Attachment 4
PPBEP COMMUNITY GRANT FINAL RESEARCH REPORT FORM

Agreement No.:	FY2425-01		
Grantee Name:	University of South Alabama		
Grantee Address:	600 Clinic Dr, Mobile, AL 36608		
Grantee's Representative:	Ronald Baker	**Telephone No.:**	251-861-2141
Project Title:	Evaluating the effectiveness of Living Shorelines for fisheries habitat in Pensacola Bay, Florida		
Please submit any high-resolution photos related to the project (include photo credit for possible use by PPBEP for use in our e-newsletter, annual report, social media, or website) with your report as image files to mbwalkinshaw@ppbep.org.			

ABSTRACT: Limit to 250 words. The abstract should include background and a statement of the problem or issue, followed by a description of the research method(s) and design, the major findings, and the conclusions reached.

Living shorelines are promoted for their potential to enhance fish habitat, yet empirical evidence remains limited. This study quantifies fish habitat benefits of high-profile public restorations in Pensacola and Gulf Breeze, Florida, expanding upon a previous year of underwater video surveys. By comparing fish communities within restored, bare, and hardened shoreline areas, we aim to identify habitat preferences and quantify the responses of fish communities to restoration. Recognizing the influence of seasonal and annual factors on fish populations, multi-year monitoring is essential to isolate restoration effects. Over two seasons, we collected 998 visual point census samples using underwater video cameras. Findings show that the restored seascapes are home to high abundances of a diversity of species, including many of importance to fisheries, such as gray snapper, sheepshead, and mullet. Comparisons between restored and adjacent unrestored habitats indicate that restoration has established valuable fish habitats, and our findings in Fall 2024 were generally consistent with those from a previous project sampling in Fall 2023. A notable difference among years was that early juvenile gray snapper were observed far more frequently in Fall 2024 than Fall 2023. Further work will quantify the enhancement of fish production due to restoration. Our public-facing website has been updated to add these new findings. Our findings help build the case for coastal restoration, and our website provides a compelling forum to foster public support and encourage the uptake of living shorelines by private land owners.

INTRODUCTION: Provide necessary background information, describe the purpose of the project, and state the key objectives.

Living shorelines (LS) are promoted for their potential to enhance fish habitat, yet empirical evidence of their effectiveness remains limited. This study quantifies the fish habitat benefits of high-profile public restorations in Pensacola and Gulf Breeze, Florida, building upon previous underwater video surveys at Project GreenShores I and II. We expanded these efforts to include Deadman's Island (Figure 1). By comparing fish communities within restored, bare, and hardened shoreline areas, we aim to identify habitat preferences and quantify fish density increases attributable to restoration.

Long-term data are crucial to understanding the full impact of LS on fish populations. By conducting a second year of fish surveys at Project GreenShores I and II, and expanding our study to include Deadman's Island, we have gathered more comprehensive data on the fisheries benefits of living shorelines. This expanded research will provide concrete evidence of how these nature-based solutions enhance fish habitat. Building upon the methodology outlined by Baker et al. (2022), we are quantifying fish community composition, probability of encounter, and density within restored habitats and adjacent control sites seasonally over multiple years, providing a more comprehensive view of the impact of LS on fish communities. By comparing fish populations in these areas, we aim to quantify the enhancement provided by LS restoration (e.g., zu Ermgassen et al., 2021).

A critical component of this project is public engagement. A public-facing website, developed with previous Community Grant funds, has been updated to include multi-year monitoring results at Project GreenShores I and II. Basic numbers on fish enhancement, coupled with videos of fish across the site, provide a powerful tool to highlight the benefits of LS restoration to the public in general, and waterfront property owners in particular. This platform is essential for engaging the public and fostering support for LS initiatives. By providing accessible information and visualizations, we aim to increase public awareness of the ecological benefits of LS and encourage wider adoption of these nature-based solutions. This research contributes to the growing body of knowledge on the effectiveness of LS, informs future restoration efforts, and empowers the public to make informed decisions about coastal management.

METHODS: Provide sufficient detail for how the project was conducted and data were collected, including specific materials and methodologies/protocols.

Replicate samples were collected with a fleet of waterproof video cameras. GoPro Hero 8 cameras were used for most of the field days, but were replaced with GoPro Hero 12 models for the last three field days of Spring 2025. Cameras were used unbaited to examine fine-scale habitat associations (Bradley et al. 2017, Baker et al. 2019). Each camera was mounted on a 30 x 30 cm base, with a 2.5m float line for deployment and retrieval (Figure 2). Up to 6 individual cameras were deployed as a set, with cameras spaced at least 20 m apart to minimize the probability of the same individual fish being recorded across multiple cameras. After deployment, cameras were left undisturbed for ~15 minutes before recovery. Using six sampling cameras concurrently is most efficient because by the time the 6th camera has been deployed, and the visibility camera and the YSI readings, the 1st camera has been deployed for 15 minutes and is ready to be retrieved. We targeted a minimum of 10 replicate camera drops for each habitat sampled, except the brick structures in Deadman's which are only extensive enough for 8 independent replicates each season. The visibility camera was mounted on a base with a 2.5 m pole extending horizontally through the field of view, marked in black and white in 10 cm increments, which allows us to calculate the area of the field of view at each site (Figure 3). The visibility camera was deployed for at least two minutes, and water temperature, salinity, and dissolved oxygen (DO) were measured using a handheld YSI meter at the end of each replicate set.

In the lab, a 10-minute clip was analyzed from each 15-minute video sample. The first 1 minute after deployment (the point at which the camera settles on the substrate) and the last 1 minute before retrieval were disregarded to minimize disturbance during deployment and retrieval from impacting the data by attracting or deterring fish. If sediment was disturbed during camera deployment, reducing visibility in the field of view, the starting point of the 10-minute clip was extended until the water cleared. The clips were then viewed for the next 10 minutes to extract data. The presence of each observed species was recorded, providing the probability of encounter or the proportion of replicates in which each species was present. We also record MeanCount, being the mean number of individuals of each taxon observed in 10 randomly selected still frames within each 10-minute clip (Schobernd et al. 2014), with a minimum of 20 seconds between frames. Dividing MeanCount by the area of the field of view produces density estimates, or the number of individuals per m^2. Differences in density between restored habitats and adjacent control sites can form the basis of production enhancement models of zu Ermgassen et al. (2021), which estimate the amount of fish production attributable to restored habitats.

Data was extracted from each video twice, independently, by two different trained observers (MS Student and Technicians). In addition to assigning fish ID, each observer noted the timestamp for every fish or mobile invertebrate observed in the video. The pooled from the two observers were used by experienced video processors (the PI and technicians) to confirm the identification and recordings of all observed organisms, producing the final QAQC'd dataset for analyses.

RESULTS: Present and describe key results from your research project. This section should accurately describe all data collected, including data summaries, significant observations, and trends (if applicable). Please attach a separate file with map(s), tables, and figures.

In Fall 2024 we collected a total of 482 samples, comprising 398 successful point census replicates, 13 samples that were discarded due to poor visibility or obstructions, and 71 visibility camera drops to measure the area of the field of view. In Spring 2025 the total was 516, being 289 successful point census, 152 unsuccessful samples, and 75 visibility drops. This gives a total of 687 successful point census samples for this project, with 123 in GreenShores control sites, 177 in GSI, 199 in GSII, 130 in Deadman's Island, and 58 in Deadman's Island control site.

In the Fall 2024 samples, a total of 65 taxa were observed (55 teleost fishes, 3 elasmobranch (ray), and 7 decapod crustaceans), representing 32 Families (23 ray-finned fishes, 3 rays, and 6 decapods) (Table 1). Pinfish, *Lagodon rhomboides*, and mullet, *Mugil* spp., were observed across all sampled habitats in Fall 2024 (Table 2). Animals were recorded from 91.2% of successful videos, while 8.8% were empty samples. Breakwaters showed the highest number of taxa (n = 48), while control offshore sites had the fewest (n = 10).

Fish and crustaceans were observed far more frequently within the restored seascapes than in the adjacent controls, and every video sample on structured habitats (i.e. riprap, breakwaters, brick structures, marsh edge, oyster reef) had animals present. In contrast, large proportions of samples from offshore control sites were empty. Rays were seen infrequently, but were most common in bare sandy areas of the offshore controls and bare areas within the restored seascapes. Pinfish and mullet were highly abundant and were seen in all habitats sampled. Gray snapper, pigfish, and sheepshead were also common across structured habitats both in the restored seascapes and the riprap shorelines in control sites.

Restored habitats at Deadman's Island were dominated by similar species to those in PGS I & PGS II, such as sheepshead, pinfish, gray snapper, pigfish, and mullet. Several species were seen more frequently or exclusively at Deadman's, particularly on the disc breakwater structures, including Atlantic spadefish, spotfin butterflyfish, spottail pinfish, slippery dick, and black drum (Table 3).

The dominant species were similar between Fall 2023 and Fall 2024, with some interesting variations. Gray snapper were observed across all structured habitats in both years, however they were seen in much higher frequencies as both early juveniles and larger individuals in 2024 than 2023. For example, early juvenile gray snapper were seen in around 30% of samples from breakwaters in 2023, but almost 80% of breakwater videos from 2024, and in less than 10% of control hardened shoreline samples in 2023 and over 70% in 2024. Similarly, pigfish, and both early juvenile and larger sheepshead were observed in higher frequencies across a greater range of habitats in 2024 than 2023, while gobies/blennies and mojarras were observed more frequently in 2023 than 2024.

Frequency of Occurrence analysis for samples from Spring 2025 will be completed after QAQC is finalized. Then density data will be extracted from all videos to allow calculation of fish enhancement in the restored habitats.

An advantage of video sampling is that it is non-destructive, meaning no organisms are captured and retained. However, this means that not all individuals observed can be identified to species level, because identifying features are not always visible in the video footage. For each observation, only the identifying features in the field of view are used for identification, and no assumptions are made based on closely related species observed in the same video.

DISCUSSION AND CONCLUSION: Present, interpret, and discuss the results, project outcomes, future research needs, and how this research connects back to the CCMP.

The restorations at GreenShores I and II and Deadman's Island have clearly created excellent fish habitat, with far higher diversity and abundance of a variety of species within the restored seascapes than in the adjacent unrestored areas. While we are yet to extract quantitative estimates of fish density from our videos, it is clear that many species occur in far higher densities within restored habitats than bare control areas. This is consistent with most previous work showing higher densities of estuarine fishes in structured habitats. The most common species across the sites are ecologically, culturally, and economically important species, including fisheries species such as gray snapper, sheepshead, mullet, speckled trout, and red drum.

The additional sampling afforded by the current grant, to include Deadman's Island and allow a second year of sampling at GSI and II, has highlighted the success in these projects at establishing valuable fish habitat, as well as allowing us to evaluate interannual differences at the GreenShores sites. Between Fall 2023 and Fall 2024 the dominant species and overall composition were similar at GS sites, confirming that differences between restored and control sites are robust and reflect success of restoration in establishing fish habitat. Early juvenile gray snapper and sheepshead, as well as pigfish, were more frequently seen in 2024 across a variety of habitats, suggesting a stronger recruitment year for these in 2024 than 2023. Despite some apparent differences in relative abundances between years, there is clearly higher diversity and abundance of species within the restored habitats than the adjacent controls.

Ongoing work will include extracting quantitative density estimates for each species in each habitat following the methods of Baker et al. (2022). With these data, we can determine how many more young-of-year juvenile fish are present in the seascape due to the presence of the restored habitats, by subtracting the densities in unrestored control habitats from those in the restored habitats. Then, by applying published growth and mortality rates for each species, we can model the amount of fish production (biomass) resulting from the restored habitats, as per zu Ermgassen et al. (2021). Production estimates are regarded as the highest level of information on habitat value by NOAA Fisheries, and provide a meaningful metric to quantify and communicate the benefits of restoration.

Our public-facing website has been updated with Fall 2024 results, and will continue to be updated as further results are completed. This website provides an engaging format to communicate the benefits of Living Shoreline restoration to the general public.

This project has several links to the PPBEP CCMP. Monitoring the fisheries species assemblages and habitat preferences within two living shoreline restoration projects and two control sites provides a better understanding of the area's fish and wildlife conservation needs (Objective 6.2). Our results indicate differences in species diversity between restored and control sites, strengthening the claims of restoration benefits, but our current data is preliminary and not a complete overview. A final determination of the habitat usage of local fish communities will aid in community planning by providing evidence of the benefits that living shoreline restoration projects have on the surrounding area and identifying the habitats that should be included to positively impact fish communities (Action 5.3.2). The project website provides clear video evidence and easy-to-understand figures that effectively communicate the benefits of green infrastructure and other low-impact designs to the public (Objective 6.2). Data and clips featured on the website, in addition to general information on the project and our methods, provide the community and collaborative partners with reports and increase awareness of ongoing monitoring and results of restoration efforts in their area (Objective 6.1, Objective 1.2)

REFERENCES: Please list references cited throughout this report. Additionally, if there are key references that PPBEP needs copies of to fully understand your methods and overall research, please attach references as individual PDFs.

Baker R, Bilbrey D, Bland A, D'Alonzo F, Ehrmann H, Harvard S, Porter Z, Ramsden S, Rodriguez A (2022) Underwater video as a tool to quantify fish density in complex coastal habitats. Diversity 14:50
Baker R, Barnett A, Bradley M, Abrantes K, Sheaves M (2019) Contrasting seascape use by a coastal fish assemblage: a multi-methods approach. Estuaries and Coasts 42:292-307
Bradley M, Nagelkerken I, Baker R, Travers M, Sheaves M (2022) Local environmental context structures animal-habitat associations across biogeographic regions. Ecosystems 25:237-251
Bradley M, Baker R, Sheaves M (2017) Hidden components in tropical seascapes: Deep-estuary habitats support unique fish assemblages. Estuaries and Coasts 40:1195-1206.

Grant C, Rodriguez A, Baker R (2023) Identifying potential drivers of fish community composition on restored oyster reefs in East Bay Pensacola. Bays and Bayous; January 2023, Mobile, Alabama.
Schobernd ZH, Bacheler NM, Conn PB (2014) Examining the utility of alternative video monitoring metrics for indexing reef fish abundance. Can. J. Fish. Aquat. Sci. 71:464–471.
zu Ermgassen PS, DeAngelis B, Gair JR, zu Ermgassen S, Baker R, Daniels A, MacDonald TC, Meckley K, Powers S, Ribera M, Rozas LP (2021) Estimating and applying fish and invertebrate density and production enhancement from seagrass, salt marsh edge, and oyster reef nursery habitats in the Gulf of Mexico. Estuaries and Coasts 44:1588-1603.

SUCCESSES AND CHALLENGES: Describe the significant successes and challenges the organization experienced related to the funded grant.

The project was very successful. We achieved high replication with 687 successful point-census video samples collected across 11 days of sampling in both Fall and Spring. At these restoration sites, this represents a high density of sample replication, providing good coverage of all habitats in the seascape. Sampling windows depended on tides because some habitats, particularly those near the shore within the restoration sites, are only accessible by boat during higher tides. Despite this, we achieved good replication across all habitats.

Rough weather limited suitable sampling conditions during Spring 2025, reducing visibility at the sites considerably and resulting in a higher rate of unusable videos from those sampling efforts. Technical issues with the new cameras on the final three days of Spring 2025 also contributed to the higher rate of unusable videos. We still achieved 289 successful replicate samples for Spring 2025.

Video sample processing takes considerable time, and as was anticipated in the original proposal, it is still ongoing at this time. After completion, the final comprehensive results and analyses will be provided to PPBEP, and the website will be updated.

LESSONS LEARNED: Describe what the organization learned based upon the results, successes, and challenges reported. Address programmatic, evaluative, or organizational changes that will be made based upon these lessons learned.

The restorations at Deadman’s Island and Greenshores I and II have created thriving seascapes with abundant and diverse fish communities, including many species of great social, ecological, and economic importance. Our project findings will ultimately quantify the number of fish these sites support, exceeding what was likely present before restoration occurred. These findings highlight the benefits of living shorelines for enhancing fish habitat, can help guide future restoration designs, and promote these benefits to the general public through our project website. Coupled with the data from a previous grant, the findings will help guide future restoration in the bay and provide a baseline for ongoing monitoring of fish communities on living shorelines.

This report is submitted in accordance with the reporting requirements of Agreement No. FY2425-01 and accurately reflects the activities associated with the project.

June 12, 2025

Signature of Grantee’s Representative | Date

Ronald Baker, Principal Investigator

Print Name and Title