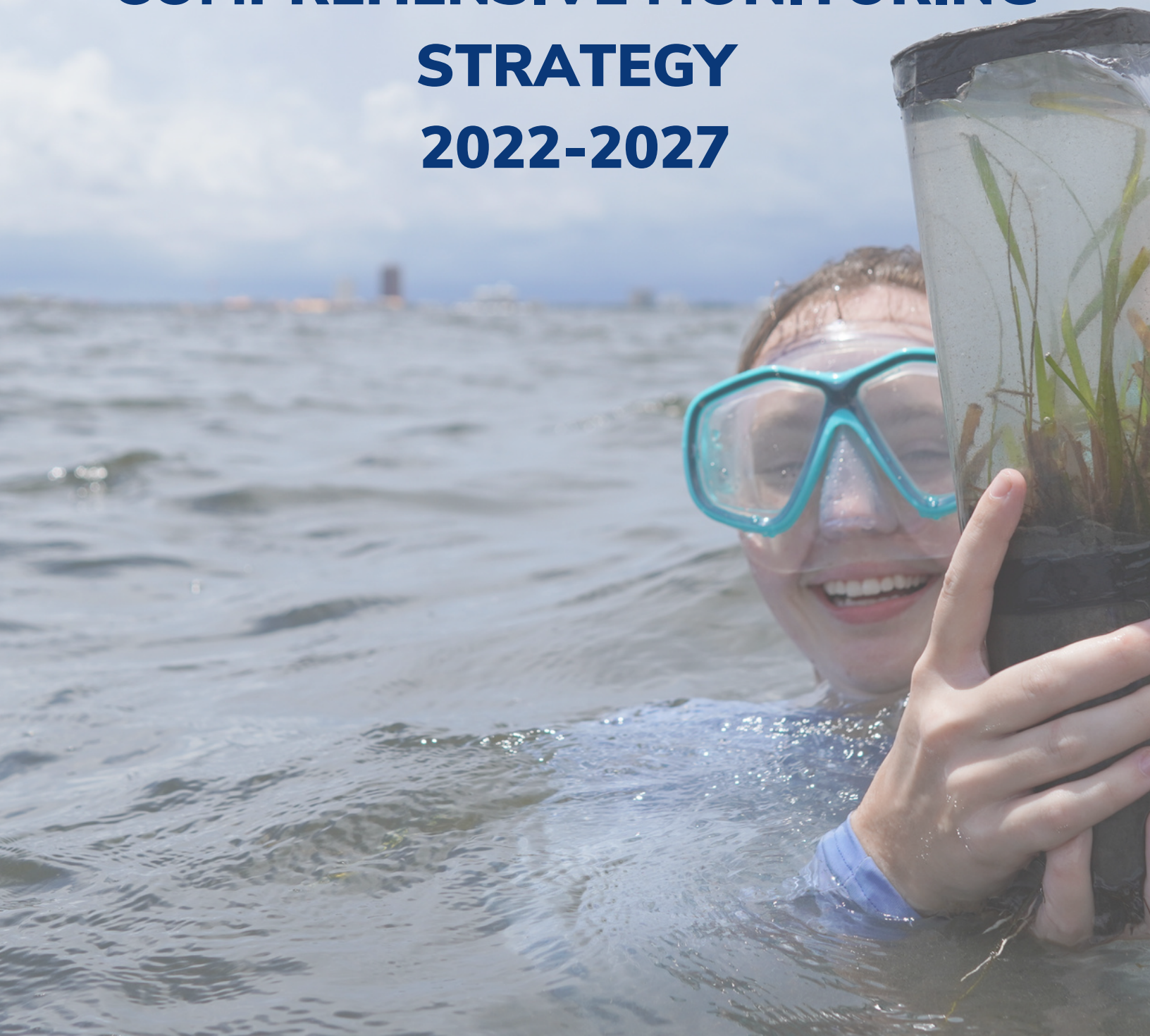
PENSACOLA & PERDIDO BAYS
ESTUARY PROGRAM

COMPREHENSIVE MONITORING STRATEGY 2022-2027



BACKGROUND

The 2022-2027 Comprehensive Monitoring Strategy is an appendix of the Pensacola and Perdido Bays Estuary Program's (PPBEP) Comprehensive Conservation and Management Plan (CCMP) and supplements the six established goal areas identified to address priority issues across the watersheds. This strategy will assist Program staff and partners with prioritizing monitoring needs to effectively assess the progress and effectiveness of CCMP actions.

Integrating a participatory framework into an adaptive management strategy provides an opportunity for increased community engagement and support. During the early stages of program establishment, PPBEP collected stakeholder feedback from various sectors of the community (e.g., state and federal agencies, NGOs, local community organizations, academia, teachers, community members, etc.) to help shape the Program's Comprehensive Monitoring Strategy. PPBEP staff and partners at the University of Florida (UF) and University of West Florida (UWF) hosted virtual workshops to gather feedback from stakeholders to help guide CCMP development and future Program actions. The purpose of the workshops was to 1) Identify and prioritize stressors across the watersheds based on impact and urgency and 2) Identify data gaps, needs, locations of interest and/or concern, and actions. The outputs from these stakeholder workshops fed directly into the CCMP Action Plan.

Additionally, technical partners assisted staff in completing a crosswalk of existing monitoring activities being conducted across the watersheds, which identified key metrics of each monitoring project or program including parameters measured, methodologies, monitoring frequency, and other key attributes (Appendix A). This information allowed the Program staff to evaluate temporal and spatial gaps in monitoring efforts and develop a strategy for expanding monitoring throughout the watersheds to effectively answer key questions on the status and trends of the ecosystem.

OVERVIEW

It is critical to assess progress made toward PPBEP CCMP goals and assess the outcomes of CCMP actions. For each CCMP goal, measurable objectives were developed collaboratively with stakeholders to help evaluate progress towards meeting those goals. Each goal and objective are linked to one or more specific action in the CCMP.

Measuring the effectiveness of those actions in bringing about environmental change is accomplished with consistent monitoring of a suite of indicators. These indicators are used to report progress toward meeting specific goals and targets and evaluate the status and trends of environmental conditions across the watersheds.

PURPOSE AND OBJECTIVES

Long-term monitoring of the Pensacola and Perdido Bays watersheds (Figure 1) is critical for PPBEP to assess environmental status and trends, and track implementation of actions and programmatic success towards achieving measurable goals as part of the CCMP.

According to EPA guidance, comprehensive monitoring programs have the ability to:

- Assist managers with improving their Programs by identifying current and emerging programs.
- Provide accountability to elected officials and the public relating to the progress toward watershed protection.
- Help identify the programs and projects that are successful.
- Provide a framework for assessing the Program as a whole.

The purpose of this Comprehensive Monitoring Strategy is to:

- Develop the structure and parameters needed for a comprehensive monitoring program.
- Expand coordination and partnerships with entities conducting monitoring throughout the watersheds to fill critical data gaps.
- Provide guidance and recommendations for improved data comparability.
- Enhance cross-state coordination.
- Assist in the evaluation of the effectiveness of CCMP actions.
- Provide the data necessary to routinely track trends and assess the health of the Pensacola and Perdido Bays watersheds.

The 2022-2027 Comprehensive Monitoring Strategy serves as a living document and will be adaptively managed over the five-year planning horizon. It incorporates existing guidance documents and resources developed by state, regional, and local organizations to ensure cross-state inter-agency coordination of monitoring activities. Refined actions will be identified in PPBEP's Annual Workplan.

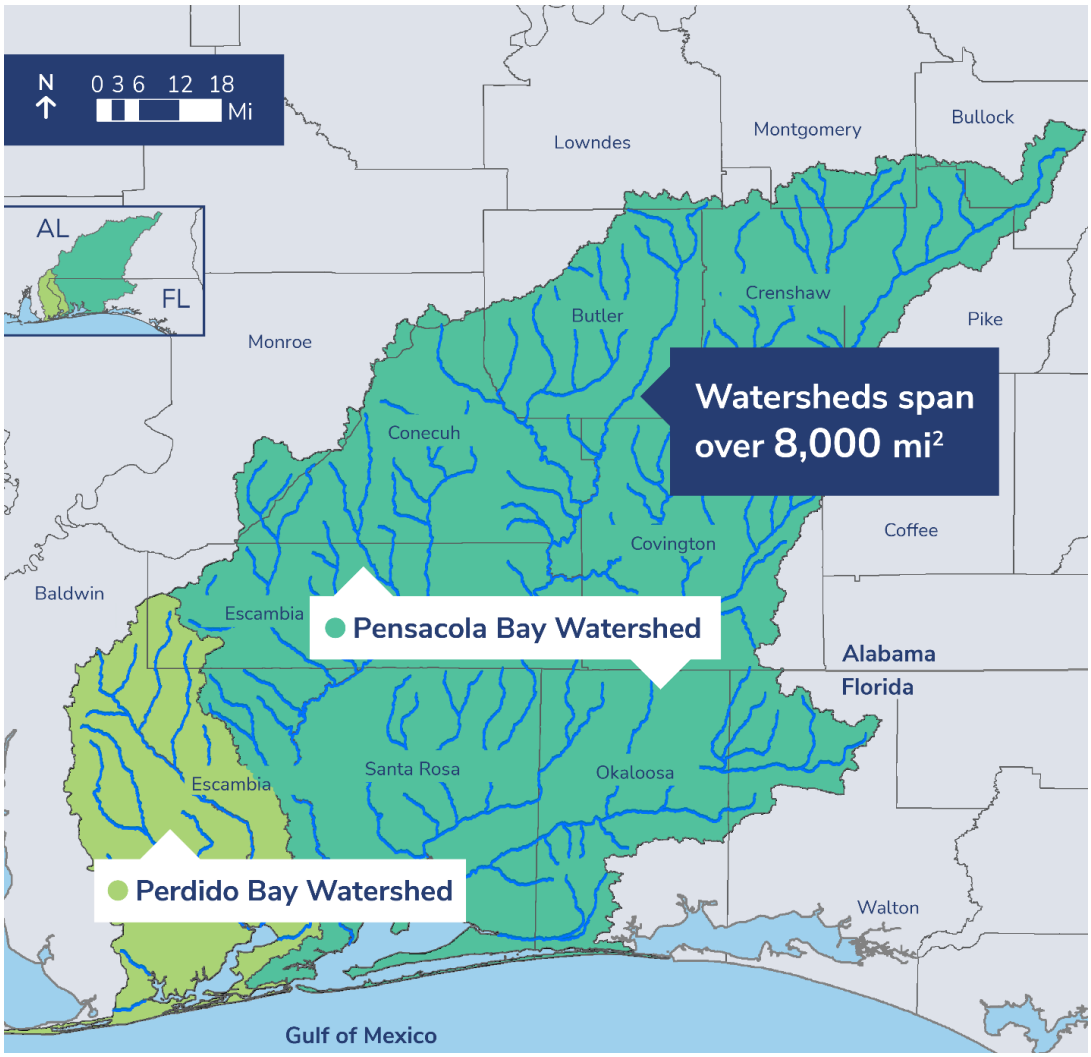


Figure 1. Pensacola Bay and Perdido Bay Watersheds.

COMPREHENSIVE MONITORING PROGRAM

The monitoring program devised and implemented by PPBEP and partners continues to build on existing efforts to assess progress of the recovery more completely and clearly and/or change in the Pensacola and Perdido Bay Systems. This Strategy provides a framework that builds on existing monitoring programs within the Pensacola and Perdido Bays watersheds. Actions addressed within the existing monitoring programs, responsible entities, data collected, sampling frequency, etc. can be found in the Appendix A. PPBEP will continue to work with partners to obtain, share, and evaluate monitoring data, and to communicate findings to the public, decision makers, and stakeholders.

Existing Monitoring Programs

There are numerous monitoring programs carried out by multiple entities in Perdido and Pensacola Bay watersheds (Appendix A). This Strategy does not intend to be an integrated monitoring plan that pulls all those activities together. Rather, the Monitoring Strategy describes current monitoring efforts conducted by federal, state, local government, and non-governmental organizations within the watersheds, as well as recommendations for expanding existing programs or establishing new ones to address gaps or needs.

Data Gaps and Evaluation

To evaluate data gaps and compile existing information on watershed and Gulf wide research, restoration, and monitoring activities, staff and technical partners developed a bibliography of existing gray and peer reviewed literature, monitoring programs, and reports. PPBEP staff compiled metadata from existing inventory databases, including the RESTORE Council Monitoring and Assessment Program (CMAP) administered by the National Oceanic and Atmospheric Association (NOAA) and U.S. Geological Survey (USGS), and the Statewide Ecosystem Assessment of Coastal and Aquatic Resources (SEACAR). The bibliography fed into the technical characterization of the watersheds, which is entitled “Watersheds 101” in the CCMP. Watersheds 101 describes the features of the watersheds, habitats and communities, ecosystem stressors, and the restoration efforts that have aided ecosystem recovery.

Additionally, the outcomes of the workshop series hosted by PPBEP staff and partners from UWF and UF identified stakeholder concerns and critical data gaps to inform the development of actions to improve the health and resilience of natural systems and the economy of Pensacola and Perdido Bays watersheds. Based on feedback from stakeholders, the top priority ecosystem stressors that were selected based on urgency and impact are outlined below (See Table 1).

Table 1. List of prioritized stressors by focus area from PPBEP's stakeholder workshop.

Focus Area	Prioritized Stressors
Water Quality and Quantity	Pathogens Eutrophication Land-use change Flooding Urbanization Poor development practices Impervious surfaces Infrastructure Sanitary sewer Stormwater
Sediment Quality and Quantity	Land-use change Impervious surfaces Poor agricultural practices Sedimentation Contaminants Polychlorinatedbiphenyls (PCBs) Heavy metals Legacy contaminants Erosion Sea-level rise Increased flooding
Habitat	Water quality Altered hydrology Development Poor development practices Shoreline hardening Improper habitat management Boating practices Old growth forest loss
Fish and Wildlife	Water quality and quantity Turbidity Stormwater runoff Salinity Pollutants Invasive species Urbanization/land conversion Habitat fragmentation

Following this workshop, data and information for specific indicators relating to the top priority stressors were compiled from open-source databases, reports, literature, and management plans, or provided directly from partner agencies and organizations (Figure 2). Data were synthesized to provide a baseline or update for stakeholders on the status and trends across the watersheds. Information was presented as a series of watershed-scale maps and figures indicating historical and current sampling efforts, indicator means, habitat extent, etc. This information not only provided a summary for workshop participants, but also provided the foundation for evaluating gaps and resource assessments needed for CCMP development and baseline data for State of the Bays report. Data needs/gaps, locations of interest, and actions for each indicator group were discussed and prioritized by stakeholders during each workshop. The top priority needs/gaps for each indicator group can be found in Table 2.

Figure 2. Environmental indicators selected for stakeholder workshop series to determine priority data needs, locations of interest/concern, and actions for incorporation into the CCMP.

Table 2. Top priority needs and data gaps identified by stakeholders in PPBEP's virtual indicator workshops.

Focus Area	Watershed	Prioritized Needs/Data Gaps
Water Quality and Quantity	Perdido Bay	Standardization of monitoring among monitoring groups across Alabama and Florida Short term, high frequency water quality monitoring in response to events (e.g., storms, oil spills, etc.) Stream monitoring throughout watersheds, especially in the Alabama portions of the watersheds Microbial source tracking data Wastewater infrastructure spatial data to identify root causes of impairments Quantify stormwater runoff hot spots and potential impacts
	Pensacola Bay	Microbial source tracking data Expansion of water quality monitoring - upper watershed tributary and coastal bay-wide scale Continuous seasonal monitoring data to better inform regional models Quantify stormwater runoff hot spots and potential impacts
Sediment Quality and Quantity	Perdido Bay	Sediment fingerprinting Sediment oxygen demand Sedimentation rates Soil characteristics Microbial source tracking data Biological (benthic and nekton) monitoring

Focus Area	Watershed	Prioritized Needs/Data Gaps
Sediment Quality and Quantity	Pensacola Bay	Comprehensive watershed scale monitoring for turbidity and total suspended solids (TSS) Sedimentation rates Unpaved roads assessment and prioritization Sediment quality monitoring (e.g., toxins, legacy contaminants)
Habitat	Perdido and Pensacola Bays	Consistent extent mapping (e.g., submerged aquatic vegetation (SAV), oyster reefs, shorelines, wetlands, etc.) Comprehensive monitoring Conduct consistent condition assessments (e.g., wetlands, oyster reefs, seagrasses/SAV) Identify priority areas for conservation (e.g., wetlands, forested uplands) Track land use land cover changes
Fish and Wildlife	Perdido and Pensacola Bays	Continue tracking manatee sightings and behavioral patterns Expand Fisheries Independent Monitoring (e.g., freshwater and marine species)

Opportunities for Filling Gaps and Expanding Monitoring

PPBEP staff have been working collaboratively with partners across Alabama and Florida to expand monitoring and outreach efforts and fill critical data gaps and therefore, have made notable progress toward activities outlined in the CCMP Action Plan. Funding provided by the Florida State Legislature and EPA supported several projects that focused on water quality and habitat monitoring across Perdido and Pensacola Bays watersheds, which include:

- Expansions of EPA's National Aquatic Resource Surveys (*partners: Escambia County, EPA, FWC, UF, UWF/BFA*)
    - National Coastal Condition Assessment
    - National Wetland Condition Assessment
- Pensacola Bay System oyster reef mapping and condition assessment (*partners: The Nature Conservancy, Marine Research Ecological Consulting Environmental, LLC)*
- Tier I and Tier II seagrass landscape scale mapping and site-specific monitoring (*partners: Dauphin Island Sea Lab and University of Southern Mississippi's Gulf Coast Research Lab*)
- Upper watersheds water quality monitoring (*partners: University of West Florida and Bream Fishermen Association*)
    - Perdido, Conecuh, Shoal, and Yellow River watersheds
- Living Shoreline Suitability Model for Pensacola and Perdido Bays (*partners: Troy University and Santa Rosa County*)
- Juvenile fish trawling survey in seagrass habitats (*partner: Dauphin Island Sea Lab*)
- PPBEP's Community Grant Program (2020-2023)
    - Projects are selected based on several criteria including CCMP action plan alignment, project approach, estuary/watershed impact, demonstration of applicant ability, community impact, and cost justification.

PPBEP staff and partners will also work towards supporting and expanding existing monitoring programs. Some of these include:

- Alabama Water Watch – expand community science water quality monitoring sites across the Perdido Bay watershed and explore community volunteer opportunities.
- Escambia County Water Quality and Land Management Division's Bays, Bayous, and Sounds water quality monitoring program – assist in field activities and expansion of sampling sites (Santa Rosa and Baldwin Counties) and use data outputs in future State of the Bays reports and funding proposals.
- Santa Rosa County's Water Quality Improvement Program – assist with data synthesis (GIS web-based application) and communication of results to public and technical audiences.
- Bream Fishermen Association water quality monitoring – support the continuation and use of this long-term dataset and work to expand sites throughout the watersheds.

- Continuous water quality monitoring at local oyster farms in the Pensacola Bay System – assist oyster farmers with continuous water quality monitoring of key parameters of interest for oyster health including pH, dissolved oxygen, salinity, temperature, and turbidity.
- Eyes on Seagrass – support existing community science seagrass monitoring program led by UF/IFAS Extension, Sea Grant, and University of West Florida, expand volunteer opportunities, and integrate community science efforts into annual Tier II monitoring.

Specific actions identified in this Strategy are to:

1) **Convene a Monitoring Working Group to provide guidance and expertise for future restoration target setting, CCMP progress tracking, and facilitation of new monitoring partnerships.**
2) **Integrate and expand existing monitoring programs across Alabama and Florida to fill critical data gaps.**
3) **Provide comprehensive working list of environmental indicators, including methodologies, recommended sampling frequencies, etc. (Appendix B)**
4) **Leverage funding to support watershed scale monitoring.**
5) **Establish methods for data standardization and reporting.**

SHARING, REPORTING, AND USE OF DATA

The first goal of PPBEP's CCMP is to be the public's source for watershed-related information, which includes several actions that lay the framework for providing easily accessible resources to the scientific community, educators, and the community.

Data collected across the watersheds as part of the Comprehensive Monitoring Program will be shared by participating partners conducting monitoring through their agency's website and/or database and by PPBEP via regional data platforms (e.g., GOMA's Gulf of Mexico Open Data Platform, GOMOD), the Program's website, and upon request. PPBEP will also share results from projects that the Program funds, partners, or leads in the form of visual summary documents on the website to highlight project goals and outcomes. PPBEP will work with partners to develop a dashboard to visualize data collected throughout the watersheds to inform a broader audience. In the next 5 years, PPBEP will host a biennial watershed science and outreach symposium with support of the Management Conference for stakeholders and students to share information on their ongoing programs and projects in the Pensacola and Perdido Bays watersheds.

PPBEP and its partners will use monitoring data in reports and presentations to provide information to technical and public audiences regarding the success of programmatic activities and effectiveness of CCMP actions. Data will also be used to describe and assess the conditions

of our bays in our biennial State of the Bays reports and publications. Staff will continue to share monitoring results and project outputs through social media platforms (i.e., Facebook, Instagram), PPBEP newsletters (i.e., Pelican Post), and regularly scheduled "Lunch and Learn webinars hosted by PPBEP and partners. Data will also be used to inform future project proposals to implement CCMP actions.

INDICATORS AND PEFORMANCE METRICS

The Program's first State of the Bays report released in May 2023 provides a snapshot of key ecosystem health metrics for the Pensacola and Perdido Bays. It features a series of infographics defining the interconnected indicators and various maps and graphs visualizing the best available historical and current information for 13 indicators. This report will be updated every two years to incorporate new datasets for existing indicators and to feature additional indicators that are of interest to the community. This report will allow us to:

- Determine if our waters are declining, improving, or staying the same.
- Identify areas where more information is needed to evaluate conditions.
- Ensure the community's quality of life.

Based on feedback received by our committees and community stakeholders and the priority actions identified in the CCMP, there were four indicator groups and 13 indicators selected for the report, which include:

- Habitats
    - Oyster reefs
    - Seagrass Beds
    - Wetlands
    - Longleaf Pine Forests
    - Habitat Change
- Water Quality
    - Total Nitrogen
    - Total Phosphorus
    - Chlorophyll-*a*
    - Turbidity
    - Dissolved Oxygen
- Bacteria
    - Beach Advisories
    - Sanitary Sewer Overflows (SSOs)
- Wildlife
    - Manatees

For each watershed, indicators were assigned a condition based on a scale of ecosystem health. The condition was described as either improving, stable, declining, critical, or undetermined based on available data for specific bay segments. For more information on the indicators and methodologies associated with State of the Bays, please visit stateofthebays.org.

Goal 1:
Source of Watershed-Related Information

Objective 1.1 Become the central repository for watershed data and visualization		
Action	**Partners**	**Expected Deliverables**
1.1.1 Develop a publicly accessible bibliography of existing gray and peer reviewed literature, reports, and oral histories for the Pensacola and Perdido watersheds	UF/UWF (FLRACEP)	Published annotated bibliography on website or alternate platform
1.1.2 Create an open science digital dashboard for tools, data, and status and trend reporting that are transparent and accessible	TBEP; FWC; Counties; Community of Practice (CoP) groups; NWFWMD	Protocol for inclusion and maintenance of dashboard; Links on PPBEP website to partner resources and available datasets/metadata; Project maps; Status and trend figures (if applicable)
1.1.3 Create an accessible list of current and relevant programs/projects and grant opportunities within our watersheds	All partners	Protocol for inclusion and maintenance of dashboard; Interactive map with project descriptions and locations hosted on PPBEP website; Inventory of grant opportunities

Objective 1.2 Be a trusted and reliable source for relaying pertinent watershed-related environmental issues to the community		
Action	**Partners**	**Expected Deliverables**
1.2.1 Coordinate the communication of post pollution or post natural disaster event monitoring and use social media and other digital platforms to inform the public of current watershed related environmental issues	FDOH; DEP; ADPH; ADEM; Local utilities; Counties; NWFWMD; NOAA; FEMA; Community groups; EPA	Communication and Information Sharing Agreement among agencies/organizations/local governments and PPBEP
1.2.2 Strengthen media relations and feature PPBEP program activities through local and regional media outlets	All media partners (e.g., PNJ, SR Gazette, WUWF, etc.)	Published social media posts, newsletters, press releases, and other media products
1.2.3 Participate and contribute to regional working groups and data sharing communities of practice	FWC; GOMA; NOAA; DISL; EPA; PLACE: SLR; NWFWMD; DEP	Published chapters of regional or state-wide reports with PPBEP as partner or co-author and products/outputs

Objective 1.3 Provide regular reports of ongoing monitoring and restoration efforts and results to the public		
Action	**Partners**	**Expected Deliverables**
1.3.1 Develop State of the Bays Report	UF/UWF (FLRACEP); Technical Committee	Published final State of the Bay report (interactive web-based platform); updated every 2 years
1.3.2 Provide Community Grant Program updates via social media platforms and annual symposium	Funding agencies; States; Sponsors; Awardees	Published social media posts; Community Grant symposium event; Articles posted on PPBEP website
1.3.3 Host watershed science and outreach symposium	All partners	Biennial symposium
1.3.4 Use social media and other digital platforms to update the public on current watershed information	All partners	Published social media posts, presentations, and other outreach products

Implementation Strategy

PPBEP partnered with UF/UWF (FLRACEP project team) to develop an open-source database of current and relevant literature using Zotero bibliography software and worked with local partners to digitize pertinent historical records. PPBEP staff and UF/UWF post-doctoral researchers developed a protocol for design, inclusion, and regular maintenance/updating of the bibliography and will be working on next steps to share the product with the public and Program partners. This bibliography was developed to help identify what other local groups are monitoring in the watersheds. In 2024, PPBEP will coordinate with neighboring Estuary Programs and other supporting programs and organizations to assist in building an effective dashboard and relevant tools for data analysis and visualization. Staff will collaborate with partners to create and maintain a list of current projects within our watersheds using ArcMap or other open-source platform to host on the Program's website to track the success of CCMP actions. PPBEP staff will assess watershed data, literature, and status and trends of selected indicators and communicate with various audiences using social media, newsletters, presentations, and other digital platforms. PPBEP's future science and outreach symposium will provide a venue for stakeholders and students to share information on their ongoing programs and projects within our watersheds.

Goal 2:
Strengthen Community Resilience

Objective 2.2 Facilitate wastewater management improvements throughout the watersheds		
Action	**Partners**	**Performance Metrics**
2.2.1 Extend central sewer service to priority areas near surface waters and retrofit existing failing wastewater infrastructure	Local utilities; AACD; Counties; Cities; ADOH; FDOH; EPA; NWFWMD	Number of identified and/or funded projects; Amount of grant funding identified and/or acquired; Number of septic units identified to be updated or converted; Measured changes in water quality post conversions or upgrades

Objective 2.3 Promote the use of green infrastructure or other low-impact designs into community planning		
Action	**Partners**	**Performance Metrics**
2.3.1 Enhance stormwater management by expanding the use of Green Infrastructure practices	Academia; Local government; Cities; Counties; Community organizations; Local utilities; NWFWMD	Number of green infrastructure practices and projects implemented; Amount of funding acquired; Estimate of acres treated; Volume of stormwater captured
2.3.2 Promote and facilitate the development of living shorelines (LS) as a sustainable alternative to shoreline armoring to reduce erosion and sediment inputs	Sea Grant; NWF; Local government; Academia; Extension; TNC; DEP; Community groups; Homeowners; Marine contractors; NWFWMD	Number of trainings offered and number of attendees; Number of outreach initiatives and campaigns; Number of LS projects implemented; Miles of shoreline converted to LS; Amount of funding received for public and private LS projects

Implementation Strategy

Staff will coordinate with partner organizations and local utilities to acquire maps of existing septic systems throughout the watersheds, prioritize areas for conversion or retrofits, and identify and acquire funding sources to assist with priority projects. The Program and its partners will track the locations of septic to sewer conversions as improvement projects are funded and completed throughout the watersheds. The Program will work with partners to prioritize areas that would benefit most from regional Green Infrastructure and Living Shoreline restoration techniques in terms of water quality improvements and shoreline protection and to develop and acquire funding to implement priority projects. Staff will encourage the use of appropriate tools (e.g., Compound Flood Modeling) and existing assessments to identify vulnerable areas to flooding and foster partnerships with EPA, academic institutions, and other organizations to assess and communicate outputs of current watershed hydrodynamic models.

Goal 3:
Improve Water Quality

Objective 3.1 Develop a comprehensive water quality watershed monitoring program throughout the Pensacola and Perdido Bays watersheds		
Action	**Partners**	**Performance Metrics**
3.1.1 Implement the Comprehensive Monitoring Strategy by establishing a comprehensive watershed monitoring program that encompasses both watersheds across state lines	EPA; FWC; DEP; ADEM; MBNEP; Baldwin, Escambia, Santa Rosa, Okaloosa Counties; Academia; Community Science organizations; BFA; Friends of Perdido Bay; AWW	Number of Water Body Identification numbers (WBIDs) and sites monitored; List of parameters monitored; Number of partner organizations and agencies engaged; Amount of funding dedicated and leveraged for water quality monitoring
3.1.2 Develop water quality targets for Pensacola and Perdido Bays to meet surface water classification designations	All partners; Technical Committee	List of measurable goals or targets for water quality parameters; Progress towards reaching targets; Amount of funding dedicated or leveraged for water quality monitoring and improvements

Objective 3.2 Identify root causes of water quality impairments and implement priority projects		
Action	**Partners**	**Performance Metrics**
3.2.1 Investigate sources of microbial pollutants in the watersheds	Academia; Counties; State agencies	Number of microbial pollutant hotspots identified; Percentage of watersheds assessed
3.2.2 Evaluate and identify point and nonpoint source hotspots for nutrients in the watersheds	DEP; ADEM; Academia; Counties; State agencies; Community science organizations; NRCS	Number of nutrient pollutant hotspots identified; Percentage of watersheds assessed
3.2.3 Implement water quality projects to meet state designated uses	City and county governments; Utilities; DEP; ADEM; EPA	Number of projects identified and planned; Number of priority source areas addressed; Percentage of areas attaining standards

Objective 3.3 Assess water quality seasonal trends to understand impacts to natural resources, including habitats and fish and wildlife		
Action	**Partners**	**Performance Metrics**
3.3.1 Evaluate seasonal trends of nutrients, chlorophyll-*a*, dissolved oxygen, and harmful algal blooms and their impacts to habitats and fish and wildlife	Academia; Counties; State agencies; Organizations	Number of sites evaluated; Number of water quality parameters assessed; Spatial extent of water quality impairments identified; Percentage of watershed assessed

Implementation Strategy

PPBEP will integrate local system knowledge into monitoring efforts and sampling designs. The Program will implement intensifications across our watersheds (expanded sampling designs) for EPA's National Aquatic Resource Surveys (NARS), specifically the National Coastal Condition Assessment (NCCA) and the National Rivers and Streams Assessment (NRSA). Staff will also work with Escambia County's Water Quality and Land Management Lab to implement their Bays, Bayous, and Sounds Program, which will collect data on several water quality indicators throughout watersheds and coordinate with partner agencies and community science groups to increase current monitoring coverage and parameters sampled (e.g., enterococcus sampling). The Program and partners will develop and implement Microbial Source Tracking (MST) studies in priority areas across watersheds (e.g., impaired WBIDs) to identify root causes of bacterial impairments. Staff will collaborate with universities and other partners to synthesize existing data (e.g., seasonal water quality trends) and conduct relevant research projects and assessments (e.g., tracking). PPBEP will work with federal partners (e.g., NOAA, USGS, EPA) to establish additional sites to increase long-term continuous monitoring throughout the Pensacola and Perdido Bay systems. This would supplement existing efforts including NOAA's environmental monitoring stations, Alabama's Real Time Coastal Observing System (ARCOS) locations, USGS's continuous water quality monitoring network, and EPA's continuous monitoring buoy system.

Goal 4:
Reduce Sedimentation

Objective 4.1 Develop a comprehensive watershed monitoring program throughout the Pensacola and Perdido Bays watersheds to assess sediment inputs		
Action	**Partners**	**Performance Metrics**
4.1.1 Develop a comprehensive sediment monitoring program that encompasses both watersheds across state lines	EPA; FWC; DEP; ADEM; MBNEP; Baldwin, Escambia, Santa Rosa, and Okaloosa Counties; Academia; Community science organizations; NRCS; Friends of Perdido Bay	Number of WBIDs and sites monitored; List of parameters monitored; Number of partner organizations and agencies engaged; Amount of funding dedicated and leveraged for sediment monitoring

Objective 4.2 Conduct a sediment study to assess sources of sediments and erosion in the watersheds		
Action	**Partners**	**Performance Metrics**
4.2.1 Identify the impact of land use land cover on the rate of soil erosion and sediment loading	Academia; FDOT; ADEM; DEP; NWFWMD; NRCS; USGS	Areas throughout watershed represented; Quantified annual sediment load
4.2.2. Identify major sediment sources within the watersheds	Academia; FDOT; ADEM; DEP; NWFWMD; NRCS; TNC	Number of sediment sources identified

Objective 4.3 Address sources of sedimentation		
Action	**Partners**	**Performance Metrics**
4.3.1 Identify unpaved roads and their contributions to water quality impairments and prioritize for paving or low impact designs	DEP; Academia; FDOT; ADEM; NWFWMD; NRCS; BFA; Counties; Cities	Number of unpaved roads identified as sediment sources; Number and/or miles of unpaved roads prioritized for future remediation
4.3.2 Collaborate with partners to prioritize, develop, design, and implement sediment reduction and remediation projects to address gully and streambank erosion	DEP; ADCNR; NRCS; FDOT; Counties	Number of projects identified and planned; Number of priority source areas addressed

Objective 4.4 Assess the effects of sediment dynamics and resuspension on benthic habitats		
Action	**Partners**	**Performance Metrics**
4.4.1 Conduct benthic sediment mapping and synthesize existing data to assess sediment type, grain size, transport, and contours	TNC; EPA; NRCS; Academia	Total acreage and percentage of benthic habitat surveyed

Implementation Strategy

PPBEP will integrate local system knowledge into future sediment/soil sampling designs. Staff will work alongside partners, including community science groups, to develop new or expand existing sediment and benthic monitoring programs to increase spatial coverage and parameters monitored. We will investigate possible correlations among contaminants to identify if one contaminant is indicative of another contaminant to minimize the number of contaminants analyzes and maximize monitoring efficiency. The Program will partner with universities and other relevant organizations to understand the impact of land use land cover (LULC) dynamics on soil erosion and sediment loading throughout watersheds. It is also a priority to identify sources of sediments (e.g., aerial photography, sediment fingerprinting, modeling, sediment budgets), develop a framework for prioritization, and collaborate with partners to develop future sediment remediation projects for available funding sources.

Goal 5:
Conserve and Restore Critical Habitat

Objective 5.1 Improve and support the health and resilience of oysters, including wild, farmed, and restored oysters, to promote a sustainable oyster fishery in the Pensacola Bay System (PBS)		
Action	**Partners**	**Performance Metrics**
5.1.2 Create a comprehensive restoration approach for Oyster Plan implementation including an analysis for future grant funding and implementation strategies	TNC; FDACs; DEP; Private sector; Aquaculture farmers; Wild harvesters; Community Science groups; Cities; Counties; Academia; Oyster Sub-Committee	Number of partners engaged; Number of proposals submitted
5.1.3 Conduct long-term monitoring to assess oyster condition and spat production and assess the effects of oysters on long-term environmental change	Academia; Community science groups; FWC; FDACS; TNC; FDA; Aquaculture farmers; Florida Oyster Recovery Science Steering Committee; Oyster Sub-Committee	Number of locations monitored; Number of parameters assessed
5.1.4 Host and support oyster restoration projects in the PBS to improve native oyster populations	Oyster Sub-Committee; UWF; College and University students; FWC; DEP; Escambia and Santa Rosa County oyster shell recycling programs; Sea Grant; DEP; Plastic-Free Restoration of Oyster Shorelines (PROS) working group; UF/IFAS	Number of oyster restoration projects; Number of volunteers engaged; Tons of recycled oyster shell deployed; Restore 2.3 mi^2 (600 ha or ~1,500 acres) of oyster reef within 10 years

Objective 5.2 Assess seagrass health and distribution and develop a restoration strategy for long-term protection and recovery		
Action	**Partners**	**Performance Metrics**
5.2.1 Conduct seagrass mapping and surveys (aerial and ground truth) to assess the current extent, distribution, and condition of seagrass species in the Pensacola and Perdido Bay systems	DISL; GCRL; NPS; GOM Seagrass Community of Practice; Academia; UF/IFAS Sea Grant Extension; UWF; FWC	Maps of percent cover and acreage of seagrass and species diversity; Tier I and II metrics

Objective 5.3 Improve and support the health and resilience of native ecosystems in the Pensacola and Perdido Bays watersheds			
Action	**Partners**	**Performance Metrics**	**Expected Deliverables**
5.3.1 Conduct regular monitoring to assess the condition of wetlands and buffer zones in the watersheds	Academia; EPA; Community Science groups	Acreage and percentage of wetlands in each wetland condition category	Evaluation report of wetland condition indices
5.3.2 Conduct a shoreline assessment of both watersheds to assess living versus armored shorelines	Counties; Troy University	Linear feet of living and armored shoreline assessed	Shoreline maps; Report of LSSM outputs and ArcGIS Story Map; Recommendations for living shoreline prioritization
5.3.3 Conduct intensification for EPA's 2028-2029 National Rivers and Streams Assessment (NRSA)	EPA; FWC; Academia; Community Science groups	Area or extent of stream condition for each classification	Evaluation of river and stream condition indices in the State of the Bays report
5.3.4 Coordinate and facilitate efforts to track expansion of mangrove species and synthesize data to communicate to the public	Sea Grant; NERRs; County extensions; USM; USGS; TNC; Northeastern University	Number of mangroves present in Pensacola and Perdido Bay systems	Map of mangrove expansion of both species (black, red) updated annually; Annual report on seed production and mangrove growth indices

Implementation Strategy

PPBEP participates in various working groups and Communities of Practice groups focused on the recovery and restoration of oyster and seagrass habitats across the Gulf of Mexico. The Program's staff are members of the Florida Oyster Recovery Science Steering Committee, Gulf of Mexico's Seagrass Community of Practice, Gulf of Mexico Alliance's cross teams (i.e., Data and Monitoring, Habitat Resources), Plastic-Free Restoration of Oyster Shorelines (PROS) Working Group, and the Panhandle Estuarine Restoration Team (PERT). The intent of these groups is to facilitate collaboration and coordination among experts and practitioners to connect monitoring, mapping, research, restoration, and management efforts; share and leverage resources and information; and compile and implement best management practice recommendations. Staff will also utilize the expertise and guidance of the Program's Oyster Sub-Committee to develop a strategy for future project implementation. The Program will continue to engage committee participants in the expansion of monitoring and the development of oyster restoration targets using existing regional oyster planning documents and handbooks.

Staff will work with EPA and TNC partners to conduct an oyster filtration model utilizing existing work of both agencies across the PBS. PPBEP and TNC funded oyster reef extent surveys and condition assessments to collect data on bottom type and oyster condition. In addition to these assessments, PPBEP will work with partners at FWC to expand oyster spat monitoring and develop a vertical oyster gardening program across the bay systems. The Program plans to host shell bagging or oyster spat monitoring array construction events and have volunteer events to construct and deploy plastic free oyster reef prisms. Staff will participate, coordinate, and engage with partners on existing oyster restoration and living shoreline projects across the bays to track progress and successes. The Program, in partnership with university researchers and the National Park Service, will continue to conduct Tier I and II seagrass monitoring in the Pensacola and Perdido Bays to continue to build a long-term dataset for the area. The Program will continue to engage partners to set short and long-term restoration goals for the Pensacola and Perdido Bay systems.

To meet objectives for wetlands and other native ecosystems, PPBEP will conduct intensifications (every 5 years) of EPA's National Wetland Condition and Rivers and Streams Assessments for both watersheds to assess the condition of these habitats and use the data to inform future projects and management priorities. Staff will work with program partners to synthesize existing information, fund future projects, and conduct shoreline assessments and develop a Living Shoreline Suitability Model for both bay systems. PPBEP will continue coordination and training for the northern Gulf of Mexico (nGOM) Mangrove Survey Network, established in 2018 by researchers at Mississippi State University to monitor mangrove presence in the nGOM.

Goal 6:
Restore and Conserve Fish and Wildlife

Objective 6.2 Coordinate and expand fisheries monitoring capacity within the Pensacola and Perdido Bay systems		
Action	**Partners**	**Performance Metrics**
6.2.1 Conduct seagrass trawling surveys to assess juvenile fish and shellfish communities and habitat quality	DISL; FWC/FWRI; EPA	Number of monitoring events; Sampling effort; Species composition and abundance; fish length frequency

Objective 6.3 Increase regional monitoring capacity for marine mammals		
Action	**Partners**	**Performance Metrics**
6.3.1 Increase long-term monitoring of manatee sighting coverage in Pensacola and Perdido Bay systems using PanhandleManatee.org	DISL; NWF; Sea Grant Extension; Community science groups	Change in annual manatee sightings over time; Change in geographic extent of sightings; Number of Panhandle Manatee website hits and reports through website; Number of people reached through outreach campaigns

Implementation Strategy

PPBEP will leverage existing efforts and identify funding for the continuation of trawling surveys (long-term dataset) within seagrass habitats in our bays to collect juvenile fish and crustacean data. Staff will also work with state agencies to expand Fisheries Independent Monitoring (FIM) to Pensacola and Perdido Bays to fill a critical data gap for the Northwest Florida. PPBEP, in partnership with DISL's Manatee Sighting Network (MSN), NWF, and Sea Grant Extension will continue to update and maintain the MSN database and the Panhandle Manatee website with current data and reporting resources.

Comprehensive Monitoring Strategy 2022-2027 Milestones

Milestone	2022	2023	2024	2025	2026	2027
Biennial State of the Bays Report						
Fill critical water quality and habitat data gaps						
Biennial Research and Outreach Symposium						
Coordinate continuous water quality monitoring at oyster farms (Pensacola Bay System)						
Technical Committee restoration target setting (e.g., water quality, habitats)						
Develop data dashboard for technical and public audiences						
EPA's National Coastal Condition Assessment Intensification						
EPA's National Wetland Condition Assessment Intensification						
EPA's National Rivers and Streams Assessment Intensification Planning						

APPENDICES

Appendix A. Monitoring Program and indicator matrix for watershed related efforts.

Appendix B. Comprehensive list of monitoring parameters for each monitoring type (e.g., water quality, sediments/soils, habitats, etc.) including specific methodologies and sampling frequencies.