Final Report

Project Title: Marine Distribution of Gulf of Mexico Sturgeon; Improved Understanding of NAVSEA Testing Through a Multi-Phase Passive Acoustic Biotelemetry Approach

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Introduction

Widely considered the southernmost extant sturgeon species, prior to overharvest the anadromous Gulf Sturgeon (*Acipenser desotoi*) occupied large river systems from Texas to peninsular Florida. Although their general patterns of habitat use and movement in estuarine and riverine systems is fairly well known, data to inform marine habitat use and occupancy modeling are generally lacking. Prior to population declines Gulf Sturgeon were found from the northern portions of South America throughout the northern Gulf of Mexico to the Florida Keys. Present freshwater distribution of Gulf Sturgeon appears limited to Gulf Coast river systems from the Mississippi River eastward to the Suwannee River, Florida (Sulak et al. 2016). While current marine distribution patterns are less documented, they have likely contracted with the concurrent loss of rivers at the edges of their distribution. Ultimately concerns centered on habitat loss/alternation and overharvest led to the ESA listing of Gulf Sturgeon as threatened in 1991 (Federal Register 1991).

Unlike the closely related Atlantic sturgeon (*A. oxyrinchus*), both juvenile and adult Gulf Sturgeon participate in the riverine migrations. Following emigration from the rivers into estuaries in the fall most adult Gulf Sturgeon are believed to move into marine waters to where they spend the winter months foraging to offset prolonged periods of fasting during freshwater residence (Fox et al. 2002). The limited information that exists suggests adult Gulf Sturgeon occupy nearshore marine waters during winter months (Ross et al. 2009, Greenheck et al. 2025))

thereby underscoring the importance of this region for growth and gonadal recrudescence. The lack of information on their habitat use and movement in marine waters is especially troubling when one considers that adults spend a major portion of their life in non-riverine habitats.

The paucity of data on marine habitat use by Gulf Sturgeon was highlighted in the aftermath of the 2010 Deepwater Horizon Oil Spill. In response to the spill event a range-wide study to examine the impact on Gulf Sturgeon was implemented. While the broad scale telemetry findings have yet to be published, the Natural Resource Damage Assessment Trustees estimated that large numbers of adult and sub-adult Gulf Sturgeon were potentially exposed to oil (NOAA 2016). In the northern Gulf of Mexico, limited efforts have been undertaken to examine marine distribution; preliminary findings from studies done in conjunction between the U.S. Fish and Wildlife Service and Eglin Air Force Base suggest that, upon exiting from north central Gulf rivers in the fall, Gulf Sturgeon are thought to either move west to Perdido Key, FL or east off of Panama City, FL (Francis Parauka USFWS Retired personal communication). Their findings bolster the work of others which have documented concentrations of sturgeon between the entrances of Saint Andrews and Saint Joseph Bays which corresponds to the eastern portion of the Panama City Operating Area (OPAREA).

During freshwater residency which extends from spring to fall, adult Gulf Sturgeon undergo a prolonged period of fasting before transiting to marine foraging areas (Mason and Clugston 1993). The lack of freshwater foraging focuses the role of marine habitats in subsequent reproductive success and ultimately is key to the recovery of this species. Improving the limited understanding of marine habitat requirements is emphasized in the Gulf Sturgeon Recovery Plan, which highlights the need for multi-year tracking studies and will also assist in the Biological Assessment required under Section 7 of the ESA. This project, which leveraged large numbers of pre-existing transmitters and passive acoustic receivers, provided much needed information to the Naval Sea Systems Command (NAVSEA) on the spatial temporal patterns of occupancy for the ESA listed Gulf Sturgeon in the Naval Surface Warfare Center (NSWC), Panama City Division Testing Range and the Panama City OPAREA. This information can be used to provide a framework for subsequent efforts to examine the exposure and response to Navy activities as well as the consequences of these responses on this imperiled species.

Methods

In October of 2021, 30 adult Gulf Sturgeon received long-lived acoustic transmitters (Innovasea Ltd. V-16-6H) that were surgically implanted according to previously developed protocols (Fox et al. 2000). This effort was also supplemented by 25 transmitters deployed in adult Gulf Sturgeon in the Choctawhatchee River on October 7 and 8, 2023. Additional tagging efforts led by the Alabama Department of Conservation and Natural Resources have taken place annually through the fall of 2025 deploying transmitters in adults on the spawning grounds in the vicinity of Geneva, Alabama as part of a companion project focused on examining spring and fall spawning populations.

To monitor for these transmitters as well as tags deployed for other projects (in Gulf Sturgeon and other species) we deployed an acoustic receiver array in the NSWC Panama City Testing Range (Figure 1) in the fall of 2021. This array consisted of 30 Innovasea (VR2AR) Acoustic Release and 46 Innovasea (VRTX) Transmitting Receivers and was maintained until mid-May 2022. In October 2022, a modified acoustic receiver array was deployed based on the findings from the first sampling season and included 37 Innovasea (VR2AR) Acoustic Release and 43 Innovasea (VRTX) Transmitting Receivers. These modifications included moving the furthest offshore receivers (40 km offshore) to the nearshore environment (<10 km offshore) where most Gulf Sturgeon were detected. Additional receivers were also added to increase resolution in the northeast portion of the study area (Figure 2). In the third field season of this project, our array was reconfigured into a finer scale array to facilitate identifying important habitats, key use areas and seasonal patterns for Gulf Sturgeon during their winter foraging season in the NSWC Panama City Test Range (Figure 3). This array was redeployed in early October 2023 and has been maintained year-round until its retrieval in December 2025, with downloading, maintenance, and battery replacing occurring periodically throughout the extended deployment. The year-round deployment of our array has been very well received by regional stakeholders, including academic and management agencies who have been carrying out telemetry projects in the Gulf. A summary of the deployment schedule for the duration of this study is located in Table 1.

In an attempt to image and locate Gulf Sturgeon with and without transmitters in the Test Range, 20 missions using a REMUS 100 Autonomous Underwater Vehicle (AUV) (equipped with a Innovasea (VEMCO) Ltd. receiver and a Marine Sonics ArcScout side scan sonar) were

conducted to search for Gulf Sturgeon within the NSWC Panama City Test Range (Figures 4 and 5). Two range tests were conducted before the search missions to determine maximum acoustic transmitter detection.

Results

The passive array detected 414 telemetered Gulf Sturgeon over the duration of the project; however, numbers detected varied across years of this project. Eleven individuals were detected in 2021 and 39 in 2022 (Table 2). We saw a large increase in the number of Gulf Sturgeon in years 2023-2025 (n=74, 112, and 90 respectively) as the array was reconfigured to further refine their core habitat areas closer to shore that were not documented in the first few seasons of this project. Importantly, this Gulf array has been detecting telemetered animals from Gulf Sturgeon populations across the entire species range. The vast majority of Gulf Sturgeon detections remained close to shore (<4km offshore) with no confirmed detections beyond seven kilometers from shore for the duration of the study (Figures 6 and 7). While most receivers within 2km of shore detected a few dozen sturgeon, the receivers in the eastern portion of the array from Tyndall Airforce Base to Mexico Beach, FL had increased detection windows and greater overall time spent in this area by individual Gulf Sturgeon (Figures 2 and 8).

On average Individual Gulf Sturgeon began to migrate into the Gulf through Destin Pass on December 10 (min = Oct 14, max = April 24, median Dec 10) and on average were last detected exiting the Gulf through Destin Pass on February 7 (min = Oct 20, max = May 3, median = Feb 20) to begin their upstream migration (Figure 8).

The 20 REMUS missions in the nearshore environment detected only a handful of telemetered sturgeon on its acoustic receiver. Additionally, identification of sturgeon targets in the side scan sonar proved difficult due to several factors. Gulf Sturgeon occupy unexpectedly shallow water, typically 7m or less, in the nearshore environment along the shore causing limited sonar ranges and the requirement for the REMUS to operate closer to the surface. Wintertime wave action in the Gulf also caused a significant swell that began to interact with the seafloor in that shallow environment, which caused stability issues for the REMUS and greatly diminished the quality of the side scan sonar data on several days. Counter to findings of Atlantic Sturgeon in the nearshore environment where Atlantic Sturgeon congregate in large numbers at the mouths

of estuaries (Breece et al. 2018), the acoustic receiver data, manual tracking, and the REMUS missions did not reveal dense aggregations of Gulf Sturgeon during the overwintering periods.

Additional Findings Beyond Gulf Sturgeon

In the first four years of the acoustic array, many other fishes including Black Drum, Bull Shark, Cobia, Crevalle Jack, Great Hammerhead, Lesser Devil Ray, Mutton Snapper, Spotted Eagle Ray, Southern Flounder, Tarpon, Triple Tail, Tiger Shark, and White Sharks were detected in our array (Table 3). In addition to these fishes, we also detected increasing numbers of ESA listed Green, Kemp's Ridley, and Loggerhead Turtles. These data have been shared with the tag owners, and we have received permission to include them in our final analysis. Note, at the writing of this report, there are still large numbers of transmitters with unidentified species so this list will likely expand after final consultation with iTag (Integrated Tracking of Aquatic Animals in the Gulf – a data sharing project based at University of Florida) when tag owners upload their information. As a result of our efforts to engage with the broader telemetry community we have been able to provide key insights for several ongoing projects. A recent publication on White Shark use of the Northern Gulf included data generated from this project (Roach et al. 2026) and a manuscript focused on Little Devil Ray occupancy utilizing data generated from this project is being prepared by Atlantine (Tine) Boggio-Pasqua (PhD student, Aix-Marseille University in France). Our array has allowed her to explore two previously undocumented behaviors focused on 1- juvenile and subadult feeding area in the Northern Gulf, and 2- the migratory corridor linking this feeding area to the Sarasota-Tampa region where feeding behavior has been recorded but too inconsistently to support a separate feeding-area proposal.

Future Work:

Our data are currently undergoing final QA/QC processing by Dr. Krystan Wilkinson of Mote Marine Laboratories. She is planning to coordinate with the iTag community to both push our collected data to the respective tag owners and confirm species identification and metadata associated with acoustic detections. We will analyze these detection data with habitat parameters such as temperature, time of year, location, and depth, to determine the primary use areas and habitat characteristics for Gulf Sturgeon during winter foraging in the Gulf of Mexico.

Additionally, data collected from the REMUS 100 missions will be evaluated in hopes of identifying fine scale Gulf Sturgeon congregations particularly in the northeastern portions of the Test Range.

Detections of unknown transmitter IDs are submitted to iTAG. Until recently, iTAG members could upload unknown transmitter IDs detected by their acoustic receiver arrays to a web portal that would notify array PIs by email detailing any matched transmitter IDs, along with associated information such as the tag owner's name and email, as well as the species associated with the transmitter. While this matching process occurred instantaneously, there were several drawbacks to the system which led to iTAG members voting to become an official node of the Ocean Tracking Network (OTN), thus ending the web portal.

Transitioning to the OTN node workflow provides a more streamlined and standardized process for researchers, with the added benefit of cross-node comparisons. This means that unknown transmitter IDs can be matched to researchers in geographic locations outside of the Gulf (e.g. along the Atlantic U.S. coast where two OTN nodes are present). All nodes push data to the OTN on specified dates each year (usually February 1st, June 1st, and October 1st). Information about species detected in receiver arrays and individual transmitter detection histories is released approximately one month later. As such, we expect additional details about species detected in the coastal array in July 2026.

Our project collected a wealth of information on both Gulf Sturgeon and other telemetered species including ESA listed turtles in the NSWC Panama City Test Range. Our findings underscore the seasonal nature of Gulf Sturgeon occupancy in the Gulf of Mexico and cursory data analysis reveals concentrations in the near shore environment from November to April with few sturgeon occurring beyond 5km from shore. Now that we understand where and when Gulf Sturgeon occur in the NSWC Panama City Test Range, we want to further refine these insights to get to questions of population and ultimately species-level impacts of Naval activities in this area to improve efficiency and enhance recovery prospects for this imperiled species.

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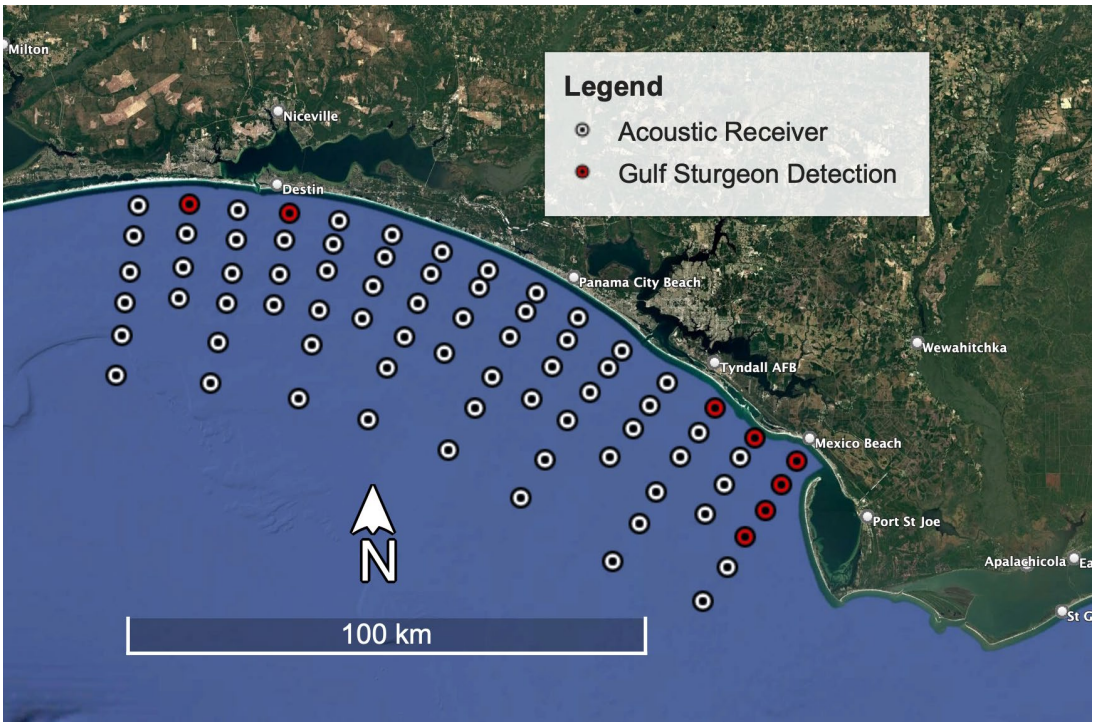

Figure 1. Deployment locations of the passive acoustic receivers to monitor Gulf Sturgeon in the US Naval Surface Warfare Center Panama City Division Testing Range. Red = receivers with detections of Gulf Sturgeon during the fall 2021 to spring 2022 field season.

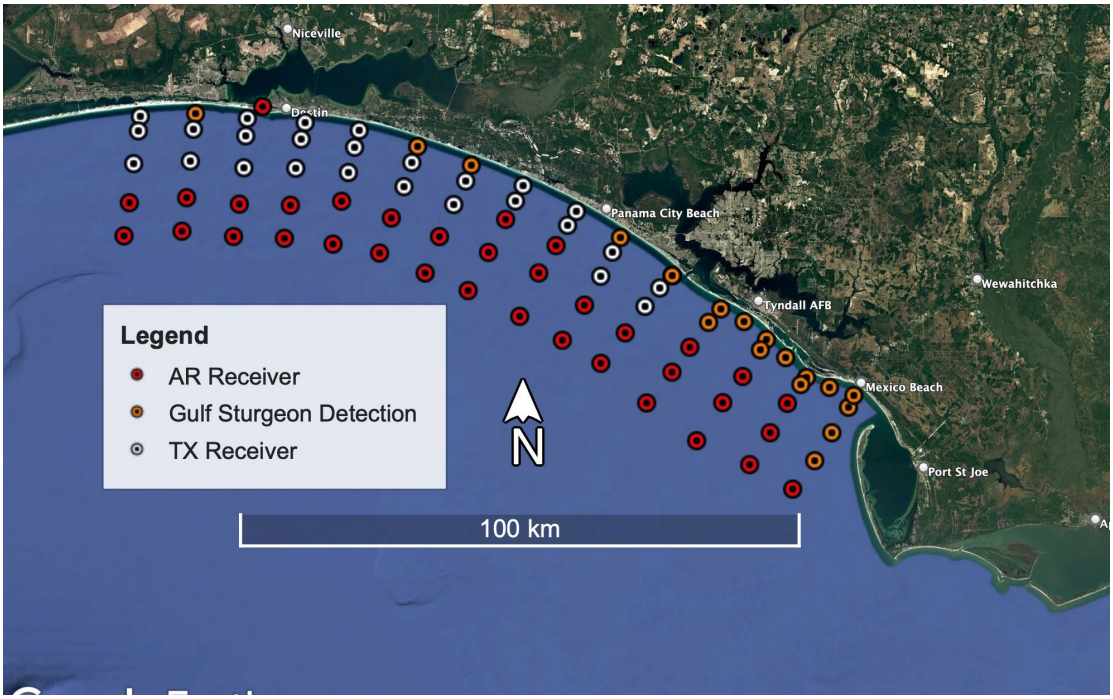

Figure 2. Deployment locations with detections of the passive acoustic receivers to monitor for Gulf Sturgeon in the US Naval Surface Warfare Center Panama City Division Testing Range in the fall 2022 to spring 2023 field season. White = TX receivers, Red = AR receivers, Orange = Detection of Gulf Sturgeon.

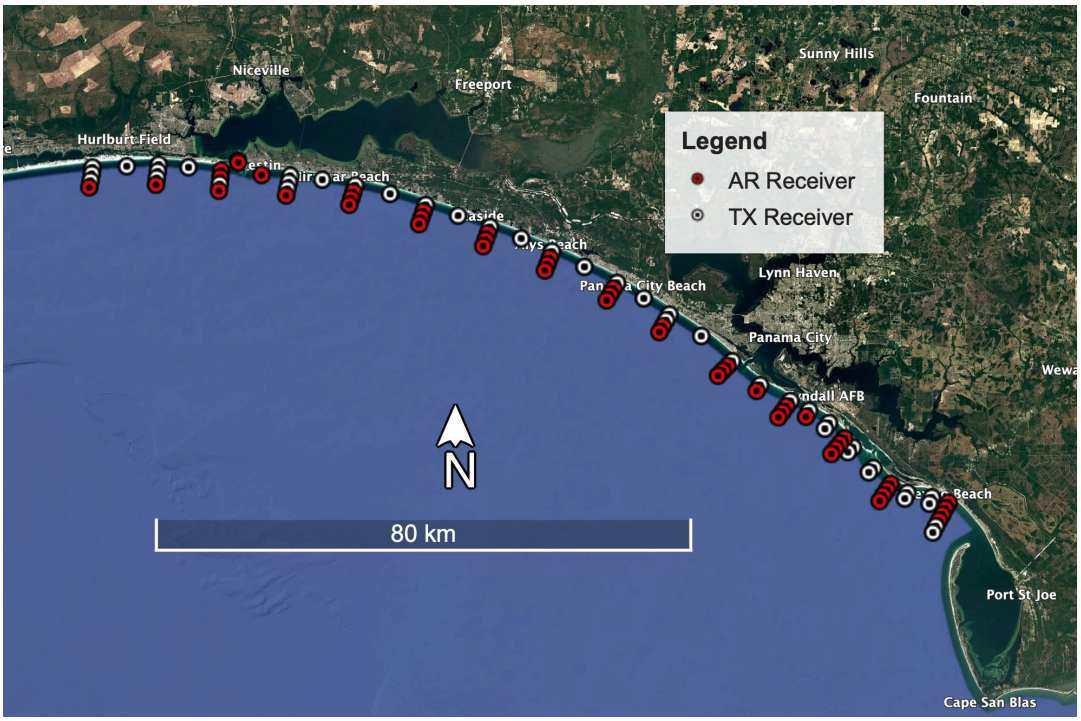

Figure 3. Deployment locations with detections of the passive acoustic receivers to monitor for Gulf Sturgeon in the US Naval Surface Warfare Center Panama City Division Testing Range in the 2023-2025 field seasons. White = TX receivers, Red = AR receivers.

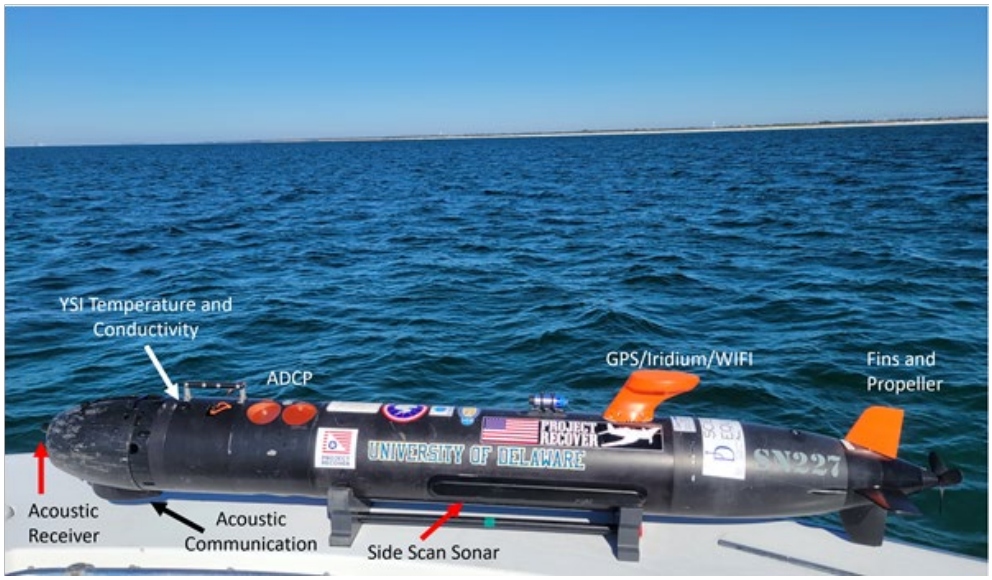

Figure 4. REMUS 100 Autonomous Underwater Vehicle equipped with side scan sonar, acoustic telemetry receiver and environmental sensors utilized to detect Gulf Sturgeon.

Figure 5. REMUS 100 Autonomous Underwater Vehicle side scan sonar mosaics. Acoustic telemetry and environmental sensors were also incorporated to detect Gulf Sturgeon and quantify their habitat.

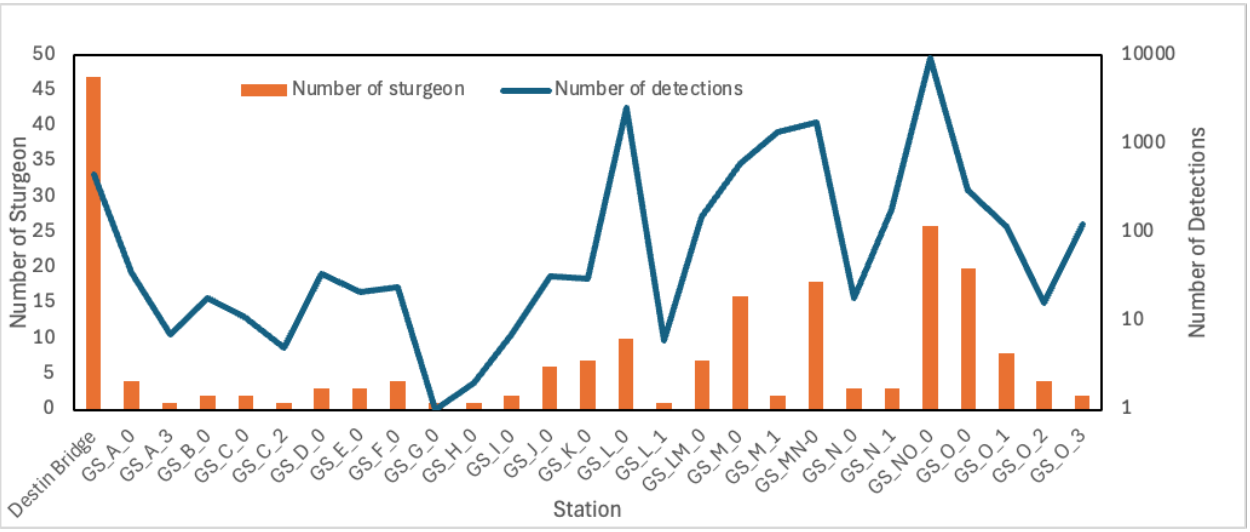

Figure 6. Year two detections (Oct 15, 2022 to May 5, 2023) and number of unique telemetered Gulf Sturgeon detected in the US Naval Surface Warfare Center Panama City Division Testing Range. Station names ending with 0 are the closest line of receivers to shore followed by 1, 2, and 3. The x axis is labeled from west to east with the first station being located at Destin Pass inside the mouth of the Choctawhatchee Bay. Only Stations with detections of sturgeon are shown. The secondary y-axis is in log scale.

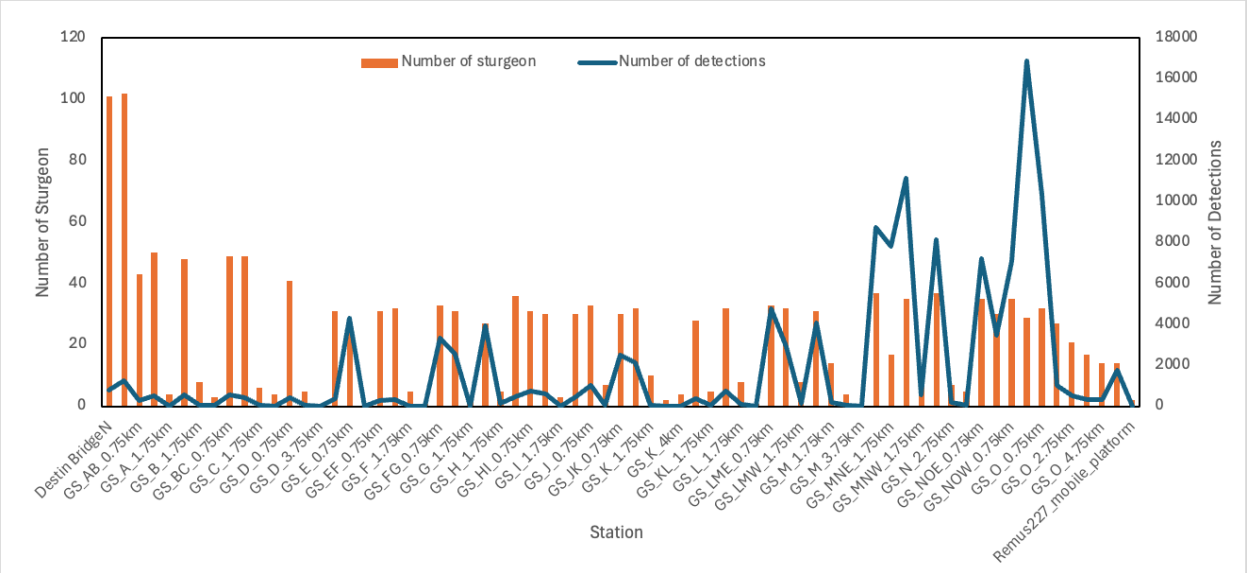

Figure 7. Year three detections and number of unique telemetered Gulf Sturgeon detected in the US Naval Surface Warfare Center Panama City Division Testing Range. Station names have the distance from the shoreline in kilometers. The x axis is labeled from west to east with the first station being located at Destin Pass inside the mouth of the Choctawhatchee Bay. Only Stations with detections of sturgeon are shown.

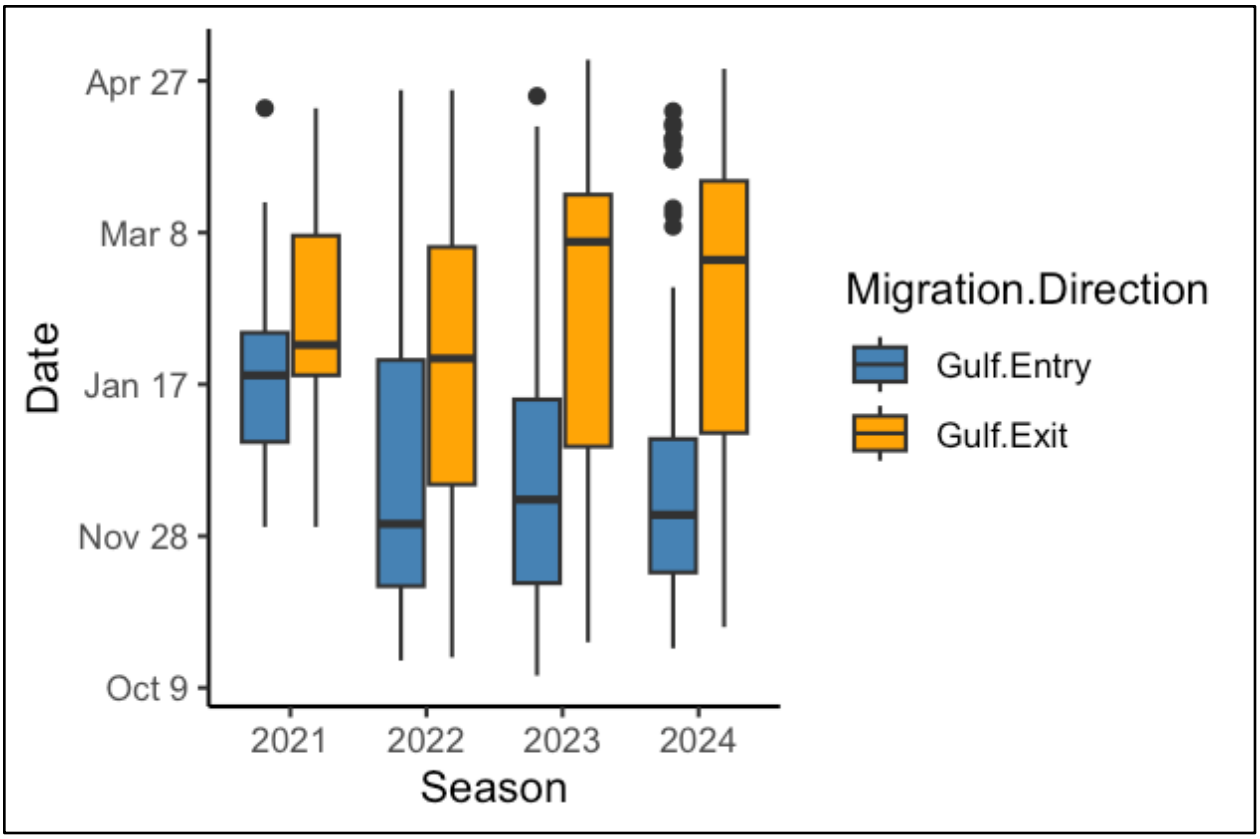

Figure 8. Box and whisker blot of the date of first and last detection of Gulf Sturgeon in the Gulf by season of the project. Note that delayed receiver deployments in the first season (2021) likely biased first detection in the Gulf to later in the year. Additionally, array configuration in later seasons better captured use of near shore Gulf waters and likely is a better estimate of actual exit dates from the Gulf.

Table 1. Monthly active assets by type to monitor for Gulf Sturgeon occurrence from October 2021-December 2025.

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
2021/2022												
VR2TXs		15	15	46	46	46	46	46	46	-	-	-
VR2ARs	-	-	-	30	30	30	30	30	30	-	-	-
Deployed Transmitters	-	30	-	-	-	-	-	-	-	-	-	-
2022/2023												
VR2TXs	-	42	42	42	42	42	42	42	42	-	-	-
VR2ARs	-	37	37	37	37	37	37	37	37	-	-	-
REMUS Missions	-	-	4	-	-	-	10	-	-	-	-	-
2023/2024												
VR2TXs	-	45	45	45	45	45	45	45	45	45	45	45
VR2ARs	-	40	40	40	40	40	40	40	40	40	40	40
Deployed Transmitters	-	25	-	-	-	-	-	-	-	-	-	-
REMUS Missions	-	-	-	3	3	-	-	-	-	-	-	-
2024/2025												
VR2TXs	-	45	45	45	45	45	45	45	43	43	43	43
VR2ARs	-	40	40	40	40	40	40	40	40	40	40	40
2025/2026												
VR2TXs	-	43	43	43								
VR2ARs	-	40	40	40								

Table 2. Total number of individual telemetered Gulf Sturgeon detected in Gulf of Mexico array for 2021-2025 field seasons.

Year	Unique Individuals
2021	**11**
2022	**39**
2023	**74**
2024	**112**
2025	**90**

Table 3. Total number of non-sturgeon species detected in Gulf of Mexico array for 2021-2025 field seasons

Species	2021	2022	2023	2024	2025
Crevalle jack	1	0	0	0	0
Bull Shark	3	13	11	5	4
Kemp's Ridley	1	0	0	1	0
Spotted Eagle Ray	0	2	0	0	0
White Shark	0	13	8	5	4
Loggerhead	0	6	12	8	0
Tiger Shark	0	1	5	5	3
Atlantic Tarpon	0	6	10	10	7
Lesser Devil Ray	0	6	30	18	0
Southern Flounder	0	1	1	0	0
Black Drum	0	3	1	0	0
Cobia	0	1	2	0	0
Green Turtle	0	1	1	0	0
Atlantic Tripletail	0	0	1	0	0
Mutton Snapper	0	0	1	0	0
Great Hammerhead	0	0	1	0	0
Unknown	4	54	76	251	198