Appendix O

Gulf Sturgeon Monitoring Report

FINAL REPORT (2012-14)
GULF STURGEON MONITORING STUDY FOR THE PROPOSED PORT OF GULFPORT EXPANSION PROJECT GULFPORT, MISSISSIPPI

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EXECUTIVE SUMMARY

This report describes the Gulf Sturgeon monitoring project that took place from fall 2012 to fall 2014, for the purpose of monitoring the area surrounding the Port of Gulfport (Port), and to determine the use of near shore and project areas by the Gulf Sturgeon. Gulf Sturgeon are known to spend the warmer months in Gulf coastal rivers, and colder months in bays and estuaries, and it was thought that the primary use of potential project areas would consist of transitory individuals during seasonal migrations.

A network of telemetry receivers was placed in an array around the Port (Gulfport array) and further east (east gate) and west (west gate) between the Port and the Pearl and Pascagoula rivers to record the movements of Gulf Sturgeon tagged with VEMCO acoustic tags. The signals sent by the acoustic tags carried by the Gulf Sturgeon were then used to determine their presence within the project area. The tagging efforts, led by Mark S. Peterson (University of Southern Mississippi, Gulf Coast Research Laboratory) and William T. Slack (U.S. Army Engineer Research and Development Center), were concentrated in the Pearl and Pascagoula rivers and we acoustically-tagged 9 fish in the fall of 2012, 25 in 2013 (8 spring/summer, 17 fall), and 6 in summer 2014 (Pearl river only). Of the 40 acoustic tags purchased by the Mississippi State Port Authority (MSPA), only 19 were attached to Gulf Sturgeon (see methods, p. 8) and the remaining 21 tags deployed were from other contemporaneous studies. Seven additional Gulf Sturgeon were captured in summer 2014 and processed minus the acoustic tag because the fish were too small for an acoustic tag (see Table 11).

The first full year of monitoring with the telemetry array was 10 September 2012 through 19 September 2013, and no Gulf Sturgeon with MSPA tags was detected on the entire Gulfport array. However, 10 fish that were part of other ongoing efforts were detected. Also, no Gulf Sturgeon were detected between 1 June and 19 September 2013. Six (all adults) of the fish were detected at the east gate, five (3 adults, 2 sub-adults) at the west gate, and seven (5 adults, 1 sub-adult, 1 juvenile) in the Gulfport array. Each telemetry receiver had between three and six Gulf Sturgeon detected, and there were a total of 12,288 detections among all 19 receivers. Only 3 of 13 (23.1%, pooled by season) tagged Gulf Sturgeon had both a high number of days between first and last detections and a high cumulative detection time within the array.

In Year 2 of the monitoring program (20 September 2013 through 3 September 2014), 17 Gulf Sturgeon were detected in the full array, with only 3 fish with MSPA tags. Nine of the fish (six adult, one sub-adult, and two juvenile) were detected at the east gate; ten fish (eight adult, one sub-adult, and one juvenile) were detected at the west gate; and fourteen fish (nine adult, three sub-adult and two juvenile) were detected in the Gulfport array. Each receiver had between three and nine Gulf Sturgeon detected but only 2,373 detections were recorded on all 19 receivers. No detections were recorded after 2 May 2014. Three of 23 (13.0%, pooled by season) tagged Gulf Sturgeon had both a high number of days between first and last detections and a high cumulative detection time within the array.

Overall, there were markedly fewer total detections in Year 2 than Year 1 data sets even though we documented a greater number of tagged Gulf Sturgeon during Year 2. Four adult Gulf Sturgeon were detected in both years of the monitoring period in the acoustic array; two from the Pearl and two from the Pascagoula drainages. This suggests some level of consistent and repeatable regional-scale movement patterns in Gulf Sturgeon from western Gulf of Mexico drainages. We also detected tagged adult Gulf Sturgeon in the Gulfport array originally captured and tagged in the Escambia, Choctawhatchee or Blackwater drainages, Florida.

The number of detections per fish and time within the array varied greatly among all the detected Gulf Sturgeon, with individuals taking both transitory paths through the array, and localized movements within the entire array. Gulf Sturgeon from each life stage category were detected (adult, sub-adult, juvenile), with adults, unexpectedly, having the greatest number of occurrences and detections. The relative low occurrence of juveniles and sub-adults suggests these life history stages may experience restricted movements away from natal rivers as young fish, and only begin to expand their range later with age. On the other hand, adults have been documented within the project area during pre- and post-migratory periods, illustrating the importance of the area as more than temporary. This suggests that the Gulfport monitored area (habitat) serves as a corridor between other habitat types, drainages, feeding zones, or is used as a pre-/post-migratory acclimation zone.

FINAL REPORT (2012–2014)
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SCOPE OF WORK

This scope of work (SOW) involved capturing and acoustically tagging juvenile and sub-adult Gulf Sturgeon (*Acipenser oxyrinchus desotoi*), deployment and maintenance of telemetry receivers, and monitoring for presence/absence of acoustically tagged Gulf Sturgeon along the near shore and project area surrounding the existing Port of Gulfport (the Port).

METHODOLOGY
Tagging

The Port purchased 40 VEMCO (a division of Amirix Systems, Inc.) acoustic tags (models V9 and V13; 69-kHz frequency) to be utilized for external placement on juvenile and sub-adult Gulf Sturgeon between fall 2012 (10-11 September) and fall 2014 (3 September). The tags were split evenly between field teams working on the Pearl and Pascagoula rivers with the expectation that 10 tags a year would be placed on Gulf Sturgeon from each river drainage during the course of two field seasons (Appendix 1). The Pascagoula field team was led by Mark S. Peterson (University of Southern Mississippi, Gulf Coast Research Laboratory [USM-GCRL]) and laboratory staff partially dedicated to this project. The Pearl River field team was led by William T. Slack (U.S. Army Engineer Research and Development Center [ERDC]) and one part-time field technician.

Based on previous years of experience by Mark S. Peterson and William T. Slack and their laboratory staff, deploying 40 tags over the proposed time period was estimated to take about 48 days of field time. Tagging efforts were carried out intermittently in upriver locations, as weather conditions allowed during each field season from May through November. Once the tags were placed on fish the expected battery life of the tags varies based on the size. Table 1 depicts tag sizes funded by this project and associated battery life.

Table 1
VEMCO Tag Sizes and Battery Life for Each Tag Size Based on VEMCO Specifications.

VEMCO Tag Size	Number	Battery Life (days)	Fish Size Range for Each Tag (centimeters Fork Length)
V9 (120-second delay)	12	522	<529
V13 (90-second delay)	28	881	529–642

Tagging Externally (fish ≤125.0 centimeters fork length)

All Gulf Sturgeon were tagged externally with a uniquely coded low-powered, ultrasonic tag (models V9 or V13; 69-kHz frequency). Other concurrent Gulf Sturgeon projects tagged adult fish with V16 tags not purchased/deployed specifically for the Gulfport monitoring project, but they were detected within the array. Prior to deployment of external tags, monofilament (40-pound test) was secured to external tags using two-part epoxy and shrinks tubing, leaving two tails dangling off either end. A large gauge needle was used to pierce the base of the dorsal fin and pull the monofilament tails through the width of the fin. A biologically inert backing plate was threaded onto the monofilament and an aluminum crimp was secured to pull both the tag and the backing plate flush against both sides of the dorsal fin, modified from methods described in Sulak et al. (2009). All tagging and tissue sampling wounds were treated with a Betadyne/Vasoline mixture prior to release following methods in Peterson et al. (2013). Although not specifically tagged during this project, adults detected on the Gulfport array were internally tagged during the course of other projects as in Havrylkoff et al. (2012) and Peterson et al. (2013). Captured Gulf Sturgeon were categorized as adults (>125.0 centimeters fork length [cm FL]), sub-adult (89.1–125.0 cm FL), or juveniles (30.5–89.0 cm FL) and were released downstream of netting activities (Parauka et al., 2011).

Specifications of transmitters that were used/detected within the array are in Table 2. All Gulf Sturgeon initially captured during the tagging process was scanned for the presence of existing PIT tags (tagged during a previous event unrelated to the Port project). If none were detected, a PIT tag was implanted at the base of the dorsal fin in accordance to standardized National Marine Fisheries Service (NMFS) protocols (Moser et al., 2000). Passive Integrated Transponder (PIT) tags were provided by another funding source and have no cost associated with implanting or purchasing PIT tags for this study. Additionally, each Gulf Sturgeon was scanned for the presence of a functional acoustic transmitter using a VEMCO VR100 receiver and hydrophone. Gulf Sturgeon found to have no acoustic tag, or tags loosened due to gill net entanglement were tagged with an appropriate sized acoustic tag (see Tables 9, 10, 11 below).

Table 2
Transmitter specifications. *While the V16 tags were not purchased/deployed specifically for the Gulfport monitoring project, they were detected within the array.

Model	Length (millimeters)	Diameter (millimeters)	Wet Weight (grams)	Dry Weight (grams)	Mean Signal Emitted (seconds)
V9	21.0	9.0	1.6	2.9	120
V13	36.0	13.0	6.0	11.0	90
*V16	95.0	16	16.0	34.0	90-110

Our V9 acoustic tags are programmed to emit their signal on average every 120 seconds (ranges from 60 to 180 seconds) whereas our V13 tags emit signals on average every 90 seconds (ranges from 50 to 130 seconds). While we did not deploy any V16 tags for the Gulfport monitoring project specifically, Gulf Sturgeon with active V16 (with signal emitted on average every 90-110 seconds) tags were regularly

detected within the array. The random program feature integrated into the tags by the manufacturer reduces the probability of multiple tags in the same general area from signaling at the same time which can lower detection efficiency.

Acoustic Array

The acoustic array for monitoring telemetry tagged fish consisted of 19 receivers (VEMCO VR2W) deployed around the project area (Figure 1) that was monitored over a 2-year period, from 10 September 2012 to 3 September 2014. The east and west gate were each composed of three receivers deployed as a longitudinal series parallel to the Port and navigation channel. The remaining 13 receivers were configured around the footprint of the Port and are hereafter referred to as the Gulfport array. Receivers were deployed and marked with U.S. Coast Guard-approved yellow regulatory type buoys made by Rolyan Buoys (model B1147RY). These are 9-inch-diameter unsinkable buoys filled with urethane foam and are 60 inches tall with 36-inch above-the-water line. They had concrete ballast (56 pounds) with a ½-inch stainless-steel mooring eye at the bottom, silver-and-orange reflective bands, and 3-inch black lettering. We also added a reflective 4 x 6-inch sticker with contact information to the buoys. The VR2Ws were attached to the ⅜-inch stainless-steel cable via cable-ties and 700-pound test monofilament. The buoys and cables were then anchored in place by 200-pound concrete blocks. These buoys and receivers were positioned about 600 meters (m) apart with each receiver having an assumed 300-m detection radius; these are conservative detection range estimates. Gulf Sturgeon detections are based on active VEMCO transmitters (see Table 2). The receivers and moorings were deployed over a 2-day period on 10-11 September 2012 using a 55-foot (ft) vessel (USM-GCRL) outfitted with an A-frame and winch. The receivers remained in place until 3 September 2014 and provided the basis for continuous monitoring within the project area. However, four receivers (see Figure 1) had some problems over this time period. For example, Buoy A was moved (e.g., drug) eastward about 3.5 km which was first noted on 8 July, 2013, and the buoy was moved back onsite on 19 July 2013. Thus, the data were not reliable on this buoy between 23 May 2013 (previous download) and 19 July 2013, because of the unknown location of the buoy. Buoys B and C sustained severe damage to the above water portion as noted on 8 August 2013, and were replaced on 19 August 2013, with no loss of data as they did not move. Finally, the mooring cable of Buoy Q was apparently cut. The buoy and receiver were recovered on the beach in Long Beach on 29 October 2013, and replaced on 19 November 2013, after tagging season ended and weather was appropriate. Detections between 27 September (previous download on 26th) and 19 November on Buoy Q were not usable. Although the movement or damage to the buoys did not influence any other receiver moorings, it did require not using detections within the dates noted above for those specific buoys.

Protocols for monitoring and maintenance of the receivers and buoys were similar to those used during previous monitoring projects (Havrylkoff et al., 2012; Peterson et al., 2013). USM-GCRL staff downloaded data every 4 to 5 weeks from receivers deployed (Appendix 1). Our buoy hurricane evacuation plan was never implemented so the project area was continuously monitored for Gulf Sturgeon use of the area surrounding the Port and adjacent near shore habitat except where noted above.

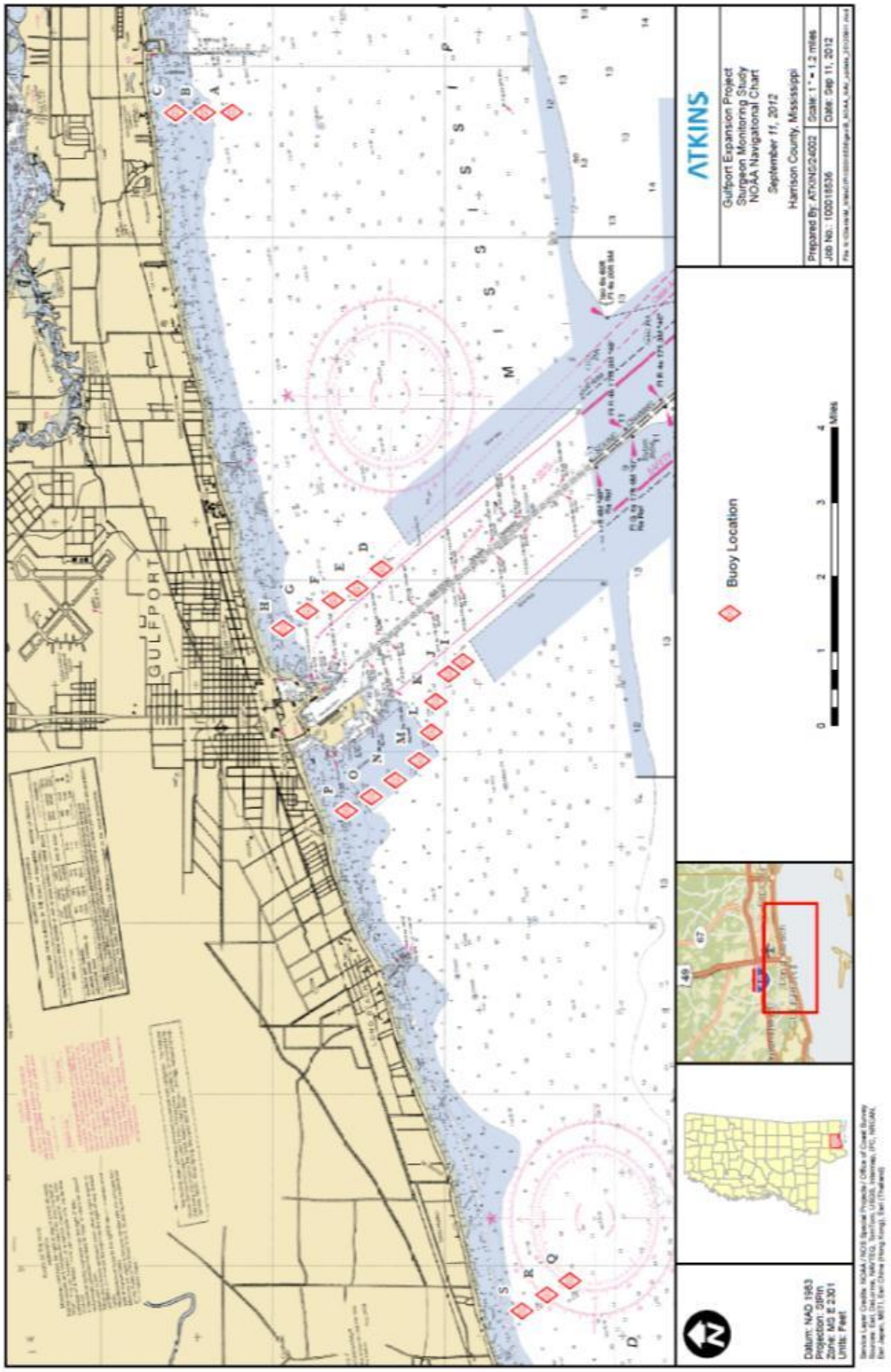


Figure 1. Map of VEMCO VR2W positions within the Mississippi Sound around the Port of Gulfport study site.

RESULTS

Sampling Tagging Efforts

2012

During the course of previous Gulf Sturgeon projects in the Pascagoula system (i.e., 2010–2011 NRDA, 2010–2014 NOAA section 6), sampling for Gulf Sturgeon by USM-GCRL personnel was partitioned between day and night periods to provide insight on activity periods in Gulf Sturgeon during their fall emigration phase. Netting during crepuscular and nighttime hours proved successful for obtaining sufficient numbers of fish that could be tagged (Grammer et al. 2015), and was continued, in part, during the described efforts by USM-GCRL on the current project for the Port. The first fall tagging period began on 24 September 2012, and was concluded for the season on 8 November 2012. The USM-GCRL team sampled for 22 total days (85 net sets) in the Pascagoula River system with a total daytime effort of 38,928 net-meter-hours (net-m-hrs), whereas the USACE-ERDC team sampled in the Pascagoula River system for a total of 8 days (26 net sets) and a total daytime effort of 11,656 net-m-hrs. Combined daytime effort resulted in 50,584 net-m-hrs, the tagging of two juveniles, a sub-adult and an adult Gulf Sturgeon for a daytime catch-per-unit-effort (CPUE, fish/net-m-hr) of 7.91×10^{-5}. During the 22 days of sampling by the USM-GCRL team, night sampling also occurred on 17 of those days for a total nighttime effort of 16,362 net-m-hrs and resulted in the tagging of two juvenile and an adult Gulf Sturgeon for a nighttime CPUE of 1.83×10^{-4}. An instance of night sampling is defined as any case where nets remained deployed following sunset as determined using the NOAA solar calculator (2014; http://www.esrl.noaa.gov/gmd/grad/solcalc/). Joint sampling efforts totaled 66,946 net-m-hrs (Table 3) on the Pascagoula River during 2012, with a total CPUE of 1.05×10^{-4}.

Table 3
Effort Summary for Fall 2012 (24 September–8 November) USM-GCRL and USACE-ERDC Combined Sampling of the Pascagoula River System.

	Day	Night
Number of days sampled	30	17
Total net-m-hrs	50,584	16,362
Number of sturgeon captured	4	3
Gulf Sturgeon CPUE	7.91×10^{-5}	1.83×10^{-4}

CPUE = catch-per-unit-effort

The USACE-ERDC team deployed 35 net sets in the Pearl River system during daylight hours from 25 September to 18 October 2012. Table 4 summarizes the sampling effort by the USACE-ERDC team in the Pearl River system. Over the 12 days sampled in the Pearl River system, two juveniles were tagged based on a total effort of 13,862 net-m-hrs. The CPUE was 1.44×10^{-4}.

Table 4
Effort Summary for Fall 2012 (25 September–18 October) USACE-ERDC Daytime Sampling of the Pearl River System.

	Day
Number of days sampled	12
Total net-m-hrs	13,862
Number of sturgeon captured	2
Gulf Sturgeon CPUE	1.44×10^{-4}

CPUE = catch-per-unit-effort

2013

Sampling efforts for Gulf Sturgeon within 2013 were again conducted in both the Pearl and Pascagoula river systems and encompassed both spring/summer and fall time periods. The USM-GCRL team reported 18 and 80 net sets, respectively, for the spring/summer and fall periods representing 7,613 and 53,324 net-m-hr effort. This effort captured 18 Gulf Sturgeon in the Pascagoula River, with two in the spring/summer and 16 in the fall sampling periods for a CPUE of 2.63×10^{-4} and 3.00×10^{-4}, respectively (Table 5).

Table 5
Effort Summary for Spring/Summer 2013 (30 May –16 July) and Fall 2013 (25 September–6 November) USM-GCRL Sampling of the Pascagoula River System.

	Spring/Summer	Fall
Number of days sampled	6	22
Total net-m-hrs	7,613	53,324
Number of sturgeon captured	2	16
Gulf Sturgeon CPUE	2.63×10^{-4}	3.00×10^{-4}

CPUE = catch-per-unit-effort

For the fall 2013 tagging period on the Pascagoula River only, which began on 25 September and was concluded on 6 November 2013, the data were split by day and night sampling periods (Table 6). During the 22 days of sampling by the USM-GCRL team, night sampling occurred on 15 of those days for a

Table 6
Day Versus Night Effort Summary for Fall 2013 (25 September–6 November) USM-GCRL Sampling of the Pascagoula River System.

	Day	Night
Number of days sampled	22	15
Total net-m-hrs	30,351	22,973
Number of sturgeon captured	3	13
Gulf Sturgeon CPUE	9.88×10^{-5}	5.66×10^{-4}

CPUE = catch-per-unit-effort

total of 53,324 net-m-hrs. The day effort was 30,351 net-m-hr whereas the night effort was 22,973 net-m-hr and these efforts yielded three and 13 Gulf Sturgeon, respectively. CPUE was 9.88 x 10^{-5} during day times but 5.66 x 10^{-4} during night collecting.

The ERDC team reported 13 sampling days in the spring/summer and 11 days in the fall periods and processed 32 and 33 net sets, respectively, in the Pearl River. They captured eight Gulf Sturgeon with six in the spring/summer and two in the fall periods. This resulted in 14,586 and 14,119 net-m-hr effort and a CPUE of 4.11 x 10^{-4} and 1.42 x 10^{-4}, respectively (Table 7).

Table 7
Effort Summary for Spring/Summer 2013 (12 March–11 July) and Fall 2013 (24 September–30 October) USACE-ERDC Sampling of the Pearl River System .

	Spring/Summer	Fall
Number of days sampled	13	11
Total net-m-hrs	14,586	14,119
Number of sturgeon captured	6	2
Gulf Sturgeon CPUE	4.11 x 10^{-4}	1.42 x 10^{-4}

CPUE = catch-per-unit-effort

2014

Sampling efforts for Gulf Sturgeon within 2014 were limited to summer in the Pearl River system. The USACE-ERDC team reported 6 net sets for the summer representing 2,739 net-m-hr effort. This effort resulted in 13 Gulf Sturgeon captured in this system with a CPUE of 4.75 x 10^{-3} (Table 8).

Table 8
Effort Summary for Summer 2014 (25 June–26 June) USACE-ERDC Sampling of the Pearl River System.

	Summer
Number of days sampled	2
Total net-m-hrs	2,739
Number of sturgeon captured	13
Gulf Sturgeon CPUE	4.75 x 10^{-3}

CPUE = catch-per-unit-effort

Gulf Sturgeon Tagged and Detections on the Entire Gulfport Array

During the 2012 sampling efforts, nine Gulf Sturgeon were tagged in both systems (Table 9), including six juvenile, one sub-adult and two adult Gulf Sturgeon. The two adult and one sub-adult were tagged using telemetry tags funded by a separate effort. These three Gulf Sturgeon in Table 9 (NOAA/SHIP) are included to better illustrate the field efforts needed to capture the target-sized individuals for the immediate project and to serve as a reference for other individuals that may show up near the Port study site during the project period.

Table 9
Summary of All Gulf Sturgeon Tagged by USM and ERDC in the Fall 2012 Season.

Date	Time	Drainage	Length (FL cm)	Tag Number	Project	Tag Type
9/26/2012	1130	Pearl	64.0	30177	MSPA	V13
10/9/2012	1420	Pearl	65.5	30182	MSPA	V13
10/16/2012	1706	Pascagoula	57.2	6214	MSPA	V9
10/25/2012	1535	Pascagoula	123.5	31790	NOAA/SHIP	V13
10/31/2012	1325	Pascagoula	147.2	46210	NOAA/SHIP	V16
10/31/2012	1917	Pascagoula	131.6	29899	NOAA/SHIP	V16
10/31/2012	1922	Pascagoula	75.0	30165	MSPA	V13
11/1/2012	2039	Pascagoula	64.6	6219	MSPA	V9
11/7/2012	1035	Pascagoula	80.0	30183	MSPA	V13

FL = fork length in centimeters.
Complete tag numbers are listed in Appendix 2.

Efforts in 2013 produced 26 captured Gulf Sturgeon (only 25 acoustically tagged) combined from both rivers (Table 10), including 14 juvenile, 5 sub-adult, and 7 adult fish. Eight Gulf Sturgeon were tagged in the Pearl and 18 in the Pascagoula River. A total of 13 Gulf Sturgeon (50% of total tags used) were tagged with MSPA purchased tags.

Efforts in 2014 (summer only) produced 13 captured Gulf Sturgeon from the Pearl River system, including 12 juvenile, 1 sub-adult, and no adult fish (Table 11). No Gulf Sturgeon was tagged with MSPA purchased tags because we were fishing as in previous years under the umbrella of several ongoing and independent projects. However, the SOW for the Port of Gulfport project did not include any tagging during the second year (summer/fall 2014) and as such all unused tags were returned to MSPA on 29 April 2014 at their request.

In terms of tag detections for the monitoring phase of this study, Gulf Sturgeon were detected simultaneously on multiple receivers because of the close proximity of receivers in the array. Our basic QA/QC procedures eliminated only exact duplicate detections that occurred on a single receiver without making a judgment on how to remove any other detection that occurred on other receivers simultaneously. For example, if a single fish was detected on multiple receivers with the same time stamp it was not removed from the detection count in this report.

The period of monitoring for the first full year of activity was 10 September 2012 through 19 September 2013; however, the dates of actual detections were from 20 September 2012 through 31 May 2013, as no fish were detected June through 19 September 2013 (Figure 2). No recently tagged (MSPA) Gulf Sturgeon (since spring 2013) were detected on the entire Gulfport array over the course of the first year. However, seven adult, two sub-adult, and one juvenile Gulf Sturgeon from either the Pearl or Pascagoula

Table 10
Summary of All Gulf Sturgeon Tagged by USM and ERDC During 2013 Sampling Efforts.

Date	Time	Drainage	Length (FL cm)	Tag Number	Project	Tag Type
5/20/2013	0925	Pearl	135.9	32244	SHIP	V16
5/20/2013	0939	Pearl	74.0	30179	MSPA	V13
5/25/2013	0953	Pearl	100.0	30180	MSPA	V13
5/26/2013	1032	Pearl	81.0	30181	MSPA	V13
5/30/2013	1319	Pascagoula	139.8	30587	NOAA	V16
6/24/2013	1311	Pascagoula	45.0	40496	NOAA Sect 6	V9
7/10/2013	1403	Pearl	50.3	6217	MSPA	V9
7/11/2013	1016	Pearl	42.8	6222	MSPA	V9
9/30/2013	1327	Pascagoula	58.0	2643	NOAA Sect 6	V9
10/8/2013	2002	Pascagoula	56.0	2638	NOAA Sect 6	V9
10/15/2013	1422	Pascagoula	155.0	31785	NOAA Sect 6	V13
10/22/2013	1022	Pearl	95.0	30187	MSPA	V13
10/22/2013	2001	Pascagoula	88.2	30169*	MSPA	V13
10/23/2013	1554	Pearl	39.8	**	**	**
10/28/2013	1751	Pascagoula	100.0	30172	MSPA	V13
10/28/2013	1943	Pascagoula	71.6	30166	MSPA	V13
10/28/2013	2352	Pascagoula	152.8	29896	NOAA	V16
10/28/2013	2343	Pascagoula	78.2	30167	MSPA	V13
10/30/2013	1529	Pascagoula	75.0	31787	NOAA Sect 6	V13
11/4/2013	2023	Pascagoula	138.6	29901	NOAA	V16
11/4/2013	1830	Pascagoula	100.0	29898	NOAA	V16
11/5/2013	2025	Pascagoula	135.0	29902	NOAA	V16
11/6/2013	0027	Pascagoula	80.4	30163	MSPA	V13
11/6/2013	1736	Pascagoula	70.4	6220	MSPA	V9
11/7/2013	0135	Pascagoula	142.2	29904	NOAA	V16
11/7/2013	0143	Pascagoula	88.0	30174*	MSPA	V13

*Denotes a fish which had a damaged acoustic tag mounting and the tag was replaced upon capture in 2013 (n=2) .
**Denotes individuals too small to tag.
FL = fork length in centimeters.
Complete tag numbers are listed in Appendix 2.

systems were detected at some point within the study area covered by the receivers (Table 12). These fish were tagged in 2010, 2011 or 2012 as part of other ongoing tagging efforts (Table 12).

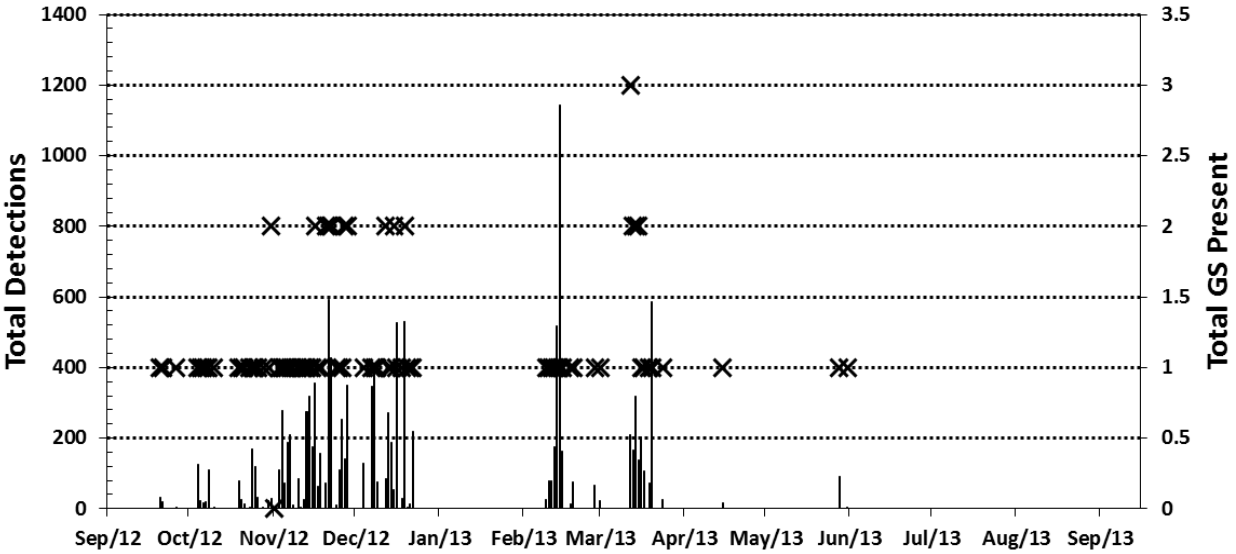
The period of monitoring for the second full year of activity was 20 September 2013 through 3 September 2014; however, the dates of actual detections were from 23 October 2013 through 1 May 2014, as no fish were detected 2 May through 3 September 2014 (Figure 3). Three Gulf Sturgeon tagged with MSPA tags in the fall of 2013 were detected on the entire Gulfport array over the course of the second monitoring

year. However, a total of 17 (out of 25 tagged; some from earlier tagging efforts) Gulf Sturgeon were detected over the second year of monitoring, 12 adult, three sub-adult, and two juvenile Gulf Sturgeon from the Pearl, Pascagoula, Escambia, Choctawhatchee and Blackwater (recaptured fish) drainages (see fish #9 and 11, Table 13) at some point within the study area covered by the receivers (Table 13). These fish were tagged in 2010, 2011, 2012 or 2013 as part of the Port project and other ongoing tagging efforts (Table 13).

Table 11
Summary of All Gulf Sturgeon Tagged by ERDC in the Summer 2014 Season.

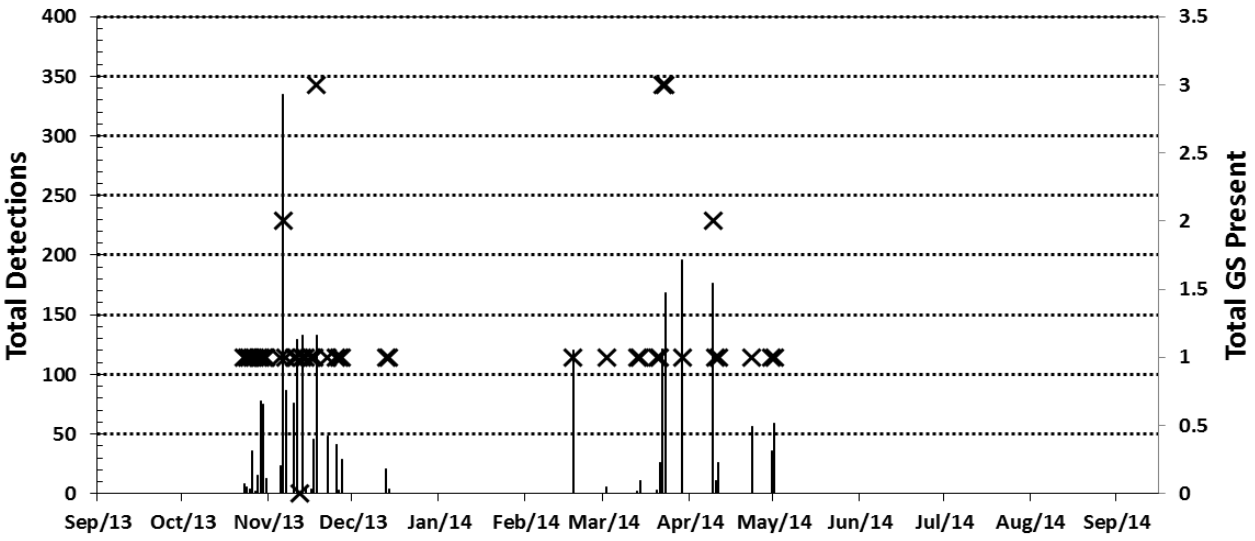
Date	Time	Drainage	Length (FL cm)	Tag Number	Project	Tag Type
6/25/2014	10:35	Pearl	42.0	**	**	**
6/25/2014	10:35	Pearl	60.9	45054	NOAA Sect 6	V13
6/25/2014	10:35	Pearl	88.1	32247	NOAA/SHIP	V16
6/25/2014	10:35	Pearl	92.5	32239	NOAA/SHIP	V16
6/25/2014	10:35	Pearl	60.4	45055	NOAA Sect 6	V13
6/25/2014	10:35	Pearl	58.3	45052	NOAA Sect 6	V13
6/25/2014	15:17	Pearl	59.9	40495	NOAA Sect 6	V9
6/25/2014	15:10	Pearl	36.2	**	**	**
6/26/2014	10:06	Pearl	59.8	**	**	**
6/26/2014	10:06	Pearl	43.6	**	**	**
6/26/2014	10:06	Pearl	49.0	**	**	**
6/26/2014	12:36	Pearl	43.4	**	**	**
6/26/2014	16:17	Pearl	63.8	**	**	**

**Denotes individuals too small to tag.
FL = fork length in centimeters.
Complete tag numbers are listed in Appendix 2.



These data include simultaneous detections as defined in the text.

Figure 2. Histogram of Total Daily Detections and Total Gulf Sturgeon Detected Compiled from All Deployed Receivers within the Array from 10 September 2012 through 19 September 2013.



These data include simultaneous detections as defined in the text.

Figure 3. Histogram of Total Daily Detections and Total Gulf Sturgeon Detected Compiled from All Deployed Receivers within the Array from 20 September 2013 through 3 September 2014.

Table 12
Gulf Sturgeon Length, Weight, and River of Origin of Fish Detected in the Entire Gulfport Acoustic Array During Year 1 Monitoring Period.

Fish #	Tag #	River of Origin	Date Tagged	FL (cm)	Weight (kg)
10	45717	Pearl	9/28/2010	162.5	47.6
6	45729	Pearl	10/7/2010	119	11.7
8	45746	Pearl	9/28/2010	132	29.9
7	45752	Pearl	9/28/2011	127.6	14.3
9	45767	Pearl	10/15/2010	148	24.2
2	31794	Pascagoula	10/13/2011	95.6	5.1
1	31795	Pascagoula	10/18/2011	67.6	1.6
3	46208	Pascagoula	10/24/2011	138	19.5
5	46210	Pascagoula	10/31/2012	147.2	26.7
4	46215	Pascagoula	10/7/2010	147	23.6

Fish number corresponds with y-axis on Figure 6.
FL = fork length in centimeters.

Receivers associated with the Port project were downloaded on 4 October, 20 November, and 13 December, 2012 and 14 January, 14 February, 14 March, 24-25 April, 23 May, 8 July, 8 and 12 August, and 26 September 2013 during the first year of the study. The number of Gulf Sturgeon detections by receiver location and individual tag are in Table 14, with a total of 12,288 detections over the period of time.

Seven adult, two sub-adult, and one juvenile fish were detected within the entire acoustic telemetry array during the 10 September 2012– 19 September 2013 monitoring period. Six of the fish (five adult, one

Table 13
Gulf Sturgeon Length, Weight, and River of Origin of Fish Detected on the Entire Gulfport Acoustic Array During Year 2 Monitoring Period.

Fish #	Tag #	River of Origin	Date Tagged	FL (cm)	Weight (kg)
17	45717	Pearl	9/28/2010	162.5	47.6
16	45748	Pearl	9/9/2013	159	NA
7	45746	Pearl	9/28/2010	132	29.9
6	45752	Pearl	9/28/2011	127.6	14.3
14	45721	Pearl	10/13/2010	148	16.5
3	30187	Pearl	10/22/2013	95	5.52
5	45714	Pearl	9/10/2013	101	17.8
8	32244	Pearl	6/20/2013	135.9	27
10	45753	Pearl	9/9/2013	137	NA
15	45737	Pearl	9/11/2013	151	NA
2	30163	Pascagoula	11/5/2013	80.4	3.0
1	2643	Pascagoula	9/30/2013	58	NA
12	46208	Pascagoula	10/24/2011	138	19.5
13	46210	Pascagoula	10/31/2012	147.2	26.7
4	30172	Pascagoula	10/28/2013	100	6.15
9	30598	Escambia	10/17/2011	137	22.1
11	46183	Choctawhatchee	10/12/2010	133	20
11	46183	Blackwater	10/11/2011	137	17.5

Fish number corresponds with y-axis on Figure 7.
FL = fork length in centimeters.

juvenile) were detected at the east gate; five fish (three adult, two sub-adult, and one juvenile) were detected at the west gate; and seven fish (five adult, one sub-adult) were detected in the Gulfport array. All 19 receivers (Table 14) had between three and six Gulf Sturgeon detected and at least 31 detections

Table 14
Summary of Gulf Sturgeon Detections on VEMCO VR2W Receivers by Individual Fish and Station during Year 1 Monitoring Period[1].

Size Class	River_Yr Tagged	Tag	East Gate			Gulfport Array													West Gate			Total Detections	Total Stations Present At
			A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S		
A	PE_2010	45717	38	178	284	4	2	16	16	4	7	11	21	66	30	61	123	55	29	17	21	983	19
A	PE_2010	45746	747	3686	1796	17	30	51	153	644	37	26	23	10	10	0	0	0	0	0	0	7230	13
SA	PR_2011	31794	0	0	0	0	5	0	0	0	1	5	0	0	0	0	0	0	0	0	1	12	4
A	PE_2010	45767	0	0	0	0	0	6	24	216	0	10	29	58	21	17	5	1	0	0	0	387	10
A	PR_2011	46208	169	830	942	40	45	36	114	449	8	9	17	22	19	19	26	33	12	3	9	2802	19
J	PR_2011	31795	0	1	4	1	1	0	2	26	0	0	0	0	0	0	0	0	0	0	0	35	6
A	PR_2012	46210	0	15	123	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	138	2
A	PR_2010	46215	233	306	47	0	12	1	0	0	27	25	8	0	0	0	0	0	0	0	0	659	8
A	PE_2011	45752	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	9	10	27	3
SA	PE_2011	45729	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	2	1	15	3
		Total Detections	1187	5016	3196	62	95	110	309	1339	80	86	98	156	80	97	154	89	61	31	42	Grand Total	12288
		Total GS @ Stat	4	6	6	4	6	5	5	5	5	6	5	4	4	3	3	3	4	4	5		

[1]Due to the physical positioning of the acoustic array, some fish are detected simultaneously on multiple receivers. Our QA/QC procedures eliminated exact duplicate detections (those that were identical). Also note no fish detected to date were tagged during the 2013 season. The time frame of detections is from 20 September 2012 (first detection) to 31 May 2013 (last detection); no further detections were recorded in the entire Port array from 1 June thru 19 September 2013. Complete tag numbers are listed in Appendix 2.

Table 15
Summary of Gulf Sturgeon Detections on VEMCO VR2W Receivers by Individual Fish and Station during Year 2 Monitoring Period[1].

Size Class	River_Yr Tagged	Tag	East Gate			Gulfport Array													West Gate			Total Detections	Total Stations
			A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S		
A	PE_2010	45717	2	0	0	0	0	0	0	0	0	0	1	1	1	11	25	3	0	6	6	56	9
A	PE_2010	45746	0	0	0	0	2	0	0	0	0	2	7	7	8	4	16	70	1	9	63	189	11
A	PR_2011	46208	27	68	65	0	8	10	157	102	8	7	5	1	6	8	17	6	1	8	17	521	18
A	PR_2012	46210	19	76	101	6	7	8	0	0	0	0	0	7	13	8	1	0	0	0	0	246	10
A	PE_2011	45752	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	1	0	0	0	6	3
A	PE_2013	45748	16	217	199	0	0	0	7	10	0	1	6	15	11	7	0	0	0	0	11	500	11
SA	PE_2013	45714	21	22	0	10	9	0	8	11	3	8	1	10	16	16	33	47	0	5	13	233	16
SA	PR_2013	30172	0	0	0	0	0	0	0	0	12	7	1	0	0	0	0	0	0	0	0	20	3
J	PR_2013	30163	22	30	0	1	10	4	7	25	0	0	0	1	0	0	8	9	0	8	21	146	12
J	PR_2013	2643	14	0	0	4	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	25	3
SA	PE_2013	30187	0	0	0	1	3	28	41	50	0	0	0	0	0	0	0	0	0	0	0	123	5
A	PE_2010	45721	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	7	11	2
A	PE_2013	45737	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	20	27	2
A	CR_2010/BR_2011	46183	0	0	0	0	7	17	19	0	0	1	13	15	23	22	17	5	5	1	0	145	12
A	ER_2011	30598	0	5	0	17	6	3	0	0	0	0	0	0	0	0	0	0	0	0	0	31	4
A	PE_2013	45753	3	4	0	0	0	0	1	6	2	3	6	0	10	2	0	0	0	0	0	37	9
A	PE_2013	32244	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	27	9	56	3
		Total Detections	124	422	365	39	52	70	247	204	25	29	40	57	89	78	121	141	27	75	167	Grand Total	2372
		Total GS @ Stat	8	7	3	6	8	6	8	6	4	7	8	8	9	8	8	7	4	9	9		

[1]Due to the physical positioning of the acoustic array, some fish are detected simultaneously on multiple receivers. Our QA/QC procedures eliminated exact duplicate detections (those that were identical). Also note no fish detected to date were tagged during the 2014 season. The time frame of detections is from 23 October 2013 (first detection) to 1 May 2014 (last detection); no further detections were recorded in the entire Port array from 2 May thru 3 September 2014. Complete tag numbers are listed in Appendix 2.

(range: 31–5,016 detections, Table 14; see Figure 4 legend), and each Gulf Sturgeon passed within the 300-m detection zone of at least two receivers (range: 2–19 receivers, Table 14; see numbers in bubbles in Figure 4) between 10 September 2012 and 19 September 2013. Gulf Sturgeon occurred throughout all stations in the entire Gulfport array but considerable activity appears to be in the east gate and eastern portion of the Gulfport array (Table 14, Figure 4). The appearance of Gulf Sturgeon in the array is clearly during established and well documented (Heise et al., 2004, 2005) immigration (February–April) and emigration (September–December) periods (Figure 6).

During the second year of the project, the array was downloaded 19 November, 11 December 2013 and 6 January, 10 March, 10 April, 21 May, 8 July, 6 August, and removed on 3 September 2014. The number

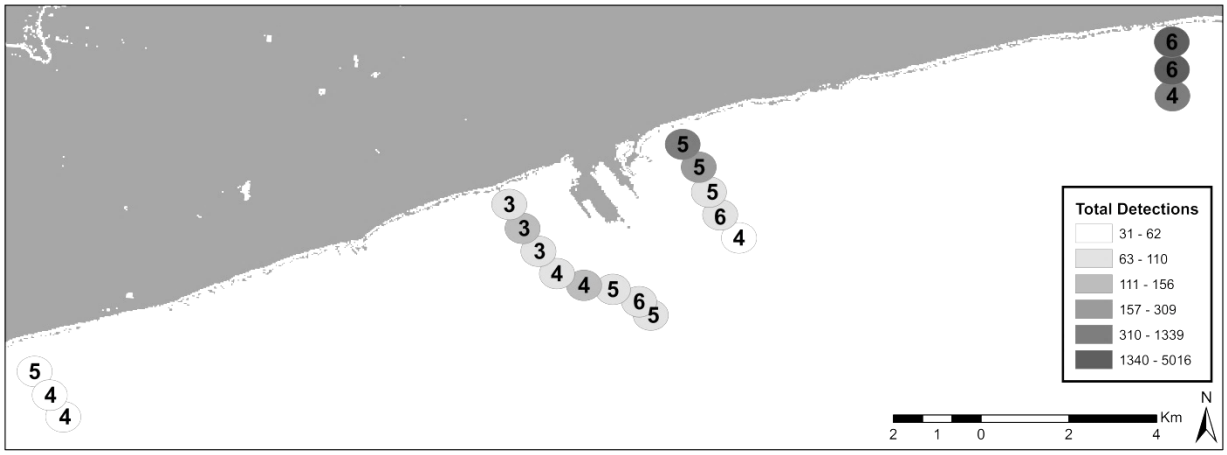


Figure 4. A Map of the Gulfport Acoustic Monitoring Array Summarizing the Number of Individual Gulf Sturgeon Detected (number in each circle) and the Relative Number of Detections at Each Monitoring Station (depicted by the shading of each circle) between 10 September 2012 and 19 September 2013.

of Gulf Sturgeon detections by receiver location and individual tag for the second year are found in Table 15, with a markedly reduced total of 2,372 detections occurring from 20 September 2013 to 3 September 2014 compared to Year 1 data.

Twelve adult, three sub-adult, and two juvenile fish were detected within the entire acoustic telemetry array during the 20 September 2013–3 September 2014 monitoring period. Nine of the fish (six adult, one sub-adult, two juvenile) were detected at the east gate; ten fish (eight adult, one sub-adult, and one juvenile) were detected at the west gate; and fourteen fish (nine adult, three sub-adult, two juvenile) were detected in the Gulfport array. All 19 receivers had between three and nine Gulf Sturgeon detected and at least 25 detections (range: 25–422 detections, see Figure 5 legend), and each Gulf Sturgeon passed within the 300-m detection zone of at least two receivers (range: 2–18 receivers, Table 15; see numbers in Figure 5 circles) between 20 September 2013 and 3 September 2014. Gulf Sturgeon occurred throughout all stations in the entire Gulfport array but considerable activity appears to be in the east gate and eastern portion of the Gulfport array (Table 15, Figure 5). The appearance of Gulf Sturgeon in the array is clearly during established and well

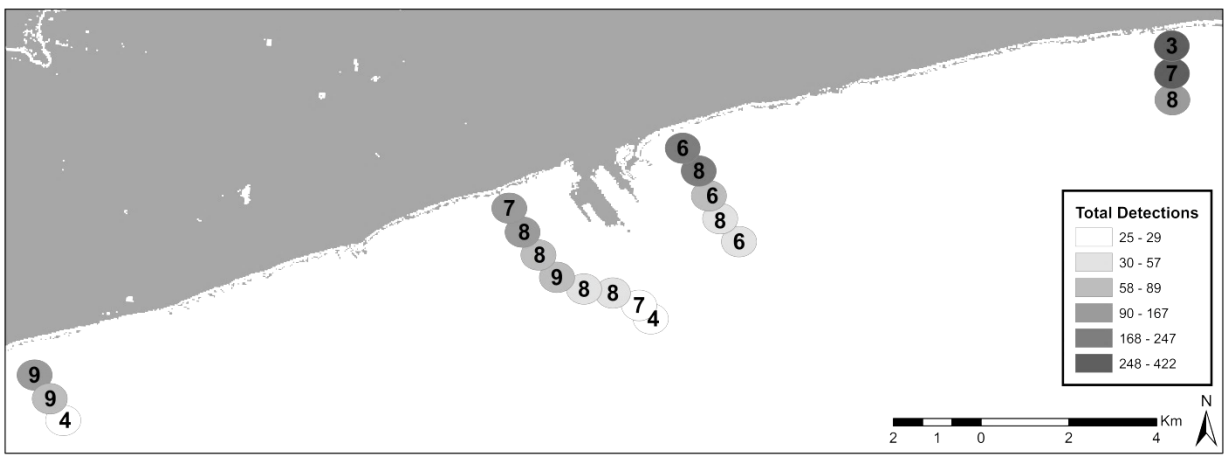
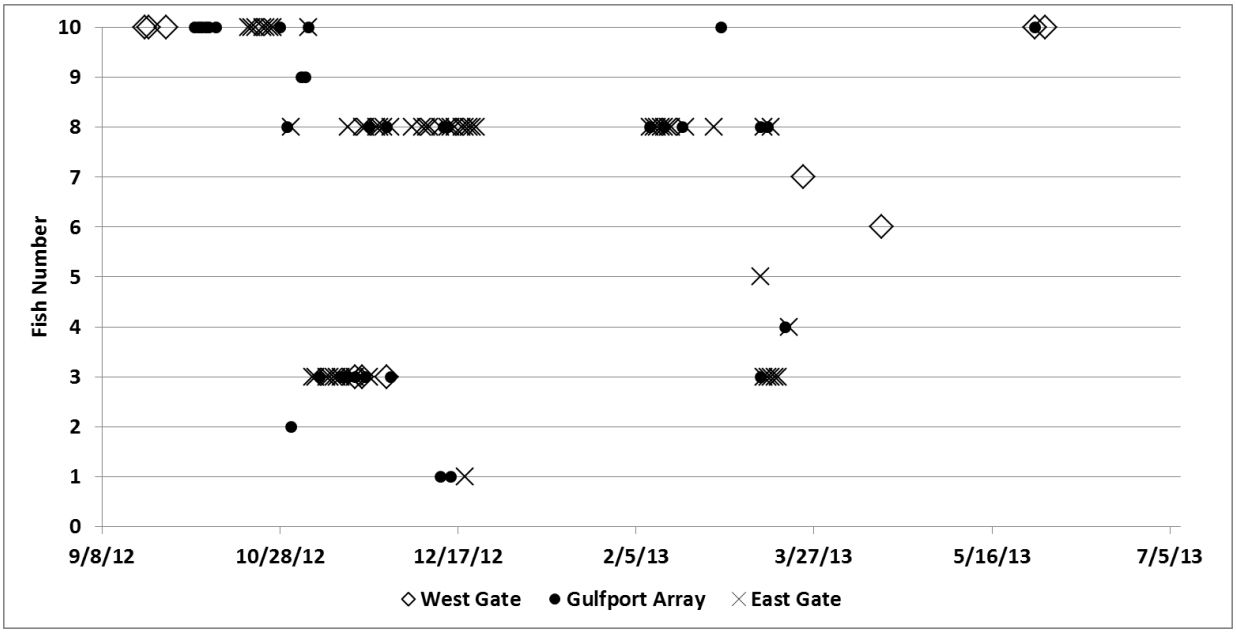


Figure 5. A Map of the Gulfport Acoustic Monitoring Array Summarizing the Number of Individual Gulf Sturgeon Detected (number in each circle) and the Relative Number of Detections at Each Monitoring Station (depicted by the shading of each circle) between 20 September 2013 and 3 September 2014.

documented immigration (February–April) and emigration (September–December) periods (Heise et al., 2004; 2005; Figure 7).

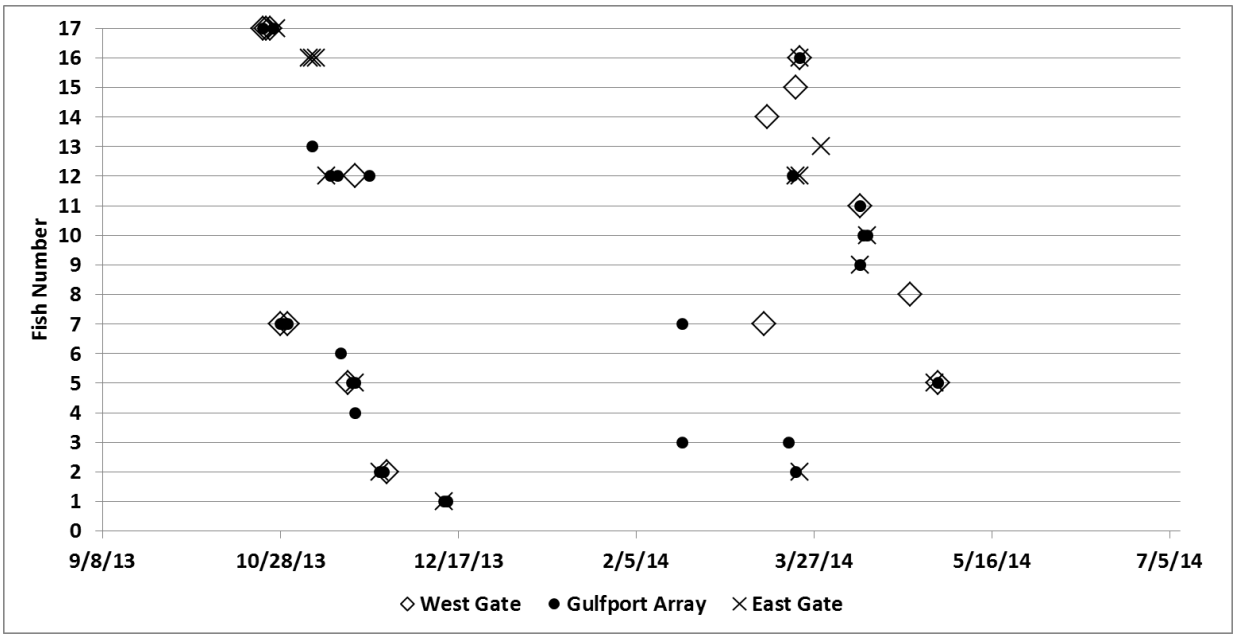
The number of detections per fish and time within the array varied greatly among all detected Gulf Sturgeon during the 10 September 2012–19 September 2013 monitoring period (Table 16). For example, three individuals (i.e., 45746, 45717, 46208; pooled by season) experienced long periods between first and last detections while their actual elapsed time within the entire Gulfport array was high, which suggests non-transitory movement through the array during the monitoring period (Table 16). In contrast, other individuals (i.e., 31794, 45767, 45729, 45752, and 46210) exhibited reduced days between first and last detection and generally had reduced elapsed time within the entire Gulfport array (Table 16), suggesting transitory movement patterns. Finally, only 3 of 13 (23.1%, pooled by season) tagged Gulf

Sturgeon had both a high number of days between first and last detections and a high cumulative detection time within the array (Table 16).



Fish numbers and corresponding data can be found in Table 12. A sturgeon was considered present if it was detected at least twice in one day.

Figure 6. Abacus Plot of Gulf Sturgeon Detected within Defined Portions of the Gulfport Acoustic Monitoring Array by Date During the Year 1 Monitoring Period.



Fish numbers and corresponding data can be found in Table 13. A sturgeon was considered present if it was detected at least twice in one day.

Figure 7. Abacus Plot of Gulf Sturgeon Detected within Defined Portions of the Gulfport Acoustic Monitoring Array by Date During the Year 2 Monitoring Period.

The number of detections per fish and time within the array varied greatly among all detected Gulf Sturgeon during the 20 September 2013–3 September 2014 monitoring period (Table 17). For example, three individuals (i.e., 30187, 46208, 45746) experienced relatively long periods between first and last detections with their actual elapsed time within the entire Gulfport array also being relatively long (Table 17); suggesting non-transitory movement within the array during the monitoring period (Table 17). In contrast, the remaining detected individuals exhibited a relatively long time period between first and last detection with some exhibiting long detection time (e.g., 45714, 45717, 30163, 45746, 45748, 45752) within the entire Gulfport array (Table 17) whereas others had short detection times (e.g., 46210, 30598, 32244, 46183, 45753) within the array (Table 17). The former group appears to exhibit non-transitory behavior while the latter group appeared to be more transitory in nature (Table 17). Finally, 3 of 23 (13.0%) tagged Gulf Sturgeon had both a high number of days between first and last detections and a high cumulative detection time within the array (Table 17).

Interestingly, four adult Gulf Sturgeon (45717, 45746, 46208, and 46210) were detected in both years of the monitoring period in the acoustic array (Tables 16 and 17); two from the Pearl and two from the Pascagoula drainages. This suggests some level of consistent and repeatable regional-scale movement patterns in Gulf Sturgeon from western Gulf of Mexico drainages.

The overall pattern of detections by life-history stage illustrates a high number of detections of adult fish within the array followed in descending order by sub-adults and juvenile stages (Figures 8 and 9). This pattern reflects, in part, the relative number of tagged individuals representing each life-history stage during the monitoring period (Tables 12 and 14). However, the high incident of adults along with generally high and consistent number of detections within the entire Gulfport array, regardless of year, season and river of origin, suggests Gulf Sturgeon are present within the area in more than a transitory manner, as previously considered.

During our 2012 and 2013 combined netting/tagging efforts, 35 Gulf sturgeon were processed and tagged with 54.3% (19) equipped with tags supplied by the Mississippi Port Authority to address the objectives of this project (see Tables 9 and 10). However, we have documented tagged individuals from both the Pearl and Pascagoula systems, as well as eastern population fish (Escambia, Choctawhatchee and Blackwater (recaptured fish) rivers), occurring within the entire Gulfport array but that were not tagged during the course of the current study. These fish were tagged during the course of other contemporaneous studies being conducted within each of the respective systems. Regardless of the source of the tagging efforts, these data do not negate the overall detection patterns or depicted periods of occurrence by Gulf Sturgeon within the project area.

Table 16
Summarized Detection Information for Gulf Sturgeon Reported in the Entire Gulfport Acoustic Array from 10 September 2012 through 19 September 2013.

Tag Number	River of Origin	Season	Stage	FL (cm)	Total Detections	Total Receivers	First Detection	Last Detection	Days Between First and Last Detection	Detection Time within Array (hr:min)	Detection Time within Array (days,hr,min)
31795	PA	F/W	J	67.6	35	6	12/9/2012	12/20/2012	12	265:33:00	11days 1hrs 33mins
31794	PA	F/W	SA	95.6	12	4	10/31/2012	11/1/2012	2	15:04:00	0days 15hrs 4mins
45746	PE	F/W	A	132	4653	8	10/30/2012	12/22/2012	54	1275:57:00	22days 3hrs 57mins
46208	PA	F/W	A	138	2035	19	11/6/2012	11/28/2012	23	522:22:00	21days 18hrs 22mins
45767	PE	F/W	A	148	387	10	11/3/2012	11/4/2012	2	30:23:00	1days 6hrs 23mins
45717	PE	F/W	A	162.5	868	18	9/20/2012	11/5/2012	47	1106:31:00	15days 2hrs 31mins
45729	PE	S/S	SA	119	15	3	4/15/2013	4/15/2013	1	0:50:00	0days 0hrs 50mins
45752	PE	S/S	A	127.6	27	3	3/24/2013	3/24/2013	1	6:21:00	0days 6hrs 21mins
45746	PE	S/S	A	132	2577	12	2/9/2013	3/15/2013	35	821:43:00	3days 5hrs 43mins
46208	PA	S/S	A	138	767	7	3/12/2013	3/17/2013	6	126:32:00	5days 6hrs 32mins
46215	PA	S/S	A	147	659	8	3/19/2013	3/21/2013	3	33:11:00	1days 9hrs 11mins
46210	PA	S/S	A	147.2	138	2	3/12/2013	3/12/2013	1	6:38:00	0days 6hrs 38mins
45717	PE	S/S	A	162.5	115	12	3/1/2013	5/31/2013	92	2177:38:00	30days 17hrs 38mins

Table 16 (continued).

	Interval Between Detections (hr:min)						
Tag Number	Min	Max	Mode	Mean	STD	CV	Total Distance Traveled (km)
31795	0:01	2:57	0:02	7:48	0:08	3.09	22.96
31794	0:01	13:40	0:02	1:22	4:05	2.99	15.32
45746	0:01	1:41	0:01	0:16	6:30	23.75	1511.92
46208	0:01	2:51	0:01	0:12	2:05	10.01	602.88
45767	0:01	1:19	0:02	0:04	0:08	1.76	86.21
45717	0:01	23:51	0:02	1:16	12:43	9.98	302.44
45729	0:01	0:13	0:02	0:03	0:03	1.04	1.18
45752	0:01	5:18	0:02	0:14	1:01	4.23	1.79
45746	0:01	21:52	0:01	0:19	7:22	23.12	1060.42
46208	0:01	6:52	0:01	0:09	1:27	8.85	154.46
46215	0:01	7:26	0:01	0:03	0:19	6.45	237.58
46210	0:01	1:11	0:02	0:02	0:07	2.47	15.73
45717	0:01	22:44	0:01	19:06	5:42	10.35	115.32

River of origin: PA=Pascagoula, PE=Pearl.

Season: F/W = fall/winter, S/S = spring/summer.

Stage: J=juvenile, SA=sub-adult, A=adult.

Complete tag numbers are- listed in Appendix 2.

Days between first and last detection: total number of calendar days between first and last detection day within the array.

Detection time within array (hr:min): sum of elapsed time between successive detections for an individual fish within the array for a specified telemetry period.

Detection time within array (days,hr,min): value for detection time within array (hr:min) converted to equivalent days,hr,min format.

Total Distance Traveled*: Total cumulative distance traveled. This includes all the moves between stations regardless of where the stations are located in relation to each other. For example, if a fish travels back and forth four times between two stations located 1 km apart, he will have traveled 4 * 2 * 1 = 8km (if ending on the station it started). The fish will have a net displacement of zero, a range of 1km and a total distance traveled of 8km.

* Definitions and calculations derived from AquaTracker ver 1.10B. José J. Reyes-Tomassini and Megan Moore with Barry Berejikian and Jonathan Lee in association with the NOAA Pacific Northwest Fisheries Science Center and the Puget Sound Telemetry Workgroup.

Table 17
Summarized Detection Information for Gulf Sturgeon Reported in the Entire Gulfport Acoustic Array from 20 September 2013 through 3 September 2014.

Tag Number	River of Origin	Season	Stage	FL (cm)	Total Detections	Total Receivers	First Detection	Last Detection	Days Between First and Last Detection	Detection Time within Array (hr:min)	Detection Time within Array (days,hr,min)
2643	PA	F/W	J	58.0	25	3	12/13/2013	12/14/2013	0.50	12:04:55	0days 12hrs 4mins
30163	PA	F/W	J	80.4	73	7	11/25/2013	11/27/2013	1.62	38:59:24	1days 14hrs 59mins
30172	PA	F/W	SA	100.0	20	3	11/18/2013	11/18/2013	0.03	0:47:40	0days 0hrs 47mins
45714	PE	F/W	SA	101.0	138	12	11/16/2013	11/18/2013	2.03	48:37:18	2days 0hrs 37mins
45717	PE	F/W	A	162.5	56	9	10/23/2013	10/27/2013	3.95	94:51:38	3days 22hrs 51mins
45746	PE	F/W	A	132.0	181	9	10/28/2013	10/31/2013	2.55	61:10:56	2days 13hrs 10mins
45748	PE	F/W	A	159.0	395	3	11/5/2013	11/7/2013	1.83	43:58:47	1days 19hrs 58mins
45752	PE	F/W	A	127.6	6	3	11/12/2013	11/14/2013	1.89	45:15:40	1days 21hrs 15mins
46208	PA	F/W	A	138.0	411	15	11/10/2013	11/22/2013	11.82	283:34:36	11days 19hrs
46210	PA	F/W	A	138.0	50	7	11/6/2013	11/6/2013	0.07	1:37:33	0days 1hrs 37mins
30163	PA	S/S	J	80.4	73	9	3/22/2014	3/23/2014	0.32	7:44:38	0days 7hrs 44mins
30187	PE	S/S	SA	95.0	123	5	2/18/2014	3/20/2014	30.50	732:03:08	30days 12hrs 3mins
30598	ER	S/S	A	137.0	31	4	4/9/2014	4/9/2014	0.22	5:20:24	0days 5hrs 20mins
32244	PE	S/S	A	135.9	56	3	4/23/2014	4/23/2014	0.05	1:16:56	0days 1hrs 16mins
45714	PE	S/S	SA	101.0	95	9	4/30/2014	5/1/2014	0.46	10:55:25	0days 10hrs 55mins
45721	PE	S/S	A	148.0	11	2	3/14/2014	3/14/2014	0.01	0:17:47	0days 0hrs 17mins
45737	PE	S/S	A	151.0	27	2	3/22/2014	3/22/2014	0.04	0:52:35	0days 0hrs 52mins
45746	PE	S/S	A	132.0	8	5	3/2/2014	3/13/2014	11.38	273:08:59	11days 9hrs 8mins
45748	PE	S/S	A	159.0	105	10	3/23/2014	3/23/2014	0.42	10:10:33	0days 10hrs 10mins
45753	PE	S/S	A	137.0	37	9	4/10/2014	4/11/2014	0.87	20:56:14	0days 20hrs 56mins
46183	CR	S/S	A	133.0	145	12	4/9/2014	4/9/2014	0.55	13:14:35	0days 13hrs 14mins
46208	PA	S/S	A	138.0	110	8	3/21/2014	3/23/2014	1.39	33:28:03	1days 9hrs 28mins
46210	PA	S/S	A	138.0	196	3	3/29/2014	3/29/2014	0.18	4:18:54	0days 4hrs 18mins

Table 17 (continued).

	Interval Between Detections (hr:min)						
Tag Number	Min	Max	Mode	Mean	STD	CV	Total Distance Traveled (km)
2643	0:01	7:08	0:01	0:30	1:37	3.24	11.27
30163	0:00	21:03	0:00	0:32	2:45	5.10	26.28
30172	0:00	0:09	0:00	0:02	0:02	1.02	0.97
45714	0:00	16:18	0:00	0:21	3:27	9.73	51.27
45717	0:00	17:13	0:00	1:43	3:53	2.26	33.09
45746	0:00	17:04	0:00	0:20	1:43	5.06	67.65
45748	0:00	23:09	0:00	0:06	1:10	10.54	202.50
45752	0:00	16:42	N/A	9:03	17:44	1.96	1.22
46208	0:00	1:53	0:00	0:41	7:33	10.92	185.93
46210	0:00	0:50	0:00	0:01	0:07	3.60	21.34
30163	0:00	4:48	0:00	0:06	0:34	5.33	21.54
30187	0:00	7:01	0:00	6:00	17:49	10.97	42.54
30598	0:00	4:33	0:00	0:10	0:49	4.64	21.21
32244	0:00	0:12	0:00	0:01	0:02	1.63	15.59
45714	0:00	4:20	0:00	0:06	0:33	4.86	16.99
45721	0:00	0:03	0:02	0:01	0:01	0.62	0.61
45737	0:00	0:10	0:00	0:02	0:02	1.07	14.99
45746	0:00	5:42	N/A	10:10	5:43	2.98	0.61
45748	0:00	3:27	0:00	0:05	0:29	4.98	35.72
45753	0:00	13:22	0:00	0:34	2:17	3.95	9.70
46183	0:00	6:55	0:00	0:05	0:35	6.47	49.24
46208	0:00	15:07	0:00	0:18	1:37	5.32	38.66
46210	0:00	0:12	0:00	0:01	0:01	1.04	79.33

River of origin: PA=Pascagoula, PE=Pearl, ER=Escambia; CR=Choctawhatchee.
Season: F/W = fall/winter, S/S = spring/summer.
Stage: J=juvenile, SA=sub-adult, A=adult.

Complete tag numbers are listed in Appendix 2.

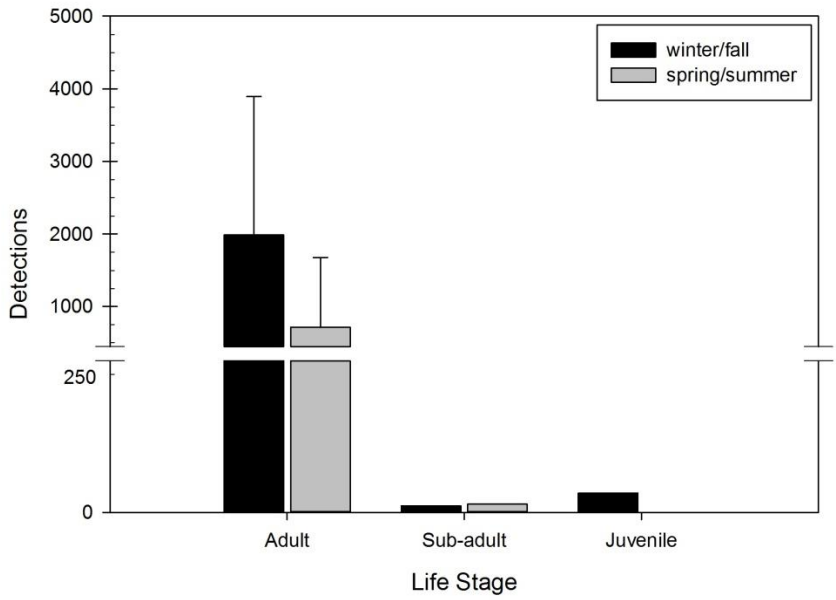
Days between first and last detection: total number of calendar days between first and last detection day within the array.

Detection time within array (hr:min): sum of elapsed time between successive detections for an individual fish within the array for a specified telemetry period.

Detection time within array (days,hr,min): value for detection time within array (hr:min) converted to equivalent days,hr,min format.

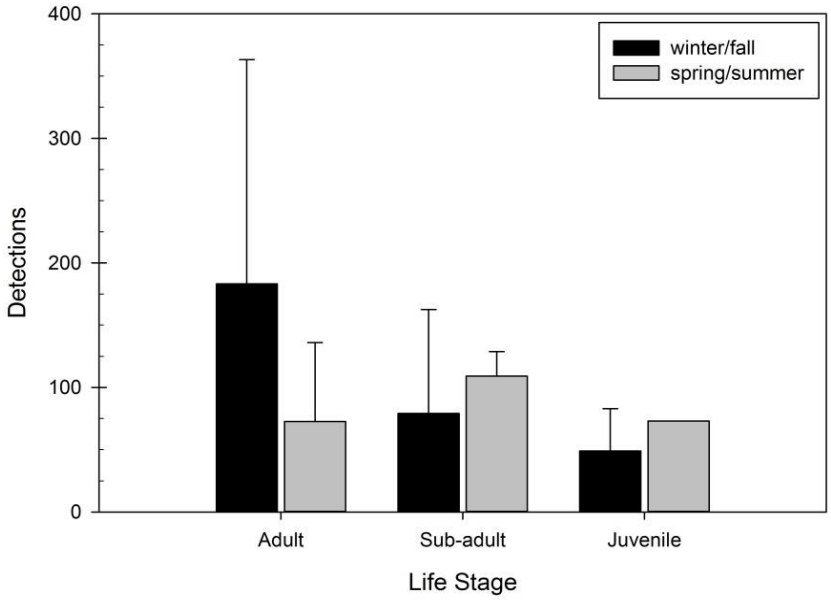
Total Distance Traveled*: Total cumulative distance traveled. This includes all the moves between stations regardless of where the stations are located in relation to each other. For example, if a fish travels back and forth four times between two stations located 1 km apart, he will have traveled 4 * 2 * 1 = 8km (if ending on the station it started). The fish will have a net displacement of zero, a range of 1km and a total distance traveled of 8km.

* Definitions and calculations derived from AquaTracker ver 1.10B. José J. Reyes-Tomassini and Megan Moore with Barry Berejikian and Jonathan Lee in association with the NOAA Pacific Northwest Fisheries Science Center and the Puget Sound Telemetry Workgroup.



The vertical bar represents 1 standard deviation. These data include simultaneous detections as defined in the text.

Figure 8. Mean Number of Detections per Individual within Each Life-History Stage by Season During the Year 1 Monitoring Period.



The vertical bar represents 1 standard deviation. These data include simultaneous detections as defined in the text.

Figure 9. Mean Number of Detections per Individual within Each Life-History Stage by Season During the Year 2 Monitoring Period.

Interpretation of Monitoring Results

The detection histories noted during the monitoring period illustrate a pattern contrary to our initial hypotheses. We originally proposed that juvenile and sub-adult life-history stages of Gulf sturgeon would be more prevalent within the near shore habitat typified within the Gulfport Harbor project area based on studies conducted in other parts of the species range (Sulak and Clugston, 1999; Sulak et al., 2009). However, more adults have been documented within the project area during the monitoring period, presumably during pre- and post-migratory periods. The relative low occurrence of juveniles and sub-adults within the project area suggests these life-history stages may experience restricted movements away from estuaries of natal rivers as young fish and only begin to exploit other more expansive habitats in their later developmental years (Peterson et al., 2013). An alternative explanation considers that the number of individuals per life-history stage documented within the array is simply a reflection of their relative abundance within the sampling areas of their respective river systems. Thus, the number of tagged fish detected within the array mirrors the relative abundance of those respective life-history stages. However, despite the low occurrence of juveniles and sub-adults within the project area during our monitoring period, the occurrence patterns documented do illustrate the importance of the area as "used" by Gulf Sturgeon, whether the habitat serves as a corridor (Havrylkoff et al., 2012; Peterson et al., 2013) between other more suitable habitats, a feeding zone, or a pre-/post-migratory acclimation zone.

Key Results

►Adult Gulf Sturgeon are mainly from the Pascagoula and Pearl drainages but there were some eastern population fish (Escambia, Choctawhatchee and Blackwater (recaptured fish) drainages) that appeared in the Gulfport array.

►Adults were more common than sub-adult and juveniles in shallow waters associated with Gulfport array.

►Overall, Gulf Sturgeon occurrence appears to be more concentrated on east gate and eastern portion of the Gulfport array compared to the west gate and western portion of the array.

►Total detections were markedly lower in the year 2 data set than year 1, with four individuals (two from each drainage) returning to the array over the 2 years of this project.

►In the Year 1 monitoring period, 3 of 13 (23.1%, pooled by season) tagged Gulf Sturgeon had both a high number of days between first and last detections and a high cumulative detection time within the array, whereas in Year 2, 3 of 23 (13.0%) tagged Gulf Sturgeon had both a high number of days between first and last detections and a high cumulative detection time within the array.

Assumptions/Caveats

Many studies have noted the reduction/interference in the detection range of acoustic signals by the VR2W receivers by both environmental (water column properties, biological noise, tidal and weather

conditions) and anthropogenic factors (physical structures, mechanical noise, boat motors) (Heupel et al., 2006; Simpfendorfer et al., 2008; Payne et al., 2010; Topping and Szedlmayer, 2011; Mathies et al., 2014). We used a conservative detection radius for our deployed receivers (300-m detection radius from center of deployed receiver) to optimize our ability to detect tagged fish within the acoustic area of interest. However, there may be some windows of time where the detection radius was larger (clear, low-noise periods of time, calm weather, etc.) and other periods of time (dredging, heavy boat traffic, etc.) where the radius may be < 300 m.

The initial assessment for any telemetry-based study is to examine the overall pattern of detections among the receivers making up the acoustic array (all fish combined) to evaluate "hot spots" within the project area. We feel we have been able to do this in a conservative approach. A high number of total detections or high number of detected individual Gulf Sturgeon within a consistent zone may help to discriminate or define more-favorable habitat or conditions. However, a high number of detections on a receiver may be interpreted as (1) the tagged fish spends an enormous amount of time exclusively within the detection radius, generally exhibiting a relatively stationary behavior with little movement, or (2) the tagged fish passes through the detection radius multiple times, repeatedly over the course of the detection period (i.e., extreme movement). This type of analytical approach was not within the scope of the SOW.

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Appendix 1

Proposed schedule of major tasks associated with tagging and monitoring telemetry tagged Gulf sturgeon for the Gulfport Harbor monitoring project.

						Project YR 1													Project YR 2												Project YR 3						
	2012												2013												2014												2015
MAJOR TASKS	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J
Buoys & Receivers																																					
Buoy construction						X	X	X																													
Array deployment								X																													
Receiver downloads									X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
Array retrieval																																	X				
Gulf Sturgeon																																					
Tagging activities								X	X	X	X						X	X	X	X	X	X	X							X							
Reports																																					
Annual												X	X	X																							
Final																																			X	X	X

Appendix 2

Listing of all acoustic tag codes used in the Port of Gulfport Gulf Sturgeon monitoring study. Project category 'Other' = studies not funded by Atkins International Gulfport project that were either conducted by the USM/ERDC teams or other sturgeon teams in other systems; thee are most likely V16 tags.

Abbreviated Tag ID	Tag ID	River of Origin	Date Tagged	FL (cm)	Project	Tag Type
2638	A69-1601-2638	Pascagoula	10/8/2013	56.0	NOAA Sect 6	V9
2643	A69-1601-2643	Pascagoula	9/30/2013	58	NOAA Sect 6	V9
6214	A69-1601-6214	Pascagoula	10/16/2012	57.2	MSPA	V9
6217	A69-1601-6217	Pearl	7/10/2013	50.3	MSPA	V9
6219	A69-1601-6219	Pascagoula	11/1/2012	64.6	MSPA	V9
6220	A69-1601-6220	Pascagoula	11/6/2013	70.4	MSPA	V9
6222	A69-1601-6222	Pearl	7/11/2013	42.8	MSPA	V9
29896	A69-9001-29896	Pascagoula	10/28/2013	152.8	NOAA	V16
29898	A69-9001-29898	Pascagoula	11/4/2013	100.0	NOAA	V16
29899	A69-9001-29899	Pascagoula	10/31/2012	131.6	NOAA	V16
29901	A69-9001-29901	Pascagoula	11/4/2013	138.6	NOAA	V16
29902	A69-9001-29902	Pascagoula	11/5/2013	135.0	NOAA	V16
29904	A69-9001-29904	Pascagoula	11/7/2013	142.2	NOAA	V16
30163	A69-1601-30163	Pascagoula	11/5/2013	80.4	MSPA	V13
30165	A69-1601-30165	Pascagoula	10/31/2012	75.0	MSPA	V13
30166	A69-1601-30166	Pascagoula	10/28/2013	71.6	MSPA	V13
30167	A69-1601-30167	Pascagoula	10/28/2013	78.2	MSPA	V13
30169	A69-1601-30169	Pascagoula	10/22/2013	88.2	MSPA	V13
30172	A69-1601-30172	Pascagoula	10/28/2013	100	MSPA	V13
30174	A69-1601-30174	Pascagoula	11/7/2013	88.0	MSPA	V13
30177	A69-1601-30177	Pearl	9/26/2012	64	MSPA	V13
30179	A69-1601-30179	Pearl	5/20/2013	74.0	MSPA	V13
30180	A69-1601-30180	Pearl	5/25/2013	100.0	MSPA	V13
30181	A69-1601-30181	Pearl	5/26/2013	81.0	MSPA	V13
30182	A69-1601-30182	Pearl	10/9/2012	65.5	MSPA	V13
30183	A69-1601-30183	Pascagoula	11/7/2012	80	MSPA	V13
30187	A69-1601-30187	Pearl	10/22/2013	95	MSPA	V13
30587	A69-9001-30587	Pascagoula	5/30/2013	139.8	NOAA	V16
30598	A69-9001-30598	Escambia	10/17/2011	137	NOAA	V16
31785	A69-1601-31785	Pascagoula	10/15/2013	155.0	NOAA Sect 6	V9
31787	A69-1601-31787	Pascagoula	10/30/2013	75.0	NOAA Sect 6	V9
31790	A69-1601-31790	Pascagoula	10/25/2012	123.5	NOAA Sect 6	V9
31794	A69-1601-31794	Pascagoula	10/13/2011	95.6	NOAA Sect 6	V9
31795	A69-1601-31795	Pascagoula	10/18/2011	67.6	NOAA Sect 6	V9
32239	A69-1601-32239	Pearl	6/25/2014	92.5	SHIP	V16
32244	A69-1601-32244	Pearl	6/20/2013	135.9	SHIP	V16

32247	A69-1601-32247	Pearl	6/25/2014	88.1	SHIP	V16
40495	A69-1303-40495	Pearl	6/25/2014	59.9	NOAA Sect 6	V9
40496	A69-1303-40496	Pascagoula	6/24/2013	45.0	NOAA Sect 6	V9
45052	A69-1303-45052	Pearl	6/25/2014	58.3	NOAA Sect 6	V13
45054	A69-1303-45054	Pearl	6/25/2014	60.9	NOAA Sect 6	V13
45055	A69-1303-45055	Pearl	6/25/2014	60.4	NOAA Sect 6	V13
45714	A69-1303-45714	Pearl	9/10/2013	101	Other	V16
45717	A69-1303-45717	Pearl	9/28/2010	162.5	Other	V16
45721	A69-1303-45721	Pearl	10/13/2010	148	Other	V16
45729	A69-1303-45729	Pearl	10/7/2010	119	Other	V16
45737	A69-1303-45737	Pearl	9/11/2013	151	Other	*
45746	A69-1303-45746	Pearl	9/28/2010	132	Other	V16
45748	A69-1303-45748	Pearl	9/9/2013	159	Other	*
45752	A69-1303-45752	Pearl	9/28/2011	127.6	Other	V16
45753	A69-1303-45753	Pearl	9/9/2013	137	Other	*
45767	A69-1303-45767	Pearl	10/15/2010	148	Other	V16
46183	A69-1303-46183	Choctawhatchee	10/12/2010	133	Other	V16
46183	A69-1303-46183	Blackwater	10/11/2011	137	Other	V16
46208	A69-1303-46208	Pascagoula	10/24/2011	138	NOAA	V16
46210	A69-1303-46210	Pascagoula	10/31/2012	147.2	NOAA	V16
46215	A69-1303-46215	Pascagoula	10/7/2010	147	NOAA	V16