Attachment 5
PPBEP COMMUNITY GRANT FINAL RESEARCH REPORT FORM

Agreement No.:	FY2023-02		
Grantee Name:	Dauphin Island Sea Lab		
Grantee Address:	101 Bienville Blvd Dauphin Island, AL 36528		
Grantee's Representative:	Ronald Baker	**Telephone No.:**	251-861-2141
Project Title:	Fisheries habitats across living shoreline seascapes: a public demonstration of the benefits of restoration		
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 lmcdonald@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 provide many benefits over traditional hard armoring. One of the most widely stated but least tested benefits is the enhancement of habitats for fisheries species. This project uses the highly visible public restorations of Project Greenshores I & II in Pensacola as demonstration sites to quantify the fish habitat benefits of these projects. Underwater video surveys were used to sample the fish communities across the seascapes at the project sites and adjacent unrestored areas. By comparing fish densities among habitats, we can quantify the number of fish present due to habitat restoration and which habitats they prefer. A dedicated project website was developed to showcase the project and its findings, providing an engaging platform for individuals to directly interact with the data by viewing video clips and figures.

Initial findings indicate that species richness is higher around particular habitats, such as the Living Shoreline breakwaters, while bare/unstructured sandy bottom had the lowest species richness. Individual species preferred particular habitats, and once the samples from Spring 2024 are processed and analyzed, the website will be updated with the final results. Demonstrating habitat enhancement values of highly visible public restoration projects will help guide future restoration projects, foster a greater appreciation of LS approaches, and encourage their wider support and uptake in the community.

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

Enhancing fisheries habitats is one of the most commonly stated benefits of living shorelines (LS) restoration projects over traditional shoreline hardening. However, evaluating the benefits of restoration for fisheries in complex coastal environments is challenging. Underwater video is a tool that can quantify fish communities across a wide range of complex coastal habitats (Baker et al. 2022). In clear water environments, video also provides a valuable tool for outreach and education to demonstrate the fisheries habitat benefits of these projects. Demonstrating habitat enhancement values of highly visible public restoration projects can help foster a greater appreciation of LS approaches and encourage their broader uptake in the community. This project will use previously tested underwater video methods to quantify the fish communities at two adjacent, highly visible public living shoreline projects, Projects Greenshores I and II in Pensacola (Fig. 1 supporting documents).

Previous PPBEP-funded projects in East Bay oyster reefs found marginal visibility that somewhat limited sampling efforts. Project Greenshores I and II are located lower in Pensacola Bay, where visibility is much better. As such, this is an ideal demonstration site of the fisheries benefits of restored seascapes with multiple habitats (e.g., intertidal marsh, oyster reefs, breakwaters, tidal creeks) because high-quality video samples can be collected easily without spending time searching for sites with suitable visibility. Observations by our team monitoring the vegetation at Project Greenshores II indicated high abundances of fish across the site, including important recreational fisheries species such as gray snapper and sheepshead. By comparing the abundance of fish between restored seascapes, adjacent bare substrates, and hardened shorelines, we can quantify how many more fish are present due to the habitat restoration and which habitats they prefer to better inform future living shoreline designs. For example, if fish prefer intertidal marshes, we can recommend that future LS designs incorporate plantings at an appropriate elevation to maximize fish habitat.

A website to engage the public was developed with general information about Living Shorelines, background on Project Greenshores I and II, and an interactive interface with the data. Users can pan across and zoom in on an image of the whole site and identify the range of habitats present. Pages linking to each habitat and species open underwater videos showing the fish communities present and data summaries. The website is user-friendly for members of the public with differing levels of interest in the project's more detailed information and analyses in a multi-layered fashion. The first layer comprises videos of the various fish species surveyed in each habitat and will be very popular with all visitors to the site. Those wishing to delve deeper into the data can do so through figures and descriptions on each page. Basic numbers on fish enhancement, coupled with videos of fish across the site, will provide a powerful tool to highlight LS restoration's benefits to the general public and particularly waterfront property owners. To ensure maximum impact, the website will be promoted through existing outreach networks, including the PPBEP website and social media posts, the Baker Lab website, as well as through other outreach opportunities, including DISL Boardwalk Talks, the PPBEP Community Grant Symposium, and other relevant events once completed.

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. 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 rope line to a float for deployment and retrieval (Figures 23 & 24). A set of 6 individual cameras was deployed at least 20 m apart to minimize the probability of the same individual fish being recorded across multiple cameras. After deployment, the boat was moved at least 50 m from the camera, and cameras were left undisturbed for ~15 minutes before recovery. Using six sampling cameras concurrently is most efficient because it minimizes the time between deploying the 6th camera and recovering the 1st one. We targeted a minimum of 10 replicate camera drops for each habitat sampled. The visibility camera (a camera on a base with a 2.5 m pole extending horizontally through the field of view, marked black and white in 10 cm increments that allow us to calculate the area of the field of view at each site, Figure 25) was dropped once on each habitat, at the end of each set of replicates. Water temperature, salinity, and DO were measured at each site with a hand-held YSI meter.

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 species observed was recorded and provided the probability of encounter or the proportion of replicates in which each species is present. Our next analysis (MeanCount) of the Fall 2023 data will provide estimates of density of various species in each habitat. MeanCount is recorded as 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. MeanCount is converted to density by dividing MeanCount by the area of the field of view, estimated with the visibility camera as described by Baker et al. (2022). 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 and MeanCount, each observer noted the timestamp for every fish or mobile invertebrate observed in the video. A comparison of the datasets between the two observers provides QAQC with this step of the process and identifies if further training is needed. The pooled datasets from the two observers were used by experienced video processors (the PI and technicians) to confirm the identification and recordings of all observed organisms.

Clips of interesting organisms were taken while videos were processed for our interactive website. DaVinci Resolve 18 was used to edit acceptable clips, which were uploaded to YouTube and embedded into the website. Pages on our methods and background information on Projects Greenshores I & II allow users to better understand our project, and a page linking to information on living shorelines provides context to their importance and need for research. There are links to Habitat and Species pages, which include links to specific habitats and species. Pages include a highlight reel, description, data summary, video clips, and, if applicable, images. Clips are still being taken and edited and will be updated along with the data summaries as we progress in our 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.

Fall 2023 field sampling occurred in October (3 days) and November (1 day) and resulted in 245 successful replicate point-census samples from four sites in Pensacola Bay (Figure 1). An additional 51 visibility drops were made to assess visibility at each site, along with 52 point-census samples that proved to have poor visibility or obstructions and were excluded from the analysis. The total number of Fall 2023 (visibility and census) samples was 348. Spring 2024 field sampling occurred in April (3 days) and May (1 day), resulting in 163 successful replicate point-census samples from the same four sites in Pensacola Bay. An additional 43 visibility drops were made to assess visibility at each site, along with 87 point-census samples that proved to have poor visibility or obstructions and were excluded from the analysis. The total number of Spring 2024 samples (visibility and census) was 293. The total number of samples between Fall 2023 and Spring 2024 was 641.

In Fall 2023, at least 15 species and 16 other taxa of fish (not possible to identify to species), two families of rays, and five taxa of crabs were observed in the videos (Table 1). Fall sampling included 92 videos from breakwaters. Our breakwater sampling included replicates along the inshore sides, the offshore side of the breakwaters, as well as the ends of breakwaters since we believed these might be occupied by different species due to their different depths and environmental conditions. The current summaries on the website were all grouped simply as "breakwaters", hence the larger sample size for this habitat than all others. Breakwaters showed the highest number of species, and Control Offshore sites had the fewest species. White mullet (*Mugil curema*) and pinfish (*Lagodon rhomboides*) were the most commonly seen species in bare areas within the restoration sites. Gray snapper (*Lutjanus griseus*), pinfish, and striped mullet (*Mugil cephalus*) were the most commonly seen species around the breakwaters. Striped mullet, pinfish, and white mullet were the most frequently seen species along the hardened shorelines of our control sites. Half of our offshore control samples were empty. In the offshore control videos where we did see organisms, hermit crabs (Paguroidea) and pinfish were the most commonly seen species in this habitat. Pinfish and mojarras (Gerreidae) were the most frequently seen species near the marsh edge. Pinfish, white mullet, and striped mullet were the most commonly seen species near the oyster reefs. Pinfish and mojarras were the most frequently seen species near restored hardened shorelines. Other species of interest to fisheries included the sheepshead (*Archosargus probatocephalus*), red drum (*Sciaenops ocellatus*), Carangids (Jacks and pompanos), and black drum (*Pogonias cromis*). Black drums were most frequently found along the Control Hardened Shoreline and in 4 of the 92 (4%) Breakwater videos. We could identify several species of jack in our videos but cannot identify all species. Florida pompano (*Trachinotus carolinus*) were found in one marsh edge video, horse-eye jacks (*Caranx latus*) were most frequently seen near the breakwaters, and Permit (*Trachinotus falcatus*) were seen around the breakwaters and oyster reefs. Early juvenile and adult sheepshead were most commonly seen near the breakwaters, but adults were also found near control hardened shorelines. Red drum were most frequently found along the Control Hardened Shoreline. Early and late juvenile Gray snapper were often seen along the breakwaters and restored hardened shorelines. Animals were recorded from 95% of successful videos, while 5% were empty samples.

Frequency of Occurrence analysis for samples from Spring 24 will be completed after QAQC is finalized.

Note that due to limited visibility and the nature of video sampling, it is not always possible to identify organisms at the species level. 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.

Species richness was higher within the restored sites, except Bare habitats. Bare habitats typically are used by fish as they move between other sites, so the low richness in Bare areas is to be expected. Breakwaters showed the highest overall species richness and the lowest was offshore the control sites. Species richness was higher around the hardened shorelines of our control sites than offshore, suggesting the presence of structure might draw some organisms. Some species, like striped and white mullet, were observed in most habitats, but some were observed in only a few or primarily one habitat, like sheepshead. Age groups were assigned only to sheepshead and gray snapper but demonstrated a preference for early juveniles for habitats containing some structure. The frequency of occurrence results for Fall 23 samples suggest differences in species richness between habitats, but all data must be looked at before making conclusions.

This project will quantify the actual fisheries benefits of highly visible public LS restoration sites on the foreshores of Pensacola. Most LS projects state fisheries habitat enhancement as one of their goals, but very few demonstrate this through robust quantitative research. As such, this project will be a key demonstration of the realized benefits of restoring fisheries' habitat and production. Increased awareness in the community of the values of coastal habitats for fisheries and the benefits of LS restorations will foster greater support for LS projects and encourage their adoption by private landowners. Further research is needed on similar restoration sites to compare and draw broad conclusions. Factoring age and behavior into our research would provide additional insights into the benefits of restoration on fish communities.

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 richness 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 offering evidence of the benefits living shoreline restoration projects have on the surrounding area and what habitats should be included to impact fish communities positively (Action 5.3.2). The project website offers clear video evidence and easy-to-interpret figures communicating the benefits of green infrastructure or 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.

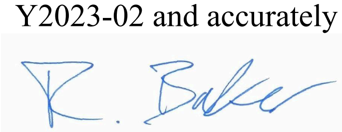
SUCCESSES AND CHALLENGES: Describe the significant successes and challenges the organization experienced related to the funded grant.

The project was very successful. We achieved high replication with over 400 successful point-census video samples from 8 days of sampling across 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 the shoreward ones within the restoration sites, are only accessible by boat during higher high tides. Despite this, we achieved good replication across all habitats. Rough weather and rainfall limited suitable sampling conditions during Spring 2024 and reduced visibility in the site considerably, leading to a higher rate of unusable videos from those sampling efforts. We still achieved 163 successful replicate samples for Spring 2024. 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.

<u>LESSONS LEARNED:</u> 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 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 quantify how many fish these sites support over and above what was likely there 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. Y2023-02 and accurately reflects the activities associated with the project.



June 14th, 2024

Signature of Grantee's Representative — Date

Ronald Baker

Print Name and Title