in a short time period and concentrated in one area, carcasses will be distributed among nearby larger and deeper waterbodies within the same basin.

Conservation Measures

Conservation measures are designed to prevent or minimize adverse impacts or to contain impacts within acceptable limits during and after project implementation. The following conservation measures and/or best management practices will be implemented as part of this project.

1. Work Crews

    a. All crews will be instructed in and required to use minimum impact camping practices and wilderness ethics.

    b. Crew camps will be located where they have minimal impact on the natural qualities of wilderness character. Generally, naturally hardened sites will be selected. Naturally hardened sites have a natural abundance of sand, gravel, or rock and a natural lack of grasses and forbs. Wherever possible, crew camps will be located at base camps used for previous projects, with minimum potential to disrupt wildlife habitat or habits.

    c. Crews will be instructed on proper food-storage practices and camps will be inspected to make sure food is properly stored.

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d. Water for the crews both at work sites and in camp will be taken from a stream or lake that will be accessed by non-sensitive paths. The crews will be instructed to avoid sensitive areas in both the work sites and crew camp areas.

e. Gray water will be disposed of over 100 ft (30 m) from any surface water and will be poured into a small pit through a screen to remove small food particles. Strained food particles are then removed from the area with other trash.

f. Special containers or pit toilets will be used for toilets in all work and camp areas. The containers will be packed or flown out at the end of the field season and disposed of in a sewage treatment facility.

g. No motorized equipment will be used in camp. A propane/white gas or battery-powered lantern or headlamp will be used to light the work and cooking area inside the work tent. All other light will be from personal flashlights and headlamps.

h. All equipment, clothing, and gear will be checked for debris, cleaned of any visible plant or soil matter, and disinfected with quaternary ammonia following SEKI's disinfection protocol prior to moving to a new site.

2. Packstock

a. SEKI's packstock operations will be subject to the same minimum impact standards and grazing regulations as general parks users.

b. Packstock (fur and hooves) and equipment will be inspected and cleaned of seeds and dirt, as necessary, before leaving the front country.

c. All SEKI grazing restrictions and regulations will be adhered to. Where grazing is not allowed, only supplemental feed products that have been either heat treated or fermented so as to render any weed seeds inviable will be fed to stock.

3. Helicopter Use

a. A helicopter will be used only if determined through the minimum requirement analysis to be the minimum tool necessary for a particular project and project site.

b. If a helicopter is determined to be the minimum tool, then a temporary landing zone will be established at the project site. The landing zone should be void of trees and boulders that could pose a threat to helicopter rotors; should be on flat, level surface; minimal exposure to heavy winds; sites with ease of landing (affects load weights that can be delivered); and in proximity to base camp.

c. No whitebark or foxtail pines may be cut to accommodate a landing zone.

d. Except in the case of a medical emergency, flights will occur only between 8:00 a.m. and 5:00 p.m. and will follow flight paths to and from the project sites designed to avoid sensitive areas.

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4. Restoration of mountain yellow-legged frogs

   a. All personnel involved in collection and handling for CMR, translocations, reintroductions, antifungal treatments, and any other methods that involve handling mountain yellow-legged frogs will be Service-approved professional biologists with sufficient experience with proper handling of endangered amphibians; or trained, but less experienced biologists who will work under the direct supervision of Service-approved professionals.

   b. All listed amphibians handling will be conducted with wet hands only and not on adults in amplexus during routine monitoring and research activities.

   c. Mountain yellow-legged frog handling will be kept to the minimum time necessary for effectively completing conservation actions.

   d. Expeditious and cautious handling, including proper climate control, will be used during translocations and reintroduction efforts, including transport out of the wilderness, travel time to captive rearing facilities, and transport back to wilderness following captive-rearing.

   e. All captive-rearing efforts will be undertaken by professional biologists and/or zoological staff experienced with animal care and disease management techniques.

   f. Collections will be limited to the minimum number of animals necessary to successfully complete recovery actions.

5. Vegetation

   a. Prior to initiating work, project work areas and crew camp sites will be surveyed for the presence of plant species of concern.

   b. If species of concern are present in work and camp sites, appropriate mitigation measures will be taken, which could include collecting seed or flagging areas during project work to protect the species from onsite activities.

   c. Equipment and materials will be inspected for soil and plant parts. Dirty materials will be cleaned before being transported to field sites. Equipment and materials that could acquire seeds from surrounding areas will be covered during transport.

   d. A list and/or map of project areas will be maintained so that sites can subsequently be surveyed for invasive non-native plants.

   e. Work crews will inspect their shoes, clothing and equipment for seeds and soil before leaving the front country. Seeds and soil will be removed and placed in bagged garbage.

6. Wildlife

   a. Crew camps will be located at least 100 ft. (30 m) away from aquatic habitat for mountain yellow-legged frogs, Yosemite toads, and Little Kern golden trout, and away from ridgeline habitat for bighorn sheep.

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b. Stock will be kept at least 100 ft. (30 m) away from core aquatic habitat for mountain yellow-legged frogs, Yosemite toads, and Little Kern golden trout; and core terrestrial habitat for bighorn sheep.

c. Prior to any approved helicopter flight, the parks' wildlife biologist will provide a map of known bighorn sheep areas, and the helicopter will avoid flying above or landing in those areas; the final approach to the landing zone will stay below the area of the historic sightings. Flights will be suspended if sheep are observed within ½ mile (0.8 kilometers) of the project area. The landing zone for the helicopter will be located approximately 500 ft. (152 m) from any area where sheep have been observed.

d. All personnel involved in garter snake relocation will be professional biologists with years of experience with proper handling and marking of snakes, or–for trained, but less experienced biologists–work under the direct supervision of professionals.

e. Handling of garter snakes for relocations will be kept to the minimum time necessary for effectively completing each relocation action.

7. Water Quality

a. Equipment and materials will be stored at least 100 ft. (30 m) from open water to reduce the likelihood of debris or sediment entering surface water.

b. Secondary containment for hazardous materials (e.g., piscicide or white gas) will be incorporated by placing buckets under transfers of materials from one container to another. If hazardous materials were nevertheless spilled, they will be cleaned up immediately and will not be allowed to seep deep into the soil or reach open water sources. Towels will be onsite to absorb pooled hazardous materials. Shovels and bags will be onsite to gather surface soil in the spill area, which will be transported to the front country for remediation.

c. Work crews will use appropriate methods for human waste treatment, which is typically a pit toilet, or special containers for removal to the front country.

8. Gill Netting

a. Crew members will walk along the shoreline scanning for non-target animals prior to pulling nets and release animals as soon as possible to reduce mortality of non-target animals.

b. To minimize the capture of non-target animals including mountain yellow-legged frogs, the shore end of gill nets will be generally set approximately 1 to 3 m from shore to provide an area where frogs on and near the shoreline can be active with lower potential for getting caught in a net. Areas observed to periodically contain many tadpoles and frogs will generally be avoided when placing gill nets.

9. Electrofishing

a. During electrofishing, crews continually scan the area in front of their progress for non-target wildlife including mountain yellow-legged frogs. If a non-target species is observed,

the electrofisher is turned off until the animal leaves the water or the shocking area. If necessary, crews capture and remove the animal downstream or to adjacent terrestrial habitat and then proceed with electrofishing.

b. Crewmembers will wear waterproof chest waders and gloves that do not conduct electricity.

c. Crewmembers will wear wading boots with felt-lined soles that provide improved stability. The output from electrofishers is engineered to specifically target fish so non-target species are much less affected by electrofishing. Felt-soled boots used for project work will only be used at project sites. Boots will remain at each project site for the summer, and will be transported out of the project area for the winter, where they will be decontaminated before their next use. This process will eliminate the potential to sustain or transport undesirable non-native species.

10. Piscicide Use

a. If adequate fishless habitat is not present at the head of streams to provide upstream source populations of invertebrates for repopulating treated areas, then a section of stream will be physically treated to remove fish and create an upstream source population. A temporary fish barrier will be installed if needed to protect a source population from fish recolonization until fish are eradicated with piscicides.

b. The state of California requires that pesticide applications be managed by trained and certified applicators. At least one member of the onsite piscicides application crew will be certified by the state of California as an applicator and all of the restoration crew working with piscicides will be trained in proper use of personal protective equipment, product safety measures, and they will operate under the direction of the certified applicator(s) and in accordance with project safety plans or job hazard analysis.

c. Application of rotenone will be carried out in a manner that strictly adheres to practices permitted by the product labeling, including use of personal protective equipment (PPE) for applicators, controlling public access during application, determining the maximum necessary application concentrations, and all other applicable guidelines.

d. Rotenone drip stations will be placed in secure and stable locations either on the stream bank or on a stand in the stream channel, and are actively monitored by project staff for the duration of the treatment. The drip nozzles of the stations will be placed very close to the water's surface to reduce the potential for piscicide drift to terrestrial environments. Rotenone applied from backpack sprayers is applied with the spray head very close to the water surface to minimize drift onto terrestrial environments.

e. Fish will be collected prior to the treatment process from the project area and placed in net baskets just upstream of drip stations to monitor the effectiveness of the piscicide treatment.

f. Although very few, if any, mountain yellow-legged frogs of any life stage are typically present in fish-containing areas, any post-metamorphic mountain yellow-legged frogs or tadpoles

observed that can be captured using dip nets and/or seines will be removed from the treatment area and placed in a nearby fishless waterbody disconnected from the treatment area while piscicide concentrations dissipate.

g. Rotenone will be neutralized by the careful addition of potassium permanganate to the water at established locations. Fish baskets will also be placed downstream of the neutralization station. Mortality of these fish will alert workers to potential releases of excess chemical in the event of human or equipment error and potential downstream effects.

h. Treated fish that do not sink will have their swim bladders punctured so the carcasses will sink to the substrate.

i. During and after rotenone treatments, water quality will be monitored to assess the effects of treatment on surface waters and bottom sediments. The monitoring will determine that: 1) effective piscicide concentrations of rotenone are applied; 2) sufficient degradation of rotenone has occurred prior to the resumption of public contact; and 3) rotenone toxicity does not occur outside the project area. An analytical laboratory will analyze water samples for rotenone and rotenolone concentrations as well as for volatile organic compound and semi-volatile organic compound concentrations.

j. The parks will also develop and implement a spill contingency plan that addresses chemical transport and use guidelines, as well as spill prevention and containment that adequately protects water quality. The spill contingency plan will be maintained on site.

k. Piscicide containers will be securely locked or guarded when taken to the field for use.

l. Any piscicide that is spilled will be scooped up (including top layer of soil) with a shovel, placed in a bag designed for product disposal, and transported out of area for disposal as required on the product label.

m. Piscicide applications will be communicated to the public using 1) temporary information and warning signs posted on trails near the treatment area, 2) staff stationed on nearby trails, 3) visits to nearby campsites, 4) verbal contacts by the nearest wilderness rangers, 4) staff at local wilderness permit stations, 5) temporary postings to the parks website and 6) information attached to wilderness permits. Any area closures will be included in the annual updates to the Superintendent's compendium.

n. Most of the piscicide applications will occur in areas that generally have little visitation. Nevertheless, prior to applications and throughout treatments, public access will be restricted through the use of signs located at trailheads and other strategic places.

o. All personnel assisting in the fish removal will use hardened or durable sites for camping and will be familiar with and practice Leave-No-Trace (LNT) principles. A crew of 8 to 15 people is expected to be sufficient to implement each treatment. Trails will be used whenever possible to move from one location to another to minimize soil and vegetation disturbance and to prevent establishing new trails. Sensitive plant habitat will be avoided. Treatment activities will be coordinated with wilderness management personnel.

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p. To incorporate the results of actual piscicide treatments in SEKI to future treatments, we will implement an adaptive management approach, in which intensive monitoring of the initial piscicide treatments is used to better describe the likely impacts of subsequent treatments, and if necessary, to redesign subsequent treatments to further minimize anticipated impacts.

Action Area

The action area is defined in 50 CFR § 402.02, as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." For the proposed project, the action area encompasses all SEKI lands associated with the 55 basins (Figure 2), including the restoration and monitoring lakes, creeks, wetlands, and associated uplands between the altitudes of approximately 6,000 to 12,000 feet subjected to project-related fish removal, crew camps, trails and frog population and disease monitoring. These basins are analogous to the frog conservation areas (FCAs) identified in SEKI for the mountain yellow-legged frog Conservation Strategy, and in total contain approximately 600 additional lakes, ponds, and marshes to the waterbodies in this project where mountain yellow-legged frog recovery actions may occur. Additionally, non-native fish will be eradicated using physical methods or piscicides from select waterbodies in 21 of the 55 basins, including 80 lakes and ponds (602 acres), five fish-containing marshes (32 acres), approximately 31 miles of stream, plus additional connected fish-containing habitat if necessary. These 85 waterbodies represent 15% of the SEKI's 550 waterbodies known to contain non-native fish. Appendix B in the Restoration Plan/FEIS has detailed maps of each individual fish eradication basin.

Analytical Framework for the Jeopardy Determination

The following analysis relies on four components to support the jeopardy determination for the Sierra Nevada yellow-legged frog, northern DPS of the mountain yellow-legged frog, Yosemite toad, and Little Kern golden trout: (1) the *Status of the Species*, which evaluates the species' range wide condition, the factors responsible for that condition, and their survival and recovery needs; (2) the *Environmental Baseline*, which evaluates the condition of these species in the action area, the factors responsible for that condition, and the role of the action area in the species' survival and recovery; (3) the *Effects of the Action*, which determines the direct and indirect effects of the proposed Federal action and the effects of any interrelated or interdependent activities on these species; and (4) *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on these three species.

In accordance with the implementing regulations for Section 7 and Service policy, the jeopardy determination is made in the following manner: the effects of the proposed Federal action are evaluated in the context of the aggregate effects of all factors that have contributed to the current status of the Sierra Nevada yellow-legged frog, northern DPS of the mountain yellow-legged frog, Yosemite toad, and Little Kern golden trout.

The following analysis places an emphasis on using the range-wide survival and recovery needs of the Sierra Nevada yellow-legged frog, northern DPS of the mountain yellow-legged frog, Yosemite toad, and Little Kern golden trout, and the role of the action area in providing for those needs as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

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Analytical Framework Adverse Modification Determination

In accordance with policy and regulation, the adverse modification analysis in this biological opinion relies on four components: (1) the *Status of Critical Habitat*, which evaluates the range-wide condition of proposed critical habitat for the Sierra Nevada yellow-legged frog, northern DPS of the mountain yellow-legged frog, and Yosemite toad; in terms of key components of the critical habitat that provide for the conservation of the listed species, the factors responsible for that condition, and the intended value of the critical habitat overall for the conservation/recovery of listed species; (2) the *Environmental Baseline*, which analyses the condition of the critical habitat in the action area, the factors responsible for that condition, and the value of the critical habitat in the action area for the conservation for the listed species; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the key components of critical habitat that provide for the conservation for the listed species of the listed species; and (4) *Cumulative Effects*, which evaluates the effects of future, non-Federal activities that area reasonably certain to occur on the key components of critical habitat that provide for the conservation of the listed species and how those impacts are likely to influence the value of the affected critical habitat units for the conservation/recovery of the listed species.

For purposes of the adverse modification determination, the effects of the proposed Federal Action, together with any cumulative effects to determine if the value of the critical habitat rangewide for the conservation/recovery of the listed species would remain functional or would retain the current ability for the key components of the critical habitat that provide for the conservation of listed species to be functionally re-established in areas of currently unsuitable but capable habitat.

Status of the Species and Proposed Critical Habitat

Mountain Yellow-Legged Frogs and Yosemite Toad

Please refer to the Programmatic Biological Opinion on Nine Forest Programs on Nine National Forests in the Sierra Nevada of California for the Endangered Sierra Nevada Yellow-Legged Frog, Endangered Northern Distinct Population Segment of the Mountain Yellow-legged Frog, and Threatened Yosemite Toad (Service file number FFESMF04-2014-F0557) for information on the status of the mountain yellow-legged frog and Yosemite toad, and their environmental baseline (including threats).

For the Sierra Nevada ecoregion, climate models predict that mean annual temperatures will increase by 3.2 to 4.3 °F by 2070, including warmer winters with earlier spring snowmelt and higher summer temperatures. Mean annual rainfall is projected to decrease from 3.6–13.3 inches by 2070; however, projections have high uncertainty and one study predicts the opposite effect (PRBO 2011). Snowpack is, by all projections, going to decrease dramatically following the temperature rise and more precipitation falling as rain (Kadir *et al.* 2013). Higher winter streamflows, earlier runoff, and reduced spring and summer streamflows are projected, with increasing severity in the southern Sierra Nevada (PRBO 2011, Kadir *et al.* 2013). Snow-dominated elevations of 6,560–9,190 feet will be the most sensitive to temperature increases, and a warming of 9 °F is projected to shift center timing, the measure when half a stream's annual flow has passed a given point in time, to more than 45 days earlier in the year as compared to the 1961–1990 baseline (PRBO 2011). Lakes, ponds, and

other standing waters fed by snowmelt or streams are likely to dry out or be more ephemeral during the non-winter months (Lacan *et al.* 2008, PRBO 2011). This pattern could influence ground water transport, and springs may be similarly depleted, leading to lower lake levels. Climate change remains a primary threat to Sierra Nevada yellow-legged frog, Northern DPS of the mountain yellow-legged frog, and the Yosemite toad.

Little Kern Golden Trout

Little Kern golden trout (*Oncorhynchus mykiss whitei*) is a subspecies of rainbow trout that is endemic to the Little Kern River drainage of Tulare County, California (Service 1978, 2011). The Little Kern River drainage occurs primarily in the Golden Trout Wilderness of Sequoia National Forest with smaller areas of the drainage in Sequoia National Park. Little Kern golden trout occur in one proposed treatment area (Crytes) included in this plan (NPS unpubl. data).

Hybridization with non-native salmonids is the most imminent threat to the Little Kern golden trout. Rainbow trout were introduced to the Little Kern basin beginning in the early 1930s or possibly earlier (Christenson 1984). Rainbow trout readily hybridized with Little Kern golden trout, producing fertile offspring (Gall *et al.* 1976). As a result of the introductions, genetic integrity of this subspecies was compromised, reducing the number of genetically pure populations and reducing the subspecies range. At the time of listing, pure populations were thought to only persist in the upper-most headwater reaches of five tributaries to the Little Kern River, and management efforts focused on piscicide eradication of introgressed (genetically compromised) populations and restocking of genetically pure Little Kern golden trout between 1975 and 1996 (Service 2011). Restoration efforts have largely been successful in removing severely introgressed populations of Little Kern golden trout and the broader influence of non-native fishes, such as brook trout. However, the hybridization with non-native rainbow trout likely still is an issue. In addition, reestablished populations are showing signs of low genetic diversity (Stephens 2007), making these populations more vulnerable to stochastic events and/or climate change (Service 2011).

Proposed Critical Habitat for the Mountain Yellow-frog Complex and Yosemite Toad

Critical habitat for the mountain yellow-frog complex and Yosemite toad was proposed on April 25, 2013 (78 FR 24515). Under the Act and its implementing regulations, we are required to identify the physical or biological features essential to the conservation of the mountain yellow-legged frog complex and Yosemite toad in areas occupied at the time of listing (in this case, areas that are currently occupied), focusing on key components of the critical habitat that provide for the conservation of the listed species. We consider these key elements, characterized as Primary Constituent Elements in this proposed critical habitat, to represent the physical or biological features that are essential to the conservation of the species.

Mountain Yellow-Legged Frog Complex

Based on our current knowledge of the physical or biological features and habitat characteristics required to sustain the species' life-history processes, we determine that the PCEs (or key elements) specific to the Sierra Nevada and northern DPS of the mountain yellow-legged frogs are:

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1. *Aquatic habitat for breeding and rearing.* Habitat that consists of permanent water bodies, or those that are either hydrologically connected with, or close to, permanent water bodies, including, but not limited to, lakes, streams, rivers, tarns, perennial creeks (or permanent plunge pools within intermittent creeks), pools (such as a body of impounded water contained above a natural dam), and other forms of aquatic habitat. This habitat must:

    a. Be of sufficient depth not to freeze solid (to the bottom) during the winter (no less than 1.7 m (5.6 ft), but generally greater than 2.5 m (8.2 ft), and optimally 5 m (16.4 ft) or deeper (unless some other refuge from freezing is available)).

    b. Maintain a natural flow pattern, including periodic flooding, and have functional community dynamics in order to provide sufficient productivity and a prey base to support the growth and development of rearing tadpoles and metamorphs.

    c. Be free of fish and other introduced predators.

    d. Maintain water during the entire tadpole growth phase (a minimum of 2 years). During periods of drought, these breeding sites may not hold water long enough for individuals to complete metamorphosis, but they may still be considered essential breeding habitat if they provide sufficient habitat in most years to foster recruitment within the reproductive lifespan of individual adult frogs.

    e. Contain:

        i. Bank and pool substrates consisting of varying percentages of soil or silt, sand, gravel, cobble, rock, and boulders;

        ii. Shallower lake microhabitat with solar exposure to warm lake areas and to foster primary productivity of the food web;

        iii. Open gravel banks and rocks projecting above or just beneath the surface of the water for adult sunning posts;

        iv. Aquatic refugia, including pools with bank overhangs, downfall logs or branches, or rocks to provide cover from predators; and

        v. Sufficient food resources to provide for tadpole growth and development.

2. *Aquatic nonbreeding habitat (including overwintering habitat).* This habitat may contain the same characteristics as aquatic breeding and rearing habitat (often at the same locale), and may include lakes, ponds, tarns, streams, rivers, creeks, plunge pools within intermittent creeks, seeps, and springs that may not hold water long enough for the species to complete its aquatic life cycle. This habitat provides for shelter, foraging, predator avoidance, and aquatic dispersal of juvenile and adult mountain yellow-legged frogs. Aquatic nonbreeding habitat contains:

    a. Bank and pool substrates consisting of varying percentages of soil or silt, sand, gravel, cobble, rock, and boulders;

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b. Open gravel banks and rocks projecting above or just beneath the surface of the water for adult sunning posts;

c. Aquatic refugia, including pools with bank overhangs, downfall logs or branches, or rocks to provide cover from predators;

d. Sufficient food resources to provide for tadpole growth and development;

e. Overwintering refugee, where thermal properties of the microhabitat protect hibernating life stages from winter freezing, such as crevices or holes within granite, in and near shore; and/or

f. Streams, stream reaches, or wet meadow habitats that can function as corridors for movement between aquatic habitats used as breeding or foraging sites.

3. *Upland areas.*

a. Upland areas adjacent to or surrounding breeding and nonbreeding aquatic habitat that provide area for feeding and movement by mountain yellow-legged frogs.

i. For stream habitats, this area extends 25 m (82 ft) from the bank or shoreline.

ii. In areas that contain riparian habitat and upland vegetation (for example, mixed conifer, ponderosa pine, montane hardwood conifer, and montane riparian woodlands), the canopy overstory should be sufficiently thin (generally not to exceed 85 percent) to allow sunlight to reach the aquatic habitat and thereby provide basking areas for the species.

iii. For areas between proximate (within 300m (984 ft)) water bodies (typical of some high mountain lake habitats), the upland area extends from the bank or shoreline between such water bodies.

iv. Within mesic habitats such as lake and meadow systems, the entire area of physically contiguous or proximate habitat is suitable for dispersal and foraging.

b. Upland areas (catchments) adjacent to and surrounding both breeding and nonbreeding aquatic habitat that provide for the natural hydrologic regime (water quantity) of aquatic habitats. These upland areas should also allow for the maintenance of sufficient water quality to provide for the various life stages of the frog and its prey base.

Yosemite Toad

Based on our current knowledge of the physical or biological features and habitat characteristics required to sustain the species' life-history processes, we determine that the PCEs, or key elements, specific to the Yosemite toad are:

1. *Aquatic breeding habitat.* (a) This habitat consists of bodies of fresh water, including wet meadows, slow-moving streams, shallow ponds, spring systems, and shallow areas of lakes, that:

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a. Are typically (or become) inundated during snowmelt,

b. Hold water for a minimum of 5 weeks, and

c. Contain sufficient food for tadpole development.

d. During periods of drought or less than average rainfall, these breeding sites may not hold water long enough for individual Yosemite toads to complete metamorphosis, but they are still considered essential breeding habitat because they provide habitat in most years.

2. *Upland areas.* (a) This habitat consists of areas adjacent to or surrounding breeding habitat up to a distance of 1.25 km (0.78 mi) in most cases (that is, depending on surrounding landscape and dispersal barriers), including seeps, springheads, and areas that provide:

a. Sufficient cover (including rodent burrows, logs, rocks, and other surface objects) to provide summer refugia,

b. Foraging habitat,

c. Adequate prey resources,

d. Physical structure for predator avoidance,

e. Overwintering refugia for juvenile and adult Yosemite toads,

f. Dispersal corridors between aquatic breeding habitats,

g. Dispersal corridors between breeding habitats and areas of suitable summer and winter refugia and foraging habitat, and/or

h. The natural hydrologic regime of aquatic habitats (the catchment).

i. These upland areas should also allow maintain sufficient water quality to provide for the various life stages of the Yosemite toad and its prey base.

All units and subunits proposed for designation as critical habitat are currently occupied by Sierra Nevada mountain yellow-legged frogs, the northern DPS of the mountain yellow-legged frogs, or Yosemite toads, and contain the PCEs, or key elements, sufficient to support the life-history needs of the species.

Special Management Considerations or Protection

When designating critical habitat, we assess whether the specific areas within the geographic area occupied by the species at the time of listing contain features that are essential to the conservation of the species and that may require special management considerations or protection.

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The features essential to the conservation of the Sierra Nevada yellow-legged frog and northern DPS of the mountain yellow-legged frog may require special management considerations or protection to reduce the following threats: The persistence of introduced trout populations in essential habitat; the effects from water withdrawals and diversions; impacts associated with timber harvest and fuels reduction activities; impacts associated with livestock grazing; and intensive use by recreationists, including packstock camping and grazing.

Management activities that could ameliorate the threats described above include (but are not limited to) nonnative fish eradication; installation of fish barriers; modifications to fish stocking practices in certain water bodies; physical habitat restoration; and responsible management practices covering potentially incompatible activities, such as timber harvest and fuels management, water supply development and management, livestock and packstock grazing, and other recreational uses. These management practices will protect the PCEs for the mountain yellow-legged frog by reducing the stressors currently affecting population viability. Additionally, management of critical habitat lands will help maintain the underlying habitat quality, foster recovery, and sustain populations currently in decline.

The features essential to the conservation of the Yosemite toad may require special management considerations or protection to reduce the following threats: Impacts associated with timber harvest and fuels reduction activity; impacts associated with livestock grazing; the spread of pathogens; and intensive use by recreationists, including packstock camping and grazing.

Management activities that could ameliorate the threats described above include (but are not limited to) physical habitat restoration and responsible management practices covering potentially incompatible beneficial uses such as timber harvest and fuels management, water supply development and management, livestock and packstock grazing, and other recreational uses. These management activities will protect the PCEs for the Yosemite toad by reducing the stressors currently affecting population viability. Additionally, management of critical habitat lands will help maintain or enhance the necessary environmental components, foster recovery, and sustain populations currently in decline.

Environmental Baseline

Mountain Yellow-legged Frog

Survey records from 1997 to 2015 confirm that the Sierra Nevada yellow legged frog and the northern DPS of the mountain yellow-legged frog both occur within the action area (Knapp 2003; NPS 2015a; Knapp unpubl. data, NPS unpubl. data). Mountain yellow-legged frogs in SEKI are currently extant at sites from 9,200 to 12,100 ft (Knapp unpubl. data). Historic records show that they ranged down to 6,400 ft occupying montane meadows in Giant Forest and Grant Grove (Vredenburg *et al.* 2007, Vredenburg unpubl. data). It is presumed that mountain yellow-legged frogs ranged downstream to the upper limits of the natural distribution of trout prior to fish planting.

Park Superintendent

Similar to rangewide declines of mountain yellow-legged frogs, populations in SEKI have declined precipitously from their historic abundance, and they are in danger of becoming extinct (Service, 2014). Surveys by Bradford *et al.* (1994) during 1989-1990 did not detect mountain yellow-legged frogs in 48% of the sites where they were found from 1955-1979. Within the Tablelands portion of the Kaweah watershed, mountain yellow-legged frogs declined in 96% of sites between the late 1970s and 1989 (Bradford *et al.* 1994). In the 1990s, mountain yellow-legged frogs disappeared from the entire Kaweah watershed.

During the summers of 1997, 2000, 2001, and 2002, Knapp conducted mountain yellow-legged frog surveys in the majority of lentic waterbodies in SEKI (n = 3,250) and detected individuals at 567 sites (Knapp 2003). From 2009-2013, he resurveyed 492 of the 567 previously occupied sites and detected them in 187 sites (38%) (Knapp unpubl. data). Since the recent surveys visited 87% of previously occupied sites, it presents a fairly accurate picture of their current status. Mountain yellow-legged frogs have disappeared from approximately 62% of previously occupied sites in the last ten years. Further, many of the extant populations have low abundance that makes these populations vulnerable to further losses. Opportunities for restoration in particular for the northern DPS of the mountain yellow-legged frog are greatest within SEKI, and therefore the Restoration Plan is a central component of the recovery of this species.

Yosemite Toad

Recent surveys of suitable Yosemite toad habitat in Kings Canyon National Park have documented the species in approximately 42 meadows (Knapp 2003; USGS unpubl. data). Yosemite toads are known to occur near two proposed fish eradication areas (McGee and Upper Evolution) (USGS unpubl. data).

Little Kern Golden Trout

The population of Little Kern golden trout inhabiting Crytes Basin is not native to this specific area. In 1887, Little Kern golden trout were transplanted to historically fishless habitat in Crytes Basin (Ellis and Bryant 1920). Since this basin is outside of the natural range of this species, it was not designated as critical habitat (Service 1978) and the population is not part of the recovery plan (Christenson 1984). In addition, recent analysis shows that this population is not genetically-pure (Stephens *et al.* 2005; Deiner *et al.* 2010, Erickson *et al.* 2010). Although this population has Little Kern golden trout morphological characteristics, it has also acquired significant admixture with rainbow trout and California golden trout, possibly from undocumented transplant after 1887. This population also exhibits substantial genetic drift (Erickson *et al.* 2010; B. Erickson, pers. comm., April 2016). As a result of this presumed founder effect and genetic isolation, this population now represents genetic composition very different from pure Little Kern golden trout.

Proposed Critical Habitat for the Mountain Yellow-legged frog and Yosemite Toad

The action area for the project includes proposed critical habitat for the Sierra Nevada yellow-legged frog and northern DPS of the mountain yellow-legged frog.

Effects of the Action

As noted previously in the Description of the Action section, the project proponent has also

proposed a set of conservation measures. The project action area includes areas in preferred alternative B of the Restoration Plan/FEIS. All of these areas are in proposed mountain yellow-legged frog critical habitat. Several of these areas are in proposed Yosemite toad critical habitat.

Little Kern golden trout occur in one proposed treatment area (Crytes; NPS unpubl. data) included in this plan. This population is not native to Crytes, it is not part of the official recovery plan for the species (Christenson 1984), and recent genetic analysis have determined this population is not genetically-pure (Deiner *et al.* 2010; Erickson *et al.* 2010).
There are anticipated effects from the SEKI Restoration Plan associated with monitoring, research, translocation, and fish eradication activities that will result in harassment and likely injury and death to individuals of the Sierra Nevada yellow-legged frog, northern DPS of the mountain yellow-legged frog, Yosemite toad, and Little Kern golden trout. Some effects such as harassment during capture, swabbing, mark and recapture, may be temporary, while seldom resulting in injury or mortality of the amphibains. There will be injury or mortality associated with fish eradication activities, as individuals that may be in the treatment areas are trapped and perish in gill nets or during piscicide treatments. Effects associated with each activity are discussed below. The fish eradication activities will eliminate this non-native hybrid population of the Little Kern golden trout.

Monitoring

Monitoring activities may result in individuals fleeing from surveyors during surveys, capture and brief handling/swabbing of some individuals, including possible PIT-tagging or elastomer marking of mountain yellow-legged frogs. This data will be used to investigate the distribution, population size, and disease status of these species. This data also will provide insight into factors that enable populations to persist to varying degrees despite on-going infection with amphibian chytrid fungus. The results will be used to prioritize sites for fish eradication and reintroductions, and to identify frog source populations. The overall risk to the majority of individuals and populations from monitoring is expected to have minimal adverse effects on the species.

Continuing Research

Research activities involving disease intervention using chemical and biological treatment will continue in SEKI. Individual mountain yellow-legged frogs that are captured for anti-fungal bathing or bacterial additions will be captured, handled, treated, and released. Research activities may result in capture and possibly injury and death. However, the treated individuals will have increased resistance to amphibian chytrid fungus and increased probability of recovery after disease intervention.

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Recent chytrid treatments demonstrated no to little detectable effects on mountain yellow-legged frog survival from capture, handling, application of the medicine, and release(Knapp 2010). In these treatments, all animals that were not immediately on the verge of dying upon capture due to having already reached catastrophic levels of amphibian chytrid function survived the treatments, were fully or nearly cleared of infection, and had substantially higher survival than untreated control animals. Although animals have little forage for up to 8 days during treatments, all treated animals appeared to have typical behavior and energy levels upon release to aid in survival. For mountain yellow-legged frogs not captured at treatment sites, and Yosemite toads that may be present, the treatment activities sometimes causes tadpole and adult individuals to exhibit a flight response, but this behavior will be temporary in nature, and any individuals that flee likely will recover and resume their prior behavior in short order.

Reintroduction/Translocation of mountain yellow-legged frogs

Two forms of population restoration for the mountain yellow-legged frog will occur in order to reestablish previously occupied habitat or augment dwindling populations: 1) natural recolonization of the restored habitat, or passive recolonization, and 2) human-assisted movement of a number of individuals from extant mountain yellow-legged frog populations to other locations, or active reintroduction. During active reintroduction, individuals may be harmed by capture, handling, transport and release into new habitat. Some animals may be transported to a captive rearing facility, by helicopter and vehicle, for "head-starting" and/or antifungal treatments. The source population of mountain yellow-legged frogs will incur a short-term loss of a small percentage of its animals, generally <10%, that likely will be replaced through reproduction and recruitment over the following several years (Knapp *et al.* 2011).

For mountain yellow-legged frogs not captured, the capture and release activities may harass individuals, which may lead to mortality or injury if animals are disoriented and at greater risk to predation or vulnerable during evasion. However, these events will be temporary in nature, and any individuals that flee will typically resume their prior behaviors within a short amount of time.

When mountain yellow-legged frogs are reintroduced to a lake site, the small population may be subject to heavy snake predation, which has negative impacts on population viability, and thus potential for reintroduction success. Translocating snakes away from reintroduction sites is expected to improve the success rates of mountain yellow-legged frog reintroductions, and will minimize or eliminate such losses. Snakes will only be relocated to areas that are not occupied by mountain yellow-legged frogs. It is anticipated that these translocation activities will be sufficient to avoid or minimize frog losses to snake predation at these reintroduction sites.

Mountain yellow-legged frog populations may be at risk of extirpation if drought causes small, occupied ponds to completely dessicate. In these cases, the entire population may be captured and relocated, or transported to a facility to establish a captive rearing program and/or head-start tadpoles until the habitat becomes suitable again for reintroduction of captured individuals and/or their progeny. Salvaging drought-threatened individuals in this way will provide a long-term benefit to the population in contrast to the potential for high mortality (Lacan *et al.* 2008) if the population is left alone.

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Restoration activities may result in take due to harassment, harm and possible injury or mortality during capture and handling, swabbing and PIT-tagging of some individuals, capture and handle stress during translocation and potential for mortality to individuals during and after reintroductions. Further, there is a short-term reduction in population size of source populations following collections. However, these negative impacts are expected to be more than offset by long-term beneficial effects to mountain yellow-legged frogs resulting from successful restoration and reintroduction (extending the occupied range and range-wide resilience and abundance of frog populations). It is anticipated that the conservation measures for handling and size restrictions for tagging, and care and transport procedures will avoid and minimize take associated with these activities.

Research Activities

Research activities are expected to result in capture, and in rare cases may lead to injury or mortality during swabbing and PIT-tagging of some individuals. For individual mountain yellow-legged frogs that are captured, inserted with a PIT tag, and re-released back into the field for CMR monitoring purposes (i.e., they will not be transported to a new habitat) there will be no anticipated short-term decline of the local population. For mountain yellow-legged frogs not captured, the capture and release activities may cause a flight response, but the disturbance is anticipated to be no different than what occurs when visitors walk by these areas. These events will be temporary in nature, and any individuals that took flight will typically resume their prior behaviors within a short amount of time. Collectively, the effects from research activities are expected to be minimal in terms of the affected individuals, and short-lived, and more than offset by the benefits gained from enhanced understanding and information of population status and trend, disease status, and other gains from increasing our understanding of mountain yellow-legged frog ecology.

Garter Snake Relocation

When mountain yellow-legged frogs are reintroduced to a lake site, the small frog population is still subject to heavy garter snake predation, whereby reintroduced individuals are injured or killed. Garter snake predation has compromised the success of at least two mountain yellow-legged frog reintroductions in SEKI and YOSE (Knapp unpubl. data). Given the relatively small numbers of mountain yellow-legged frog individuals anticipated to be available for translocations and reintroductions, all garter snakes detected will be relocated away from these sites for one to two years following reintroduction. This will give small mountain yellow-legged frog populations a chance to successfully breed, increase in abundance and stabilize enough so that they can persist amid natural snake predation once snake relocations are ceased. Snakes detected during monitoring will be captured, marked, and moved by foot to a site within the same basin that does not have mountain yellow-legged frogs and is at least 1 mile away. It is expected that no more than 20 snakes will be relocated from all reintroduction sites in any given year. Over the long-term snakes are expected to return to mountain yellow-legged frog reintroduction sites, and ultimately the recovery of mountain yellow-legged frogs will positively influence the local snake populations as well. As snakes will be moved for two years to unoccupied, distant sites, effects from garter snake predation to reintroduced frog will be avoided or minimized.

Use and Support of Crew Camps

Effects on the listed species from the use of crew camps, and helicopters and stock to support the

mobilization and demobilization of crew camps are expected to be insignificant or discountable because trips are infrequent (twice a season) and exposure intervals are limited (30 minutes to 2 hours). Crew camps will be located in upland areas away from aquatic habitat. Noise from helicopters landing and taking off near crew camps will be temporary and away from the core habitats are not expected to be present at most source or recipient sites. With the enumerated conservation measures, impacts from these project activities to listed species and critical habitat are expected to be fully discountable.

Fish Eradication (Physical and Chemical)

Under this Plan, non-native fish will be removed from 85 waterbodies (31 lakes, 49 ponds, five marshes) and approximately 31 miles (50 kilometers) of connected stream habitat contained in 21 basins. Non-native fish will be removed using physical methods (gill netting and electrofishing) from 52 waterbodies (27 lakes, 24 ponds, one marsh) and approximately 15 miles of stream contained in 17 basins. Non-native fish will be removed using piscicides (rotenone) from 33 waterbodies (four lakes, 25 ponds, four marshes) and approximately 16 miles of streams contained in nine basins. The following sections describe effects of fish eradication to each listed species.

Mountain Yellow-legged Frogs

Extensive research has shown that non-native trout have substantial adverse effects on mountain yellow-legged frogs, due to predation, competition and population fragmentation (Service 2014). Removing non-native trout reverses these effects and allows mountain yellow-legged frog populations in treatment areas to expand (Knapp *et al.* 2007; NPS 2012).

Removal of non-native fish from the additional 85 treatment waterbodies and 31 miles of streams contained in 21 basins included in this alternative will provide significant long-term beneficial effects on mountain yellow-legged frogs, due to: 1) expected increases in existing populations to more robust (less-vulnerable) sizes, and 2) the potential for extirpated mountain yellow-legged frog populations to be reestablished in restored habitat.

In treated areas with extant mountain yellow-legged frog populations, individuals sometimes get caught in gill nets. Depending on the length of time before staff find and release them, individuals can be killed, released with visible injury, or released with no visible injury. In SEKI between 2001-2013, 205 mountain yellow-legged frogs were captured in gill nets, including 145 that died (84 frogs, 61 tadpoles), 21 that were released injured, and 39 that were released with no visible injury (NPS 2015a). The total gill net effort was 8,313,701 net hours.

In treated areas with extant mountain yellow-legged frog populations, individuals sometimes get stunned by electrofishing. Individuals typically hop or swim away as soon as the electrofishing field is stopped; rarely individuals need from several seconds to two minutes to recover before moving away from the work area. In SEKI between 2001-2013, a total of 497 hours of electrofishing resulted in zero observed mountain yellow-legged frog mortalities (NPS 2015a).

Eradicating non-native fish using gill nets and electrofishers has had an adverse effect on a small percentage of individual mountain yellow-legged frogs, these treatments have had a substantial beneficial effect at the population and species scales of mountain yellow-legged frogs. Removal of non-native fish resulted in a very large overall increase frog populations in the treatment areas (NPS

2012). Between 2001 to 2011, SEKI eradicated fish from ten lakes and nearly eradicated fish from three lakes. In nine of these lakes, in which mountain yellow-legged frogs remained disease free three years after fish removal, average density (tadpoles + frogs) increased by 13-fold, with one lake showing a 49-fold increase. Several of these restored populations are now among the largest in the ranges of mountain yellow-legged frogs. In addition, typically no or few incidental captures occur during the first year of fish removal, while these appear to increase as mountain yellow-legged frogs increasingly migrate into waterbodies approaching eradication. CDFW has reported similar results from restoration efforts adjacent to disease-free sites (CDFW 2011).

In addition, fish traps may be used to facilitate eradication in areas with extensive amounts of stream habitat containing high-densities of fish. Fish traps are expected to have no effect on mountain yellow-legged frogs for the following reasons. First, few to no mountain yellow-legged frogs occur in habitat with high density fish populations (Knapp *et al.* 2005). Second, individuals that may be present will likely not colonize a trap containing non-native fish because they are able to sense fish presence (Vredenburg 2004) and thus will be expected to avoid them. Therefore, the potential for disturbance, injury or mortality to mountain yellow-legged frog individuals due to fish traps is expected to be low.

In piscicide treatment areas with extant mountain yellow-legged frog populations, project mitigation measures include capturing as many individuals as possible and moving them to adjacent untreated waterbodies before treatments are conducted. Most, but not all, of the frogs in the treatment areas are expected to be captured and moved out of treatment areas. Any tadpoles are not captured and moved will be harmed by piscicide treatments, because tadpoles breathe through gills (rotenone targets gill-breathing organisms) and tadpoles cannot leave the water. CFT Legumine™ application concentrations of 1 ppm (= 50 ppb rotenone) in streams and 4 ppm (= 200 ppb rotenone) in lakes exceed the 24 hr LC_{50} concentration of 5 ppb rotenone for northern leopard frog tadpoles (*Rana pipiens*) (Hamilton 1941), and 30 ppb rotenone for southern leopard frog tadpoles (*Rana sphenocephala*) (Chandler and Marking 1982). Since these species are in the same genus as mountain yellow-legged frogs, mountain yellow-legged frog tadpoles are expected to have similar rotenone LC_{50} concentrations as leopard frog tadpoles.

However, the specific response of tadpoles to rotenone depends on development stage (Hamilton 1941). Younger larvae that are dependent on gill respiration are far more sensitive than older larvae that are near metamorphosis and breathing air. Therefore, the majority of younger mountain yellow-legged frog tadpoles exposed to piscicide treatments will be expected to experience mortality, while a small percentage may be affected, but will survive. In contrast, it is expected that some older tadpoles will be killed, while some will be affected, but will survive.

Adult mountain yellow-legged frogs that are not captured and moved will not be expected to be harmed when rotenone is applied at normal concentrations (Farringer 1972; Billman *et al.* 2012), because frogs primarily breathe through skin and they can leave the water. Adult amphibian skin may be more of a barrier to rotenone than gills due to skin having a smaller relative surface area and a greater relative distance for rotenone to diffuse across (Fontenot *et al.* 1994). In addition, CFT Legumine™ application concentrations of 1 ppm (= 50 ppb rotenone) in streams and 4 ppm (= 200 ppb rotenone) in lakes do not exceed the 24 hr LC_{50} concentration of 240 to 1,580 ppb rotenone for northern leopard frog adults (Farringer 1972). As with tadpoles, mountain yellow-legged frog adults are expected to have similar rotenone LC_{50} concentrations as leopard frog adults. Therefore,

piscicide treatment will not be expected to kill a significant number of adults, although this remains possible.

Amphibian eggs are thought to be less sensitive to rotenone because their rate of chemical uptake from water is much lower than tadpoles or fish (Ling 2003). In addition, piscicide treatments are expected to be conducted in August or September, after all mountain yellow-legged frog eggs will have hatched. Piscicide treatments are therefore expected to have no effect on mountain yellow-legged frog eggs.

Due to the distance between treatment sites and extant mountain yellow-legged frog populations, individuals present in untreated waterbodies adjacent to piscicide treated waterbodies are expected to be able to move into the treated areas with no adverse effects within several days after the treatment is concluded (Pope and Matthews 2001). If any mountain yellow-legged frogs arrived within one to two days after treatment, they likely will be adult or subadult frogs (not tadpoles), which do not have gills and thus will be expected to not be affected by habitat conditions.

The eradication of non-native trout from the piscicide treatment waterbodies will provide a large increase in habitat for the mountain yellow-legged frogs occupying these basins, with corresponding benefits over time of enhanced survival, growth and reproduction, including population increase above pre-treatment levels within one year (Billman *et al.* 2012). Many of the waterbodies eradicated of fish will be large, deep and/or cold waterbodies that will provide substantially enhanced habitat for remnant mountain yellow-legged frog populations currently restricted to small, shallow ponds. Treatment will create large areas of fishless habitat with high capacity to buffer drying and warming expected over time, thus allowing for the persistence of mountain yellow-legged frogs in a period of rapid and unprecedented change.

The adverse effects to individual frogs and tadpoles realized incidental to the restoration activities implemented during this project will thereby be offset substantially by the long-term beneficial effects on mountain yellow-legged frogs in the 85 additional treated waterbodies and 31 miles (50 kilometers) of streams, due to: 1) expected increases in existing mountain yellow-legged frog populations to more robust (less-vulnerable) sizes in response to non-native trout removal, and 2) the expansion of frog ranges within SEKI along with establishing more metapopulation-level resiliency as extirpated mountain yellow-legged frog populations are reestablished in restored high elevation habitat.

Given all these considerations, it is evident that the adverse effects to some individuals lost to fish eradication activities (mostly gill netting by catch) will be offset in the long term at the population level by the benefits of habitat restoration activities inherent in this project design. Although there is a temporary degradation in water quality affecting this PCE for mountain yellow legged frog in streams where chemical fish eradication is conducted, this impact is more than counterbalanced by the intended purpose and benefit from the action—the removal of predatory/resource competitor fish from frog habitat and a return to natural community dynamics under which these frogs evolved.

<u>Proposed Critical Habitat for the Mountain yellow-legged frog complex</u>

The proposed action specifically targets treatments of two PCE's, or key components of the proposed critical habitat that provide for the conservation of the mountain yellow-frog complex:

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1) Aquatic habitat for breeding and rearing, and 2) Aquatic nonbreeding habitat (including overwintering habitat). By removing non-native fish that prevent Sierra Nevada yellow-legged frog and northern DPS of the mountain yellow-legged frog from surviving in aquatic features proposed for treatment, the proposed treatments will enable each treated water body or aquatic feature to support new populations Sierra Nevada yellow-legged frog and northern DPS of the mountain yellow-legged frog in the future. The proposed action thus will result in a substantial increase in the value of each key component to provide for the conservation of Sierra Nevada yellow-legged frog and northern DPS of the mountain yellow-legged frog because a primary stressor is being removed from the habitat.

Yosemite Toad

Yosemite toads were recently detected in two basins (McGee and Upper Evolution) proposed for treatment (USGS unpubl. data), but are not expected to be present in any of the remaining treatment basins. All of the treatment waterbodies in McGee Basin and most of the treatment waterbodies in Upper Evolution are proposed for physical fish-removal (e.g., gill netting, electrofishing, disruption or covering of redds, and fish traps). The recent detections of Yosemite toads in these areas was in habitat adjacent to the proposed treatment waterbodies in Upper Evolution, and in habitat on the edge of the proposed treatment waterbodies in McGee. Thus, there is low potential for Yosemite toads to be adversely affected by gill netting and electrofishing in McGee and Upper Evolution. Although toad numbers are very low in these basins, and their behavior and life history do not render them particularly vulnerable to these activities, there is potential for a small number of Yosemite toads to be harassed, harmed, injured, killed, or experience significant disruption in behavior as they are caught in gill nets and/or electrofishing fields during the treatment period in these areas.

Two stream sections in Upper Evolution are proposed for fish removal using piscicides, and thus there is potential for Yosemite toads to be affected by a piscicide treatment in this treatment area. However, the treatment will be conducted in August or September, after all Yosemite toad adults will have finished breeding and likely moved from aquatic to nearby terrestrial habitat, which is their typical post-breeding behavior (Kagarise Sherman 1980). In addition, many and potentially all tadpoles will have metamorphosed into juvenile toads, which also often move from breeding ponds to adjacent terrestrial habitat. Furthermore, if any individuals are observed in treatment habitat, they will be captured and moved, which will further reduce the number Yosemite toads that will be affected by the treatment. These situations and mitigation measures make it unlikely there will be an adverse effect on this species overall, or within the action area.

Nevertheless, if Yosemite toad tadpoles are present, and they cannot be captured and moved, they will be injured or killed by the treatment. Although no rotenone toxicity data exist for toad species, Yosemite toad tadpoles are likely to have similar 24 hr LC_{50} concentrations as leopard frog tadpoles (5 to 30 ppb rotenone). Although CFT Legumine™ application concentrations (streams = 50 ppb rotenone; lakes = 200 ppb rotenone) exceed the expected 24 hr LC_{50} concentration for Yosemite toad tadpoles, tadpoles present in August or September will be older tadpoles. Therefore, if any tadpoles are still present at that time of year in the treatment site, the treatment will result in some tadpoles being killed, while some are affected but will survive.

If adult toads are present, and they are not able to be captured and moved, they will not be expected to be harmed by the treatment. Yosemite toad adults likely have similar 24 hr LC_{50} concentrations

as leopard frog adults (240 to 1,580 ppb rotenone). CFT Legumine™ application concentrations (25 to 50 ppb rotenone) do not exceed the expected 24 hr LC_{50} concentration for Yosemite toad adults. Therefore, Yosemite toad adults exposed to the piscicide treatment may be affected, but most will survive.

Although conservation measures are expected to minimize any treatment effects on individuals in the two populations adjacent to the treatment waterbodies, the project has the potential to have effects on individual Yosemite toads if they are within the treatment areas during gill-netting and piscicide application.

Proposed Critical Habitat for the Yosemite Toad

The proposed action specifically targets treatment of PCE's, or key components of the proposed critical habitat that provide for the conservation of the Yosemite toad: 1) Aquatic habitat for breeding and rearing. By removing non-native fish that prevent the Yosemite toad from surviving in aquatic features proposed for treatment, the proposed treatments will enable each treated water body or aquatic feature to support new or increased populations of this species in the future. The proposed action thus will result in an increase in the value of each key component to provide for the conservation of Yosemite toad because a primary stressor is being removed from the habitat.

Little Kern Golden Trout

A trout population with a small fraction of Little Kern golden trout genes within its genome occurs in one of the treatment basins (Crytes). However, this population is an introduced, non-native population occupying historically fishless habitat that is not a component of the recovery plan for this species (Christenson 1984) and the site is not located within critical habitat. Recent genetic analysis (Erickson *et al.* 2010) shows this population is heavily introgressed and evidencing high levels of genetic drift, indicating it is not genetically pure, and in fact genetically very dissimilar to pure Little Kern golden trout. Therefore, the trout in Crytes Basin have no potential value for current or future restoration of Little Kern golden trout within its native range. This population's genetic content cannot be feasibly be restored to its non-introgressed state, and it is highly unlikely the Service will approve introducing these fish to their native range, as it will lead to further introgression of non-native genes into the pure Little Kern golden trout populations. The SEKI Restoration Plan will eradicate these fish from Crytes Basin using a combination of physical methods, including gill netting and electrofishing in one lake and one lake/pond complex, and piscicides, in the form of rotenone in adjacent stream and marsh areas. This fish population in the lake/pond complex will be eradicated by these activities.

Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. During this consultation, the Service identified global climate change and the advance of the chytrid fungus as future non-federal actions that are reasonably certain to occur in the action area of the proposed project. The actions within the SEKI Restoration Plan are designed in part to address these stressors.

Park Superintendent

Conclusion

After reviewing the current status of the Sierra Nevada yellow-legged frog, northern DPS of the mountain yellow-legged frog, Yosemite toad, and Little Kern golden trout, the environmental baseline for the action area, the effects of the proposed SEKI Restoration Plan, and the cumulative effects, it is the Service's biological opinion that the SEKI Restoration Plan, as proposed, is not likely to jeopardize the continued existence of the Sierra Nevada yellow-legged frog, northern DPS of the mountain yellow-legged frog, Yosemite toad, and Little Kern golden trout. The Service reached this conclusion because the project-related effects to the species, when added to the environmental baseline and analyzed in consideration of all potential cumulative effects, will not rise to the level of precluding recovery or reducing the likelihood of survival of the species based on the following:

1. The restoration of mountain yellow-legged frog habitat through eradication of non-native trout will result in substantial improvement in mountain yellow-legged frog habitat quality and connectivity in the treatment basins, and eventually lead to greater metapopulation abundance and resiliency.

2. The relatively short duration (1 to 4 years) of fish eradication activities in each fish eradication basin will minimize the duration and frequency of adverse effects on listed species.

3. The potential effect upon a very small percentage of each mountain yellow-legged frog population is outweighed by the potential for expansion of these populations to the restored habitat.

4. The limited areal extent of project activities within fish eradication basins represents a relatively small percentage of the number of basins with extant frogs in SEKI, and smaller percentage of the number of populations across the ranges of both species.

5. All fish eradication, frog restoration and frog-occupied waters, and nearby waters, will be monitored in this Plan to continue documenting the recovery, distribution, and population and disease status of mountain yellow-legged frog populations.

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After reviewing the current status of proposed critical habitat for the Sierra Nevada yellow-legged frog, northern DPS of the mountain yellow-legged frog, and the Yosemite toad, the environmental baseline for the action area, the effects of the proposed SEKI Restoration Plan, and the cumulative effects, it is the Service's biological opinion that the SEKI Restoration Plan, as proposed, is not likely to destroy or adversely modify proposed critical habitat. The Service reached this conclusion because the project-related effects to the proposed and designated critical habitat, when added to the environmental baseline and analyzed in consideration of all potential cumulative effects, will enhance the value of the affected key components, or PCEs, to provide for the conservation of these species based on the following: (1) effects to essential physical or biological features will be temporary; (2) these actions will not destroy any essential physical or biological features of the habitat; and (3) the Restoration Plan will enhance proposed critical habitat via removing predatory fish. The effects to Sierra Nevada yellow-legged frog and northern DPS of the mountain yellow-legged frog proposed critical habitat are small and discrete, relative to the entire area designated, short in duration, and are expected over time to appreciably enhance the value of the critical habitat for the conservation of the Sierra Nevada yellow-legged frog, northern DPS of the mountain yellow-legged frog, and the Yosemite toad.

INCIDENTAL TAKE STATEMENT

Section 9(a)(1) of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened fish and wildlife species without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service as actions that create the likelihood of injury to a listed species to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. Harm is defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with this Incidental Take Statement.

The measures described below are non-discretionary, and must be implemented by the National Park Service so that they become binding conditions of any grant or permit issued by the NationalPark Service as appropriate, in order for the exemption in section 7(o)(2) to apply. The National Park Service has a continuing duty to regulate the activity covered by this Incidental Take Statement. If the National Park Service: (1) fails to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document; and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the National Park Service must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(3)].

Amount or Extent of Take

The Service anticipates that incidental take of the mountain yellow-legged frogs will include take which is detectable and quantifiable, along with take that will be more difficult to detect because of their life history. Mountain yellow-legged frogs can be difficult to locate due to their cryptic

appearance and finding a dead or injured individual is unlikely due to their relatively small size. Losses of mountain yellow-legged frogs may also be difficult to quantify due to seasonal fluctuations in their numbers, random environmental events, changes in water regime at their breeding ponds, or additional environmental disturbances. The conservation measures described above in the project description will substantially reduce, but do not eliminate, the potential for incidental take of frogs and toads.

Monitoring, Research, and Captive Breeding

Therefore the Service anticipates that any mountain yellow-legged frogs within the action area may be subject to incidental take in the form of non-lethal harm and harassment. In addition, the Service anticipates incidental take of the northern DPS of the mountain yellow-legged frog, the Sierra Nevada yellow-legged frog, and Yosemite toad in the form of capture, harm, and harassment of eggs, tadpoles, subadults, and/or adults inhabiting or utilizing the 55 monitoring/research basins in the Plan at Sequoia and Kings Canyon National Parks. This includes harassment by capture, handling and swabbing up to 1900 individual frogs/year; and capture and PIT tagging up to 1000 frogs/year; and capture, handling and swabbing up to 700 Yosemite toads per year.

Fish Eradication and Piscicide

The Service anticipates quantifiable incidental take in the form of harm, as injury or death, of two (2), not to exceed four (4) egg masses in a given year; eight (8), not to exceed twenty (20) tadpoles in a given year; and eight (8), not to exceed sixteen (16) subadults/adults in a given year for the duration of the project for either mountain yellow-legged frog species from physical fish eradication activities.

The Service anticipates incidental take in the form of harm, as injury or death of forty (40), not to exceed eighty (80) tadpoles in a given year; and five (5), not to exceed ten (10) subadults/adults in a given year for the duration of the project for Sierra Nevada yellow-legged frog from fish eradication activities via piscicide.

The Service anticipates incidental take in the form of harm, as injury or death of sixty (60), not to exceed ninety (90) tadpoles in a given year; and eight (8), not to exceed twelve (12) subadults/adults in a given year for the duration of the project for northern DPS of the mountain yellow-legged frog from fish eradication activities via piscicide.

The Service anticipates incidental take in the form of harm as injury or death of two (2), not to exceed four (4) egg masses in a given year; three (3), not to exceed ten (10) tadpoles in a given year, and three (3), not to exceed six (6) subadults/adults in a given year for the duration of the project for Yosemite toad from physical fish eradication activities.

The Service anticipates incidental take in the form of harm as injury or death of twenty (20), not to exceed forty (40) tadpoles in a given year, and one (1) not to exceed three (3) subadults/adults in a given year for the duration of the project for Yosemite toad from fish eradication activities via piscicide.

The Service anticipates incidental take in the form of harm as death for all individuals of the hybrid Little Kern golden trout in Crytes basin.

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At the end of the first season, the Service and the Park Service will reevaluate the level of incidental take to assess whether anticipated levels of incidental take align with the actual amount of incidental take and whether there is a need for modification or clarification of the conservation measures or authorized incidental take.

Upon implementation of the following *Reasonable and Prudent Measures*, all such take will become exempt from the prohibitions described under section 9 of the Act. Therefore, reinitiation will be triggered if the amount of incidental take is exceeded by the National Park Service.

Effect of the Take

The Service has determined that the level of anticipated take is not likely to result in jeopardy to the Northern Distinct Population Segment of the mountain yellow-legged frog, the Sierra Nevada yellow-legged frog, the Yosemite toad, and the Little Kern golden trout. Effects to proposed critical habitat of the Sierra Nevada yellow-legged frog and northern DPS of the mountain yellow-legged frog will be temporary, and will not destroy any essential features of the habitat but rather the action will enhance the value of the treated aquatic features for conservation and recovery of all three listed amphibians species via removing predatory fish.

Although effects to individual frogs and toads will occur, at a metapopulation level, these will be insignificant. This is because the vast majority of mountain yellow-legged frogs in treatment areas will not be affected by fish eradication activities, and also because the risk is reduced by the conservation measures that will be implemented as part of the project in the immediate and near-term. There is a very low likelihood that incidental take will occur for Yosemite toad during physical and chemical fish eradication. The incidental take that will occur as a result of this project on the Little Kern golden trout at Crytes is not detrimental to the species recovery potential, as this population is genetically distinct from pure Little Kern golden trout, currently exists outside the native range of this species, and restoration of its native genetic heritage of the affected population to a natural state is infeasible. In the long-term, the positive impacts from habitat restoration in these high elevation basins indicate this project will have cumulative net benefits to the mountain yellow-legged frog. Overall, the actions are expected to substantially benefit these two species through the eradication of non-native trout, and implementation of the suite of active frog restoration methods recommended in the mountain yellow-legged frog Conservation Strategy (Service in preparation).

Reasonable and Prudent Measures

All necessary and appropriate measures to avoid or minimize effects on the Sierra Nevada yellow-legged frog, northern DPS of the mountain yellow-legged frog, Yosemite toad, and Little Kern golden trout resulting from implementation of this project have been incorporated into the project's proposed conservation measures. Therefore, the Service believes the following reasonable and prudent measure is necessary and appropriate to minimize incidental take of the Sierra Nevada yellow-legged frog, northern DPS of the mountain yellow-legged frog, Yosemite toad, and Little Kern golden trout:

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All conservation measures, as described in the biological assessment and restated here in the Project Description section of this biological opinion, shall be fully implemented and adhered to. Further, this reasonable and prudent measure shall be supplemented by the terms and conditions below.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the National Park Service must ensure compliance with the following terms and conditions, which implement the reasonable and prudent measure described above. These terms and conditions are nondiscretionary.

1. The National Park Service shall implement the Conservation Measures as described in this biological opinion.

2. Mountain yellow-legged frog surveys, including capture and handling for measurements and examining for infections, shall follow the guidelines found in Knapp and Matthews (2000) as revised during the life of this project, or other guidelines as authorized by the Service.

3. The use of PIT-tagging and the injection of colored elastomers are authorized to mark individual mountain yellow-legged frogs, and shall be implemented in the following manner:

   a. No mountain yellow-legged frogs less than 4 centimeters snout-vent length (SVL) shall be PIT-tagged. PIT tags of appropriate size shall be used (8-12 mm).

   b. Crews shall note any physical or behavioral changes to individual mountain yellow-legged frogs that could possibly be attributed to the insertion of PIT tags or injection of colored elastomer, such as swelling, bleeding, infection, or changes in swimming ability. This information shall be included in the annual reports.

   c Tissue samples for genetic research may be collected from tadpoles or adult mountain yellow-legged frogs. Tissue samples may be collected from swabbing the skin surface. Alternatively, for genetic research that may require a larger individual sample, clipping of a single toe from post-metamorphs to obtain tissue samples shall be allowed with the use of surgical scissors only.

4. Collection of individual mountain yellow-legged frogs for examination and treatment of infectious disease.

   a. All captured individual mountain yellow-legged frogs may be examined, swabbed for determining the presence of infectious disease, and treated if a known or experimental treatment is available. Dead or moribund individual mountain yellow-legged frogs should also be swabbed, if practical, to determine cause of death.

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b. If individual mountain yellow-legged frogs are found to have signs of infection or determined to be infected by chytrid fungus (chytridiomycosis), they may be treated using itraconazole. Individuals may be retained in specially designed cages at the collection site for up to two weeks while being treated. Treatment method may vary; however, the field crew must have suitable experience conducting the treatment method.

5. For the captive rearing and translocation program:

a. All collection, transport, captive care, and release activities will follow the associated methods and protocols specified in the translocation plan as described in Knapp *et al.* (2011) and the Conservation Strategy (Knapp, Appendix A *in* Service in preparation). Any deviation from these methods and protocols requires prior approval from the Service.

b. The National Park Service, and all captive rearing facilities, shall assure to the maximum extent practicable that all individuals removed will not contract a disease, unless that is part of the immunization procedure for disease treatment. Potential threats to the mountain yellow-legged frog regarding the introduction and/or spread of disease shall be closely monitored.

c. Only individuals removed from the wild for captive rearing that are sick, injured, or have no reasonable prospect of being reintroduced to the wild may be euthanized for scientific research and vouchering of specimens, or if deemed fit enough, used for display or public outreach by the holding facility.

d. The San Francisco Zoo, Oakland Zoo, or other facility authorized by the Service may receive mountain yellow-legged frogs for captive rearing and husbandry pursuant to this Biological Opinion. The following measures shall be implemented by the facility(ies).

i. All proposed captive rearing activities for the upcoming season will be submitted in writing for review and approval by the Service and the California Department of Fish and Wildlife. The Service will be notified via email within 24 (24) hours following delivery of individual mountain yellow-legged frogs to the captive facility(ies). Notification will include numbers and lifestages of individuals delivered, condition and status of individuals, and collection location. In emergency situations, injured individuals shall be delivered first to a qualified veterinarian or Service approved biologist.

ii. The number of individual frogs taken into captivity annually will not exceed the capacity of the facility(ies) to provide adequate care and husbandry as determined by the Service.

iii. Individuals will be transferred to the captive facilities and returned to the wild using appropriate methods to avoid and minimize harassment, death and injury to the animals. Carrier containers shall keep the individual individuals cool, adequately hydrated, and free from injury or death due to contact with protruding or sharp objects within the interior.

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iv. Incoming individuals displaying signs of any infectious pathogens shall be immediately separated upon observation and kept physically isolated (quarantined) from any living amphibians residing in the facility(ies), including mountain yellow-legged frogs from other locations. Infected individuals will be treated by a veterinarian, or by a qualified technician under instruction of a veterinarian, until the individual is evaluated as free of the infection.

v. Individuals will be held in an American Zoological Association-approved tank or natural display.

vi. Once in captivity, individual frogs will not, under any circumstances, be bred in captivity without the written permission of the Service.

vii. All handling shall be done in an expedient manner with minimal harassment and injury to the individuals being handled. The hands and arms of all workers handling frogs shall be free of lotions, creams, sunscreen, oils, ointment, insect repellent, or any other material that may harm frogs.

6. For emergency salvage of mountain yellow-legged frogs:

   a. Only pools that have been determined to be unable to continue supporting eggs or tadpoles until the wet season shall be considered for salvage actions. These pools shall be monitored by SEKI field crews to determine drying rates and assess predation pressures. The National Park Service will have discretion on the timeline for further action.

Monitoring:

In order to monitor whether the amount or extent of incidental take anticipated from implementation of the project is approached or exceeded, the National Park Service shall adhere to the following reporting requirements. Should this anticipated amount or extent of incidental take be exceeded, the National Park Service must immediately reinitiate formal consultation as per 50 CFR 402.16.

1. For those components of the action that will result in habitat degradation or modification whereby incidental take in the form of harm is anticipated (i.e., fish removal by piscicides), the National Park Service will coordinate with the Service before each annual piscicide fish eradication action is anticipated. Once a piscicide eradication is initiated, it may be followed through to completion, per the project description in this biological opinion, unless the take limit is exceeded during that action, indicating the need for immediate coordination with the Service, and reinitiation. Updates shall also include any information about changes in project implementation that result in habitat disturbance not described in the Project Description and not analyzed in this Biological Opinion.

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2. For those components of the action that result in direct encounters between listed species and project workers and their equipment, whereby take in the form of harassment, harm, injury, or death occurs that has not been analyzed in this Biological Opinion, the National Park Service shall immediately contact the Chief Endangered Species Forest Division, at the Service's Sacramento Fish and Wildlife Office at (916) 414-6600 and via email to report the encounter. If encounter occurs after normal working hours, the National Park Service shall contact the Service at the earliest possible opportunity the next working day.

3. The National Park Service will provide the Service an annual report of incidental take associated with project activities covered by this biological opinion, which shall include: summary of project activities, total numbers of animals captured/swabbed/tagged/sampled, and the total numbers of individuals accidentally killed or injured. The annual report is due by February 28 of the succeeding calendar year for which the prior field season's activity is being reported.

4. The National Park Service will provide either: 1) interim documents every five (5) calendar years from the date this project is approved that will include: (a) summary discussions of significant research results; (b) maps and descriptions of completed and ongoing actions; (c) results of restoration efforts, including estimates of population sizes, if appropriate; (d) other pertinent observations regarding the status or ecology of the species; *or* 2) regularly disseminate the required information as part of (ongoing) annual Conservation Strategy meeting updates with the Service and other agencies per the adaptive management process established in that document.

5. Should incidental take averages indicate higher than anticipated levels of incidental take trending above the authorized ten year incidental take estimates, the National Park Service will coordinate during the off season with the Service to evaluate trends, adjust activities, or reinitiate consultation to ensure compliance under the Act.

6. The National Park Service will provide, no later than ten (10) calendar years following the first complete year of implementation of project activities, information to the Service indicating project performance, including beneficial impacts in terms of areas of habitat restored, and any population level benefits observed, trends and study findings from monitoring and research, in order to evaluate the beneficial effects to frog populations from overall project activities in the context of incidental take. This project summary report will also include: (a) summary discussions of significant research results; (b) maps and descriptions of completed and ongoing actions; (c) results of restoration efforts, including estimates of population sizes, if appropriate; and (d) other pertinent observations regarding the status or ecology of the species. Presuming SEKI begins this project his season, the calendar date of the first interim project report will be February 28, 2026.

7. The Service must be notified as soon as possible if large numbers of the northern DPS of the mountain yellow-legged frog, and/or Sierra Nevada yellow-legged frog are found injured, sick or dead (e.g., due to illness, chemicals, or other factors), foul play is suspected, or unauthorized take

of any listed species is observed or suspected. For such incidents, notification should be made by a National Park Service biologist, National Park Service law enforcement ranger, or other qualified National Park Service personnel. We recognize that the activities in this project will occur in the back country a substantial distance from roads, telephones, and cellphone service for long periods of time, so the notification should be made as soon as practicable. The report of the incident should include the date(s), location(s), habitat description, photographs, maps, preserved specimens (if possible), and any other pertinent information. The Service contact is the Chief of the Endangered Species Division (Forest) at the Sacramento Fish and Wildlife Office at (916) 414-6621.

Deviations from these terms and conditions may be authorized in writing by the Service as an appendage to this biological opinion.

The reasonable and prudent measure, with its implementing terms and conditions, is designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take described for each species in the Amount or Extent of Take section is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The National Park Service must provide an explanation of the causes of the taking as soon as possible and review with the Service the need for possible modification of the reasonable and prudent measure.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities that can be implemented to further the purposes of the Act, such as preservation of endangered species habitat, implementation of recovery actions, or development of information and databases. The Service has the following recommendations:

1. The National Park Service should continue to assist the Service in implementing the Conservation Strategy and, where applicable, recovery plans for the Northern Distinct Population Segment of the mountain yellow-legged frog, Sierra Nevada yellow-legged frog, Yosemite toad, Little Kern golden trout, and the Sierra Nevada bighorn sheep.

For the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, we request notification of the implementation of any of the conservation recommendations.

REINITIATION – CLOSING NOTICE

This concludes formal consultation on the Restoration of Native Species in High Elevation Aquatic Ecosystems Plan and Final Environmental Impact Statement in Sequoia and Kings Canyon National Parks for the endangered northern Distinct Population Segment of the mountain yellow-legged frog,the endangered Sierra Nevada yellow-legged frog, the threatened Yosemite toad, the threatened Little Kern golden trout, and the endangered Sierra Nevada bighorn sheep. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required where discretionary Federal agency

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involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

This concludes formal conference on the effects of the Restoration of Native Species in High Elevation Aquatic Ecosystems Plan and Final Environmental Impact Statement in Sequoia and Kings Canyon National Parks for the proposed critical habitat for the mountain yellow-legged frog Pursuant to 50 CFR § 402.10.10(d), you may ask the Service to adopt this conference report as a biological opinion issued through formal consultation if the proposed critical habitat is designated as critical habitat. The request must be in writing. If the Service reviews the Restoration of Native Species in High Elevation Aquatic Ecosystems Plan and finds that there have been no significant changes in the action as analyzed, the Service will adopt the conference report as the biological opinion for the critical habitat.

If you have any questions about this biological opinion and conference opinion on the Restoration of Native Species in High Elevation Aquatic Ecosystems Plan, please contact Steven Detwiler, Senior Scientist, Forest/Foothill Division at the letterhead address, via email (steven_detwiler@fws.gov), or at telephone (916) 414-6569; or Chris Nagano, Chief, Endangered Species Division (Forest) via email (chris_nagano@fws.gov), or at telephone (916) 414-6621.

cc:
Daniel Boiano, Sequoia and Kings Canyon National Park, Three Rivers CA
Nancy Hendricks, Sequoia and Kings Canyon National Park, Three Rivers CA
Laura Patterson, California Department of Fish and Wildlife, Sacramento CA
Marguerite Gordus, California Department of Fish and Wildlife, Fresno, CA
Rob Grasso, Yosemite National Park, Yosemite, CA

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APPENDIX M: CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD COORDINATION

In December 2013, the Central Valley Regional Water Quality Control Board (CRWQCB) submitted substantive comments on the Restoration of Native Species in High Elevation Aquatic Ecosystems Draft Environmental Impact Statement (Restoration Plan/DEIS). Park staff contacted a representative from the Board to seek a better understanding of their comments and to help determine what permits would be needed under each alternative.

The Central Valley Regional Water Quality Control Board would determine whether to grant Waste Discharge Requirements and whether the proposed piscicide treatments are consistent with provisions for piscicide treatments in the Water Quality Control Plan for the Tulare Lake Basin and the Sacramento River Basin and San Joaquin Basin.

Prior to project implementation, SEKI would obtain the necessary permits. If piscicide applications are approved, a project-specific National Pollutant Discharge Elimination system (NPDES) permit for rotenone application would be obtained. The NPDES permit for the proposed treatments would contain receiving water limits applicable to rotenone projects as contained in the Tulare Basin, and Sacramento and San Joaquin Plans (CRWQCB). It would also require water quality monitoring to verify compliance with receiving water limits within the project area and in downstream waters both during and after the treatment.

If blasting of rock underlying a natural cascade to create a vertical fish barrier is selected for implementation, the parks would obtain a Section 401 Water Quality Certification from the Central Valley Regional Water Quality Control Board in order to be permitted to alter a stream course.

The following is the correspondence related to coordination with the Central Valley Regional Water Quality Control Board on the proposed project.

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United States Department of the Interior

NATIONAL PARK SERVICE
Sequoia and Kings Canyon National Parks
47050 Generals Highway
Three Rivers, California 93271-9651
(559) 565-3341

IN REPLY REFER TO:

1.A.1.

May 20, 2016

Debra Mahnke
Central Valley Regional Water Quality Control Board
1685 East Street
Fresno, California, 93706

Dear Debra:

We would like to provide you with an update on our Restoration of Native Species in High Elevation Aquatics Ecosystem Plan and Final Environmental Impact Statement (Restoration Plan/FEIS). In December 2013, you submitted substantive comments on our draft environmental impact statement (EIS) and Restoration Plan. We have spent the past two years reviewing the comments, preparing responses, and updating the plan based on the input we received during the 2013 public review period. We have also completed a peer review of the Restoration Plan, involving outside agencies and universities. We will send you a full copy of the updated Restoration Plan/FEIS when it is available later this summer.

We appreciate your close review of the document and your thoughtful comments, and your follow up telephone conversations with our environmental protection specialist Nancy Hendricks, and our aquatic ecologist Danny Boiano to help address your questions.

We are using our EIS as an Environmental Impact Report (EIR) per the California Environmental Quality Act (CEQA) to allow us to proceed with state permitting once an alternative is selected. If we receive approval for the plan with a Record of Decision, we will initiate the necessary permitting, including a National Pollutant Discharge Elimination System (NPDES) permit for the discharge of aquatic pesticides (piscicides) to waters of the United States. If the project is approved, we expect the permitting effort to begin this fall.

If approved, piscicide treatments in the Restoration Plan/FEIS would follow guidance and standard operating procedures documented in Planning and Standard Operating Procedures for the Use of Rotenone in Fish Management (Finlayson et al. 2010) and project plans used at North Cascades National Park (NPS 2015) and Silver King Creek, California (FWS 2010). We have included the detailed piscicide treatment protocols, which will be appendix N in the Restoration Plan/FEIS, for your information. Piscicide application would be carried out in a manner that strictly adheres to practices permitted by the product labeling, including use of personal protective equipment (PPE) for applicators, controlling public access during application, determining the maximum necessary application concentrations, and all other applicable guidelines. Experienced piscicide applicators would be directly involved in piscicide treatments in SEKI, and all treatments would be managed by applicators certified by the state of California to apply piscicides in state waters. Though not a requirement for federal land managers, we

believe this certification would help us to ensure applications are correct and best management practices are applied during treatment activities. All of the restoration crew working with piscicides would be trained in proper use of PPE, product safety measures, and they would operate under the direction of the certified applicator(s) and in accordance with project safety plans or job hazard analysis.

The key revisions in this Restoration Plan/FEIS made in response to comments received during the public review of the draft plan and EIS are summarized below:

Chapter 1 – Purpose and Need —Updated with clarified text for plan goals, objectives, and background. Figure 2 has been updated to reflect one additional year of data (2013). Figure 4 has been updated to reflect two additional years of data (2012 and 2013) and corrected to account for re-analysis of the survey data. Table 4 has been updated to include additional information obtained since 2013. The Issues and Impact Topics section has been updated to include information from the public review period.

Chapter 2 - Alternatives — Updated to include clarified, revised or additional information in the following sections: Elements Common to All Action Alternatives, alternative B (preferred), alternative C, alternative D, and Alternatives Considered But Dismissed From Detailed Analysis. The primary topics include site assessments, restoration of mountain yellow-legged frogs (MYLFs), monitoring, fish disposal, and piscicide use (including methods for treatment and monitoring for invertebrates and water quality).

Specific changes for fish eradication in alternative B (preferred) include:

- Total number of fish eradication waterbodies decreased from 87 to 85;
- Total acreage of fish eradication waterbodies decreased from 708 to 634;
- Total number of fish eradication stream miles decreased from 41 to 31;
- Number of physical treatment waterbodies increased from 49 to 52;
- Acreage of physical treatment waterbodies increased from 483 to 492;
- Number of physical treatment stream miles increased from 14 to 15;
- Number of piscicide treatment waterbodies decreased from 38 to 33;
- Acreage of piscicide treatment waterbodies decreased from 225 to 142;
- Number of piscicide treatment stream miles decreased from 27 to 16;
- Number of physical treatment lake basins increased from 15 to 17;
- Number of piscicide treatment basins decreased from 11 to 9;
- Physical treatment in two lakes in Swamp Basin was added. These lakes were proposed but not selected in the Preliminary Restoration of MYLFs project (NPS 2001), and were overlooked when the Restoration Plan/DEIS was developed;
- Treatment in the outlet of Horseshoe was changed from physical to piscicide, based on the basin site assessment completed in late summer 2013 (after the Restoration Plan/DEIS was developed);

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- Piscicide use in Barrett, Slide, and Tablelands was removed after re-evaluating the habitat restoration needed in each area and determining that sufficient restoration could be achieved with a decrease in the proposed fish eradication area, which would allow for the project objectives to be met using physical fish eradication methods.

Specific changes for restoration of mountain yellow-legged frogs in "Elements Common to All Action Alternatives" include 1) clarifying methods for frog translocations and antifungal treatment, and adding methods for capture-mark-recapture surveys, captive rearing and immunizations, salvaging drought-threatened populations, and garter snake relocation; and 2) increasing (from 40 to 55) the number of basins containing fishless habitat important for conservation of MYLFs and other native species. The methods added had not emerged as recommended restoration actions in the MYLF Conservation Strategy when the Restoration Plan/DEIS was published in 2013, but were developed and included in the now nearly-complete strategy, expected for publication in 2016 (FWS in preparation). Similarly, the 15 basins added were either identified in the strategy as frog conservation areas or were known to have been recently occupied by MYLFs, and thus all are good potential frog recovery sites.

Chapter 3 – Affected Environment — This chapter has been updated to clarify, revise, or add information.

Chapter 4 – Environmental Consequences — This chapter has been updated to clarify, revise or add information in the following impact topics: special status, wildlife (vertebrate and invertebrate sections), wild and scenic rivers, water quality (related to the federal and state antidegradation policies and beneficial uses), wilderness character, health and safety, visitor experience and recreation, and sustainability and long-term management.

Appendices — All of the appendices of the document have been updated to include clarified, revised or additional information.

To address your specific comments, we have reviewed California Code of Regulations, title 14, section 15126, and the following topics are included in the FEIS:

(a) Significant Environmental Effects of the Proposed Project.
(b) Significant Environmental Effects Which Cannot be Avoided if the Proposed Project is Implemented.
(c) Significant Irreversible Environmental Changes Which Would be Involved in the Proposed Project Should it be Implemented.
(d) Growth-Inducing Impact of the Proposed Project.
(e) The Mitigation Measures Proposed to Minimize the Significant Effects.
(f) Alternatives to the Proposed Project.

The Restoration Plan/FEIS is a NEPA/CEQA compliant document. It discusses significant environmental effects on the proposed project ("Chapter 4, Environmental Consequences") and includes significant environmental effects which cannot be avoided ("Chapter 4 – Environmental Consequences, Adverse Impacts that could not be Avoided") and significant irreversible environmental changes which would be involved in the proposed project should it be implemented ("Chapter 4 – Environmental Consequences, Irreversible or Irretrievable Commitment of Resources"). Mitigation measures are detailed in "Chapter 2 - Alternatives, Mitigation Measures Common to All Alternatives", as are alternatives to the proposed

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project. There is not potential for growth-inducing impact resulting from the proposed project. The project occurs in wilderness and there is no potential for the project to foster population growth or economic growth in the parks' wilderness as a result of project implementation. Therefore we ruled out growth inducing impacts as an issue in this plan under "Impact Topics Dismissed from Further Analysis."

We have updated the "Chapter 3 - Affected Environment" to include information on the designated beneficial uses of the water bodies in the project area, as identified in the Central Valley Water Board's Water Quality Control Plan for the Tulare Lake Basin (Second Edition, revised January 2015) and Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (Fourth Edition, revised June 2015).

We anticipate releasing the final Restoration Plan/FEIS this summer which will be followed by a 30-day no action period. We will be submitting the document to the California State Clearinghouse at that time. Once the 30-day no action period ends, we will forward the document with a recommended alternative to the NPS Pacific Regional Director, who will issue the Record of Decision for the plan.

If you have any questions, please contact aquatic ecologist Danny Boiano at (559) 565-4273 or by email at danny_boiano@nps.gov.

Sincerely,

Woody Smeck
Superintendent

Attachment

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APPENDIX N: PISCICIDE TREATMENT PROTOCOLS

This appendix describes piscicide treatment protocols, data collection, and pre- and post-treatment monitoring methods that would occur only if either alternative B or D in the Sequoia and Kings Canyon National Parks (SEKI) Restoration of Native Species in High Elevation Aquatic Ecosystems Final Environmental Impact Statement (Restoration Plan/FEIS) is selected in the final plan/record of decision.

These protocols are taken directly (with some site-specific modification, especially to species and water quality monitoring plans) from the North Cascades National Park Service Complex *Project Plan: Skymo Lakes Restoration* (NPS 2015C), which uses methods nearly identical to the techniques proposed in this Restoration Plan/FEIS.

All piscicide treatments would strictly adhere to the label requirements for CFT Legumine™ and the detailed protocols found in the Rotenone SOP Manual (Finlayson et al. 2010A). This appendix includes a detailed summary of methodologies planned for (1) pre-treatment, (2) during applications, and (3) post-treatment monitoring. However, this appendix is not intended to be all-inclusive. Further details regarding rotenone and piscicide treatment protocols (including the Rotenone SOP Manual; Finlayson et al. 2010A) are available to the public on the American Fisheries Society Fish Management Chemicals Subcommittee's Rotenone Stewardship Program webpage: http://rotenone.fisheries.org/.

Prior to each piscicide treatment, various surveys and bioassays would be conducted to establish baselines for various physical, chemical, and biological conditions of the treatment area. These surveys would include various water quality and hydrologic assessments and amphibian visual encounter surveys at all treatment sites, and benthic macroinvertebrate and zooplankton surveys at the first two to three treatment sites (and potentially additional treatment sites). Surveys would also be completed after treatments are conducted to assess status of fish removal, water quality, and response of aquatic biota following treatment. In addition, this appendix describes the methodology for safe on-site transport, handling, application, storage, spill response, and deactivation of rotenone (CFT Legumine™), record-keeping for the treatment process, and site close-out operations.

Pre-Treatment Surveys, Bioassay, and Other Tasks

Additional physical, chemical, and biological data would be collected preceding each piscicide treatment to characterize any changes in the physical and chemical conditions of the treatment area that may influence CFT Legumine™ toxicity, and CFT Legumine™ and potassium permanganate ($KMnO_4$) application rates; to provide logistical information to facilitate the project's operations; and to provide baseline data on the status of amphibians prior to treatment. Additionally, for the first two to three piscicide treatments, biological data would be collected to determine the baseline pre-treatment benthic macroinvertebrate and zooplankton assemblages.

Physical, Chemical, Biological Data Collection

The following pre-treatment measurements and surveys would be completed within five days of CFT Legumine™ application to ensure the treatment area conditions are accurately characterized and represented. Further detail on measurements taken can be found in the Rotenone SOP Manual (Finlayson et al. 2010A) and label requirements for CFT Legumine™ (Zoëcon 2015). Additionally, if piscicide use proposed in this Restoration Plan/FEIS is approved, then a full implementation plan would be in place prior to any piscicide treatments.

In brief, data acquisition for these surveys would consist of determining and/or measuring:

- The quantity of rotenone needed for each given lentic habitat by collecting bathymetry data, which would involve:
  - Setup of transects across the waterbody using buoys set at regular intervals,
  - Taking depth measurements at each buoy along each transect,
  - Calculating the average depth based on all depth measurements,
  - Multiplying the average depth by the waterbody surface area to determine treatment volume;
- The quantity of rotenone needed for each given stream reach to be treated, which would involve:
  - Computing stream flow rate (preferably using an electric flow meter).
  - Select exposure time and dilution (generally, flows >25 ft^3/s should use undiluted product and flows <25 ft^3/s should use diluted product),
  - Estimating the amount of rotenone needed and application rate;
- Secchi depth transparency;
- Water temperature, dissolved oxygen, and pH depth profiles;
- Nutrient and chlorophyll-a samples;
- Amphibian visual encounter surveys;
- Water quality samples;
- Littoral benthic macroinvertebrate samples from lakes.

Additionally, benthic macroinvertebrate from lakes and streams, and zooplankton samples from lakes, would be collected in proposed treatment areas and nearby control areas outside of proposed treatment areas. These monitoring efforts would initially occur in the first two to three piscicide treatments. Monitoring would occur one summer before treatment, immediately before and after treatment, and for at least two summers after treatment to more comprehensively characterize the pre-treatment condition, disturbance to, and recovery of these assemblages. For additional information, see the ***Benthic Macroinvertebrates*** section of Post-Treatment Biomonitoring and Evaluation below, and the *Invertebrate Recovery* section at the end of this appendix.

Typically, very few MYLF of any life stage are present in habitats containing fish. Low densities of post-metamorphic frogs are occasionally observed in shallow areas connected to the main waterbody, but inaccessible to fish due to natural barriers (e.g., rock piles or thick emergent vegetation adjacent to the water). Tadpoles are rarely present in fish-containing areas. When present, there are usually only a small number of tadpoles confined to peripheral areas inaccessible to fish (e.g., within boulders at the shoreline). However, immediately prior to any piscicide treatments, visual encounter surveys would be conducted and MYLFs of all life stages would be collected using dip nets and/or seines. Captured MYLFs would be removed from the treatment area and placed in a fishless waterbody in the same basin with the same amphibian chytrid status (i.e., infected or uninfected). (Generally, the presence or absence of amphibian chytrid fungus is the same throughout a basin.) The recipient waterbodies would be disconnected from the treatment area so tadpoles could not swim back into the treatment area, and at least several hundred meters away so frogs would not return to the treatment area within the treatment period.

Benthic macroinvertebrate collections would also occur along with amphibian collection efforts just prior to treatment. Invertebrates would be collected from randomly selected areas within the treatment area using D-ring dip nets. All collected invertebrates would be held at the stream edge in oxygenated aquariums (e.g., plastic bins or plexiglass aquaria) along with substrate collected from their point of capture. Battery-powered aerators would be used to maintain adequate oxygen levels in the aquaria. Once rotenone levels have dissipated following rotenone treatment, invertebrates would be released back to their original point of capture. Although collections like these would not guarantee representative species composition or rare species within the treatment area, this kind of collection could help facilitate benthic macroinvertebrate recolonization of the treatment area.

Project Setup Tasks

Numerous tasks would be completed before the application of CFT Legumine™, including: transportation of personnel and equipment to the project area; verification of conditions in the treatment area (and, if necessary, potential modifications to the treatment plan); set-up and testing of boat application equipment; set-up and calibration of drip stations; set-up and calibration of the rotenone deactivation station; set-up and distribution of live cars (e.g., mesh bags with metal hoops on each end, floats on the top hoop, and a drawstring top to prevent any fish from escaping; Finlayson 2010A) containing sentinel fish (collected on site using a variety of methods, including electrofishers, traps, or seines) that are used to help determine treatment efficacy; locating and setting up sleeping, cooking, and staging areas in a way that minimizes impacts on vegetation and wildlife; posting signs to warn the public around the treatment area; and conducting a pretreatment meeting.

The certified applicator(s) and any individual in a supervisory role during treatments would have attended a piscicide treatment class, typically offered annually. All personnel involved in applying piscicides would receive training related to piscicide treatment prior to being involved in any rotenone treatments (see Safety and Exposure Mitigation section below).

The pretreatment meeting is a critical component of this project and would include: reviewing the treatment plan; reviewing the procedures for the safe handling and application of CFT Legumine™ and potassium permanganate; distributing personal protective equipment and providing instructions on its use; assigning roles to all project personnel and outlining the chain of command; briefing all personnel in the operation of treatment equipment; and completing a Green, Amber, Red (GAR) safety assessment.

Pre-Treatment Bioassay

An on-site bioassay would be conducted to ensure that the CFT Legumine™ is effective and applied in amounts lethal to the target trout species, while minimizing adverse effects on non-target organisms and the environment. The CFT Legumine™ label (Zoëcon 2015) identifies lethal concentrations required to kill many fish species; however, lethal concentrations are affected by environmental and water quality conditions (e.g., pH, alkalinity, water temperature, sunlight exposure) and may require adjustments in the concentration used, given the specific conditions of the treatment area, based on results of the bioassay.

The bioassay would be conducted on-site one day before the treatment. Methods for conducting the bioassay would generally follow those given in Finlayson et al. (2010A; SOP 5 and 14). The bioassay would be conducted using replicate sets of five 95 L plastic totes, filled with 70 L of lake water, and situated in the lake near the shoreline. A stock solution of CFT Legumine™ would be mixed to achieve a concentration of 50 ppb rotenone (the active ingredient)/1 ppm of CFT Legumine™ by adding 1 ml of the CFT Legumine™ concentrate to 1 L of water. The active concentrations of CFT Legumine™ tested and amounts of stock solution that are added to achieve these concentrations in 70 liters of water can be found in Table N-1.

Table N-1. Concentrations of CFT Legumine™ achieved by adding the listed amount of stock solution to 70 L of water.

Concentration of CFT Legumine™	0 ppm	0.25 ppm	0.5 ppm	1.0 ppm	2.0 ppm
Amount of Stock Solution	0 ml	17.5 ml	35 ml	70 ml	140 ml

After the CFT Legumine™ has been allowed to mix in each container, five small trout (<150 mm) of the targeted species would be captured on site (using electrofishers, seines, or traps) placed in each tote and

monitored every 30 minutes for eight hours of exposure time. Changes in coloration, response to stimuli, respiration stress (measured by gill movement), the number of live fish, fish on their sides, and dead fish would be recorded at each monitoring interval. Dissolved oxygen and water temperature would also be measured at the same time. Each tote would be aerated with aeration stones only if dissolved oxygen levels drop below 8 mg/L.

The Minimum Effective Dose (MED), the lowest concentration of CFT Legumine™ that produces 100% mortality of the test fish after 8 hours of exposure, would then be doubled to come up with a treatment concentration in order to ensure all target organisms are killed (Finlayson et al. 2010A).

Material Handling: CFT Legumine™ and Potassium Permanganate

All project staff would be briefed and clearly understand the details on storage, transportation, decontamination, and spill containment prior to treatment following guidance outlined in the Material Data Safety Sheet (MSDS) for CFT Legumine™ and potassium permanganate labels.

Safety and Exposure Mitigation

A successful CFT Legumine™ application results in no exposure to personnel handling the chemical (i.e. mixers, loaders, and applicators) or the public. To ensure adequate protection, all personnel handling CFT Legumine™ would wear personal protective equipment (PPE) as required by the EPA and listed on the product label (Zoëcon 2015), including, at a minimum, long-sleeved shirt, long pants, chemical resistant gloves, goggles, and approved respirators. Additionally, given the remote environment and limited ability to wash field clothing, Tyvek™ suits with hoods will be provided as PPE to minimize the risk of exposure.

To ensure adequate protection of the public, the following protective measures would be put into place:

- The CFT Legumine™ and potassium permanganate product labels and MSDS would be followed;
- The treatment area would be clearly marked and identified with posted signs;
- Public access to the project area would be prohibited during treatment and for up to two weeks following treatment;
- Dead fish would not be consumed;
- Treated water would not be ingested;
- Out-flow from the treatment area would be deactivated with potassium permanganate.

At least two pre-project safety trainings would be held prior to the start of each piscicide treatment and an Operation Leadership risk assessment would be completed with the participation of all personnel. The first training would be held at SEKI headquarters at the start of each project's mobilization. This training would be attended by all personnel who would be involved with handling or transporting the CFT Legumine™ from the storage facility to the field during mobilizations. The second training would be held on site at the project area one day prior to the application of the CFT Legumine™. Topics covered at these meetings would include:

- A review of the CFT Legumine™ product label and MSDS;
- A review of the potassium permanganate product label and MSDS;
- The proper use of the required PPE, exposure control, the safe mixing and application of CFT Legumine™, health effects of the CFT Legumine™ formulation, and first aid measures;
- Environmental considerations including: driving conditions, helicopter safety, water safety, dehydration, sun exposure, safe use of application equipment, radio communication, and situational awareness.

Storage

CFT Legumine™ would be stored in the original five gallon metal containers until it is applied to the treatment area. Prior to transportation to the project area, the CFT Legumine™ would be stored according to the label, with guidance provided in Finlayson et al. (2010A, SOP 4: CFT Legumine™ Storage, Transportation, and Spill Containment Plan) and the MSDS. During transport to the project area the CFT Legumine™ would be stored in the original five gallon containers and inside of a large steel box that is lined with plastic and locked. Absorbent padding would be placed around the containers inside each box. The five gallon containers would be removed from the box the day of treatment and placed in plastic-lined berms located near the shoreline of each lake or stream within the treatment area.

Transportation

A helicopter or packstock would be used to transport the CFT Legumine™, potassium permanganate, and other equipment and materials to each project area. Transport operations would be staged at the packstock corral or helispot (i.e., the landing zone, which will vary depending on the site and act as the staging area) that is closest to each treatment area. The CFT Legumine™ would be transported from the storage area at SEKI's frontcountry headquarters in Ash Mountain to each staging area, packaged in the previously described steel box. The CFT Legumine™ would also be transported from each staging area to each treatment area while packaged CFT Legumine™ in the same steel box configuration.

On-site Transfer and Mixing of CFT Legumine™

All measurement and mixing of the CFT Legumine™ would be done on the day of treatment and over the waters to be treated. For boat application, the CFT Legumine™ would be hand pumped into a graduated bucket and transferred to a 20 gallon tank that is located on each boat. Each tank would then be filled with water so that each tank is mixed with 1 gallon of CFT Legumine™ in 10 gallon of water.

Measurement and mixing of CFT Legumine™ for backpack sprayers and drip stations would also be conducted near the shoreline and/or in a shallow area of the lake. Using a graduated cylinder, 150 ml of CFT Legumine™ would be measured and placed in labeled, opaque, wide-mouth Nalgene bottles. These bottles would then be placed in sealed plastic bags that are packed with absorbent material. On the day of the treatment each packaged bag of CFT Legumine™ would be hand carried to the treatment area that would either be sprayed in the treatment area are or used to charge a drip station.

Spill Response and Containment

In the event of a CFT Legumine™ spill on land or in water, the spill would be controlled and contained as described below. The project manager would document any spill, regardless of the amount spilled. Documentation would include: the amount CFT Legumine™ spilled; specific location of the spill; and the description, date, and time of the spill, and control/containment/cleanup activities. The SEKI Dispatch radio communication center would be immediately notified for spills occurring outside of the treatment area (e.g., enroute from the helicopter staging area to the treatment area). Following the initial contact, SEKI dispatch personnel would make contact with other park staff as described in the SEKI Spill Prevention, Control, and Countermeasure Plan (NPS 2013C). In addition, dispatch personnel would notify the Washington Emergency Management Division as soon as possible after the spill.

If the spill is located in an area accessible to the public then immediate action would be taken to isolate the hazardous area by keeping everyone a safe distance and upwind from the site. After donning the appropriate personal protective equipment, the first step of the spill response team would be to control the flow of CFT Legumine™ by taking all possible steps to stop or contain the leak or spill.

To contain spills on land, staff would stop the spill at its source; dike the liquid in pools with booms; absorb with clay, soil, or other noncombustible, absorbent material. Following containment, the CFT Legumine™ would be deactivated with an oxidizing agent such as potassium permanganate.

To contain spills in water, a determination would be made as to whether or not the location of the spill is designated for immediate treatment. For an accidental spill of CFT Legumine™ into waters not designated for immediate treatment, the project manager would initiate neutralization procedures using potassium permanganate to minimize further contamination (as described in Finlayson et al. (2010A, SOP 7: Determining the Need and Methods for Chemically induced Deactivation). For an accidental spill of CFT Legumine™ into waters designated for immediate treatment, the project manager would note the time of the spill, the amount spilled, and actions taken. Additionally, the project manager and project personnel would keep detailed notes on the effects on sentinel fish in cages and conduct on-site monitoring to determine if material from the spill travels downstream from the treatment area, and thus the immediate need for operating the potassium permanganate deactivation station.

Public Communication

SEKI would follow public notification standards and treatment area restrictions as outlined in the American Fisheries Society (AFS) Rotenone SOP Manual, Supplement 1 (Finlayson et al. 2010A) and EPA label requirements for CFT Legumine™ (Zoëcon 2015). Some of the specific plans for public communication are listed below.

Park personnel would provide multiple news releases regarding individual piscicide treatments to local media outlets and on the SEKI website. At the minimum, a short-term release notice would be provided one to three weeks ahead of the application date (Finlayson et al. 2010A). An additional medium- to long-term release notification may also be provided three to 12 months prior to the treatment date. Media outlets may include local newspapers, radio, and television stations (e.g., those located in Fresno, Tulare, and/or Inyo counties). News releases would include: a description of the project area, the general reason for treatment, name and concentration of rotenone formulation used and the deactivation agent, public and/or water use restrictions, posting procedures, the anticipated amount of time that the area would be affected, and the names and contact information of designated applicator(s) and/or agency contact person(s). Press releases would be provided to media outlets for either voluntary publication or to broadcast to the public.

Notices would be provided to sport shops in park gateway communities via mail, email, or directly-given handbills. Piscicide application would only be conducted within SEKI park boundaries, therefore, no private property owners or water rights holders would need to be contacted separately, since rotenone deactivation and natural degradation would occur long before treated water flows anywhere near private land. Wilderness permit desks and stations would be provided information to inform visitors regarding which areas would be receiving upcoming treatments, the duration of the treatment, and any which areas would be closed to the public during the treatment period.

SEKI and affiliated personnel would also place signs in and around the treatment area to notify the public. Signs would be placed in various locations, including public access points to the treatment area (e.g., trailheads and trail junctions) and/or at least every 250 ft (76 m) along the treatment area. Signs would be placed at least 7-14 day prior to treatment at public access points and on the day of application at the site itself. During treatment, the application area would be off-limits to the public and non-project staff.

According to CFT Legumine ™ label requirements (Zoëcon 2015), application notification signs can be removed and the area can technically be re-opened to the public and non-project staff once application is complete because <90 ppb of active rotenone would be applied. However, SEKI management and affiliated personnel would use their discretion to decide when to remove placards. The site closures would likely average around 7 days after neutralization, but the exact length of closures would vary depending on site-specific characteristics. Generally, there would be a minimum closure time of 72 hrs and a maximum closure time of 14 days.

The notification signs would be made of heavy waterproof stock or laminated paper signs to withstand weather, would be the minimum size necessary to reduce impacts on wilderness, and would include the following information:

- "DANGER/PELIGRO"
- "DO NOT ENTER WATER/NO ENTRE AGUA: Pesticide Application"
- CFT Legumine Fish Toxicant
- The purpose of the application
- The start date and time of application
- The end date and time of application
- "Recreational access (e.g., wading, swimming, boating, fishing, etc.) within the treatment area is prohibited while rotenone is being applied."
- "Do not swim or wade in treated water while placard is displayed."
- "Do not consume dead fish from treated water."
- The name, address, and telephone number of the responsible agency or entity performing the application.
- "DO NOT DRINK WATER/NO BEBA AGUA" signs would be installed during the treatment period (Although rotenone and additives found in CFT Legumine™ are applied at levels well below EPA levels of concern, the parks' decision to advise visitors not to drink water in or near treatments is precautionary and only for a limited amount of time post-treatment.).

CFT Legumine™ Application

Rotenone would be applied as the liquid CFT Legumine™ formulation below water using: (1) a small boat with oars and/or an electric motor for lakes and ponds; (2) direct metering into flowing streams; and (3) hand-held equipment, such as backpack sprayers, in difficult to reach aquatic areas (Finlayson et al. 2000, EPA 2007A). Sentinel fish would be collected prior to the treatment process from the project area using electrofishing units, seines, or fish traps and placed in live car net baskets just upstream of the drip stations to monitor the effectiveness of the treatments. Rotenone would be applied according to label instructions for normal species (trout in this plan), which allow for treatment concentrations up to 1.0 parts per million (ppm) of CFT Legumine™ product [50 parts per billion (ppb) active ingredient rotenone] in flowing streams and standing water (lakes/ponds/marshes; Zoëcon 2015). Piscicide treatments would occur in mid-late summer, with the specific timing determined by site-specific characteristics, including streamflow (targeting lower flows), water temperature (targeting warmer conditions; i.e., late summer conditions, when water temperatures are typically >10°C, NPS unpublished data), and site accessibility.

Liquid rotenone would be applied to lakes and ponds using an inflatable boat. GPS units would be used to place buoy transects that divide lentic waterbodies into manageable sections to more easily keep track of where rotenone would be applied. Rotenone formulations would be pumped (using small electric pumps) below the surface of the lake. Application to streams would also apply a diluted liquid form of rotenone for 4 to 8 hours through a series of metered dispensing stations (gravity-fed) placed at specified intervals along the stream's course. Stations would be placed in secure and stable locations, either on the stream bank or on a stand in the stream channel, and actively monitored by project staff for the duration of the treatment. The drip nozzles of the stations would be placed very close to the water's surface to reduce the potential for piscicide drift to terrestrial environments. Because rotenone breaks down and loses its toxicity within hours in flowing water (Finlayson et al. 2000), drip stations would be placed at intervals between about 0.5 to 2 miles apart (anywhere between 1 and 2 hours of stream travel time) along the stream, depending on conditions, to maintain concentrations lethal to fish. The placement and number of drip stations would be determined at the time of treatment to address current conditions. A non-toxic dye would be used to determine chemical travel time (Finlayson et al. 2010A, SOP 11). Backpack sprayers with hand-held wands would be used to apply highly diluted liquid rotenone in backwater areas along

streams and the littoral zones of lakes where mixing may be incomplete due to minimal water movement. This would help to ensure that untreated refuges do not occur and would minimize the likelihood of project failure from incomplete eradication. When applied from backpack sprayers, small amounts of piscicide are applied directly to the water surface in a small, steady stream (as opposed to an actual spray), which minimizes drift onto terrestrial environments.

The total combined concentration of CFT Legumine™ from boat applications, backpack dispensers, and drip stations would be up to 1.0 ppm in streams and lakes, as required by the product label for normal use given the water characteristics such as pH, temperature, depth, and sensitivity of the target species. The final concentration would be calculated as described in the "Pre-treatment Bioassay" section of this chapter. Based on water quality conditions measured during pre-treatment surveys, the estimated amount of CFT Legumine™ needed to treat each treatment area would be a concentration of up to 1.0 ppm in streams and lakes.

Each treatment area would be divided into application units consisting of lakes and streams. The piscicide would be apportioned to each of these units based on the volume of water contained in the lake treatment habitat, or a combination of discharge and travel time for the stream treatment habitat.

Each application of CFT Legumine™ would begin at approximately 08:00 and would take up to eight hours. For treatment areas with no barriers to fish passage within the treatment area, all application units would be treated at the same time to ensure the fish are continuously exposed to a lethal dose of rotenone downstream to a barrier. For treatment areas with barriers to fish passage within the treatment area, application units can be treated at different times. Deeper lakes may be treated in two stages, with the first stage treating depths below the thermocline and the second stage treating depths above the thermocline. The deep-water treatment is expected to discourage fish from leaving shallower waters and provide better distribution of CFT Legumine™ through the water column. Two boats may be used for this stage, with each boat pumping a diluted CFT Legumine™ solution from tanks via weighted hoses. Boats would follow the buoyed grid system during the application process. Following deep-water treatment, shallow water would be treated with the remaining CFT Legumine™. Shallow lakes would not require a separate treatment below the thermocline.

The lake inlet (up to a barrier) and outlet stream(s) of each treatment area would be treated for 4 to 8 hours and would start at the same time as lake treatments to ensure that fish cannot find a refuge from the piscicide. The outlet stream would be treated with a drip station placed at the start of each outlet and additional stations placed along the stream at appropriately intervals, based on stream travel time to the downstream barrier. Drip stations would consist of a 10 gallon bucket attached to a float controlled dish that has been calibrated to dispense at a consistent flow rate of 80 ml per minute. The amount of CFT Legumine™ added to 10 gallons of water would vary depending on the rate of stream flow (Table N-2). The initial drip station flow rate, amount of CFT Legumine™, and water added to the bucket would be recorded. The flow rate would be monitored, adjusted, and recorded at 1 hour intervals during the 8 hour treatment period.

Table N-2. The total amount of CFT Legumine™ that should be added to 10 gallons of water to treat a stream at 1 ppm for 8 hours at a rate of 80 ml/hour given a range of flows between 0.1 to 1.0 cubic feet per second (cfs).

Stream Discharge (cfs)	CFT Legumine™[1] (ml)
0.1	82
0.2	163
0.3	245
0.4	326
0.5	408
0.6	490
0.7	571
0.8	653
0.9	734
1.0	816

[1]Amount of CFT Legumine™ is calculated as: X = Y(102 F)H where: X = CFT Legumine™ diluted into 10 gallons of water (ml), Y = desired treatment concentration of CFT Legumine™ (ppm), Q = stream discharge (cfs), and H = the duration of the treatment (hours).

Several backpack sprayers would treat shallow (boat inaccessible) areas around each lake shoreline, seeps, and sections of the inlet and outlet stream channel that did not show good dispersal based on pre-treatment surveys. Six backpack spraying applications would be completed at 1.5 hour intervals, beginning at approximately 09:00. Backpack sprayers would be filled with a 2% solution of CFT Legumine™ (mixed as 150 ml CFT Legumine™ to 2 gallons of water).

Monitoring the effects of each treatment would begin shortly after the completion of the lake application and would continue for three days. Sentinel fish kept in live cars (5 fish/cage) would be used to help monitor treatment effectiveness. Live cars would be set the day before treatment to acclimate trout and minimize the potential confounding effects of post-handling stress. Sentinel fish would be checked again immediately before treatment to ensure no trout died overnight. In lakes, live cars would be located near the surface, at mid-depth, and at the lake bottom. To ensure sentinel fish exposure accurately reflects conditions experienced during treatment, live cars would not be checked for at least 24 hours post treatment (i.e., if live cars are pulled up to the surface earlier, trout may be moved through higher piscicide concentrations in shallow areas that may not be present at lower depths, which could confound results). In streams, live cars would be placed in semi backwater areas (if available) just upstream of drip stations. The final live car within the treatment area would be located just upstream of the deactivation site. Additionally, a drift net would be placed across the stream channel at the 30-minute stream travel time distance to prevent fish from leaving the treatment area. The drift net would be checked periodically to remove dead trout and debris.

All dead fish collected would have their swim bladders punctured and would be dropped into the deepest part of each treatment lake and/or deeper adjacent lakes. Data forms for recording rotenone use and monitoring fish sentinel cages would be used. In lakes, numerous gill nets (dependent on treatment lake size) would be continuously fished (checked and reset every 24 hrs) for three days following the treatment day. In streams, electrofishers and visual searches would be used to determine initial treatment effectiveness. Short-term determination of treatment effectiveness would be made if there is 100% mortality of all sentinel fish and no live fish are observed or caught using any survey method

(electrofishers or gill nets). Final determination of treatment success would be made during site revisits in the following two summers.

Rotenone Deactivation

Environmental factors such as pH, sunlight, stream discharge, water temperature, and stream gradient affect the toxicity and breakdown of rotenone. As rotenone travels downstream, light exposure, aeration, and agitation due to the physical movement of the water contribute to the degradation of rotenone and decreases its toxicity. Steep stream gradients would help to deactivate rotenone. In addition, tributaries contributing flow below each treatment area would reduce the toxicity of rotenone through dilution. As an additional precaution, rotenone would be deactivated using liquid potassium permanganate dispensed into the outlet stream below each treatment area.

For a typical piscicide application, 1 ppm of potassium permanganate for every 1 ppm of rotenone formulation used would be applied at the most downstream point of the stream section from which fish removal is desired. In addition to the 1 ppm potassium permanganate used to neutralize the rotenone, another 1 ppm is applied to satisfy the background oxidation demand, and another 1 ppm is applied as residual or buffer. Background oxidation demand is determined using an oxygen meter. Clear and low-productivity waters typical of SEKI's high elevations are expected to have relatively low background oxidation demand, and thus to be satisfied by 1 ppm potassium permanganate. However, in cases where the background oxidation demand is more than 1 ppm potassium permanganate, more neutralizing agent must be used. The typical target concentration for neutralizing a piscicide treatment in a stream is therefore 3 ppm, but in cases where background demand is high it could range up to 4 to 5 ppm. Potassium permanganate would be applied to each stream using a 2.5% solution for deactivation (Table N-3).

The rotenone deactivation station would typically be located at the top of the downstream fish barrier in each treatment area. The station would be operated continually, starting at a certain point after the beginning of each treatment, until rotenone has fully dissipated.

Neutralization occurs within 30 minutes of contact between the treated water and the potassium permanganate, so fish and other aquatic organisms may still be affected by piscicide the distance water moves downstream in 30 minutes. This water would be considered part of the project area. A 1 ppm potassium permanganate residual would be maintained at the 30-minute travel time downstream location by increasing or decreasing the amount of potassium permanganate to ensure complete neutralization of rotenone leaving the project area. A chlorimeter to test for total chlorine can be used for this measurement by multiplying the total chlorine value by 0.89 (Finlayson et al. 2010A, SOP 7, pg. 71: "A less accurate estimate of $KMnO_4$, but an easier approach, is the DPD [N, N-diethyl-p-phenylenediamine sulfate] method for measuring total chlorine. Through the introduction of a powder containing DPD, potassium iodine, and a buffer, the oxidizing potential of the solution is measured spectrophotometrically or using a color wheel. The oxidizing potential of permanganate is about 89% of total chlorine, so results from this method can be multiplied by 0.89 to get an approximate measure of KMnO4 concentrations in water.") One live car of five sentinel fish would be placed just upstream of the neutralization station to confirm rotenone efficacy through the treatment area and to signal when neutralization should commence. Sentinel fish would be replaced at least once per day (Finlayson et al. 2010A, SOP 5) from an oxygenated tank with healthy fish, which will be collected on site (using methods mentioned above) just before treatment begins. Neutralization would be stopped when fish in this live car remain alive and appear unstressed for at least four hours. Additionally, one live car with sentinel fish would be placed at each of 15-minute, 30-minute, and approximately 1-hour flow travel time below the deactivation station as a backup, to ensure fish are not being killed beyond the 30-minute travel time below the deactivation station. Behavior of these fish would alert workers to the efficacy of rotenone deactivation in the stream section below the neutralization station.

Reservoirs with a metering device that can be manually controlled would be used to dispense potassium permanganate. The reservoirs would be initially calibrated prior to operation and adjusted at regular intervals as needed during operation. To calibrate metering devices, the valve on one tank is opened and a large graduated cylinder is used to measure the amount diluted potassium permanganate exiting the drip box over a 15 second period. Immediately before and during operation, the contents of the reservoir would be stirred (with a boat paddle) to ensure that all of the potassium permanganate is in solution. If the reservoirs or metering system begin to precipitate potassium permanganate, the reservoir and lines would be flushed with clean water prior to refilling for the next round.

Stream discharge at the site would be recorded daily before and during operation and adjustments in delivery rates made according to Table N-3. For any given discharge, the weight of potassium permanganate added to each barrel would be calculated and recorded.

Table N-3. Dispensing rates for a 2.5% solution of potassium permanganate calculated for various stream discharge rates to achieve an application rate of 3 ppm.

Stream Discharge (cfs)	Potassium permanganate (g/hr)	Potassium permanganate (g/24 hr)	Dispensing Rate for 2.5% Potassium permanganate Solution[1]		
			ml/min	L/hr	L/24 hrs
0.1	30.5	732	21	1.26	30.24
0.2	61.0	1464	42	2.52	60.48
0.3	91.5	2195	63	3.78	90.72
0.4	122.0	2927	84	5.04	120.96
0.5	152.5	3659	105	6.30	151.20
0.6	183.0	4390	126	7.56	181.44
0.7	213.0	5112	147	8.82	211.68
0.8	244.0	5856	168	10.08	241.92
0.9	274.5	6588	189	11.34	272.16
1.0	305.0	7320	210	12.60	302.40

[1] A 2.5% solution of potassium permanganate is achieved by dissolving 1 pound of KMn04 crystals into 5 gallons of water (25g/L).

[2] The dispensing rate is calculated as: LF = Y * 70 * Q where LF = dispensing rate of 2.5% solution of KMn04 (ml/min), Y = desired concentration of KMn04, and Q = stream discharge.

Rotenone treatments in standing waters (lakes, ponds, and marshes) would not be neutralized within the treated standing water habitats. If the outlet stream(s) of treated standing waters are flowing at the time of treatment, then they would be neutralized with potassium permanganate beginning at approximately 100 ft (30 m) in elevation below the elevation of the lake. This method would allow for natural degradation and breakdown of a substantial amount of rotenone-containing water, and thus less potassium permanganate would be needed to achieve neutralization. Any rotenone that remains in the treated standing water habitats would detoxify through natural degradation and breakdown.

Water Quality Monitoring

During and after rotenone treatments, water quality would be monitored to assess the effects of treatment on surface waters. The monitoring would determine if: (1) effective piscicide concentrations of rotenone have been applied; (2) sufficient degradation of rotenone has occurred prior to the resumption of public contact; and (3) rotenone toxicity has occurred outside the project area. An analytical laboratory would

analyze water samples for rotenone and rotenolone (a common breakdown product of rotenone) (Ling 2003) concentrations as well as for volatile organic compound and semi-volatile organic compound concentrations.

During the treatment and neutralization period, water quality samples would be collected from various locations within the treatment area, and within and below the neutralization area. Sampling locations and collection frequency are specified in the permit. In streams, samples are expected to be collected from at least three locations within the stream treatment reach (top, middle, and bottom), plus three monitoring locations in the neutralization area (two minutes, 30 minutes, and 120 minutes flow time below the neutralization station). In lakes, samples are expected to be collected from the surface and at various depths at several locations throughout each treatment lake. The sample collection frequency is expected to be several times per day, including just prior to treatment, during treatment, and until rotenone degrades to <40 ppb. Following stream neutralization, water samples are expected to be collected once every seven days, until rotenone is no longer detected in samples. For several recent CFT Legumine™ treatments in Silver King Creek, California, water quality samples were non-detect for rotenone within seven days following neutralization (Mussulman S., pers. comm., 2016). It is possible it could take longer in some areas.

Holding times and temperature requirements of water samples would be adhered to. Water quality monitoring would follow the methods of SOP 16 in Finlayson et al. (2010A). These requirements would present a challenge given the remote locations of most of the proposed treatment areas, and the likelihood that storage and processing would take place at a non-local laboratory; however, these challenges have previously been overcome in SEKI wilderness (Clow et al. 2013).

There are several factors that can influence water quality related to the degradation process of the rotenone formula. Those include, but are not limited to: lake vegetation, groundwater influence, ultraviolet radiation, suspended solids, pH, temperature, rotenone travel time, substrate, oxidation-reduction potential, stream gradient, and lake depth and mixing regime (Britton et al. 2011; Brown and Zale 2012; NPS 2013B; Finlayson et al. 2014; Chapter 4, Impacts of Alternative B; Appendix G, Ecological Risk Assessment, Water). Detailed, on-the-ground habitat assessments would be conducted prior to piscicide treatments to ensure applications are at an effective concentration unique to the habitat and its biological and physical properties, and to investigate how these features would influence rotenone's persistence and impact on water quality.

Water quality monitoring would adhere to the state and federal criteria established by the required permit(s) from the California Regional Water Quality Control Board (CRWQCB) and/or EPA in order to conduct piscicide treatments in California. A unique permit would likely be required for each piscicide treatment area. The registration of CFT Legumine™ through the EPA and CDPR results in a product label that stipulates requirements for treatment concentration, duration, neutralization, and placarding (Zoëcon 2015). Permits obtained from the CRWQCB and/or EPA include stipulations for water quality monitoring.

During treatments, access areas to the treatment area would be placarded, and the project area would be closed to the public and all non-project staff. Detailed instructions for placarding are described in the *Communication Plan* section above. Placards would be removed and closures would be lifted once sampling has shown rotenone to be <40 ppb in water samples and/or sentinel trout can survive for 24 hours, which is expected to be a maximum of 7 to 14 days following neutralization (Finlayson et al. 2010A, Zoëcon 2015).

Post-Treatment Biomonitoring and Evaluation

To ensure that all fish have been removed from each treatment area, fish surveys using gill nets, backpack electrofishers, and visual searches would be conducted for two summers following treatment.

To monitor recovery of amphibians resulting from the absence of nonnative fish and possible treatment impacts, amphibian visual encounter surveys would be conducted for two or three summers following treatment.

Benthic Macroinvertebrates: Information to address concerns regarding benthic macroinvertebrates can be obtained using a replicated Before-After-Control-Impact experimental time series using multiple reaches (Green 1979, Underwood 1994, 1997). The following approach would be used in at least the initial two or three basins selected to receive any approved piscicide treatments. If information from the initial benthic macroinvertebrate studies suggests additional monitoring is needed (e.g., there are significant differences among basin benthic macroinvertebrate species assemblages, especially in regard to species more sensitive to piscicides), benthic macroinvertebrate monitoring would continue in subsequent basins proposed for piscicide treatment.

It is important to sample multiple sites within multiple Control and Experimental reaches in each watershed, if possible, to provide replication at the reach scale (Vinson et al. 2010), and such nested replication has been used in the ongoing work at Sixty Lake Basin (Holmquist and Schmidt-Gengenbach 2014). In some small and/or unbranched SEKI streams, it may be difficult to designate multiple experimental reaches, and in these cases replication would need to be at the scale of groups of individual samples within the same reach. Fifteen to twenty sites in each of the two reach categories would generally provide good power (which should be estimated a priori rather than retrospectively; Hoenig and Heisy 2001, Nakagawa and Foster 2004). Control reaches would be upstream of Experimental reaches. Efforts would be made to locate Control and Experimental reaches that are similar in terms of stream order, gradient, substrate, depth, and flow. A stratified random process would be used to select sites from within areas of comparable habitat. If post-sampling analyses indicate differences between Control and Experimental reaches, comparisons can still be made, because pre-application data would be available for both categories of reaches.

Sampling would be done one year before rotenone application (pre-treatment), shortly before and after piscicide application (to evaluate immediate effects), and at least two additional summers following application (to evaluate medium-term effects). In each study year, sampling would be done during the month anticipated for piscicide application (typically August) and during the following month (September). Additional monitoring may occur if time, personnel, and funding allow. Control and Experimental stream reaches would thus typically be sampled in August and September in the year preceding application, immediately before and after August rotenone treatment during the application year, during September of the application year, and in August and September of the year following application.

Control and Experimental stream reaches would thus be sampled multiple times and at multiple places in the years preceding application, immediately before and after rotenone application, later during the application year, and at least two years following application. Use of the Control reaches and multiple, nested, sampling locations, sampling months, and years would allow accounting for natural spatial and intra- and inter-annual variability. Interactions would be of particular interest: for instance, no Control-Experimental differences prior to application, divergence of the Experimental reaches from Before, and Control reaches after, application, followed by a possible reduction in differences with increased time after application.

Data collection in streams would be density-based (Vinson et al. 2010), which would enable a variety of response variables to be assessed, including abundance, richness, dominance, evenness, diversity, rank-abundance, functional feeding groups, responses of individual taxa, algal depth and cover, and siltation, using both uni- and multi-variate approaches. Faunal collections would be made with a standard Surber sampler (Surber 1937, Hauer and Resh 2007, Southwood and Henderson 2000; see also Waddle and Holmquist 2013, Holmquist and Waddle 2013). The Surber sampler is a 0.3 m x 0.3 m quadrat with a connected 0.3 m x 0.3 m framed net that is aligned perpendicular to the substrate. Mesh size is 0.5 x 0.5 mm. The quadrat is pressed against, and demarcates, a portion of the stream bed. The associated substrate is disturbed by hand, and organisms are swept downstream by the current into the net. Samples would be sorted completely in the lab, rather than subsampled, because complete sorting reduces the variance of metrics, increases taxon richness, and improves proportion-based metrics (Courtemanch 1996, Doberstein et al. 2000).

There may be cascading effects of piscicide treatment on algal growth in streams; a proliferation of algae following removal of invertebrate herbivores may occur. A transect 0.5 m upstream of each subsample location would be used for measurement of algal cover and layer using the rapid-assessment methodology of Fetscher et al. (2009). Each transect associated with each Surber sample would include algal thickness measurements and cover estimation at five equidistant points across sampled habitat (Holmquist et al. 2015).

A variety of physical data would be collected at each subsampling site after biological sampling is completed. Depth would be recorded as a mean of four equidistant measurements within the Surber quadrat. Substrate characteristics within each quadrat can be categorized via the Wentworth substrate scale (Allan and Castillo 2007) and embeddedness would also be estimated. A flow meter would be used to measure velocity at 0.6 depth and 0.25 m upstream of each sampler location. Water temperature would also be recorded. Percent tree canopy cover would be determined with a convex spherical densiometer and slope can be estimated with a Suunto clinometer or equivalent. In addition to providing overall habitat information, these physical measurements would be used to test/confirm assumptions regarding habitat similarity between Control and Experimental reaches.

Benthic macroinvertebrate sampling in lakes would follow standard methods, such as those used by Deiner et al. (2013). Samples would be collected in the littoral zone of lakes and taken via 15 sweeps with a D-net outfitted with a 0.5 mm mesh bag. Sweeps will be taken from all available habitat types, and the number of sweeps in a particular habitat type would reflect the proportional availability of that habitat type. For example, if 20% of the littoral zone is made up of silt, three sweeps would be taken from silt habitats.

One standard sweep is about 1 m in one direction, followed immediately by a 1 m sweep in the opposite direction through the same area. Sweeps would be made after vigorously stirring up the substrate. After sweeping, net contents would be transferred into a sorting pan containing lake water. All benthic macroinvertebrates would be removed and placed in a labelled sample bottle.

Samples would for both stream and lake monitoring would be preserved in 95% ethanol and shipped to a reputable laboratory for identification to the lowest possible taxonomic level possible for each taxon collected.

Zooplankton: Zooplankton sample collection and laboratory-based taxon identification would be conducted using the following methods from Knapp et al. (2001). Collections would occur during the day from the deepest portion of the lake using float tubes (small, portable, inflatable rafts).

Samples would be collected by taking vertical tows from the bottom to the surface with a conical plankton net (29.5 cm diameter, 64-mm mesh) in the deepest part of each lake. One to five replicate tows would be made until substantial numbers of zooplankton are present in samples (Stoddard 1987, Bradford et al. 1998). Samples would be preserved in ethanol and shipped to a reputable laboratory for identification to the lowest possible taxonomic level possible for each taxon collected.

Record Keeping and Reporting

Daily records of rotenone and potassium permanganate application would be maintained by staff at each treatment and detoxification station. These records include the following information; date, operator name, station #, flow (cfs), concentration of CFT Legumine™, duration, grams of potassium permanganate/hr, starting time and ending time. Water temperature, rotenone, and comments or observations would be recorded hourly, including any deviations from the treatment plan. All records would be given to the project manager at the completion of each day's work. Information from the records would then be summarized by the project manager.

A final report would be completed after each treatment. The report would include background information on the project, a treatment overview, and steps taken to meet compliance with FIFRA and CWA (NPS 2008D; AOP 10).

Project Close-out Operations

At the conclusion of the final potassium permanganate application and prior to exiting each project area, the field team would gather and remove all items brought into each project area. The project manager would perform a final walk-through of each project area to ensure no chemicals or equipment are left behind. The project manager would have any postings or notices removed no more than two weeks following each treatment.

Piscicide Use Adaptive Management Framework

If alternative B or D is selected, no piscicide treatments would occur until 2017, at the earliest. The estimated implementation timeline of proposed piscicide treatments is shown in chapter 2 (alternative B, Development of the Site-Specific Treatment Plans). An adaptive management approach would allow SEKI to incorporate the results of piscicide treatments in order to adjust future treatments. Results of the monitoring of the initial piscicide treatments would be used to better understand the likely impacts of subsequent treatments, and if necessary, to redesign subsequent treatments to further minimize anticipated impacts. The following describes the approach for implementing a piscicide use adaptive management framework.

Number of Treatments: The general protocol would be to treat habitat once in mid- to late summer, monitor in September, and monitor again in the following early to mid-summer. If live fish are found during the monitoring period, a second treatment would be conducted. If no live fish are found during the monitoring period, then a second treatment would not be necessary. Some of the proposed treatment areas in SEKI are small (e.g., one outlet stream of Upper Bubbs) and one treatment would likely be effective for eradicating all fish. Other proposed treatment areas are larger (e.g., lower portion of Sixty Lake Basin), and while one treatment may eradicate all fish in these areas, additional treatment(s) may be necessary. Whether reapplications may be necessary in a treatment area is based on several site-specific factors, such as fish species, habitat size and complexity, streamflow and gradient, water temperature, water quality, and others. If fish eradication is unsuccessful after three treatment years (initial year plus two reapplication years) at a particular site, then piscicide use would be abandoned at that site.

Treatment Concentrations: One goal is to use the lowest piscicide concentration in each treatment area that still allows eradication of all fish after one treatment. The CFT Legumine™ label stipulates

application concentrations for trout (normal species) to be from 0.5 to 1 ppm of product (25 to 50 ppb active ingredient rotenone). The initial two to three treatments would likely be applied with a target concentration of 1 ppm. If it appears that eradication could have been achieved using less than 1 ppm of product in the initial treatments, then a portion of the next treatment may be treated with a target concentration of 0.5 to 0.75 ppm of product. This would allow testing to determine whether fish eradication could be achieved in certain sites in the lower range of prescribed concentrations, and thus minimize potential environmental effects. Habitat complexity is one factor that may affect whether lower concentrations are feasible.

Treatment Design: Results of initial treatments in SEKI as well as other recent high elevation treatments in the U.S. would be evaluated to inform the implementation design of subsequent treatments. Each new treatment would attempt to use the most up-to-date practices that should maximize the potential for successful fish eradication using the minimum number of treatments and/or the lowest piscicide concentration.

Invertebrate Recovery: To evaluate recovery of benthic macroinvertebrate and zooplankton assemblages resulting from (1) the absence of nonnative fish predation and (2) possible treatment impacts, benthic macroinvertebrate and zooplankton assemblages in streams and lakes in the first two or three treatments would be sampled for two or three summers following each treatment. If results at these study sites show recovery has occurred by the second or third summer following treatment, then macroinvertebrate and zooplankton studies would not be conducted for the remaining piscicide treatments.

Benthic macroinvertebrate and zooplankton "recovery" is defined as the following. *Assemblages in treated habitats largely resemble assemblages in untreated fishless habitats, having a similar number of taxa and abundance. This would suggest that ecological function typically provided by benthic macroinvertebrate and zooplankton assemblages in fishless habitat has returned to the treated habitat; and the treated habitat would thus be in a restored ecological state compared to when it was impacted by nonnative fish.* If results of the initial studies are highly variable, in which some treatments show sufficient recovery of benthic macroinvertebrates and zooplankton but some treatments show poor recovery by the second or third summer following treatment, then invertebrate studies would continue following subsequent treatments until a consistent pattern of sufficient recovery is shown. If the first two or three treatments all show poor recovery of benthic macroinvertebrates and zooplankton by the second or third summer following treatment, then piscicide use in this plan would be re-evaluated.