PENSACOLA
& PERDIDO BAYS
ESTUARY PROGRAM

COMPREHENSIVE CONSERVATION & MANAGEMENT PLAN

A Prescription for Healthy Bays

Deployment of Oyster Spat Monitoring Arrays
PPBEP

Contents

Cover Image: Escribano Point ***(Darryl Boudreau, NWFWMD)***

Tarkiln Bayou
PPBEP

Preface

Executive Director's Message

On behalf of the Pensacola and Perdido Bays Estuary Program (PPBEP), we are pleased to release our first Comprehensive Conservation and Management Plan (CCMP) for the Pensacola and Perdido Bay Systems – A Prescription for Healthy Bays.

Following the Deepwater Horizon Oil Spill in 2010, community leaders convened to identify actions that could have a transformational impact on our environment, economy, and community.

Seeing successes of environmental stewardship and economic development in other communities across the country, and wanting to build on a foundation laid by numerous organizations and individuals, it was apparent a stakeholder-driven, science-based organization was needed to help coordinate identification of environmental stressors, form partnerships, leverage resources, implement priority actions, and monitor the health of our watersheds.

Eight years later, that idea turned into reality. In 2018, the then Bay Area Resource Council (BARC) transitioned into the Pensacola and Perdido Bays Estuary Program thanks to the dedication of BARC members to secure RESTORE Act funds from the USEPA Gulf of Mexico Division and Gulf Coast Ecosystem Restoration Council.

Since then, the PPBEP Management Conference and staff have worked diligently to produce this roadmap for improving the health and resilience of our bays, watersheds, and communities. Great care has been taken to ensure recommended actions are based on community values and driven by the best available science. The resulting plan has prescribed six goals, 23 objectives, and 49 actions that are necessary steps toward attaining a future with clean waters, thriving habitats, and resilient communities for all.

To all PPBEP Management Conference stakeholders that have participated in this nearly three-year planning effort – thank you for your unwavering dedication to this process and the Program.

Like never before, we have an opportunity in front of us to make historic investments in our communities. It will take a collective effort to secure financial resources and political support to attain the goals and implement the actions identified in this CCMP. By working together, we can demonstrate to the community, the region, and the nation that environmental stewardship and economic development go hand-in-hand, improving our environment and quality of life for generations to come.

We look forward to working with all of our partners to protect what matters most.

Sincerely,

Matt J. Posner
Executive Director

Upper Perdido Bay
Darryl Boudreau, NWFWMD

Acknowledgements

The Pensacola & Perdido Bays Estuary Program (PPBEP) would like to thank all the individuals and organizations that contributed to the development of PPBEP's first Comprehensive Conservation and Management Plan (CCMP) – A Prescription for Healthy Bays.

Your dedication to this process and value to the community cannot be understated and has resulted in the Plan that follows, setting the stage for continued successful collaboration to protect and restore the Pensacola and Perdido Bay watersheds. PPBEP's Management Conference and staff express their gratitude for the hard work and dedication of all who participated in the CCMP development process.

Funding for the 2022 PPBEP CCMP and establishment of the Program was made possible by the Gulf Coast Ecosystem Restoration Council and U.S. Environmental Protection Agency Gulf of Mexico Division through Cooperative Agreement Number 00D81118.

PPBEP would like to offer special thanks to:

- The EPA Gulf of Mexico Division and RESTORE Council staff for consistent leadership and support throughout the process: Amy Newbold, Marc Wyatt, John Bowie, and Ben Scaggs
- The Bay Area Resource Council's (BARC) Board and Technical Advisory Committee for countless hours of in-kind support to develop the proposal to establish the Estuary Program
- Technical, stakeholder, and editorial assistance provided by Jessica Bibza, Darryl Boudreau, Jane Caffrey, Amanda Croteau, Matt Deitch, Haley Gancel, Tesfay Gebremicael, Holly Greening, Ken Heck, Amy Newbold, Chasidy Hobbs, and Carrie Stevenson
- Senator Broxson, Representative Andrade, Representative Williamson, and Representative Salzman for their support of PPBEP's legislative appropriations which has made it possible to fund many of the accomplishments included in the CCMP
- The Nature Conservancy and members of the Stakeholder Work Group for their dedication to producing the Oyster Fisheries and Habitat Management Plan for the Pensacola Bay System which has been incorporated into the CCMP
- The Coastal and Heartland, Choctawhatchee Bay, Indian River Lagoon, Mobile Bay, Tampa Bay, Sarasota Bay, and St. Andrew and St. Joseph Bays Estuary Programs that offered invaluable support, encouragement, and lessons learned

Finally, we would like to thank all members of the PPBEP Management Conference – Policy Board, Technical Committee, Education and Outreach Committee, Oyster Sub-Committee, and Business Partnership Program – for their immeasurable contributions.

Annual Management Conference

PPBEP

CCMP Purpose

Pensacola and Perdido Bays Estuary Program's Comprehensive Conservation and Management Plan (CCMP) – Prescription for Healthy Bays, is intended to serve as a guide for implementing monitoring, research, reporting, restoration, education and outreach, and policy priorities that enhance the community's quality of life and economic prosperity, while improving the health and sustainability of the Pensacola and Perdido Bay watersheds.

The CCMP recommends priority actions developed in partnership with community stakeholders to address stressors that impair our waters. The identified actions are important steps to restoring our land and water, while maintaining a balance between humans and nature.

This guiding document allows stakeholders to work collectively, across jurisdictional boundaries, toward a shared vision for the recovery of our waters. The CCMP also allows PPBEP and its partners to leverage funding opportunities to make this vision a reality.

How the CCMP **Influences Change**

Investing in Our Future
An investment in the implementation of the CCMP is an investment in a future with clean water, healthy habitats, resilient communities, and a thriving economy.

Big Lagoon State Park
PPBEP

Executive Summary

The PPBEP CCMP – A Prescription for Healthy Bays – serves as a ten-year action plan for improving the health and resilience of the Pensacola and Perdido Bay systems and watersheds. The PPBEP CCMP is a living document, with a five-year update planned in 2027 and a ten-year full revision planned in 2032.

The six goals, 23 objectives, and 49 actions prescribed in this CCMP are the culmination of a three-year planning process in which PPBEP engaged hundreds of stakeholders to identify community values and uses of the bay systems and watersheds; prioritize environmental stressors of importance to stakeholders; identify associated root causes through a thorough review of the best available science; establish comprehensive goals for environmental indicator improvements; and prioritize implementable actions to be undertaken by the PPBEP Management Conference.

This CCMP is broken into three primary sections:

Voices of the Bays

The Estuary Program worked with the UWF Haas Center to administer a community values and uses survey between 2020 to 2021 that was completed by over 750 respondents. Natural beauty, ecosystem services, and fishable waters were the most valued aspects of the Pensacola and Perdido bay systems and watersheds.

Trash free lands and waters, healthy habitats, wildlife abundance, wildlife diversity, and natural riverbanks and shorelines were perceived as very important for healthy watersheds. Industrial discharges, coastal development, sewage treatment discharges, population increases, and upstream development were perceived as the greatest environmental challenges. Water quality improvements, natural habitat restoration, resilience, green infrastructure, and community outreach and education initiatives were the top investment priorities ranked by survey respondents.

Big Sabine
PPBEP

Watersheds 101

During the best available science review and associated Technical Committee workshop series completed between 2020 and 2021, four focus areas emerged: water quality and quantity; habitat; sediment quality and quantity; and fish and wildlife.

Prioritized stressors include water quality degradation attributed to sediment, pathogen, and nutrient loading from stormwater runoff and failing and inadequate wastewater infrastructure; habitat fragmentation and degradation from land use conversion and inadequate land development practices; increased sedimentation from stormwater runoff; eroding stream banks from inadequate buffering and land management best management practice standards; and degraded sediment quality and fish and wildlife abundance from legacy impairments that have decreased the resilience of ecosystem function.

Pensacola Beach
PPBEP

Action Plan

As a result of stakeholder engagement and identified environmental stressors, the PPBEP Management Conference has established the following six goals of this CCMP:

1. The PPBEP should be an unbiased, trusted, centralized source of watershed related information for the community;
2. Strengthen community resilience;
3. Improve water quality in the Pensacola and Perdido Bay systems to support economically and ecologically important and resilient ecosystems and communities;
4. Reduce sedimentation in the Pensacola and Perdido Bay systems by identifying sediment sources and assessing impacts on our waterways and critically important habitats;
5. Conserve and restore critical habitat extend and condition to support wildlife across the Pensacola and Perdido watersheds; and
6. Restore and conserve fish and wildlife by coordinating monitoring and conservation efforts across the Pensacola and Perdido watersheds

Implementation of each action identified in the Action Plan will be further defined during development of the Program's Annual Workplans and CCMP progress tracked in the Program's Annual Reports.

While robust water quality improvements have been realized in the Pensacola and Perdido bay systems, additional work remains. It will take the collective effort of Management Conference partners to assist in accomplishing these needed and time sensitive actions. Fortunately, great strides are already underway to protect what matters most. Let's get to work!

This effort was made possible by the Gulf Coast Ecosystem Restoration Council and the USEPA Gulf of Mexico Division through Cooperative Agreement Number 00D81118.

Introduction

Pensacola Beach

Darryl Boudreau, NWFWMD

History of the Program

The value of working across jurisdictional boundaries to identify and address environmental needs of local waters has been recognized for decades. In 1985, the Governor's Escambia/ Santa Rosa Coast Resource Planning and Management Committee recognized the need for a comprehensive inventory of the characteristics of the area bay systems. The Bay Area Resource Inventory Program was established to provide a unified, standard set of data to be updated on a regular basis, that would aid in the evaluation, maintenance, and enhancement of the physical, chemical, biological, economic, and aesthetic qualities that comprise the diverse character and value of the bay system (BARC 1998).

Bay Area Resource Council

Recognizing the need for a local, independent, science-based organization charged with coordinating monitoring and restoration across the Pensacola Bay System, Santa Rosa County and the Cities of Gulf Breeze and Pensacola formed the Bay Area Resource Council (BARC) through the adoption of an Interlocal Agreement on May 18, 1987. The Interlocal Agreement was amended on July 22, 1997, to expand membership to include Escambia County and the City of Milton.

The BARC served as a monthly forum for elected officials, natural-resource managers, academia, industry, and concerned citizens to share information and resources to better local decision making to improve the health of Santa Rosa Sound, East Bay, Blackwater Bay, Escambia Bay, and Pensacola Bay.

While BARC had limited dedicated funding and staff, it thrived under the leadership and passion of dedicated public servants and community volunteers that recognized that by working together, our community could accomplish so much more.

BARC Educational Initiatives

In 2001, under the leadership of former Florida House Rep. Holly Benson, "Bay Day" was founded to provide local 5th graders an opportunity to experience hands-on environmental science and water quality lessons to empower the next generation of bay ambassadors. The Florida Department of Environmental Protection Northwest District brought together partners from various local and regional agencies to establish the Environmental Education and Coordination Team (EECT) that would eventually be transferred to BARC leadership. In 2005, the BARC EECT took charge of Bay Day's annual organization, expanding the reach to both Escambia and Santa Rosa counties. Between 2001 and 2019, over 16 Bay Day events were held, reaching over 9,300 students.

Bay Day 2022
PPBEP

Bay Day 2018
Carrie Stevenson

In 2004, the BARC EECT's Resource Rangers video series went live. This eleven-part series, hosted by Resource Ranger Glenn Griffith, covered a range of important environmental topics targeted for ages 8 to 14. A team of environmental educators produced the video script and associated lesson plans, while a professional production company produced the series for distribution. The series was aired on local public broadcasting stations and was distributed to local schools for showing with an accompanying visit from the Resource Ranger himself to lead hands-on environmental science lessons. The Resource Rangers video series was popular and successful, winning at least ten awards between 2004 and 2007.

Between 2009 and 2015, EECT and the Resource Rangers expanded their outreach by hosting field trips with local school groups across the watershed to provide hands-on education. Field trips included seining, dip netting, seagrass identification, water quality and stormwater demonstrations, and more. Over its nearly seven-year run, EECT hosted 45 field trips reaching nearly 2,000 students.

Watershed Planning

In 2004, the BARC Technical Advisory Committee (TAC) obtained grant funding from the U.S. EPA and the Florida Coastal Management Program to produce and publish the Pensacola Bay Watershed Management Plan, an update to the original plan released in 1998. Released in 2005, the Pensacola Bay Watershed Management Plan focused on six action areas – air quality, database management, land management, waste management, water quality, and public education. These six action areas were intended to align closely with EPA's Clean Water Action Policy framework and BARC's own goals to restore and maintain water resources, promote watershed awareness, develop partnerships, promote economic prosperity and quality of life, and advocate for action to preserve and restore the bay.

However, with Hurricane Ivan devastating the area in September 2004, the Great Recession rippling across the nation in 2008, and the BP Deepwater Horizon Oil Spill impacting the entire Gulf Coast in 2010, understandably, few resources were allocated to implementing the 2005 Watershed Management Plan.

Establishing an Estuary Program

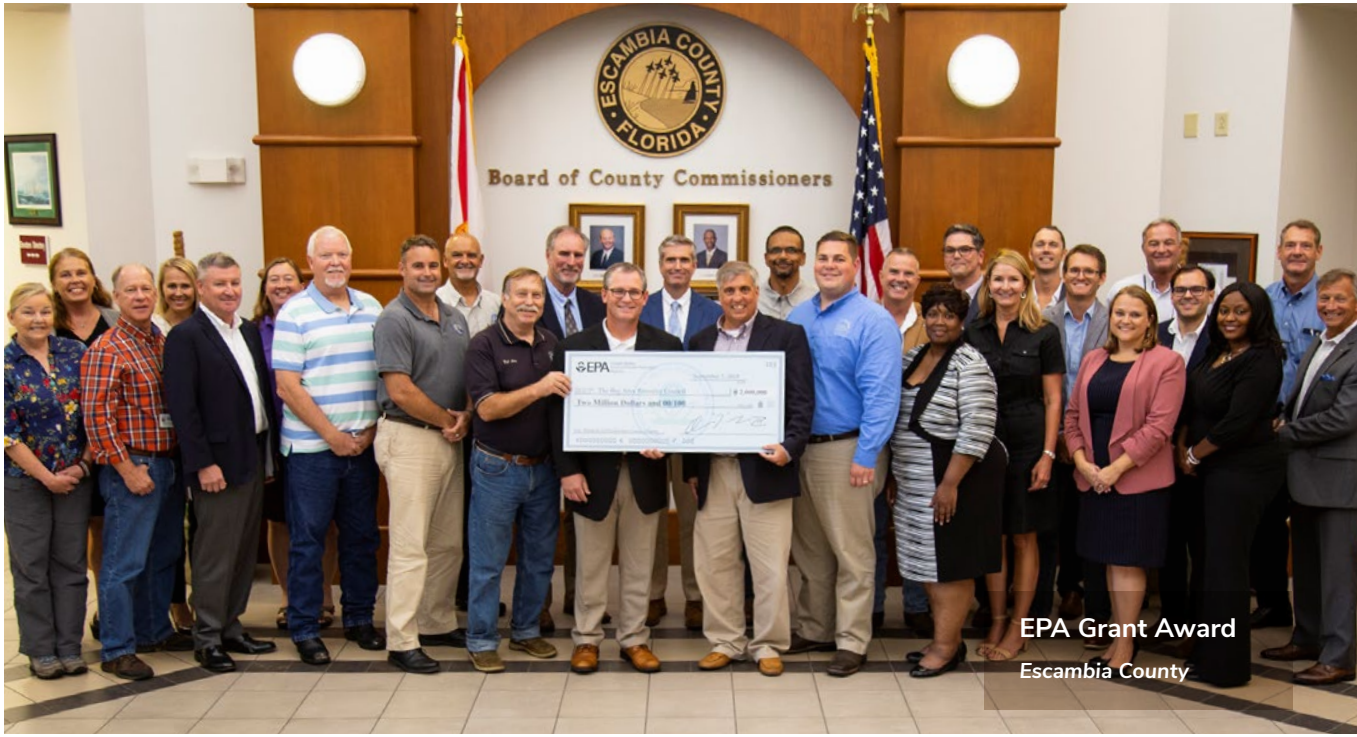
On the heels of the Deepwater Horizon disaster, and with it becoming ever more apparent BP would be held responsible for their negligence, local community leaders, resource managers, and academics convened in the early days following the oil spill to strategize how best to allocate penalty funds, assuming they would eventually make their way back to the Gulf Coast. While various strategies and projects were proposed, one underlying theme was

clear – no one wanted to look back thirty years post-Deepwater Horizon and ask, "what did we accomplish with these once in a generation resources?" without having substantial success to point to.

Seeing the success of EPA's National Estuary Programs across the country it became apparent that an independent, science-based, stakeholder-driven organization could provide oversight and coordination of monitoring, reporting, restoration, outreach and education, and policy initiatives at the watershed-scale. Thanks to the lobbying of various local and regional groups, EPA allocated $2 million in the Gulf Coast Ecosystem Restoration Council's first Funded Priorities List in 2015 to establish a new Estuary Program.

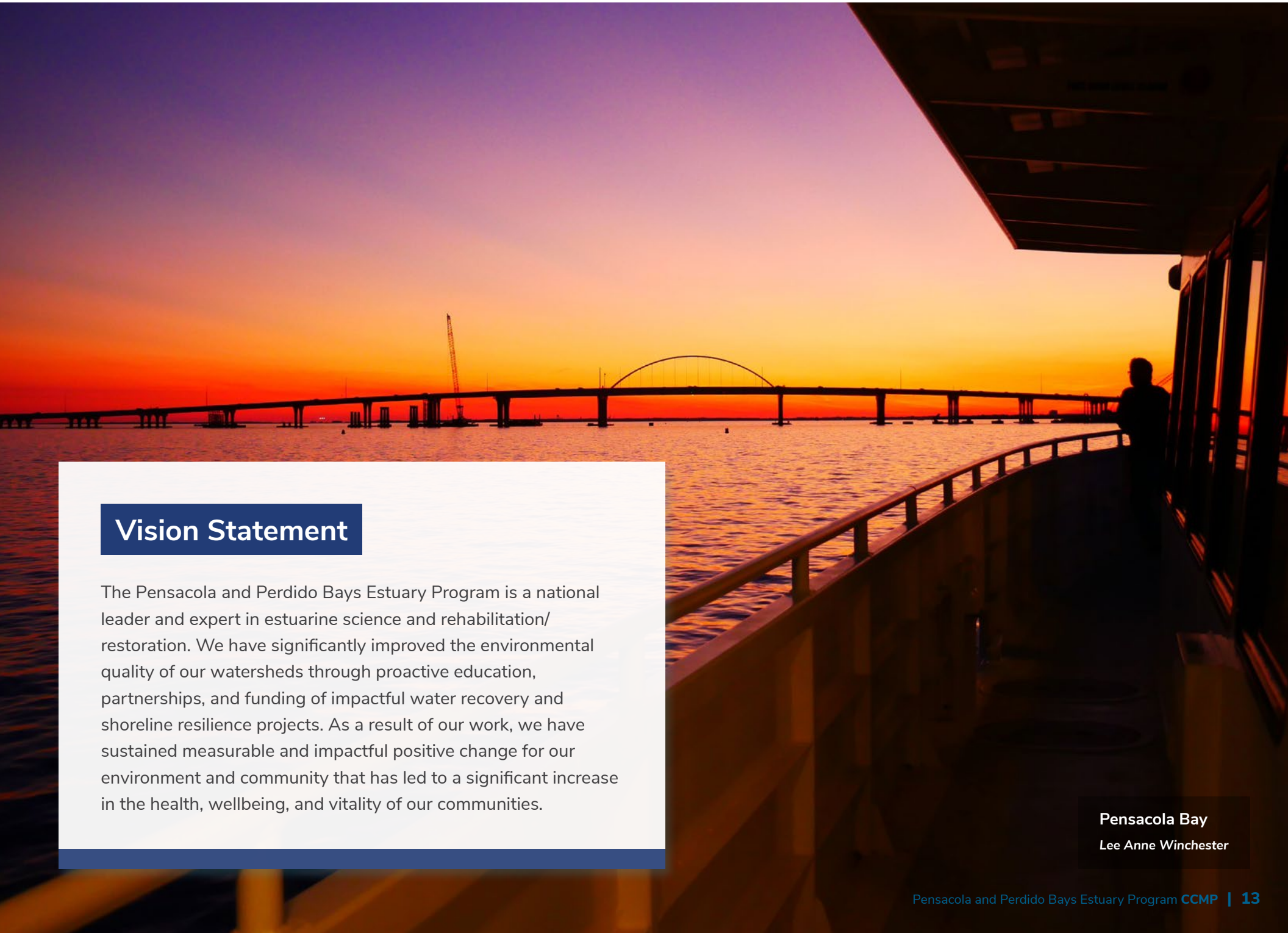
As prospects to establish a new Estuary Program materialized, a renewed sense of energy filled the BARC TAC post-oil spill. In 2017, the EPA Gulf of Mexico Program (GMP) issued its Request for Proposals, targeting watersheds between Perdido Bay in the west and Apalachicola Bay in the east. In the summer of 2017, over fifteen members of the BARC TAC dedicated hundreds of hours to prepare a proposal to transition the BARC into the Pensacola and Perdido Bays Estuary Program. In August 2017, the EPA Gulf of Mexico Program announced BARC's proposal was successful and $2 million would be awarded to establish PPBEP and production of the Program's first CCMP.

On September 5th, 2018, the BARC officially transitioned into PPBEP, expanding membership to include Baldwin County AL, Okaloosa County FL, the City of Orange Beach AL, and the Town of Century FL.



EPA Grant Award
Escambia County

Since then, the Estuary Program Management Conference has been established, comprised of the Policy Board, Technical Committee, Education and Outreach Committee, and Business Partnership Committee. The Program Office has been established and staff, including the Executive Director, Senior Scientist, Environmental Scientist, Community Outreach Coordinator, Community Outreach Assistant, and Volunteer Coordinator were hired to prepare the Plan before you – A Prescription for Healthy Bays.



Vision Statement

The Pensacola and Perdido Bays Estuary Program is a national leader and expert in estuarine science and rehabilitation/ restoration. We have significantly improved the environmental quality of our watersheds through proactive education, partnerships, and funding of impactful water recovery and shoreline resilience projects. As a result of our work, we have sustained measurable and impactful positive change for our environment and community that has led to a significant increase in the health, wellbeing, and vitality of our communities.

Pensacola Bay
Lee Anne Winchester

Mission Statement

Pensacola and Perdido Bays Estuary Program serves as a trusted source for residents, businesses, industry, and the community on issues relating to preserving, restoring, improving and maintaining the natural habitat and ecosystem of the bays, estuaries and watersheds of Pensacola and Perdido Bays. PPBEP strives to achieve a healthy and collaborative environment by:

- Elevating and increasing the importance, awareness and understanding of environmental quality
- Employing rigorous, unbiased and scientifically sound science to inform and guide decisions, policies, and initiatives
- Funding programs and projects that protect the environment, increase ecological resilience
- Building a network of inclusive, multi-stakeholder partnerships that takes into account factors affecting the environment, the economy, and the community-at-large for the benefit of improving the quality of life for all

Pensacola Bay
Lee Anne Winchester

Management Conference

The Pensacola and Perdido Bays Estuary Program was formed through the adoption of an Interlocal Agreement in 2018 by Escambia, Okaloosa, and Santa Rosa Counties in Florida; Baldwin County, Alabama; the Cities of Gulf Breeze, Milton, and Pensacola, and the Town of Century in Florida; and the City of Orange Beach, Alabama.

At the core of the Pensacola and Perdido Bays Estuary Program is a Management Conference comprised of a collective group of dedicated elected officials, resource managers, academics, educators, business representatives, and interested stakeholders which guide the strategic direction of the Program.

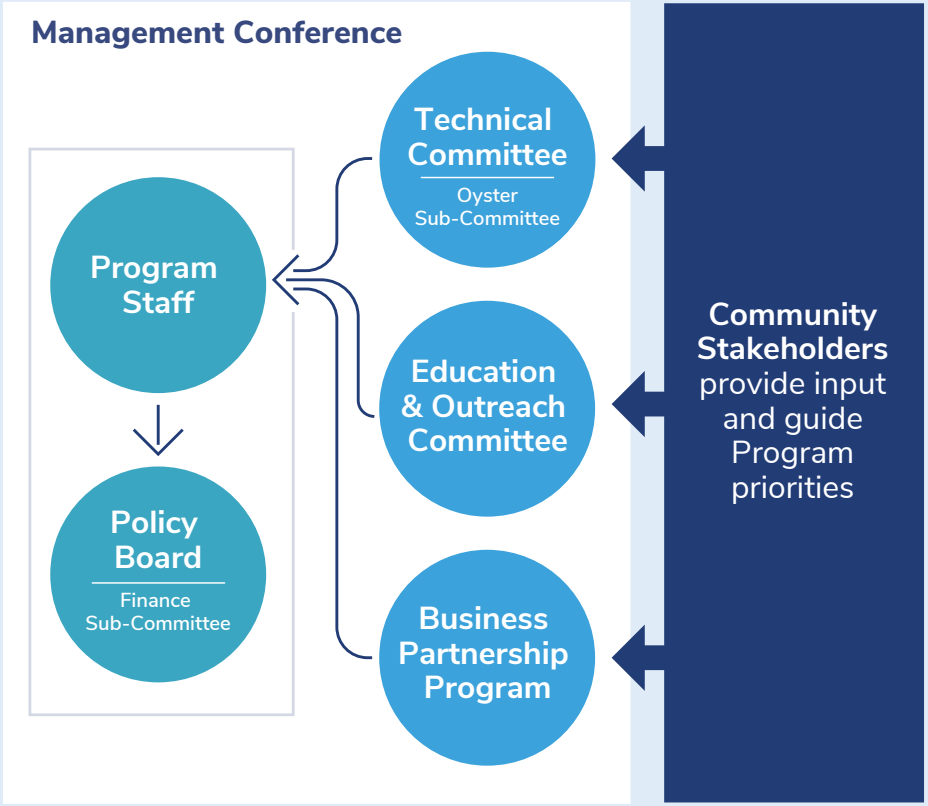
Policy Board

The Policy Board serves as the governing body, establishing Program policy, overseeing Program administration, and setting budget priorities. The Policy Board is comprised of eleven members representing the nine local governments and municipalities party to the Program's Interlocal Agreement.

FINANCE SUB-COMMITTEE

The Finance Sub-Committee is charged with reviewing Program expenditures, providing direction on annual budget preparation, reviewing the annual Program audit, and assisting staff with establishing fundraising targets. The Finance Sub-Committee is comprised of five members of the Policy Board, or their designees.

PPBEP Organizational Structure



Pensacola and Perdido Bays Estuary Program organizational structure displaying the interconnection among the community stakeholders, committees, Policy Board, and Program staff.

Technical Committee

The Technical Committee provides technical and scientific guidance to the Policy Board, staff, and Management Conference as a whole. The Committee supports staff in identifying priority issues, root causes, and actions while also assisting in restoration target setting and CCMP implementation. The TC is led by a Chair and Vice Chair and membership is open to any interested stakeholder. Participants represent many sectors of the community including academic institutions, natural resource management agencies, community organizations, state and federal governments, non-government organizations (NGO), local municipalities, and industry.

OYSTER SUB-COMMITTEE

The Oyster Sub-Committee provides technical guidance to staff on the implementation of the Oyster Habitat and Fisheries Management Plan for the Pensacola Bay System. The sub-committee is a continuation of a stakeholder working group that was established by The Nature Conservancy in 2019 to develop the first Oyster Fisheries and Habitat Management Plan for the Pensacola Bay System. The sub-committee is comprised of representatives from the aquaculture and fishing industries, watermen, regulatory agencies, resource managers, academia, and NGOs. Findings from the sub-committee are reported out to the Technical Committee and Policy Board.

POLICY BOARD MEMBERS (2018 – 2022)

Baldwin County
Dan Dealy representing:
- Commissioner Billie Jo Underwood
- Commissioner Skip Gruber
- Commissioner Joe Davis

Ashley Campbell representing:
- Commissioner Jeb Ball

City of Gulf Breeze
Councilmember Renee Bookout*
Councilmember J.B. Schluter
Mayor Cherry Fitch

City of Milton
Councilmember Alan Lowry
Councilmember Peggi Smith
Councilmember Shannon Rice

City of Orange Beach
Woody Speed*

City of Pensacola
Councilmember Jewel Cannada-Wynn
Councilmember Ann Hill

Escambia County
Commissioner Grover Robinson*
Commissioner Douglas Underhill*
Commissioner Robert Bender*
Commissioner Jeff Bergosh

Okaloosa County
Commissioner Nathan Boyles
Alex Fogg
Michael Norberg

Santa Rosa County
Commissioner Sam Parker
Commissioner Bob Cole*
Commissioner Dave Piech*

Town of Century
Mayor Henry Hawkins
Mayor Benjamin Boutwell

* Served as Chair and/or Vice Chair

COMMITTEE CHAIRS (2018 – 2022)

Technical Committee
Chips Kirschenfeld (2018 – 2019 Chair)
Tim Haag (2018 – 2019 Vice Chair)
Jessica Bibza (2020 – 2021 Chair)
Ken Heck, Jr. (2020 – 2021 Vice Chair)
Paul Looney (2022 Chair)
Casey Fulford (2022 Vice Chair)

Education and Outreach Committee
Carrie Stevenson (2019 – 2022 Chair)
Rick O'Connor (2019 Chair)
Chris Verlinde (2019 – 2021 Chair)
Chasidy Hobbs (2021 – 2022 Chair)

Education and Outreach Committee

The Education and Outreach Committee provides guidance on community outreach initiatives to the Policy Board, staff, and the Management Conference as a whole. The Committee assists staff with developing educational initiatives, event planning and management, and curriculum development and implementation. It is led by a Chair and Vice Chair and membership is open to any interested stakeholder. The committee is comprised of representatives from local universities and school districts, hospitality and tourism development organizations, local municipalities, county extension, state and federal agencies, local government, and community organizations.

Business Partnership Program

The Business Partnership Program engages a broad spectrum of industries that support environmental stewardship, economic development, and quality of life improvement. This committee aids staff in educating business leaders, leveraging financial and in-kind donations to implement transformational projects, informing decision makers, catalyzing actions that improve environmental health and quality of life, and supporting all business sectors that rely on a healthy environment and thriving economy. The Business Partnership Program is led by a Chair and Vice Chair, while membership is open to any interested business stakeholder.

Community Stakeholders

Stakeholders represent many sectors of the community, including residents, property owners, visitors, public officials, government and agency representatives. This diverse group provides insight into the valued aspects of the watersheds and the natural resources, perceptions of environmental challenges and what is required to maintain or elevate their quality of life. This information feeds into the Program's priority actions to restore and protect the watersheds and their systems.

Annual Management Conference Meeting
PPBEP

PPBEP Staff


PPBEP

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Partnerships

Interlocal Agreement Parties

Garcon Point

Darryl Boudreau, NWFWMD

The Watersheds

The Pensacola and Perdido Bay Watersheds span over 21,000 km^2 encompassing large portions of southern Alabama and the Florida panhandle. These watersheds, equipped with their longleaf pine forests, numerous rivers, expansive wetlands, seagrass beds, oyster reefs, bays, bayous, sounds and beaches, are home to countless ecologically important species of birds, fish, mammals, and invertebrates. These watersheds also provide valuable ecosystem services to the millions of residents and visitors that frequent this area including buffering intense storms, stabilizing shorelines, trapping sediments, filtering nutrients, storing carbon, and providing nursery and foraging grounds for recreationally important species of fish and shellfish. Since these coastal areas are highly desirable to live, recreate, and work in, the stressors that we impose upon these natural resources is significant.

The EPA National Estuary Program (NEP) was established in Section 320 of the Clean Water Act. Each of the existing 28 NEPs have established study areas approved by EPA. To be consistent with the NEPs, the Pensacola and Perdido Bays Estuary Program (PPBEP) has established the study area depicted in Figure 1 for purposes of NEP designation. PPBEP's study area will be contiguous with the existing Mobile Bay National Estuary Program (MBNEP) study area. As PPBEP utilizes a watershed-based approach to address natural resource management issues, PPBEP will collaborate with MBNEP and other partners on activities of mutual importance for the restoration and preservation of the Perdido Bay System.

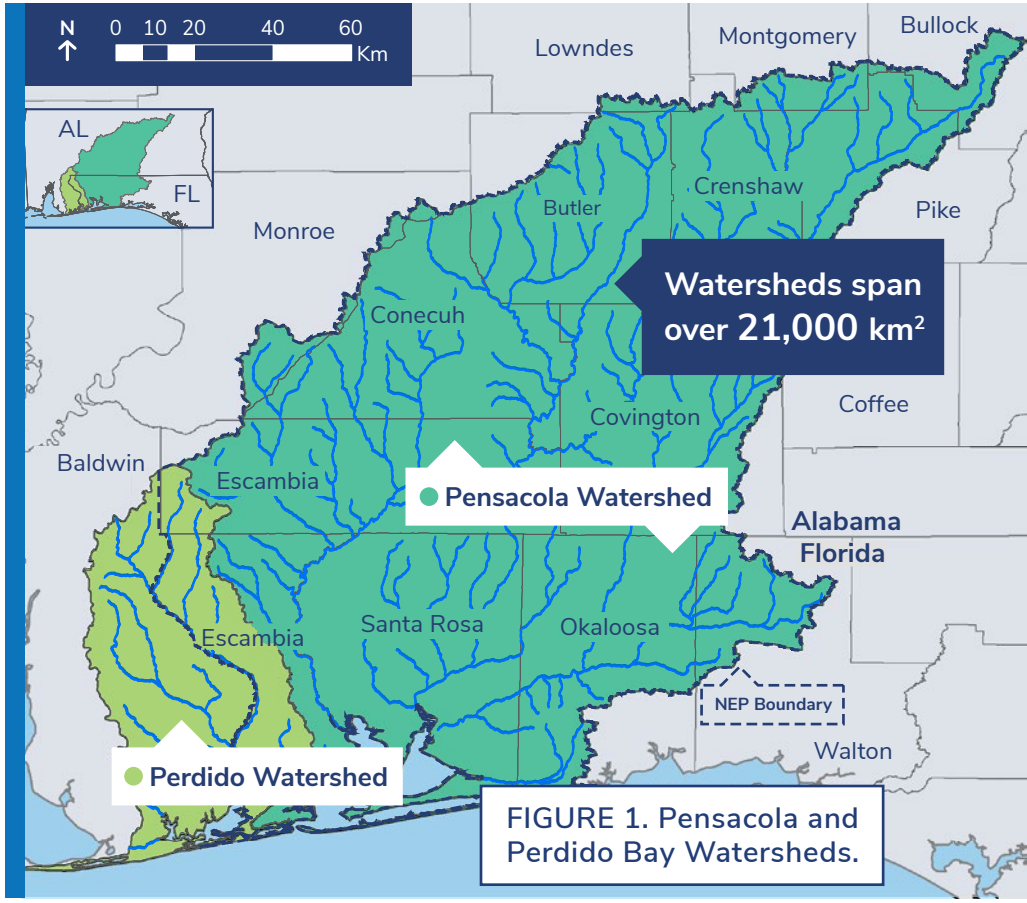


FIGURE 1. Pensacola and Perdido Bay Watersheds.

History of the Pensacola and Perdido Bay Watersheds

P Pensacola Bay Watershed
PB Perdido Bay Watershed

Pre 1500s P PB

Native Americans hunted, fished, and raised crops along the coast

[Placeholder for local tribe's narrative]

1559 P

America's first settlement

The City of Pensacola was established by Don Tristan de Luna and Spanish settlers.

1960s P PB

Environmental degradation

Chemicals from industrial wastewater impacted waterways causing seagrass and oyster declines.

1693 PB

Spanish settlers discover the "Lost" Key and Bay

Carlos de Siguenza y Gongora was sent by the Spanish to locate the entrance to Perdido "Lost" Bay.

1940s - 1950s P PB

Industrialization and urbanization

The region experienced an expansion of military presence, degradation from timber treatment operations, power and chemical plants, paper mills, and urban sprawl post WWII.

1881 P PB

Pensacola and Atlantic Railroad

Railroad freight transportation led to the expansion of the timber industry.

1865 - 1883 P

Booming Red Snapper fishery

In 1872, the first fish house was constructed in Pensacola, where fish were processed, packaged, and shipped by rail or boat.

1906 PB

First man-made Perdido Pass dug

A cut, known as Perdido Pass, was made to make navigation into Perdido Bay easier. Perdido Pass has shifted locations many times throughout history. Prior to the pass, Perdido Bay was predominantly a freshwater system.

April 10, 2010

Deepwater Horizon Oil Spill

The Deepwater Horizon oil rig exploded, dumping over 4 million barrels of crude oil into the Gulf of Mexico off the coast of Louisiana, making it the largest spill in the history of marine oil drilling operations.

2018 P PB

PPBEP established

BARC transitions to PPBEP.

2022 P PB

CCMP approved

PPBEP's first Comprehensive Conservation and Management Plan (CCMP) is developed for the Pensacola and Perdido Bay Watersheds.

1971 P

Escambia Bay declared dead

A local community organization, The Bream Fishermen Association; "drafted a declaration" to bring awareness to the impacts.

2012

RESTORE Act passed

The RESTORE Act passed, allocating 80% of penalties from Deepwater Horizon Oil Spill impacts back to the Gulf Coast.

1970s P PB

Fish kills and shellfish harvest declines

Numerous fish kills were reported in Pensacola and Perdido Bay Systems due to industrial discharges.

Community takes action.

1972

Clean Water Act

A milestone in American environmental policy that regulated pollutant discharged and set standards to water quality.

1989 PB

Bay Area Resource Council (BARC) established

BARC, PPBEP's predecessor, was made up of local stakeholders and representatives from 5 local governments (City of Pensacola, Escambia County, Santa Rosa County, City of Gulf Breeze, and City of Milton) to improve local waters.

Some local species illustrations provided by and modified from: Integration and Application Network (ian.umces.edu/media-library).

Voices of the Bays

Perdido Key Demonstration Garden

Escambia County

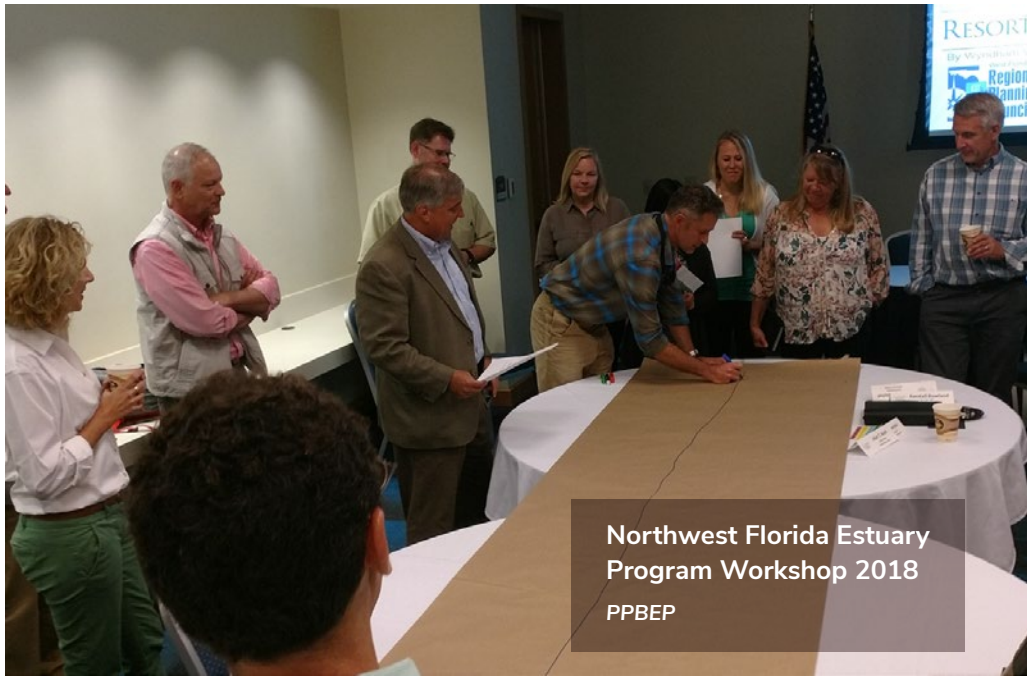
Engaging the Community: The Road to Completing the CCMP

In April 2018, over 60 stakeholders representing state and federal agencies, local governments, academia, non-governmental organizations (NGOs), and other local organizations across the Pensacola and Perdido Bays, Choctawhatchee Bay, and St. Andrew Bay watersheds attended the Northwest Florida Estuary Program workshop led by former TBEP Executive Director/Senior Scientist, Holly Greening.

The purpose of the workshop was to collectively brainstorm water quality issues and potential solutions and to learn valuable lessons on the benefits and challenges surrounding collaborative planning and adaptive management from the TBEP. Stakeholders from each watershed participated in a group activity involving the co-development of a timeline for each of their estuaries, including historic events, severe storms, changes to the landscape, restoration projects, and other impactful events. The latter half of the workshop focused on key issues and root causes across the watershed and lessons learned from the TBEP. To conclude, the Estuary Programs were advised to engage stakeholders throughout the entire process of Comprehensive Conservation and Management Plan (CCMP) development including data compilation, goal and target setting, and project planning and implementation to maximize success and to ensure the Plan encompasses diverse perspectives. The timeline of impactful events for the Pensacola and Perdido Bay Systems that was developed as a part of this workshop was incorporated into the historical overview of the PPBEP (See page 21 — History of the Pensacola and Perdido Bay Watersheds).

PPBEP Dialogue Session

PPBEP

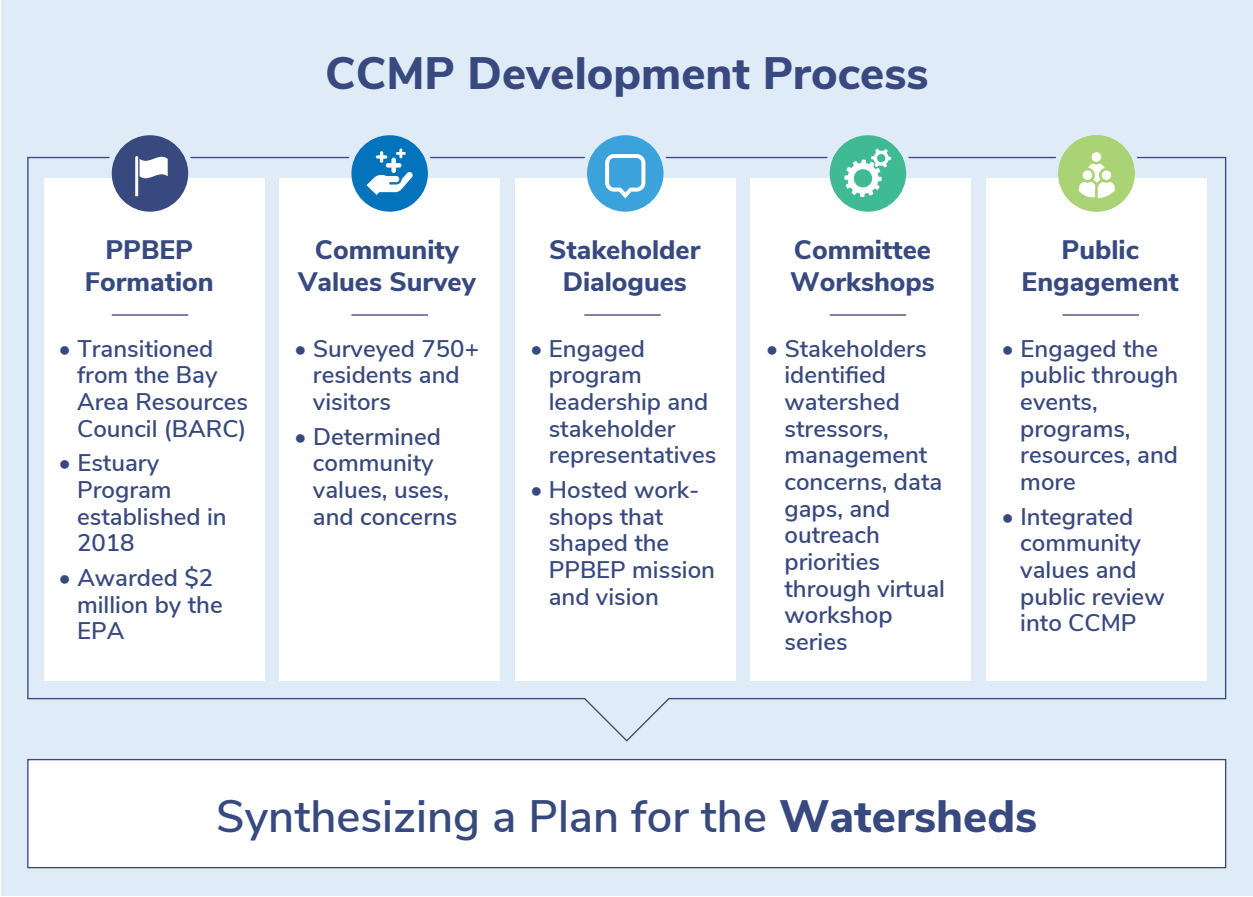


Northwest Florida Estuary Program Workshop 2018

PPBEP

Following establishment of the PPBEP Management Conference in September 2018, the Policy Board, Technical Committee, and Education and Outreach Committee began meeting monthly to discuss the CCMP development process and timeline. In February 2019, the Technical Committee hosted a workshop to gather stakeholder input on the compilation of relevant resources and identified key priorities, issues, and overarching goals and objectives to include in the CCMP. The workshop outputs resulted in the adoption of the CCMP Developmental Workplan, which served as a scope of work for completing the various elements of the CCMP and supporting strategic plans.

In July 2020, the PPBEP expanded its public community engagement via a virtual impact event which was organized and hosted by CivicCon. CivicCon is a program that aims to inform and empower communities through civic conversations to drive progress and change. During the event, Estuary Program staff introduced the Program and the purpose of the CCMP and encouraged community participation to help PPBEP achieve their mission of protecting and restoring the watersheds. Just prior to the PPBEP impact event, CivicCon hosted an event where EPA provided an overview of the history and benefits of the National Estuary Program (NEP) highlighting effective collaborative multi-stakeholder led projects across the Nation. Additionally, a panel of local experts discussed the current challenges facing local waterways and how the newly established Estuary Program could contribute to long-term change. This event provided a critical insight into the importance and value of creating an Estuary Program. PPBEP highlighted the history of the Pensacola and Perdido watersheds, the stressors impacting the ecological and human health of these systems, and the status and trends of oyster reef and seagrass extent. In addition, the PPBEP staff gave an overview of the Program's purpose, mission, and overarching goals as well as current projects and opportunities for community members to get involved. The Program reached over 150 people through this event to share the vision for the future of Pensacola and Perdido Bays and their watersheds.



Community Values Survey

To develop a successful stakeholder driven CCMP, public input and engagement are key processes to understand and incorporate community environmental concerns.

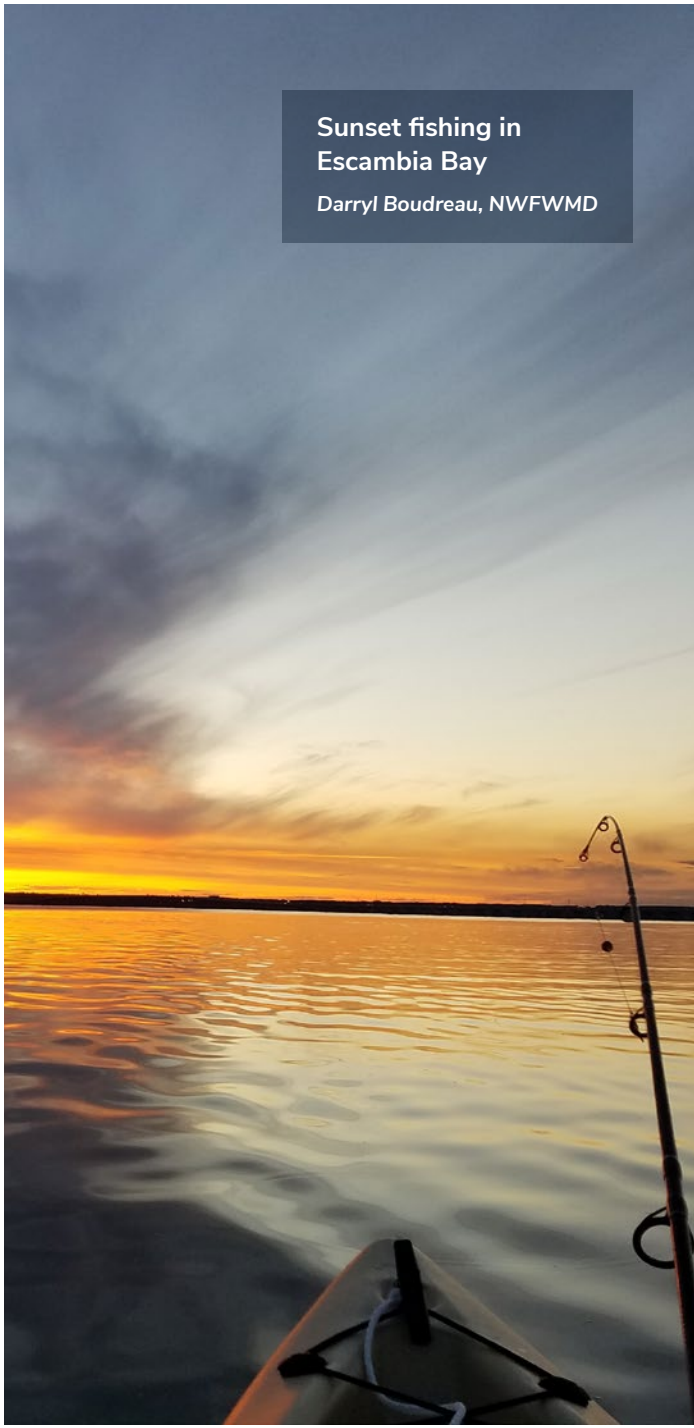
PPBEP partnered with the University of West Florida (UWF) Hass Center to survey residents and visitors regarding their use and valued attributes of the watersheds, identify environmental challenges, and gain feedback on appropriate funding sources to support the recovery of the watersheds. From October 2020–January 2021, participants were recruited via three main methods: 1) email list-serves provided by fishing licenses and registered voter databases, 2) social media broadcasting, and 3) flyer distribution. Seven-hundred fifty-four participants completed the online survey.

Participants were asked to rate the current state of the environmental condition of each watershed, and to identify the activities that they participate in within each watershed. Most participants rated the environmental condition of both watersheds as average or better. Respondents identified waterfront dining, wildlife viewing, and beaching as the activities they engage in at least monthly in the Pensacola Bay and the Perdido Bay watersheds.

Participants were given a list of watershed attributes and were asked to select those that were important to them. Participants consistently ranked natural beauty, ecosystem services (e.g., flood and erosion control, water, and air filtration), and fishable water as their top three most valued aspects of both watersheds. They were also asked to identify attributes of a healthy watershed. While all items tested were selected by respondents as important, healthy habitats (e.g., wetlands, seagrass beds, oysters, and upland forests) and trash free land and water were selected most frequently.

Respondents were also asked to identify environmental concerns for each watershed, priorities for financial investment and appropriate sources of funding for those investments. Industrial discharges, coastal development, and municipal sewage treatment discharges were the most cited environmental concerns for the Pensacola Bay watershed. Industrial discharges, coastal development, and agriculture activities within the watershed were the most cited environmental concerns for the Perdido Bay watershed. Water quality improvements and natural habitat restoration (e.g., seagrass, oysters) were both identified as important priorities for financial investments. State government, tourist development tax, and local government were selected as appropriate sources of funding for watershed projects.

Overall, the survey informed CCMP development by providing information on community values and concerns. It also provided a baseline of community opinions of watershed health that can be used to support the success of PPBEP's efforts to communicate the status of our watersheds and efforts to improve them. See Appendix 1 for the full Haas Center Community Values Report findings.

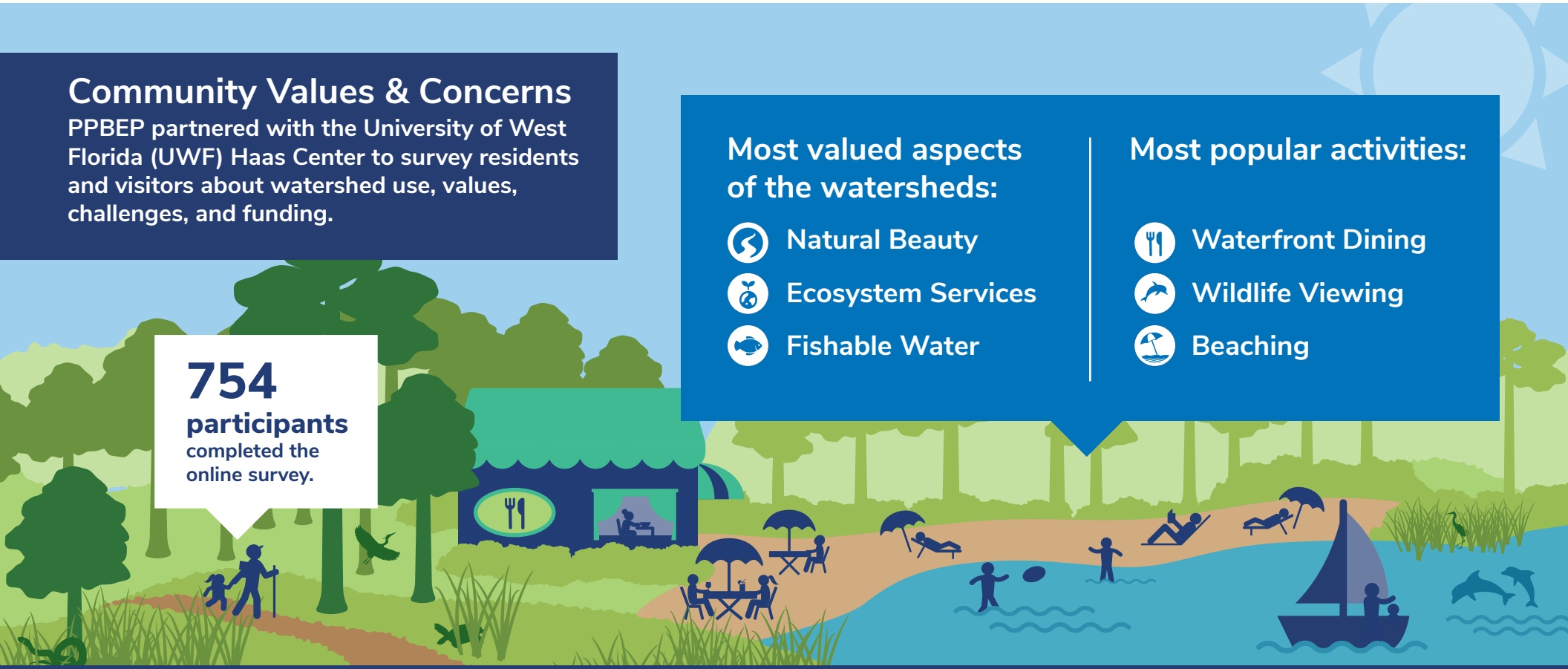


Sunset fishing in Escambia Bay

Darryl Boudreau, NWFWMD

Community Values & Concerns

PPBEP partnered with the University of West Florida (UWF) Haas Center to survey residents and visitors about watershed use, values, challenges, and funding.



754 participants completed the online survey.

Most valued aspects of the watersheds:

- Natural Beauty
- Ecosystem Services
- Fishable Water

Most popular activities:

- Waterfront Dining
- Wildlife Viewing
- Beaching

TOP 5 Very Important Aspects of Healthy Watersheds:

- Trash Free Land and Water
- Healthy Habitats
- Wildlife Abundance
- Wildlife Diversity
- Natural Riverbanks and Shorelines

TOP 5 Environmental Challenges:

- Industrial Discharges
- Coastal Development
- Municipal Sewage Treatment Discharges
- Population Increase
- Upstream Development

TOP 5 Investment Priorities:

- Water Quality Improvements
- Natural Habitat Restoration
- Resilience
- Green Infrastructure
- Community Outreach/Education

Core Dialogue Sessions and Branding

PPBEP partnered with idgroup, a local Certified B Corporation specializing in integrated brand communications and change management, to ignite the support of key stakeholders in moving the Program's mission forward.

A series of community dialogue sessions engaged Program leadership, staff, and stakeholders including educators, representatives from state and federal agencies, local governments, community organizations, residents, industry, and local businesses in discussions regarding the Program's mission, future goals and aspirations as well as opportunities for improvement. Participants contributed their perspectives on ways the PPBEP could better connect the story of the organization to the people and communities it serves.

Insights from the Core Dialogue Sessions and the Community Values Survey informed the development of a brand platform and logo that represent the shared vision of our stakeholders. The brand promise, protecting what matters, and the key messages are directly connected to the Program's mission. The visual brand, or logo, was comprised of three elements to represent 1) the estuarine system, 2) the effect water has on the ecosystem, and 3) a commitment to protecting the watersheds and its communities. The co-developed brand platform serves as a guide to effectively communicate the PPBEP's role and mission to the public and builds a foundation for future action campaigns and community buy-in.

The Community's values live at the core of PPBEP's culture and directs the decisions and behaviors of its members which, in turn, influences the experience people have with the Program. Core strengths are characteristics the PPBEP's leadership will build upon and leverage to maximize community engagement to ensure the Program is identifying and addressing the most important issues in the watershed.

BRACKISH WATER
To represent the estuary system where salt and freshwater converge.

PELICAN
To represent the delicate affect the water has on the wildlife and ecosystem of the Pensacola & Perdido Bays area.

SHIELD*
To convey a commitment to protecting the estuary ecosystem.
*Not in the sense of enforcement

Three elements that comprise PPBEP's visual logo

The following core values and strengths were identified as part of the stakeholder dialogue sessions:

CORE VALUES

- Creating Impact
- Proven Science
- Community Inclusion
- Mutual Health, Vitality, and Collaboration
- Resiliency/Sustainability

CORE STRENGTHS

- Foundation of Science
- Inclusive, Multi-Stakeholder Collaboration
- Effective Resource Management
- Quality of Life
- Non-Partisan

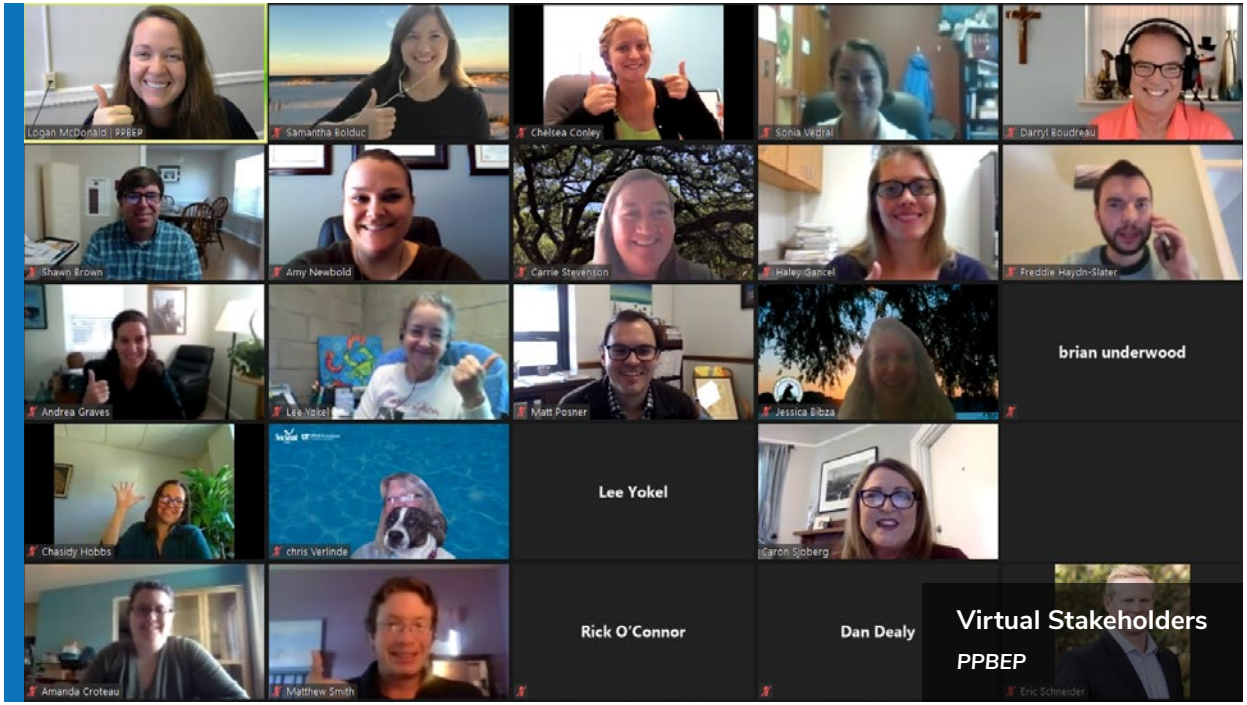
Stakeholder Dialogue Sessions
PPBEP

Stakeholder Participatory Process and Evaluation

Integrating participatory frameworks into an adaptive management strategy provides an opportunity for increased community engagement and support. The U.S. EPA's National Estuary Program (NEP) has shown great success in collaborative science-based decision-making efforts that have led to the implementation of actions to improve water quality, restore habitats, and elevate the quality of life in their communities. The PPBEP was built upon an existing network of local stakeholders from their predecessor the Bay Area Resource Council (BARC), providing a strong stakeholder base at the inception of PPBEP's development.

Amongst the many challenges a new program may face in the early stages of establishment, the global COVID-19 pandemic was one that was unexpected. The PPBEP had to pivot away from more traditional in-person committee meetings and community engagements to solely virtual platforms (e.g., Zoom, GoTo Meeting, Google Meets). Despite this hurdle, staff turned to innovative virtual whiteboard tools (e.g., Mural, Google Jamboard, Miro) to design activities and collect stakeholder feedback from various sectors of the community (e.g., State and federal agencies, NGOs, local community organizations, academia, citizens).

Beginning in Fall 2020, PPBEP staff and partners at University of Florida (UF) and University of West Florida (UWF) hosted a virtual workshop series to gather feedback from stakeholders to help guide CCMP development and future program actions. Support was provided by a Florida RESTORE Act Centers of Excellence Program grant (FLRACEP) awarded to UF/UWF to assist three panhandle Estuary Programs (Pensacola and Perdido Bays, Choctawhatchee Bay, St. Andrew and St. Joseph Bays) with CCMP development. The goal of the workshop series was to identify specific stakeholder concerns and devise actions to improve the health and resiliency of natural systems and the economy of the Pensacola and Perdido watersheds. Additionally, workshop outputs helped identify knowledge and data gaps needed to effectively assess and ultimately improve environmental issues within the watersheds.



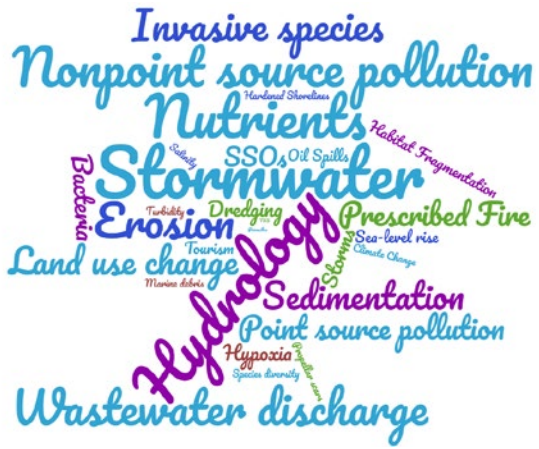
Virtual Stakeholders
PPBEP

Environmental stressors identified during the workshop series

Focus Areas	Prioritized Stressors
Water Quality/ Quantity	Pathogens Nutrients; Eutrophication Land-use change: • Flooding • Urbanization • Construction • Impervious surfaces
Habitat	Water quality Altered hydrology Development • Land-use change • Shoreline hardening Improper habitat management • Boating practices • Old growth forest loss
Sediment Quality/ Quantity	Land-use change: • Impervious surfaces • Agriculture Sedimentation Contaminants • PCBs • Heavy metals • Industrial Discharge Erosion • Sea-level rise
Fish & Wildlife	Water quality/quantity • Turbidity • Stormwater • Salinity • Pollutants Invasive species Urbanization Habitat • Fragmentation • Conversion

The initial workshop in the series was a stressors assessment to identify and prioritize environmental stressors and management concerns within the watersheds. Prior to the workshop, the UF/UWF FLRACEP team compiled a list of key stressors that had been previously identified in local watershed management plans. The stressors and management concerns were compiled into a word cloud which was used to initiate discussion of current and ongoing stressors. Workshop participants self-selected into small breakout groups by each focus area topic based on their expertise and interests. Participants brainstormed stressors for four different focus areas: water quality and quantity, sediment quality and quantity, habitat, and fish and wildlife. Stressors were prioritized based on urgency and impact, and measurable indicators (i.e., what do we need to measure to effectively assess the stressor or its impacts) were identified for each prioritized stressor. Participants provided spatial information for identified stressors such as areas of historical concern and current hotspots.

In preparation for each workshop, indicator (identified in the stressors assessment) data and information were consolidated from multiple open-source databases (e.g., EPA's Water Quality Portal, DEP's Watershed Information Network, National Wetlands Inventory), reports, literature, and management plans, or provided directly by partner agencies and organizations including: Bream Fishermen Association (BFA), Friends of Perdido Bay, Alabama Water Watch, Alabama Department of Environmental Management (ADEM), Northwest Florida Water Management



Habitat Concerns Word Cloud

District (NWFWMD), Florida Fish and Wildlife Conservation Commission (FWC), U.S. Fish and Wildlife Service (FWS), U.S. Geological Survey (USGS), and EPA then synthesized to provide a baseline or update for stakeholders on the status and trends across the watershed.

Information was presented as a series of watershed scale maps indicating historic and current sampling efforts, indicator means, habitat extent, and additional figures and tables displaying other pertinent information. This information not only provided a summary for workshop participants, but also the technical foundation for evaluating gaps, resource assessments needed for CCMP development, and baseline data for a future "State of the Bays" report development.

Indicators selected for the workshop series included:

WATER QUALITY

Dissolved oxygen (DO)

Salinity

Pathogens: *E. coli* and Enterococcus

Chlorophyll-a

Nutrients: Total Nitrogen (TN), Dissolved Inorganic Nitrogen (DIN), Total Phosphorus (TP), TN:TP

HABITATS

Seagrass/Submerged Aquatic Vegetation (SAV)

Freshwater wetlands and floodplains

Coastal and estuarine wetlands

Forested uplands

SEDIMENTS

Sediment in water column: Total Suspended Solids (TSS), turbidity, Secchi depth

Sediment as substrate: grain size, toxins (e.g., mercury, dioxins, and polychlorinated biphenyls or PCBs)

FISH AND WILDLIFE

Coastal/estuarine fauna

Marine mammals

Fish/fisheries

Upland/freshwater fauna

A virtual stakeholder workshop was conducted for each of the four focus areas: water quality and quantity, sediment quality and quantity, habitat and fish and wildlife. During each workshop participants identified and prioritized knowledge gaps, root causes and barriers, and CCMP actions. Each workshop included self-selected breakout rooms where participants focused their discussion on concerns relating to a particular watershed (water and sediment workshops) or resource category (habitat and fish and wildlife workshops) related to their expertise or interest. Prior to the participatory activities, attendees were given a summary of the stressors assessment discussion and overview of indicator data that was compiled.

Following each workshop, participants were asked to complete an evaluation. The evaluation tool was developed by UWF to assess participants' satisfaction with the workshop format, content, expectations, participation (including equity and representation), and outcomes. Response feedback from each workshop was considered and incorporated into the planning of the subsequent workshops and informed the format of future CCMP development engagements.

In Spring 2021, once the workshop series had concluded, PPBEP staff and the project team at UF/UWF synthesized workshop outputs and feedback to develop a framework for the draft Action Plan of the CCMP, which included relevant goals, objectives, actions, implementation strategies, partners, role of PPBEP, identified funding sources, expected deliverables, and performance metrics for tracking success for top priority needs and issues across the Pensacola and Perdido Bay watersheds. To ensure that the Action Plan aligned with the needs of our stakeholders, the Technical Committee was asked to provide comments and edits to the draft. Feedback was compiled by the UF/UWF team (an unbiased party), evaluated by PPBEP, and feasible and relevant recommendations were incorporated. Comments that were not incorporated were edits such as including more actions that were not prioritized by the larger stakeholder group in our workshop series. Gaining feedback at each step of the Action Plan development process (e.g., prioritization during the workshops and Technical Committee edits) provided invaluable stakeholder guidance in the development of PPBEP's first CCMP.

Regional and Gulf-Wide Management Plans

Numerous local, regional, and Gulf-wide management plans have previously been developed which include the Pensacola and Perdido Bay watersheds. While elements of some of these plans are still timely and relevant, many others are dated. Nonetheless, information within these plans provided a solid foundation for development of the PPBEP CCMP.

Alabama Department of Conservation and Natural Resources (ADCNR); Alabama Department of Environmental Management (ADEM)

- 2013–2018 Alabama Coastal Area Management Program Strategic Plan

Baldwin County

- Horizon 2025: Comprehensive Plan 2008–2025

Bay Area Resource Council

- 2005 Pensacola Bay Watershed Management Plan (WMP)

***Deepwater Horizon* Oil Spill Natural Resource Damage Assessment (NRDA)**

- 2017 Strategic Framework for Oyster Restoration Activities

Escambia County

- 2022 Carpenter Creek/Bayou Texar Watershed Management Plan (WMP)
- 2015–2030 Comprehensive Plan

Florida Department of Agriculture and Consumer Services (FDACS); Florida Forest Service

- 2013 Ten-Year Resource Management Plan for the Blackwater River State Forest (Santa Rosa and Okaloosa Counties)

Florida Department of Environmental Protection (DEP)

- 2020 Ft. Pickens Aquatic Preserve Management Plan
- 2018 Big Lagoon State Park, Tarkiln Bayou Preserve State Park, and Perdido Key State Park Multi-Unit Management Plan (UMP)
- 2016 Blackwater River State Park UMP
- 2011 Bayou Chico Basin Management Action Plan (BMAP)
- 2008 Yellow River Marsh Preserve State Park UMP

Florida Fish and Wildlife Conservation Commission (FWC)

- 2018 Florida's Freshwater Priority Resources: A Guide for Future Management

Moore's Creek
PPBEP

Gulf Coastal Ecosystem Restoration Council (RESTORE)

- 2019 Planning Framework
- 2016 Comprehensive Plan

Gulf of Mexico Alliance

- 2021–2026 Governor's Action Plan IV for Healthy and Resilient Coasts

Longleaf Alliance

- 2018–2022 SoLo-ACE Longleaf Partnership Conservation Plan
- 2009 Range-Wide Conservation Plan for Longleaf Pine

Mobile Bay NEP

- Gulf Frontal WMP (lower Perdido Bay)

National Oceanographic Atmospheric Association

- National Coastal Zone Management Program Strategic Plan 2018–2023

National Park Service (NPS); U.S. Department of Interior (DOI)

- 2014 Gulf Islands National Seashore (Florida and Mississippi) General Management Plan

National Wildlife Federation (NWF)

- 2020–2025 Gulf Program Strategic Plan

Northwest Florida Water Management District (NWFWMD)

- 2017 Pensacola Bay System Surface Water Improvement Plan (SWIM)
- 2017 Perdido River and Bay SWIM Plan
- 2019 Strategic Water Management Plan (SWMP)

The Nature Conservancy (TNC)

- 2021 Oyster Fisheries and Habitat Management Plan for the Pensacola Bay System
- 2014 Pensacola Bay Community-Based Watershed Plan
- 2014 Perdido Bay Community-Based Watershed Plan

Santa Rosa County

- 2040 Comprehensive Plan

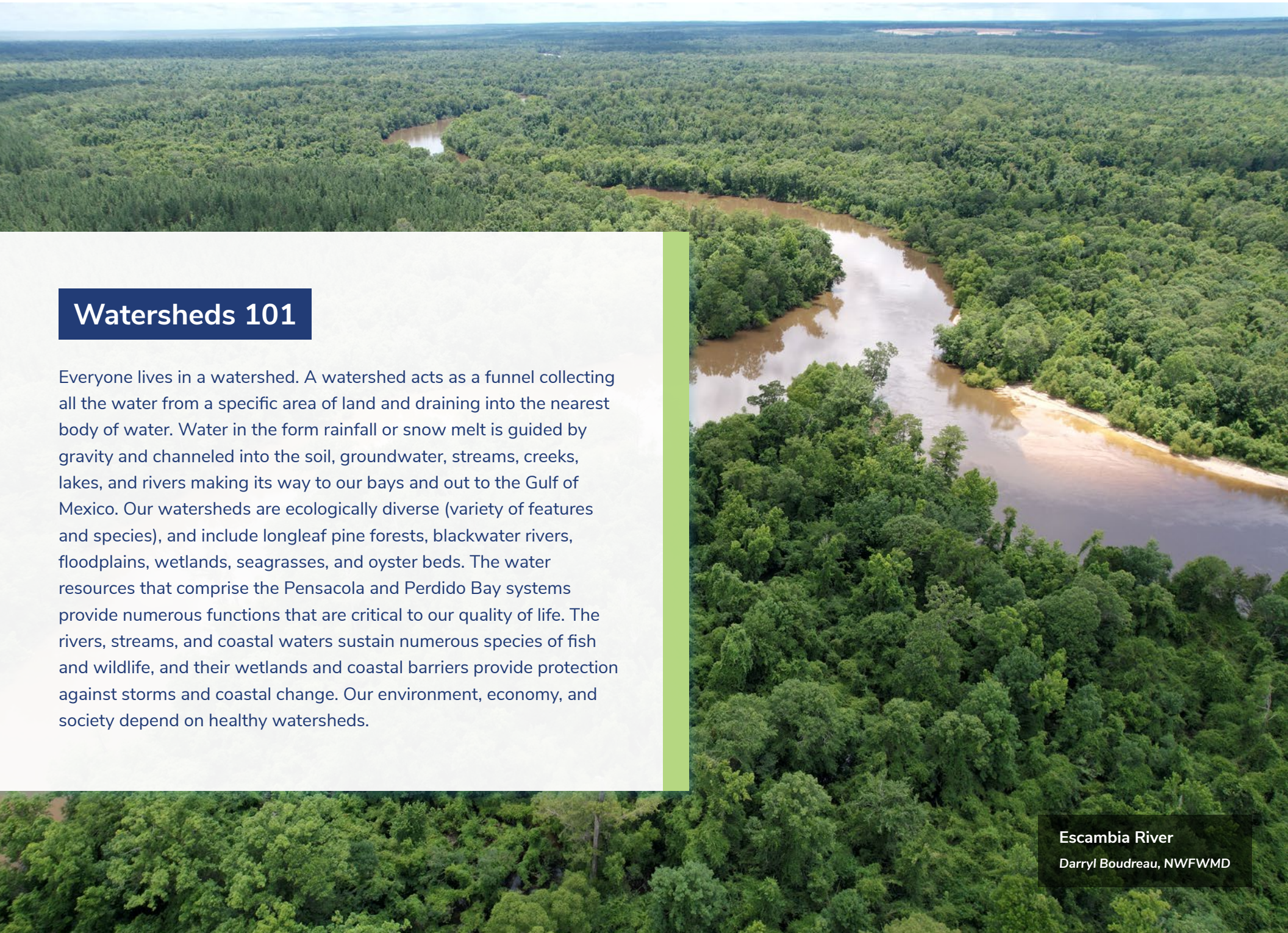
U.S. EPA

- 2020 National Water Reuse Action Plan: Collaborative Implementation

Fundy Bayou
PPBEP

Watersheds 101

Everyone lives in a watershed. A watershed acts as a funnel collecting all the water from a specific area of land and draining into the nearest body of water. Water in the form rainfall or snow melt is guided by gravity and channeled into the soil, groundwater, streams, creeks, lakes, and rivers making its way to our bays and out to the Gulf of Mexico. Our watersheds are ecologically diverse (variety of features and species), and include longleaf pine forests, blackwater rivers, floodplains, wetlands, seagrasses, and oyster beds. The water resources that comprise the Pensacola and Perdido Bay systems provide numerous functions that are critical to our quality of life. The rivers, streams, and coastal waters sustain numerous species of fish and wildlife, and their wetlands and coastal barriers provide protection against storms and coastal change. Our environment, economy, and society depend on healthy watersheds.



Escambia River
Darryl Boudreau, NWFWMD

Key Elements of our Watersheds

Longleaf Pine Forest:

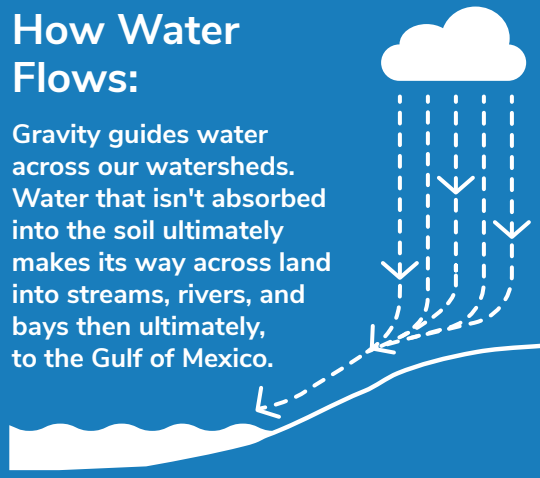
Upland habitats are home to many species of plants and animals and play a critical role in water infiltration.

Wetlands:

These important barriers retain excess nutrients and pollutants, trap sediment, and protect us from flooding and wave energy.

How Water Flows:

Gravity guides water across our watersheds. Water that isn't absorbed into the soil ultimately makes its way across land into streams, rivers, and bays then ultimately, to the Gulf of Mexico.



Seagrass Beds:

Submerged grasses filter water, provide nursery and foraging grounds for wildlife, store carbon, and stabilize sediments.

Oyster Reefs:

These ecosystem engineers provide habitat to fish and shellfish, protect shorelines, and filter water for particles and nutrients.

Gulf Coastal Plain

General Characteristics

The Gulf of Mexico (GoM) has a unique combination of ecological richness, economic value, and physical location that makes it unique amongst other oceans and water bodies across the Nation. The habitats that make up the Gulf coastal watersheds support many unique species of plants and animals that rely on these areas for its natural resources. The estuaries that drain these watersheds are ecologically diverse and support many ecologically, recreationally, and commercially important species, including oysters, seagrasses, and other fish species.

The East Gulf Coastal Plain encompasses more than 170,000 km^2 and extends from southwestern Georgia across the Florida Panhandle to southeastern Louisiana (TNC 2001). The Gulf Coastal Plain is a complex natural system with a wide variety of landscapes characterized by flat physiography with longleaf pine-dominated uplands, seepage bogs, wetlands, salt marshes, estuaries, and barrier islands. The geology of the Gulf Coastal Plain is characterized by low soil diversity consisting of unconsolidated sand, silt, and clay soils generated through weathering of the Appalachian Mountains. The southern portion of the Gulf Coastal Plain, near the coast, is characterized by the products of prehistoric marine deposition when sea level was higher than present, leading to dolomitic and sandy clayey limestones, shell beds, and sands (USDA 2004). The Gulf Coastal Plain is known for its densely populated longleaf pine forests, diverse rivers and streams, large expanses of wetlands, complex estuarine and tidal systems, and large environmental disturbances such as hurricanes and wildfires (TNC 2001). This region is a North American hotspot for biodiversity and endemism (i.e., species being found in single defined geographic location) in terrestrial, freshwater, and other aquatic systems due to the lack of glaciation (Thorne 1993, Sorrie and Weakley 2001). For example, these freshwater aquatic systems house a large biodiversity of fish and mussels with many species being endemic to single rivers or tributaries (Master et al. 1998, TNC 2001). Therefore, these ecosystems are at a high risk for biodiversity loss and are threatened by hydrologic alterations, pollution, and invasive species introductions (TNC 2001). Additionally, longleaf pine uplands make up a significant portion of the Gulf Coastal Plain and in recent years this ecosystem has been threatened due to development, habitat fragmentation, and a lack of natural and prescribed fire, which is needed to maintain a healthy ecosystem (TNC 2001).

Blackwater River State Forest
PPBEP

Climate Characteristics

The Gulf Coastal Plain has a warm, humid maritime climate. The climate is uniform except for the slightly higher temperatures during the summer (Henderson and Grissino-Mayer 2009). Rainfall in the eastern Gulf Coastal Plain is bimodal, with higher rainfall in summer and winter and lower rainfall in spring and fall. Annual average rainfall over the region is high compared to other regions in the United States, with an annual average precipitation of 1,700 mm (data from 1991–2020) recorded in Pensacola, FL (NOAA 2022).

The Pensacola and Perdido watersheds are located at a subtropical latitude and situated on the GoM coast. The proximity to the coast results in less temperature variability compared to inland areas. Average annual temperature and precipitation (between 1981–2010) was 17.8°C and 1,630 mm, respectively (Geologic Society of Alabama [GSA] 2009, University of Florida Conservation Clinic 2010). Almost half of the annual precipitation falls during the summer months and the least amount of rainfall is during the fall (USDA 1995).

Winds are generally from the south during the winter and the north during the summer. The watersheds experience tropical storms and hurricanes during the summer and fall, which cause extreme wind and rain events. The occurrence of hurricanes and tropical storms has increased in recent years with an average of 2 tropical storms occurring in this region per year (Knight and Davis 2009). Heavy rain events not associated with tropical development are also becoming increasingly common (Yu et al. 2016). During 2014, a 500-yr rainfall event destroyed homes, wiped out roads, and washed away bridges in the Pensacola metropolitan area (NOAA 2014, Kim et al. 2020). High annual rainfall generates high surface runoff which transports nutrients, organic matter, pollutants, and sediments to the waterways, which in turn can degrade water quality.

Navarre Beach
PPBEP

Perdido Bay Watershed

Geographic Characteristics

The Perdido watershed is approximately 3,238 km^2 extending across portions of Florida and southern Alabama, which ultimately drains into the Gulf of Mexico through the Perdido Pass (Figure 2). A portion (30%) of the watershed is located in Escambia County, FL while the other 70% is located in Baldwin and Escambia Counties, AL (NWFWMD SWIM 2017a). The watershed lies within the Gulf Coastal Plain physiographic region, characterized by gentle hills, sharp ridges, prairies, and alluvial plains (NWFWMD SWIM 2017a). The Florida portion of the watershed covers two physiographic regions, the Western Highlands to the north and the Gulf Coastal Lowlands to the south (USDA 2004). The two regions are separated by a relic marine escarpment. The Western Highlands are 115 m above sea level, while the Gulf Coastal Lowlands near Perdido Bay is 30 m above sea level (Rupert 1993). The Western Highlands have gently rolling hills with seepage bogs and the Gulf Coastal Lowlands have sloping marine terraces (Wolfe et al. 1988, Rupert 1993), while the coastlines are comprised of sand dunes and beaches.

Geologic features of the watershed follow the stratigraphy of western Florida Panhandle, which is characterized by the products of prehistoric marine deposition when sea level was higher than present, leading to dolomitic and sandy clayey limestones, shell beds, and sands (USDA 2004). Overlying sediments are composed of siliclastic sediments composed of mainly quartz sand weathered from the Appalachian Mountains (Smith 2001) with sand, gravel, limestone, chalk, marl, and clay (Omernik 1995).

There are two aquifers present in the system: the sand-and-gravel aquifer and the Floridian aquifer system. The sand-and-gravel aquifer is the surficial aquifer that provides fresh drinking water to the watershed (NWFWMD SWIM 2017a). In the Perdido region, the Floridian aquifer system, which sits underneath the sand-and-gravel aquifer, has few carbonate sediments in comparison to the rest of the aquifer and has less carbonate sediments than any other northern Gulf of Mexico estuary, which may contribute to the lack of oysters in the bay (Parker 1968).

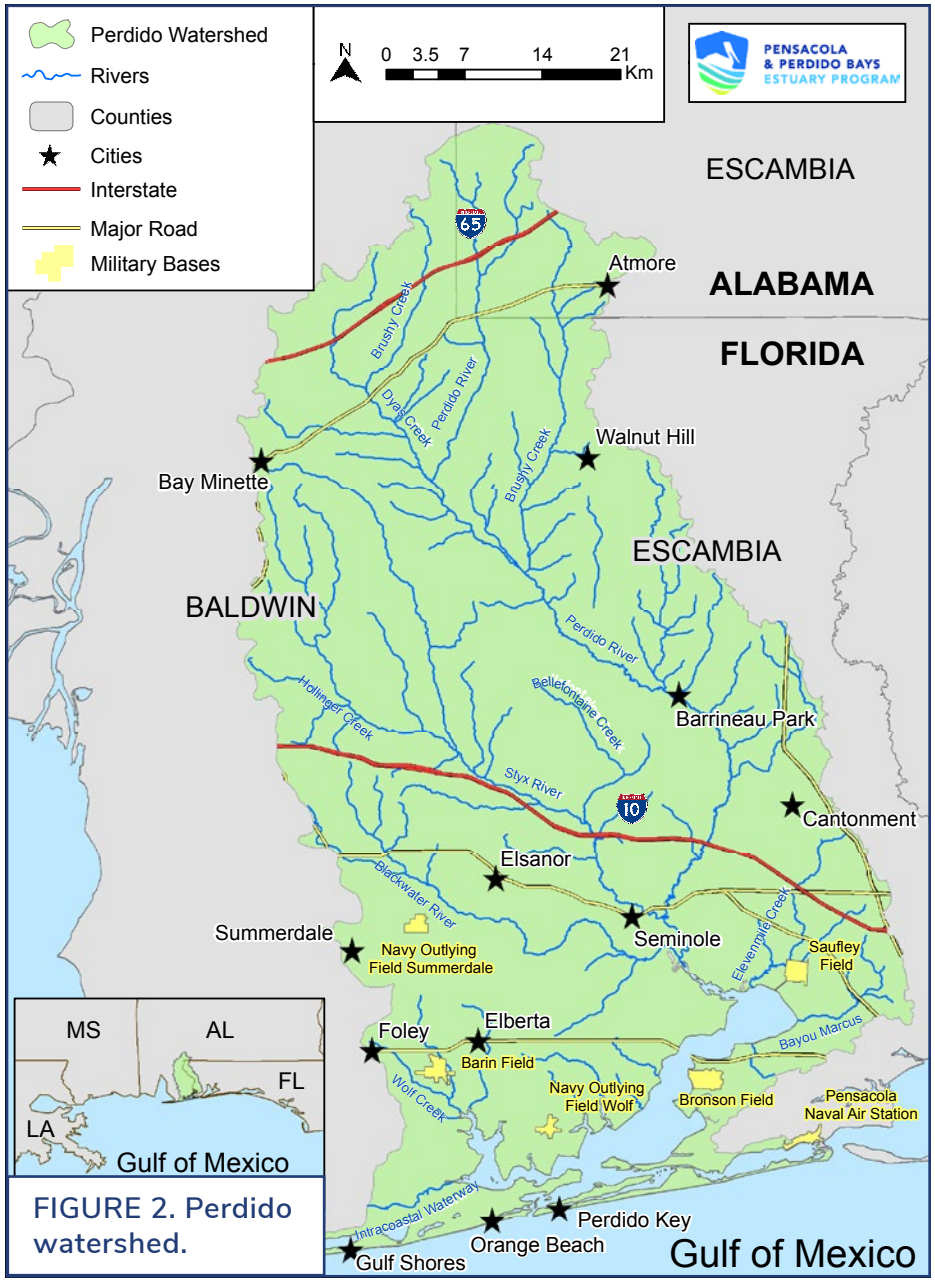


FIGURE 2. Perdido watershed.

Hydrologic characteristics

Perdido Bay

Perdido Bay is a small (130 km^2) shallow (mean depth: 2 m) estuary that includes Wolf Bay, Bay La Launch, Arnica Bay, Bayou St. John, Cotton Bayou, and Big Lagoon (Figure 3). Perdido Bay discharges into the Gulf of Mexico through Perdido Pass and connects to Pensacola Bay via Big Lagoon. Old River is situated between Ono Island to the north and Perdido Key to the South. Big Lagoon is bordered by Big Lagoon State Park and the Pensacola Naval Air Station to the north and Perdido Key in the south.

Notorious for being difficult to find, the Spanish named the Bay "Perdido", which translates to "lost". The original pass shifted may times in the past and had dangerous currents that made navigating Peridido Pass a treacherous voyage for early settlers that attempted to colonize the area (Sunshine 1880). The channelization of a permeant pass (Mullen 2020) and creation of railroads in the late 1800s and early 1900s led to a population boom in the area (Hildreth 1959). Currently, the southern portion of the bay is a tourist destination, with high development and population. Additionally, the northern reaches of the bay have been impacted by industry in the northern bay since the 1950s (Florida State Board of Health 1958, 1967).

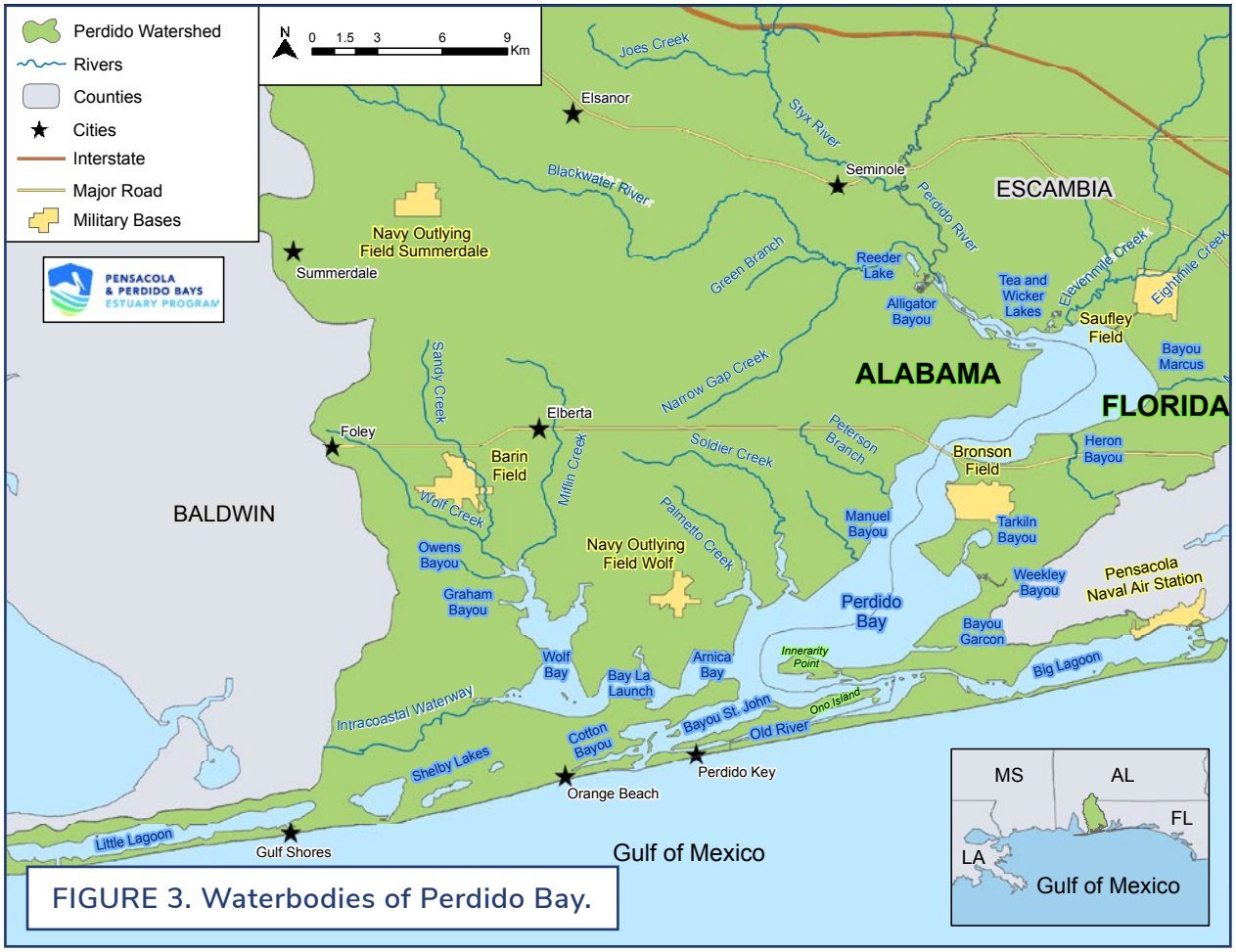


FIGURE 3. Waterbodies of Perdido Bay.

River Systems

Perdido River

The Perdido River is the main source of fresh-water input to Perdido Bay and is designated by the State of Florida as an Outstanding Florida Water with a large portion of the area protected by conservation lands. This river is a hotspot for recreational activity and marks the state boundary line between Florida and Alabama. The Perdido River is formed at the Fletcher and Perdido Creek confluence. Near the mouth of the Perdido River, the Sytx and Blackwater Rivers converge with the Perdido River. Major tributaries of Perdido Bay are Elevenmile Creek, Wolf Creek, Sandy Creek, Miflin Creek, Brushy Creek, Boggy Creek, McDavid Creek, and Jacks Branch.

Elevenmile Creek

Elevenmile Creek discharges directly into Perdido Bay near the mouth of the Perdido River. International Paper (IP), situated on Elevenmile Creek, is the largest industrial point source in the watershed. Until 2013 IP directly discharged effluent into Elevenmile Creek when IP relocated their discharge to a new 1,381-acre effluent distribution system or treatment wetland to treat 23.5 million gallons per day (MGD) (Nutter and

Associates, Incorporated 2015). Historically, IP has been regarded as the largest point source pollutant into Perdido Bay and has been the subject of repeated water quality violations (FDEP 2006). While water quality improvements following the construction of the treatment wetland have been observed, the Creek remains listed as an impaired waterbody. The creek receives 68% of its flow from groundwater and the effluent may still affect water quality (DEP 2008, NWFWMD SWIM 2017a).

Wolf Creek
Wolf Creek is a smaller tributary in the Perdido system that flows into Wolf Bay. This creek, along with Miflin and Hammock Creeks drain ~124 Km^2 (Lusk 2017). Wolf Creek is an urbanized creek that flows through the center of Foley, AL, crossing many city roads.

Coastal Waterbodies

Gulf Coast Intracoastal Waterway (GIWW)
The Gulf Coast Intracoastal waterway (GIWW) is a man-made channel that runs from Brownsville, TX to St. Marks, FL and was constructed to create quick and easy shipping routes to transport goods. The section within the Perdido watershed was completed in 1934 and is approximately 4 m deep by 40 m wide (Alperin 1983). Land cuts were made between Bon Secor Bay in Mobile Bay and Perdido Bay and between Perdido Bay and Big Lagoon. Land alterations such as these have the potential to influence the hydrology of the bay system.

Big Lagoon
Big Lagoon is a small bay at the base of Perdido Bay that connects to Perdido Bay on the west to Pensacola Bay on the east via the GIWW. This lagoon has extensive seagrass beds of turtlegrass (*Thalassia testudinum*) along the shorelines (DEP 2001). Big Lagoon is a highly trafficked area during the summer months and thus has concerns for prop scarring. Big Lagoon State Park encompasses land boarding Big Lagoon and a portion of the watershed. This park is home to many important species and is a stopover point for many migratory birds.

Tarkiln Bayou and Weekley Bayou
Weekley and Tarkiln bayous are north of Bayou Garcon. Tarkiln Bayou is the largest bayou in Perdido Bay and is surrounded by tidal marsh and pine flatwoods. The bayou is shallow with a depth of 1–2 m and depths at the narrow mouth are shallow enough to walk across during low tides (NWFWMD SWIM 2017a). Tarkiln Bayou is considered to be one of the last remaining pristine bayous in Northwest Florida (Kirschenfeld et al. 2006) and is surrounded by the Tarkiln Bayou State Preserve and Perdido Pitcher Plant Prairie, home to many species of concern.

Bayou Garcon
Bayou Garcon is an inlet north of Innerarity point on the east side of Perdido Bay. Bayou Garcon is surrounded by extensive wetlands. Garcon Bayou Nature Park is a ~1 km^2 protected area near Bayou Garcon.

Bayou Marcus, Heron Bayou, and Alligator Bayou
Bayou Marcus, Heron Bayou, and Alligator Bayou are north of Tarkiln Bayou. Surrounding Bayou Marcus is Bayou Marcus Wetlands and the Bayou Marcus Water Reclamation Facility (BMWRF) owned by Emerald Coast Utilities Authority (ECUA). The BMWRF has a boardwalk through the Bayou Marcus Wetlands and is a part of the Great Florida Birding and Wildlife

ICW near Galvez Landing
Darryl Boudreau, NWFWMD

Trail. Bayou Marcus Wetlands has endangered, threatened, and species of special concern within its wetlands, including the American Alligator (*Alligator mississippiensis*), Gopher tortoise (*Gopherus polyhemus*), and various pitcher plant species.

Graham Bayou
Graham Bayou is connected to Perdido Bay via Wolf Bay in Alabama. The Graham Creek Nature Preserve conserves more than 2 km^2 of wetlands and natural habitat near Graham Bayou that are home to rare plant and animal species.

Wolf Bay
Wolf Bay is designated as an Outstanding Alabama Water that sustains diverse plant and animal life, such as the American alligator (*Alligator mississippiensis*), the Alabama red-bellied turtle (*Pseudemys alabamensis*), and the West Indian manatee (*Trichechus manatus*). It is located in Baldwin County, AL and is the westernmost embayment in the Perdido Bay basin. Wolf Bay has a long history of water quality stewards, the Wolf Bay Watershed Watch, that have been collecting water quality data since 1998.

Lakes

Shelby Lakes
Shelby Lakes are coastal lakes located within the Gulf State Park near Gulf Shores, AL. Shelby Lakes are comprised of Shelby Lake, Middle Lake, and Little Lakes and cover 3.6 km^2. Shelby Lakes are primarily freshwater lakes, separated from the Gulf of Mexico by dunes, that have intermittent saltwater intrusion during storm events, creating a unique environment with freshwater and saltwater fish species (Liu et al. 2007). The lakes are surrounded by pine-hardwood forests and salt marshes and are primarily used for recreation.

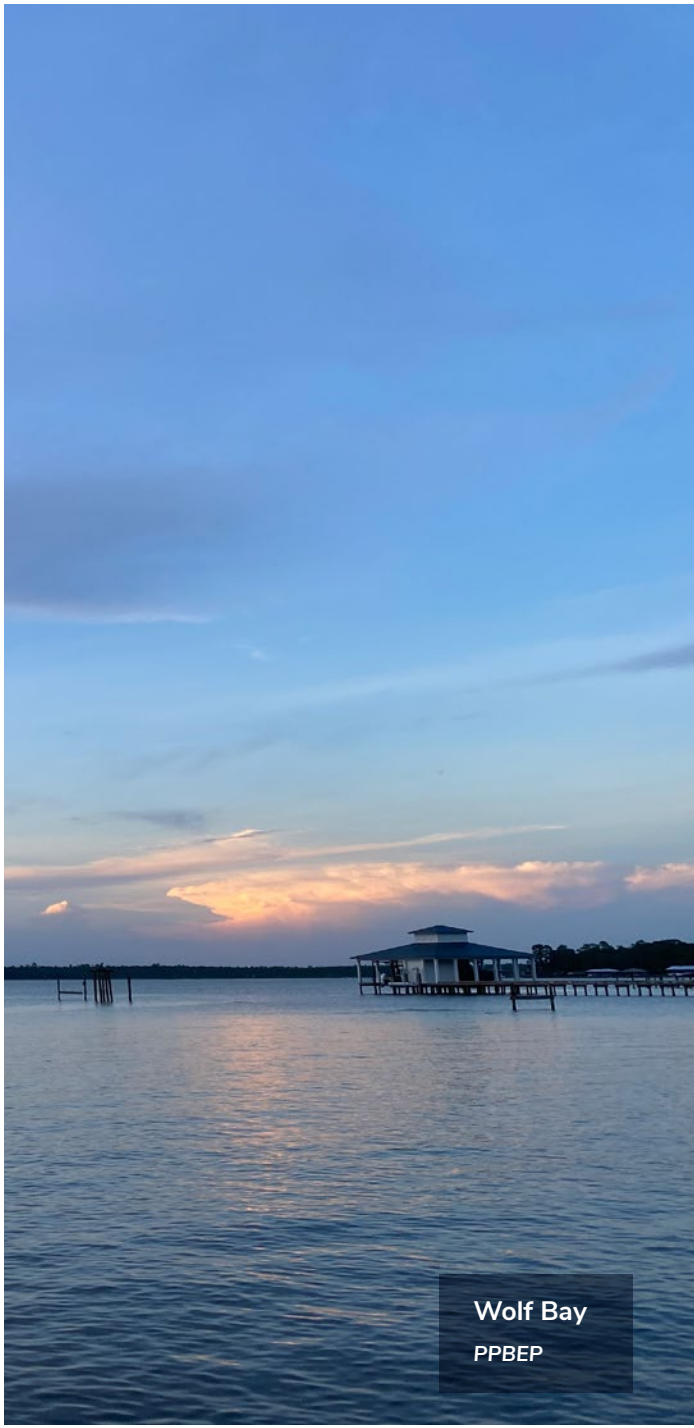
Tee and Wicker Lakes
Tee and Wicker Lakes (0.05 km^2) are man-made lakes located at the head of Perdido Bay just west of Elevenmile creek.

Floodplains and Wetlands

Floodplains and wetlands are at the interface of terrestrial and aquatic environments and act as buffers for pollution runoff, stabilizing structures, and habitat for many species. Floodplains are largely concentrated around the Perdido River and other major tributaries and include palustrine and tidal wetlands. Large floodplains are found near the lower Perdido River near northern Perdido Bay and the northeastern side of Perdido Bay where Garcon Swamp is located. Wet prairies are common in the Perdido watershed and provide habitat for many plant species including endangered pitcher plants.

Tarkiln Bayou and Perdido Pitcher Plant Prairie
Tarkiln Bayou Preserve State Park is a wetland preserve home to four species of endangered pitcher plants, including the white-topped pitcher plant (*Sarracenia leucophylla*) endemic to the Gulf Coast (NWFWMD SWIM 2017a). Over 100 rare animals depend on the wet-prairie habitats within the preserve. This preserve uses prescribed fire and trash cleanups to protect the wetlands.

Garcon Swamp
The Garcon Swamp flows into Bayou Garcon and is a large wetland system located south of Tarkiln Bayou and north of Big Lagoon.


Wolf Bay
PPBEP

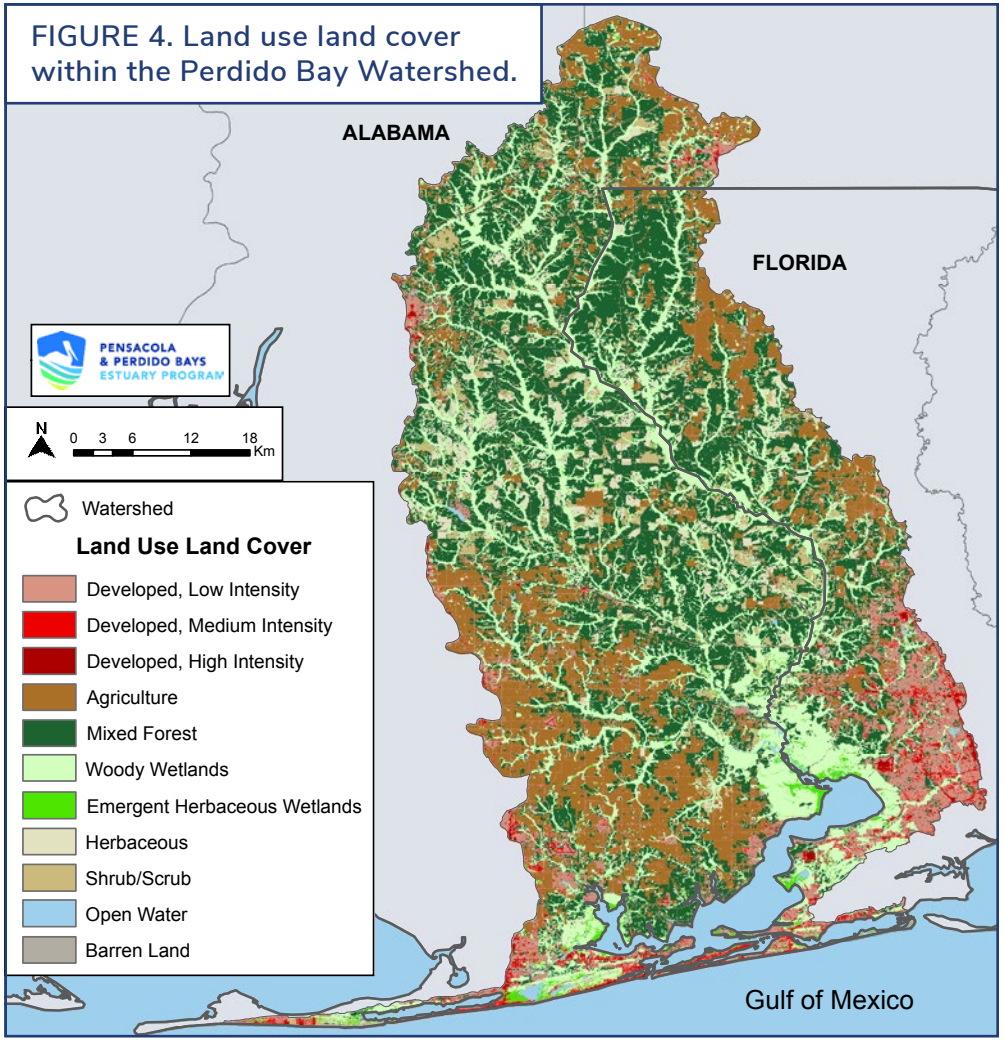
Land Use and Population

Land Use and Land Cover

Land use and land cover (LULC) within the Perdido watershed consists of mixed upland forest (36%), agricultural lands (17%), marsh and wetlands (23%), urban areas (12%), shrubland (5%), herbaceous areas (5%), open water (1%), and open areas (1%) (Figure 4) (National Land Use Land Cover Database 2019). Urban and industrial areas are concentrated around Pensacola, Cantonment, Perdido Key, Gulf Shores, and Orange Beach. This region also has many military bases within the watershed that encompass ~12 km^2. The Florida portion of the watershed is dominated by developed and forested lands with rapid urbanization occurring in Pensacola, while the Alabama portion of the watershed is dominated primarily by agriculture and forested areas (Figure 4). Agricultural activities have been known to cause high nutrient concentrations in Wolf Bay (Livingston 2001).

In recent years urban and agriculture expansion has increased within the Perdido watershed (Le et al. 2015). Such changes can alter freshwater flows and nutrient and sediment loading into waterways. In Perdido, terrestrial uplands have been significantly modified, which may impact wetland hydrology (NWFWMD SWIM 2017a). A study by Wang and Kalin (2011) in Wolf Bay indicated a 20% increase in urban areas and a 9% reduction of forest coverage between 1992 and 2005. An expansion of urban areas occurred at the expense of evergreen forests and wetlands. Overall, due to a combination of wetland draining, conversion of agriculture, urban development, expansion of exotic species, and climate change, the natural landscape has significantly changed over the last 100 years (Volk et al. 2017). As a result of population growth and climate change, future LULC will continue to change, affecting the freshwater and estuarine ecosystems.

FIGURE 4. Land use land cover within the Perdido Bay Watershed.



Data from the 2019 National Land Use Land Cover Database (USGS 2019).

Population and Urbanization

Population growth and urban development is expected to increase. For example, the population of the Florida portion of the watershed, where it covers only 30% of the total area, increased ~16% from 2010 to 2020. Similarly, the population of Orange Beach, Gulf Shores, and Foley increased by ~50% between 2010 and 2020 (U.S. Census 2020). Population growth in coastal areas is more rapid in comparison to upland areas. For example, between 1990 and 2010 the population of Orange Beach and Gulf Shores (coastal cities) increased by 141% and 199%, respectively, whereas the population of Bay Minette and Atmore (inland cities) increased by only 12% and 2%, respectively, and Atmore lost 17% of its population from 2010–2020 (U.S. Census 2020). The continued pressure put on coastal areas will be a challenge for effectively managing the natural resources.

Conservation Lands

Multiple conservation lands exist within the Perdido watershed, which are essential to protect natural resources, communities, and preserve wildlife corridors (Figure 5). The NWFWMD, ADCNR, and TNC own large tracts of land along the Perdido River including the Perdido River Water Management Area, the Perdido River Management Area, and the Perdido River Preserve, respectively. Additional conservation lands within the Perdido watershed include Perdido Key State Park, Gulf Islands National Seashore, Big Lagoon State Park, Tarkiln Bayou Preserve, Splinter Hill Bog, Gulf State Park, Graham Creek Nature Preserve, and Jones Swamp Wetland Preserve. Efforts to conserve lands for wildlife and future generations are imperative to restore healthy ecosystems.

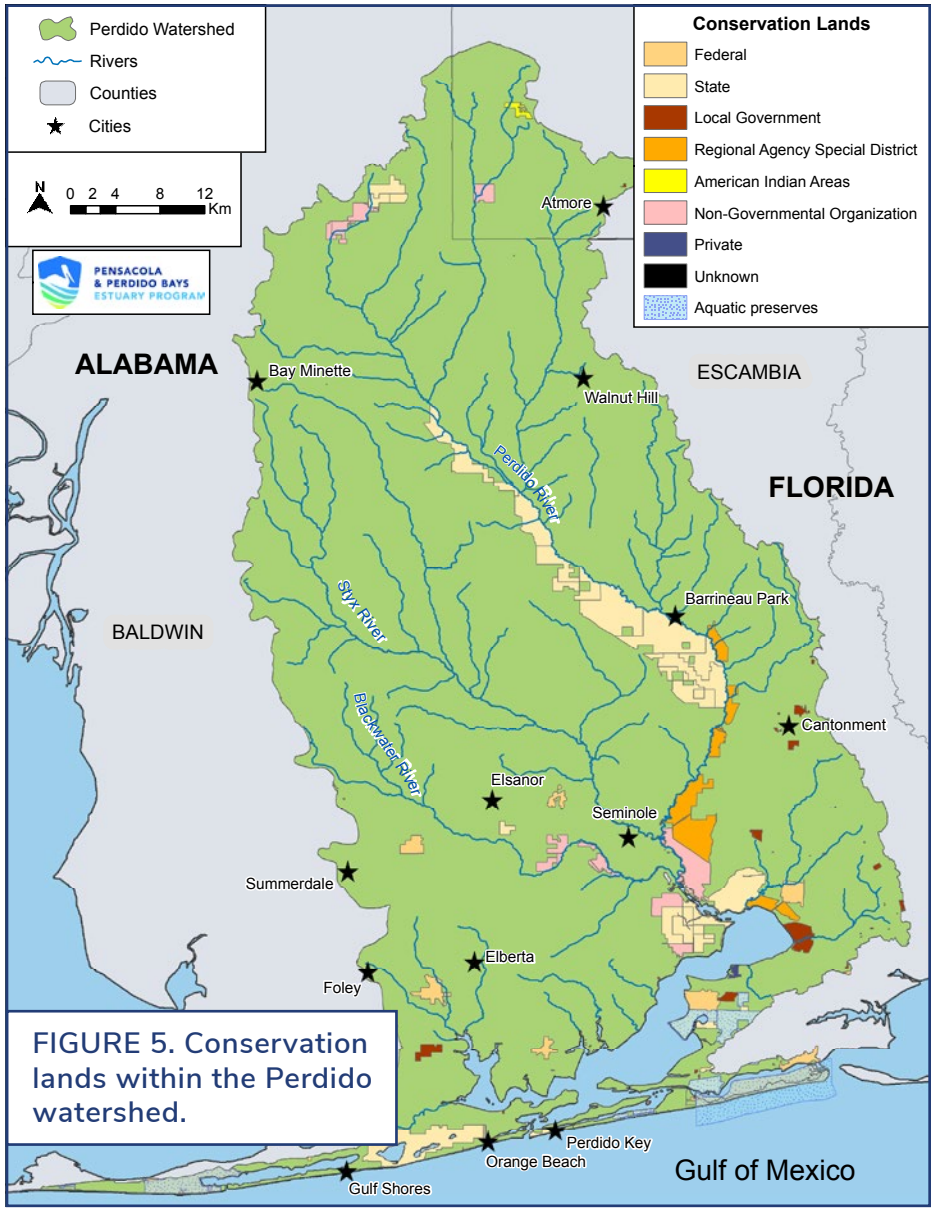


FIGURE 5. Conservation lands within the Perdido watershed.

Data retrieved from the USGS Protected Areas Databases of the U.S. Conservation lands are classified by managing entities and includes lands owned by entities or lands that are easements, designations, and proclamations (U.S. Geological Survey (USGS) Gap Analysis Project (GAP) 2020).

Pensacola Bay Watershed

Geographic Characteristics

The Pensacola Bay watershed encompasses the Northwest Florida panhandle and extends to portions of southern Alabama (Figure 6). The watershed is approximately 18,130 km^2 (NWFWMD 2016) with a portion (35%) of the watershed in the Florida Panhandle (Escambia, Okaloosa, Santa Rosa, and Walton Counties) and the remainder (65%) of the watershed in Alabama (Covington, Escambia, Conecuh, Butler, Crenshaw, Pike, Bullock, Montgomery, and Coffee Counties).

The topography of the watershed is characterized by gently rolling hills, sharp ridges, prairies, and alluvial floodplains. In Florida, there are two localized physiographic features: the Western Highlands and the Gulf Coastal Lowlands (USGS 2013). The Western Highlands encompass the main river systems (Escambia, Blackwater, and Yellow) and hillside seepage bogs (Wolfe et al. 1988). The Western Highlands have greater relief than the Gulf Coastal Lowlands and are dominated by limestone bedrock of the Citronelle formations, ancient delta deposits of clays, clayey sands, and gravels that form stream-incised hills (e.g., Bay Bluff along Escambia Bay) (USDA 2004, NWFWMD SWIM 2017b). The elevation of the Western Highlands ranges from 115 m in Alabama to 30 m in the relict marine terrace (Rupert 1993). The Gulf Coastal Lowlands are dominated by connected estuarine embayments, wetlands, and parallel terraces rising from the coast, which formed during the Pleistocene Epoch after growth and melting of ice caps caused sea level fluctuation (NWFWMD SWIM 2017b). The elevation of the Gulf Coastal Lowlands is 10 m above sea level.

The geology of the Pensacola watershed is similar to Perdido where most of the land features are the products of prehistoric marine deposition when the sea level was higher: dolomitic limestone, sandy clayey limestone, shell beds, clayey sands, and sands (Scott et al. 2001). Overlying sediments are composed of siliclastic sediments composed of mainly quartz sand weathered from the Appalachian Mountains (Smith 2001).

FIGURE 6. Pensacola watershed.

There are two aquifers present in the system: the sand-and-gravel aquifer and the Floridian aquifer system. The sand-and-gravel aquifer is the surficial aquifer that provides fresh drinking water to Escambia and Santa Rosa Counties (NWFWMD 2013). The aquifer is recharged via direct rainfall (NWFWMD 2013). The Floridian aquifer system, largely composed of carbonate sediments, is beneath the sand-and-gravel aquifer and provides fresh drinking water for Walton, Okaloosa, and Santa Rosa Counties (NWFWMD 2014).

Hydrologic Characteristics

Pensacola Bay

The Pensacola Bay system (370 km^2) is a shallow (3.5 m), microtidal (tides of 0.5 m), coastal plain riverine-estuarine system that is partially protected by barrier islands (Figure 7). The system is a well-stratified estuary with relatively high freshwater input (Escambia River [200 m^3 s^{-1}] provides 65% of the discharge to the Bay [EPA 2005]), with a flushing time of 18 days (Pratt et al. 1990). Pensacola Bay is comprised of five interconnected waterbodies that include Escambia Bay, Pensacola Bay, Blackwater Bay, East Bay, and Santa Rosa Sound. Water from Pensacola Bay ultimately discharges into the Gulf of Mexico through Main Pass of Pensacola Bay, which is 0.8 km wide and dredged to a depth of 12–15 m for shipping activities (Pratt et. al. 1990).

Pensacola Bay historically had a productive oyster fishery mainly in Escambia, East, and Blackwater Bays, but due to decades of water quality declines from sedimentation and nonpoint and point source pollution, the oyster fishery has collapsed (FWC 2019). Shrimping and scallop industries also used to be prevalent in the Bay but are no longer harvested. Seagrass declines from sedimentation are also problematic but may be recovering in recent years (Carlson and Yarbro 2020). Santa Rosa Sound is an important area of seagrass habitat.

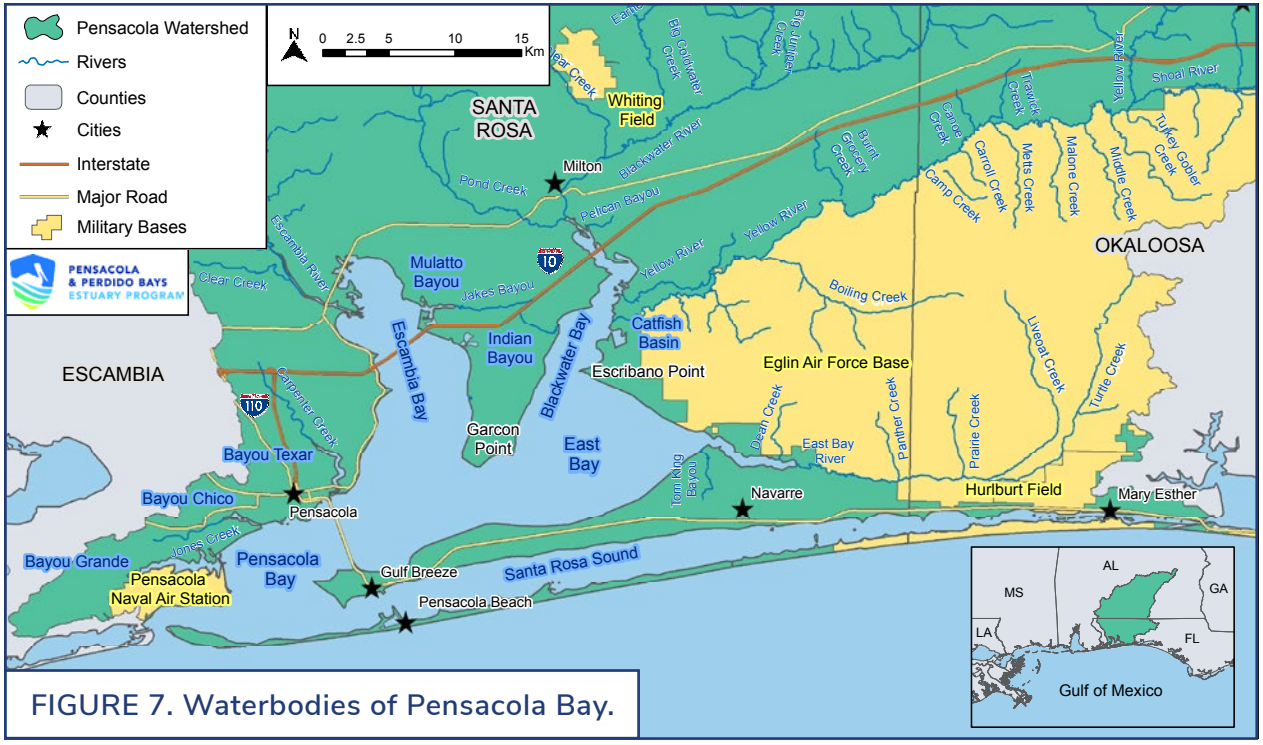


FIGURE 7. Waterbodies of Pensacola Bay.

River Systems

The Pensacola Bay system has four major rivers that discharge freshwater into the Bay providing nutrient inputs to support productive ecosystems: Escambia, Blackwater, Yellow, and East Bay Rivers, with the first three rivers being major river systems in the Pensacola watershed. The Escambia, Blackwater, and Yellow Rivers originate in southern Alabama as blackwater streams, which have a high tannin content. The blackwater rivers are home to endemic and endangered species. The Blackwater River and portions of the Yellow River are designated as Outstanding Florida Waters.

Escambia River

The Conecuh River in Alabama forms the northern part of the Escambia River, which is the largest river in the watershed with 90% of its basin in Alabama. This river drains 6,797 km^2 into Escambia Bay (Pratt et. al. 1990). The

Escambia River provides 63% of the freshwater discharge into Pensacola Bay (EPA 2005). This river is impacted from industrial, domestic, and nonpoint source pollution. The Pensacola Chemical Complex (previously Solutia and Monsanto Textiles Company) and Gulf Clean Energy Center (previously Gulf Power) are two historical industrial contributors to water quality declines. Tributaries of the Escambia River include Pine Barren Creek, Canoe Creek, Mitchell Creek, Little Pine Barren Creek, McDavid Creek, Bray Mill Creek, Big Escambia Creek, Holland Branch, and Blue Water Creek.

Blackwater River

The Blackwater River originates near Bradley, Alabama, and drains 1,384 km^2 into Blackwater Bay. Blackwater River is an Outstanding Florida Water that gets its reddish tint from draining the surrounding flatwoods (Lewis 2010). This river receives most of its surface flow from groundwater discharge from the sand-and-gravel Aquifer (Hand et al. 1996). While water quality in general is considered to be good, health advisories have been issued for mercury contamination in largemouth bass (BARC 2005). Currently, concerns center around wastewater effluent entering the river. Large tracts of land along Blackwater River are in conservation land in the Blackwater State Forest. This river is an important canoe and recreational river. Tributaries of Blackwater River include Big Coldwater Creek, Pond Creek, Juniper Creek, Panther Creek, and Sweetwater Creek.

Yellow River

The Yellow River originates in Andalusia, Alabama in the Conecuh National Forest and is joined by the Shoal River in Crestview, Florida and drains 2,197 km^2 of wetlands into Blackwater Bay (NWFWMD SWIM 2017b). The portion of the river that contains the Yellow River Marsh Aquatic Preserve is an Outstanding Florida Water. Tributaries of Yellow River include Murder Creek, Gum Creek, Titi Creek, and the Shoal River.

East Bay River

East Bay River is a tannic river that drains a portion of Eglin Air Force Base, Hurlburt Field, and urban areas of Santa Rosa and Okaloosa Counties. Nutrients, sedimentation, and bacterial contamination are concerns as population growth and development continue to alter the landscape that drains into the river.

Coastal Waterbodies

Bayou Texar

Bayou Texar, located in central Pensacola, has a long history of poor water quality including fish kills and bacterial contamination likely stemming from urban stormwater runoff. Bayou Texar is near two superfund sites: the Agrico Chemical Company (1889–1975) and Escambia Wood Treating (1942–1982). Contaminated groundwater from these superfund sites is a concern for Bayou Texar (Mohrherr et al. 2005). Sediments have high levels of PAHs, DDTs, and metals (NWFWMD SWIM 2017b). While water quality has improved in recent years, legacy contaminants from the sediments may continue to impact water quality for years to come.

The headwaters of Bayou Texar, Carpenter's Creek, drain urbans areas in Pensacola and input sediment and stormwater into the bayou. The Creek is also impacted by streambank erosion and channelization. Currently, the Carpenter Creek and Bayou Texar Watershed Management Plan

Yellow River
PPBEP

is being developed with the goals of restoring the watershed to reduce non-point pollution and sedimentation.

Bayou Chico

Bayou Chico, located near downtown Pensacola, receives freshwater from Jones and Jackson Creeks, which drain urban areas of Pensacola. This bayou has had historically poor water quality due to industrial, residential, and urban activities (Lewis et al. 2016). Bayou Chico is impacted by stormwater runoff, domestic and industrial wastewater discharges, shipyard operations, nutrient enrichment, and sediment contamination. One of the main industrial polluters of Bayou Chico was American Creosote Works, a wood-treating facility that operated from the 1900s to 1982 and discharged a variety of pollutants to the sediments and surface water (i.e., creosote, PCPs, VOCs, PAHs). At the height of its pollution, there was a layer of hydrocarbon sludge overlying the sediment and foam on the surface waters. The American Creosote Works superfund site is just north of Bayou Chico and may still be delivering phenols via groundwater (Liebens et al. 2007). Sediments have high levels of PAHs, DDTs, and metals (Waller et al. 1998, NWFWMD SWIM 2017b). Since the 1980s when local governments commenced remediation projects, fish have come back to the bayou.

Bayou Grande

Bayou Grande is the southernmost bayou in Pensacola Bay. Bayou Grande has the Pensacola Naval Air Station on its southern shore, the residential area of Navy Point on its northern shore, and relatively undeveloped areas on the western shore. While Bayou Grande is larger than the other urban bayous (Texar and Chico), its watershed is small compared to the other bayous, indicating that runoff pollution should be lower than in the other urban bayous. Industrial waste from the Pensacola Naval Air Station was discharged directly into Bayou Grande from the 1930s-1973. Wastes introduced into the bayou include mercury, radium paint, solvents, and other heavy metals (Mohrherr et al. 2008). Other pollutants found in Bayou Grande include PCBs and pesticides. While industrial pollution is a source from the Naval Base, high bacterial loads originate from Navy Point (Snyder 2006). Bayou Grande does have historical water quality issues like the other urban bayous, but it is less affected by urbanization than the other urban bayous.

Mulatto Bayou

Mulatto Bayou is a small bayou located in Santa Rosa County on Garcon Point (eastern shore of Escambia Bay). Sediments were dredged from this bayou during the construction of the Interstate-10 Bridge in 1965. Dredging from the interstate bridge and dredging in the 1970s to make neighborhood canals covered seagrass beds with sludge deposits (Livingston et al. 1972). Mulatto Bayou still has dense seagrass beds, but changes in water quality due to development in the surrounding area are concerning for the persistence of these seagrass beds.

Indian Bayou

Indian bayou is located on the northwest side of Garcon Point. The bayou is surrounded by mainly natural landscape with the small neighborhood of Avalon Beach at its headwaters. Sedimentation is a concern in Indian Bayou due to developmental pressures and the presence of seagrass beds in the bayou.

Bayou Chico
Escambia County

Lakes

The Florida portion of the watershed has multiple man-made impoundment lakes constructed during the 1950s-1970s that are used as Fish Management Areas. The largest man-made lakes are Hurricane Lake, Bear Lake, and Lake Karick in Blackwater State Forest.

Floodplains and Wetlands

Floodplains and wetlands are at the interface of terrestrial and aquatic environments and act as buffers for pollution runoff, stabilizing structures, and habitat for many species. Extensive floodplains exist around the major rivers of the watershed: the Escambia, Yellow, Blackwater, and Shoal Rivers. Major wetlands are located on the Garcon Point Peninsula and Fairpoint Peninsula (southern peninsula in Pensacola Bay). Wet prairies and pitcher plant bogs are found throughout the Blackwater River State Forest, the Yellow River Marsh Preserve State Park, and the Garcon Point Water Management Area.

Jones Swamp

Jones Swamp is a wetland in the Jones Creek watershed that drains into Bayou Chico. A part of the swamp (5 km^2) is managed by Escambia County as the Jones Swamp Wetland Preserve and Nature Trail. This preserve acts to improve water quality in Bayou Chico and Pensacola Bay by preserving wetland buffers. Activities within the preserve include prescribed burning to enhance native vegetation, creek restoration, flood reduction, and stormwater education.

Gaberonne Swamp

Gaberonne Swamp is on the western shore of Escambia Bay located in the Scenic Heights area. Gaberonne Swamp has been affected by development for the past few hundred years. Historically this area was the site of a rice plantation. Currently large residential developments surround the swamp. Due to changes in hydrology, freshwater and saltwater inputs have changed the swamp ecosystem, which has a rich animal and plant diversity. The surrounding area is impacted by stormwater and flooding. The City of Pensacola identified Gaberonne Swamp as an area in need of resilience planning due to its flooding issues and has undergone recent stormwater improvements (City of Pensacola 2022).

Garcon Point

Garcon Point is the peninsula that separates Escambia and East Bay. Garcon Point consists of wet prairie wetland habitat and is home to many rare and endangered species, including various pitcher plant species, the Panhandle Lily (*Lilium iridollae*), the Henslow Sparrow (*Centronyx henslowii*) and LeConte's Sparrow (*Ammodramus leconteii*). The Garcon Point Water Management Area (WMA) is a preserve owned by the Northwest Florida Water Management District located in Garcon Point. This preserve protects wetlands to improve water quality in Pensacola Bay.

Garcon Point
Darryl Boudreau, NWFWMD

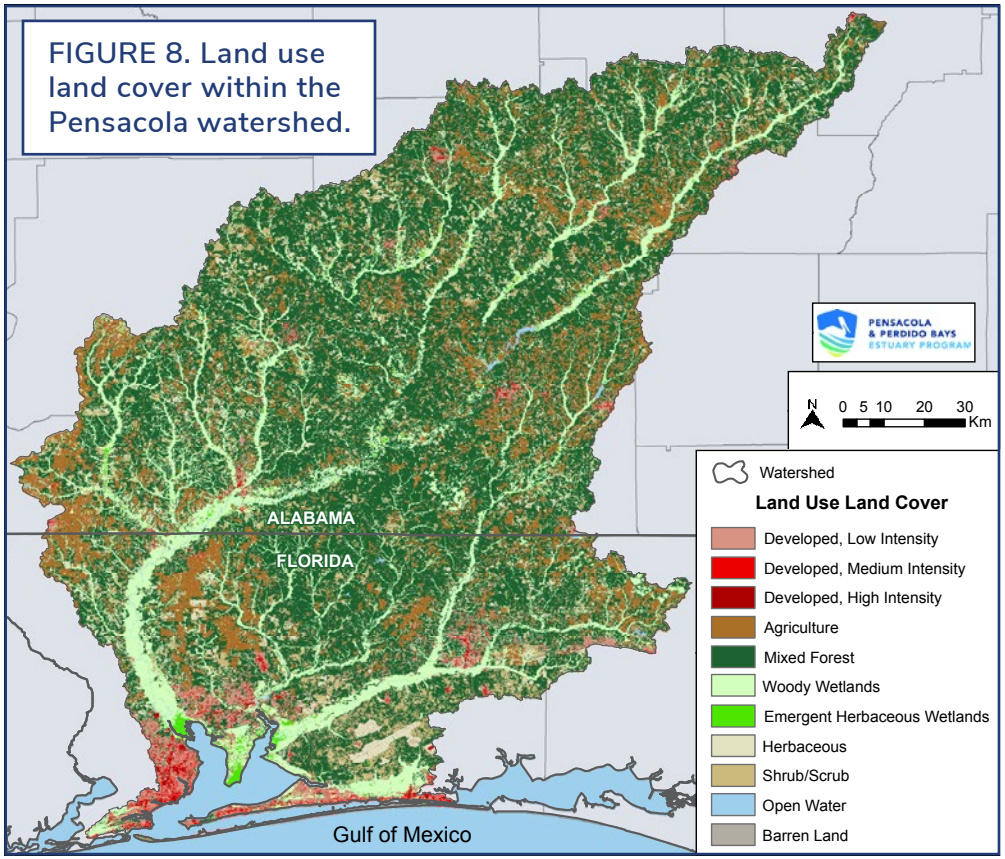
Land Use and Population

Land Use and Land Cover

Land use and land cover (LULC) in the Pensacola watershed consists of mixed upland forest (51%), agricultural lands (12%), marsh and wetlands (15%), urban areas (8%), shrubland (8%), herbaceous areas (5%), open water (1%), and open areas (0.5%) (Figure 8) (National Land Use Land Cover Database 2019). North of Interstate 10 in the Florida portion of the watershed, land uses are predominately agriculture and silviculture (NWFWMD 2016). Urban development in the Florida portion of the watershed is concentrated in the southern coastal zone and includes the Pensacola metropolitan area, Pace, Milton, Gulf Breeze, Pensacola Beach, Navarre, and Crestview. Land uses in the Alabama portion of the watershed are predominately mixed upland forest and agricultural lands. Pockets of urban development exist around the Alabama cities of Andalusia, Opp, Brewton, and Greenville. Industrial areas are located along waterfronts, particularly Bayou Chico and lower Escambia River. Floodplains and wetlands are concentrated around the main river stems, Escambia, Blackwater, Yellow, Shoal, and East Bay Rivers, and Garcon Point and Jones Creek.

Large tracts of land in the Pensacola watershed are military bases. The Pensacola Naval Air Station covers 23 km^2 in Escambia County, FL, Whiting Field covers 15 km^2 in Santa Rosa County, FL, and Eglin Air Force Base covers 1,900 km^2 in Santa Rosa, Okaloosa, and Walton Counties. Eglin Air Force Base also extends into the neighboring Choctawhatchee watershed. Eglin Air Force Base Natural Resources Team has been successful in protecting endemic species and communities and providing recreational activities for the public (Natural Resources Team 2013).

FIGURE 8. Land use land cover within the Pensacola watershed.



Data from the 2019 Land Use Land Cover Database (USGS 2019).

Population and Urbanization

Like other coastal watersheds, land use in the Pensacola watershed has been altered due to increasing populations (Handley et al. 2007). Areas with the largest population growth are Escambia and Santa Rosa Counties located in the southern coastal zone (NWFWMD SWIM 2017b). Populations of Escambia, Santa Rosa, and Okaloosa Counties, FL have increased by 220% since 1960 (Handley et al. 2007). According to the U.S. Census Bureau (2020), Escambia County's population increased 8%, Santa Rosa County's population increased 24%, and Okaloosa County's population increased 17% between 2010 and 2020. Population growth across the watershed is disproportionate, with the Florida portion of the watershed expected to see an increase in population of growth and the Alabama portion of the watershed expected to decrease in population (U.S. Census Bureau 2020). For

example, the Alabama counties of Escambia, Covington, Conecuh, Butler, and Crenshaw decreased ~6% between 2010 and 2020 (U.S. Census Bureau 2020).

Between 1989–2002, urban growth along the coast has occurred at the expense of agriculture and upland forests (Yang and Liu 2005). For example, agricultural lands in Escambia County lost 13,247 ha of land in five years (1992 – 1997), while urban areas gained 6,071 ha of land for the same period (Yang and Liu 2005). Urbanization increases nonpoint source pollution, stormwater runoff, wastewater generation, and results in habitat loss and fragmentation.

Conservation Lands

Multiple conservation lands exist within the Pensacola watershed, which are essential to protect natural resources, communities, and preserve wildlife corridors (Figure 9). Federal, state, and local government, and non-governmental organizations have jurisdiction over conservation lands within the watershed. Conservation lands include the Blackwater, Escambia, and Yellow River Water Management Areas, Gulf Islands National Seashore, Blackwater River State Forest, Conecuh National Forest, Escribano Point Wildlife Management Area, Blackwater River and Yellow River Marsh Preserve, Eglin Air Force Base, Hurlburt Field, and the Pensacola Naval Air Station. These lands provide a buffer system for protecting water quality, reducing flooding, and preserving terrestrial and aquatic ecosystems (Handley et al. 2007). The Yellow River Marsh Aquatic Preserve and the Fort Pickens Aquatic Preserve are the two Aquatic preserves in the Pensacola watershed and covers 202 km^2.

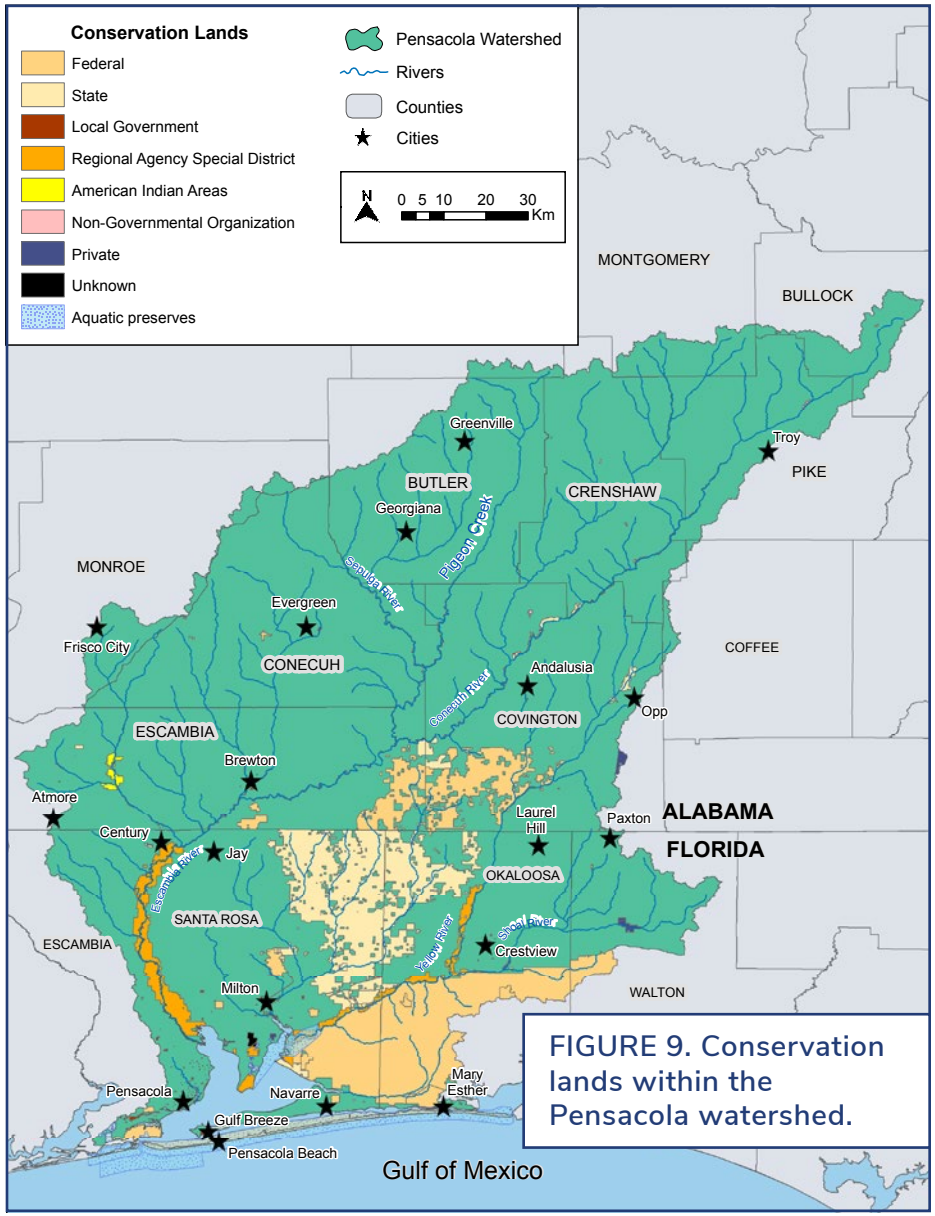


FIGURE 9. Conservation lands within the Pensacola watershed.

Data retrieved from the USGS Protected Areas Databases of the U.S. Conservation lands are classified by managing entities and includes lands owned by entities or lands that are easements, designations, and proclamations (U.S. Geological Survey (USGS) Gap Analysis Project (GAP) 2020).

Habitats and Communities

The Pensacola and Perdido watersheds have several important habitats stretching from the headwaters down to the coast to support fish and wildlife. There are terrestrial habitats which include bluffs, longleaf pine-wiregrass forests, flatwoods, and upland hardwood forests. Upland habitats are home to many longleaf pine-dependent species. Moving further down the watershed there are riparian and floodplain habitats, which act as important buffers to the aquatic systems and have unique habitats such as pitcher plant bogs. Near the coast, salt marshes and estuaries support juvenile fish species, oysters, seagrasses, and soft bottom benthic communities. More detailed habitat and community descriptions can be found in NWFWMD SWIM 2017 a, b, and the FNAI website.

Splinter Hill Bog Preserve
PPBEP

Longleaf Pine, Sandhill, and Flatwoods Forests

Longleaf Pine (*Pinus palustris*) ecosystems are prevalent throughout the southeastern United States. From the early 1800s to the 1930s longleaf pines were brought to near extinction as they were harvested for the timber industry to be used in ship, railroad, and building construction (Frost 1993). Additionally, pines have been cleared for agriculture and development, intensively managed for silviculture, and tapped for turpentine and resin. Pine plantations in the area are planted for timber harvest and contain Slash Pine (*Pinus elhotti*), Sand Pine (*Pinus clausa*), and Loblolly Pines (*Pinus taeda*) (BARC 2005). These are productive fire-adapted ecosystems that are threatened by development and poor fire management. Longleaf pine habitats need regular fire to maintain and rejuvenate the forests. State lands and preservation lands undergo prescribed fire to mimic the natural burning of the forest. Yet, there are many stretches of longleaf forest that are not in conservation lands and are threatened from lack of fire. Additionally, encroachment of development is a threat to longleaf pine habitats.

Longleaf pines are evergreen conifers with long needlelike leaves that can grow 20–30 m tall. Within the Pensacola and Perdido watersheds there are sandhill and flatwood longleaf pines systems. Sandhill longleaf pine ecosystems typically have a Wiregrass (*Aristida stricta*) understory with multiple oak species like Turkey Oak (*Quercus laveis*) and support diverse plant and animal species, such as the Red-Cockaded Woodpecker (*Picoides borealis*), Gopher Tortoise (*Gopherus polyhemus*), Gopher Frogs (*Rana capito*), the Eastern Indigo Snake (*Drymarchon corais couperi*), and the Reticulated Flatwoods Salamander (*Ambystoma bishop*). The red-cockaded woodpecker is a keystone species that utilizes living pine trees greater than 80 years old to make their cavities. Insects, birds, squirrels, and frogs utilize red-cockaded woodpecker cavities. Similarly, gopher tortoises burrow holes that are utilized by more than 350 species, including gopher frogs and the eastern indigo snake. The endangered reticulated flatwoods salamander inhabits slash and longleaf pine-wiregrass and wetland habitats. They are

threatened from low population density, fragmented and restricted range due to loss of longleaf pine habitat, and inadequate fire management (FWS 2020). Tracts of Eglin Air Force Base and Hurlburt field help conserve critical habitat for the reticulated flatwoods salamander. Pine flatwoods are in floodplains with sandy, well-drained soils, with moderate amounts of organic matter. Flatwoods primarily surround rivers and bayous. The Blackwater River State Forest, Conecuh National Forest, and Eglin Air Force Base have the largest remaining area of mature longleaf pines in the world (NWFWMD SWIM 2017 b).

Stream and Riverine Habitats

Rivers along the northern Gulf of Mexico have high biodiversity and endemism, supporting numerous freshwater fish, mussels, clams, reptiles, and amphibians (Blaustein 2008). The watersheds have rainfall and/or groundwater fed alluvial, softwater, and blackwater streams with sand, silt, and gravel substrates (Bass and Cox 1985, FWC 2012). While all rivers are impacted by nonpoint source pollution, the Escambia River suffers from legacy pollution from point sources, mainly industrial discharges in the lower portion of the river near Cantonment, FL. Current threats to these riverine habitats are sedimentation due to development and loss and fragmentation of habitat due to damming, channelization, and impoundment construction.

Different habitats within the rivers are critical for species persistence. Gravel and pebble habitats are found in the upper reaches of the Escambia and Yellow Rivers. These habitats are important for fishes that utilize gravel substrates for part or all of their life history (Knight et al. 2019). Fishes that live in these gravel and pebble habitats that are endemic, endangered, and/or threatened are the Crystal Darter (*Crystallaria asprella*), River Redhorse (*Moxostoma carinatum*), Saddleback Darter (*Percina vigil*), Southern Logperch (*Percina austroperca*), Pallid Chub (*Macrhybopsis pallida*), and the Gulf Sturgeon (*Acipenser oxyrinchus desotoi*). Sturgeon, for example, depend upon gravel habitats for their early life stages. Sturgeon inhabit most Florida panhandle rivers, but due to damming activities, only the Suwannee, Choctawhatchee, and Yellow Rivers have large sturgeon spawning grounds. Portions of the Escambia, Conecuh, Blackwater, and Shoal Rivers are designated as critical habitat for the Gulf Sturgeon.

The Escambia River is a large alluvial river that is home to many endemic freshwater fishes, mussels, and clams. The Crystal Darter, Harlequin Darter (*Etheostoma histrio*), Cypress Minnow (*Hybognathus hayi*), River Redhorse, Saddleback Darter, Southern Logperch, and Blacktip Shiner (*Lythrurus atrapiculus*) can be found in the Escambia River. Endemic mussels and clams have narrow home ranges within the Escambia, Conecuh, and Yellow Rivers, putting these species at high risk for extinction if their habitat is lost. For example, the Choctaw Bean (*Villosa choctawensis*) is found in 13 locations and the endangered Round Ebony Shell (*Fusconaia rotulata*) is found in only 2–3 locations. Furthermore, the Round Ebony Shell is only endemic to a small stretch of the Conecuh River and has a historical range of 95 km (FNAI). Many of these freshwater bivalves are increasingly found in fewer locations. Threatened freshwater bivalves include the Southern Sandshell (*Hamiota australis*) and the Fuzzy Pigtoe (*Pleurobema strodeanum*). The Escambia, Yellow, and Shoal Rivers are federally designated critical habitat for several species of freshwater fishes and mussels.

Escambia River
Darryl Boudreau, NWFWMD

Bogs and Seepage Slopes

Bogs are inundated for most of the year, creating habitat for rare and endangered plants and animals. Many types of bog-like habitats can be found in the Pensacola and Perdido watersheds including seepage slopes, swamps, and wet prairies. Seepage slopes are 9–15 m gradient habitats, bordered by upland pines, where groundwater percolates from the surface for most of the year, creating a continually moist ground. Blackwater streams originate from swamps which provide organic and tannin materials to create the "blackwaters." Wet prairies support diverse plant communities including the carnivorous pitcher plants (Walker 2001). Two main species are found in the Pensacola and Perdido watersheds: the White-Topped Pitcher Plant (*Sarracenia leucophylla*) and the Red Pitcher Plant (*Sarracenia rubra*). These plants bloom between April-May and pitchers develop in the fall. Pitcher plants can be found at various locations throughout the watersheds, and can be found on various conservation lands, including Splinter Hill Bog Preserve, Tarkiln Bayou Preserve State Park, Eglin Air Force Base, and Blackwater River State Forest.

Other rare and endemic species found in these bog habitats include the Panhandle Lily (*Lilium iridollae*). Almost half of the remaining populations of the Panhandle Lily, found in floodplains, swamps, bogs, and seepage slopes, are protected on the lands of the Blackwater River State Forest and Eglin Air Force Base. The Bog Spicebush (*Lindera subcoriacea*) is a shrub found along streamsides and in seepage slopes. Within the Pensacola and Perdido watersheds there is only one known population of bog spicebush, which is located on the Eglin Air Force Base (FNAI). The American Chaffseed (*Schwalbaea americana*) is federally endangered and has been found at seepage slopes in Blackwater River State Forest (FDACS 2013). The Seal Salamander (*Desmognathus monticola*) lives in seepage slopes and shaded ravines. Within Florida these salamanders are only found in Canoe Creek in Escambia County. Main threats to bog and seepage slope type habitats are small population sizes of rare and endemic species, silviculture, wetland draining, and development.

Fundy Bayou
PPBEP

Floodplains and Wetlands

Freshwater Wetlands

Floodplains and wetlands provide important buffers, regulating stormwater runoff, filtering contaminants, stabilizing shorelines, and providing habitat for many plant and animal species. Floodplains also attenuate flood impacts, playing a vital role in ecosystem resiliency as flood impacts may increase in the future due to climate change. Dense wetlands are found along the major rivers within the watersheds and in large wetland areas like Garcon and Escribano Point. Many of the historical wetlands in the lower parts of the watersheds were drained in the late 1700 and early 1900s to prevalent malaria and widespread disease (Rea 1969). Wetlands were also converted to urban areas as population in the area grew. Development of wetlands reduces the natural flood storage and filtration capacity, threating water quality.

Rare and endemic species depend on floodplains and wetlands for habitat. The endangered Reticulated Flatwoods Salamander (*Ambystoma bishop*) inhabits slash and longleaf pine-wiregrass and wetland habitats. The Cypress Crayfish (*Cambarellus blacki*) is found along the Escambia River floodplain and surrounding cypress ponds. Within Escambia County, these crayfish are found at few locations, with one location on the Escambia River Water Management Area. The Escambia Crayfish (*Procambarus escambiensis*) is found along the Perdido River at 8 locations in Escambia County, FL and Baldwin County, AL in riparian and herbaceous wetlands (FNAI). Crayfish have been reported near the Perdido River Preserve and Tarkiln Bayou State Park.

Estuarine Wetlands

Tidal salt marshes are prevalent throughout the Pensacola and Perdido coastal zone in low energy environments. These are important juvenile habitats for many fish, finfish, and invertebrate species. Salt marshes are also important in filtering runoff from land and buffering the shoreline against storms. Species composition is influenced by salinity tolerance, soil type, and elevation (Bertness et al. 1992). Common species of marsh grasses are Black Needlerush (*Juncus roemerianus*) and Smooth Cordgrass (*Spartina alterniflora*). Other marsh grasses found are Sawgrass (*Cladium jamaicense*), Maidencane (*Panicum hemitomon*), Giant Cutgrass (*Zizaniopsis miliacea*), and Cattails (*Typha spp.*). Salt marshes provide habitat for numerous species, including Fiddler Crabs (*Uca sp.*), Marsh Periwinkles (*Littoraria irrorata*), and Mussels (*Mytilidae*). Threats include salt marsh draining and filling for development.

Estuarine Habitats

Estuaries, located at the interface of terrestrial and ocean environments, are ecologically diverse and productive habitats. These habitats provide important juvenile and nursery habitat for many fish and shellfish species, are economically and recreationally important fishing areas, and provide many ecosystem services such as shoreline protection and nutrient removal. Each year estuaries in the United States provide millions of dollars' worth of ecosystem services (Restore America's Estuaries 2021).

Within the Pensacola and Perdido watersheds, estuaries make up our bays, bayous, and coastal inlets. These waterbodies are important for threatened and endangered species. The threatened Gulf Sturgeon (*Acipenser oxyrinchus desotoi*) use Pensacola and Perdido Bays and Big Lagoon as important winter habitats (NWFWMD SWIM 2017b). Other estuarine fish that utilize the coastal areas are the Alabama Shad (*Alosa alabamae*), Skipjack Herring (*Alosa chrysochloris*), Striped Bass (*Morone saxatilis*), Hogchocker (*Trinectes maculatus*), Channel Catfish (*Ichthyomyzon punctatus*), Longnose Gar (*Lepisosteus osseus*), and American Eel (*Anguilla rostrate*). Estuaries are also important for marine mammals. The West Indian Manatee (*Trichechus manatus*) are seasonal migrants to these waters (Cloyed et al. 2021). Manatees were downlisted from endangered to threatened in 2017 and are becoming more common in this region due to population rebounds and warming waters.

Indian Bayou
PPBEP

Pensacola and Perdido estuaries have been heavily exploited by humans since the colonization by Europeans and continue to experience human pressure due to the population density living along the shorelines. Pensacola Bay was the snapper fishery of the world from the 1880s-1950s, with the height of production seen during 1895–1929 (McNeil 1977, Grinnan 2018). In 1902, the snapper fishery peaked as fisherman overfished the population and pushed the snapper industry into deeper waters to catch the remaining fish (McNeil 1977). Similarly, Pensacola Bay was once known for its shrimping industry (1980s-1990s). In recent years fewer shrimping boats are seen in the bay due potentially to declining shrimp populations and shifts in fishermen careers (O'Connor 2022). In addition to overfishing pressures, estuaries have long been used for dumping and waste disposal. In the 1880s untreated sewage was discharged directly into the bay. By the late 1960s widespread fish kills were reported due to industrial waste discharge in Escambia River, Bayou Chico, and upper Perdido Bay (U.S. Federal Water Pollution Control Administration 1969, 1970a, 1970b). While water quality has improved with the development of sewage systems and wastewater treatment plants and creation of the Clean Water Act, current declines in water quality are a concern. Population growth and land use change threatens our estuaries with sedimentation and nutrient and pathogen inputs.

Navy Point Oysters
PPBEP

Submerged Habitats

Submerged Aquatic Vegetation

Seagrass beds are found in tropical and temperate zones around the world. The shallow coastal zones of the Perdido and Pensacola Bay systems are dominated by Shoalgrass (*Halodule wrightii*) mixed with other less abundant species, Turtlegrass (*Thalassia testudinum*) and Manatee Grass (*Syringodium filiforme*). Seagrasses extend from the lower Perdido Islands and Big Lagoon to the Pensacola Bay System and Santa Rosa Sound. Other species of submerged aquatic vegetation (SAV) are present in the upper bays and more freshwater or brackish (freshwater mixed with saltwater) environments including the most common Wild Celery or Eelgrass (*Vallisneria americana*) and Widgeon Grass (*Ruppia maritima*). These marine flowering plants provide many benefits to various fish and shellfish species including food resources and nursery grounds or protection from predators. Some fish that use seagrass beds as nursery grounds are the Gulf Menhaden (*Brevoortia patronus*), Red Drum (*Sciaenops ocellatus*), Blue Crab (*Callinectes sapidus*), and the Gulf Flounder (*Paralichthys albigutta*). Seagrasses also sequester nutrients from the water column, store carbon, trap sediments, and act as a storm and wave buffer protecting shorelines from erosion which are all valued ecosystem services provided to our coastal communities. Main threats include poor water quality and excess nutrients, sedimentation, storms, and propeller scarring.

Oyster Reefs

The Eastern Oyster (*Crassostrea virginica*) is found in intertidal and subtidal estuarine ecosystems along the Atlantic and Gulf Coasts. Oysters are sessile filter feeding invertebrates that create complex reef structures that provide homes for other organisms including mussels, crabs, small fish, and shrimps. Oyster reefs protect and stabilize our shorelines from storms and wave action, sequester nutrients, and filter water. Oyster populations are declining due to changing salinity regimes, nutrient enrichment and pollution, overharvesting,

and loss of suitable substate for young oysters to settle upon. Historically, the Pensacola Bay system including East, Blackwater, and Escambia Bays had extensive oyster reefs. Remaining oysters are restricted to small sections of Escambia and Blackwater Bays. Perdido Bay has no known historical or current presence of oyster reefs and oysters are only found along pilings in the salty waters nearer the Gulf of Mexico.

Soft Bottom Habitats

Large areas of the Pensacola and Perdido bays, bayous, and rivers consist of soft bottom habitats, mainly composed of mud and mud/sand. While these habitats lack the foundation for colonizing and sessile organisms, rich communities live within these habitats. Tube worms, mollusks, isopods, amphipods, crabs, and burrowing shrimp are found in soft bottom habitats. These habitats are also important feeding areas for invertebrates, fish, and shorebirds, such as the Piping Plover (*Charadrius melodus*). Stressors to soft bottom habitats include boating/propeller scarring, low dissolved oxygen, and metal and pesticide pollution.

Coastal Barrier Systems

Coastal barrier island systems at the mouth of the bays provide a protective barrier for the coastline. Barrier islands consist of white sandy quartz beaches with zones of vegetation and sand dunes. Vegetation is important for stabilizing the dune system, which provide a natural protection against storm surge. The vegetation generally changes from grassy to woody from the foredune to the backdune. Species found on the seaward side (i.e., foredune) are Sea Oats (*Unicola paniculata*), Dune Elder (*Iva imbricata*), Sea Rocket (*Cakile lanceolata*), and Sea Purslane (*Sesuvium portulacastrum*). Species found on the backdune are Spanish Bayonet (*Yucca aloifolia*), Myrtle Oak (*Quercus myrtifolia*), and Greenbriar (*Smilax auriculata*).

Dunes provide important habitat for the endangered beach mouse. The Perdido Key Beach Mouse (*Peromyscus polionotus trissyllepsis*) and the Santa Rosa Beach Mouse (*Peromyscus polionotus leucocephalus*) prefer sand dunes with moderate vegetation cover, including Sea Oats and Beach Dropseed (*Sporobolus virginicus*). The Perdido Key beach mouse is found on Perdido Key in Florida and Alabama, and the Santa Rosa beach mouse is found along Santa Rosa Island, Florida. The Perdido Key mouse is on conservation lands of the Gulf Islands National Seashore and the Perdido Key State Recreation Area. Threats to beach mice include hurricanes (Hurricanes Erin and Opal in 1995 severely depressed beach mice populations) and other activities damaging dunes (boardwalk construction, off-road-vehicles), and feral cats (Bird et al. 2002).

Similar to the dune systems, the sandy shoreline also provides habitat for many species such as invertebrates, shorebirds, and turtles. Sea turtles inhabit marine coastal and oceanic waters and utilize coastal beach and dune habitats for nesting during warmer months (April-September). Sea turtles found in the Pensacola and Perdido Bays include the threatened Loggerhead Sea Turtle (*Caretta caretta*) and the endangered Green (*Chelonia mydas*) and Leatherback (*Dermochelys coriacea*) Sea Turtles. Threats to nesting environments include development, coastal armoring, and light pollution, which can cause hatchlings to crawl away from the ocean upon hatching. Ocean threats include marine debris which entrap sea turtles and debris that is mistakenly ingested as food (e.g., plastic shopping bags mistaken for jellyfish).

Johnson's Beach, GUIS
Darryl Boudreau, NWFWMD

Legacy Watershed Issues

Pensacola and Perdido Bays have suffered from human disturbance and misuse of natural resources since industrialization. Particularly, unregulated industry in the early to mid-1900s led to areas with groundwater contamination and poor surface water quality. Multiple superfund sites exist within the watersheds, with most of the sites located in coastal areas. Some of these sites have been remediated, while others remain active cleanup sites potentially inputting contaminants into ground and surface waters. Remediation of contaminated sites is an ongoing effort and will require consistent investments to ensure clean waters for the future.

Superfund Sites

The Pensacola Bay system has 5 active EPA National Priority List (NPL) Superfund sites:

- American Creosote Works (Pensacola, FL), listed in 1983
- Agrico Chemical Company (Pensacola, FL), listed in 1989
- Pensacola Naval Air Station (Pensacola, FL), listed in 1989
- Whiting Field (Milton, FL), listed in 1994
- Escambia Wood Treating (Pensacola, FL), listed in 1994

and one delisted Superfund site

- Mowbray Engineering Company (Greenville, AL), listed from 1983–1993

Three superfund sites are located near the urban bayous of Texar and Chico and two superfund sites are associated with Naval activity. The Agrico Chemical Company and Escambia Wood Treating are located within a mile of Bayou Texar, delivering contaminated groundwater (Mohrherr et al. 2005). American Creosote Works delivers phenols into Bayou Chico via groundwater (USGS 1986).

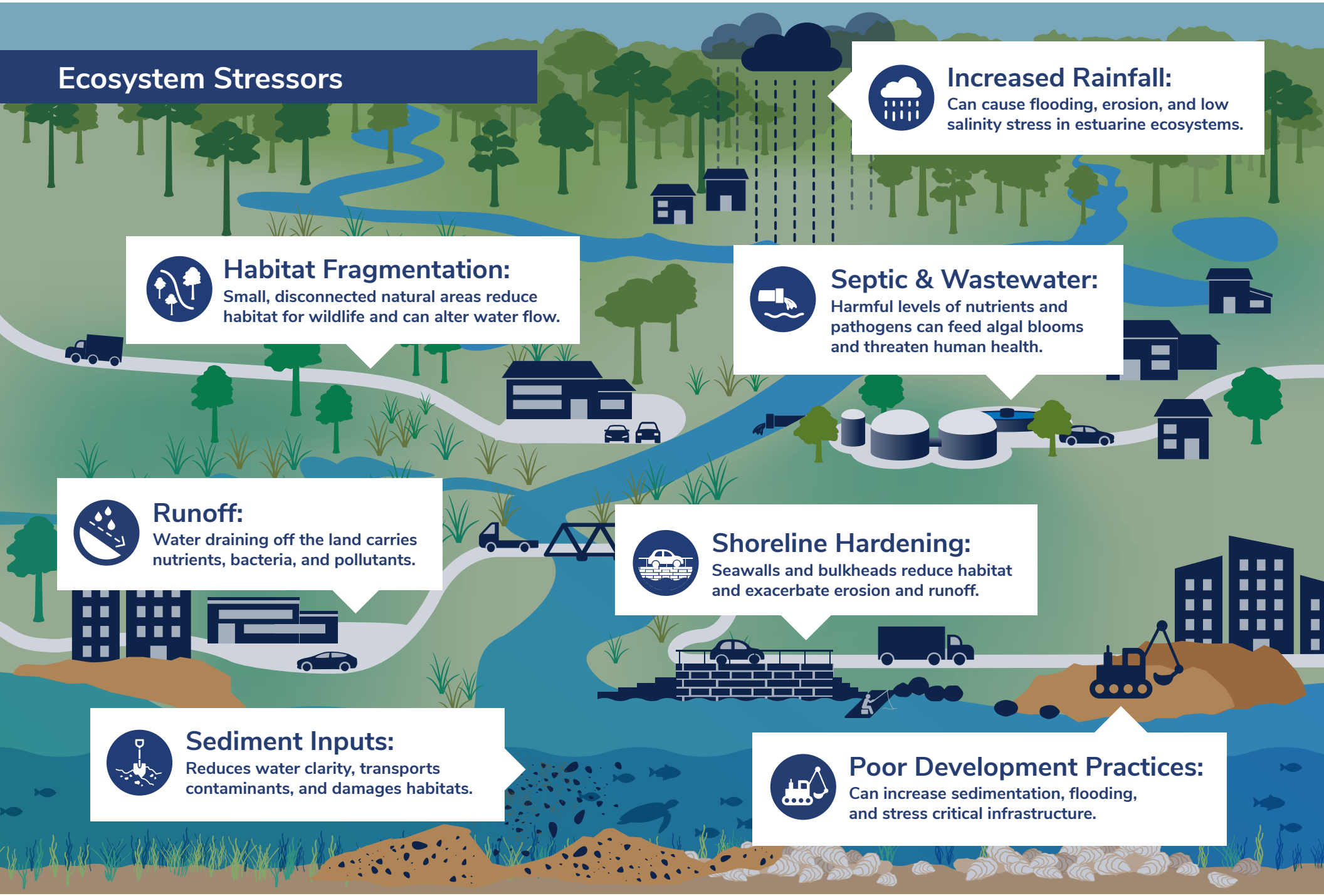
There are 33 non-NPL Superfund sites located within the Pensacola watershed. Seven non-NPL sites are located in Alabama and 26 are located within Florida. A non-NPL site is a Superfund site that is not placed on the NPL list and involve short-term clean up options under the emergency removal program.

The Perdido Bay system has 4 delisted EPA National Priority List (NPL) Superfund sites and no active sites:

- Pioneer Sand Company (Warrington, FL), listed from 1983–1993
- Dubose Oil Products Company (Cantonment, FL), listed from 1986–2004
- Beulah Landfill (Pensacola, FL), listed from 1990–1998
- Perdido Ground Water Contamination (Perdido, AL), listed from 1983–2017

There are 10 non-NPL Superfund sites located within the Perdido watershed. Three are in Alabama and 7 are in Florida.

Ecosystem Stressors



Increased Rainfall:
Can cause flooding, erosion, and low salinity stress in estuarine ecosystems.

Habitat Fragmentation:
Small, disconnected natural areas reduce habitat for wildlife and can alter water flow.

Septic & Wastewater:
Harmful levels of nutrients and pathogens can feed algal blooms and threaten human health.

Runoff:
Water draining off the land carries nutrients, bacteria, and pollutants.

Shoreline Hardening:
Seawalls and bulkheads reduce habitat and exacerbate erosion and runoff.

Sediment Inputs:
Reduces water clarity, transports contaminants, and damages habitats.

Poor Development Practices:
Can increase sedimentation, flooding, and stress critical infrastructure.

Point Source Pollution

Historical industrial and manufacturing facilities have led to water quality degradation and sediment toxicity. Many of the facilities with historical pollution issues are located on rivers in the upper reaches of the bays. Water quality and sediment toxicity issues stemming from industrial operations has led to findings of noncompliance and eventual improvements to discharge operations to reduce environmental impacts.

International Paper

International Paper (IP) is a pulp and paper mill located in Cantonment, FL near Elevenmile Creek that is one of the largest sources of wastewater in Perdido Bay and watershed. This facility has a history of water quality violations (DEP 2006) and spurred the organization of environmental groups such as the Perdido Bay Environmental Association and the Friends of Perdido Bay (an offshoot of the Perdido Bay Environmental Association), which formed via concerned Perdido Bay residents. IP discharged wastewater into Elevenmile Creek causing long-term water quality issues downstream into Perdido Bay (Livingston 2000). In 2013, IP upgraded their wastewater treatment to an on-site treatment wetland, removing direct discharge of wastewater from Elevemile Creek, and discharging 27 million gallons per day into the wetlands (Nutter and Associates, Incorporated 2015). While IP is still working to comply with state and federal water quality standards, IP has made progress to contribute to community organizations and regional partnerships, and environmental stewardship.

Pensacola Chemical Complex

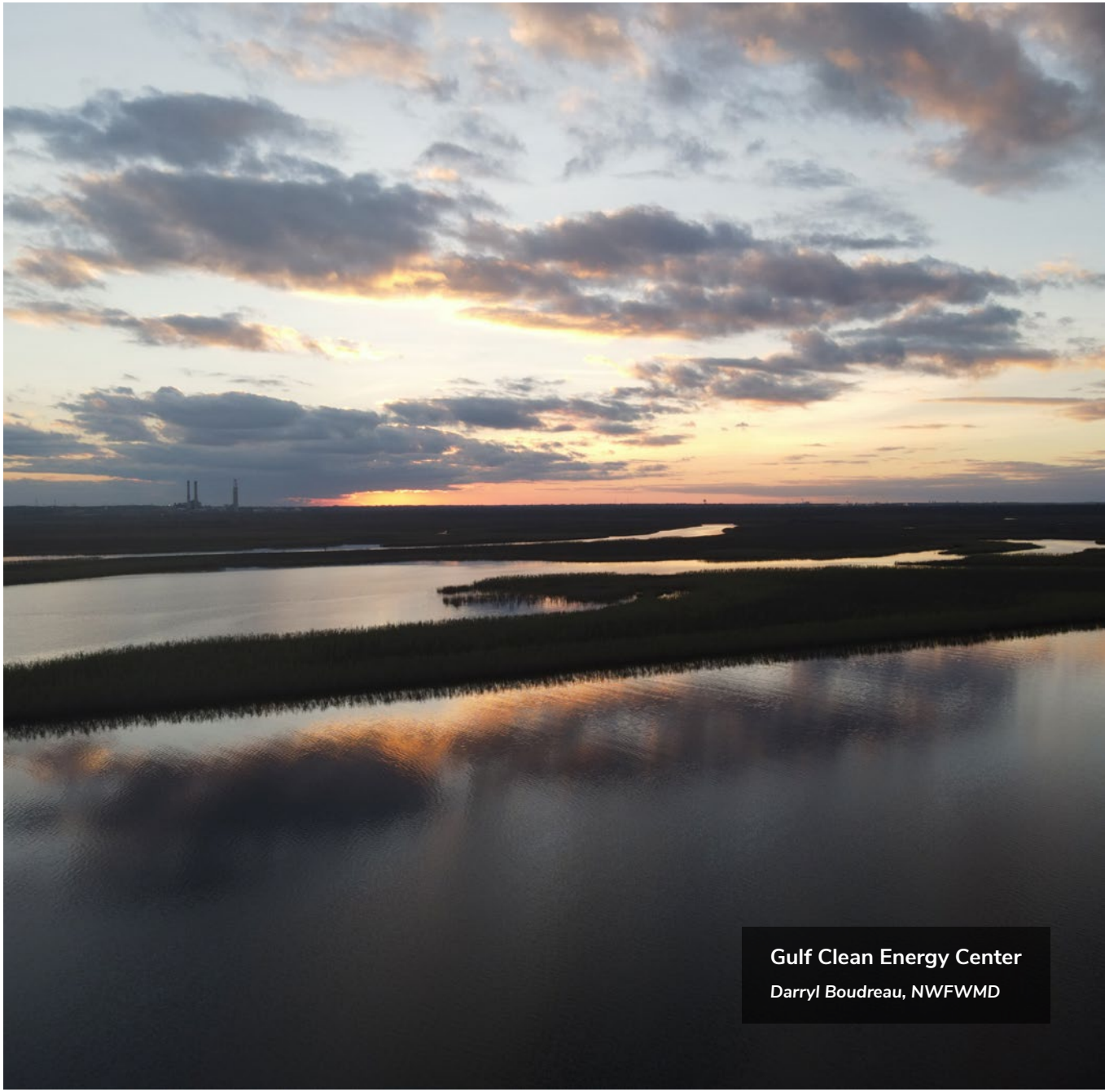
The Pensacola Chemical Complex is a ~8 km2 petrochemical production site located on the Escambia River in Gonzalez, Florida. Several companies are located at the Pensacola Chemical Complex including Ascend Performance Materials (nylon production) and Exxon Mobil Chemical Company (Santoprene TPV production). This complex was built in 1953 as Monsanto. The plant changed names to Solutia Inc. in 1997 and in 2009 the nylon division morphed into Ascend Performance Materials. This plant has a history of PCB pollution and was responsible for a PCB spill into Escambia River in 1969 (Duke et al. 1970, Mohrherr et al. 2009). According to EPA's Toxic Release Inventory, this facility ranks 12 for the top 100 industrial facilities for on-site disposal due to their deepwell injection (EPA TRI 2020).

Gulf Clean Energy Center

The Gulf Clean Energy Center (owned by Florida Power and Light) was built in 1945 as the James F. Crist Generating Plant (Plant Crist) and is located at the mouth of the Escambia River on Governor's Bayou. Prior to 2021, this facility was a coal burning power plant transporting coal barges up the Escambia River and disposing of waste into coal ash ponds built across the bayou. In 2021 Plant Crist converted to natural gas and was renamed the Gulf Clean Energy Center. Coal ash ponds have the potential to contaminate groundwater with arsenic, cadmium, copper, manganese, and sulfate. The coal ash pond located across the Bayou from the Gulf Clean Energy Center is unlined and could impact water and sediment quality through the potential release of leachate from the coal ash pond to Escambia River (Clean Water Fund 2012).

Industry and Citizen Action

Humans have impacted water quality since colonization. During the mid-1900s many industries established operations in the coastal areas of the watersheds, particularly Escambia River, Bayou Chico, and Elevenmile Creek. For many years, unregulated industrial effluent and untreated runoff was discharged into surface waters leading to water quality declines. While the public did have concerns about water quality in the early 1900s, it was not until the pervasive fish kills of the late 1960s and early 1970s in Pensacola Bay, and benthic invertebrate die-offs in the late 1980s in Perdido Bay, that caused large-scale citizen action and federal involvement (Olinger et al. 1975). The state of the Pensacola Bay system was considered degraded near the port (Florida State Board of Health 1969), oysters were found with PCBs (Duke et al. 1970), and large fish kills were seen in Mulatto Bayou and Bayou Texar (Livingston et al. 1972, Moshiri et al. 1972). In response to poor water quality, multiple community science groups formed, and the Federal Water Pollution Control Administration (FWPCA) held an interstate conference in 1970, 1971, and 1972. Recommendations were made to reduce the pollutant loading from Monsanto, American Cyanamid Company, and Air Products, Inc. on the Escambia River.



Gulf Clean Energy Center
Darryl Boudreau, NWFWMD

Chronic Watershed Issues

Impaired Waters

The Pensacola and Perdido systems have water quality impairments in both Florida and Alabama (Figure 10 and Figure 11). Causes of water quality impairments are nonpoint and point source pollution from land use practices that convert landscapes from natural, vegetated landscapes to hardened or cleared areas. The Florida Department of Environmental Protection (DEP) has identified 19 impaired waters in the Florida portions of the Pensacola and Perdido Bay Systems based on Florida's Impaired Surface Waters Rule, Chapter 62-303, Florida Administrative Code (updated July 2022) (Table 1). Ten segments are impaired for bacteria, 11 for metals (10 iron, 1 lead) and 2 for nutrients (1 chlorophyll a, 1 total phosphorous). The Alabama Department of Environmental Management (ADEM) has identified 38 impaired waters in the Alabama portions of the watersheds based on ADEM's Water Division – Water Quality Program Administrative Code, Chapter 335-6-10 (Water Quality Criteria) (Table 1). Fourteen segments are impaired by bacteria, 25 by metals (2 lead, 23 mercury), and 2 for organic enrichment. Some segments have more than one impairment, meaning there are more impairments than waterbodies impaired.

DEP identified two waterbodies impaired for bacteria in waterbodies classified for shellfish harvesting, as designated by the Shellfish Environmental Assessment Section (SEAS) of the Florida Department of Agriculture and Consumer Services (FDACS) (segments listed below with waterbody identification numbers [WBIDs]). All impaired segments are found in the Pensacola Bay System. No impaired shellfish waters are identified in Perdido Bay due to no known waterbodies classified for shellfish harvesting.

- East Bay River (Marine Portion) (WBID 701C)
- Santa Rosa Sound (915)

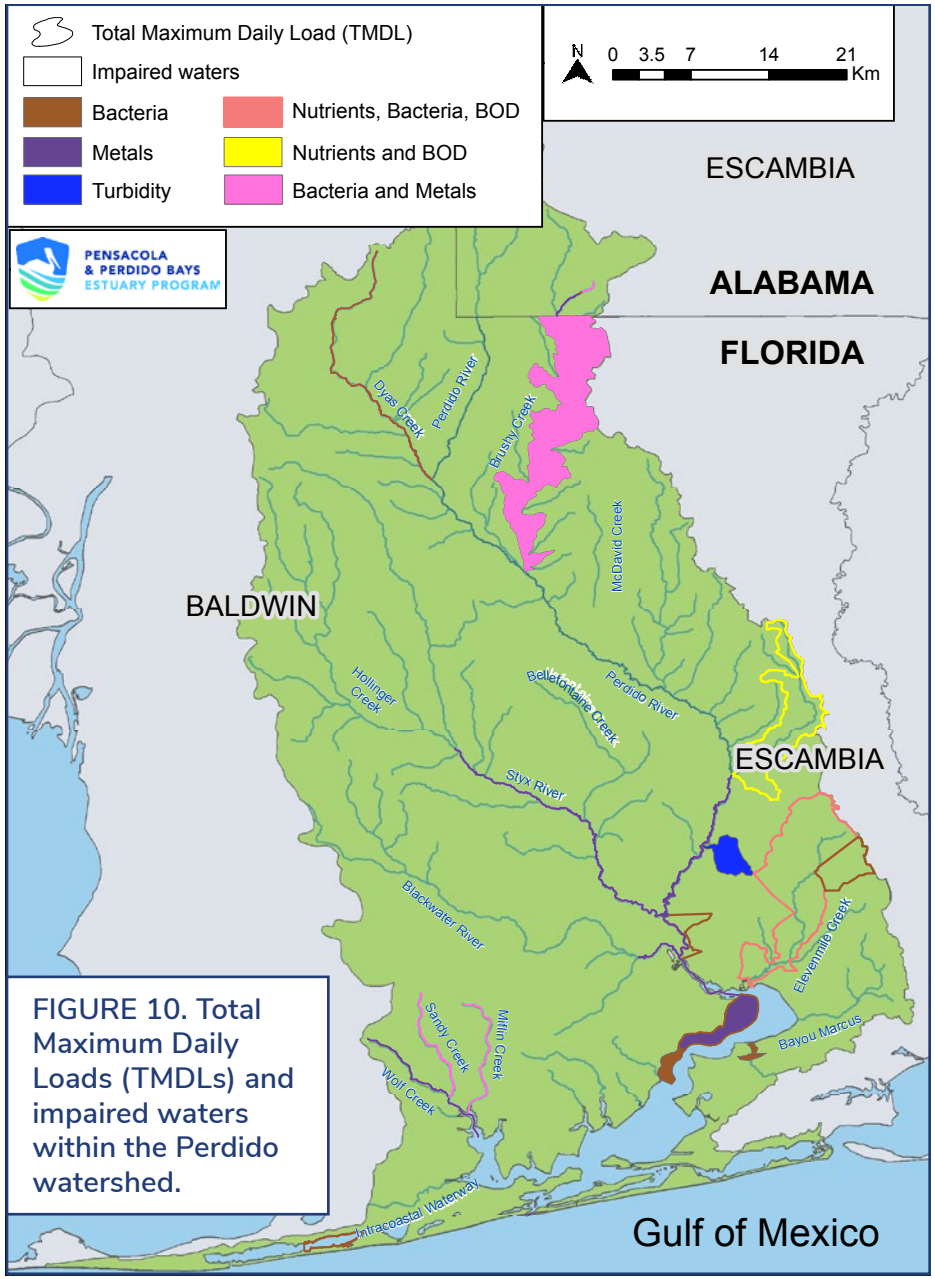


FIGURE 10. Total Maximum Daily Loads (TMDLs) and impaired waters within the Perdido watershed.

TMDLs were obtained from Florida Department of Environmental Protection (DEP) and U.S. Environmental Protection Agency approved TMDL lists (data downloaded July 2022). Impaired waters in Florida and Alabama were obtained from DEP 2022 data (downloaded July 2022) and Alabama Department of Environmental Protection (ADEM) 2020 data (downloaded in February 2022), respectively.

Impaired waters undergo a course of action based on sufficient data for which a Total Maximum Daily Load (TMDL) will be developed. TMDLs indicate the maximum amount of a pollutant that can be added to a waterbody while still attaining water quality standards. Waterbodies with TMDLs have specific requirements to reduce pollutant loading to improve the water quality. TMDLs established for state-listed waters and TMDLs established by the U.S. EPA are listed in Table 2. Impairments and TMDLs within the watersheds mainly consist of bacteria followed by metal and nutrient impairments. Twenty-eight TMDLs are established for bacteria, 8 for nutrients, 1 for dissolved oxygen, 4 for organic enrichment (biochemical oxygen demand) and two for siltation (Table 2). Some waterbodies have more than one established TMDL. For example, Bayou Chico has two TMDLs, one for bacteria and one for nutrients.

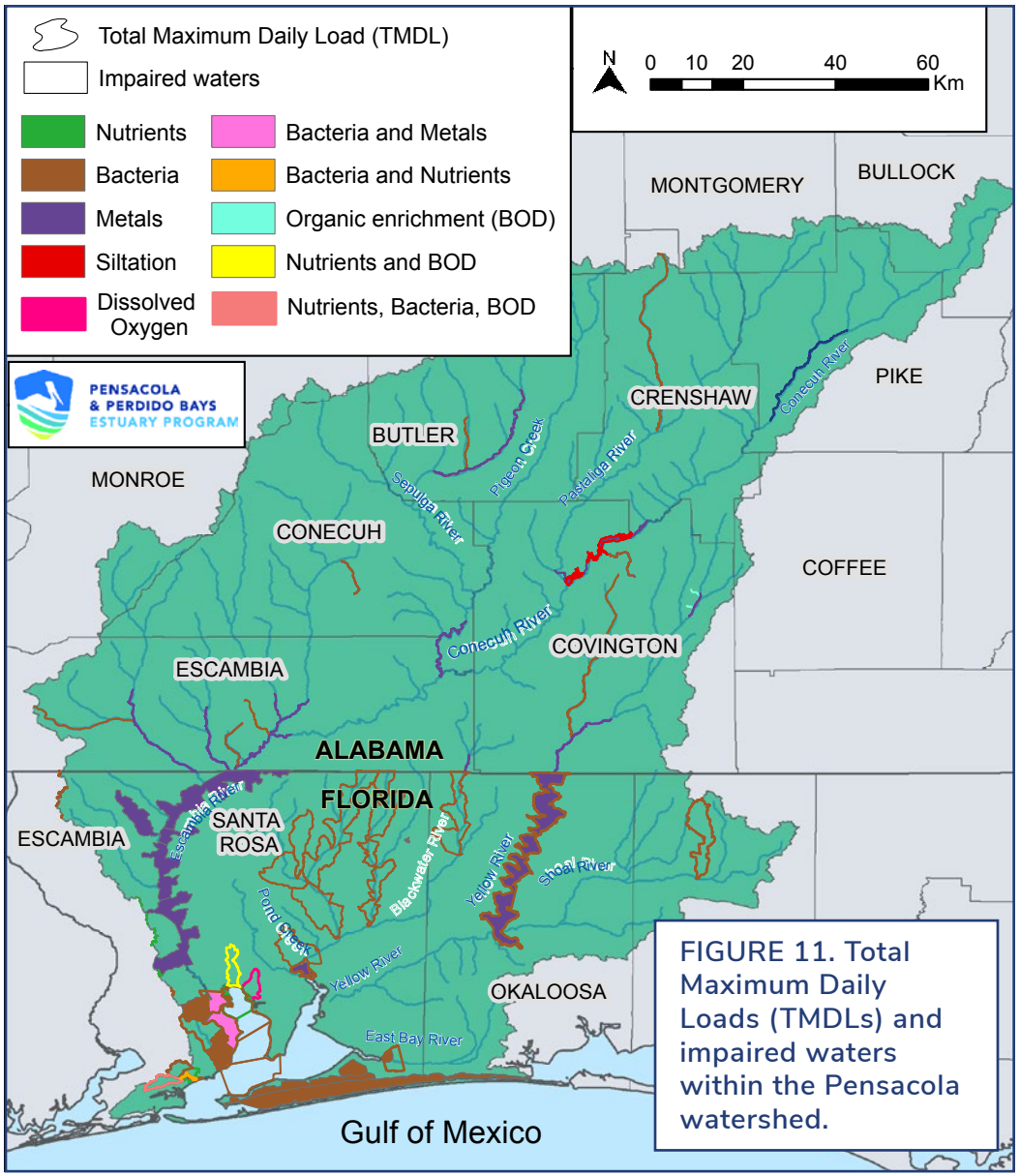


FIGURE 11. Total Maximum Daily Loads (TMDLs) and impaired waters within the Pensacola watershed.

TMDLs were obtained from Florida Department of Environmental Protection (DEP) and U.S. Environmental Protection Agency approved TMDL lists (data downloaded July 2022). Impaired waters in Florida and Alabama were obtained from DEP 2022 data (downloaded July 2022) and Alabama Department of Environmental Protection (ADEM) 2020 data (downloaded in February 2022), respectively.

TABLE 1. Impaired Waters

Impaired waters in the Pensacola and Perdido systems recognized by the Florida Department of Environmental Protection (DEP) (data accessed July 2022) and Alabama Department of Environmental Management (ADEM) (data accessed February 2022).

Metals without an asterisk are mercury, * indicates lead, ** indicates iron, * indicates lead and iron**

Location	Waterbody	Impairment	Water Body ID #
Bear Lake	**Bear Lake**	Nutrient N	179A
Blackwater River	**Blackwater River (Tidal)**	Metals** M	24AB
Blackwater River	**Blackwater River**	Metals M	AL03140104-0104-100
Blackwater River	**Blackwater River**	Metals M	AL03140106-0603-101
Bridge Creek (Tidal Portion)	**Bridge Creek (Tidal Portion)**	Bacteria B	872B
Brushy Creek	**Brushy Creek**	Bacteria and Metals** B M	4
Direct Runoff to Bay	**Direct Runoff to Bay**	Bacteria B	893
East Bay River	**East Bay River (Marine Portion)**	Bacteria B	701C
Escambia River	**Escambia River**	Metals** M	10A
Escambia River	**Escambia River**	Metals** M	10B
Escambia River	**Escambia River**	Metals*** M	10C
Escambia River	**Escambia River**	Metals** M	10D
Escambia River	**Escambia River**	Bacteria and Metals** B M	10F
Escambia River	**Conecuh River**	Metals M	AL03140301-0302-102
Escambia River	**Feagin Creek**	Bacteria B	AL03140301-0403-100
Escambia River	**Conecuh River (Gantt Lake)**	Metals M	AL03140301-0404-111
Escambia River	**Conecuh River**	Metals M	AL03140301-0404-112
Escambia River	**Conecuh River (Point A Lake)**	Metals M	AL03140301-0405-101
Escambia River	**Little Patsaliga Creek**	Bacteria B	AL03140302-0303-100
Escambia River	**Patsaliga Creek (Point A Lake)**	Metals M	AL03140302-0506-101
Escambia River	**Rocky Creek**	Bacteria B	AL03140303-0201-101
Escambia River	**Persimmon Creek**	Metals M	AL03140303-0204-102
Escambia River	**Sepulga River**	Metals M	AL03140303-0704-100

Location	Waterbody	Impairment	Water Body ID #
Escambia River	**Sandy Creek**	Bacteria B	AL03140304-0106-200
Escambia River	**Burnt Corn Creek**	Metals M	AL03140304-0305-101
Escambia River	**Murder Creek**	Metals M	AL03140304-0404-101
Escambia River	**Franklin Mill Creek**	Bacteria B	AL03140304-0404-200
Escambia River	**Conecuh River**	Metals M	AL03140304-0506-100
Escambia River	**Jernigan Mill Creek**	Bacteria B	AL03140304-0506-300
Escambia River	**Little Escambia Creek**	Metals M	AL03140304-0605-100
Escambia River	**Sizemore Creek**	Bacteria B	AL03140305-0102-100
Escambia River	**Big Escambia Creek**	Metals M	AL03140305-0302-100
Graveyard Branch	**Graveyard Branch**	Bacteria and Metals** B M	639
Mitchell Creek	**Mitchell Creek**	Metals** M	71
Perdido Bay	**Lillian Bridge**	Metals M	AL03140107-0103-100
Perdido Bay	**Suarez Point**	Bacteria B	AL03140107-0204-302
Perdido River	**Dyas Creek**	Bacteria B	AL03140106-0203-100
Perdido River	**Brushy Creek**	Metals* M	AL03140106-0302-101
Perdido River	**Boggy Branch**	Metals M	AL03140106-0302-201
Perdido River	**Boggy Branch**	Bacteria B	AL03140106-0302-202
Perdido River	**Boggy Branch**	Bacteria and Metals* B M	AL03140106-0302-203
Perdido River	**Perdido River**	Metals M	AL03140106-0703-100
Rest Area Run	**Rest Area Run**	Turbidity	542
Santa Rosa Sound	**Santa Rosa Sound**	Bacteria B	915
Styx River	**Styx River**	Metals M	AL03140106-0507-100
Texar Bayou	**Texar Bayou**	Bacteria B	738
Thompson Bayou	**Thompson Bayou**	Bacteria B	586
Tom King Creek	**Tom King Creek**	Bacteria B	833
Wolf Bay	**Wolf Creek**	Metals M	AL03140107-0201-100
Wolf Bay	**Sandy Creek**	Bacteria and Metals B M	AL03140107-0201-210
Wolf Bay	**Sandy Creek**	Bacteria and Metals B M	AL03140107-0201-220

Filtering Water Sample for Nutrients

PPBEP

Location	Waterbody	Impairment	Water Body ID #
Yellow River	**Yellow River**	Metals** (M)	30
Yellow River	**Lightwood Knot Creek (Lake Frank Jackson)**	Metals (M)	AL03140103-0102-102
Yellow River	**UT 3-C to Lightwood Knot Creek (Lake Frank Jackson)**	Organic enrichment (BOD) (O)	AL03140103-0102-700
Yellow River	**UT 2-S to Lightwood Knot Creek (Lake Frank Jackson)**	Organic enrichment (BOD) (O)	AL03140103-0102-800
Yellow River	**Five Runs Creek**	Bacteria (B)	AL03140103-0203-100
Yellow River	**Yellow River**	Metals (M)	AL03140103-0402-100

TABLE 2. Total Maximum Daily Loads

Total Maximum Daily Loads (TMDLs) in the Pensacola and Perdido systems adopted by the Florida Department of Environmental Protection (DEP) (data accessed July 2022) and Alabama Department of Environmental Management (ADEM) (data accessed February 2022), and the U.S. Environmental Protection Agency (EPA).

Location	Waterbody	TMDL	Water Body ID #
Blackwater River	**Big Coldwater Creek**	Bacteria (B)	18
Blackwater River	**Big Coldwater Creek (East Fork)**	Bacteria (B)	18A
Blackwater River	**Big Juniper Creek**	Bacteria (B)	19
Blackwater River	**Blackwater River**	Bacteria (B)	24A
Blackwater River	**Blackwater River**	Bacteria (B)	24D
Blackwater River	**Blackwater River (Tidal)**	Bacteria (B)	24AB
Blackwater River	**Manning Creek**	Bacteria (B)	127
Blackwater River	**West Fork**	Bacteria (B)	11A
Conecuh River	**Gantt Dam**	Siltation (S)	AL03140301-0404-111
Conecuh River	**Point A Dam**	Siltation (S)	AL03140301-0405-101
Escambia River	**Escambia River**	Bacteria (B)	10F
Pensacola Bay	**Bayou Chico**	Bacteria and Nutrients (B) (N)	846

Escambia County Water Quality Lab
Escambia County

Location	Waterbody	TMDL	Water Body ID #
Pensacola Bay	**Bayou Chico Beach**	Bacteria B	846CB
Pensacola Bay	**Bayou Chico Drain**	Nutrients N	846C
Pensacola Bay	**Bayou Texar**	Bacteria B	738
Pensacola Bay	**Carpenter Creek**	Bacteria B	676
Pensacola Bay	**East Bay River (Marine Portion)**	Bacteria B	701A
Pensacola Bay	**Escambia Bay (North Segment)**	Bacteria B	548A
Pensacola Bay	**Escambia Bay (North Segment)**	Nutrients N	548AA
Pensacola Bay	**Escambia Bay (South Segment)**	Bacteria B	548B
Pensacola Bay	**Jackson Creek**	Bacteria B	846B
Pensacola Bay	**Jones Creek**	Nutrients, Bacteria, Organic enrichment (BOD) N B O	846A
Pensacola Bay	**Judges Bayou**	Dissolved oxygen D	493A
Pensacola Bay	**Judges Bayou (Tidal Segment)**	Nutrients N	493B
Pensacola Bay	**Pace Mill Creek**	Nutrients and Organic enrichment (BOD) N	420
Pensacola Bay	**Pensacola Bay (North Segment)**	Bacteria B	548C
Pensacola Bay	**Sanders Beach**	Bacteria B	848DA
Perdido Bay	**East of Little Lagoon Pass**	Bacteria B	AL03140107-0205-102
Perdido Bay	**Elevenmile Creek**	Nutrients, Bacteria, Organic enrichment (BOD) N B O	489
Perdido Bay	**Lillian Bridge**	Bacteria B	AL03140107-0103-100
Perdido Bay	**Tenmile Creek**	Bacteria B	489A
Perdido River	**Brushy Creek**	Bacteria B	4
Perdido River	**Jacks Branch**	Nutrients and Organic enrichment (BOD) N O	291
Perdido River	**Perdido River (South Fresh)**	Bacteria B	462B
Yellow River	**Turkey Creek**	Bacteria B	117
Yellow River	**Yellow River**	Bacteria B	30

Tenmile Creek Water Sampling
Escambia County

Stormwater and Wastewater

Stormwater and wastewater are common issues in communities around the globe. As wastewater infrastructure continues to age and human population continues to grow, managing wastewater will continue to be a growing issue. Similar to other areas, the Pensacola and Perdido watersheds are also affected by stormwater runoff and wastewater discharge, which transport pollutants from the landscape into waterways. Stormwater is a nonpoint source (NPS) pollutant that collects landscape pollutants, nutrients, pathogens, and sediments from impervious surfaces, lawns, and construction sites during rain events and deposits those pollutants into waterways. Stormwater runoff is one of the primary sources of NPS pollution in the Pensacola and Perdido watersheds (NWFWMD SWIM 2017 a, b). Multiple entities are permitted for Municipal Separate Storm Sewer Systems (MS4), which are conveyance systems that convey stormwater to surface waters under the National Pollutant Discharge Elimination System (NPDES) Stormwater Program. Entities with MS4 permits within the Pensacola and Perdido watersheds:

- Escambia County, FL
- Santa Rosa County, FL
- Okaloosa County, FL
- Walton County, FL
- Baldwin County, AL (Loxley)
- City of Pensacola, FL
- City of Gulf Breeze, FL
- City of Fort Walton Beach, FL
- City of Milton, FL
- Town of Mary Esther, FL
- Town of Century, FL
- University of West Florida
- Pensacola Naval Air Station
- Hurlburt Field
- Eglin Air Force Base
- Lower Perdido Bay Cities (Orange Beach)
- Middle Perdido Bay (Lillian)

Direct wastewater inputs are point source pollutants discharged from wastewater treatment plants (WTP) (municipal and industrial), that discharge treated wastewater into the environment, releasing nutrients, pathogens, heavy metals, and emerging pollutants to surface waters. Many WTPs in the lower watersheds no longer directly discharge into surface waters, but rather effluents are distributed into a spray field system, are diverted to treatment wetlands, or are beneficially reused. WTPs that currently discharge directly into surface waters are in the process of converting and upgrading their technology and discharge method and location. For example, International Paper (IP) in Cantonment, FL used to discharge industrial effluent in Elevenmile Creek causing wide-spread water quality issues for Perdido Bay. In 2013, effluent from IP was diverted to a newly constructed wetland treatment pond, improving nutrient concentrations in Elevenmile Creek.

Stormwater Outfall
Escambia County

Another example is the relocation of the Main Street Wastewater Treatment Plant from downtown Pensacola to the Central Water Reclamation Facility in Cantonment, FL in 2011. This removed effluent inputs from lower Pensacola Bay, and now 100% of the wastewater is being reclaimed. Currently, the City of Milton is in the process of building a new WTP (North Santa Rosa Regional Water Reclamation Facility) that will increase plant capacity from 2.5 to 4.5 million gallons a day (MGD) to accommodate population growth. The current Milton WTP is operating close to max capacity, averaging 2.2 MGD, and during heavy rain events, untreated effluent can overflow into the Blackwater River. There are plans for the North Santa Rosa Regional Water Reclamation Facility to relocate the WTP to a new location, eliminating direct effluent discharge into Blackwater River and relocating the facility out of the floodplain.

Untreated wastewater can enter surface waters during storm events when precipitation overwhelms the system, when sewer lines are blocked due to grease build up or vandalism, when lift stations are offline, or when the WTP is operating at max capacity. All of these instances can lead to sanitary sewer overflows (SSOs), which discharge heavy loads of pollutants including nutrients and pathogens into runoff and surface waters. Additionally, the current sewer collection system is over 100 years old in downtown Pensacola and needs rehabilitation and/or retrofit to protect water quality. Lateral lines at private and commercial properties are under-inspected and can also be leaking untreated wastewater into ground and surface waters. Several local utilities, including the Emerald Coast Utilities Authority (ECUA), are currently seeking opportunities to educate homeowners about the importance of lateral line inspections. Maintenance, regular upgrades, and education can help reduce wastewater loads and improve the health of the bays.

Septic systems are commonly found in rural and unincorporated areas of the watersheds, and in older communities developed prior to the widespread availability of a centralized sewer collection system. Septic tanks that are placed in improper soil, unmaintained, and/or nonfunctioning can leach nutrients, bacteria, viruses, chemicals, and other water quality pollutants associated with raw wastewater into groundwater and the surrounding waterways. One solution is to encourage property owners to convert from septic to the cities' centralized sewer system. Centralized sewer systems are more efficient at removing nutrients, medicines, and other potentially harmful chemicals from wastewater and further treat wastewater than septic tanks prior to discharging the wastewater.

Development and Land Management

Coastal communities globally are experiencing pressures due to high population densities and suburbanization. Coastal and upland development can negatively change the landscape, lowering biological diversity, mobilizing sediment, reducing natural filtration capacity for stormwater, and decrease natural flood resilience. Development in the watersheds is primarily located in the coastal zone but is infringing into rural areas, converting primarily agriculture and rural residential zoned areas to medium and high density suburban single family residential zoning. Suburban sprawl leads to an increase in land use conversion, stormwater runoff, water quality decline, and car-dependent transportation. Compact, walkable development patterns, on the other hand, help preserve open space, forests, and agriculture lands and further advances in water quality improvement and community resilience.

Stakeholders have expressed concern over sedimentation in upper Pensacola Bay due to surrounding development and poorly implemented or non-existent construction best management practices. New residential developments are rapidly converting stream and wetland buffer areas across the watersheds, increasing sediment loading and furthering decline in water quality due to inadequate buffering requirements. Enhancing enforcement of existing land development code regulations in addition to coordinating policy recommendations and incentives across the watersheds have been identified by stakeholders as a critical need.

As population in the region continues to rise, properly managed landscapes will be necessary to restore and protect the natural resources. Properly managed systems allow for implementing best management practices, establishing buffer zones, and promoting trees and native species. Using smart development practices can help manage urban sprawl while protecting the land and water for future generations.

Climate Change Impacts

The changing climate is a major stressor across communities worldwide, but the Gulf of Mexico is experiencing these changes at accelerated rates (Williams 2013). Some of its associated stressors include relative sea-level rise, intensified and more frequent hurricanes and storm-events, and rising sea surface temperatures (Holland and Bruyere 2014). According to the 2022 sea-level rise projections, portions of Baldwin, Escambia, Santa Rosa, and Okaloosa Counties will experience 2 feet of sea-level rise by 2060 and up to 6 feet by 2100, according to NOAA's intermediate-high scenario (NOAA 2022). Due to increased frequency and intensity of storms and hurricanes causing heavy rainfall, communities are more often experiencing extreme flood events which are compounded by the effects of sea-level rise. More severe and frequent flooding events overwhelm wastewater infrastructure, which is in need of retrofit and rehabilitation, threatens residential and commercial infrastructure and lives, and increases pollutant runoff into local waterways. In response to increased expenses associated with rebuilding infrastructure after flood events, many coastal areas (e.g., Escambia County and the City of Pensacola) have incorporated resiliency planning and nature-based solutions into their Stormwater Master Plans and Basin Management Plans (i.e., Bayou Chico BMAP) to reduce flooding and nonpoint source pollution.

Undergrounded creeks also have the ability to exacerbate flooding in coastal areas. As seas continue to rise and/or storm surge pushes farther inland, undergrounded creeks, such as those in downtown Pensacola (Washerwomen and Cadets Creeks), become overwhelmed and worsen flooding conditions. Resiliency and development planning need to consider undergrounded creeks to help mitigate or control flooding issues in downtown Pensacola as the climate continues to change.

As seas continue to rise, saltwater intrusion via surface or groundwater flows into freshwater reaches, i.e., upper estuaries, freshwater marshes, swamps and river systems, will alter the biogeochemistry of the system and change species and habitat distributions (Herbert et al. 2015). For example, salt marsh migration and encroachment inland occurs as sea-level rises and saltwater penetrates farther inland (Fagherazzi et al. 2020), degrading wetlands, altering ecosystem processes, and influencing the ecosystem services that these habitats provide. As estuaries start to change their salinity structure, oysters and other salinity-dependent habitats and species will need to migrate to stay within their preferred salinity ranges. The effects of climate change and salinity alterations needs to be included in restoration planning (Hynes et al. 2022), particularly for oysters that require certain salinities to thrive within. Furthermore, saltwater intrusion can lead to the salinization of groundwater, threatening local drinking water sources. The effects of saltwater intrusion are complicated and widespread challenges that need to be at the forefront of community planning.

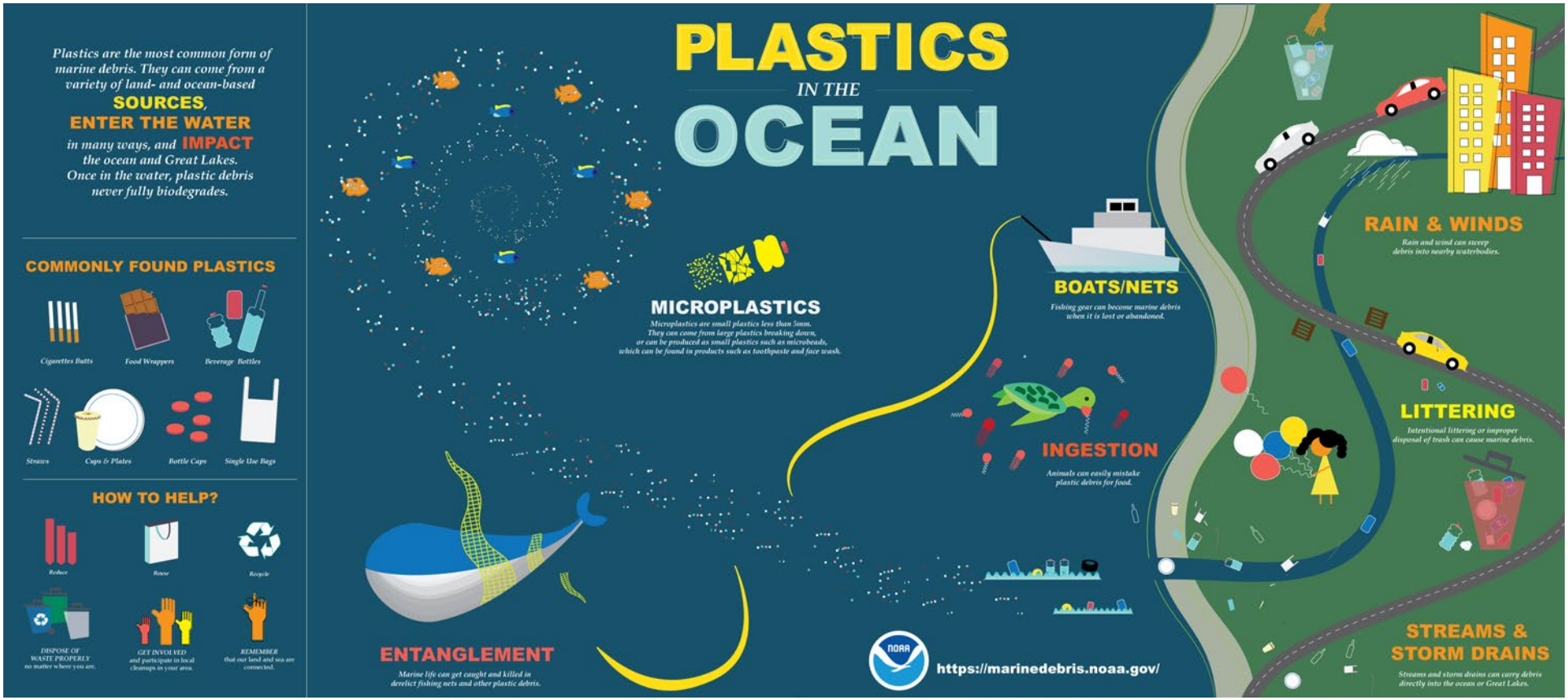
Hurricane Sally Flooding in Downtown Pensacola

PPBEP

Marine Debris and Litter

Globally, there has been increased awareness and concern for the negative impacts of marine debris and litter on the economy, environment, and wildlife. Throughout the Gulf of Mexico (GoM), litter from land-based sources (e.g., littering, stormwater discharge, densely populated areas), makes its way across the landscape into waterways causing water quality declines, wildlife entanglement, and boating hazards. Debris can also come from ocean-based sources such as fishing vessels, offshore natural gas and oil rigs, and cargo ships. Marine debris is defined as "any persistent solid material

that is manufactured or processed and directly or indirectly, intentionally, or unintentionally, disposed of or abandoned into the marine environment" (NOAA Marine Debris Program [MDP] 2022). Nearly 80% of the debris in the Gulf is made up of plastics, with 50% being single use plastics (e.g., straws, food containers, soda and water bottles) (NOAA MDP 2022). In addition to plastics, larger items including abandoned and derelict vessels and fishing gear can obstruct navigational channels and harm the environment by leaking fuel, oil, and other harmful chemicals into surrounding waters. More recent concerns are focused on the chemicals within plastics, such as phthalates, that are suspected to be endocrine disrupters affecting reproduction in marine organisms, especially filter feeders (e.g., oysters) (Godswill and Godspel 2019). Plastics also absorb pollutants, such as polycyclic aromatic hydrocarbons (PAHs), a by-product from burning fossil fuels, which can reach concentrations up to a million times greater than the levels found in marine waters. Additionally, plastics never biodegrade or leave the environment unless physically removed. The larger plastics weather and break down into smaller pieces called microplastics, small pieces of plastic or fibers that are smaller than 5 mm. Microplastics have been found in the air, drinking water, food products, and cosmetics (Katyal et al. 2020, McGuire et al. 2020). Due to the prevalence of plastics and debris in both marine and terrestrial



Plastics in the ocean: sources and impacts
NOAA Office of Response and Restoration Marine Debris Program

environments, increased encounters with various wildlife species have caused negative impacts on their health and condition around the world.

To monitor and track the abundance and diversity of litter in marine environments, partners across the Gulf have established programs and conducted large-scale projects to better understand the impacts on coastal ecosystems. The Florida Microplastic Awareness Project (FMAP, est. 2015) is a state-wide community science effort led by the University of Florida Institute of Food and Agriculture Sciences (UF-IFAS) Florida Sea Grant Extension, investigating the prevalence and concentrations of microplastics in coastal waters (https://flseagrant.ifas.ufl.edu/microplastics/). To monitor and track the extent of primary microplastics (i.e., nurdles or plastic pellets), the Mission-Aransas National Estuarine Research Reserve runs a community science initiative called Nurdle Patrol. Locally, PPBEP is collaborating with partners and local community science programs to conduct nurdle surveys across the Perdido and Pensacola coastlines. Throughout the Pensacola and Perdido Bay watersheds, a vast and active network of non-profit and for-profit organizations are focused on cleaning up trash and educating communities on the negative impacts of water-borne trash and marine debris on our estuaries. Some of those groups include Ocean Hour, Keep Pensacola Beautiful, Emerald Coast Keeper, Clean Horizons, and Osprey Initiative.

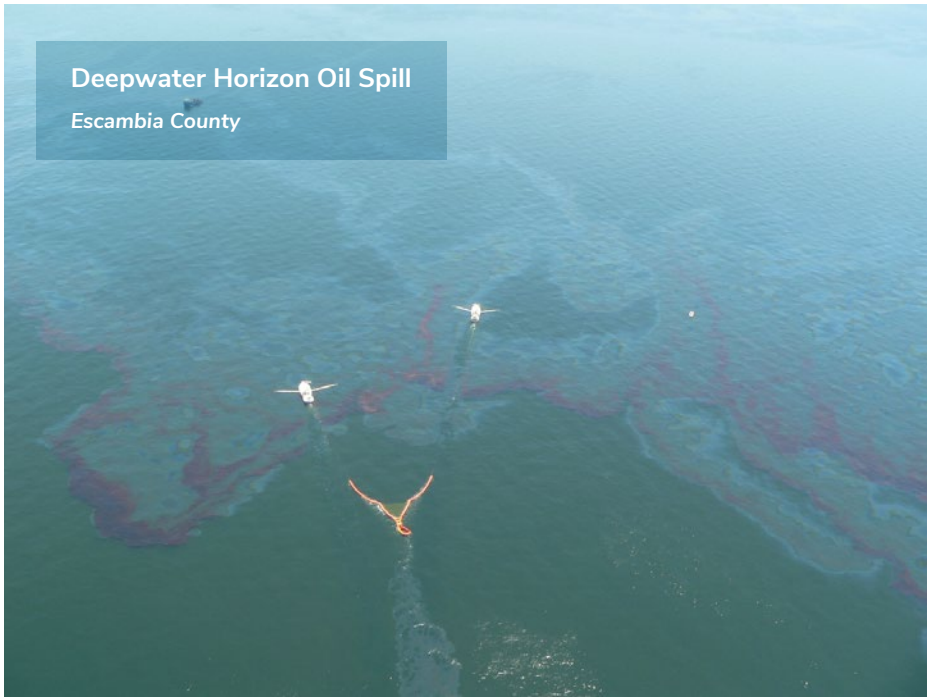
To address the threats of debris in coastal environments, municipalities and agencies have enacted policies, programs, and initiatives to reduce the impacts of litter on local wildlife. The “Leave No Trace” and “Leave Only Footprints” ordinances implemented by many Gulf counties prohibit obstructions or personal property from being abandoned or unattended on GoM beaches that could present obstacles to endangered and threatened wildlife (e.g., sea turtles and shorebirds). In addition, local initiatives and campaigns have been implemented throughout coastal Alabama and Florida to raise awareness and educate the public on the hazards of litter in the environment (e.g., Clean Water Futures Campaign). On a National scale, the EPA created the Trash Free Waters Program (est. 2013) to reduce the volume of trash entering waterways by working with local partners across the U.S. to implement collaborative solutions that target land-based sources. In 2006, Congress authorized the NOAA Marine Debris Program (MDP) as the U.S. Federal government’s lead for addressing the issue of marine debris. The MDP works with educators, researchers, practitioners, industry representatives, federal and state governments, and non-governmental organizations to raise awareness for this issue and develop effective solutions for marine debris removal and prevention. Regionally, the Gulf of Mexico Alliance’s (GOMA) Marine Debris Cross Team works collaboratively with NOAA’s MDP to develop and implement a Regional Action Plan to address marine debris in the GoM. PPBEP serves as a member on the Cross Team and will continue to work collaboratively with community partners across the watersheds to implement actions from the CCMP.

Pond Creek Cleanup

PPBEP

Restoring What Was Lost

Despite the many challenges communities have faced over the years and the environmental issues that impact the health of our watersheds, policy changes and small- and large-scale restoration efforts have been effective at improving our ecosystems. The Federal Pollution Act of 1948 was the first major U.S. law to address water pollution which in turn increased public awareness and concern and led to additional amendments in 1972 and the law became known as the Clean Water Act (CWA). This established a structure for regulating discharges into waterways across the United States and allowed the Environmental Protection Agency (EPA) to implement pollution control programs including setting standards for industrial wastewater. These amendments also maintained existing water quality requirements for contaminants, funded construction of sewage treatment plants, and recognized the need to address critical problems caused by nonpoint source pollution.



Deepwater Horizon Oil Spill

Escambia County

Updated regulations played a critical role in addressing some of the root causes of widespread environmental issues in riverine and estuarine environments. The amount of funding available to make necessary improvements and implement large-scale restoration projects was a barrier for many organizations. A key event that greatly impacted the future of Gulf of Mexico (GoM) restoration was in April 2010 when the Deepwater Horizon (DWH) oil rig exploded, causing 4 million barrels of oil to spill into the GoM over 87 days, before it was capped on July 15. It was the largest spill in the history of marine oil drilling operations. Legal settlements from the DWH Oil Spill resulted in $16.7 billion for economic and environmental restoration efforts to be used across the GoM. This Resources and Ecosystem Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast (RESTORE) Act funding changed the capacity that organizations along the Gulf Coast had for implementing restoration projects.

Pensacola and Perdido's Legacy

Like other coastal systems worldwide, the Pensacola and Perdido systems have been heavily influenced by anthropogenic (human induced) activities. These areas built their economies on logging (1800s-1930s), commercial fishing (snapper, oysters, shrimp), and industry (1900s-present). Logging heavily impacted the upper watershed when 99% of the longleaf pines were removed to build railroads, furniture, and export timber world-wide (Frost 1993). The logging industry clear-cut the watershed leading to large-scale sedimentation of creeks, rivers, and the bays. The effects of sedimentation contributed to declines of the natural resources, including oysters and seagrass beds. Humans overfished snappers (1880s), oysters (1980s), and lead to decline of other invertebrate and fish species in the rivers and bays. Industry moved into the area and contributed to water quality declines by discharging unregulated industrial effluent into the waterways. Conversion of wetlands in 1880s for mosquito ditching and to make land available for development led to loss of natural flood protection, filtration capacity, and other ecosystem services that these habitats provide. These combined long-term stressors lead to water quality declines, degrading the natural state of

these systems (Florida State Board of Health 1969). Large-scale fish kills and oyster die-offs started in the late 1960s and early 1970s (Livingston et al. 1972, Olinger et al. 1975). These die-offs were attributed to unregulated industrial pollution from Escambia River and Bayou Chico. Stormwater and urban runoff into Bayou Texar were reported to cause extensive fish kills in the 1970s (Moshiri et al. 1972). Perdido Bay was also affected by water quality declines around this time. By the late 1980s, International Paper was cited as the cause of a clam die-off in upper Perdido Bay (Livingston 1989).

The very public decline in water quality (i.e., fish washing ashore dead) stemmed the formation of local community science organizations that spearheaded the restoration of Pensacola and Perdido Bays. This also brought national and federal attention to Pensacola Bay, resulting in the Federal Water Pollution Control Administration funding studies of the system in the 1970s. The Bream Fisherman Association and the Perdido Bay Environmental Association (now Friends of Perdido Bay) started advocating for the health of the bays and estuaries by encouraging management decisions be made in sound science. To provide that sound science, BFA started a long-term monitoring program that has been tracking water quality since the 1970s. These past and current efforts are invaluable to assessing the improvement of the systems as PPBEP and others continues to act as stewards of the bays. The PPBEP was formed from the Bay Area Resource Council, an organization that worked on the bay's issues for ~20 years before RESTORE funding established the Estuary Program. As funds are used from the DWH Oil Spill to restore Pensacola and Perdido Bays, it needs to be acknowledged that PPBEP and partners are building on the hard work of others, and by working together we can protect, restore, and improve these systems for future generations.

Water Quality Restoration

Humans depend on clean waters for a healthy and thriving environment and economy. Clean waters are also necessary for abundant fish and wildlife populations, which humans depend on for their natural resources. While water quality is not as poor as it was in the 1970s due to community science, local, and national action, there are many improvements that are still needed. Stormwater and urban runoff and leaching of excess nutrients and sediments into the waterways will continue to be a challenge in these systems as precipitation becomes more frequent and intense, as the landscapes continues to house more development and people, and as the wastewater infrastructure continues to age. Point source pollution from industry and wastewater treatment plants continue to discharge treated effluent into the waters, adding to nutrient over enrichment and bacterial contamination. Development pressures in the coastal watershed will continue to input sediment, nutrients, and other pollutants into our bays and estuaries. Thus, supporting and implementing restoration activities that mitigate or decrease pollutant entry is needed to bring back healthy waters and ecosystems.

Beach Haven Stormwater Improvements
Escambia County

Restoring buffers and implementing restoration projects that improve water quality (e.g., oyster restoration) is a necessary action to restore and protect water quality of the bays and the organisms that depend on them. Since RESTORE funding has become available, 10 projects have leveraged RESTORE funds according to the Deepwater Horizon Project Tracker. Projects range from sediment reduction activities such as paving unpaved roads to wastewater improvements and general habitat restoration to improve downstream water quality. As more funds become available and dedicated partners across the watersheds continue to leverage funds for water quality improvements, the systems should continue to see positive improvements supporting healthy and vibrant economies and ecosystems.

RESTORE Funded Projects

- Pensacola Bay and Perdido River Watersheds – Nutrient Reduction (USDA)
- Gulf Coast Conservation Reserve Program (GCCRP) (Planning and Implementation) –(USDA)
- Dirt Road Paving District 1, 4, 5 (Santa Rosa County)
- Carpenter Creek Headwaters Water Quality Improvements (DEP)
- Government Street Regional Stormwater Pond at Corrine Park Jones (City of Pensacola)
- Bayou Chico Restoration (Escambia County)
- Beach Haven – Joint Stormwater and Wastewater Improvement Project – Phase II (Implementation) (DEP)
- Pensacola Bay Unpaved Roads Initiative (DEP)
- Rattlesnake Bluff Road and Riverbank Restoration (FWS)

Habitat Restoration and Conservation

Habitats within the Pensacola and Perdido watersheds have been degraded as humans have converted the landscapes to support the growing population, which in-turn has also affected aquatic habitats. Wetlands have been converted, fragmented, and destroyed since the mid-1800s when disease was prevalent and there was a need to clear land for development. Currently, wetlands and riparian buffers are at risk from erosion, saltwater intrusion, and fragmentation. Fragmentation is also a concern for upland terrestrial forested habitats that provide a home for many species, including threatened and endangered species. Landscape fragmentation can impede migration and movements of animals that depend on uninterrupted landscape for their survival. Additionally, loss of upland habitats can lead to sedimentation of river and estuarine environments, negatively effecting benthic habitats.

Acquiring land for land acquisition into conservation lands is imperative to ensure wildlife corridors will be available to species as humans continue to convert the landscape. The Northwest Florida Sentinel Landscape was established in 2022, providing a significant commitment towards preserving lands for wildlife. The Sentinel Landscape protects portions of longleaf pine forests, rural, and agriculture areas to be restored, protected, and made resilient by the military bases that the Landscape runs through. Large tracts of land in Perdido, Blackwater, and Yellow Rivers are also in conservation lands. RESTORE funds have been used to purchase multiple tracts of lands to put into conservation. PPBEP and partners will continue to look for more land to buy into conversation to protect the landscape for future generations and wildlife.

Upper Perdido Bay
Darryl Boudreau, NWFWMD

Longleaf pine restoration is needed to ensure a healthy and productive upper watershed. Since the decimation of longleaf pines, the importance of these ecosystems to the health of the watershed and bays has come to light. For example, the effect that clearcutting had on the sedimentation of benthic habitats and the reliance of these systems by multiple threatened and endangered species is now well known. Northwest Florida has some of the best managed longleaf pine ecosystems in the United States thanks to the hard work and dedication of the Longleaf Alliance and the Gulf Coastal Plain Ecosystem Partnership (GCPEP). Acquiring more longleaf pine uplands and continuing to fund staff for rotating prescribed fire efforts is needed to ensure healthy recovery of this ecosystem.

Living shorelines are natural alternatives to bulkheaded shorelines and can help stabilize the shore, provide habitat for organisms, create aesthetically pleasing scenery, and increase the value of shoreline property. These shorelines are made by using plants in combination with harder structures to stabilize the shore. Plants are typically placed most shoreward with the harder structures more seaward. This mimics the natural shoreline creating a stabilizing and wave attenuating effect that can better protect shorelines. Many living shorelines have been implemented and/or planned for Perdido and Pensacola Bay. Project Greenshores Phase I was a successful restoration project implemented in the early 2000s to restore salt marshes, seagrasses, and oysters along the shoreline of downtown Pensacola. Project Greenshores Phase II was constructed just west of Phase I in Spring 2022. Other completed living shorelines are Escambia County's Navy Point Living Shoreline, City of Gulf Breeze's Deadman's Island, and DEP's East Bay Project Reefs. A living shoreline habitat suitability model is being completed for Pensacola and Perdido Bays by Troy University to find sites most suitable to construct living shorelines.

Other living shorelines in progress of construction

- Escambia County's Pensacola Bay Living Shoreline
- Santa Rosa County's Floridatown Park Living Shoreline
- Santa Rosa County' Navarre Park Living Shoreline
- The Nature Conservancy's East Bay Oyster Habitat Restoration

Seagrasses are habitats that many fish and invertebrate species rely on for their nursery habitat. Historical declines in seagrass beds were attributed to poor water quality and sedimentation leading to shading and disease, and boat prop scarring. In recent years there has been gains in seagrass beds attributed in part to improved water quality (Handley et al. 2020). PPBEP and partners received a NOAA Actionable Science Grant to address the inclusion of seagrass genetics into restoration planning. This effort will make restored seagrasses more resilience to local environmental conditions, hopefully improving the success of future seagrass restoration.

Overall, there have been tremendous efforts across the watershed to restore and conserve habitats to improve the ecosystems. Many RESTORE projects have been funded under the categories of land acquisition and habitat

Bayou Grande
PPBEP

restoration. More work will continue to be needed to conserve habitats to support healthy environments.

RESTORE Funded Projects

- Perdido River Land Conservation and Habitat Enhancements (ADCNR)
- Perdido River Land Acquisition (Molpus Tract) (ADCNR)
- Perdido Bay/Pass Islands Acquisition – Restoration (City of Orange Beach)
- Restoration and Management of Escribano Point Coastal Habitat – Phase II (The Trust for Public Land)
- East Bay Oyster Habitat Restoration (TNC)
- Oyster Restoration in the Pensacola Bay System (Ecosystem Restoration Support Organization)
- Planning Assistance for the Elevenmile Creek Stream Restoration Design (Escambia County)
- Bayou Chico Restoration (Escambia County)
- Lower Perdido Islands Restoration (TNC)
- Wolf Creek Headwaters Restoration – Phase I (City of Foley)
- Lillian Park Beach Habitat and Shoreline Protection (Baldwin County and ADCNR)
- Yellow River Aquatic Preserve Shoreline Restoration (Earth Ethics, Inc)
- Johnson Beach Access Management and Habitat Protection (NPS)
- Little Lagoon Living Shoreline (FWS)
- Seagrass Recovery Project at Gulf Islands National Seashore (FWS)
- Perdido Key Dune Restoration Project (DEP)
- Beach and Dune Habitat Protection at Gulf Islands National Seashore (NPS)
- Pensacola Beach Dune Restoration Project (DEP)
- Navarre Beach Park Coastal Access and Dune Restoration (DEP)
- Panhandle Dune Restoration (FWC, FWS)
- Alabama Dune Restoration Cooperative Project (FWS)

Living Coastal and Marine Resources

Coastal and marine resources provide an array of ecosystem services that have been lost or suppressed as these resources have been degraded due to overfishing, habitat loss, and pollution. Furthermore, the loss of commercial fisheries in recent years has impacted the economic benefits that healthy fisheries could provide. The snapper and oyster industries are examples of poorly managed fisheries that collapsed due to overextraction and human pressures. The oyster fishery collapsed in Pensacola Bay after the Deepwater Horizon Oil Spill but had been declining since the 1980s. There are efforts underway to bring a healthy and thriving oyster industry (wild and aquaculture harvest) back to Pensacola Bay.

The Nature Conservancy spearheaded the first ever oyster management plan that will tackle an estuary-scale restoration of oysters. By undergoing a bay-wide restoration plan, recovery of oysters will hopefully bring back multiple ecosystem services and provide cumulative benefits such as water quality improvements, fisheries enhancement, and shoreline stabilization. The PPBEP is tasked with implementing the plan and ensuring that multiple restoration projects are implemented simultaneously to cover the necessary area to bring back oysters to harvestable levels. The Oyster Fisheries and Habitat Management Plan for the Pensacola Bay System (Birch et al. 2021) is also focused on bringing a thriving aquaculture industry to the region. This ecosystem-based approach aims to bring back oysters to support oyster harvest and increase fisheries production to promote recreational fishing opportunities.

RESTORE Funded Projects

- East Bay Oyster Habitat Restoration (TNC)
- Oyster Restoration in the Pensacola Bay System (Ecosystem Restoration Support Organization)

Improving the Vital Signs of the Estuaries

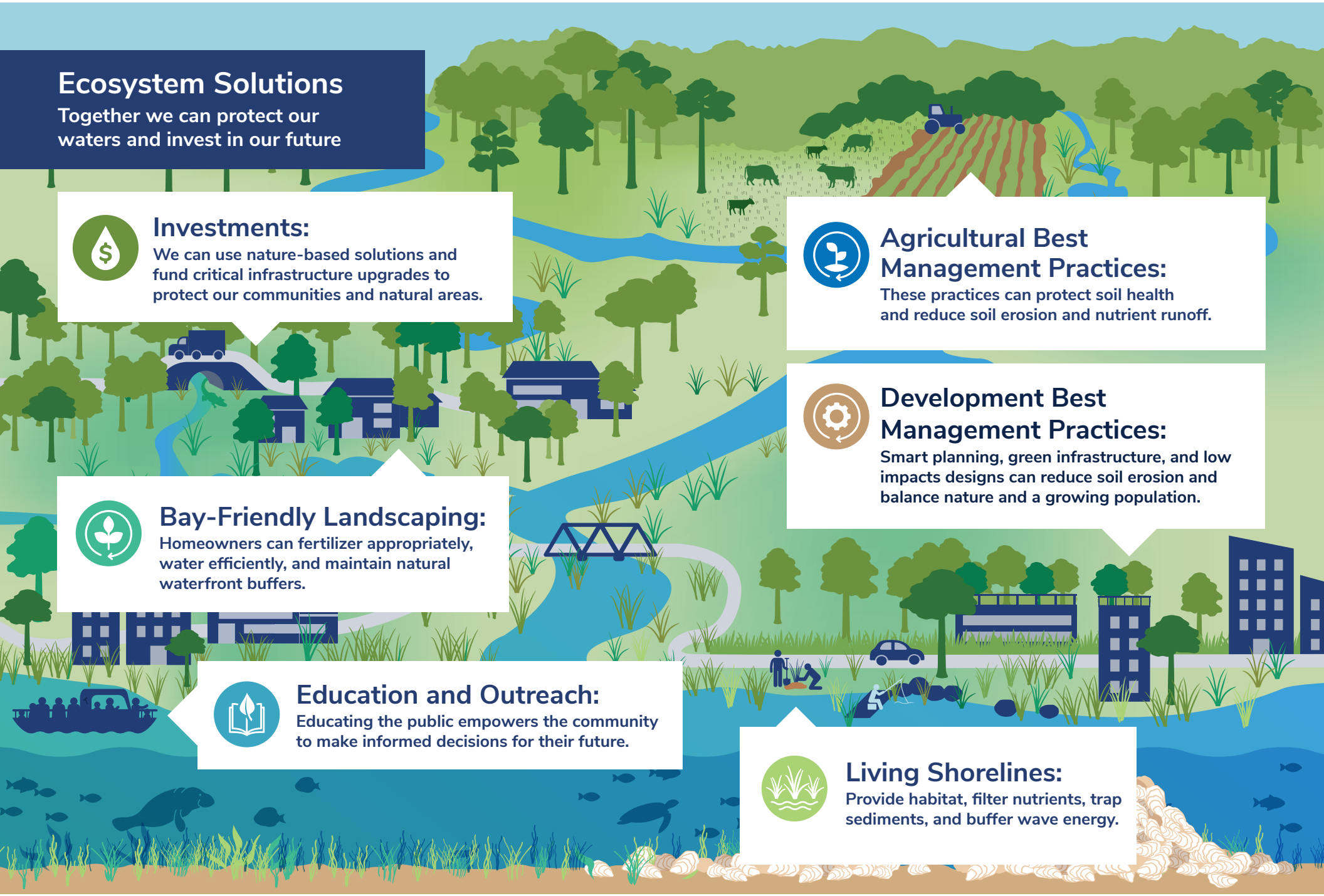
Since the inception of the Clean Water Act and local communities spurring into action to improve the natural resources and water quality, ecosystems throughout the United States have seen improvements. Now in the Gulf of Mexico with the availability of Deepwater Horizon funds and the available funding to support large-scale and multiple restoration projects, more organizations and projects are working to protect and enhance systems than ever before. While there have been many restoration efforts within the Pensacola and Perdido watersheds, projects are place-based and rarely cross state boundaries. With the development of a dedicated Estuary Program, the PPBEP strives to work across state boundaries taking a watershed approach to support collaborative efforts to restore our systems for healthy ecosystems and economies for generations to come. Our Action Plan provides the blueprint for current and future restoration projects to be undertaken within the next 10 years.

Project Greenshores Site 2 in Pensacola Bay

Samantha Richardson

Ecosystem Solutions

Together we can protect our waters and invest in our future



Investments:

We can use nature-based solutions and fund critical infrastructure upgrades to protect our communities and natural areas.

Agricultural Best Management Practices:

These practices can protect soil health and reduce soil erosion and nutrient runoff.

Development Best Management Practices:

Smart planning, green infrastructure, and low impacts designs can reduce soil erosion and balance nature and a growing population.

Bay-Friendly Landscaping:

Homeowners can fertilizer appropriately, water efficiently, and maintain natural waterfront buffers.

Education and Outreach:

Educating the public empowers the community to make informed decisions for their future.

Living Shorelines:

Provide habitat, filter nutrients, trap sediments, and buffer wave energy.

Action Plan

As a result of the technical characterization of the watersheds and stakeholder engagement process, the PPBEP developed the following action plan focused on six goal areas that address priority issues identified across the Pensacola and Perdido Bay Systems that are based on both the community's values and uses of the watersheds and the best available science.

These recommended actions will assist the Program and its partners in identifying achievable targets for the restoration and long-term protection of the watersheds while maintaining a critical balance between human use and the health and resiliency of native ecosystems.

Perdido River
Darryl Boudreau, NWFWMD

GOAL 1

Source of Watershed Related Information

GOAL 2

Strengthen Community Resilience

GOAL 3

Improve Water Quality

GOAL 4

Reduce Sedimentation

GOAL 5

Conserve and Restore Critical Habitat

GOAL 6

Restore and Conserve Fish and Wildlife

Darryl Boudreau, NWFWMD

Action Plan Summary

GOAL 1

Source of Watershed Related Information

Objective 1.1

Become the central repository for watershed data and visualization

ACTION 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

ACTION 1.1.2

Create an open science digital dashboard for tools, data, and status and trend reporting that are transparent and accessible

ACTION 1.1.3

Create an accessible list of current and relevant programs, projects, and grant opportunities within our watersheds

Objective 1.2

Be a trusted and reliable source for relaying pertinent watershed related environmental issues to the community

ACTION 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

ACTION 1.2.2

Strengthen media relations and feature PPBEP program activities through local and regional media outlets

ACTION 1.2.3

Participate and contribute to regional working groups and data sharing communities of practice

Objective 1.3

Provide regular reports of ongoing monitoring and restoration efforts and results to the public

ACTION 1.3.1

Develop State of the Bays Report

Community Grant Symposium

PPBEP

ACTION 1.3.2

Provide Community Grant Program updates via social media platforms and annual symposium

ACTION 1.3.3

Host watershed science and outreach symposium

ACTION 1.3.4

Use social media and other digital platforms to update the public on current watershed information

Green Roof on Escambia County Central Office Complex
Escambia County

GOAL 2

Strengthen Community Resilience

Objective 2.1

Inform community planning and development decisions

ACTION 2.1.1

Promote the use of smart growth and best land management practices to maximize the health and resilience of our communities to natural disasters

Objective 2.2

Facilitate wastewater management improvements throughout the watersheds

ACTION 2.2.1

Extend central sewer service to priority areas near surface waters and retrofit existing failing wastewater infrastructure

ACTION 2.2.2

Educate and incentivize the community on the importance of sewer and septic system maintenance and sewer connections

Objective 2.3

Promote the use of green infrastructure or other low-impact designs into community planning

ACTION 2.3.1

Enhance stormwater management by expanding the use of Green Infrastructure practices

ACTION 2.3.2

Promote and facilitate the development of living shorelines as a sustainable alternative to shoreline armoring to reduce erosion and sediment inputs

Objective 2.4

Identify areas within the watersheds that are at risk for current and future compound flooding and identify solutions to lessen impacts

ACTION 2.4.1

Identify high-risk areas using compound flood models to educate communities, aid in community planning, and improve FEMA Community Rating System (CRS) scores

ACTION 2.4.2

Better understand hydrodynamic fluctuations and patterns in the Pensacola and Perdido Bays to inform restoration and ecosystem-scale improvements

ACTION 2.4.3

Participate in EPA's Climate Ready Estuaries Program; NOAA's Climate Smart Communities Program

Objective 2.5

Implement storm drain marking throughout the watersheds to raise awareness of stormwater runoff to our waterways

ACTION 2.5.1

Partner with local schools and other partner organizations to complete storm drain marking

Objective 2.6

Assess social vulnerability of communities under a changing climate

ACTION 2.6.1

Assess social vulnerability of communities from impacts associated with climate change and support communities in long-term resiliency planning

ACTION 2.6.2

Produce an environmental justice needs assessment for the watersheds and incorporate recommendations into future community planning, project development, and education and outreach initiatives

ACTION 2.6.3

Produce a social vulnerability index and map social vulnerability across the Pensacola and Perdido Bay Systems.

2014 Flooding on Piedmont Street, Pensacola

Carrie Stevenson

Perdido Bay
Darryl Boudreau, NWFWMD

GOAL 3

Improve Water Quality

Objective 3.1

Develop a comprehensive water quality watershed monitoring program throughout the Pensacola and Perdido Bay watersheds

ACTION 3.1.1

Implement the Comprehensive Monitoring Strategy by establishing a comprehensive watershed monitoring program that encompasses both watersheds across state lines

ACTION 3.1.2

Develop water quality targets for Pensacola and Perdido Bays to meet surface water classification designations

Objective 3.2

Identify sources, root causes, and transport of priority water quality pollutants in the watersheds

ACTION 3.2.1

Investigate sources of microbial pollutants in the watersheds

ACTION 3.2.2

Evaluate and identify point and nonpoint source hotspots for nutrients in the watersheds

Objective 3.3

Assess water quality seasonal trends to understand impacts to natural resources, including habitats and fish and wildlife

ACTION 3.3.1

Evaluate seasonal trends of nutrients, chlorophyll-a, DO, and HABs and their impacts to habitats and fish and wildlife

GOAL 4

Reduce Sedimentation

Objective 4.1

Develop a comprehensive watershed monitoring program throughout the Pensacola and Perdido Bay watersheds to assess sediment inputs

ACTION 4.1.1

Develop a comprehensive sediment monitoring program that encompasses both watersheds across state lines

Objective 4.2

Conduct a sediment study to assess sources of sediments and erosion in the watersheds

ACTION 4.2.1

Identify the impact of land use land cover (LULC) on the rate of soil erosion and sediment loading

ACTION 4.2.2

Identify major sediment sources within the watersheds

ACTION 4.2.3

Collaborate with partners to prioritize, develop, design, and implement sedimentation reduction and remediation projects

Objective 4.3

Address unpaved roads as a source of sedimentation

ACTION 4.3.1

Identify unpaved roads and their contributions to water quality impairments, and prioritize for paving or removal efforts

Objective 4.4

Assess the effects of sediment dynamics and resuspension on benthic habitats

ACTION 4.4.1

Conduct benthic sediment mapping and synthesize existing data to assess sediment type/ grain size, transport, and contours

Big Lagoon State Park
PPBEP

Marsh Periwinkle Snail
PPBEP

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

ACTION 5.1.1

Form and convene a sub-committee to assist in implementing the Oyster Fisheries and Habitat Management Plan for the Pensacola Bay system

ACTION 5.1.2

Create a comprehensive restoration approach for Oyster Plan implementation including a comprehensive analysis for future grant funding and implementation strategies

ACTION 5.1.3

Conduct long-term monitoring to assess oyster condition and spat production and assess the effects of oysters to long-term environmental change

ACTION 5.1.4

Host and support oyster restoration projects in the Pensacola Bay system to improve native oyster populations

Objective 5.2

Assess seagrass health and distribution and develop a restoration strategy for long-term protection and recovery

ACTION 5.2.1

Conduct seagrass mapping and surveys (aerial and ground truth surveys) to assess the current extent, distribution, and condition of seagrass species in the Pensacola and Perdido Bay systems.

ACTION 5.2.2

Evaluate current protection measures and develop a comprehensive restoration strategy for seagrass/SAV

Objective 5.3

Improve and support the health and resiliency of native ecosystems in the Pensacola and Perdido Bay watersheds

ACTION 5.3.1

[Wetlands] Conduct regular monitoring surveys to assess the condition of wetlands and buffer zones in the Pensacola and Perdido Bay systems

ACTION 5.3.2

[Shorelines] Conduct a shoreline assessment of both watersheds to assess living vs. armored shorelines

ACTION 5.3.3

[Riparian] Conduct intensification for the EPA NARS NRSA (National Rivers and Streams Assessment)

ACTION 5.3.4

[Mangroves] Coordinate and facilitate efforts to track expansion of mangrove species and synthesize data to communicate to the public

ACTION 5.3.5

[Invasive species] Support removal and prevention activities for invasive species

ACTION 5.3.6

Define measurable habitat restoration and conservation targets (acres and condition) to support living resources, the economy, and biodiversity

Objective 5.4

Coordinate with partners to identify and assess critical habitats of highest risk for imperiled and protected species

ACTION 5.4.1

Assess potential wildlife corridors and habitat fragmentation concerns for imperiled and protected wildlife species

Splinter Hill Bog Preserve
PPBEP

Striped Killifish
PPBEP

GOAL 6

Restore and Conserve Fish and Wildlife

Objective 6.1

Collaborate and communicate fish and wildlife monitoring efforts

ACTION 6.1.1

Work with partners to increase the visibility of local community science initiatives and communicate volunteer opportunities and updates

Objective 6.2

Coordinate and expand fisheries monitoring capacity within the Pensacola and Perdido Bay watersheds

ACTION 6.2.1

Conduct seagrass trawling surveys to assess juvenile fish/shellfish communities and habitat quality

Objective 6.3

Increase regional monitoring capacity for marine mammals

ACTION 6.3.1

Increase long-term monitoring of manatee sighting coverage in Pensacola and Perdido Bays utilizing Panhandlemanatee.org

GOAL 1

Source of Watershed Related Information

First Annual Meeting of the Management Conference

PPBEP

Objective 1.1

Become the central repository for watershed data and visualization

Objectives

Serve as a central repository for estuarine and watershed data, research, and restoration projects for the Pensacola Bay and Perdido Bay watersheds. Provide easily accessible resources for the scientific community, educators, and the public (watershed bibliography, data, data visualizations, trends, tools, etc.).

Status

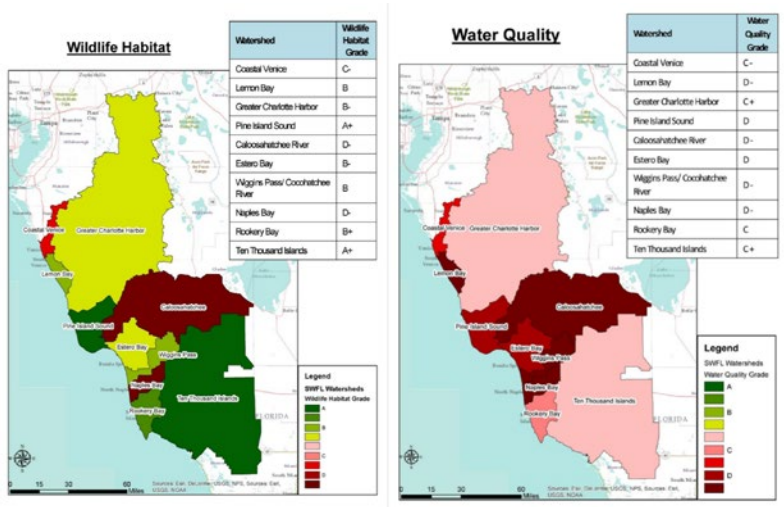
Ongoing. PPBEP and the Florida RESTORE Act Centers of Excellence Program team (FLRACEP) from University of West Florida and University of Florida compiled a bibliography of existing peer-reviewed literature, grey literature, reports, theses and dissertations, oral histories, and relevant datasets for the Pensacola and Perdido watersheds. In addition, PPBEP Senior and Environmental Scientists are working to collaborate with the Gulf of Mexico Alliance (GOMA) to contribute to their Gulf of Mexico Open Data Platform (GOMOD). The GOMOD platform was developed to make it easier for users to discover, explore, and access data for the region. PPBEP staff have also partnered with representatives from NOAA and USGS to integrate the Council Monitoring and Assessment Program (CMAP) inventory of existing habitat and water quality monitoring and mapping metadata for programs into the Program's Comprehensive Monitoring Strategy and existing inventory or local monitoring efforts.

Related Actions

Water Quality Objective 3.1; Sediment Objective 4.1; Habitat Actions 5.1.3, 5.2.1; Fish and Wildlife Objective 6.1

BACKGROUND

PPBEP conducted a series of stakeholder workshop discussions on watershed level concerns about water quality and quantity, sediment quality and quantity, habitat, and fish and wildlife. A common theme across all the topic areas was the need for a centralized source of information. This repository will contain both historical and current information on both bay and watershed research. In addition to the availability and access to research and ongoing monitoring data, stakeholders also expressed a desire to have a compilation of all past and ongoing restoration, green infrastructure, and other improvement projects. The importance of providing engaging and informative data visualizations for researchers, decision makers, educators, and the public was discussed and recommended as a lead role for PPBEP.



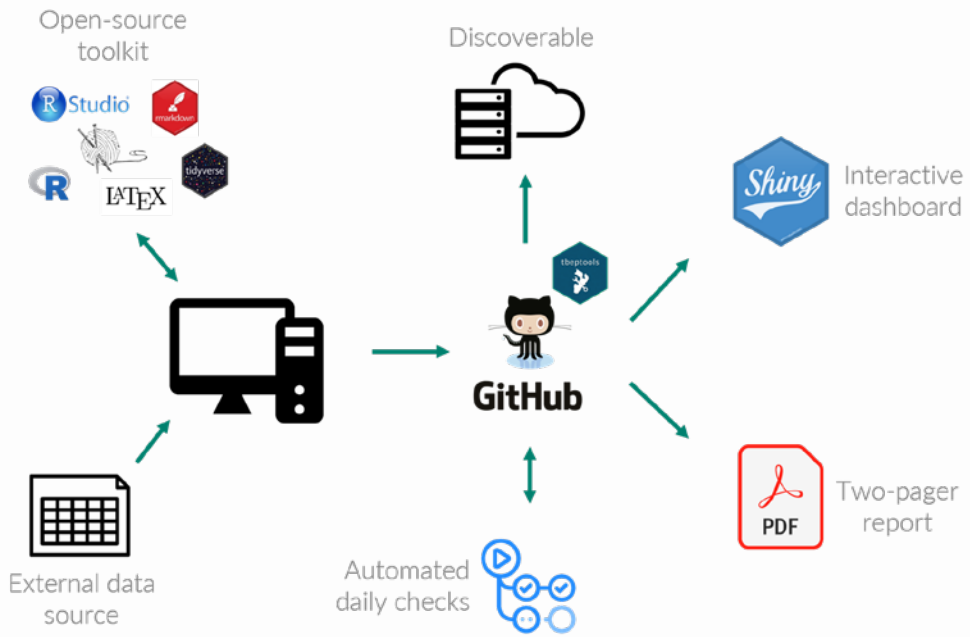
Examples of Estuary Report Cards from Charlotte Harbor

Conservancy of Southwest Florida

Bayou Chico
Escambia County

Many National Estuary Programs (NEP) serve as centralized data repositories for their bays and watersheds and host raw data, reports and summaries, and visualization tools on their websites. One example is the Tampa Bay Estuary Program (TBEP) who provide water quality, habitat, and biotic reports and data. TBEP also has current and archived water quality report cards, a GIS library, links to other regional databases, and data visualization tools for decision makers. Their open science framework was designed to ensure that the ongoing data collection and research are transparent, reproducible, and discoverable.

Having a centralized trusted source for regional data that is easily accessible is important for management and public awareness. By having all data in one place, it can be queried by parameter, location, and year to facilitate the identification of data and monitoring gaps. Data visualizations are both a useful tool for managers and decision makers and an effective public engagement strategy to increase public awareness of research and ongoing concerns in our systems.



Generalized open science workflow
TBEP

ACTION 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

IMPLEMENTATION STRATEGY

Partner with UF/UWF (FLRACEP), GOMA, NOAA, EPA, and other partners to contribute to existing data platforms and develop and manage an opensource database of current and relevant literature for the watersheds; Work with partners to digitize pertinent historical records

- **TIMEFRAME:** 2020 – 2022 (updated biennially)
- **PPBEP ROLE:** Leader
- **PARTNERS:** UF/UWF (FLRACEP)
- **FUNDING:** Committed: EPA; FL COE
- **DELIVERABLES:** Published annotated bibliography on website or alternate platform
- **PERFORMANCE METRICS:** Number of publications and reports included in bibliography; Number of site visits and downloads

ACTION 1.1.2

Create an open science digital dashboard for tools, data, and status and trend reporting that are transparent and accessible

IMPLEMENTATION STRATEGY

Develop protocol for design, inclusion, and maintenance; Partner with TBEP and other supporting programs/organizations to assist in building an effective dashboard and relevant tools for data analysis and visualization

- **TIMEFRAME:** 2022 – 2024
- **PPBEP ROLE:** Leader
- **PARTNERS:** TBEP, FWC, Counties, Community of Practice (CoP) groups, NWFWMD
- **FUNDING:** Pursuing
- **DELIVERABLES:** Completed open science dashboard that provides status and trend information on priority watershed health indices
- **PERFORMANCE METRICS:** Number of unique and repeat website visits

Santa Rosa Sound
PPBEP

ACTION 1.1.3

Create an accessible list of current and relevant programs, projects, and grant opportunities within our watersheds

IMPLEMENTATION STRATEGY

Develop protocol for project incorporation and maintenance; 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 PPBEP website or stand-alone website

TIMEFRAME: 2022 – 2026

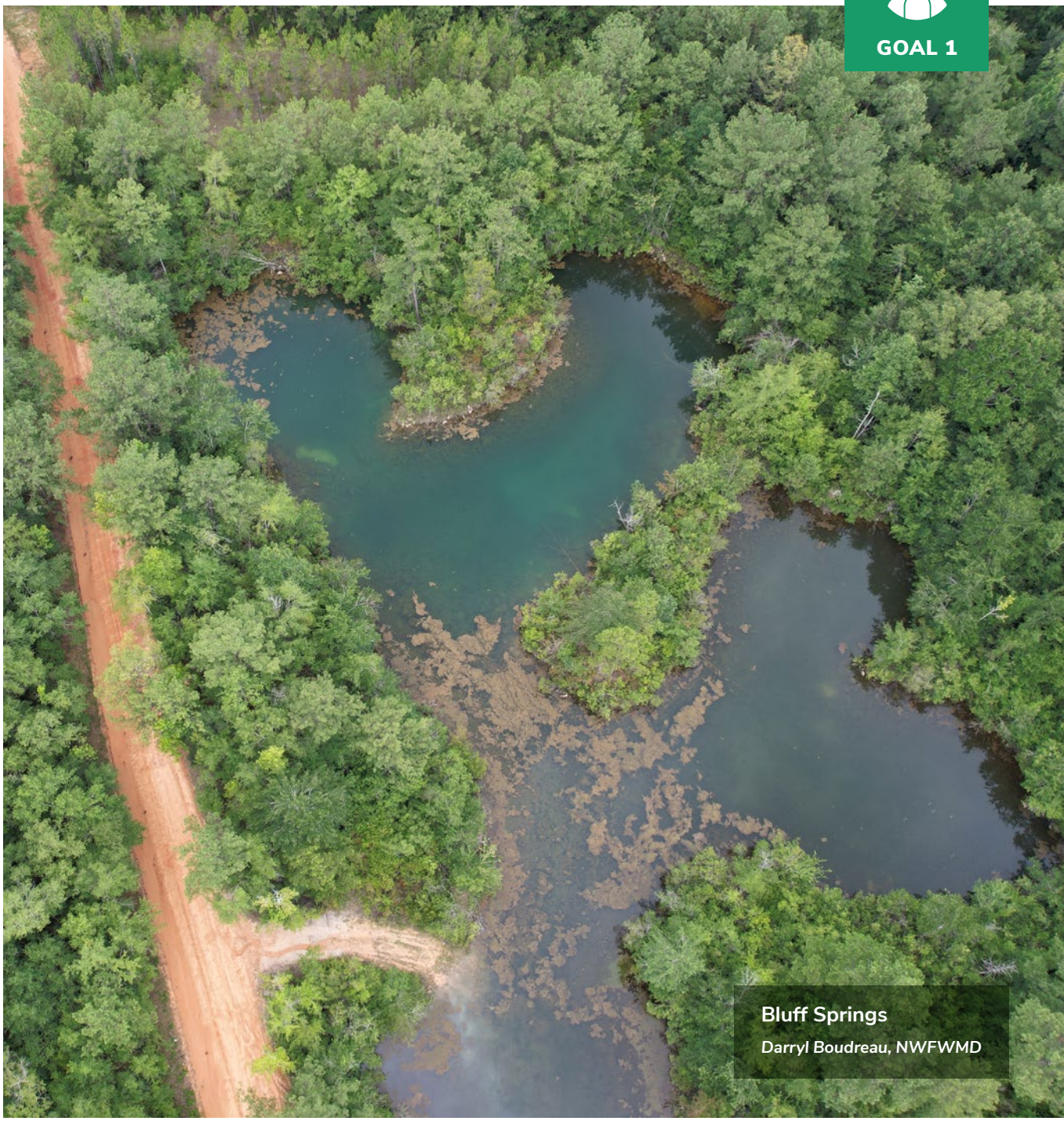
PPBEP ROLE: Leader

PARTNERS: All partners

FUNDING: Committed – FL COE

DELIVERABLES: Protocol for inclusion and maintenance of dashboard; Interactive map with project descriptions and locations hosted on PPBEP website; Inventory of grant opportunities (living document)

PERFORMANCE METRICS: Number of efforts/projects listed across watersheds available to public; Interactive map with project descriptions and locations hosted on PPBEP website; Number of unique and repeat website visits; Number and value of grants awarded; Link each project to priority issue to track funding obtained to address priority issues



Bluff Springs
Darryl Boudreau, NWFWMD

Objective 1.2

Be a trusted and reliable source for relaying pertinent watershed related environmental issues to the community

Objectives

To better protect public and environmental health and increase community understanding of watershed issues by serving as a centralized and reliable source of information.

Status

Ongoing. The PPBEP has built partnerships with agencies, local governments, and local utilities to obtain and cross-share relevant watershed information such as sanitary sewer overflows. The program will continue to strengthen and grow these partnerships, integrate into Emergency Management response networks, and disseminate information to local media.

Related Actions

Education and Outreach Strategic Plan Action 2.1.3 and 2.1.4

BACKGROUND

PPBEP held a series of stakeholder workshops to identify and prioritize the Program's education and outreach efforts. Communication of watershed related information was identified as a high priority, which is especially important following natural disasters or large-scale events (hurricanes, large sanitary sewer overflows, etc.). Multiple agencies and organizations are responsible for collecting and reporting pressing watershed information, but this information is rarely centralized into one location or disseminated by a single organization. The lack of centralization can make it challenging for community members to know where to look for information or how to access it. Even if community members can access the data they are looking for, data across the watersheds is not always provided in an easily digestible format.

PPBEP strives to serve as a trusted reliable source for communicating relevant, often time sensitive, watershed related information that is important to public and environmental wellbeing. In addition to cross-sharing information, the Program aims to translate data into clear and understandable terms and visual figures (when appropriate). Ensuring that the public is aware of current issues in our watersheds empowers community members to make informed decisions (whether to fish, boat, swim, etc.) based on watershed conditions. Gathering this information is also a critical first step in building context and public support for initiatives, campaigns, and funding to address root causes of environmental issues impacting our watersheds.

PPBEP strives to serve as a trusted reliable source for communicating relevant, often time sensitive, **watershed related information that is important to public and environmental wellbeing.**

Indian Bayou
PPBEP

ACTION **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

IMPLEMENTATION STRATEGY

Partner with county and state representatives and subscribe to relevant list-serves to receive timely information and create visuals for sharing; Integrate into counties' Emergency Management response network; Work with local utility boards, FDOH, ADOH, FDEP, ADEM, and local governments to obtain pertinent information regarding events and health advisories

- **TIMEFRAME:** 2022 – 2026
- **PPBEP ROLE:** Leader; Communicator
- **PARTNERS:** FDOH, DEP, ADPH, ADEM, Local utilities, Counties, NWFWMD, NOAA, FEMA, Community groups, EPA
- **FUNDING:** Committed – EPA Grant
- **DELIVERABLES:** Communication and Information Sharing Agreement among agencies/organizations/local governments and PPBEP
- **PERFORMANCE METRICS:** Number of posts; Number of individuals reached by posts and engagements; Number of times PPBEP is included ER briefings; Number of times plan/protocol was utilized (Education and Outreach Strategic Plan); Number of partner agencies/organizations to sign agreement

ACTION **1.2.2**

Strengthen media relations and feature PPBEP program activities through local and regional media outlets

IMPLEMENTATION STRATEGY

Partner with communications/media departments of agencies and organizations within our community; Utilize local media outlets for the dissemination of information

- **TIMEFRAME:** Daily
- **PPBEP ROLE:** Leader
- **PARTNERS:** All media partners (e.g., WEAR, BLAB, PNJ, Santa Rosa Gazette, WUWF, etc.)
- **FUNDING:** Committed – EPA Grant, Local governments
- **DELIVERABLES:** Published social media posts, newsletters, press releases, and other media products
- **PERFORMANCE METRICS:** Number of press releases; Number of featured stories; Number of postings; Social media metrics (number of hits, followers, views, reached; number of shares), Number of unique partners engaged through collaboration

ACTION 1.2.3

Participate and contribute to regional working groups and data sharing communities of practice

IMPLEMENTATION STRATEGY

Attend, participate, and contribute to Seagrass CoP, Oyster Data Sharing, FWC projects (SIMM, OIMMP, CHIMMP), Florida Oyster Recovery Science (FORS), PERT, ACF Interagency Coastal Regulations workgroup, GOMA committees and Manatee Sighting Network (MSN) efforts

TIMEFRAME: Quarterly

PPBEP ROLE: Collaborator

PARTNERS: FWC, GOMA, NOAA, DISL, EPA, PLACE: SLR, NWFWMD, DEP

FUNDING: Committed – EPA Grant, Local governments

DELIVERABLES: Participation and contribution to local, state, and regional reporting activities.

PERFORMANCE METRICS: Number of working groups where PPBEP is represented; Number of relevant reports and other outputs as co-author or active partner

FWC Oyster Spat Monitoring

PPBEP

Objective 1.3

Provide regular reports of ongoing monitoring and restoration efforts and results to the public

Objectives

Provide the community with current information and data from ongoing projects and monitoring efforts

Status

Ongoing. For the past two years, the PPBEP has received funding from the Florida State Legislature to support their Community Grant Program (est. 2020), which has provided support for partners to develop education and outreach programs, conduct monitoring, implement a community garden, and survey oyster reef fish communities across the Perdido and Pensacola watersheds. Updates and findings from these programs and projects are featured on a segment of our monthly newsletter, the Pelican Post, and staff also create spotlight articles featuring specific projects on the Program's website (www.ppbep.org/news). Photos and videos from project activities are also shared on PPBEP social media platforms (e.g., Facebook, Instagram) to inform and engage community members on the ongoing work throughout the watersheds and advertising volunteer opportunities. Information from partner agencies and organizations related to sanitary sewer overflows, severe storms/hurricanes, algae blooms, spills, and other environmental concerns and alerts are also shared via newsletters, website, and social media platforms. The PPBEP drafts content for upcoming events including volunteer opportunities, watershed related news, and project/program highlights for press releases to the local media (e.g., Pensacola News Journal, Santa Rosa Press Gazette) and radio (e.g., WUWF) platforms.

Related Actions

Education and Outreach Strategic Plan Action 1.3.4, 1.4.6, 2.1.1, and 2.2.2

BACKGROUND

During the workshop series with the Technical and Education and Outreach Committees, stakeholders expressed the need for increased communication regarding watershed related events, information, and data. The PPBEP strives to be a trusted source of information for the public and that starts with collaboration among key stakeholders, effective inter-agency communication, and data sharing. Since its inception, the PPBEP has made great strides in developing curriculum and relevant outreach campaigns on various topics, hosting community events and field trips, and creating consistent messaging to help achieve this goal. The PPBEP will continue to report on activities being conducted across the watersheds to ensure that community members receive the best available science and information in digestible formats to assist with their informed decision making as environmental stewards.

The Community Grant Program, established Summer 2020 with support from Florida State Legislature, has funded 18 projects totaling $450,000 that have been focused on various aspects of watershed health including monitoring, outreach, restoration, education, and research. Project leads report on their progress, project activities and deliverables, and any challenges that may have had to overcome within that time frame. This information is synthesized and shared using the Program's social media pages, the monthly newsletter (Pelican Post), and feature articles hosted on their website.

The Community Grant Program has funded:

18 projects

totaling

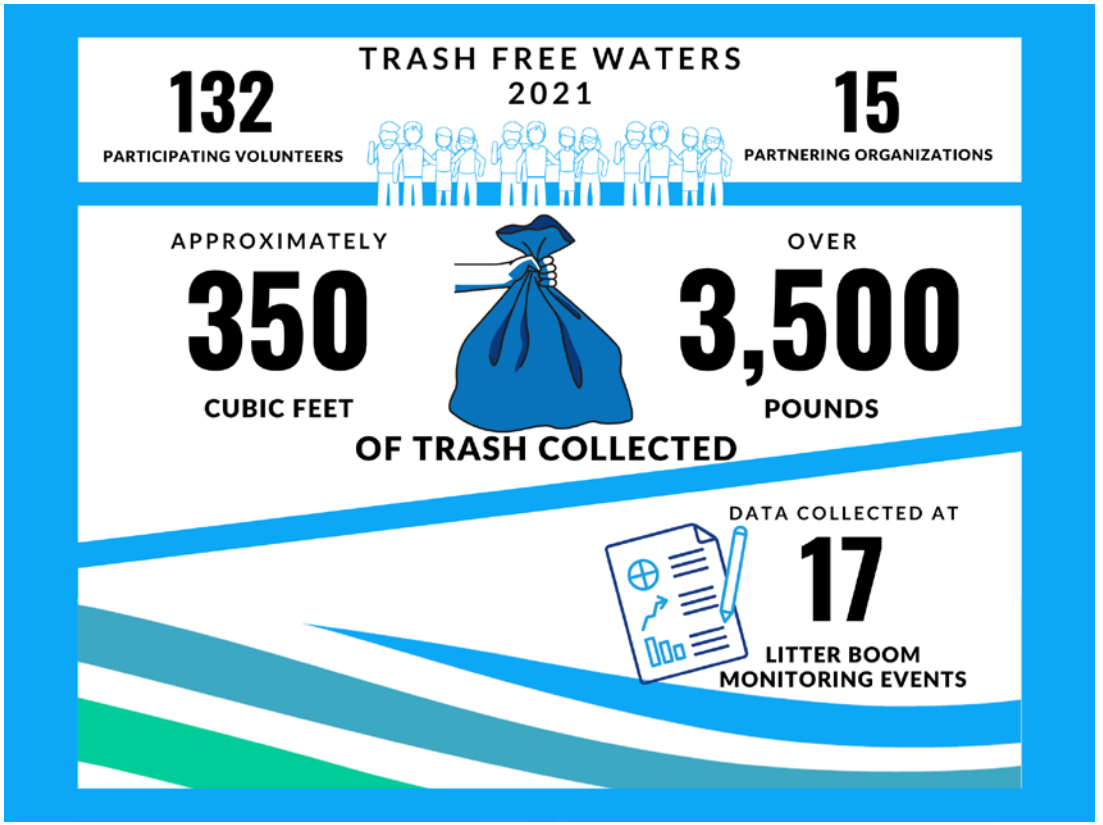
$450,000

At the conclusion of the grant period, the PPBEP hosts an annual Community Grant Symposium, normally during National Estuaries Week in September, to give current grant recipients an opportunity to present on the findings and impact of their projects and to award the next round of selected grants for the next funding cycle.

Communicating Results

In the coming years, the Program aims to host a biennial research symposium to highlight current projects and programs across the watersheds and to connect researchers, educators, natural resource managers, local government leaders, students, community organizations, and the public to celebrate successes and foster new partnerships. This will be an opportunity for increasing awareness, learning from previous efforts (e.g., successes, failures, challenges), furthering the potential for effective restoration and protection of our watersheds, and leveraging future funding opportunities. Neighboring Programs that organize and host similar events, for example, MBNEP hosts their biennial Bays and Bayous Symposium, have shown success through cross-state participation.

In addition to a symposium, the PPBEP plans to create an annual State of the Bays report to inform stakeholders and community members on the status and trends of key indicators across the Pensacola and Perdido Bay watersheds. Estuary Programs and environmental organizations throughout the United States have produced State of the Bays reports in highly visual and web-based platforms (e.g., TBEP, Potomac Conservancy, Indian River Lagoon NEP) that evaluate estuaries using a stoplight approach or grading system for various indicators, including water quality, fish, habitats, and land use. The PPBEP's first State of the Bays report will be released in 2022 highlighting what we have learned from the literature, Program led projects and assessments completed during 2020–2022 and other related information collected by partner organizations and agencies that align with the CCMP goals and objectives. This report will present an overview of the watersheds and their features using graphics and visuals to effectively present scientific concepts as a baseline of information for future watershed related work and serve as a trusted source of information.



2021 Trash Free Waters Results

PPBEP

Autism OddysSea 2022
Navarre Beach Marine Science Station

ACTION 1.3.1

Develop State of the Bays Report

IMPLEMENTATION STRATEGY

Assess watershed data, literature, and status and trends of selected indicators

- **TIMEFRAME:** Biennially
- **PPBEP ROLE:** Leader
- **PARTNERS:** UF/UWF (FLRACEP), EPA
- **FUNDING:** Committed – EPA grant
- **DELIVERABLES:** Published final State of the Bay report (interactive web-based platform)
- **PERFORMANCE METRICS:** Number of unique/repeat site visits, number of unique entities accessing report

ACTION 1.3.2

Provide Community Grant Program updates via social media platforms and annual symposium

IMPLEMENTATION STRATEGY

PPBEP staff communicate with funded programs to create visuals for social media platforms and newsletter; Make final reports available on PPBEP website

- **TIMEFRAME:** Annually
- **PPBEP ROLE:** Leader
- **PARTNERS:** Funding agencies; States; Sponsors
- **FUNDING:** Committed - Florida State Appropriations, sponsorships
- **DELIVERABLES:** Published social media posts; Community Grant symposium event; Articles posted on PPBEP website
- **PERFORMANCE METRICS:** Amount of funding received; Number of projects funded; Number of grant symposium attendees; Geographic spread of projects; Number of press releases covering event; Social media metrics (e.g., number of hits, number of shares, etc.) number of issues covered, number of demonstrable improvements to issues addressed

ACTION 1.3.3

Host watershed science and outreach symposium

IMPLEMENTATION STRATEGY

Provide a venue for stakeholders and students to share information on their ongoing programs and projects within our watersheds

- **TIMEFRAME:** Biennially
- **PPBEP ROLE:** Leader
- **PARTNERS:** All partners
- **FUNDING:** Needed
- **DELIVERABLES:** Biennial symposium
- **PERFORMANCE METRICS:** Number of attendees; Number of agencies/organizations represented; Number of presentations (posters/oral); Geographic spread of attendees and presenters; number of priority topics covered.

ACTION 1.3.4

Use social media and other digital platforms to update the public on current watershed information

IMPLEMENTATION STRATEGY

Communicate with the public using social media, presentations, and other digital platforms

TIMEFRAME: Daily

PPBEP ROLE: Leader; Communicator

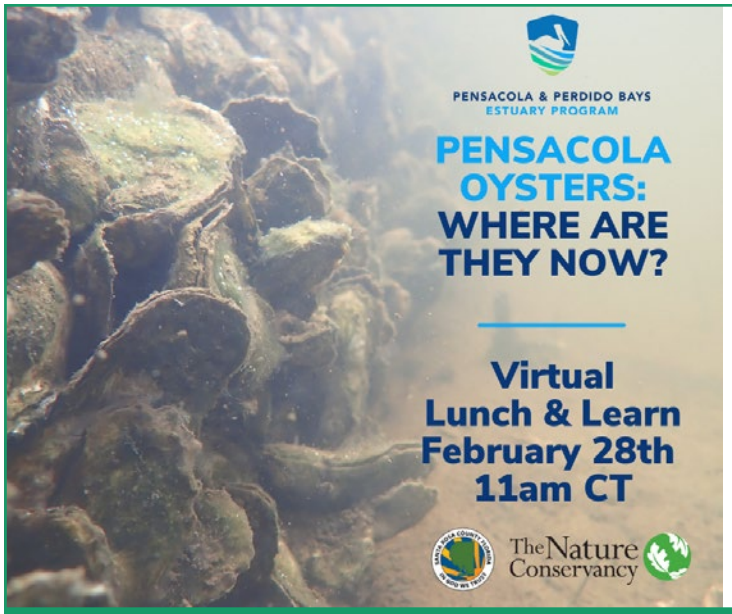
PARTNERS: All partners

IDENTIFIED FUNDING SOURCE(S): EPA grant

DELIVERABLES: Published social media posts, presentations, and other outreach products

PERFORMANCE METRICS: Number of posts and outreach campaigns; Number of topics or content presented; Number of individuals reached by posts and engagements, and engagement trends

Seagrass Volunteer Opportunity
PPBEP



Lunch and Learn Webinar
PPBEP

GOAL 2

Strengthen Community Resilience

Admiral Mason Stormwater Park
Darryl Boudreau, NWFWMD

Objective 2.1

Inform community planning and development decisions

Objectives

Ensure comprehensive plans and land development codes are consistent with the goals and objectives of the CCMP, and that local government staff and elected officials have the tools, training, and data necessary to support sound community planning and development decisions that support environmental stewardship and a thriving economy

Status

Not yet started.

Related Actions

Action 2.4.1; Action 2.4.2; and Action 2.6.1

The Pensacola Bay and Perdido Bay watersheds are experiencing tremendous growth.

Population increase between 2010 and 2020:

Baldwin County	27%	Santa Rosa County	24%
Escambia County	8%	Okaloosa County	17%

BACKGROUND

The Pensacola Bay and Perdido Bay watersheds are experiencing tremendous growth. Between 2010 and 2020, Baldwin County's population increased 27.2%, Escambia County's population increased 8.2%, Santa Rosa County's population increased 24.2%, and Okaloosa County's population increased 17.1% according to the 2020 Census. Coastal Alabama and Florida are some of the most rapidly growing areas in the United States. For example, Baldwin County has been ranked the 7th fasted growing metropolitan area in the country and fastest growing in Alabama (2020 US Census). With an increase in population to coastal counties, enhanced coordination with local planning officials is critical to ensure future development and long-term community planning adequately address natural resource management and community resilience concerns.

Comprehensive plans, developed and implemented by local governments, are intended to serve as a policy planning tool to allow for economic development and natural resource protection. Land development codes, also developed and implemented by local governments, serve as a regulatory enforcement tool to manage population growth, and protect natural resources. Effective comprehensive plans and land development codes can often be a determining factor for attaining fishable and swimmable waters and supporting healthy communities.

The PPBEP will establish partnerships with each jurisdiction in the Pensacola and Perdido watersheds and complete a crosswalk of each comprehensive plan and land development code to evaluate consistency with the goals of the CCMP. Based on the findings of the crosswalk, the PPBEP will recommend revisions to each comprehensive plan and land development code to ensure consistency across the watersheds that support stewardship of natural resources, healthy communities, and economic resilience.

ACTION 2.1.1

Promote the use of smart growth and best land management practices to maximize the health and resilience of our communities to natural disasters

IMPLEMENTATION STRATEGY

Partner with local governments and boards to identify needed data and studies that would be useful to help inform land development codes, planning documents, etc.

- **TIMEFRAME:** 2023 – 2025
- **PPBEP ROLE:** Communicator
- **PARTNERS:** City and county governments; Municipalities
- **FUNDING:** Needed
- **DELIVERABLES:** Published development guidance document, data, and studies requested by local governments to help inform policies and codes.
- **PERFORMANCE METRICS:** Number of engagements with stakeholders and decision makers, number of studies produced, % of local government priorities addressed
- **LOCATION(S):** Areas experiencing accelerated growth in the watersheds; Coastal counties in Baldwin and Escambia counties; Areas with at risk riparian zone loss

Corinne Jone Park in Downtown Pensacola
Darryl Boudreau, NWFWMD

Objective 2.2

Facilitate wastewater management improvements throughout the watersheds

Objectives

Work with local domestic wastewater facilities to help identify and prioritize wastewater improvements throughout the watersheds and assist in public outreach promoting septic-to-sewer conversion and septic system maintenance to reduce public health risk to pathogen exposure. Partner with local utilities to secure funding for wastewater treatment improvement, expansion to priority areas with failing septic tanks and growing areas, etc.

Status

Not yet started

Related Actions

Water Quality Objective 3.2, Habitat Objective 5.2; Education and Outreach Strategic Plan Action 1.4.5

Tampa Bay Estuary Program's Pipe Up campaign to educate homeowners on lateral line maintenance (www.tbep.org/pipeup).

BACKGROUND

Throughout the counties in Florida, there are ~54,000 known or likely septic tanks in the Pensacola watershed and ~12,000 in the Perdido watershed, respectively (FDOH 2016). Septic systems are commonly found in rural and unincorporated areas of the watersheds, and in older communities developed prior to the widespread availability of a centralized sewer collection system. Septic tanks placed in improper soil, not maintained, and/or not functioning properly can leach nutrients, bacteria, viruses, chemicals, and other water quality pollutants associated with raw wastewater into groundwater and the surrounding waterways. Failed septic tanks can also be a human health risk if the wastewater makes its way to the surface of a yard. To ameliorate septic tank pollution, a more environmentally friendly alternative is to replace septic systems by connecting properties and businesses to the cities' centralized sewer system. Centralized sewer systems are more efficient at removing nutrients, medicines, and other potentially harmful chemicals from wastewater and further treat wastewater than septic tanks prior to discharging the wastewater.

Many communities around the United States are promoting the conversion of septic to sewer to improve local water quality, while other communities promote septic system maintenance programs. Communities, such as Baldwin County, have participated in incentive programs that pay for one free septic tank pump. Maintaining septic tanks, which need to be pumped every 3–5 years, can be costly for homeowners, and these incentive programs provide homeowners and the community with a short-term solution to alleviate water quality issues stemming from unmaintained septic tanks. Other communities provide discounts or reasonable payments plans for homeowners and businesses to utilize to tap into the centralized sewer system. PPBEP will collaborate with partners throughout the watersheds to educate the public about sewer and septic system maintenance programs, opportunities to implement septic to sewer conversion programs, and the benefits of proper wastewater management on human health and environmental resources.

ACTION 2.2.1

Extend central sewer service to priority areas near surface waters and retrofit existing failing wastewater infrastructure

IMPLEMENTATION STRATEGY

Work with partners to complete an inventory of septic systems throughout the watersheds; identify potential pathogen and nutrient hot spots; Partner with local utilities to prioritize areas for conversion or retrofits to identify and acquire funding sources to assist with priority projects; Identify funding sources to support WWTP capacity and advanced treatment enhancements

TIMEFRAME: 2022 – 2025

PPBEP ROLE: Collaborator

PARTNERS: Lead(s): Local utilities; Partners: AACD, Counties, Cities, ADOH, FDOH, EPA, NWFWMD

FUNDING: Pursuing

DELIVERABLES: Map of prioritized areas for septic to sewer conversions/expansions or retrofits within our watersheds; Funded project deliverables; Assessment of number, size, age, and condition of current septic systems, Outreach materials to help inform the community for needed improvements and increase support for needed investments

Sewer over Septic
A FLORIDA & TALLAHASSEE PROJECT

CITY OF TALLAHASSEE

City of Tallahassse's septic to sewer program allows eligible properties to connect to sewer at no cost.

Volusia County, FL educational graphic for their septic to sewer program

PERFORMANCE METRICS: 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

LOCATION(S): Beachfront communities; RV resorts; Miramar Dr. (Perdido); Commercial properties (Brownsville, Paradise Beach, Navy Blvd, Innerarity island); Areas with outdated/ failing infrastructure; Highly developed neighborhoods in flood risk areas

ACTION 2.2.2

Educate and incentivize the community on the importance of sewer and septic system maintenance and sewer connections

IMPLEMENTATION STRATEGY

Implement outreach campaign to educate communities (e.g., homeowners, decision makers, etc.) across the watersheds on the impacts of septic tanks and failing infrastructure on water quality and the benefits of properly maintained wastewater infrastructure

TIMEFRAME: 2023 – 2025

PPBEP ROLE: Leader; Communicator

PARTNERS: Local utilities, Conservation Districts, NRCS, Sea Grant, UF-IFAS, ACES Extension, Neighborhood groups, NWFWMD

FUNDING: Needed

DELIVERABLES: Published outreach campaigns and materials (e.g., septic to sewer education, water quality benefits)

PERFORMANCE METRICS: Number of individuals reached by campaign(s) and engagements

LOCATION(S): Pensacola and Perdido watersheds

Objective 2.3

Promote the use of green infrastructure or other low-impact designs into community planning

Objectives

Build partnerships to promote green infrastructure or low-impact design projects in the Pensacola and Perdido watersheds as a method to improve water quality, increase resilience, improve community health, and support economic growth. Support local governments, private property owners, and other entities in the development of living shorelines in Pensacola and Perdido Bays. Support government entities and developers in implementing regional stormwater strategies.

Status

Ongoing. Currently seeking opportunities to partner and support groups in the watersheds applying for green infrastructure and other low-impact design funding. Santa Rosa County, in collaboration with PPBEP, was awarded a National Fish and Wildlife Foundation: National Coastal Resilience Grant to develop a living shoreline habitat suitability model (LSSM) for the Pensacola Bay System. PPBEP, through its EPA grant, funded the completion of the LSSM in the Perdido Bay System in Florida, building on an LSSM previously completed in the Perdido Bay System in Alabama. By fall 2022, the LSSM will be complete for the entire Pensacola and Perdido Bay Systems, providing a publicly available tool for use in shoreline stabilization decision making by coastal property owners.

The Emerald Coast Regional Council, in partnership with NWFWMD, secured funding from the Federal Highway Administration to develop and implement a pilot process to integrate regional stormwater management into FDOT capital improvement projects. The pilot initiative is planned to commence in 2022 focusing on two projects in Escambia and Santa Rosa Counties.

Related Actions

Sediment Objective 4.2; Habitat Action 5.3.2; Education and Outreach 1.4.4

Green Roof on Escambia County Central Office Complex

Escambia County

BACKGROUND

Green infrastructure (GI) and other low-impact designs (LID) are resilient approaches to dealing with stormwater. Green infrastructure can provide flood control and improve the treatment of stormwater at a lower cost than traditional man-made stormwater management practices (https://www.epa.gov/green-infrastructure/green-infrastructure-cost-benefit-resources). The premise of GI and LID is to utilize the natural landscape features and hydrology to promote the infiltration, filtration, storage, evaporation, and transpiration of stormwater. When a landscape is developed, the natural vegetation and hydrology is removed from the system, soils are compacted and impervious surfaces (e.g., roads and rooftops) are created, lowering the infiltration of stormwater. Green infrastructure reintroduces infiltration pathways for stormwater and can help lessen pollutant loading to our waterways and lessen the impacts of flooding events. Furthermore, GI and LID can provide aesthetically pleasing green spaces for the community to enjoy.

Many counties within the PPBEP watersheds have started to incorporate GI and LID into their stormwater and land management plans. For example, Escambia County received a Section 319 Nonpoint Source Management Program Implementation Grant in 2016 to create the Escambia County Low Impact Design BMP Manual to be incorporated into the Escambia County Land Development Code. This manual provides GI and LID solutions as options for future stormwater management. Options include incorporating green roofs and permeable pavement to ameliorate the effects of stormwater. Santa Rosa County also received a Green Infrastructure Grant in 2021 from EPA to improve impaired waters within the Pensacola Bay Watershed. The PPBEP strives to promote the use of GI practices throughout the counties and cities within our watersheds by working with partners to acquire funding to implement proposed LID plans and educate homeowners and businesses about the benefits of utilizing GI and LID practices.

Living shorelines as a green infrastructure alternative to hardening shorelines

Living shorelines are resilient shoreline stabilization techniques, typically placed within estuarine systems, that reduce erosion, improve water quality, provide shoreline protection, and provide habitat for other organisms. While living

shorelines are not a one-size fits all solution, living shorelines are environmentally favorable alternatives to bulkheads and other shoreline armoring practices. Previous living shorelines projects in the Pensacola Bay System have been very successful. Project Greenshores (PGS) Phase I (completed in 2003) in Pensacola Bay is an award-winning living shoreline constructed to lessen wave energy during storms and restore oyster reefs, saltmarsh, and seagrass habitat.

PGS has become a model for living shoreline projects across the Gulf Coast and has demonstrated the effectiveness of living shorelines to improve resilience multiple times. Most notably, in 2004, less than a year after PGS was completed, Hurricane Ivan struck with minimal impacts to the project site and surrounding infrastructure observed. In 2020, Hurricane Sally struck with minimal impacts to the project site observed while seawalls to the west and east of the project site were destroyed.

Project Greenshores Site 1 in Pensacola Bay

Darryl Boudreau, NWFWMD

Current and future living shorelines projects in Pensacola and Perdido Bays:

Living Shoreline Habitat Suitability Model for Pensacola and Perdido Bays

LOCATION: Pensacola and Perdido Bays

PURPOSE: Assess Pensacola and Perdido Bay shorelines to evaluate land use, water depth, habitat type, wave dynamics, sediment transport, and the presence or absence of hardened coastal infrastructure (i.e., sea walls). Outcomes of the living shoreline suitability model is to determine where to prioritize placement of living shorelines. The PPBEP will fund the Perdido Bay living shoreline habitat suitability model.

LEAD: Santa Rosa County and PPBEP

FUNDING SOURCE: NFWF. EPA

PROGRESS: Planning phase

Floridatown Living Shoreline Project

LOCATION: Floridatown Park, Escambia Bay

PURPOSE: Reduce erosion into Escambia Bay

LEAD: Santa Rosa County

FUNDING SOURCE: DEP

PROGRESS: Permitting

Pensacola Bay Living Shorelines Project

LOCATION: White Island, Magazine Point, and Sherman Inlet, Pensacola Naval Air Station

PURPOSE: Enhance resilience of Naval Air Station Pensacola and the Bayou Davenport neighborhood by stabilizing erosion and restoring shorelines, creating saltmarsh habitat, and improving water quality, and creating suitable conditions for seagrass establishment

LEAD: Escambia County; Partners: DoD; DEP

FUNDING SOURCE: RESTORE (Pot 2); NFWF, DoD

PROGRESS: Permitting

Navy Point Living Shoreline

LOCATION: Navy Point Park, Bayou Grande (Pensacola watershed)

PURPOSE: Reduce erosion, create habitat, and improve water quality

LEAD: Escambia County

FUNDING SOURCE: NFWF

PROGRESS: Complete

Living Shoreline Course for Marine Contractors

LOCATION: N/A

PURPOSE: Educate marine contractors, landscapers, local governments, and coastal homeowners on living shoreline construction best practices

LEAD: NFWF, FWC, SeaGrant

FUNDING SOURCE: PPBEP

PROGRESS: Completed in Summer 2021

Project Greenshores Site 2

LOCATION: Pensacola Bay

PURPOSE: Lessen wave energy during storms; restore oyster reefs, saltmarsh, and seagrass habitat

LEAD: DEP

FUNDING SOURCE: NRDA

PROGRESS: Monitoring

Pensacola East Bay Oyster Habitat Restoration Project

LOCATION: East Bay/Escribano Point

PURPOSE: Restore oyster habitat, create habitat for other species.

LEAD: TNC

FUNDING SOURCE: NFWF GEBF

PROGRESS: Construction phase

Residential Living Shoreline Projects

LOCATION: Big Lagoon, Bayou Texar, Bayou Grande, Santa Rosa Sound, Yellow River Marsh Aquatic Preserve

PURPOSE: Restore and create habitat, attenuate waves, stabilize shoreline

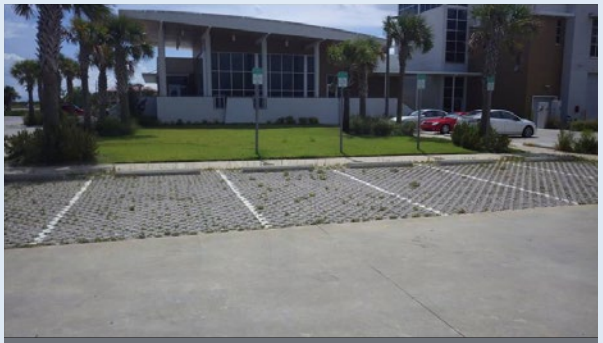
LEAD: DEP

FUNDING SOURCE: USFWS

PROGRESS: Complete

Types of Green Infrastructure

- Bioretention systems (rain gardens)
- Treatment bioswales
- Vegetated natural buffers
- Pervious pavement
- Green roofs
- Rain barrels (i.e., rainwater harvesting)
- Tree boxes



Pervious pavement at the Perdido Key fire station.

Escambia County

Navy Point Living Shoreline

Annabelle Rose Photography

Navy Point Living Shoreline

Annabelle Rose Photography

ACTION 2.3.1

Enhance stormwater management by expanding the use of Green Infrastructure practices

IMPLEMENTATION STRATEGY

Work with partners to prioritize areas within our watersheds that would benefit most from regional Green Infrastructure techniques; Develop and acquire funding to implement priority projects

- **TIMEFRAME:** 2023 – 2026
- **PPBEP ROLE:** Leader; Communicator
- **PARTNERS:** Academia, Local government, Cities, Counties, Community organizations, Local utilities, NWFWMD
- **FUNDING:** Needed
- **DELIVERABLES:** Funded project deliverables
- **PERFORMANCE METRICS:** Number of Green Infrastructure practices/projects implemented; Amount of funding acquired; Implementation of one Green Infrastructure project; Estimate of acres treated; Volume of stormwater captured
- **LOCATION(S):** Hot spot areas with high stormwater flows (upper watersheds; cities; Impervious pavement areas in highly developed communities)

ACTION 2.3.2

Promote and facilitate the development of living shorelines as a sustainable alternative to shoreline armoring to reduce erosion and sediment inputs

IMPLEMENTATION STRATEGY

Work with partners to develop and acquire funding for living shoreline projects; Educate homeowners about the benefits of living shorelines vs. bulkheads and further hardening; Provide living shoreline training for contractors

- **TIMEFRAME:** 2023 – 2026
- **PPBEP ROLE:** Collaborator
- **PARTNERS:** Sea Grant, NWF, Local government, Academia, Extension, TNC, DEP, Community groups, Homeowners, Marine contractors, NWFWMD
- **FUNDING:** Pursuing
- **DELIVERABLES:** Contractor training manual; Education/outreach materials; Funded project deliverables
- **PERFORMANCE METRICS:** Number of trainings offered and number of attendees; Number of outreach initiatives/campaigns; Number of living shoreline projects implemented; Miles of shoreline converted to living shorelines; Amount of funding received for public/private living shorelines projects
- **LOCATION(S):** Coastal areas throughout watersheds; High erosion areas where living shorelines could prevent further impacts

Objective 2.4

Identify areas within the watersheds that are at risk for current and future compound flooding and identify solutions to lessen impacts

Objectives

Identify current flooding issues and prepare future compound flooding scenarios for use in community planning to enhance FEMA Community Rating System (CRS) scores and prepare and implement a unified regional adaptation plan that promotes environmental stewardship and improved quality of life for all residents.

Status

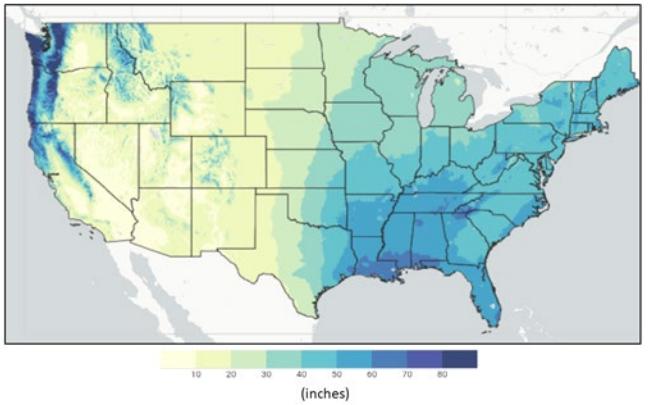
Not yet started

2014 flood event on Piedmont Street, Pensacola

Carrie Stevenson

BACKGROUND

Coastal areas along the Gulf of Mexico (GOM) are vulnerable to inland flooding caused by hurricanes, storm surges, and heavy rainfall. On average, the Pensacola Bay area receives approximately 65 inches of rainfall annually, the second highest average annual rainfall in the continental U.S. Average annual rainfall is anticipated to increase as a result of climate change (Georgescu et al. 2021). In recent years, historic flood events have tested the resiliency of our communities and infrastructure. For example, in Spring 2014, Escambia and Santa Rosa Counties received 20.5 inches of rain in a 24-hour period, destroying property and washing out roads and bridges, causing $56 million in damages throughout Escambia County alone (Kim et al. 2020). In September 2020, Pensacola received over 24 inches of rain over a two-day period during Hurricane Sally (NOAA's National Weather Service). As a result, the estimated cost of private property damages throughout the City of Pensacola was $16 million, while the combined cost of damages to public property in the City of Pensacola and Escambia County, Florida was estimated at $183 million (Little 2020). By the end of the century, U.S. flood costs are expected to exceed $2,000 billion per year (Hinkel et al. 2014, Strauss et al. 2012).



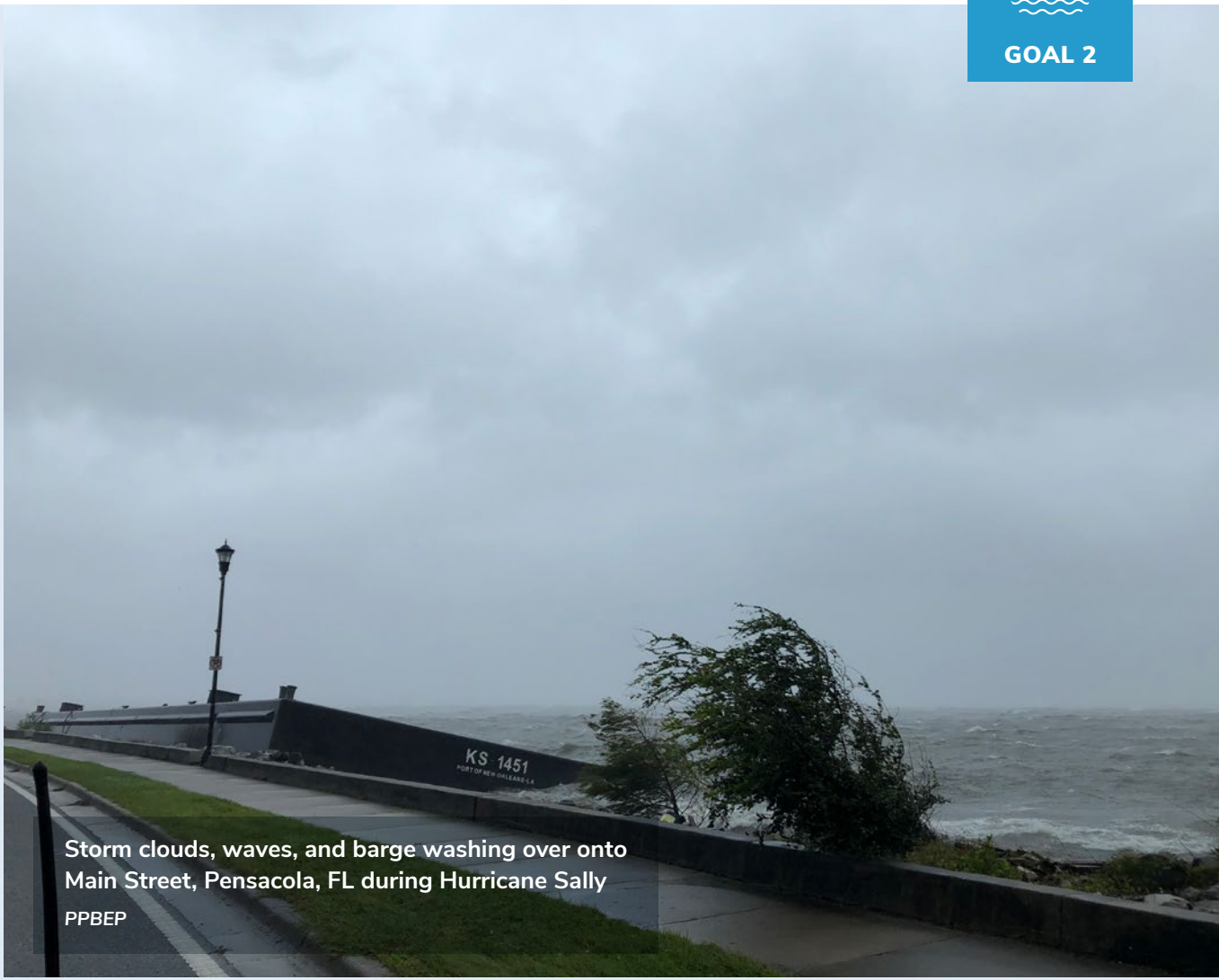
Annual average rainfall (inches) from 1991–2020

NOAA

Climate Change Implications

Impacts from flood events can be compounded by sea-level rise (SLR), which is rising at an estimated 3 mm yr^{-1} (Sweet et al. 2022, Geselbracht et al. 2015). This compound flooding scenario can reduce the capacity of existing stormwater management systems to adequately address inland and coastal flooding. Further, increased urban sprawl can also exacerbate the effects of flooding by reducing infiltration, increasing stormwater runoff, and enhancing flood vulnerable areas due to an increase in impervious surfaces and loss of riparian buffers. In addition, coastal wetland systems and estuaries are vulnerable to SLR due to development and their low-lying nature (Bilskie et al. 2018). More frequent flooding events make our natural resources, communities, and infrastructure more vulnerable.

Sea-level rise can not only put communities at risk for increased flooding, but also put natural resources at risk. An increase in sea level will potentially change the shoreline profile, in turn changing storm surge patterns and freshwater inundation. Changes in sea level will eventually inundate low coastal areas, causing salt intrusion into the estuaries and rivers, potentially altering our fisheries. Better knowledge of hydrodynamic patterns in the Pensacola and Perdido Bays is needed to predict the effects of current and future sea level rise scenarios and associated salinity changes. These data are crucial to understanding the future effects on our fisheries and economy and to implement remediation strategies.



Storm clouds, waves, and barge washing over onto Main Street, Pensacola, FL during Hurricane Sally

PPBEP

PPBEP is working with the Program for Local Adaptation to Climate Effects: Sea Level Rise (PLACE: SLR) to educate and bring awareness to our coastal communities about the effects of SLR and the need for proactive community resiliency planning. The staff at PLACE: SLR also developed an award winning SLR focused curriculum and educational program that engages youth, educators, municipal officials, decision makers, and community members. PPBEP and its partners hope to empower residents and decision makers within at-risk communities to take adaptive action.

ACTION 2.4.1

Identify high-risk areas using compound flood models to educate communities, aid in community planning, and improve FEMA Community Rating System (CRS) scores

IMPLEMENTATION STRATEGY

Use appropriate tools (e.g., Compound Flood Modeling) and existing assessments to identify vulnerable areas to flooding

TIMEFRAME: 2022 – 2023

PPBEP ROLE: Leader; Collaborator

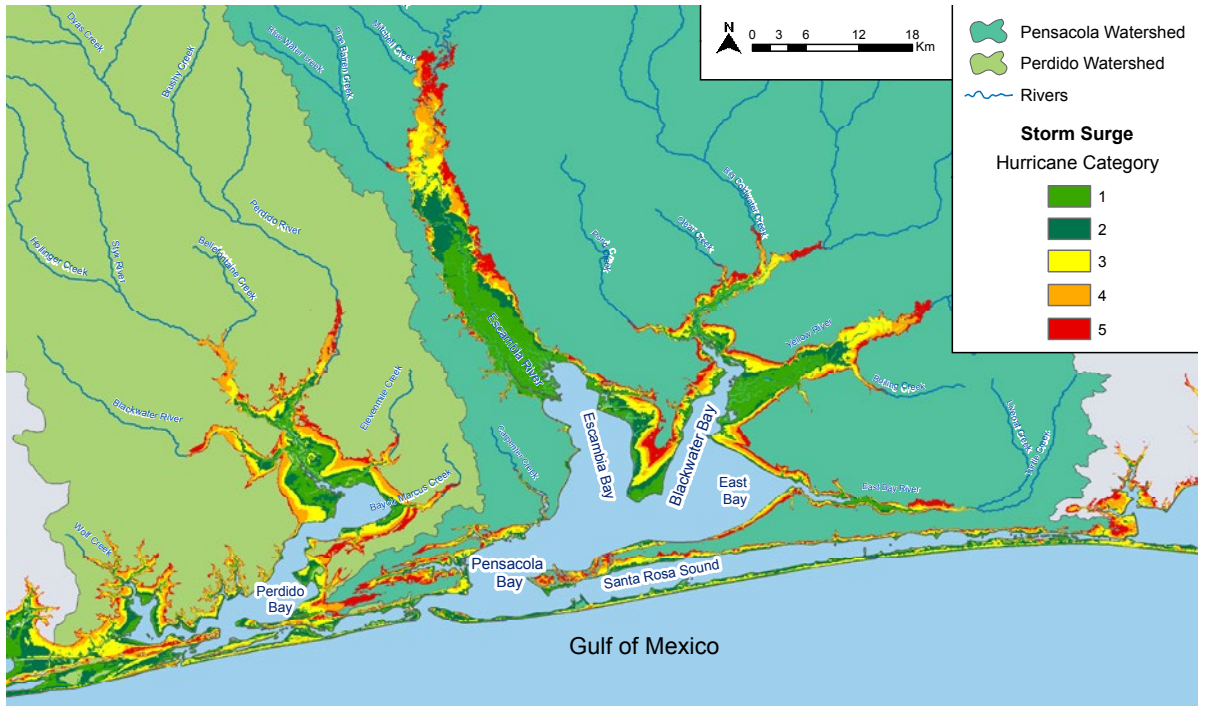
PARTNERS: Academia, Local government, PLACE: SLR, USM, EPA, NWFWMD

FUNDING: Committed; Resilient Florida

DELIVERABLES: Map of model outputs of flooding vulnerability and risk for both watersheds; Map showing high risk areas with underlying causes/stressors; Host leader/stakeholder workshop on SLR/flood/storm surge projections

PERFORMANCE METRICS: Number of hosted community trainings and workshops to educate leaders and stakeholders; Number of people that participate in trainings and workshops; Number of high-risk communities or sub-watershed units identified

LOCATION(S): Coastal communities; Tidally influenced; High flood risk areas



Storm surge under high tide conditions for hurricane categories 1–5.
Zachry et al. 2015

ACTION 2.4.2

Better understand hydrodynamic fluctuations and patterns in the Pensacola and Perdido Bays to inform restoration and ecosystem-scale improvements

IMPLEMENTATION STRATEGY

Partner with EPA, academic institutions, and other organizations to assess and communicate outputs of current watershed hydrodynamic models

TIMEFRAME: 2022 – 2024

PPBEP ROLE: Collaborator

PARTNERS: Academia, Local government, NGOs, TNC, EPA

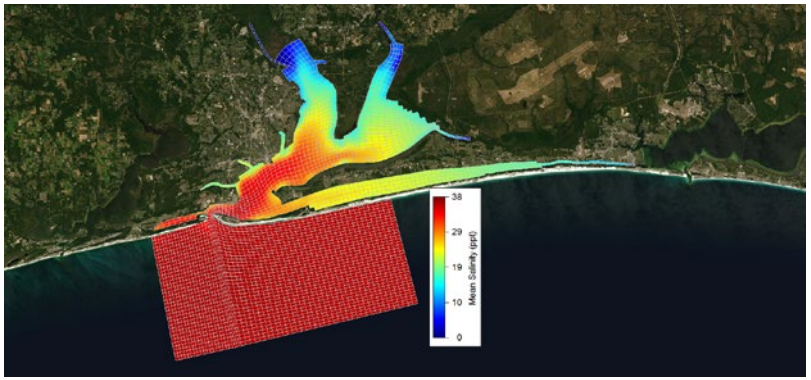
FUNDING: Needed

DELIVERABLES: Report on hydrodynamic model outputs (e.g., water residence time, particle tracking, salinity and temp gradients, surface wave models, sediment transport)

PERFORMANCE METRICS: Number of models produced; Number of times outputs are used in reports and/or education and outreach materials

LOCATION(S): Pensacola and Perdido watersheds

a)



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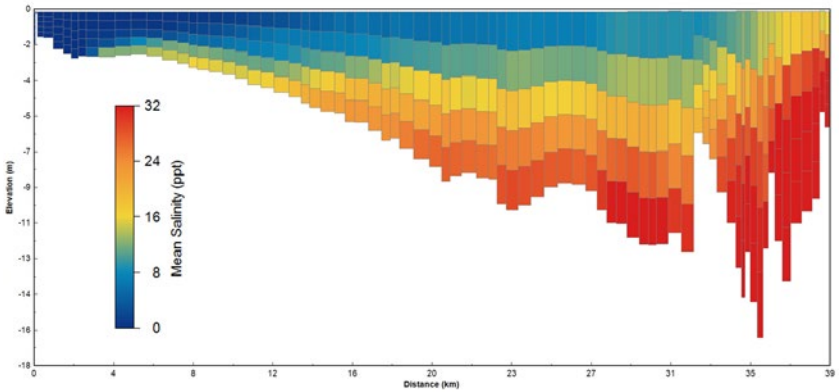


a) Mean annual surface salinity (ppt) for 2014 simulated using an Environmental Fluid Dynamics Code (EFDC) hydrodynamic model of Pensacola Bay. Model grid cells are depicted as grey boxes.

b) Snapshot (4/21/2014) of the simulated salinity profile for Pensacola Bay between the outflow of the Escambia River (Distance: 0 km) and Pensacola Pass (Distance: 39 km). Results were generated using the Environmental Fluid Dynamics Code (EFDC) hydrodynamic model. Model grid cells are depicted as grey boxes.

Brandon Jarvis, USEPA Office of Research and Development, Center for Environmental Measurement and Modeling

ACTION 2.4.3

Participate in EPA's Climate Ready Estuaries Program; NOAA's Climate Smart Communities Program

IMPLEMENTATION STRATEGY

Partner with EPA and NOAA to implement best practices to assess climate vulnerability, develop adaptation strategies, engage community members, and address climate associated vulnerability root causes

TIMEFRAME: 2022 – 2025

PPBEP ROLE: Leader

PARTNERS: Academia, Local government, NGOs, TNC, EPA, NOAA

IDENTIFIED FUNDING SOURCE(S): Pursuing

DELIVERABLES: Unified Regional Adaptation Plan

PERFORMANCE METRICS: Number of regional plans produced

LOCATION(S): Pensacola and Perdido watersheds

Causes of heavy flooding in coastal and inland areas
NOAA

Objective 2.5

Implement storm drain marking throughout the watersheds to raise awareness of stormwater runoff to our waterways

Objectives

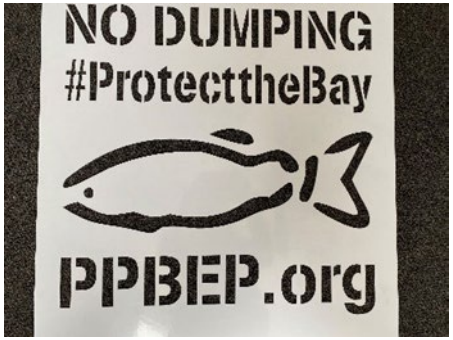
Partner with local schools and other organizations to mark storm drains in the PPBEP extent to educate communities about the linkages between storm drains and local waterways.

Status

Ongoing. PPBEP is working with three local educators to install storm drain markers on public school campuses (Escambia High School, Workman Middle School, and Gulf Breeze High School). PPBEP and partners will continue to work with educators to expand storm drain marking to other schools and locations throughout our communities to educate citizens about stormwater and runoff to the bays.

Related Actions

Education and Outreach Strategic Plan Action 1.3.3



UWF Community Engagement through Environmental Science (CEES) storm drain marker template.

BACKGROUND

Organizations around the country have been successful at using storm drain marking as a tool to enhance community engagement and promote watershed awareness of stormwater issues. Storm drain marking is used to raise awareness of storm drain locations around the community and educate citizens on how items disposed of down storm drains end up in our local waterways. Through increased awareness of storm drains, organizations hope to lessen illicit dumping down storm drains and improve local water quality. In Volusia County, Florida, the Natural Resources Department mapped high runoff areas and targeted storm drain markings within neighborhoods in the high runoff zones (Volusia County, n.d.). High runoff areas are susceptible to large volumes of waste materials being brought to storm drains and therefore community members need to know to properly dispose of trash. Locally, partners in Alabama developed a comprehensive stormwater campaign called, “Create a Clean Water Future.” Through this campaign, non-profits, local governments, and businesses work together to improve public understanding of stormwater and its impacts. This program encourages individuals to promote watershed stewardship and lessen trash entering our storm drains (CCWF, n.d.).

Storm drain marking is an easy, cost-effective way to engage citizens around stormwater and water quality issues. PPBEP worked with UWF students in the Community Engagement through Environmental Science course in Spring 2020 to develop a student-led community engagement project. Students secured funding to purchase supplies for a large-scale storm drain marking program within the PPBEP watersheds. Additionally, three K-12 educators opted to incorporate storm drain marking into their curriculum and guide students through the process of marking storm drains on their campuses. PPBEP hopes to expand storm drain marking efforts across the watersheds and include more school and communities, particularly those in Alabama.

ACTION 2.5.1

Partner with local schools and other partner organizations to complete storm drain marking

IMPLEMENTATION STRATEGY

Identify schools to participate and implement storm drain marking protocol

- **TIMEFRAME:** 2022 – 2024
- **PPBEP ROLE:** Leader
- **PARTNERS:** PPBEP, UWF CEES, Santa Rosa County, Escambia County, Baldwin County, Cities, High schools
- **FUNDING SOURCE(S):** Funded - UWF
- **DELIVERABLES:** Map of storm drains currently marked throughout watersheds and priority areas for future marking
- **PERFORMANCE METRICS:** Number of schools or organizations per county to complete storm drain marking; Number (and percent) of storm drains marked throughout our watersheds
- **LOCATION(S):** Watershed wide; Coastal communities; School campuses

Storm Drain Medallion
PPBEP

Objective 2.6

Assess social vulnerability of communities under a changing climate

Objectives

Characterize social vulnerability of communities throughout the watersheds and integrate best management practices to reduce social vulnerability in community planning, project development, and education and outreach initiatives

Status

Ongoing. PPBEP is currently in the planning stages of developing a community resilience readiness survey to acquire more information to add to the City of Pensacola's existing vulnerability assessment to support future resilience planning efforts in Pensacola, FL.

Additionally, PPBEP has partnered with EPA's Office of Research and Development Gulf Ecosystem Measurement and Modeling Division to model community assets and vulnerabilities within the Pensacola and Perdido watersheds for use in restoration and conservation decision making.

BACKGROUND

Resilience readiness is defined as community's acceptance and understanding of the climate change risks that it faces. As our climate continues to change, communities and infrastructure will be at an increasing risk during natural disasters, such as hurricanes and major flooding events. Risks are not distributed equally across communities as different socioeconomic areas will bounce back from disasters at different rates, with underprivileged areas recuperating more slowly. Therefore, many communities have started planning for future events associated with the effects of climate change by conducting vulnerability and resiliency assessments. These projects study the ecological, social, and economic vulnerabilities of communities and help guide future planning efforts by integrating coastal adaptation measures into local planning and policy.

Floodwaters and compromised infrastructure after a 2014 flood event in Pensacola, FL.

Escambia County

Escambia County and the City of Pensacola recently completed coastal vulnerability assessments. The City of Pensacola conducted a Sea Level Rise Vulnerability Assessment, which took into account ecological, social, and infrastructure vulnerabilities associated with sea level rise only; flooding caused by rainfall, storm surge, or other hydrologic processes were not considered. This Sea Level Rise Vulnerability Assessment looked at sea level rise scenarios for 2040, 2070, 2100, which are expected to have sea level rises of 16, 38, and 70 inches, respectively. Five Priority Planning Areas were identified as areas in need of resilience planning especially for future infrastructure projects (Figure 12). Escambia County also completed a Coastal Vulnerability Assessment to improve community resilience to coastal flooding (DECO 2016). Their scenarios were sea level rise associated with mean higher high water, 100-yr, and 500-yr flood events and they identified flooding hotspots in Pensacola: Downtown Pensacola, southwest of Bayou

FIGURE 12. City of Pensacola's Five Priority Planning Areas prioritized in their Sea Level Rise Vulnerability Assessment

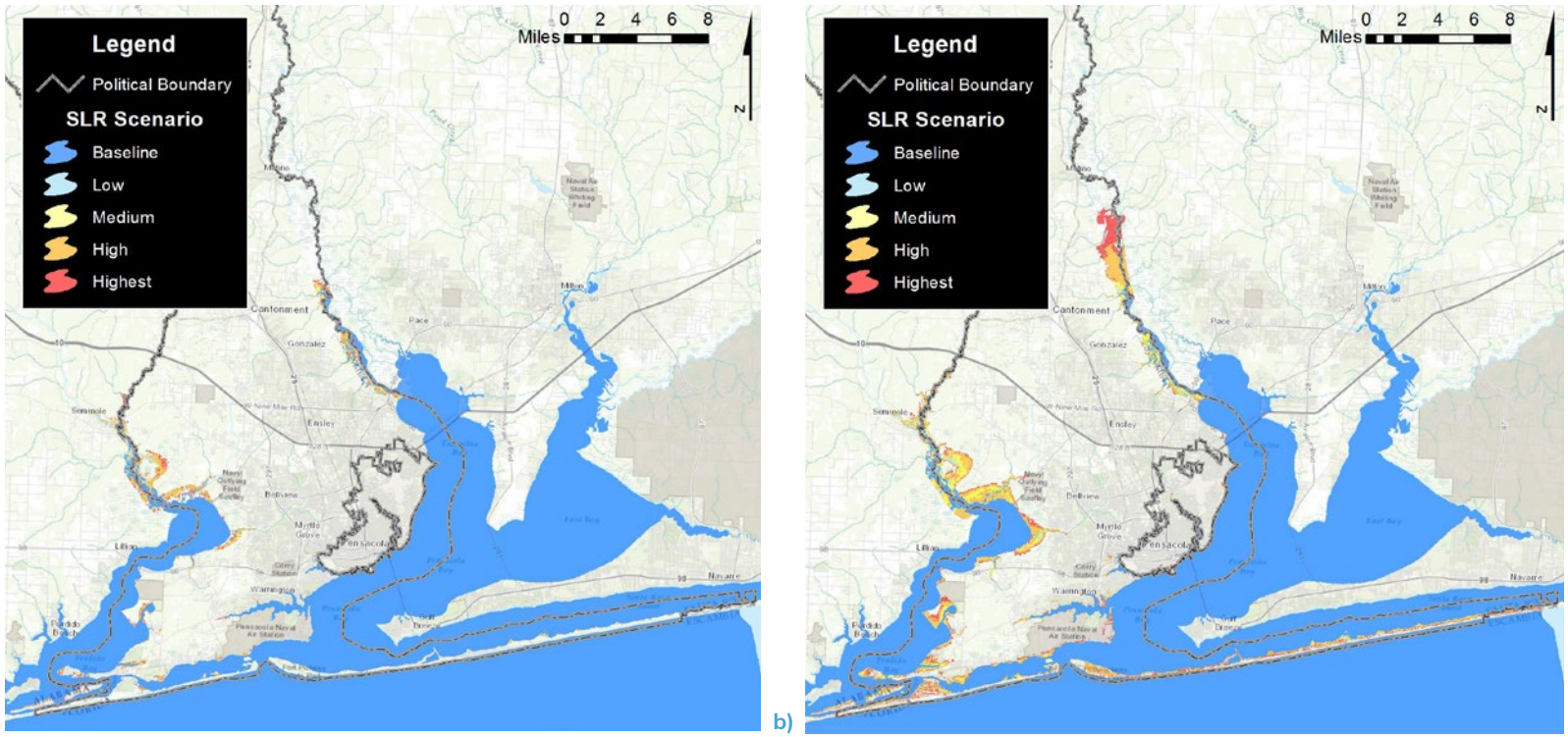
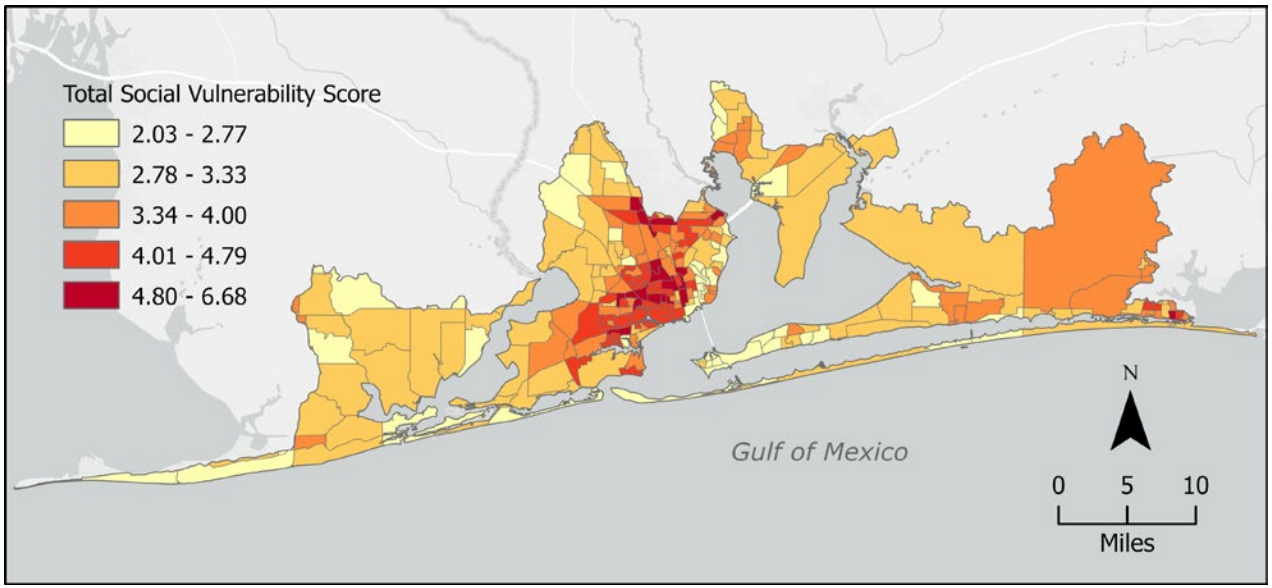


FIGURE 13. Escambia County-wide tidal flooding under mean higher high water conditions for sea level rise scenarios for 2045 (a) and 2085 (b). Note: only Escambia County is represented on the maps and no data were provided for Santa Rosa or Baldwin Counties.

Florida Department of Economic Opportunity, Coastal Vulnerability Assessment: Escambia County, Florida

Grande, lower Perdido Bay, Escambia Rivers, and Santa Rosa Island (Figure 13). Additionally, under the highest sea level rise and flooding scenarios, road infrastructure and bridges will become vulnerable. These vulnerability assessments suggest implementation of multiple strategies should be employed to reduce the socioeconomic impacts of sea level rise and create resilient communities in these low-lying coastal areas. For effective implementation, areas with high risk of flooding should be identified and prioritized. Areas at high risk of flooding can be utilized to promote infrastructure projects that incorporate low-impact development (LID) and create buffer zones for flood protection.

The PPBEP was awarded a Community of Practice (CoP) grant through NOAA and the Alabama-Mississippi Sea Grant Consortium to develop a community-based Resilience Readiness assessment for the City of Pensacola, Florida. Our data will feed into the City of Pensacola's Sea Level Rise Vulnerability Assessment and provide needed socioeconomic information. This project takes a novel approach to addressing local vulnerability by assessing local risk perceptions around sea level rise to inform pilot, community-based resiliency action. The project will provide a methodological framework for future projects that seek to apply community-based methods to assess and address community resilience, social vulnerability, and inequity.



Social vulnerability calculated from 15 variables. The map panel displays the overall social vulnerability of block groups in the Pensacola and Perdido Bay estuaries. age-dependence (<5 and >65 years old), non-white population, per capita income, population under 25 without a high school diploma or GED, household poverty, no household vehicle access, linguistic isolation, crowded housing, unemployment, rental occupancy, single parent households, housing value, lack of complete plumbing in house, access to internet/computer, and length of residence in county. Each of the variables represent characteristics associated with increased vulnerability, and are aggregated into three categories: individual vulnerabilities, family vulnerabilities, and housing vulnerabilities. Individual and family vulnerabilities represent the scale of assessment, while housing represents structural aspects of the housing units driving potential vulnerability. Map created by Kyle Buck with the U.S. EPA.

ACTION **2.6.1**

Assess social vulnerability of communities from impacts associated with climate change and support communities in long-term resiliency planning

IMPLEMENTATION STRATEGY

Work with partners to conduct a survey across lower Escambia County to collect information on perceptions of climate change/SLR and associated risk

TIMEFRAME: 2022 – 2024

PPBEP ROLE: Leader; Collaborator

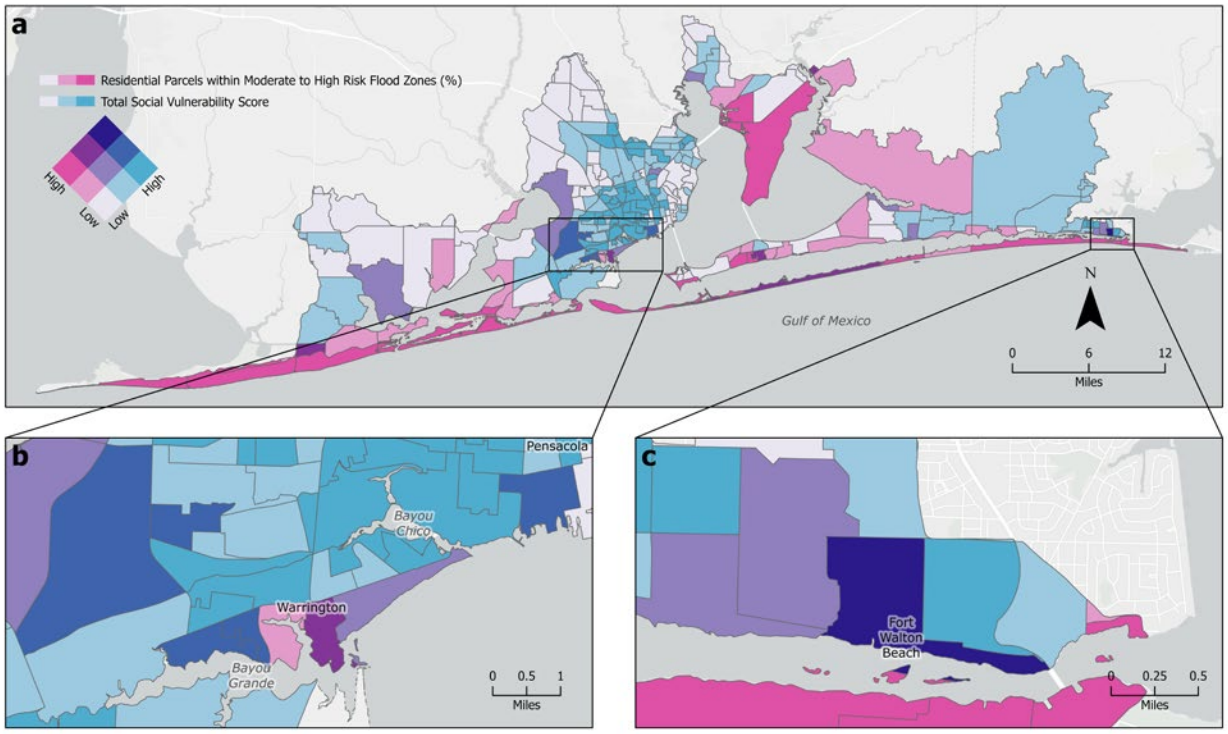
PARTNERS: Academia, Local governments, PLACE: SLR, USM

FUNDING: Committed - NOAA CoP

DELIVERABLES: Report of Community Survey results; Interactive tool (integrate into City of Pensacola's Sea Level Rise Vulnerability Assessment tool)

PERFORMANCE METRICS: Number of communities reached; Number of people that participate in public forum

LOCATION(S): Pensacola Bay Watershed



Social vulnerability and flood susceptibility map. a) Bivariate map showing the intersection of the percentage of residential non-vacant parcels within moderate to high flood risk zones and the amount of avoided runoff (m^3/ year) due to tree cover per census block group throughout the Pensacola and Perdido Bay Watersheds. b) Bright pink census block groups are block groups where there are high percentages of residential parcels within moderate to high flood zones and low amounts of avoided runoff due to tree cover. c) Land Use Land Cover data can be used to identify areas with high amounts of impervious surfaces and low amounts of total greenspace. Maps created by Kyle Buck with the U.S. EPA.

ACTION 2.6.2

Produce an environmental justice needs assessment for the watersheds and incorporate recommendations into future community planning, project development, and education and outreach initiatives

IMPLEMENTATION STRATEGY

Work with partnering agencies to identify representatives of historically disadvantaged communities to serve in a working group capacity to aid in the development of an environmental justice needs assessment, identify environmental justice barriers and, with the support of technical experts, propose project, policy, and outreach recommendations

- **TIMEFRAME:** 2023 – 2026
- **PPBEP ROLE:** Leader; Collaborator
- **PARTNERS:** Local governments; NGOs; Religious organizations; Business groups
- **FUNDING:** Needed
- **DELIVERABLES:** Environmental Justice Needs Assessment
- **PERFORMANCE METRICS:** Number of communities reached; Number of people reached
- **LOCATION(S):** Pensacola and Perdido Watersheds

ACTION 2.6.3

Produce a social vulnerability index and map social vulnerability across the Pensacola and Perdido Bay Systems.

IMPLEMENTATION STRATEGY

Work with EPA's Office of Research and Development Gulf Ecosystem Measurement and Modeling Division to evaluate and map social vulnerability and community resilience of the Pensacola and Perdido Bay Systems

- **TIMEFRAME:** 2022
- **PPBEP ROLE:** Collaborator
- **PARTNERS:** EPA
- **FUNDING:** Committed - EPA
- **DELIVERABLES:** Web-based map social vulnerability inclusive of a suite of indices.
- **PERFORMANCE METRICS:** Number of communities reached; Number of people engaged
- **LOCATION(S):** Pensacola and Perdido Watersheds

GOAL 3

Improve Water Quality

Perdido Islands
Darryl Boudreau, NWFWMD

Objective 3.1

Develop a comprehensive water quality watershed monitoring program throughout the Pensacola and Perdido Bay watersheds

Objectives

Increase the understanding of water quality dynamics within the Pensacola and Perdido Bay systems by implementing the Comprehensive Monitoring Strategy through the establishment of a collaborative comprehensive watershed monitoring program.

Status

Ongoing. The PPBEP has developed a Comprehensive Monitoring Strategy in parallel with CCMP development that provides 1) an inventory of ongoing monitoring programs within the watersheds; 2) identification of temporal and spatial data gaps; and 3) establishes actions to be taken to coordinate development of a Comprehensive Monitoring Program that leverages partnerships and resources across the watersheds.

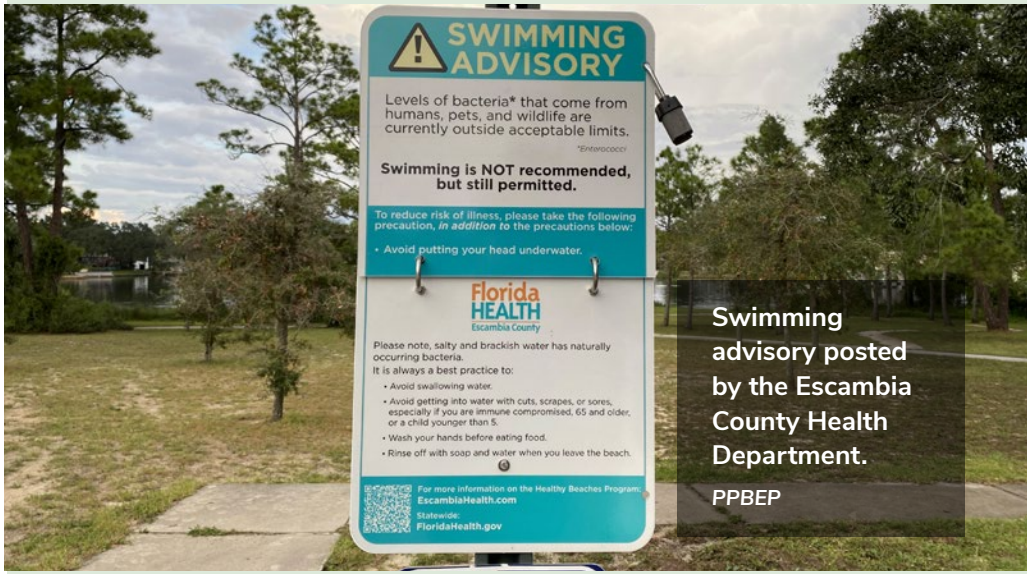
The workshops series that was conducted with the Technical and Education and Outreach committees gave staff insight into legacy and current issues across the watersheds, data needs and gaps, and actions that could assist with improvements in various areas (water quality and quantity, sediment quality and quantity, habitat, and fish and wildlife). This critical information has been used to address preliminary data gaps by building partnerships to conduct nationwide surveys (NCCA, NWCA) to assess coastal and wetland condition, map and monitor oyster reefs across the bay systems, and involve community members in community science monitoring of waterfowl, microplastics, and water quality. In 2022, the Program and its partners at UWF/BFA and Escambia County will be assessing streams across the upper watersheds to fill water quality data gaps, and conduct water quality monitoring across the bays, bayous, and sounds (e.g., chemistry, fecal coliforms, nutrients) to evaluate potential impairments.

Related Actions

Comprehensive Monitoring Strategy (Actions 3.1, 4.1)

BACKGROUND

Good water quality is critical for fish, wildlife, habitat quality, local economy (fisheries, ecotourism), and recreation. Many regularly monitored water quality parameters are indicators of ecosystems health such as nutrients, chlorophyll-a, dissolved oxygen, and water clarity. Other contaminants such as pathogens, heavy metals, and toxins are of particular concern to human health and fish and wildlife. Sources of water quality degradation include urban and agricultural runoff, wastewater contamination (SSO events, septic discharge, direct effluent discharge), poor agricultural practices, and development. Water quality in the Pensacola and Perdido Bay systems gained widespread attention in the late 1960s and early 1970s when fish kills were observed in Pensacola Bay and large die-offs of benthic invertebrates were seen in Perdido Bay. Concern over these events led to the creation of local community science organizations, such as the Bream Fishermen Association and the Perdido Bay Environmental Association, and public support for water quality management and mitigation. In recent years instances of harmful algal blooms, such as red tide along the Florida Gulf Coast, have raised new concerns about declines in water quality.



Swimming advisory posted by the Escambia County Health Department.

PPBEP

Results from the PPBEP Community Values Survey emphasized the awareness and importance of water quality concerns to the public. Participants ranked fishable waters in their top three most valued aspects of both watersheds and identified healthy habitats and trash-free waters as important aspects of a healthy watershed. Industrial discharge, coastal development, and municipal sewage treatment discharge were the most cited environmental concerns for the Pensacola Bay watershed. While in the Perdido Bay watershed, industrial discharges, coastal development, and agricultural activities were identified as top environmental concerns. Participants also identified that financial investment should be given to water quality improvements locally.

Several local, state, and federal agencies, as well as community science groups (e.g., Bream Fishermen Association, Florida Lake Watch, Alabama Water Watch), regularly sample various locations in the bays and watersheds. Despite ongoing monitoring efforts across the watersheds, there are spatial and temporal sampling gaps. Better communication and collaboration among monitoring groups and across jurisdictional boundaries was identified as a concern by the Technical Committee. Better communication of data and sampling efforts will help reduce unnecessary duplication of monitoring efforts.

PPBEP will work with partners to implementing the Comprehensive Monitoring Strategy through the establishment of a collaborative comprehensive watershed monitoring program. The Program will standardize methods for comparable results, address existing spatial and

NCCA Water Quality Monitoring
PPBEP

temporal gaps, reduce duplication of efforts, increasing monitoring capacity, allow for quicker detection of new concerns, and aid in the ability to respond and coordinate post-event sampling (e.g., SSO post-monitoring). Sampling design will incorporate stakeholder knowledge regarding historical and contemporary areas of concern, as well as target areas for data related to habitat restoration, green infrastructure projects, etc. PPBEP is also increasing our monitoring capacity through direct partnerships. Staff from the PPBEP, EPA, Escambia County Water Quality and Land Management Division (WQLM), and the Florida Fish and Wildlife Conservation Commission (FWC) collaborated to conduct an intensification of the EPA's National Coastal Condition Assessment (NCCA) to collect baseline information on the water quality conditions of the bays, bayous, and sounds (Bays, Bayous, and Sounds program). The intensification added 26 sites to the original NCCA sampling design of six sampling sites for our watersheds allowing for more coverage of our coastal waters across Florida and Alabama. The parameters that were collected as part of the survey, normally conducted nationwide every 5 years, included water chemistry, human health indicators (e.g., fecal indicator bacteria, fish tissue contaminants), benthic communities, and sediment quality. This information will feed into the Program's first "State of the Bays" report which will be a visual tool for communicating the current status and condition of our waterways to the public and stakeholders. The NARS National Rivers and Streams Assessment (NRSA) will be conducted in 2023–2024, which PPBEP will be partner with EPA and other partners to design, implement, and fund an intensification to evaluate the current conditions of freshwater ecosystems across the Perdido and Pensacola Bay watersheds. Additionally, efforts are underway to address water quality monitoring gaps in the upper portions of our watersheds. This is a partnership between UWF/BFA and PPBEP that was developed from results of the workshops series where spatial monitoring gaps were identified. The PPBEP hopes to continue expanding partners across the watersheds to create and effective long-term monitoring program that will help better address the water quality status and trends of our waterways.

NCCA Water Quality Monitoring

PPBEP

ACTION 3.1.1

Implement the Comprehensive Monitoring Strategy by establishing a comprehensive watershed monitoring program that encompasses both watersheds across state lines

IMPLEMENTATION STRATEGY

Integrate local system knowledge into sampling design; Continue to implement NARS surveys (NCCA, NRSA) and Bays, Bayous, and Sounds program throughout watersheds and coordinate with partner agencies and community science groups to increase current monitoring coverage and parameters sampled (e.g., enterococcus sampling)

- **TIMEFRAME:** 2022
- **PPBEP ROLE:** Leader
- **PARTNERS:** EPA, FWC, DEP, ADEM, Escambia County, Santa Rosa County, Universities, Community science organizations, BFA, Friends of Perdido Bay, Alabama Water Watch
- **FUNDING:** Needed
- **DELIVERABLES:** Published Comprehensive Monitoring Plan (approved by the EPA)
- **PERFORMANCE METRICS:** Number of WBIDs and sites monitored; List of parameters monitored (in Comp Monitoring Plan); Number of partner organizations/ agencies engaged; Amount of funding dedicated and leveraged for water quality monitoring
- **LOCATION(S):** Pensacola and Perdido watersheds

ACTION 3.1.2

Develop water quality targets for Pensacola and Perdido Bays to meet surface water classification designations

IMPLEMENTATION STRATEGY

Engage local experts and community stakeholders from the Technical Committee and Oyster Sub-Committee to set quantitative water quality targets for key parameters based on the best available science (e.g., nutrients, fecal bacteria) to support the designated use of local waterways and the recovery/restoration of critical habitats and associated communities.

- **TIMEFRAME:** 2023 – 2026
- **PPBEP ROLE:** Leader
- **PARTNERS:** All partners; PPBEP Technical Committee
- **FUNDING:** Needed

NCCA Survey
PPBEP

- **DELIVERABLES:** Published Comprehensive Monitoring Plan including measurable goals and targets prioritized by stakeholders with concurrence from FDEP, ADEM, and EPA
- **PERFORMANCE METRICS:** List of measurable goals/targets for WQ parameters; Progress towards reaching targets; Amount of funding dedicated and leveraged for water quality monitoring and improvements.
- **LOCATION(S):** Pensacola and Perdido watersheds

Objective 3.2

Identify sources, root causes, and transport of priority water quality pollutants in the watersheds

Objectives

Identify hotspots of nutrient and microbial pollutants within the Pensacola and Perdido watersheds, prioritize areas for future remediation projects to improve water quality, and support alternative restoration planning to achieve water quality compliance.

Status

Not yet started

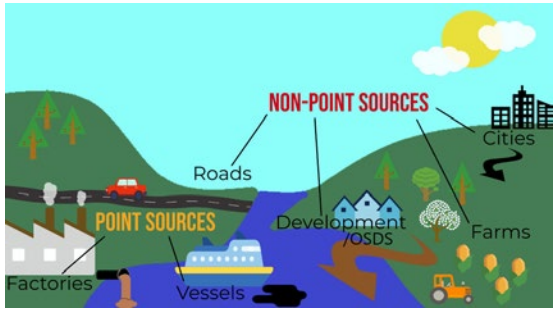
Related Actions

Oyster Fisheries and Habitat Management Plan for the Pensacola Bay System Strategy PPBEP4; Habitat Objective 5.2; Fish and Wildlife Objective 6.3

BACKGROUND

Nutrients (N, P) and microbial loads from land-based sources (natural and human-based) can degrade water quality and in turn affect the health of natural resources and have human-health implications. Excess nutrient loading to a body of water has the potential to cause algal blooms and may result in low oxygen events and fish kills, and in extreme cases, large-scale ecosystem degradation. Furthermore, excess nutrients can lead to a change in the balance of nutrients, leading to changes in bacterial (Monchamp et al. 2018) and phytoplankton communities (Riegman 1993), changing ecosystem functioning. On the other hand, excess microbial loads to a body of water can be a human health risk and can result in shellfish, fishing, and recreational swimming closures, impacting how citizens are able to use waterways. Therefore, negative effects from nutrients and microbial loads not only have the potential to affect our natural resources, but how and when humans can utilize those resources.

Nutrients and microbial pollutants stem from both point and nonpoint sources within the watershed. Point sources originate from an easily identifiable point of discharge, such as an outfall pipe, whereas nonpoint sources are delivered from over a larger area within the watershed. Examples of point sources include wastewater treatment plants, paper



Examples of point and nonpoint sources of pollution in a watershed

Mezzacapo et al. 2020

and pulp mills, and chemical and manufacturing industries. Examples of nonpoint sources include septic tanks and urban and agriculture runoff, which also conveys fertilizers, herbicides and insecticides, and other toxic contaminants.

To improve water quality, sources of pollutants need to be identified and remediated and transport pathways need to be known. Typically, point sources are easier than nonpoint sources to manage pollutant loads from. Best management practices can be beneficial to reduce nonpoint source loads. For example, limiting fertilizer and pesticide use, controlling erosion from the landscape, and reducing impervious surfaces and increasing vegetative cover are ways to manage pollutant loads and improve water quality. Restoration and other remediation projects can help control pollutant loads, improving water quality and in turn improving habitats and natural resources that our communities and economy depend upon.

The PPBEP strives to identify the main pollutant loads to our waterways and help conceive projects that will help remediate the effects of pollution and improve our water quality and way of life. Potential projects will include source tracking studies to identify major pollutant sources to the Pensacola and Perdido waterways.

Farm in Jay, Florida
PPBEP

ACTION 3.2.1

Investigate sources of microbial pollutants in the watersheds

IMPLEMENTATION STRATEGY

Develop and implement Microbial Source Tracking (MST) studies in priority areas across watersheds (e.g., impaired WBIDs)

- **TIMEFRAME:** 2023 – 2026
- **PPBEP ROLE:** Collaborator
- **PARTNERS:** Universities, Counties, State agencies
- **FUNDING:** Needed
- **DELIVERABLES:** Report on microbial sources including hotspot map and list of identified sources of microbial pollutants
- **PERFORMANCE METRICS:** Number of microbial pollutant hotspots identified; Percent of watershed assessed
- **LOCATION(S):** Impaired waterways; Coastal communities; Urban watersheds; Upper reaches of watersheds (second order creeks)

ACTION 3.2.2

Evaluate and identify point and nonpoint source hotspots for nutrients in the watersheds

IMPLEMENTATION STRATEGY

Partner with FDEP and ADEM to prioritize basins and parameters to monitor during annual state Strategic Monitoring Plan (SMP) development, and partner with universities and other partners to synthesize existing data and conduct relevant research studies and assessments (e.g., tracking)

- **TIMEFRAME:** 2023 – 2026
- **PPBEP ROLE:** Leader; Collaborator
- **PARTNERS:** FDEP, ADEM, Universities, Counties, State agencies, Community science organizations, NRCS
- **FUNDING:** Needed
- **DELIVERABLES:** Report on nutrient sources including hotspot map and list of identified sources of nutrients
- **PERFORMANCE METRICS:** Number of nutrient pollutant hotspots identified; Percent of watershed assessed
- **LOCATION(S):** Pensacola and Perdido watersheds; Highly developed areas

Objective 3.3

Assess water quality seasonal trends to understand impacts to natural resources, including habitats and fish and wildlife

Objectives

Evaluate water quality trends (historical and seasonal) in the rivers, bays, and bayous of the Pensacola and Perdido systems to better understand natural and human-induced effects on the natural resources and provide information on how to improve water quality.

Status

Ongoing. UF/UWF (FLRACEP) is assessing water quality trends in the rivers and estuaries using publicly available data. Historical and current data are being used to determine changes in water quality. PPBEP will also continue to partner with organizations across the watersheds to monitor water quality and provide more data for trend analysis.

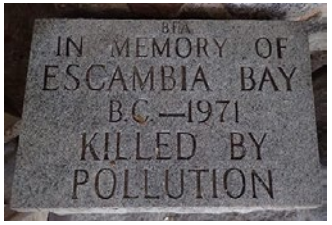
Related Actions

Oyster Fisheries and Habitat Management Plan for the Pensacola Bay System Strategy PPBEP4

BACKGROUND

During the 1960s residents were concerned with the deterioration of water quality seen throughout the Pensacola and Perdido Bay systems (particularly Escambia Bay and upper Perdido Bay where impacts from industry were prevalent. By 1971, the Bream Fishermen Association declared Escambia Bay "dead" (http://breamfishermen.org).

Water quality deterioration at that time was not unique to the Gulf Coast but was occurring throughout the country. In response to declines in water quality, the Clean Water Act of 1972 was enacted to restore and maintain the ecological integrity of the nation's waters. Through this act, pollution to waters decreased and water quality significantly improved between 1972–2001 (dates analyzed for the study) (Keiser and Shapiro 2018). While water quality improvements are still attributed to the Clean Water Act, declines in water quality are still a concern due to increasing urban and residential development (Atasoy et al. 2006). Many water quality concerns, such as fish kills and loss of benthic habitat (e.g., oysters and seagrasses), still plague our local waters and residents would like to see our waterways improve and the natural resources return.



Bream Fishermen Association memorial headstone for Escambia Bay (circa 1971)
BFA

Historically, some bodies of water within the Pensacola and Perdido Bay watersheds have had some of the worst water quality in Florida. For example, Bayou Chico has a long history of industrial pollution (Matheson 2004). Timber and wood preservative industries existed until the mid-20th century and wastewater was directly discharged into Bayo Chico as recent as the early 1970s. Currently, shipbuilding, oil storage, marinas, and residential properties line the waterfront of Bayou Chico. Legacy contaminants still reside in the sediments of Bayou Chico with ecological integrity remaining poor (Mohrherr et al. 2006). The Bayou Chico Basin Management Plan (BMAP) was adopted in 2011 to outline studies needed to improve water quality (i.e., pathogen loads) (DEP 2011). Other Bayous such as Texar and Grande, also located within Pensacola Bay, also have their own historical water quality challenges. Therefore, it is important to understand historic and current water quality trends to provide continued water quality improvement to our waters.

Changes in water quality can affect the productivity and distribution of freshwater and estuarine habitats such as seagrass and oysters. Excessive nutrient inputs can enhance algal growth in turn obstructing sunlight needed for seagrass growth and survival, and increase turbidity, affecting oyster productivity. Furthermore, excess sediment loading can also cause high turbidity and decrease seagrass and oyster productivity. Poor water and sediment quality are potential reasons for oyster declines in Pensacola Bay (Collard 1991). Over time, continued poor water quality can reduce seagrass and oyster habitat extent within a system, potentially causing far reaching ecosystem effects. Thus, it is important to understand trends (historical and seasonal) in water quality, particularly nutrients, chlorophyll-a, dissolved oxygen, water clarity, and turbidity, and understand how those trends relate to changes in estuarine habitat health and extent. Of particular interest in our area is the need to better understand summer dissolved oxygen trends as those can be confounded by human and natural causes. Low dissolved oxygen events can cause fish and benthic habitat kills, but these events can be spatially and temporally patchy, resulting in difficulty to address these issues.

Industry in Bayou Chico, Pensacola, FL

UWF Historic Trust

There is a need to understand seasonal and annual water quality trends to better understand the drivers impacting freshwater and estuarine habitats and species, so we can effectively address those drivers. A better understanding will result in more effective remediation measures and future projects and will help guide policy changes. PPBEP in collaboration with UF/UWF FLRACEP will assess spatial and temporal water quality changes in the rivers, bayous, and estuaries of the Pensacola and Perdido Bay systems to better understand trends over time (~1970s-present) and seasonal trends. These data will provide baseline information for 1) if/where water quality is declining or improving 2) how seasonal effects influence the trends 3) the effects water quality is having on our natural resources.

ACTION 3.3.1

Evaluate seasonal trends of nutrients, chlorophyll-a, DO, and HABs and their impacts to habitats and fish and wildlife

IMPLEMENTATION STRATEGY

Partner with universities and other partners to synthesize existing data and further investigate the seasonal trends of water quality parameters

TIMEFRAME: 2022 – 2025

PPBEP ROLE: Collaborator

PARTNERS: Universities, Counties, State agencies, Organizations, UF/UWF (FLRACEP)

FUNDING: Needed

DELIVERABLES: Report on seasonal trends including impacts to habitats and wildlife; Integrate information into water quality dashboard; Information reported in State of the Bays report

PERFORMANCE METRICS: Number of sites assessed; Number of water quality parameters assessed; Spatial extent of water quality impairments identified; Percentage of watershed assessed.

LOCATION(S): Pensacola and Perdido watersheds; Effluent outfalls; Legacy issue areas; Blackwater/East Bays; Socio-economic factors (lower income; new development), Focus on areas that experience seasonal hypoxia

Microsystin and nutrient water samples
PPBEP

GOAL 4

Reduce Sedimentation

Peanut Farm
PPBEP

Objective 4.1

Develop a comprehensive watershed monitoring program throughout the Pensacola and Perdido Bay watersheds to assess sediment inputs

Objectives

Increase the understanding of sediment quality and sediment dynamics within the Pensacola and Perdido Bay systems through a collaborative comprehensive watershed sediment monitoring program.

Status

Ongoing.

Related Actions

Comprehensive Monitoring Strategy

Wetland surface sediment in the Pensacola and Perdido systems
UF-IFAS

BACKGROUND

Sediments serve as reservoirs of contaminates that are bound to particles. Sediment contamination threatens the condition of the benthic community, fish, wildlife, and public health. Contaminates can degrade over time producing secondary products that have their own impacts on the ecosystem and human health. Concern for sediment contamination in Pensacola and Perdido Bays occurred during the 1960s when industrial impacts were brought to public attention. The first extensive evaluation of sediment quality in Pensacola Bay was by Olinger et al. (1975). Waters with historical sediment contamination are Bayou Chico, upper Bayou Texar, lower Bayou Grande, mid- and upper-Escambia Bay, and the Pensacola Bay waterfront (i.e., the port of Pensacola) Sources of sediment contamination include direct industrial discharge (historical and current), stormwater, and wastewater discharge. For example, in the 1970s, as a result of unregulated industrial discharge, sediments of Escambia Bay and River were contaminated with DDT, dioxins, and PCBs (Liebens and Mohrherr 2015). Sediment contamination in Bayou Chico was so widespread due to industries dumping their wastes into the bayou that homeowners filed lawsuits against the corporations in the 1950s (Mohrherr et al. 2006). Legacy contamination within these systems that have been buried can be resuspended and transported by storm-events, dredging, or other activities causing sediment resuspension.

Sedimentation is the process by which particles in the water column settle out, and excessive sedimentation can smother benthic habitats. Particles can be introduced into a system from runoff (urban stormwater, agricultural), erosion, development, unpaved roads, construction, and internal resuspension. Sedimentation was repeatedly identified by stakeholders during the workshop series as a priority concern for the health and sustainability of seagrass and oyster habitats within the bay systems and overall sediment quality for fish and wildlife. There are few sedimentation studies within these systems, however the Florida Fish and Wildlife Conservation Commission (FWC) recently kicked off a Florida Trustee Implementation Group (TIG) NRDA project, which will conduct sedimentation monitoring across the Pensacola Bay System (N=8).

Benthic organisms and other fish and wildlife are dependent on good sediment quality for their health and persistence. Friends of Perdido Bay, a community organization, have been opportunistically monitoring sediment toxicity of upper Perdido Bay since the 1980s. Other sediment toxicity studies have focused on the urban bayous of Pensacola Bay due to heavy industrial presences. Additionally, sediment characteristics such as sediment composition and grain size are important for understanding habitat distributions and associated species assemblages. During data compilation during the workshop series, it was highlighted that few individuals/organizations are collecting information on grain size. UWF (led by Dr. Jane Caffrey) and the Gulf Ecosystem Measurement and Modeling Division (GEMMD) (SPI Network led by Dr. Janet Nestlerode) collect grain size data in the urban bayous and the middle of Pensacola Bay, respectively. Very few studies of grain size analysis were found for Perdido Bay. Stakeholders identified the need for more grain size data to effectively assess bottom type for sediment toxicity characteristics and assessing future restoration projects.

PPBEP partnered with EPA to do an intensification of the National Coastal Condition Assessment (NCCA) and the National Wetlands Condition Assessment (NWCA) sampling in the Pensacola and Perdido systems. EPA's NCCA and NWCA surveys are completed every 5 years. In the Summer of 2021, sediments at 24 sites throughout Pensacola and Perdido Bays were sampled during NCCA for toxicity, metals, organics, total organic carbon, and grain size. The intensification added 24 sites to the original

Sampling of wetland sediments for the 2021 NWCA

UF-IFAS

NCCA sampling design of six sampling sites for our watersheds allowing for more coverage of our coastal waters across Florida and Alabama. The PPBEP partnered with EPA and researchers from the University of Florida and University of West Florida to conduct an intensification of NWCA. From May – August 2021, field crews collected data on a suite of parameters from estuarine wetlands across the Perdido and Pensacola watersheds including soil composition, texture, and toxicity. This information will feed into the Program's first State of the Bays Report which will be a visual tool for communicating the current status and condition of our waterways to the public and other stakeholders.

Overall, stakeholders identified the need for more frequent and widespread monitoring of sedimentation, sediment quality, and sediment characteristics. Additionally, the standardization of monitoring methods was highlighted as a need for comparable results across organizations. Regular monitoring is important to aid in quicker detection of emerging contaminants and illicit discharges, coordinate post-event sampling, and assess the impacts of restoration or mitigation strategies. The PPBEP will develop a comprehensive sediment monitoring program which will increase monitoring capacity and coverage (spatial and temporal) through collaboration and partnerships. Additionally, the monitoring program will incorporate historical and local knowledge to monitor historical hotspots and emerging areas of concern.

NCCA survey teams collecting sediment and water samples

Darryl Boudreau, NWFWMD

ACTION 4.1.1

Develop a comprehensive sediment monitoring program that encompasses both watersheds across state lines

IMPLEMENTATION STRATEGY

Integrate local system knowledge into future sampling design; Work with partners, including community science groups to develop long-term sediment and benthic monitoring programs; Increase spatial coverage and parameters monitored; Investigate possible correlations between contaminants to maximize monitoring efficiency

TIMEFRAME: 2022 – 2026

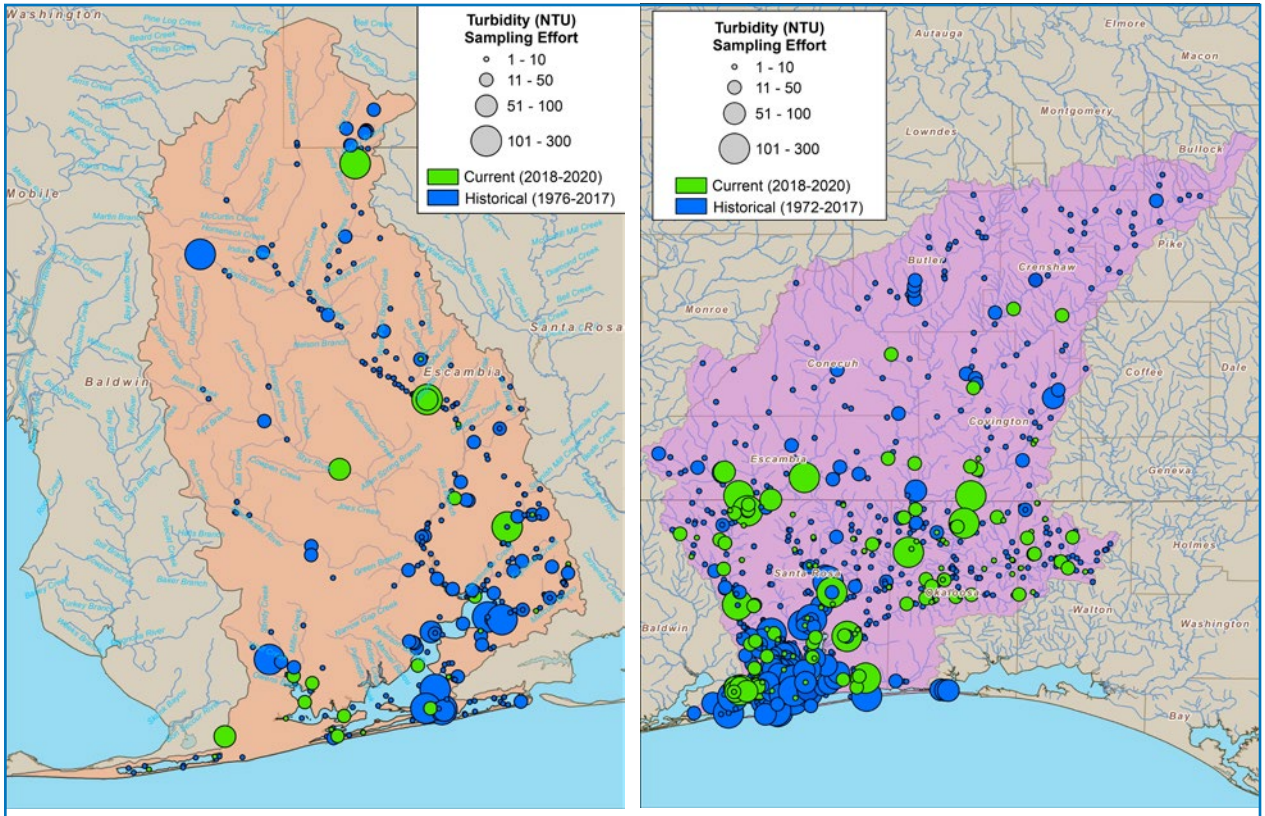
PPBEP ROLE: Leader

PARTNERS: EPA, FWC, DEP, ADEM, Escambia County, Santa Rosa County, Universities, Community Science Organizations, NRCS, Friends of Perdido Bay

FUNDING: Needed

DELIVERABLES: Published Comprehensive Monitoring Plan (approved by the EPA); Bayou Chico Sediment Report; NCCA/NWCA reports; State of the Bay report deliverables

PERFORMANCE METRICS: Number of WBIDs and sites monitored; List of parameters monitored (in Comprehensive Monitoring Plan); Number of partner organizations/agencies engaged; Amount of funding dedicated and leveraged for sediment monitoring



Sampling locations for turbidity in a) Perido Bay watershed and b) Pensacola Bay watershed.

Blue symbols are historical sites (Perdido: 1976–2017; Pensacola: 1972–2017) and green symbols are locations that are considered current (2018–2020). Size of symbol indicates the total number of samples taken.

LOCATION(S): Pensacola and Perdido watersheds; Bayou Chico

Objective 4.2

Conduct a sediment study to assess sources of sediments and erosion in the watersheds

Objectives

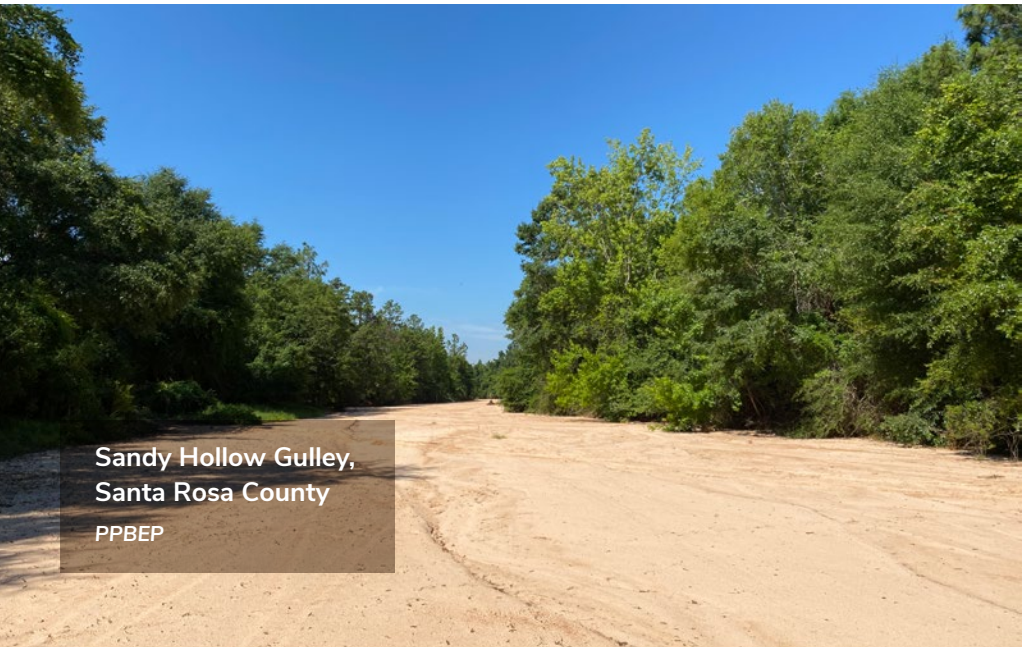
Identify major sources of sediment to the Pensacola and Perdido Bay waterways and assess the relationship between land use land cover (LULC) and soil erosion and sedimentation rates of those major sources.

Status

Not yet started.

Related Actions

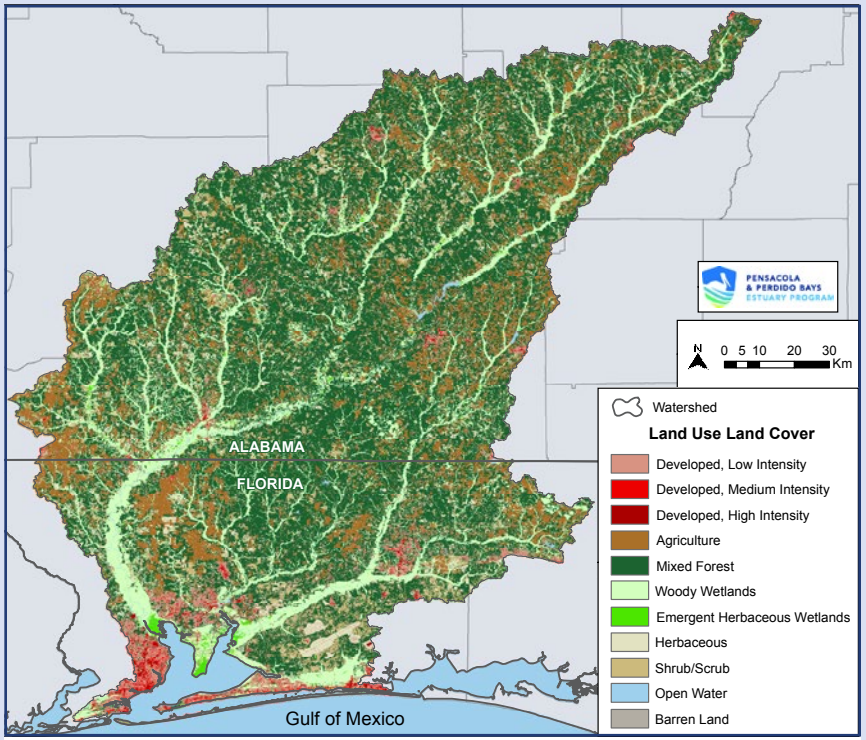
Habitat Objective 5.2; Oyster Fisheries and Habitat Management Plan for the Pensacola Bay System Strategy PPBEP4



Sandy Hollow Gulley, Santa Rosa County
PPBEP

BACKGROUND

Soil erosion from the landscape is transported via rivers and is deposited downstream contributing to the sediment accretion, pollutant transport, and sedimentation of benthic habitats. Increased sedimentation to a waterbody can degrade water quality by lowering light penetration, smothering benthic habitats, and introducing pollutants and pathogens that are attached to sediments. Rates of soil erosion and sedimentation are influenced by the land use land cover (LULC) of a watershed and human activities. For example, more urbanized landscapes or landscapes in the process of changing from forested to agriculture or urban are more likely to be sources of



Land use land cover of the Pensacola watershed

sediment than a forested landscape. Forested areas also provide sediment stabilization and lessen erosion to waterbodies. As populations continue to grow, especially in coastal areas, changes in development and LULC will continue to impact soil erosion and sedimentation to our waters.

Sedimentation from human activities in the watersheds has negatively impacted seagrass and oysters in the Pensacola and Perdido Bay systems. Seagrass burial by excess sediment loading is a known stressor to seagrasses in Pensacola Bay and Santa Rosa Sound (Yarbro and Carlson 2016). Fine-grained sediment loading has increased to East Bay since the 1960s (George 1988), where a large percentage of oyster reefs have been lost. In fact, a recent oyster mapping study done by TNC and PPBEP identified known oyster reef locations that were smothered with sediment and no longer productive. Identification of sediment sources is an important step in restoring and improving seagrass, oyster, and other benthic habitats in the Pensacola and Perdido Bay systems.

Pole measuring visibility in high turbidity waters near oyster reefs in Pensacola Bay

The Baker Lab at the University of South Alabama/ Dauphin Island Sea Lab

Identifying the main sediment sources in the watersheds is imperative to mitigate, lessen, and/or reverse the effects of sedimentation to our waterways and prioritize restoration funds on the biggest sources. Understanding the relationships between sediment sources and LULC can help pinpoint hotspots of erosion. Once sources are identified, best management practices, including restoring riparian buffer zones, better stormwater management, and lessening impacts of development and agricultural, can be utilized to ameliorate sedimentation and improve the water quality and the status of benthic habitats of downstream waterbodies.

ACTION 4.2.1

Identify the impact of land use land cover (LULC) on the rate of soil erosion and sediment loading

IMPLEMENTATION STRATEGY

Partner with universities and other partners to understand the impact of LULC dynamics on soil erosion and sediment loading

- **TIMEFRAME:** 2022 – 2024
- **PPBEP ROLE:** Collaborator
- **PARTNERS:** Universities, FDOT, ADEM, NWFWMD, NRCS, USGS
- **FUNDING:** Needed
- **DELIVERABLES:** Report including model outputs on the impact of LULC to soil erosion rates and sedimentation
- **PERFORMANCE METRICS:** Areas throughout watershed represented; Quantified annual sediment load
- **LOCATION(S):** Pensacola and Perdido watersheds; Focus on AL coastal areas; Styx and Blackwater Rivers

ACTION 4.2.2

Identify major sediment sources within the watersheds

IMPLEMENTATION STRATEGY

Partner with universities and other partners to identify sources of sediment (e.g., aerial photography, sediment fingerprinting, modeling, sediment budgets)

- **TIMEFRAME:** 2023 – 2026
- **PPBEP ROLE:** Collaborator
- **PARTNERS:** Universities, FDOT, ADEM, NWFWMD, DEP, TNC, NRCS
- **FUNDING:** Needed
- **DELIVERABLES:** Report on sediment sources including hotspot map and list of identified sources of sediment within the watersheds
- **PERFORMANCE METRICS:** Number of sediment sources identified
- **LOCATION(S):** Escambia watershed; Blackwater watershed; Yellow River basin; Areas with eroding soils; Active construction zones; Bare ground Agriculture areas

ACTION 4.2.3

Collaborate with partners to prioritize, develop, design, and implement sedimentation reduction and remediation projects

IMPLEMENTATION STRATEGY

Identify partners and potential funding sources for prioritized sedimentation reduction and remediation projects

- **TIMEFRAME:** 2022 – 2023
- **PPBEP ROLE:** Leader
- **PARTNERS:** FDEP, ADCNR, NRCS, FDOT, Counties
- **FUNDING:** Needed
- **DELIVERABLES:** List of potential project concepts and identified funding sources
- **PERFORMANCE METRICS:** Number of projects identified and planned; Number of priority source areas addressed
- **LOCATION(S):** Watershed-wide; Areas of greatest concern for sediment inputs into bay systems (Carpenter, Pine, Moore, Sandy Hallow Creeks)

Objective 4.3
Address unpaved roads as a source of sedimentation

Objectives

To assist partners in identifying unpaved roads causing sedimentation issues within Pensacola and Perdido Bays watersheds and partner with other organizations to obtain funding to address sedimentation coming off those roads.

Status

Ongoing. DEP's Pensacola Bay Unpaved Roads Initiative is actively identifying and prioritizing unpaved roads and stream crossings to be addressed through future projects to improve water quality in the Pensacola Bay watershed. Fifteen locations will be identified to reduce sediment loading to Pensacola Bay.

Unpaved Road Near the Perdido River, FL
PPBEP

BACKGROUND

There are over 1.6 million miles of dirt and unpaved roads in the United States (USDA 2012). Unpaved roads are used for a multitude of transportation purposes, including agricultural, construction, rural, private, and silvicultural purposes. Unpaved roads can adversely influence surrounding environments, including streams, rivers, other waterbodies, and riparian zones, through erosion and increased sediment delivery. Counties throughout Florida and Alabama have utilized the "hilltop to hilltop" program which surveys dirt roads and assesses overall condition to assist in road paving prioritization. The erosion and sedimentation from unpaved roads have the potential to negatively affect downstream aquatic habitats, benthic organisms, and water quality.

Tributaries in the Pensacola and Perdido watersheds are known to be affected by sedimentation from unpaved roads (NWFWMD 2017). Ongoing oyster mapping and monitoring efforts in Pensacola Bay have identified heavy siltation of oyster reefs in the upper reaches of the Bay, due to sedimentation from a variety of human-induced sources. Projects have been developed by agencies such as DEP and TNC to stabilize some unpaved roads with the Pensacola and Perdido Bays watershed to improve water quality. Most recently, DEP received funds from NRDA to identify unpaved roads and prioritize 15 of those roads for future unpaved roads stabilization projects. The PPBEP will coordinate and identify potential partners and funding sources for future sediment remediation projects in the watersheds, particularly projects that address unpaved roads.

ACTION 4.3.1

Identify unpaved roads and their contributions to water quality impairments, and prioritize for paving or removal efforts

IMPLEMENTATION STRATEGY

Partner to identify key sources of sediment inputs due to unpaved roads in the watersheds and develop framework for prioritization

TIMEFRAME: 2023 – 2025

PPBEP ROLE: Collaborator

PARTNERS: DEP, Universities, FDOT, ADEM, NWFWMD, NRCS, BFA, Counties, Cities

FUNDING: Committed and Pursuing

DELIVERABLES: Report on status of and priority of unpaved roads and identified impacts to water quality; Framework for prioritization and future improvements

PERFORMANCE METRICS: Number of unpaved roads identified as sediment sources; Number/miles of unpaved roads prioritized for future remediation

LOCATION(S): Pensacola Bay watershed; Agriculture BMPs

Unpaved Road Near the Perdido River, FL

PPBEP

Objective 4.4

Assess the effects of sediment dynamics and resuspension on benthic habitats

Objectives

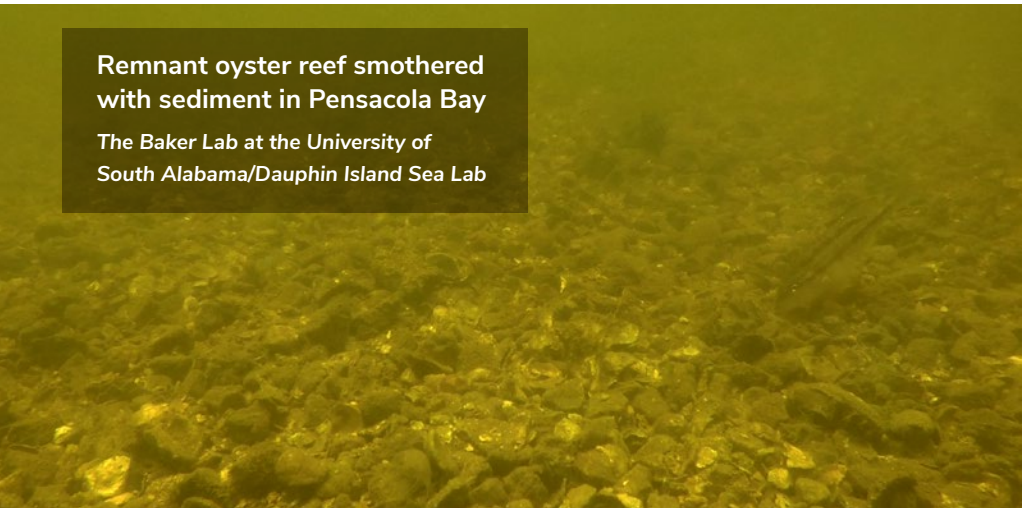
Identify areas within the Pensacola and Perdido Bays impacted by sedimentation and better understand bay bottom type to lessen impacts of sedimentation on submerged habitats and provide information to assist in oyster restoration in Pensacola Bay.

Status

Ongoing. During Summer 2021 oyster mapping efforts were conducted to assess bottom type, including buried shell, in Escambia and East Bays. TNC received funding to conduct the East Bays survey and PPBEP filled a gap and funded a similar mapping effort in Escambia Bay. These surveys highlight areas of Pensacola Bay that succumbed to sedimentation and provides the groundwork to assess the effects of sediment dynamics on oysters and other submerged habitats in Pensacola and Perdido Bays.

Related Actions

Oyster Fisheries and Habitat Management Plan for the Pensacola Bay System Strategy PPBEP4



Remnant oyster reef smothered with sediment in Pensacola Bay

The Baker Lab at the University of South Alabama/Dauphin Island Sea Lab

BACKGROUND

Estuarine bottom types are heterogenous, contributing to differences in sediment quality and quantity and the sustainability of benthic habitats and associated species. For example, oysters need hard bottom substrate to settle upon whereas infaunal organisms may depend on softer substrates. Changes to hard bottom types, including transitions to a softer bottom due to high sediment loading, can change species compositions and cause physiological stress to a multitude of organisms and their different life stages (e.g., high turbidity can smother fish and shellfish). In estuarine and coastal waters, sediment inputs stem from natural sources that are accelerated by human activities, such as land use changes in the watershed. In Pensacola and Perdido Bays, nearshore coastal development is known to cause sedimentation to our systems. For example, land clearing activities from agriculture and silviculture and erosion from unpaved roads has increased sedimentation to the Blackwater River Basin (NWFWMD 2017). To assess the effects of sedimentation and ultimately preserve and conserve good ecological status of benthic habitats in the Pensacola and Perdido Bay systems, bottom type needs to be mapped to assess changes over time and identify areas with sedimentation issues.

Current and future oyster restoration efforts within Pensacola Bay will benefit from bottom type mapping to assess the condition of know oyster reefs, including the degree of sedimentation, and help plan for future restoration site implementation. An ongoing Florida TIG project will also place sediment collectors at various locations in Pensacola Bay to assess sedimentation rates. Implementing a restoration project in areas with high sediment influxes is problematic for the success and resiliency of those restored reefs. The PPBEP will continue to support sediment type and sediment resuspension assessments of the bays. Efforts need to be identified in Perdido Bay to address knowledge gaps of Perdido Bay bottom type.

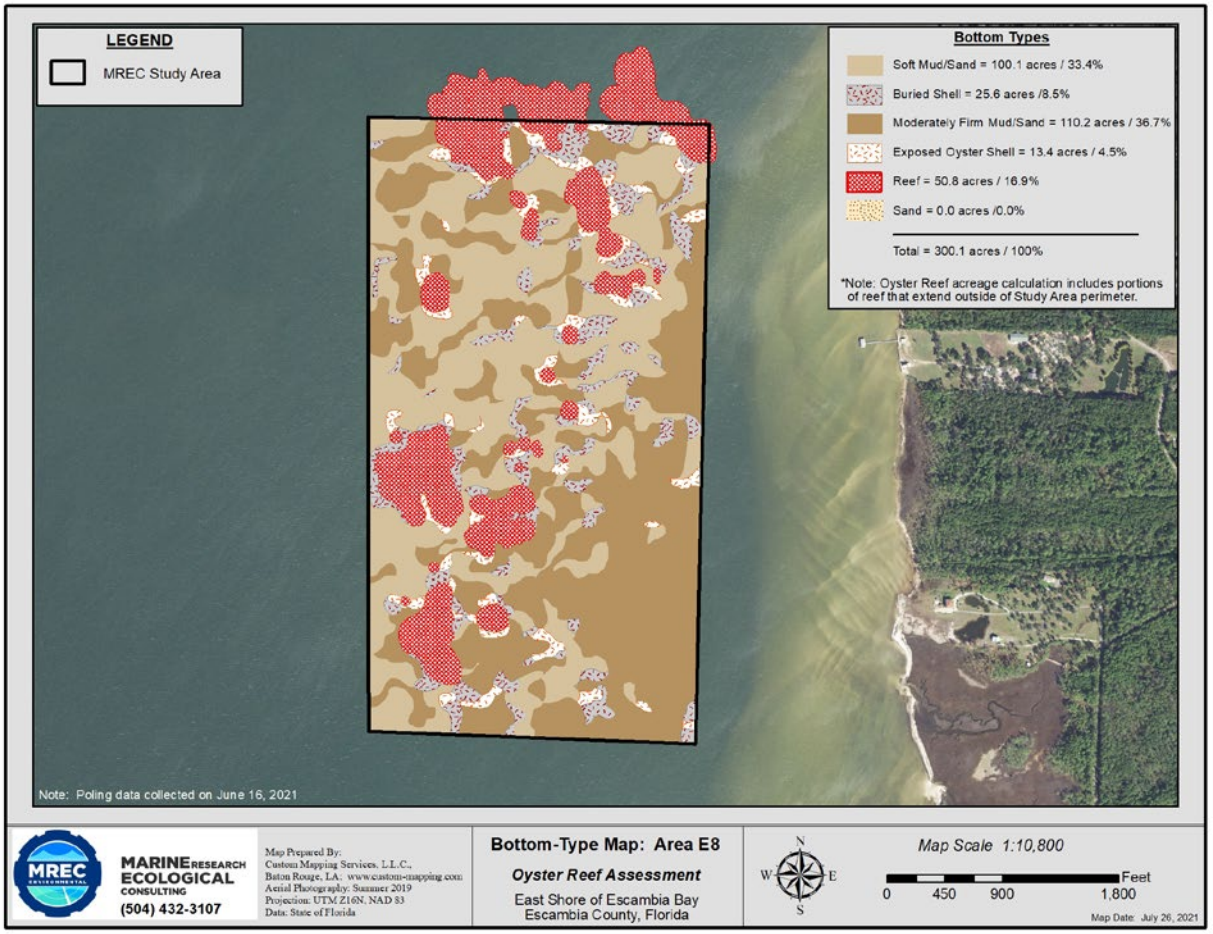
ACTION 4.4.1

Conduct benthic sediment mapping and synthesize existing data to assess sediment type/grain size, transport, and contours

IMPLEMENTATION STRATEGY

Incorporate sediment bottom type data from ongoing oyster mapping efforts in East, Blackwater, Pensacola, and Escambia Bays; Synthesize existing data from partner organizations

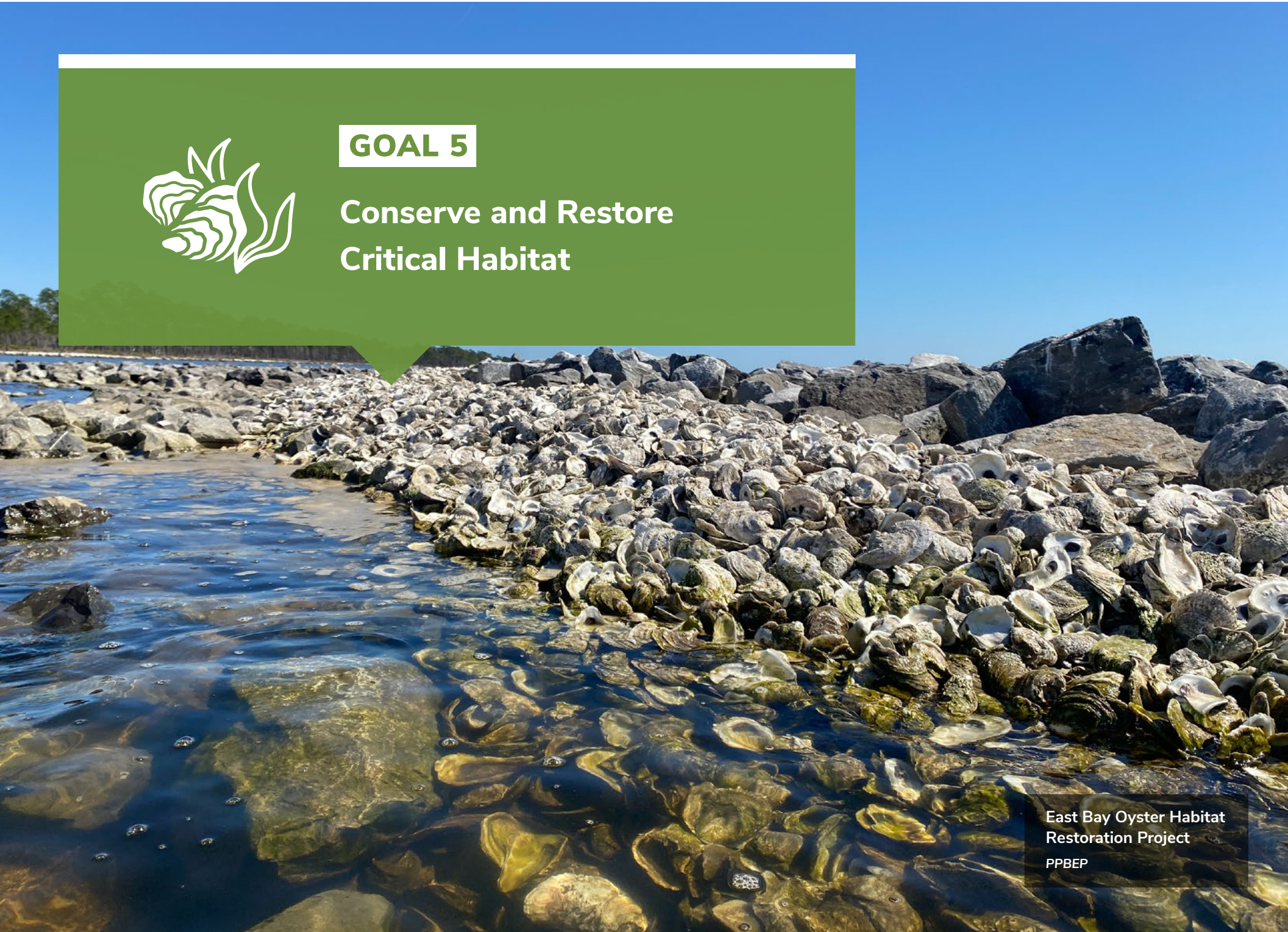
- **TIMEFRAME:** 2022 – 2023
- **PPBEP ROLE:** Leader
- **PARTNERS:** TNC, EPA, NRCS, Universities
- **FUNDING:** Committed - Florida State Appropriation
- **DELIVERABLES:** Report including total area surveyed; Sediment maps and bottom type characteristics for the Pensacola Bay System
- **PERFORMANCE METRICS:** Total acreage and percentage of benthic habitat surveyed
- **LOCATION(S):** Pensacola Bay system; Perdido watershed (future)



Bottom type around an oyster reef scanned during the 2021 oyster bottom type sampling. Grey areas show oyster reefs buried by sedimentation

GOAL 5

Conserve and Restore Critical Habitat



East Bay Oyster Habitat Restoration Project

PPBEP

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

Objectives

Utilize Oyster Sub-Committee members and partners to identify funding sources for implementation and develop a bay-wide monitoring program; Map and monitor existing oyster habitats and add to existing knowledge base and models; Support community-based oyster monitoring and management; Expand oyster spat/gardening programs by engaging volunteers

Status

Ongoing. PPBEP convened a fact-finding Oyster Sub-Committee of the Program's Technical Committee in June 2021 to advise the implementation of the Oyster Fisheries and Habitat Management Plan for the Pensacola Bay System. This sub-committee started as a group of representatives from multiple sectors including state/federal agencies, oyster fishery, local government, aquaculture, academia, local community groups, development, and businesses that were part of a Stakeholder Working Group (SWG) lead by The Nature Conservancy (TNC) in 2019 for the initial development of the Management Plan. This sub-committee will enable the PPBEP to focus on the long-term protection and restoration of a critical natural resource in our communities: oysters, as both a fishery and a habitat. Using the best available science, leveraging partnerships and funding, the Program hopes to achieve short- and long-term success with oyster outreach and education and restoration across the Pensacola Bay System.

Related Actions

Oyster Fisheries and Habitat Management Plan for the Pensacola Bay System Strategy PPBEP2, PPBEP3, A3, and PPBEP5; Education and Outreach Strategic Plan Actions 1.1.1, 1.2.1, and 1.2.2

BACKGROUND

Oysters are sessile filter feeding invertebrates that create complex reef structures that provide homes for other organisms including mussels, crabs, small fish, and shrimps. Oysters are a keystone species and ecosystem engineers that can also act as an environmental health indicator. In our region, reefs are comprised of the eastern oyster (*Crassostrea virginica*), and they are found in intertidal and subtidal estuarine ecosystems along the Gulf Coast. Oyster reefs provide ecosystem services that impact our quality of life. Reefs provide nursery and foraging habitat for economically and recreationally important fish and invertebrate species, protect and stabilize our shorelines from storms and wave action, sequester nutrients, and filter our waters (Grabowski and Peterson 2007). Oyster reefs have the potential to save communities $85,000 per year per hectare when

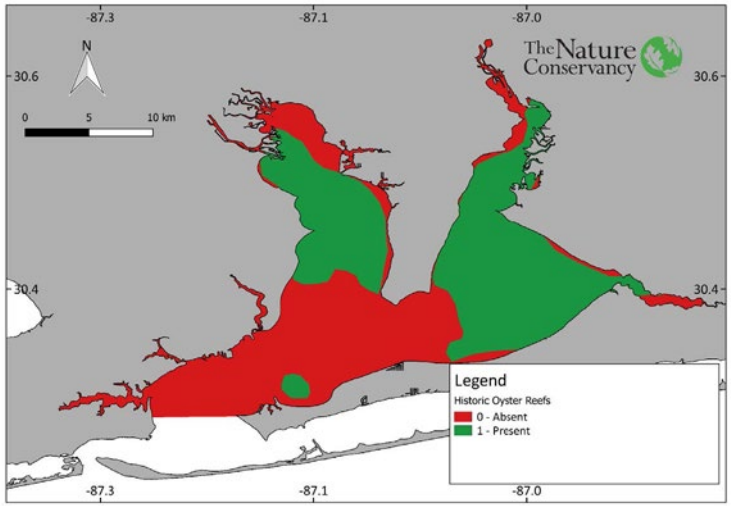


FIGURE 14. Historical oyster reef presence from 1883 throughout Escambia, Pensacola, Blackwater, and East Bays based data from the U.S. Fish Commission

TNC

used in place of artificial breakwaters or other hardened structures (Spalding et al. 2016). These functions also provide secondary benefits including fish production and healthy and extensive submerged aquatic vegetation, like seagrass beds, that rely on clear water and sunlight for growth and production. In turn, these plants can store carbon, trap sediments, and sequester nutrients further improving the health of our estuaries.

Historically, the Pensacola Bay system including East, Blackwater, and Escambia Bays had extensive oyster reefs, represented by the earliest map of oyster coverage in 1883 (Figure 14). Globally an estimated 85% of oyster reefs have been lost (Beck et al. 2011), and regionally in Pensacola Bay, only an estimated ~240 acres of reef remained as of 2015 (FWC 2019) (Figure 15). Oyster declines are due to human-induced impacts including overfishing, sedimentation, and algal blooms. Other threats to oysters include suboptimal and fluctuating salinities, climate change and sea level rise, disease, and oil spill impacts (Radabaugh et al. 2022). Declines in oyster extent and health could mean a subsequent decline in the economy, seagrass coverage, water quality, and associated fish and shellfish communities that rely on this natural resource.

While shellfish harvesting is permitted in approved or conditionally approved harvest areas in Pensacola Bay (National Shellfish Sanitation Program) , Perdido Bay waters are unclassified due to no known oyster reefs present and thus oystering is prohibited (DWH NRDA Trustees 2017). For these reasons, the Program decided to focus on oyster related efforts in the Pensacola Bay System for our first CCMP to align with priorities set in other state-wide management plans.

Oyster Fisheries and Habitat Management Plan for the Pensacola Bay System

Currently, there are no known oyster plans in the United States that utilize a holistic oyster management approach, such as bay-wide oyster management (Birch et al. 2021). In coordination with the state and community stakeholders, The Nature Conservancy (TNC) piloted the first bay-scale recovery plan for the Pensacola Bay System. TNC used a transparent, inclusive, and consensus-based decision-making process that encouraged collaboration and support from all sectors across the community. The result was meant to be a model for other bay systems that strive for community ownership and management based on the best available science. The State of Florida is due to kick off a similar state-wide planning effort in 2022. The Oyster Fisheries and Habitat Management Plan for the Pensacola Bay System took 1.5 years to complete and included 4 themes: Ecology, Wild Harvest and Aquaculture, Economy, and Public Education and Communication.

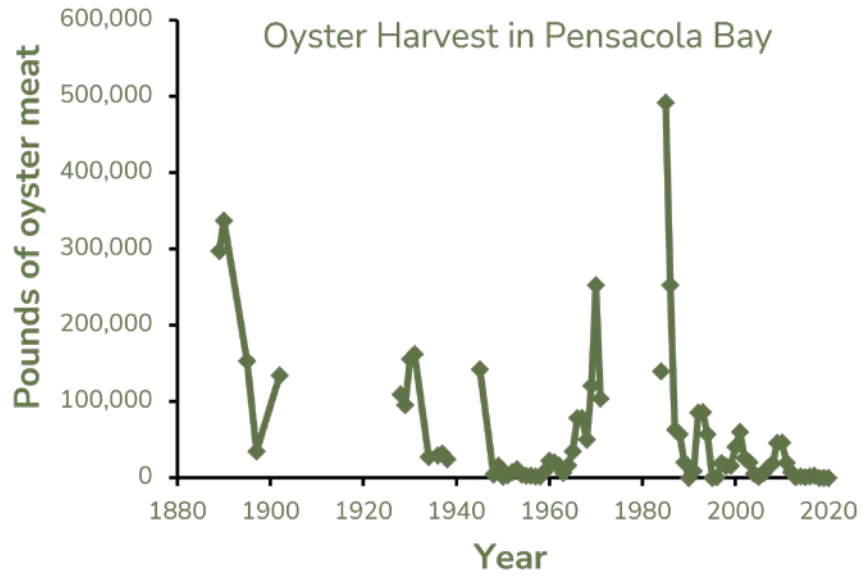


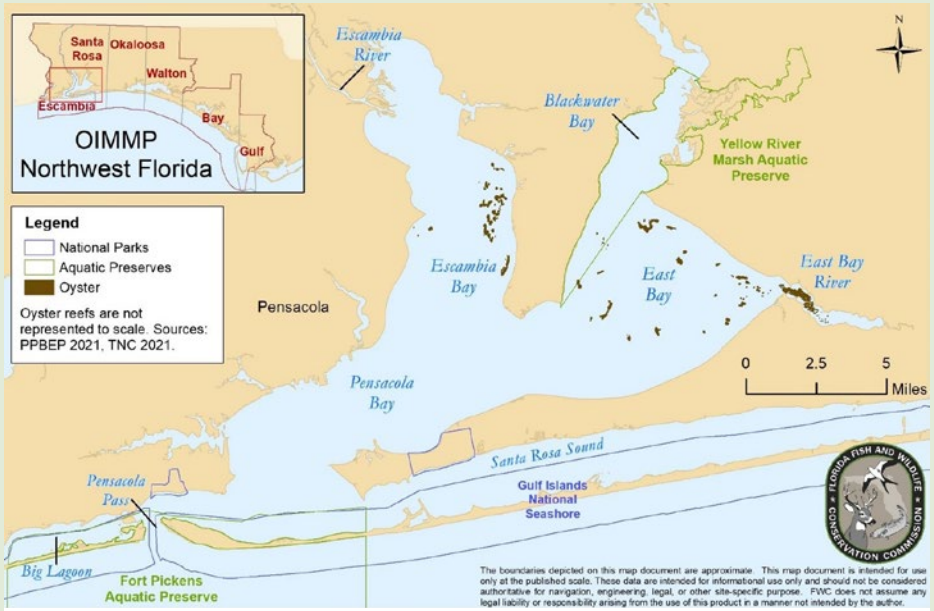
FIGURE 15. Oyster landings (lbs) from 1880 to 2020 in Pensacola Bay
U.S. Commission of Fish and Fisheries

Oyster associated projects

Oyster Mapping

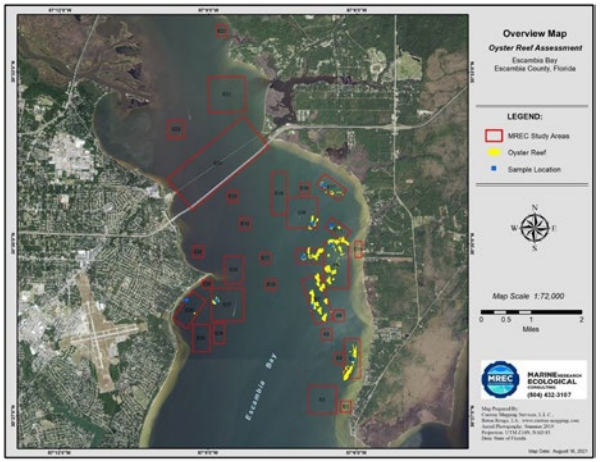
Santa Rosa County contracted TNC to complete oyster mapping and condition assessment for Blackwater and East Bays using RESTORE funds. Preparation for oyster habitat mapping included an analysis of the data gaps in oyster resources from both bays to establish a baseline of the extent and condition of existing oyster reefs. Oyster habitat mapping included compiling and preparing aerial imagery, existing maps, and associated Geographic Information Systems (GIS) shapefiles of intertidal and subtidal oyster reef habitat within the project area and conducting ground truthing and condition analysis on any mapped reefs. The same methodology was employed in Escambia Bay by Marine Research Ecological Consulting (MERC) for the PPBEP with funding appropriated by the State of Florida legislature. These two mapping efforts provide comprehensive information on the remnant and restored oyster reefs in the PBS. Both projects were completed by September 2021. The data sources were used to create preliminary maps of oyster habitat, identify gaps in existing mapped areas and in areas not yet mapped throughout the bays, and make recommendations for future oyster restoration and management.

Across the Gulf Coast, stakeholder working groups have convened to focus on statewide and regional collaboration for the protection and restoration of oyster reefs throughout the region. In 2016, The Florida Fish and Wildlife Conservation Commission (FWC) started a series of workshops to bring



Bays and mapped oyster extent in the Pensacola Bay System.

Oyster mapping sources: PPBEP (2021) and TNC (2021), each mapped from side-scan sonar in 2020–2021. Map source: FWC OIMMP Report 2022



Areas mapped for reef extent across Escambia Bay (red boxes), oyster quadrat sampling locations (blue symbols), and current oyster reef coverage (yellow)

Pensacola East Bay Oyster Habitat Restoration Project

Darryl Boudreau, NWFWMD

stakeholders together (e.g., oyster scientists, managers, non-profits, community organizations) throughout Florida to develop an Oyster Integrated Mapping and Monitoring Program (OIMMP), which focuses on the status of oysters and the future of the resource. The Pensacola Bay System is part of the Northwest Florida chapter of this program and a technical report gets updated and published every few years highlighting relevant oyster data, recommendations for oyster management, mapping, and monitoring.

Local Oyster Restoration Projects

Many agencies and community organizations are currently leading restoration projects and monitoring in the Pensacola Bay system. The Bream Fishermen Association in partnership with University of West Florida (UWF) implemented Project Oyster Pensacola (POP) in 2018. Cages were stocked with locally reared oysters, deployed off docks to grow oysters, track oyster survival, and monitor water quality and invertebrate communities within the cages. The goal of the pilot project was to increase community awareness about the importance of oysters and their connection to water quality, engage the public in research, and to provide baseline information for future oyster restoration efforts.

Other small and large-scale oyster restoration throughout the Pensacola Bay System include:

- NRDA cultched reefs
- East Bay Living Shoreline Project
- NAS Pensacola Living Shoreline
- DEP Living Shoreline projects on private property
- Navy Point Living Shoreline Project
- Reef prism (Santa Rosa County Extension)
- EscaRosa OysterCops

Oyster Restoration Site Selection Workshop

PPBEP

ACTION 5.1.1

Form and convene a sub-committee to assist in implementing the Oyster Fisheries and Habitat Management Plan for the Pensacola Bay system

IMPLEMENTATION STRATEGY

Utilize a committee to assist with project planning, implementation, monitoring, and policy recommendations

- **TIMEFRAME:** Ongoing
- **PPBEP ROLE:** Co-Leader
- **PPBEP ROLE:** Leader
- **PARTNERS:** TNC, FDACS, DEP, Private sector, Aquaculture farmers, Wild harvesters, Community science groups, Cities, Counties, Universities
- **FUNDING:** Committed
- **DELIVERABLES:** Established an active Oyster Sub-Committee supporting the Oyster Fisheries and Habitat Management Plan for the Pensacola Bay system development
- **PERFORMANCE METRICS:** Number of partners engaged; Number of project proposals submitted
- **LOCATION(S):** Pensacola Bay System

ACTION 5.1.2

Create a comprehensive restoration approach for Oyster Plan implementation including a comprehensive analysis for future grant funding and implementation strategies

IMPLEMENTATION STRATEGY

Work with partners (e.g., Oyster Sub-Committee) to develop a strategy for future project implementation

- **TIMEFRAME:** 2022
- **PARTNERS:** TNC, FWC, FDACS, Aquaculture farmers, Community science groups, Universities, Watermen
- **FUNDING:** Committed – Florida State Appropriation; Pursuing
- **DELIVERABLES:** Comprehensive restoration approach document/protocol
- **PERFORMANCE METRICS:** Number of grants awarded; Total grant funds allocated
- **LOCATION(S):** Pensacola Bay watershed

ACTION 5.1.3

Conduct long-term monitoring to assess oyster condition and spat production and assess the effects of oysters to long-term environmental change

IMPLEMENTATION STRATEGY

Engage Oyster Sub-Committee members to assist in developing monitoring strategy using existing regional oyster planning documents and handbooks; Conduct an oyster filtration rate model in partnership with TNC; Conduct baseline native oyster reef surveys to assess oyster condition and fisheries habitat

- **TIMEFRAME:** 2023 – 2026
- **PPBEP ROLE:** Collaborator; Facilitator
- **PARTNERS:** Universities, Community science groups, FWC (Matt Davis and Ryan Gandy), FDA, TNC, FDACS, Aquaculture farmers, FORS Working Group
- **FUNDING:** Needed
- **DELIVERABLES:** Oyster monitoring strategy (handbook) incorporated into Comprehensive Monitoring Plan
- **PERFORMANCE METRICS:** Number of sites/locations monitored
- **LOCATION(S):** Pensacola Bay watershed

ACTION 5.1.4

Host and support oyster restoration projects in the Pensacola Bay system to improve native oyster populations

IMPLEMENTATION STRATEGY

Develop or expand oyster spat and/or oyster gardening; Host shell bagging or oyster spat monitoring construction events; Hold volunteer events to construct and deploy plastic free oyster reef prisms; Create and manage a prioritized list with spatially explicit maps of restoration project for the Pensacola Bay System on the Habitat Suitability Model outputs; Participate in TNC East and Blackwater Bay Restoration Project and Pensacola Bay Living Shoreline Project (Escambia County)

- **TIMEFRAME:** 2022 – 2026
- **PPBEP ROLE:** Leader; Promoter
- **PARTNERS:** Oyster Sub-Committee members, UWF, College/university students, FWC (methodology/coordination), DEP, Escambia County and Santa Rosa County oyster shell recycling programs, Sea Grant, DEP, PROS, UF-IFAS
- **FUNDING:** Pursuing
- **DELIVERABLES:** List of oyster restoration projects conducted
- **PERFORMANCE METRICS:** Number of oyster restoration projects; Number of volunteers engaged; Tons of recycled oyster shell deployed
- **LOCATION(S):** Pensacola Bay watershed

Oyster Restoration Site Selection Workshop

PPBEP

Objective 5.2

Assess seagrass health and distribution and develop a restoration strategy for long-term protection and recovery

Objectives

Update the current extent and condition of seagrass beds across the Pensacola and Perdido Bay watersheds; Engage stakeholders in a participatory planning process to learn from the past to develop a future restoration strategy for seagrasses increasing their resiliency to climate stress by incorporating genetic diversity metrics.

Status

Ongoing. PPBEP's partnership with the University of New Orleans and Mississippi State University on a NOAA Actionable Science Grant (2021 – 2022) has enabled the Program to engage with a wide range of stakeholders including researchers, practitioners, and community stakeholders to develop a strategic plan for future seagrass restoration based on future climate change scenarios. The goal of this project is to reduce unknowns for restoration success by focusing on the inclusion and benefits of genetic variation. Steps include conducting a literature review of seagrass health, genetic diversity, and resiliency, determining community values and perceptions of seagrass habitats, inventorying past and present planning efforts, and evaluating the effectiveness of restoration techniques. The project team selected ten members from various local agencies and organizations (e.g., FWC, DEP, MBNEP, Seagrass CoP, TNC) to serve on an Advisory Panel to help guide the project engagements and deliverables. Future partnerships with the Dauphin Island Sea Lab, Gulf Coast Research Lab, University of West Florida, and UF/IFAS Sea Grant Extension will allow for increased monitoring capacity throughout the bays while engaging members of the community.

Related Actions

Education and Outreach Strategic Plan Action 2.1.1

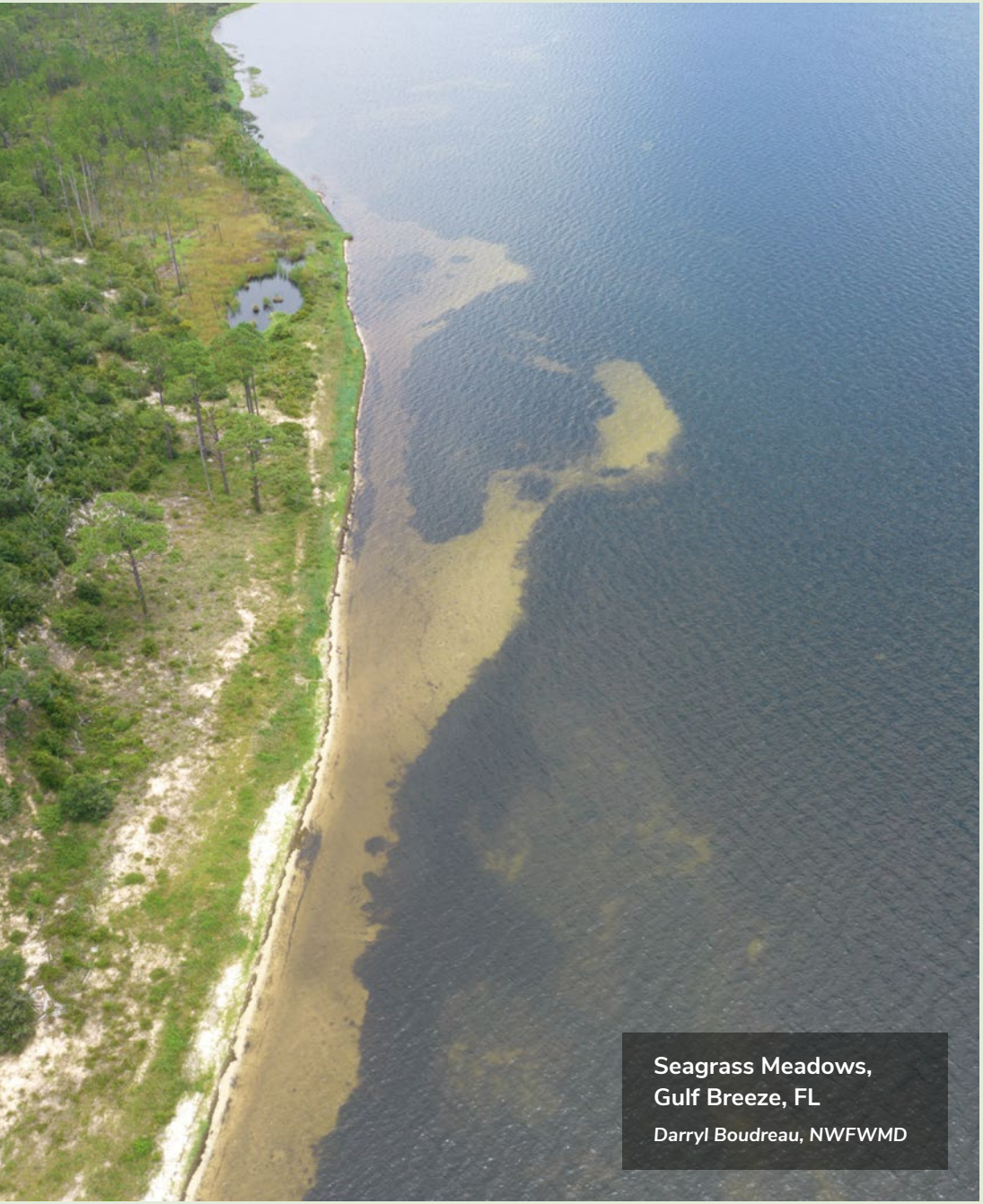
BACKGROUND

Seagrass beds are important aquatic ecosystems across the Gulf of Mexico and tropical and temperate zones around the world. These marine flowering plants provide many benefits to various fish and shellfish species including food resources and protection from predators. They also sequester nutrients from the water column, store carbon, trap sediments, and act as a storm and wave buffer protecting shorelines from erosion which are all valued ecosystem services provided to our coastal communities.

The shallow coastal zones of the Perdido and Pensacola Bay systems are dominated by shoalgrass (*Halodule wrightii*) mixed with other less abundant species, turtle grass (*Thalassia testudinum*) and manatee grass (*Syringodium filiforme*). Seagrasses extend from the lower

Mixed seagrass bed of turtle grass (wide flat blade; *Thalassia testudinum*) and manatee grass (narrow cylindrical blade; *Syringodium filiforme*)

PPBEP



Seagrass Meadows, Gulf Breeze, FL

Darryl Boudreau, NWFWMD

Perdido Islands and Big Lagoon to the Pensacola Bay System and Santa Rosa Sound. Other species of submerged aquatic vegetation (SAV) are present in the upper bays and more freshwater or brackish (freshwater mixed with saltwater) environments including the most common wild celery or eelgrass (*Vallisneria americana*) and widgeon grass (*Ruppia maritima*).

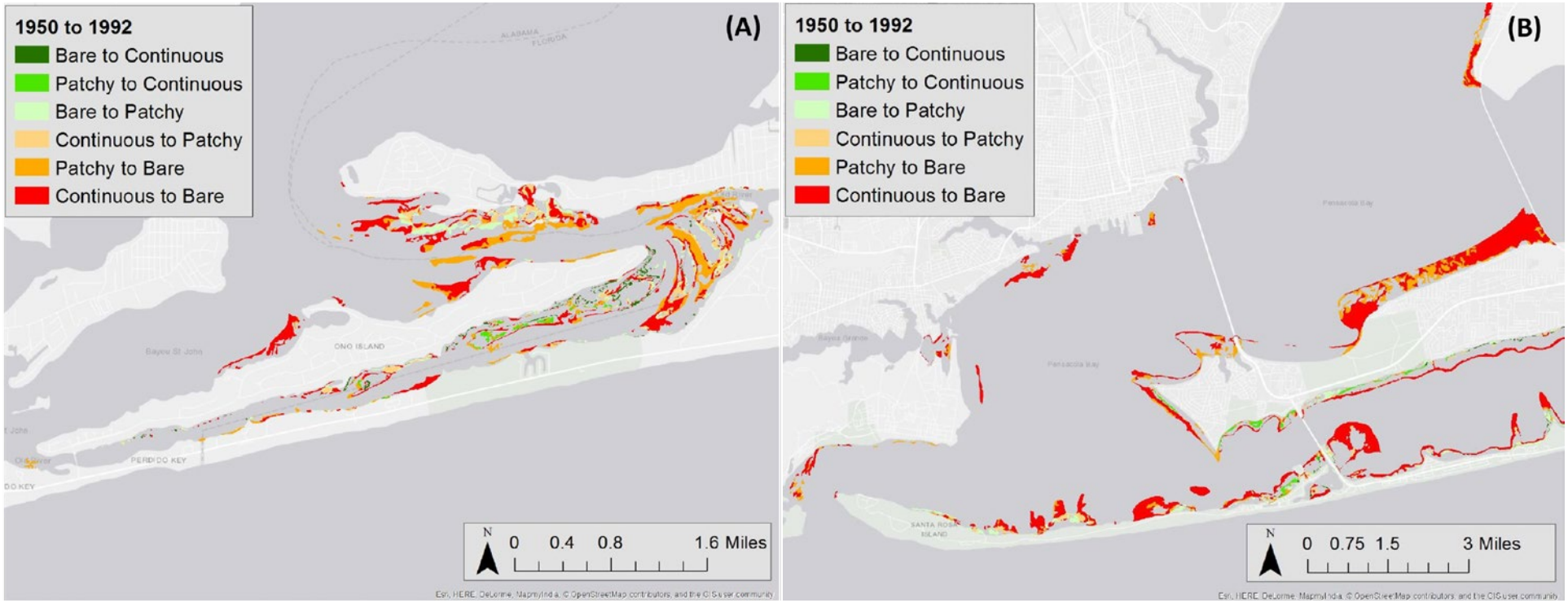
Between 1987 and 2002, approximately 80% of the seagrass acreage had disappeared in Perdido Bay, leaving only 122 acres (FWC, SIMM 2018). However, since a 2010 mapping effort, there has been a 27% increase in seagrass coverage. South Pensacola Bay, East Bay, and Santa Rosa Sound lost 60% of seagrass coverage between 1955 and 2017, although seagrass cover did increase (primarily in Santa Rosa Sound) by 13% (454 acres) from 2010 to 2017 (FWC, SIMM 2018). Although some of these losses can be attributed to disturbance during tropical storms, poor water quality and propeller scarring are the two most common impacts or roadblocks to recovery of seagrass communities in our estuaries (FWC, SIMM 2020). Other stressors include dredging, sedimentation, eutrophication (growth of algae from excess nutrients in the water column), land use changes, and altered hydrology (distribution and flow of water across the landscape). These stressors can cause negative impacts, including habitat fragmentation and localized or large-scale die-offs.

Comprehensive long-term mapping and monitoring programs are critical for tracking the status and trends of seagrass habitats over time, informing future restoration, and potentially preventing future extensive damages. The Gulf of Mexico (GOM) Seagrass Community of Practice (CoP) was established in 2017 to support the management, research, restoration, and conservation of seagrasses in shallow coastal environments throughout the Gulf. The CoP's goals are to facilitate information exchange, maximize collaboration by connecting experts and practitioners, and improve advocacy efforts around seagrass efforts. In addition, existing planning, research, monitoring, and restoration efforts that have been conducted or are currently active throughout the Perdido and Pensacola Bay systems, including (but not limited to):

- Gulf Frontal Watershed Management Plan (Lead: MBNEP)
- Perdido Islands Management Plan (Lead: Orange Beach, TNC)
- Community science monitoring program and research lead by partners at the University of West Florida and UF/IFAS Sea Grant Extension office. The have community members and students monitor sites throughout Big Lagoon, Santa Rosa Sound, and
- The Florida Fish and Wildlife Conservation Commission's (FWC) statewide Seagrass Integrated Mapping and Monitoring Program (SIMM) was developed to protect and manage seagrasses in Florida by providing a collaborative resource for data sharing and to provide stakeholders and natural resource managers a summary of the status of seagrasses on a regular basis.
- The Florida Department of Environmental Protection (DEP) manages seagrasses and SAV and conducts semi-annual monitoring within our Aquatic Preserves, including Yellow River Marsh Aquatic Preserve and the Ft. Pickens Aquatic Preserve within the Pensacola Bay watershed.
- Gulf Coast Research Lab lead seagrass monitoring through NPS boundaries in coastal Alabama and Florida panhandle.
- The Dauphin Island Sea Lab (DISL) has conducted seagrass monitoring and restoration projects in the Pensacola and Perdido Bay Systems since the early 2000s. Researchers at the DISL have carried out many studies that mapped seagrass extent in Perdido Bay, and monitored seagrass cover, ecological condition, and carried out seagrass restoration in Perdido bay and Big Lagoon using several different techniques.

Birdstake Restoration
DISL

As noted above, PPBEP has partnered with researchers at the University of New Orleans and Mississippi State University through a NOAA Actionable Science Grant opportunity to develop a strategic plan for seagrass restoration incorporating resilience through genetic diversity. To expand on existing efforts and fill stakeholder identified data gaps, the PPBEP has also partnered with the DISL to map seagrass extent in both the Perdido and Pensacola Bay Systems using multispectral digital imagery and with the University of Southern Mississippi's Gulf Coast Research Lab (GCRL) to survey seagrass for percent cover, species composition, and overall condition during the peak growing season (Summer/Fall 2022). This work will inform the status and trends of seagrass coverage and condition in our bays, bayous, and sounds which will assist with future protection measures, restoration projects, and contribute to the implementation of the Program's Comprehensive Monitoring Strategy.



Seagrass coverage changes over time from 1950 to 1992 in (A) lower Perdido Bay and (B) South Pensacola Bay and western Santa Rosa Sound

FWC

ACTION 5.2.1

Conduct seagrass mapping and surveys (aerial and ground truth surveys) to assess the current extent, distribution, and condition of seagrass species in the Pensacola and Perdido Bay systems.

IMPLEMENTATION STRATEGY

Utilize and expand existing community science monitoring programs in the Pensacola and Perdido Bay systems; Continue to conduct annual surveys; Build on existing mapping efforts and identify coordinating agency to conduct future aerial surveys

TIMEFRAME: 2022 – 2026 (At least every 3–5 years)

PPBEP ROLE: Leader; Collaborator

PARTNERS: DISL, GCRL, NPS, Seagrass CoP, Universities, Sea Grant IFAS Extension, UWF, FWC

FUNDING: Committed – EPA, AL COE

DELIVERABLES: Seagrass extent maps reported in the State of the Bay

PERFORMANCE METRICS: Maps of percent cover and acreage of seagrass and species diversity

LOCATION(S): Pensacola and Perdido Bays

ACTION 5.2.2

Evaluate current protection measures and develop a comprehensive restoration strategy for seagrass/SAV

IMPLEMENTATION STRATEGY

Work with partners to set short and long-term restoration goals for the Pensacola and Perdido Bay systems; Support and expand on seed-based restoration projects (e.g., wild celery, *Vallisneria americana*) and propeller scar restoration; Evaluate genetic resilience of seagrasses

TIMEFRAME: 2021 – 2022

PPBEP ROLE: Collaborator

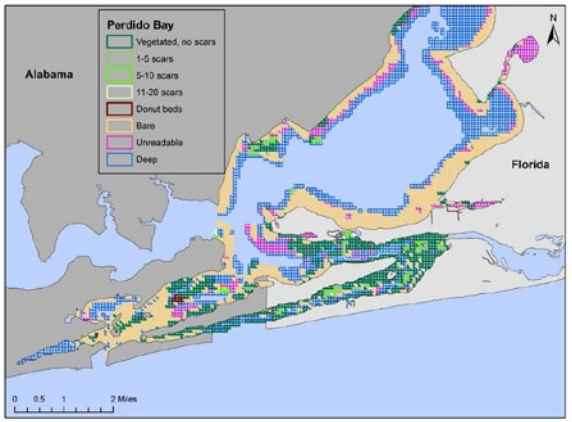
PARTNERS: UNO, Seagrass CoP, Universities, DISL, DEP, USM, TNC, MBNEP

FUNDING: Committed and Pursuing - NOAA Actionable Science Grant

DELIVERABLES: Comprehensive Restoration Strategy developed, including how best to incorporate genetic diversity into seagrass restoration

PERFORMANCE METRICS: Identification of restoration goals (e.g., number of restoration projects identified, acreage to be restored); Implementation funding acquired

LOCATION(S): Watershed-wide



Scoring of 1 hectare grid cells for propeller scarring throughout lower Perdido Bay seagrass beds

FWC SIMM Report 2018

Objective 5.3

Improve and support the health and resiliency of native ecosystems in the Pensacola and Perdido Bay watersheds

Objectives

Define habitat conservation and restoration targets and collaborate with partners to monitor select native ecosystems and invasive species throughout the Pensacola and Perdido Bays watersheds

Status

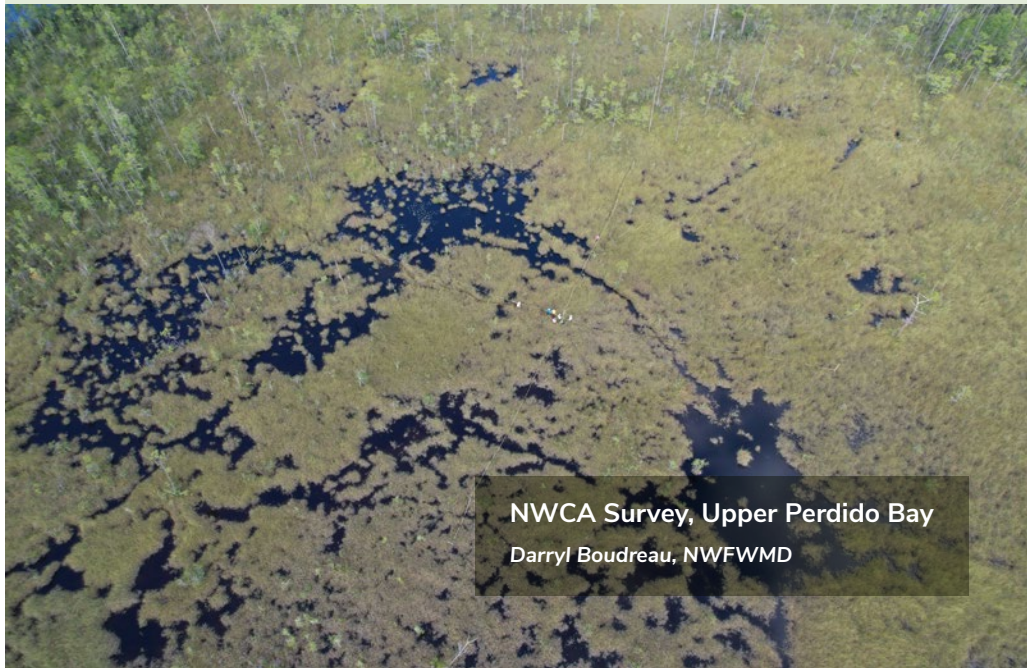
Ongoing. The PPBEP conducted an intensification of the EPA's National Wetlands Condition Assessment in summer 2021 as part of the National Aquatic Resource Survey (NARS) Program. The Program partnered with EPA staff to randomly select an additional 30 stations in designated estuarine wetlands across the Perdido and Pensacola watersheds to add to EPA's original sampling strategy. The survey was conducted in partnership with researchers at the University of Florida and the University of West Florida. Santa Rosa County, PPBEP, and Troy University secured NFWF funding to conduct a Living Shoreline Suitability Model and develop a master plan for the Pensacola and Perdido Bay Systems and their shorelines. Project outcomes will function as a tool for assessing impacts to the shorelines due to land use changes and storms, to identify short and long-term coastal resilience needs, and prioritize projects and other activities within the watersheds. In addition to these efforts, the PPBEP will lead coordination among team leads as part of the Mangrove Survey Network (MSN), which intends to track the expansion of black and red mangroves across the northern Gulf of Mexico spanning from Harrison County (MS) to Franklin County (FL). To assess the status and condition of our rivers and streams, the PPBEP plans to conduct an intensification for EPA's National Rivers and Streams Assessment (NRSA) in 2023, like the previously conducted NCCA and NWCA surveys to establish a baseline for future monitoring and restoration efforts.

Related Actions

Education and Outreach Strategic Plan Action 2.2.1

BACKGROUND

Throughout the Pensacola and Perdido Bay watersheds, many native ecosystems need protection and restoration, including freshwater and estuarine wetlands, forests, dunes, rivers, and streams, to ensure they provide our communities with essential ecosystem services. These habitats can stabilize shorelines, filter surface runoff, trap sediments, store carbon, and provide nursery and hunting grounds for many species of fish and wildlife. Environmental stressors such as land use change, sea level rise, and hardening of shorelines can have negative impacts on these critical habitats, which could cause cascading effects including habitat degradation or loss and fisheries and water quality declines. Many native pine forests have been cut for timber, cleared for agriculture, or managed for silviculture (the science and art of growing and cultivating forest crops) (NWFWMD 2017). As coastal development continues to increase, it is important that the PPBEP and its partners prioritize tracking the current extent and condition of existing native ecosystems through regular monitoring and assessments to help inform future management and conservation.

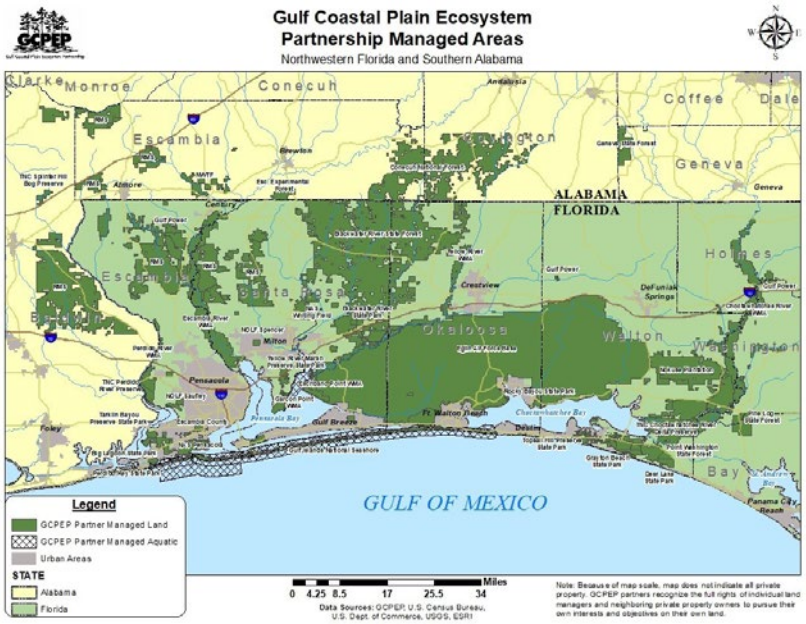


NWCA Survey, Upper Perdido Bay

Darryl Boudreau, NWFWMD

The Florida Department of Environmental Protection (DEP), Northwest Florida Water Management District (NWFWMD), The Nature Conservancy (TNC), Alabama Department of Conservation and Natural Resources (ADCNR), the Longleaf Alliance, county and city governments, and local organizations have prioritized estuarine habitat restoration, strategic land conservation, invasive species management, comprehensive monitoring, and interstate coordination as top priority needs in their management plans.

Six Rivers Cooperative Invasive Species Management Area, part of the Florida Invasive Species Partnership and Cooperative Invasive Species Management Areas (CISMA) network, was established in 2009 to facilitate collaboration among land managers to address the growing threat of invasive and nonnative species in northwest Florida and coastal Alabama. The management area spans Baldwin, Escambia, Santa Rosa, Okaloosa, Covington, Walton, Holmes, and Washington counties. Partners include (but not limited to) the Longleaf Alliance, FWC, USFWS, TNC, USDA/NRCS, NWFWMD, county governments, and UF/IFAS. This network builds upon the previous successes of the Gulf Coastal Plain Ecosystem Partnership (GCPEP) formed in 1996, comprised of 16 private and public partners that collectively own 1.3 million acres containing the remaining old growth longleaf pine trees, some of which are 500 years old (GCPEP, 2019).



Map of the Gulf Coastal Plain Ecosystem Partnership (est. 2014) managed lands in Alabama and Florida

Invasive species are nonnative plants or animals that are introduced into an environment anthropogenically or by human activity (e.g., ship ballasts, produce crates, aquarium trade) that reproduce and spread prolifically and have harmful impacts on the native ecosystem (NOAA, TNC). The top five invasive plant species identified in the Six Rivers Management Area include cogon grass (*Imperata cylindrica*), Chinese Tallow Tree (*Triadica sebifera*), Chinese Privet (*Ligustrum sinense*), Japanese Climbing Fern (*Lygodium japonicum*), and Torpedo Grass (*Panicum repens*). Other invasive species found throughout Alabama and Florida include kudzu (*Pueraria montana*), Tropical Soad Apple (*Solanum viarum*) and aquatic species such as Eurasian Water Milfoil (*Myriophyllum spicatum*) and Hydrilla (*Hydrilla verticillata*). There are also nonnative fishes and mammals throughout our watersheds in freshwater, marine, and upland environments including zebra mussels, lionfish, feral swine, nutria, and the Cuban treefrog which have caused significant damages including the spread of disease, destruction of grasslands, species composition shifts, and direct impacts on threatened or endangered species (FWC, USFWS). Partner agencies (e.g., UF/IFAS, USFWS) have developed removal and management programs to control invaders and restore impacted habitats.

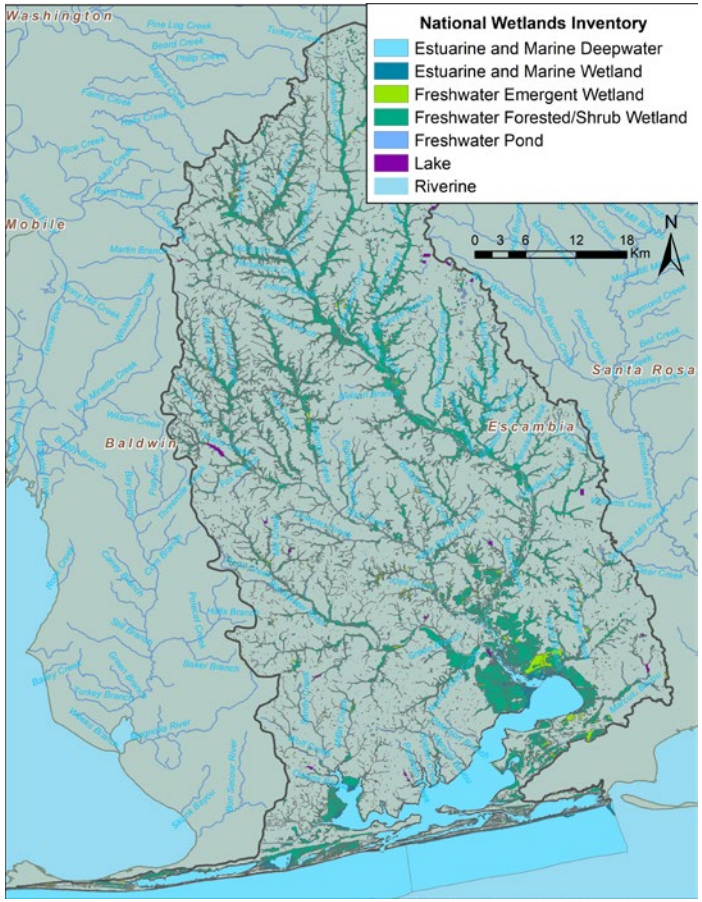
There are many preserves, state parks, and water and wildlife management areas across the Perdido and Pensacola Bay watersheds that focus on the protection and management of wetland habitats, dunes, and forests and are frequently visited by residents and tourists including:

- Jones Swamp Wetland Preserve and Nature Trail
- Big Lagoon State Park
- Blackwater River State Forest
- Perdido Key State Park
- Gulf Islands National Seashore
- Tarkiln Bayou Preserve State Park
- Yellow River Water Management Area

- Lower Escambia River Water Management Area
- Perdido River Water and Wildlife Management Areas
- Perdido Bay/Crown Pointe Preserve
- Lillian Swamp Complex
- Bayou Marcus Wetland
- Conecuh National Forest
- Garcon Bayou Nature Park
- Graham Bayou Nature Preserve
- Bon Secour National Wildlife Refuge
- Splinter Hill Bog Preserve
- Gulf State Park
- Baycliff Preserve
- Covington Wildlife Management Area

Recognizing the importance of wetlands across the US, Congress enacted the Emergency Wetlands Resources Act (1986) which requires USFWS to regularly map the extent of wetlands and produce nationwide status

(a)



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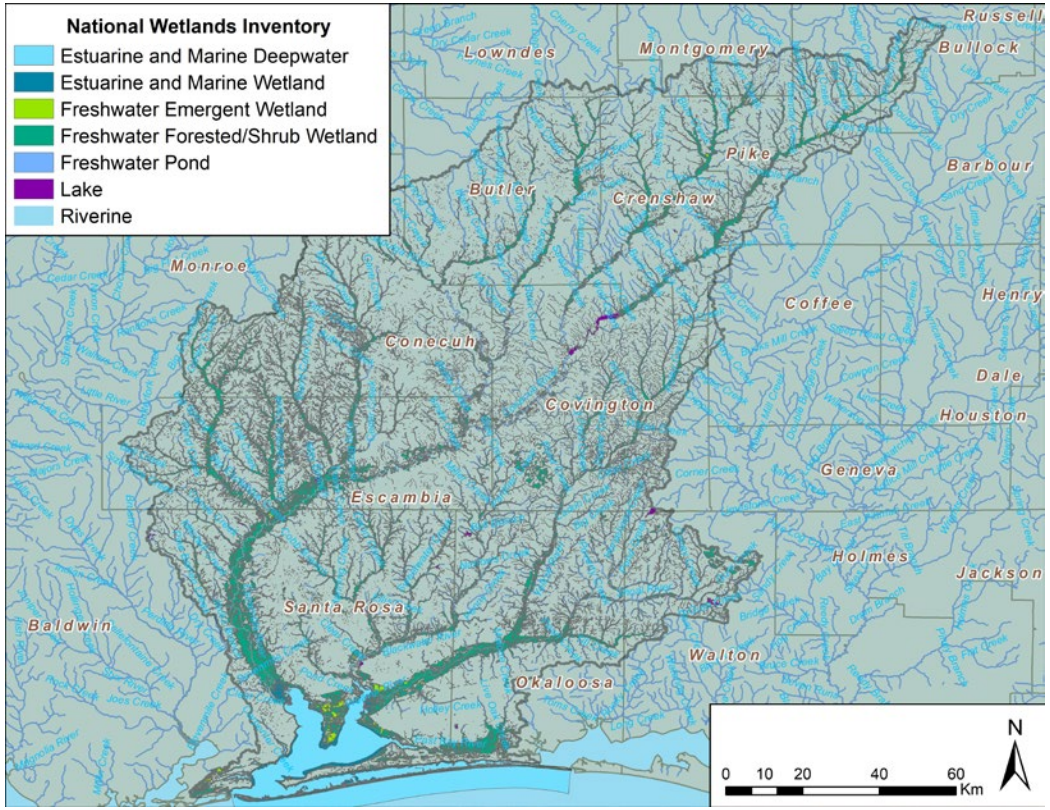


Wetland types in Perdido (a) and Pensacola (b) watersheds.

Data source: National Wetlands Inventory. Data downloaded March 2021.

Living Shoreline

Annabelle Rose Photography

and trends reports every decade (USFWS 2020). The Wetlands Status and Trends project comprises the monitoring component of the National Wetlands Inventory (NWI) program, which provides data for wetland science, management, and policy on local (regional) and national scales. In addition to the NWI program, the National Wetland Condition Assessment (NWCA) and National Rivers and Streams Assessment (NRSA) are both nested under the EPA's National Aquatic Resource Surveys (NARS) are conducted on a 5-year cycle. The NRSA supports a longer-term goal of determining whether the rivers and streams within our nation's watersheds are getting cleaner and how to best invest in protecting and restoring them for future generations. The PPBEP is currently collaborating with EPA staff and to design and implement an intensification (like NCCA and NWCA) of the NRSA in 2023.

Effective long-term comprehensive watershed monitoring is critical for evaluating ecosystem status and trends, predicting, and informing future restoration and management efforts, and demonstrating programmatic success. The Mangrove Survey Network (MSN) was established in 2018 by researchers at Mississippi State University to track the expansion of mangroves along northern Gulf of Mexico (nGOM) coastal counties including: Harrison (MS), Jackson (MS), Mobile (AL), Baldwin (AL), Escambia (AL/FL), Santa Rosa (FL), Okaloosa (FL), Walton (FL), Bay (FL), Gulf (FL), and Franklin (FL). MSN participating partners leads include representatives from academic institutions, Sea Grant Extension, National Estuarine Research Reserves, and other local community organizations. In 2022, the Pensacola and Perdido Bays Estuary Program (PPBEP) became the lead coordinator for the MSN. The MSN is and will continue to be an example of successful collaboration across multiple states, counties, and water bodies allowing for enhanced data collection and tracking. Some partners have implemented community science programs to assist in completing the surveys, allowing for enhanced engagement and education of community members throughout the coastal watersheds.

ACTION 5.3.1

[Wetlands] Conduct regular monitoring surveys to assess the condition of wetlands and buffer zones in the Pensacola and Perdido Bay systems

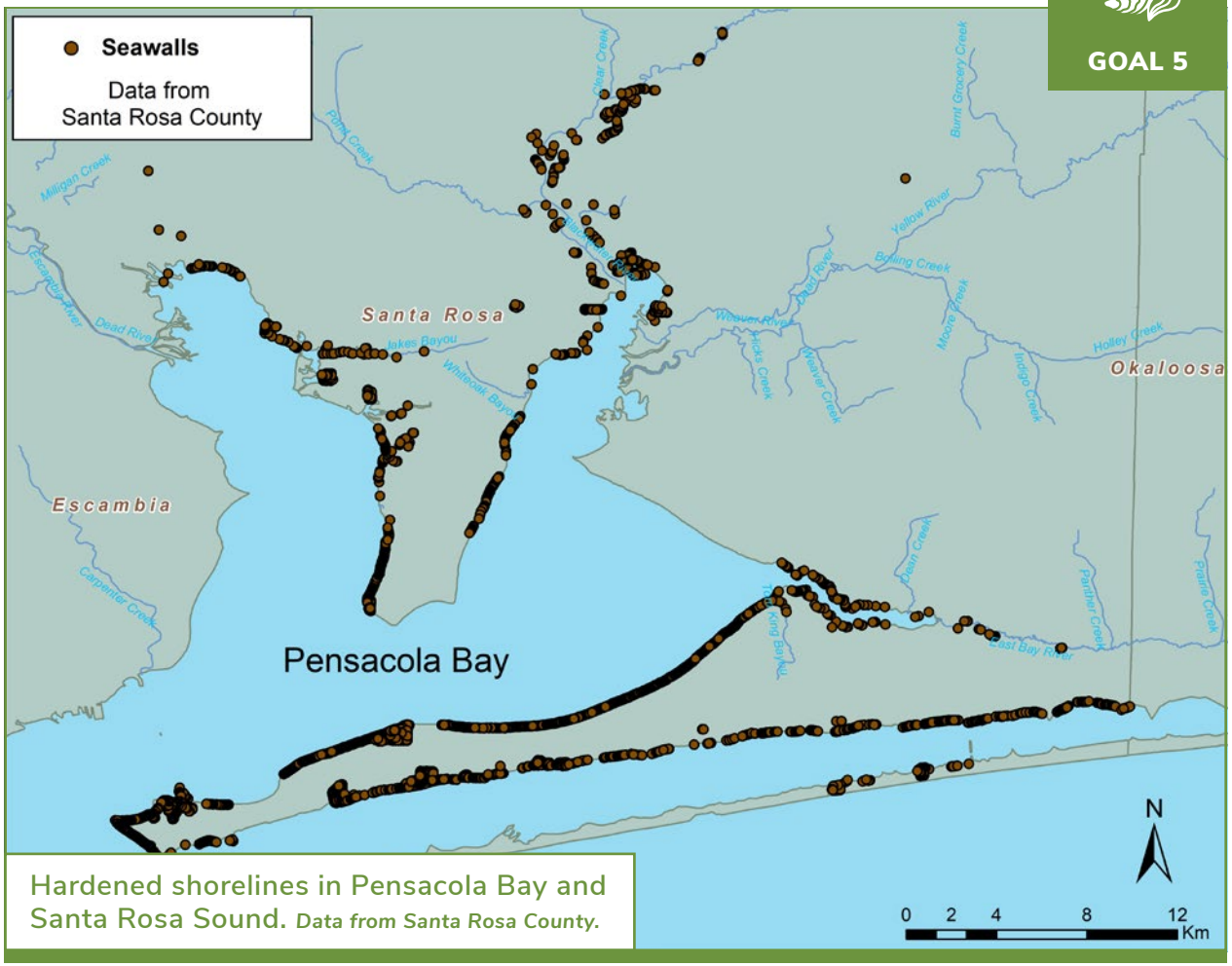
IMPLEMENTATION STRATEGY

Continue to conduct intensification of NWCA for both watersheds

- **TIMEFRAME:** 2026 (every 5 years)
- **PARTNERS:** Universities, EPA, Community science groups
- **PPBEP ROLE:** Leader
- **FUNDING:** Needed
- **DELIVERABLES:** Evaluation report of wetland condition indices in State of the Bays report
- **PERFORMANCE METRICS:** Acreage and percent of wetlands in each wetland condition category
- **LOCATION(S):** Watershed-wide

ACTION 5.3.2

[Shorelines] Conduct a shoreline assessment of both watersheds to assess living vs. armored shorelines



Hardened shorelines in Pensacola Bay and Santa Rosa Sound. *Data from Santa Rosa County.*

IMPLEMENTATION STRATEGY

Work with program partners to synthesize existing information, fund future projects, and conduct shoreline assessments and develop LSSM

- **TIMEFRAME:** 2022
- **PPBEP ROLE:** Collaborator
- **PARTNERS:** Santa Rosa County, Baldwin County, Troy University
- **FUNDING:** Committed – EPA grant and NFWF grant
- **DELIVERABLES:** Shoreline maps; Report of LSSM outputs; Recommendations for living shoreline prioritization
- **PERFORMANCE METRICS:** Linear feet of living and armored shoreline assessed
- **LOCATION(S):** Pensacola Bay watershed (future: Perdido Bay watershed)

ACTION 5.3.3

[Riparian] Conduct intensification for the EPA NARS NRSA (National Rivers and Streams Assessment)

IMPLEMENTATION STRATEGY

Collaborate with EPA and other program partners to fund, plan for, and implement an intensification for the National Rivers and Streams Assessment

- **TIMEFRAME:** 2023 – 2024 (every 5 years)
- **PPBEP ROLE:** Leader
- **PARTNERS:** EPA, FWC, Universities, Community science groups
- **FUNDING:** Pursuing
- **DELIVERABLES:** Evaluation of river and stream condition indices in State of the Bays report
- **PERFORMANCE METRICS:** Area/extent of stream condition for each classification
- **LOCATION(S):** Watershed-wide

ACTION 5.3.4

[Mangroves] Coordinate and facilitate efforts to track expansion of mangrove species and synthesize data to communicate to the public

IMPLEMENTATION STRATEGY

Continue coordination and training for the nGOM Mangrove Survey Network

- **TIMEFRAME:** 2022 – 2026 (annually)
- **PPBEP ROLE:** Leader; Coordinator
- **PARTNERS:** Sea Grant, NERRs, County Extension, USM, USGS, TNC, Northeastern University
- **FUNDING:** Needed
- **DELIVERABLES:** Map of mangrove expansion of both species (black, red) updated annually; Annual report on seed production and mangrove growth indices
- **PERFORMANCE METRICS:** Numbers of mangroves present in Pensacola and Perdido Bays
- **LOCATION(S):** northern Gulf of Mexico (regional)

The only known red mangrove (*Rhizophora mangle*) in the Pensacola and Perdido watersheds. This mangrove is near the Pensacola Naval Base near Sherman's Inlet.
Geoff Smith, FWC

ACTION 5.3.5

[Invasive species] Support removal and prevention activities for invasive species

IMPLEMENTATION STRATEGY

Coordinate with program partners (CISMA and GCPEP) to support community science initiatives for documenting invasive species throughout the watersheds

TIMEFRAME: 2022 – 2026

PPBEP ROLE: Promotor; Facilitator

PARTNERS: Sea Grant, Counties, IFAS Extension, CISMA, GCPEP

FUNDING: Committed and Needed

DELIVERABLES: Outreach materials developed; Maps of area covered; List of invasive species reported

PERFORMANCE METRICS: Number acres identified; Number of acres treated

LOCATION(S): Watershed-wide

ACTION 5.3.6

Define measurable habitat restoration and conservation targets (acres and condition) to support living resources, the economy, and biodiversity

IMPLEMENTATION STRATEGY

Collaborate with technical and community partners to develop short and long-term targets based on the best available science.

TIMEFRAME: 2023 -

PPBEP ROLE: Coordinator; Facilitator

PARTNERS: All partners

FUNDING: Needed

DELIVERABLES: Established list of measurable restoration and protection targets for native habitats (e.g., wetlands, shorelines, long-leaf pine)

PERFORMANCE METRICS: List of measurable goals/targets; Progress towards reaching targets; Amount of funding dedicated and leveraged for achieving targets.

LOCATION(S): Watershed-wide

Beach vitex removal in Pensacola Beach

Rick O'Connor

Objective 5.4

Coordinate with partners to identify and assess critical habitats of highest risk for imperiled and protected species

Objectives

Partner with local groups to assess habitat fragmentation and utility of wildlife corridors to protect current and future habitats to help conserve imperiled and protected species.

Status

Not yet started.

Related Actions

Habitat Action 5.3.5

The Florida Wildlife Corridor

BACKGROUND

Wildlife corridors are natural, unfragmented pathways that permit the movement of wildlife during part or all of their life cycles. Protecting and restoring wildlife corridors is essential for conserving species, including imperiled and protected species. Wildlife corridors are particularly important for migratory species that rely on connected pathways and species with large home ranges.

Wildlife corridors are at risk due to habitat fragmentation, which is becoming prevalent throughout the world as development increases to support the growing human population. Habitat fragmentation can lead to species loss and isolation, disrupting our natural ecosystems. Land acquisition and conservation can be used as a strategy to preserve or re-connect important wildlife corridors.

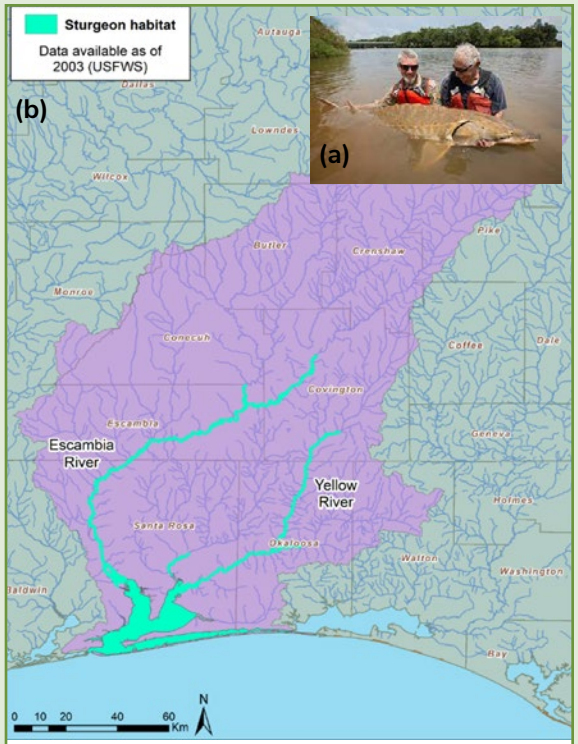
The Pensacola and Perdido Bays systems are home to many imperiled and protected species with threatened wildlife corridors. An increase in watershed development has raised concerns over the state of wildlife corridors in these systems. Alabama and Florida have long invested in strategic acquisitions of conservation lands to protect water resources and natural habitats through the Alabama Forever Wild Trust Fund and the Florida Forever Fund. In 2021, Florida Governor DeSantis passed the Florida Wildlife Corridor Act, which strives to preserve continuous parcels of land throughout Florida from Florida national and state parks with open land tracts. PPBEP will build off this effort and coordinate partners to prioritize land acquisition in the Alabama portions of their watersheds. Protection of wildlife corridors can benefit many species in the Pensacola and Perdido systems (Table 3).

In February 2022, the Sentinel Landscape Partnership, formed in 2013 by the U.S. Department of Defense, Department of Agriculture, and Department of Interior, announced the adoption of the Northwest Florida Sentinel Landscape. The Northwest Florida Sentinel Landscape encompasses rural and agricultural lands, iconic longleaf pine forests, threatened and endangered species habitat and all northwest Florida's military installations. "The Northwest Florida Sentinel Landscape aims to enable collaborative efforts and provide greater access to funding assistance from federal, state, and local governments

and private sector programs. These programs will be employed toward military mission assurance, restoring and increasing resiliency and sustainability of habitat and water resources, retaining working agriculture and forest lands as compatible, resilient, and sustainable land uses; mitigating coastal risks, and increasing the climate resilience of military installations and the landscapes that overlap mission footprints (Sentinel Landscape 2022).

TABLE 3. Species endemic to the Pensacola and Perdido Bays systems.

Common Name	Scientific Name	Range	Conservation Status (IUNC)
Birds			
Red-cockaded woodpecker	*Picoides borealis*	Southeastern Coastal Plain	EN Endangered
Amphibians			
Fowler's Toad	*Anaxyrus fowleri*	Western FL panhandle	LC Least concern
Bird-voiced treefrog	*Hyla avivoca*	Southeastern Coastal Plain	LC Least concern
Florida Bog Frog	*Rana okaloosae*	Okaloosa and Santa Rosa Counties, FL	VU Vulnerable
Cricket Frog	*Acris crepitans*	Western FL panhandle	LC Least concern
Reticulated Flatwoods Salamander	*Ambystoma bishopi*	Slash and longleaf pine ecosystems west of the Apalachicola River	EN Endangered
Reptiles			
Yellow-bellied slider	*Trachemys scripta scripta*	Southeastern Coastal Plain	LC Least concern
Gopher Tortoise	*Gopherus polyphemus*	Southeastern Coastal Plain	TH Threatened
Fish			
Gulf Sturgeon	*Acipenser oxyrinchus desotoi*	Mississippi River, LA to Suwannee River, FL	TH Threatened
Florida sand darter	*Ammocrypta bifascia*	Perdido River to Apalachicola, FL	LC Least concern
Crystal Darter	*Crystallaria asprella*	Escambia River drainage near the AL state line	TH Threatened



Gulf sturgeon (a) and habitat range extent (b) in the Pensacola and Perdido watersheds.
Ryan Hagerty, USFWS

Common Name	Scientific Name	Range	Conservation Status (IUNC)
Fish			
Choctawhatchee Darter	*Etheostoma davisoni*	Choctawhatchee and Pensacola Bay, FL drainages	NA
Brown Darter	*Etheostoma edwini*	Perdido River to St. Johns River, FL	LC Least concern
Harlequin Darter	*Etheostoma histrio*	Escambia River, FL watershed	NA
Speckled darter	*Etheostoma stigmaeum*	Pensacola Bay, FL	LC Least concern
Saddleback darter	*Percina vigil*	Escambia River, FL watershed	LC Least concern
Bluenose shiner	*Pteronotropis welaka*	Escambia county to St. Johns, FL	VU Vulnerable
Bivalves			
Narrow Pigtow	*Fusconaia escambia*	Northwest FL and South Alabama	TH Threatened
Southern sandshell	*Hamiota australis*	Northwest FL and South Alabama	TH Threatened
Alabama Moccasinshell	*Medionidus acutissimus*	Alabama, Georgia, Mississippi	EN Endangered
Choctaw Bean	*Obovaria choctawensis*	Escambia River to Choctawhatchee River, FL	EN Endangered
Fuzzy Pigtoe	*Pleurobema strodeanumm*	Northwest FL and South Alabama	TH Threatened
Southern Kidneyshell	*Ptychobranchus jonesi*	Northwest FL and South Alabama	EN Endangered
Round Ebonyshell	*Reginaia rotulata*	Conecuh River, FL	EN Endangered
Gulf Spike	*Elliptio pullata*	Escambia River to Suwannee River, FL	NA
Southern Fatmucket	*Lampsilis straminea*	Amite River, LA to Suwannee River, FL	NA
Crustaceans			
Lavender Burrowing Crayfish	*Creaserinus byersi*	Pascagoula River, MS to Escambia River, FL	NA
Panhandle crayfish	*Procambarus evermanni*	Escambia River at Flomaton and from Santa Rosa and Escambia Counties, FL	NA
Mammals			
Perdido Key Beach Mouse	*Peromyscus polionotus trissyllepsis*	Perido Key FL and AL	NA

ACTION 5.4.1

Assess potential wildlife corridors and habitat fragmentation concerns for imperiled and protected wildlife species

IMPLEMENTATION STRATEGY

Coordinate to assess and prioritize areas for land acquisition and restoration

TIMEFRAME: 2023 – 2026

PPBEP ROLE: Facilitator

PARTNERS: Longleaf Alliance, USFWS, ADCNR, FDEP, FWC, TNC, La Florista Perdida, International Paper, Florida Wildlife Corridor Coalition, Forever Wild, DoD, Conservation Florida, South Alabama Land Trust, NWFWMD, GCPEP, Northwest Florida Sentinel Landscape

FUNDING: Needed

DELIVERABLES: Map of existing corridors and identified prioritized land parcels for conservation across Perdido and Pensacola watersheds (focus on Perdido and Blackwater corridors)

PERFORMANCE METRICS: Number of parcels/segments added to Florida Wildlife Corridor; Number of acres restored within the watershed; Number of acres restored

LOCATION(S): Riparian buffer zones and forested lands throughout both watersheds; Wildlife corridors (Blackwater, Eglin, Perdido)

Perdido Key Beach Mouse

USFWS

Perdido Key Beach Mouse Habitat Range

Escambia County

GOAL 6

Restore and Conserve Fish and Wildlife

Diamondback Terrapin
Molly O'Connor

Objective 6.1

Collaborate and communicate fish and wildlife monitoring efforts

Objectives

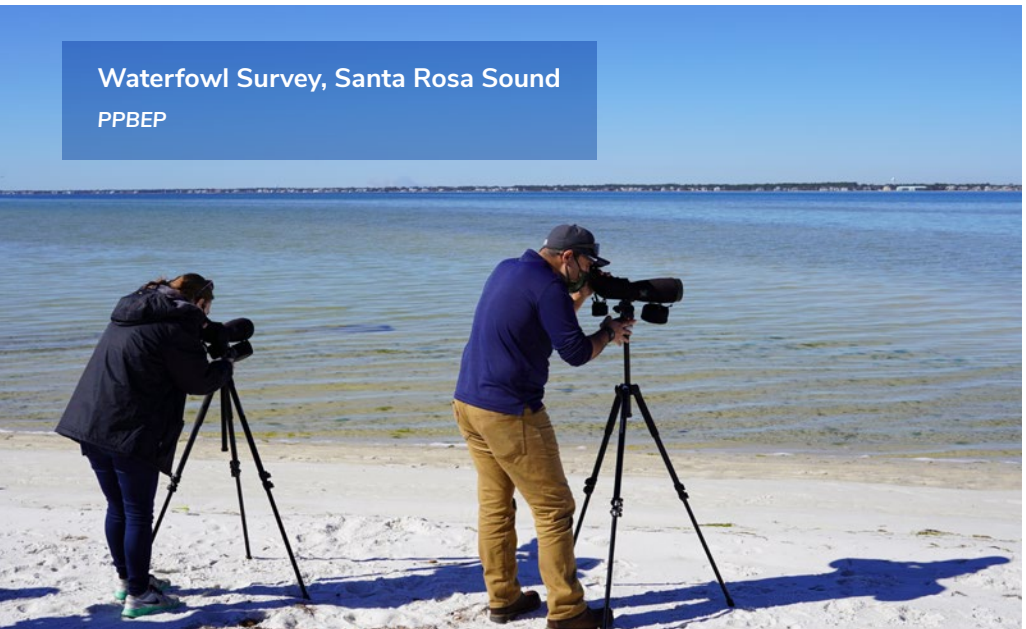
Increase regional monitoring capacity for fish and wildlife through collaboration and communication with partner organizations. Increase public awareness and participation in community science initiatives by advertising and promoting volunteer opportunities. Communicate the results of monitoring efforts to partners and the public through science dashboard tools available on the PPBEP website.

Status

Not yet started

Related Actions

Education and Outreach Strategic Plan Action 2.1.1



Waterfowl Survey, Santa Rosa Sound
PPBEP

BACKGROUND

The Pensacola and Perdido Bays and their watersheds are home to variety of imperiled or threatened species, migratory species, and endemic species, such as loggerhead sea turtles. Perdido Key beach mouse, Florida manatee, and snowy plovers. Many species are economically important for commercial and recreational harvest or ecotourism. Other species play invaluable roles critical for ecosystem health and sustainability or provide direct benefits through ecosystem services (e.g., oysters). However, other introduced species can negatively impact habitat, compete with native species for resources, or cause direct harm through predation to native species assemblages (e.g., lionfish).

There are many regional and local efforts to monitor populations of interest. These efforts include both natural resource management agencies and community science initiatives. PPBEP will facilitate regional monitoring efforts of fish and wildlife by increasing monitoring capacity through collaboration and communication with partner organizations. PPBEP will increase public awareness and participation in community science monitoring programs by advertising and promoting volunteer opportunities.

PPBEP will also facilitate the communication of monitoring data both between partners and to the public. PPBEP will work towards increasing the visibility of existing monitoring programs by sharing program updates and results through newsletters and social media and incorporating data and reports into the PPBEP science dashboard and bibliography.

Snowy Plover with Chick
FWC

ACTION 6.1.1

Work with partners to increase the visibility of local community science initiatives and communicate volunteer opportunities and updates

IMPLEMENTATION STRATEGY

Coordinate and promote ongoing community monitoring and education efforts within our watersheds (e.g., sea turtle nesting, shorebirds, etc.) and disseminate data to public

TIMEFRAME: 2022 – 2026

PARTNERS: Escambia, Baldwin, Santa Rosa, and Okaloosa Counties, Audubon, City of Orange Beach, City of Pensacola, FWC, USFWS, Share the Beach, Sea Grant

FUNDING: Needed

DELIVERABLES: Shared efforts within the communities

PERFORMANCE METRICS: Number of stakeholder groups represented; Monitoring metrics for represented wildlife (e.g., beach mice, sea turtles, birds); Number of social media posts pushed

LOCATION(S): Coastal counties (beaches, wetlands, upland forests, etc.)

PPBEP ROLE: Promoter

Community science monitoring initiatives led by UF-IFAS Extension in the Pensacola and Perdido systems.

Monitoring Effort	Locations Monitored	Partners	Project Duration
Terrapins	Escambia county	USGS	2007 – present
	Santa Rosa county		
	Okaloosa county		
	Walton county		
Scallops	Big Lagoon	None	2015 – present
Horseshoe crabs	Kees Bayou	FWC	2021 – present
	Park West West		
	Park West East		
	Little Sabine South		
	Little Sabine North		
	Morgan Park		
	Mom Beach		
	Sharp Point		
	Big Sabine		
Invasive species	Pensacola Beach	None	2014 – present
	GINS NLO		
	Perdido Key		
	Ft. Pickens Jetties		
	Navarre Beach		
	Innerarity Point		
	Perdido Bay		
	Shoreline Park		
	Santa Rosa Boat Ramps		

Objective 6.2

Coordinate and expand fisheries monitoring capacity within the Pensacola and Perdido Bay watersheds

Objectives

Facilitate the regular monitoring of estuarine aquatic species assemblages with an emphasis on fisheries species and fish communities through collaboration and partnerships.

Status

Not yet started.

Trawling in seagrass beds

DISL

BACKGROUND

Some of the first known accounts of fisheries surveys conducted in the Pensacola Bay System date back to the late 1800's which described the diversity of the fish community (Lewis et al. 2016). Regional branches of the EPA and the Florida Fish and Wildlife Commission (FWC) Fish and Wildlife Research Institute (FWRI) have conducted fisheries-independent monitoring in estuarine and freshwater environments throughout the Pensacola and Perdido Bay watersheds since the 1980s. Following the many fish kills in the 1960s and 1970s, Bream Fishermen's Association (BFA) and UWF conducted trawling and creel surveys to assess fish abundance, condition, diversity, and size frequency. Most of these efforts have been conducted during sporadically through time and don't provide continuous monitoring to evaluate status and trends of communities over time.

More recently, monitoring across the bay systems has been episodic and patchy with relatively low spatial and temporal coverage in coastal areas throughout the Perdido and Pensacola Bays. Program staff at the Apalachicola Field Laboratory (FWC) implemented monitoring from 2017–2019 as part of their Fisheries Independent Monitoring (FIM) Program, a project funded by National Resource Damage Assessment (NRDA). The FIM team conducted monthly monitoring from July to December following a stratified random sampling design in Pensacola Bay and Santa Rosa Sound. Seine nets (river and bay) were used to collect young of the year (YOY) fish in tidal tributaries and bay environments. In addition to previous FIM monitoring, FWRI's Garcon Point Aquatic Research Lab, one of the Institute's 28 field labs located throughout Florida, has conducted research on imperiled freshwater fish species in the Perdido, Escambia, Yellow, and Blackwater Rivers since 2005. As part of their monitoring program, they assess status and trends of sport fish and cryptic species throughout rivers and streams including species of shiner, darter, gar, and the Gulf sturgeon. In the Alabama portions of the watershed, Alabama Department of Environmental Management (ADEM) has collected fish in areas of known or suspected contamination throughout Escambia and Baldwin Counties for analysis of contaminant levels since 1970 as part of their annual Fish Tissue Monitoring Program (FTMP) (2020 ADEM

Fish Tissue Monitoring Program Report). In 1991, ADEM expanded the program to be a cooperative statewide effort between ADEM, Alabama Department of Public Health (ADPH), and ADCNR.

During the PPBEP's Technical Committee Workshop Series conducted in Spring 2022, stakeholders identified fisheries monitoring data needs including population trends over time, fish recruitment to seagrass beds and oyster reefs, tropicalization trends/species shifts or time as a result of climate change, and more consistent fish community monitoring across both watersheds. In Fall 2022, PPBEP will fill a gap in monitoring of fish and invertebrate communities within the bays and sounds by partnering with researchers at the Dauphin Island Sea Lab, who have conducted otter trawl surveys of seagrass communities in Pensacola and Perdido Bays since 2005, to assess juvenile fish species composition and habitat quality for economically important finfish and shellfish. As part of our Community Grant Program, researchers at DISL have been collecting video footage of fish communities utilizing remnant and restored oyster reefs in East Bay, Pensacola Bay, and Blackwater Bay using a passive method of data collection. This work will serve as a baseline of information for future oyster restoration and management efforts. PPBEP will also work to expand regional monitoring efforts and capacity by increasing the spatial coverage, targeted species and/or habitats, and frequency of monitoring through increased collaboration and partnerships.

ACTION **6.2.1**

Conduct seagrass trawling surveys to assess juvenile fish/shellfish communities and habitat quality

IMPLEMENTATION STRATEGY

Leverage existing efforts and identify funding for the continuation of trawling surveys (long-term dataset) within seagrass beds in our bays to collect valuable juvenile fish and crustacean information; Expand Fisheries Independent Monitoring (FIM) to Pensacola and Perdido Bays

TIMEFRAME: 2022 – 2026

PARTNERS: DISL, FWC/FWRI, EPA

FUNDING: Committed – EPA grant

DELIVERABLES: Map of spatial coverage of monitoring locations; Report on fish and invert abundance, diversity, and size; FWC report

PERFORMANCE METRICS: Number of monitoring events; Sampling effort; Species composition and abundance; Fish length frequency

LOCATION(S): Seagrass/SAV beds throughout Pensacola and Perdido (bays, bayous, sounds)

PPBEP ROLE: Collaborator

Objective 6.3

Increase regional monitoring capacity for marine mammals

Objectives

Continue to support DISL and NWF in obtaining manatee sighting information for Pensacola and Perdido Bays. Increase public awareness to document and report manatee sightings to panhandlemanatee.org, a partnership between PPBEP, DISL, NWF, and UF-IFAS Extension.

Status

Ongoing. The Pensacola and Perdido Bays Estuary Program (PPBEP) continues to house the panhandlemanatee.org website to facilitate quick and easy reporting from the public for manatee sightings in the bays and rivers. During Summer 2021, the Panhandle Manatee Program distributed boater education kits and performed outreach at boat ramps, marinas, and local festivals to educate boaters and the public on safe boating practices around manatees and reasons why reporting manatee sightings is important. During the Summer 2022, outreach efforts will be expanded to other target groups, such as anglers, and coastal residents, visitors, and businesses.

BACKGROUND

Manatees are an important keystone species for Gulf of Mexico rivers and estuaries, helping to sustain healthy seagrass beds. Historically, manatee range extent has been confined to peninsular Florida where temperatures are higher than the in the northern Gulf of Mexico (nGOM). Due to rising temperatures and the increasing manatee population, manatees have expanded their range to the nGOM. In 2008, the Dauphin Island Sea Lab (DISL) in Alabama established the Manatee Sighting Network (MSN) to collect, map, and track manatee movements in the nGOM, mainly outside of Florida between Alabama and Mississippi. Manatees are seasonal warm season migrants to the nGOM but do need to migrate back to peninsular Florida in the colder months to reduce the likelihood of cold stress, which kills many manatees in the nGOM during the colder months. Since the inception of MSN, manatee sightings have become more frequent in the nGOM and potentially in the Pensacola and Perdido Bays systems (Figure 16).

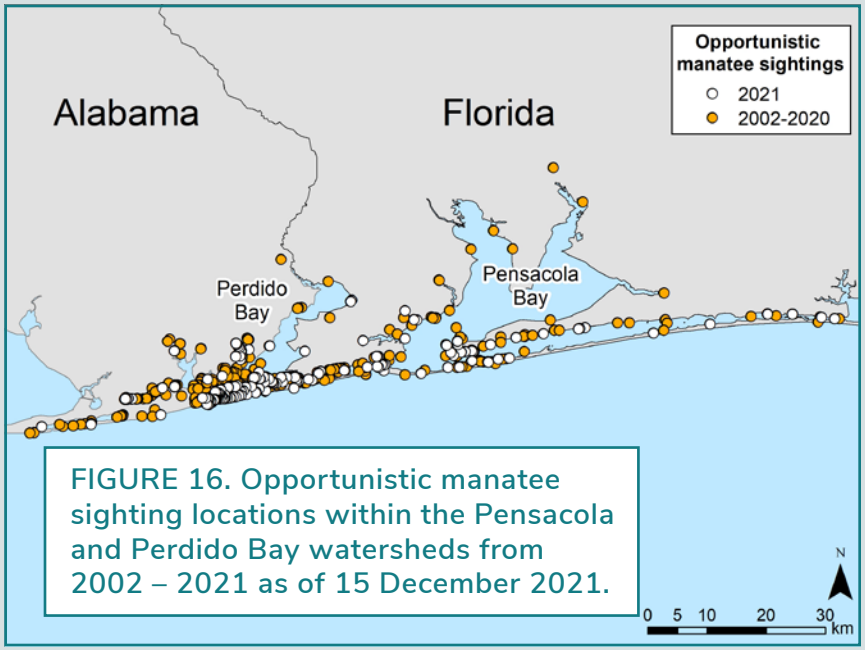


FIGURE 16. Opportunistic manatee sighting locations within the Pensacola and Perdido Bay watersheds from 2002 – 2021 as of 15 December 2021.

Data compiled by the Dauphin Island Sea Lab's Manatee Sighting Network (DISL/MSN; Carmichael 2020, Carmichael et al. 2021)

Reasons for increased manatee sightings could be due to increased effort on the publics part in sighting manatees and/or range expansion/population growth of manatees due to rising temperatures and manatee conservation efforts. To increase spatial coverage of MSN, the Panhandle Manatee Program partnership was formed among PPBEP, DISL, and NWF to collect manatee sighting data from the Pensacola and Perdido Bays systems and create a website that reports all data back to MSN to house in a centralized database. Maps with quarterly manatee sightings will then be posted on the panhandlemanatee.org website to share information collected with the public. This partnership will address data gaps in manatee sightings in the Pensacola and Perdido Bays systems.

Additionally, human recreational activities, such as boating, can also put manatees at risk for negative human interactions. Boating strikes are particularly problematic for manatees which are slow travelers, reside near the surface, and are difficult to see in the turbid waters of Pensacola and Perdido bays and river systems. To educate the public on safe boating practices, the Panhandle Manatee Program developed boater education kits to distribute to boaters at boat ramps and marinas surrounding Pensacola and Perdido Bays. Furthermore, the Panhandle Manatee Program has booths at local festivals to educate the public about manatee presence in the PPBEP waterways and to promote the use of reporting sightings via panhandlemanatee.org. This work will feed into local manatee conservation in the area, while also assisting in data collection for MSN.

Manatees at Navarre Beach Pier
John Starrett

Manatee in Ono Island Canal located in Perdido Bay
Anonymous DISL/MSN Contributor

ACTION 6.3.1

Increase long-term monitoring of manatee sighting coverage in Pensacola and Perdido Bays utilizing Panhandlemanatee.org

IMPLEMENTATION STRATEGY

Continue to partner with DISL, NWF, and Sea Grant Extension to update and maintain Manatee Sighting Network database (DISL); Maintain and update Panhandle Manatee website with current data and reporting resources

TIMEFRAME: 2021- 2026

PARTNERS: DISL, NWF, Sea Grant Extension, Community science groups

FUNDING: Pursuing

DELIVERABLES: Develop Panhandlemanatee.org; Maps of sighting locations

PERFORMANCE METRICS: Change in annual manatee sightings/reports and change over time; Change in geographic extent of sightings; Number of Panhandle Manatee website hits/reports through website; Number of people reached through outreach campaigns

LOCATION(S): Coastal areas throughout watersheds (rivers, creeks, bays, bayous, sounds, coastal zone); Areas with seagrass/SAV

PPBEP ROLE: Collaborator; Promoter

Panhandle Manatee Program interns and volunteers at the 2021 Pensacola Seafood Festival

PPBEP

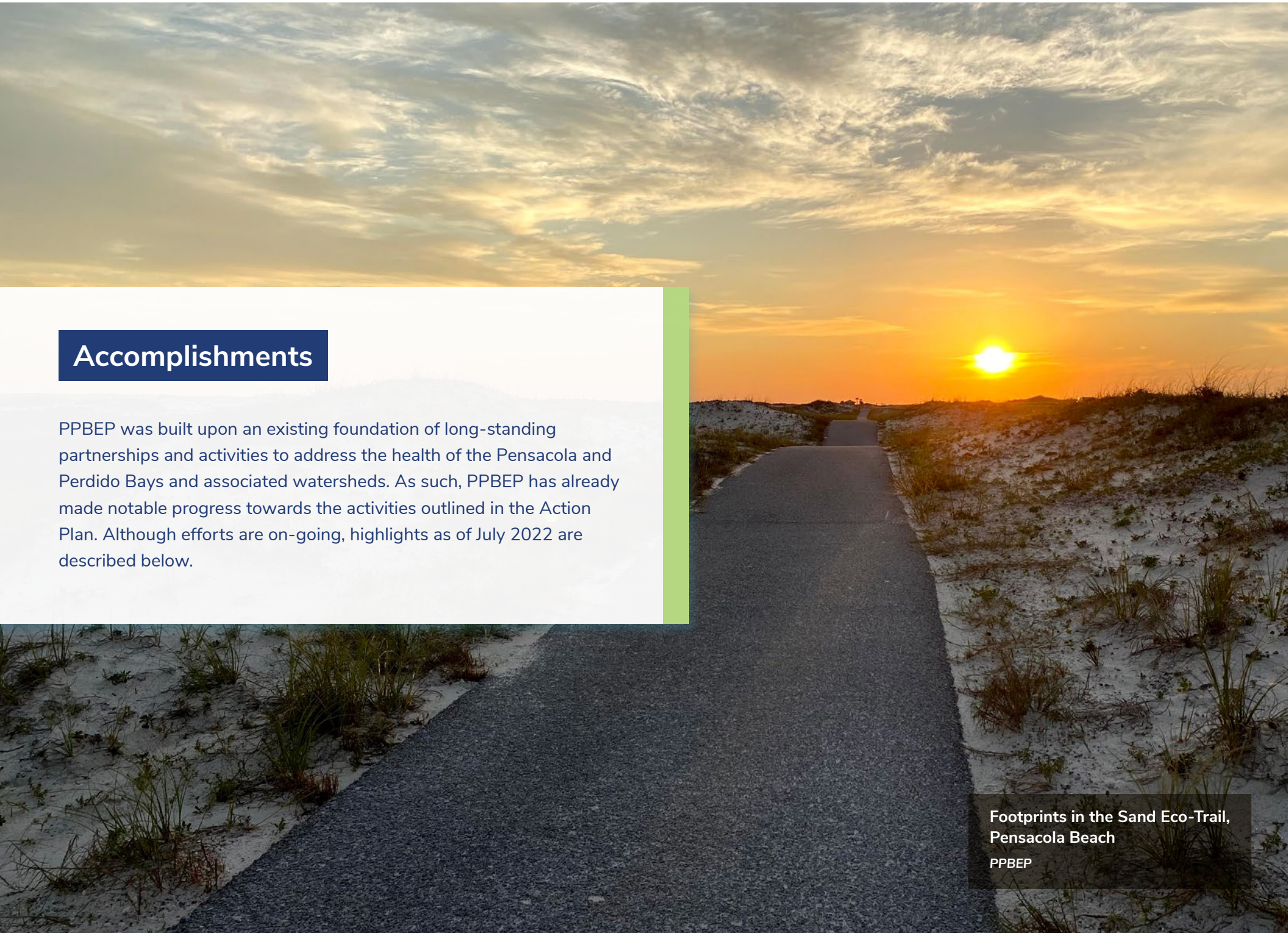
National Wildlife Federation

Respect Manatee Sighting Network Educate Dauphin Island Sea Lab

Dauphin Island Sea Lab
Alabama Center for Marine Education and Research

Accomplishments

PPBEP was built upon an existing foundation of long-standing partnerships and activities to address the health of the Pensacola and Perdido Bays and associated watersheds. As such, PPBEP has already made notable progress towards the activities outlined in the Action Plan. Although efforts are on-going, highlights as of July 2022 are described below.



Footprints in the Sand Eco-Trail, Pensacola Beach

PPBEP

National Aquatic Resource Surveys

The National Aquatic Resource Surveys (NARS) are collaborative programs between EPA, states, tribes, and other organizations designed to assess the quality of the nation's coastal waters, lakes, streams, and wetlands using a statistical survey design (EPA). In 2019, the PPBEP identified EPA's National Coastal Condition Assessment (NCCA) and the National Wetland Condition Assessment (NWCA) as potential partnership opportunities to develop baseline and condition assessments of the Pensacola and Perdido Bays coastal waters and estuarine wetlands (Figure 17).

The NCCA, a national coastal monitoring program established in 2005, is a statistical survey of the condition of our Nation's marine coastal waters and Great Lakes that occurs every 5 years. The goals of the NCCA are to determine what percentage of coastal waters are in good, fair, or poor condition for key indicators of water quality, ecological health, and recreation and to evaluate the relevant importance of key stressors in coastal environments. The goals of the NWCA are to understand wetland health by providing information on key ecological indicators and determine the stressors most associated with poor condition. The NCCA evaluates four indices including water quality, sediment quality, benthic community condition, and fish tissue contaminants. The NWCA evaluates vegetation, soil, hydrology, water chemistry, algae, and buffer characteristic indices. These assessments are meant to complement existing status and trend programs throughout the U.S., including the U.S. Fish and Wildlife Service (USFWS) Wetland Status and Trends Program, which characterizes changes in wetland coverage over time across the US.

The PPBEP had the unique opportunity to partner with EPA Office of Research and Development (ORD) and Region 4 staff and other local partners (e.g., Escambia County Water Quality and Land Management Division and Marine Resources Division; FWC; UF) to design and conduct intensifications for both the NCCA and NWCA to assess conditions on a smaller local scale. Each intensification expanded on the base design to include an additional 24–30 randomized sites throughout our watersheds using EPA's standardized methods. Due to COVID-19 restrictions and Hurricane Sally, the NCCA was postponed from August 2020 to June 2021 which overlapped with the NWCA, which was conducted from May through August 2021. EPA and PPBEP staff coordinated sampling

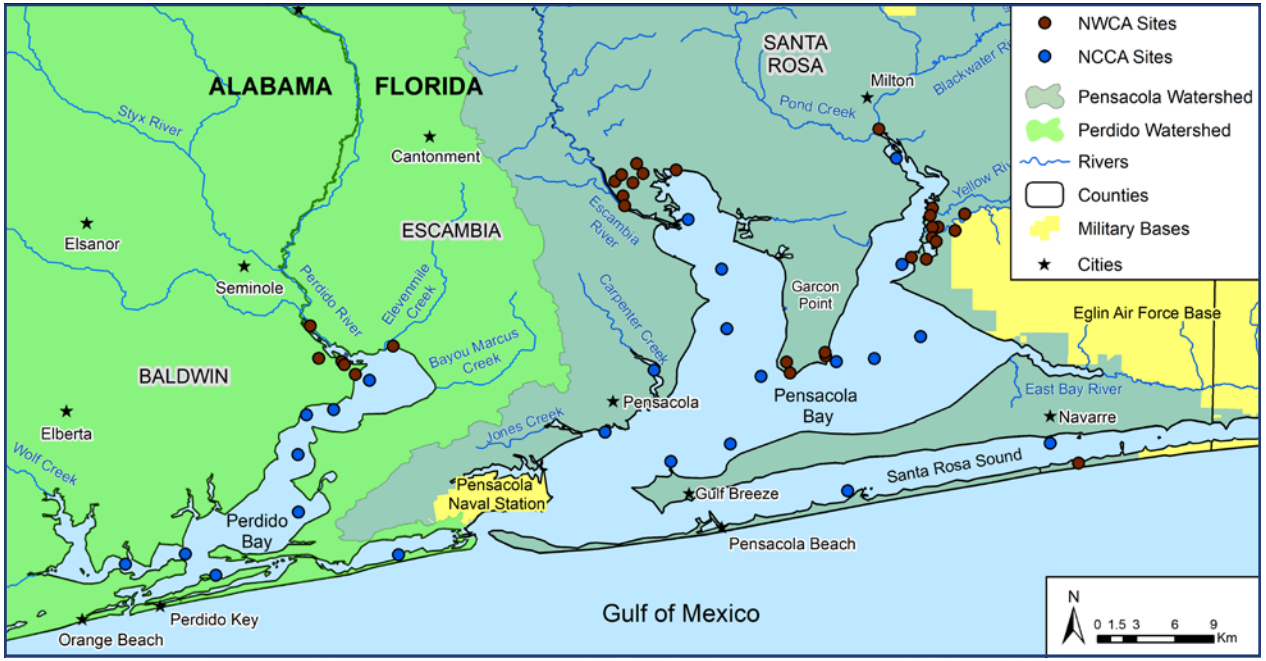


FIGURE 17. Map showing National Wetland Condition Assessment (NWCA) sites in brown and the National Coastal Conditional Assessment (NCCA) sites in blue. Sites were assessed in partnership with the U.S. Environmental Protection Agency in 2021.

itineraries with agencies that were contracted to sample base sites for the original NCCA and NWCA designs, including Alabama Department of Environmental Management (ADEM), Florida Fish and Wildlife Research Institute (FWRI), and University of Florida (UF). The data collected from both assessments will be presented in the Program's State of the Bays report. Both efforts have provided a foundation for the PPBEP to build on existing networks and partnerships to conduct watershed wide monitoring to track the status and trends across our watersheds.

Funding: Florida State Legislature | $140,000

Leverage: EPA Region 4 | In-kind Support

Partners: EPA; Escambia County; FWC; UF

Outputs: Coastal Condition Assessment; Estuarine Wetlands Condition Assessment

Timeline: Complete (November 2021)

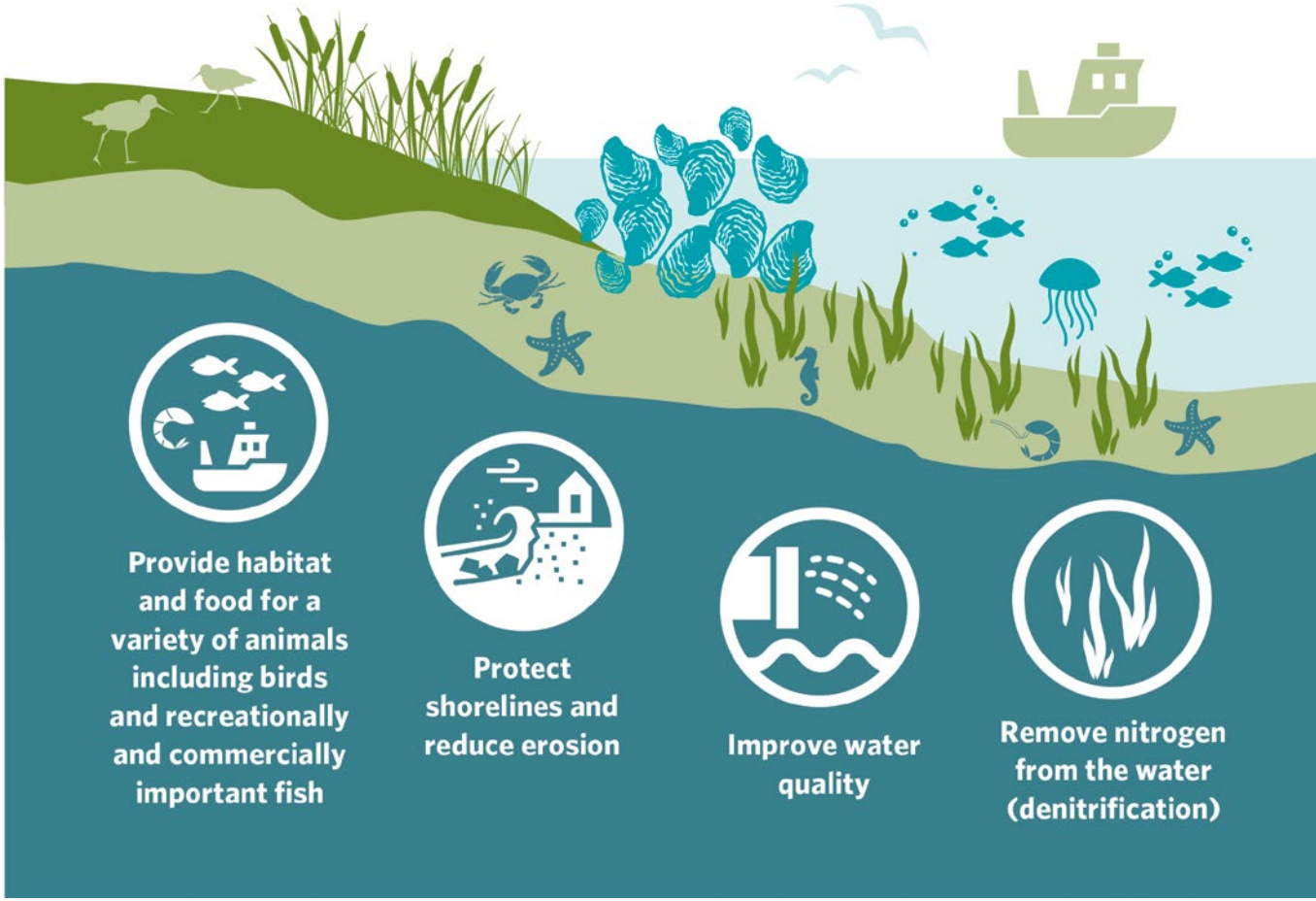
NCCA Group Photo
GEMMD

Related Actions:

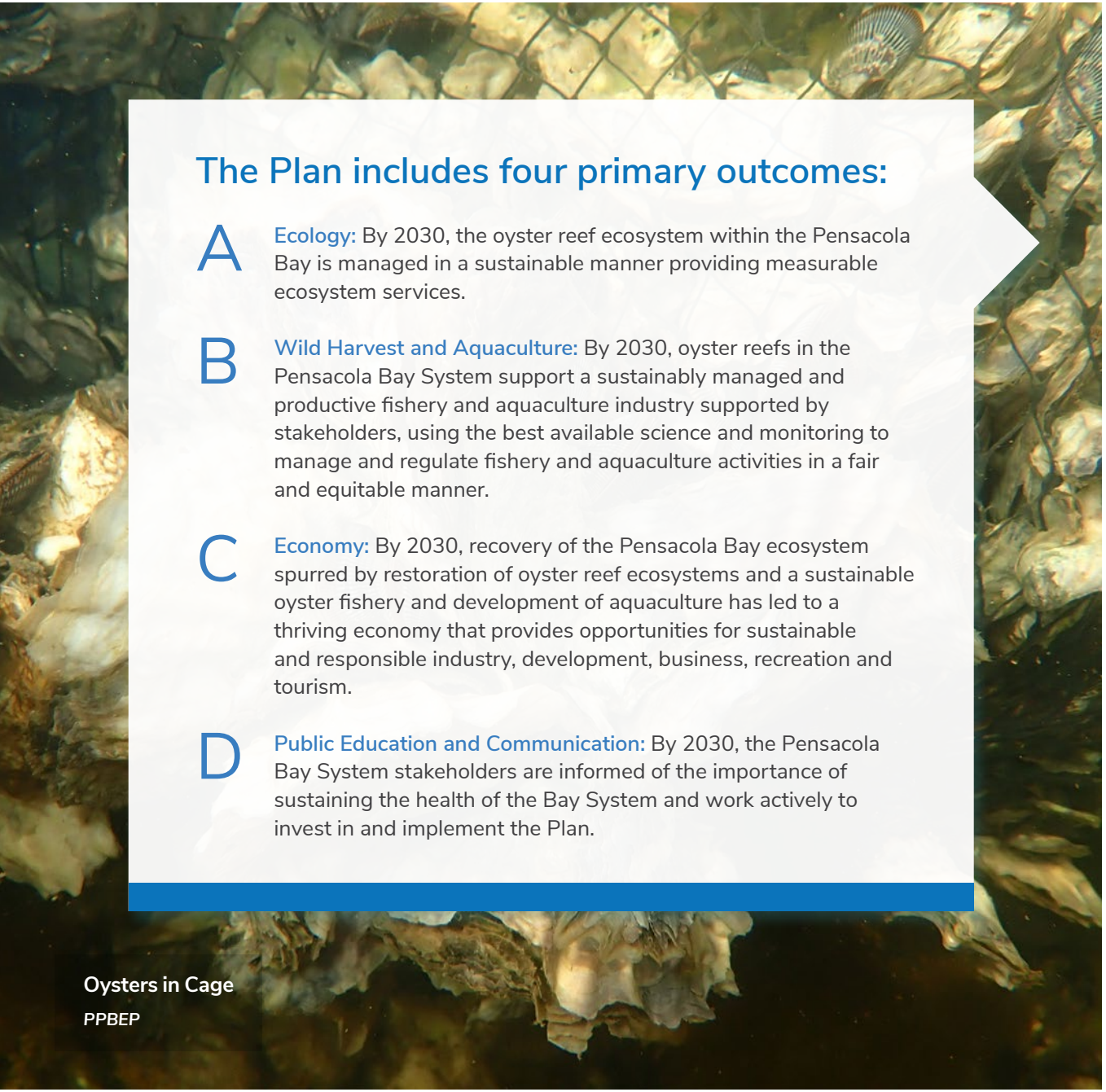
3.1.1 | 4.1.1 | 5.3.1

Oyster Fisheries and Habitat Management Plan

The Pensacola Bay System (PBS) has experienced a 72% decline in oyster reef area since the 1980's, which has triggered impacts on the communities, the economy, the fishery, and the surrounding ecosystem. In 2018, TNC convened a working group of scientists, government and business representatives, oystermen, community groups, and engineers as part of a collaborative and consensus-based planning effort to develop a management plan for oysters in the PBS. FWC and the Florida Department of Agriculture and Consumer Services (FDACS) assisted TNC in initiating the planning process in the absence of a statewide plan. The Oyster Fisheries and Habitat Management Plan, published May 2021, addresses management of wild oyster harvest and aquaculture farming in harmony with the recovery of oyster habitat and aims to serve as a model for management of oyster resources across other Florida estuaries, throughout the United States, and globally. To ensure the implementation of the plan, as part of the stakeholder working group, the PPBEP committed to integrating the top priorities identified in the plan into their CCMP.



Ecosystem services provided by oyster reefs
The Nature Conservancy (TNC)



The Plan includes four primary outcomes:

A **Ecology:** By 2030, the oyster reef ecosystem within the Pensacola Bay is managed in a sustainable manner providing measurable ecosystem services.

B **Wild Harvest and Aquaculture:** By 2030, oyster reefs in the Pensacola Bay System support a sustainably managed and productive fishery and aquaculture industry supported by stakeholders, using the best available science and monitoring to manage and regulate fishery and aquaculture activities in a fair and equitable manner.

C **Economy:** By 2030, recovery of the Pensacola Bay ecosystem spurred by restoration of oyster reef ecosystems and a sustainable oyster fishery and development of aquaculture has led to a thriving economy that provides opportunities for sustainable and responsible industry, development, business, recreation and tourism.

D **Public Education and Communication:** By 2030, the Pensacola Bay System stakeholders are informed of the importance of sustaining the health of the Bay System and work actively to invest in and implement the Plan.

Oysters in Cage

PPBEP

The plan is intended to be a living document, adapted as new data sources become available, projects are completed, and environmental conditions change. As part of this science-based management effort, TNC was able to compile existing stakeholder data to develop a Habitat Suitability Model (HSM), which incorporates a set of environmental indicators to identify the most promising areas for oyster reef restoration, wild oyster harvest and aquaculture, and ecosystem services regeneration. The HSM informed the plan's priorities and strategies and continues to act as a guide for future planning efforts and CCMP implementation.

- **Funding:** TNC Florida
- **Leverage:** 800 hours collectively invested by Working Group members
- **Partners:** Working Group Members
- **Outputs:** Oyster Fisheries and Habitat Management Plan
- **Timeline:** Complete (May 2021)

Related Actions

5.1.1 | 5.1.2 | 5.1.3 | 5.1.4

Oyster Mapping and Condition Assessment

Partners at TNC led a mapping and condition assessment of oyster reefs in the Pensacola Bay System through a grant provided by Santa Rosa County's RESTORE Act Direct Component funds. Project mapping was completed in August 2021. Preparation for oyster habitat mapping included an analysis of the data gaps in oyster resources from East and Blackwater bays to establish a baseline of the extent and condition of existing oyster reefs. Oyster habitat mapping included compiling and preparing aerial imagery, existing maps, and associated GIS shapefiles of intertidal and subtidal oyster reef habitat in the project region. This was followed by a side-scan sonar survey (acoustic measure of variations along the bottom) along transects covering a certain acreage of the bay systems, which were divided into study areas. To ground truth bottom characteristics, polling surveys were conducted to determine bottom type along each transect (e.g., sand, buried shell, reef, soft) and oysters were collected from areas where reefs were present to assess condition and density.

The same survey and assessment design was used for Pensacola and Escambia Bays using funds provided by the Florida State Legislature awarded to the PPBEP. These two assessments provide comprehensive information on the remnant and restored oyster reefs in the PBS and filled a critical data gap that had been identified by stakeholders in the Oyster Fisheries and Habitat Management Plan. These data sources were used to create preliminary maps of oyster habitat and suitability and make recommendations for future bay-wide scale oyster restoration and management. Oyster reef data layers and oyster condition indices were incorporated into the most recent update of the Oyster Integrated Mapping and Monitoring Program (OIMMP) Report for the Northwest Florida Chapter led by FWC and partners.

- **Funding:** Florida State Legislature | $120,000
- **Leverage:** Santa Rosa County/TNC | $150,000
- **Partners:** TNC; Santa Rosa County
- **Outputs:** Oyster reef extent maps; Oyster condition assessment for PBS
- **Timeline:** Complete (August 2021)

Related Actions

4.4.1 | 5.1.3 | 5.1.4

White Sands Conservation Area, Navarre

PPBEP

Oyster Documentary

Restoration of oyster reefs is a critical component of managing the ecological health of the Pensacola and Perdido Bays systems. Impacts on oyster reefs are generated throughout the watershed, from the first order streams down through the bayous to the bays. It is critical to the success of the CCMP to ensure that a significant percentage of the general population understand the importance of ecological restoration and environmental management and this project will assist with that.

The *Oyster Fisheries and Habitat Management Plan* identified the creation of an oral history project as an important action to help increase public awareness and support for a healthy and well managed oyster habitat and fisheries and the ecosystem services they provide.

The Estuary Program partnered with Mississippi State University to facilitate the creation of a half hour documentary that investigates the history of the area's oyster industry, the current and future threats to the oyster industry, and steps being taken today and, in the future, to protect and preserve the oyster industry (5.1, Education and Outreach Strategy Action 1.3.1, 1.4.3;).

The documentary features interviews with selected local oyster harvesters, oyster seed producers, area historian(s), and others involved in the oyster industry to provide the firsthand account of the industry's history, hardships, and outlook. In addition to these expert interviews, the film will follow selected individuals as they go about their work in the oyster industry; these characters will provide the emotional and human connection to the story, experiencing the oyster industry through their eyes and thoughts.

Funding: PPBEP EPA Grant | $50,000

Partners: MSU

Outputs: Oyster documentary to air on local PBS affiliates

Timeline: December 2022

Related Actions

5.1.4

Education and Outreach Strategy 1.3.1

Education and Outreach Strategy 1.4.3

Oyster Farm Maintenance

Avalon Aquaculture

Upper Watershed Streams Assessment

Partners at the University of West Florida and the Bream Fishermen Association will conduct a condition assessment of the upper Perdido River, Escambia River/Conecuh, and Yellow River/Shoal watersheds to generate meaningful data to fill stakeholder identified water quality data gaps. The study will establish 24 sampling stations that aim to fill spatial and temporal data gaps identified by the gap analyses conducted by Florida RESTORE Act Center of Excellence Program (FLRACEP) staff at UWF and UF presented as part of the Technical Committee's workshop series in Spring 2021 to support CCMP development. Sites will be selected in areas with clear data gaps based on a gradient of land use characteristics to inform potential impacts to waterways and bays downstream. The assessment will include water quality parameters, including microbiology, chemical, and physical characteristics. There will be five sampling events at each of the stations throughout 2022. This work will also serve as a baseline for a future intensification of the EPA's National Rivers and Streams Assessment (NRSA) that will be led by the PPBEP.

Funding: PPBEP EPA Grant | $75,000

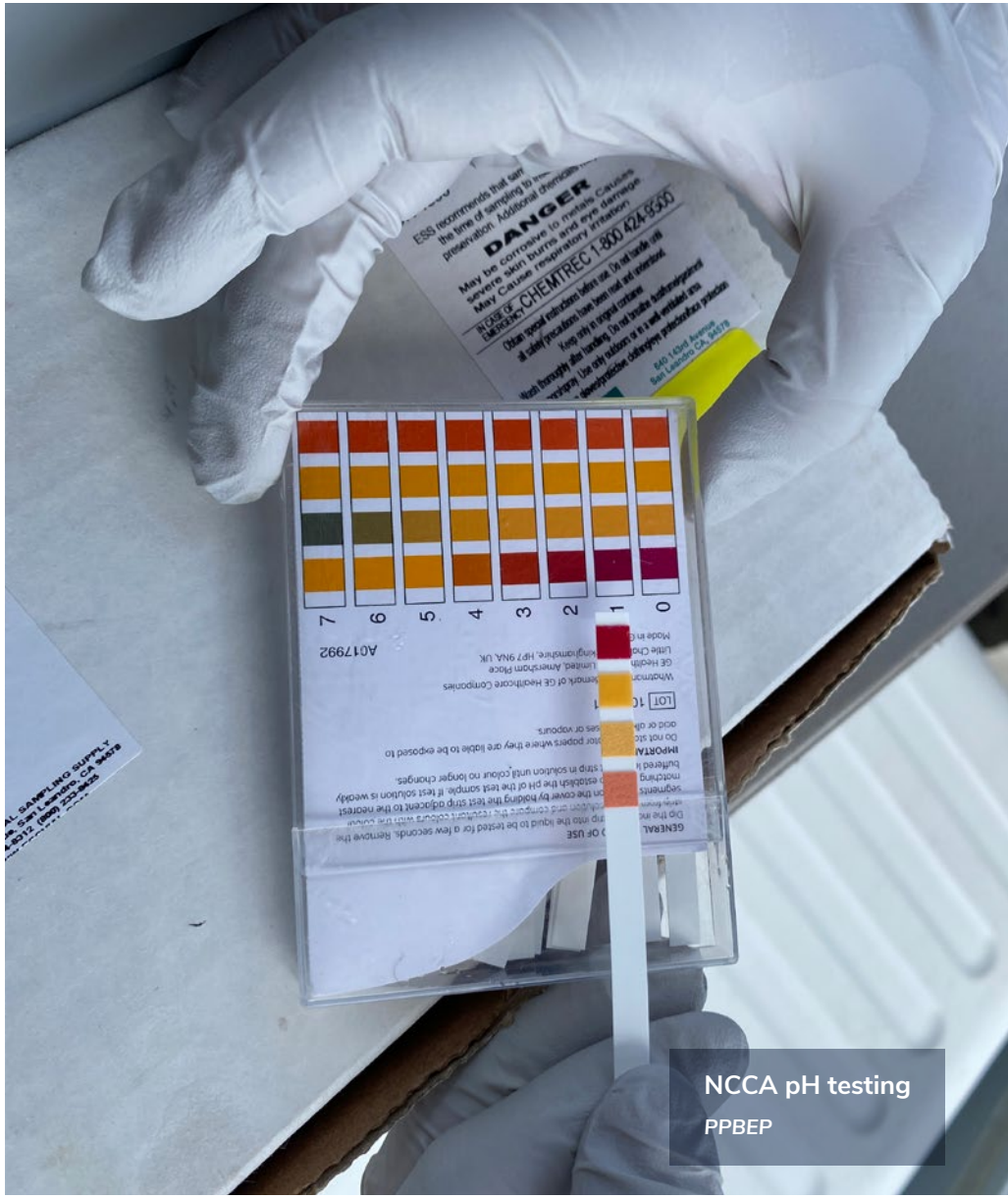
Partners: UWF; BFA

Outputs: Upper Watersheds Condition Assessment

Timeline: December 2022

Related Actions

5.3.3



NCCA pH testing
PPBEP

Living Shoreline Suitability Model

The PPBEP partnered with Santa Rosa County and researchers at Troy University to evaluate coastal processes within the Pensacola and Perdido Systems by assessing shoreline conditions to create a GIS based Living Shorelines Suitability Model (LSSM). This will assist in predicting the best management practices for shoreline properties and determines which are suitable for living shorelines. A model will be created for approximately 240 miles of shoreline throughout the Perdido and Pensacola Bay Systems building off an existing framework completed for coastal Alabama. Partners at Troy University are presently running the LSSM model for Escambia Bay, Pensacola Bay, and East Bay, Florida through funding from NFWF and Santa Rosa County, which is anticipated to be completed by May 2022. This project would help fill a data gap to help support future living shoreline site selection, restoration, and coastal resiliency planning for the greater Pensacola/Perdido Bay Region.

A Living Shoreline Suitability Model (LSSM) is currently being developed for the Pensacola Bay System through a National Fish and Wildlife Foundation (NFWF) National Coastal Resilience Fund grant secured by Santa Rosa County, PPBEP, and Troy University. The model has already been completed for the Alabama side of the Perdido Bay System. Perdido Bay and Big Lagoon, Florida are the only areas remaining not yet modeled. This contract would engage Troy University to complete the LSSM in Perdido Bay and Big Lagoon, resulting in both watersheds being fully mapped and modeled. The LSSM will support CCMP Goal 2: ensure our communities are resilient to disturbances and environmental impacts, Objective 2.3 promote the use of green infrastructure or other low-impact designs into city and community planning, Action 2.3.2 promote and facilitate the development of living shorelines as a sustainable alternative to shoreline armoring to reduce erosion and sediment inputs. The LSSM will locate hardened and natural shorelines and evaluate opportunities for incorporation of green infrastructure.

- **Funding:** PPBEP EPA Grant | $30,000
- **Leverage:** NFWF NCRF | Santa Rosa County/PPBEP | $74,000
- **Partners:** Troy University; Santa Rosa County
- **Outputs:** Living Shoreline Suitability Model; Story Map
- **Timeline:** December 2022

Related Actions

5.3.2

Garcon Point

Darryl Boudreau, NWFWMD

Seagrass Extent Mapping

The Program partnered with researchers at the Dauphin Island Sea Lab (DISL) to map seagrass extent using multispectral digital imagery throughout the Perdido and Pensacola Bay systems. This project will build on an existing mapping effort the DISL is conducting in coastal Alabama by expanding coverage into the Florida jurisdiction of the Perdido and Pensacola Bay Systems. The flight lines used to obtain photography will includes areas with known submerged aquatic vegetation (SAV) and those areas that could potentially have SAV. Imagery will be collected late summer into early fall 2022 to capitalize on the peak growing season.

The project deliverables will be used to update existing seagrass coverage maps for Pensacola and Perdido Bays and would be a continuation of previous efforts conducted in coastal Alabama and Florida lead by UWF, DISL, and FWC. This project would assist in filling a data need for the two PPBEP bay systems and would provide the data necessary to make future management decisions for the protection and restoration of seagrass and SAV beds.

- **Funding:** PPBEP EPA Grant | $60,000
- **Leverage:** DISL | $100,000
- **Partners:** DISL
- **Outputs:** Seagrass extent maps for the Pensacola and Perdido Bay Systems
- **Timeline:** December 2022

Related Actions

5.2.1

Seagrass Monitoring

Restoration of seagrass habitat is a critical component of managing the ecological health of the Pensacola and Perdido Bay systems. To effectively establish and monitor targets for CCMP actions, the PPBEP requires accurate and current data on the extent and condition of existing seagrass beds (*Action 5.2.1*).

The Program partnered with the University of Southern Mississippi's Gulf Coast Research Lab to implement a fixed station annual seagrass monitoring program in the Perdido and Pensacola Bay Systems that will provide information on the ecological condition of seagrasses during the peak growing season (late summer/early fall). The contract will result in a comprehensive assessment of the spatial variation and abundance of seagrasses at the fixed stations to ground-truth seagrass presence data collected during the mapping effort. It will relate seagrass distribution and condition to water quality and light parameters collected at the time of seagrass monitoring.

- **Funding:** PPBEP EPA Grant | $50,000
- **Leverage:** GCRL In-kind Support | $15,000
- **Partners:** USM/GCRL
- **Outputs:** Seagrass map products and visuals; Tier 2 monitoring data summary; seagrass seed density data summary
- **Timeline:** December 2022

Related Actions

5.2.1

The resulting spatial and temporal data on the distribution and condition of seagrasses will be used by PPBEP to:

- Serve as a present-day baseline of seagrass distribution and condition
- Detect seagrass response to change
- Predict seagrass response to future changes
- Inform decision making processes for conservation and management of coastal, nearshore species, including those of commercial and recreational importance seagrass imaging

PPBEP

Building Resilience into Seagrass Bed Restoration: The Role of Genetic Variation

Researchers at the University of New Orleans, in partnership with the PPBEP and Mississippi State University, received funding from the National Oceanic and Atmospheric Administration's (NOAA) Actionable Science Program to develop a strategic plan for seagrass restoration in the Pensacola and Perdido Bays. This project aims to reduce the unknowns of restoration success by focusing on the benefits of genetic diversity (range of different inherited traits within a species). The plan that is developed collaboratively with the project team, an advisory panel of experts, practitioners, and community stakeholders will assist in the critical management decisions related to the restoration of seagrass beds, dominated by widgeon grass (*Halodule wrightii*), in the Pensacola and Perdido Bays for resiliency to climate stress. The advisory panel is comprised of representatives from the Gulf of Mexico Seagrass Community of Practice (CoP), FWC, Florida Department of Environmental Protection, Mobile Bay National Estuary Program (MBNEP), NOAA, Alabama Department of Conservation and Natural Resources (ADCNR), and TNC.

As part of the strategic planning process, the project team conducted a literature review of existing relevant seagrass data and information, developed surveys to gather feedback from northern Gulf of Mexico researchers, practitioners, and local community users on their experiences with restoration techniques, perceptions of seagrass condition and extent, and on potential data needs.

PPBEP

Funding: NOAA Actionable Science | $118,000

Partners: PPBEP; UNO; MSU; NOAA

Outputs: Literature review and meta-analysis report on restoration and resiliency in seagrass environments; Community user, manager, and practitioner survey reports; Seagrass Restoration workshop report; Strategic Plan for seagrass restoration in the Pensacola and Perdido Bay Systems

Timeline: August 2022

Related Actions

5.2.2

Explore the Shore Program
PPBEP

Community Grant Program

The PPBEP Community Grant Program funds local action projects led by local governments, educational institutions, and non-profit organizations that serve to restore, preserve, connect, inform, and educate. The funding opportunity was established through the support of the Florida Legislature, with $200,000 awarded in 2020, and grew to $250,000 in awards in 2021. Community Grant proposals are reviewed by a Selection Committee (comprised of members from both the Technical and Education and Outreach Committees) that provides recommendations to the Policy Board, who then select the grant recipients. The PPBEP hosts an annual Community Grant Symposium, held during National Estuaries Week, that provides grant recipients the opportunity to share their efforts and findings with the community.

During the first funding cycle (2020–2021), ten grants and a total of $200,000 were awarded:

- Living Shoreline Training for Marine Contractors, National Wildlife Federation, $12,872.75 – Held a two-day Living Shoreline Training that engaged 25 participants and produced a living shoreline manual for marine contractors in Northwest Florida (Related Action 2.3.2)
- Quantifying Fish Communities on Remnant Oyster Reefs in Pensacola and Perdido Bays with Underwater Video: A Baseline for Monitoring Restoration Projects, University of South Alabama, $18,045 – Collected 512 video samples from 11 oyster reefs in East Bay and identified observed species (Related Action 6.1.1/6.2)
- Explore the Shore Science Show and Stations, Pensacola MESS Hall, $5,000 – Provided hands-on education to 600 students. (Education and Outreach Strategy Action 1.5.2)
- Bayou Grande and Davenport Bayou Water Quality Monitoring Program, Escambia High School, $10,000 – Engaged 235 students in water quality monitoring and research (Education and Outreach Strategy Action 1.4, 1.3)
- Bringing Back Our Bayous, Booker T. Washington High School, $10,000 – Engaged 150 students in water quality monitoring and research (Education and Outreach Strategy Action 1.4, 1.3)
- A Compelling Mini-Series Featuring the Positive Social and Economic Impacts of our Waterways, 350 Pensacola/Community Action Network, $36,000 – Produced ten, two-minute videos about our waterways (Education and Outreach Strategy Action 1.4)
- Wintering Waterfowl Use of the Pensacola and Perdido Bays Estuary System, University of West Florida, $13,248.89 – Completed a longitudinal analysis of waterfowl abundance in Escambia and Santa Rosa counties (6.1.1)

- Escambia Watershed Documentary Project, Blackwater Soil and Water Conservation District, $25,620 – Produced a 12-minute documentary on agriculture and the Escambia River (Education and Outreach Strategy Action 1.4)
- Increasing Watershed Responsibility Through a Local Inventory of Microplastics and Educational Community Outreach, University of West Florida Amount: $ 19,645.86 – Quantified microplastics from 40 sites across the Pensacola Bay Watersheds and engaged students in research (Education and Outreach Strategy Action 1.3.2)
- Citizen Science Water Quality and Habitat Monitoring Network: A Path to Connect, Inform, and Educate for Smart Community Resiliency, Institute for Human and Machine Cognition, $49,567 – Configured proof-of-concept for a community science based augmented reality app for Bayou Texar (3.1.1/ Education and Outreach Strategy Action 1.1)

During the second funding cycle (2021–2022), eight grants and a total of $250,000 were awarded:

- Perdido Key Coastal Demonstration Garden, Escambia County Natural Resources, $10,450 (Education and Outreach Strategy Action 1.4.4)
- Estuary Exhibit, Pensacola MESS Hall, $11,627 (Education and Outreach Strategy Action 1.4)
- Historical Ecology of Pensacola and Perdido Bays: Using the Past to Protect the Future of Our Bays, University of West Florida, $43,461 (1.1.1)
- Fish communities on remnant and restored oyster reefs of East and Escambia Bays: a baseline for assessing restoration success, University of South Alabama, $22,850 (6.1.1/6.2)
- Citizen Science Water Quality and Habitat Monitoring Network: Community Deployment and Network Sustainability, Institute for Human and Machine Cognition $49,830 (3.1.1/ Education and Outreach Strategy Action 1.1)
- Santa Rosa County Watershed Awareness Signage and Stormwater Drain Marking Project, Santa Rosa County, $16,573 (2.5.1, Education and Outreach Strategy Action 1.3.3)
- EscaRosa OysterCorps, Franklin's Promise Coalition, $49,999 (5.1.4)
- Fischer Landing Master Plan Study, Town of Century, $45,210 (4.3.2)

Acknowledgements: The Estuary Program offers our deepest appreciation to Representative Andrade and Senator Broxson for sponsoring the Program's legislative funding request. Special thanks to Emerald Coast Oyster Company for sponsoring the inaugural Community Grant Symposium in 2021.

Funding: Florida State Appropriation | $450,000

Leverage: Grantee Match and In-kind Support | $285,000

Partners: 18 Grantees

Outputs: Listed Above

Timeline: Ongoing

Related Actions

1.3.2

EscaRosa OysterCorps
PPBEP

Communities RISE (Resilience in Sea-Level Rise Education)

The effects of sea level rise (SLR) and climate change will disproportionally affect communities across the northern Gulf of Mexico (nGOM) due to a combination of factors including socioeconomic challenges, higher than average rates of SLR, and low-lying topography. Resilience of nGOM social, economic, and cultural resources in the face of SLR requires an informed and engaged community and leadership that understands risks, options for adaptation, and the processes required for action. This project uses a holistic approach to address SLR resilience barriers through inclusive education ranging from high school students to community groups that capitalizes and expands on existing efforts and resources available throughout the Gulf of Mexico (GOM). The main objective is to produce a comprehensive, sustainable SLR education program that spans ages, locations, and demographics to generate better prepared nGOM coastal communities.

The PLACE:SLR team is partnering with staff from PPBEP, Santa Rosa County, UF/IFAS Extension, and City of Pensacola to design and host a Community Connection Dialogue and a series of "Pop-In" events across the watershed to bring together the science, civic process, and solutions to residents and municipal officials. The Pop-Ins will use immersive learning tools at every-day locations throughout the watershed and are meant to target new audiences that aren't already aware or engaged in conversations surrounding climate change and SLR. Expected outcomes in achieving this goal would be that coastal residents are able to describe the risks of SLR in their communities, are aware and support ongoing resilience efforts, and that residents and municipal officials build productive and trusting relationships to act on reducing identified risks.

Communities RISE Workshop
PPBEP

Funding: NOAA Environmental Literacy Grant | $ 450,000

Partners: PPBEP; City of Pensacola; 350 Pensacola; UF/IFAS Extension; Santa Rosa County

Outputs: A comprehensive, sustainable SLR education program; Six educator workshops across the Gulf of Mexico; Twelve Community Connection Dialogues; Twelve "Pop-Ins" led by the Project Team; Twelve "Pop-Ins" led by nGOM coastal community members and/or youth

Timeline: December 2024

Related Actions

2.6.1

Resilience Readiness: A Community-Based Participatory Assessment in the City of Pensacola, Florida

In November 2021, the PPBEP secured funds from the Mississippi-Alabama Sea Grant Consortium, NOAA's Office for Coastal Management, and the Gulf of Mexico Climate and Resilience Community of Practice (CoP) to develop a climate adaptation project with local communities at risk that will serve as an example for other communities across the GOM. Sea level rise and climate change continue to impact coastal communities through increased frequency of flood events and major storms. To address these issues on a local scale, the PPBEP staff is collaborating with researchers at the University of West Florida, sustainability planners at the City of Pensacola, an agent from UF/IFAS Sea Grant Extension, and staff from the Program for Local Adaptation to Climate Effects: Sea Level Rise (PLACE: SLR) to develop a demonstration project. A main element of the project will be developing and administering resilience readiness surveys in selected communities within city limits of Pensacola, Florida. Specifically, this project focuses on residents of the City's five priority planning areas to assess each community's "resilience readiness" or awareness and acceptance of local risk for impacts associated with sea level rise and climate change. Citizens' perceptions of vulnerable and resilient areas of the community will be visualized using sketch mapping activities. Undergraduate honors students at the University of West Florida will work with PPBEP staff to finalize and administer the surveys and analyze the results. This project will compile, analyze, and package the survey data so it can be incorporated into the City of Pensacola's Sea Level Rise Vulnerability Assessment tool (2021; Sea Level Rise Vulnerability Assessment | Pensacola, FL) This project uses a novel approach to addressing local vulnerability by assessing local risk perceptions around sea level rise to inform pilot, community-based resiliency actions. This work will provide a framework for future projects that seek to apply community-based methods to address community resiliency, social vulnerability, and inequity. The purpose is to assess vulnerability of critical coastal communities to sea level rise and support communities in long-term resiliency planning by achieving the following goals:

1. Enhance resilience planning efforts in the City of Pensacola by providing community vulnerability data by assessing local perceptions of climate risks.
2. Engage students in a meaningful research experience that emphasizes learning and development in resiliency and environmental science. Students are equipped to support and develop future resilience efforts, expanding the local capacity and support for climate resilience planning.
3. Build community resiliency through partnership building and community participation in pilot project development and implementation.
4. Build on existing and develop new cross-organizational partnerships to identify, design, and implement one pilot resiliency project with the intent to prioritize a sustainable project that can serve as an asset to community resilience.

This project builds partnerships that support local climate adaptation planning, while seeking to build trust between the program and residents in the watershed. This project is a springboard for future community-driven resiliency action in the Pensacola and Perdido watersheds.

Funding: NOAA/MS-AL Sea Grant | $28,000

Partners: PLACE:SLR; City of Pensacola; UWF

Outputs: Community Resilience Perceptions Survey Results; Implementation of a pilot resiliency project

Timeline: January 2023

Related Actions

2.6.1

Trash Free Waters

In 2019, the Program received funding from EPA's Trash Free Waters Program to develop a holistic community-based litter removal and reduction program. Throughout a four-year period, the project aims to identify and mediate potential sources of water-borne trash in three creeks within the Pensacola Bay System: Jones Creek (Escambia County), Carpenter Creek (City of Pensacola), and Pond Creek (Santa Rosa County). The project heavily engages community members in trash removal and prevention, collaborating with local businesses, non-profits, and schools to reduce water-borne trash and improve the safety, health, function, and beauty of our local creeks. This project also supports PPBEP's mission of protecting and restoring water quality and natural resources within the watersheds through partnerships, using a scientifically-sound, community-based approach to enhance resilience.

The Program contracted Osprey Initiative, a local environmental consultant specializing in litter removal and solutions, to install six floating litter booms (3 per creek), conduct tactical clean ups within the creeks, and to assist with implementation of the Escaped Trash Assessment Protocol (ETAP) developed by the EPA to standardize data collection among all funded TFW projects. Before project activities commenced, Osprey conducted a training with PPBEP staff to review the data collection process and demonstrate best practices.

To date, 134 volunteers have removed over 3,500 pounds (lbs.), approximately 350 cubic feet, of combined trash and debris from Jones Creek, Carpenter Creek, and Pond Creek. The Program has many partners to thank for their continued involvement in planning and participation in events, promoting events, and providing passionate volunteers.

The PPBEP has made lasting connections with community members and organizational partners while addressing water-borne trash, one of the most visible environmental impacts that our local waterways face. The Estuary Program will continue to build collaborative partnerships with community members and organizations to pursue relevant, innovative ways to build community resilience and promote watershed health.

Jones Creek Cleanup
PPBEP

Pond Creek Litter Boom Monitoring
PPBEP

Funding: EPA | $297,000

Partners: City of Pensacola; Escambia County; Santa Rosa County

Outputs: Install six litter capture devices in Carpenter, Jones, and Pond Creeks to evaluate trash flow and quantity; Remove 5,000 lbs. of trash and legacy debris from the 3 creeks; Recruit 45 volunteers to monitor and remove trash collected in litter booms; Engage 1,000 people through educational programs and outreach events; Engage two schools per watershed with educational programming and volunteer opportunities; Develop watershed curriculum; Develop Property Trash Reduction Plans to reduce trash and debris contributions

Timeline: June 2023

Related Actions

Education and Outreach Strategy 2.2.3

Education and Outreach Strategy 2.3.2

Litter Boom Monitoring at Carpenter Creek

PPBEP

Storm Drain Marking Program

In Spring 2020, PPBEP worked with Chasidy Hobbs (UWF) and several seniors enrolled in the Community Engagement through Environmental Science (CEES) course who developed community education and outreach resources to support Estuary Program objectives. Students conducted research on existing National Estuary Programs and formed high-priority project recommendations based on their research. The CEES student team identified storm water drain marking as an effective, implementable outreach project. Students generated a budget and secured funding to purchase supplies for a large-scale storm drain marking project within the PPBEP watershed. In addition, the team developed an implementation strategy, defining safety considerations, a project timeline, and reference materials all to facilitate the installation of storm drain markers across the PPBEP watershed. Amidst the COVID-19 pandemic, three K-12 educators elected to incorporate storm drain marking into their curriculum and guide students through the process of marking storm drains on their campus. Storm drain marking proves to be an accessible, cost-effective way to engage with citizens around storm water, community resilience, and water quality. PPBEP seeks to expand the storm drain marking program as a component of its Education and Outreach Strategy and CCMP Action Plan.

- **Funding:** UWF | $5,000
- **Partners:** UWF
- **Outputs:** Stormwater drain markings in priority locations across the watersheds
- **Timeline:** Ongoing

Related Actions

2.5.1 **Education and Outreach Strategy 2.3.3**

Storm Drain Marking at Workman Middle School
Elizabeth Walker

Appendices

Appendix 1. UWF Haas Center Community Values Survey

Appendix 2. Oyster Fisheries and Habitat Management Plan for the Pensacola Bay System

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Acronyms

AACD	Alabama Association of Conservation Districts
ACES	Area Cooperative Educational Services
ADCNR	Alabama Department of Conservation & Natural Resources
ADEM	Alabama Department of Environmental Management
ADOH	Alabama Department of Health
ADPH	Alabama Department of Public Health
AFB	Air Force Base
BARC	Bay Area Resource Council
BARC TAC	Bay Area Resource Council Technical Advisory Council
BFA	Bream Fisherman Association
BMAP	Basin Management Action Plan
BMP	Best Management Practice
BOCC	Board of County Commissioners
BP	British Petroleum
B-WET	Bay Watershed Education and Training
BWFP	Baghdad Waterfront Florida Partnership
CAC	Citizen Advisory Council
CBA	Choctawhatchee Basin Alliance
CBEC	Choctawhatchee Bay Estuary Coalition
CCMP	Comprehensive Conservation and Management Plan
CFR	Code of Federal Regulations
CHIMMP	Coastal Habitat Integrated Mapping & Monitoring Program
CISMA	Cooperative Invasive Species Management Area
COE/ FL/ AL	Centers of Excellence/ Florida/ Alabama
DEP	Department of Environmental Protection
DIN	Dissovled Inorganic Nitrogen
DISL	Dauphin Island Sea Lab
DO	Dissolved Oxygen
DOH	Department of Health
DOI	Department of Interior
ECUA	Emerald Coast Utilities Authority
EECT	Environmental Education Coordinating Team
EP	Estuary Program
EPA	Environmental Protective Agency
EPA GMP	U.S. EPA Gulf of Mexico Program
EPA ORD	U.S. EPA Office of Research and Development
ER	Emergency Response
ESA	Endangered Species Act
ESRL	Environmental Science Research Laboratory
ETAP	Escaped Trash Assessment Protocol
FDA	Food & Drug Administration
FDACS	Florida Department of Agriculture & Consumer Services
FDEO	Florida Department of Economic Opportunity
FDEP	Florida Department of Environmental Protection
FDOH	Florida Department of Health
FDOT	Florida Department of Transportation
FEM	Forum of Environmental Measures
FEMA	Federal Emergency Management Agency
FFS	Florida Forest Service

FIM	Fisheries Independent Monitoring
FLRACEP	Florida RESTORE Act Centers of Excellence Program
FORS	Florida Oyster Recovery Science (working group)
FWC	Florida Fish and Wildlife Conservation Commission
FWRI	Fish and Wildlife Research Institute
GCPEP	Gulf Coast Plain Ecosystem Partnership
GCRL	Gulf Coast Research Lab
GEBF	Gulf Environmental Benefit Fund
GI	Green Infrastructure
GIS	Geographic Information System
GOM	Gulf of Mexico
GOMA	Gulf of Mexico Alliance
HABs	Harmful Algal Blooms
HSM	Habitat Suitability Model
HUD	U.S. Department of Housing and Urban Development
ICPR	Interconnected Channel and Pond Routing Model
IFAS	University of Florida, Institute of Food and Agricultural Sciences extension
IHMC	Institute for Human and Machine Cognition
IP	International Paper
LID	Low-Impact Design
LSSM	Living Shoreline Suitability Model
LULC	Land use/Land cover
MBNEP	Mobile Bay National Estuary Program
MC	Management Conference
MREC	Marine Research Ecological Consulting
MSN	Manatee Siting Network
MSN	Mangrove Survey Network
MST	Microbial Source Tracking
MSU	Mississippi State University
N	Nitrogen
NAACP	National Association for the Advanced Placement of Colored People
NARS	National Aquatic Resource Surveys
NAS	Naval Air Station
NASA	National Aeronautics and Space Administration
NASEM	National Academics of Sciences, Engineering, and Medicine
NCCA	National Coastal Condition Assessment
NELAP	National Environmental Laboratory Accreditation Program
NEP	National Estuaries Program
NERRS	National Estuarine Research Reserve Systems
NFWF	National Fish & Wildlife Foundation
NGO	Non-governmental Organization
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NRDA	Natural Resource Damage Assessment
NRM	Natural Resources Management
NRSA	National Rivers & Streams Assessment
NWCA	National Wetland Coastal Assessment
NWF	National Wildlife Federation
NWF	Northwest Florida
NWFWMD	Northwest Florida Water Management District
NWI	National Wetland Inventory

OB	Orange Beach
ODP	Observational Data Plan
ODMP	Observational Data Management Plan
OIMMP	Oyster Integrated Mapping & Monitoring Program
ORD	Office of Research & Development, EPA
P	Phosphorus
PBS	Pensacola Bay Systems
PCB	Polychlorinated Biphenyls
PERT	Panhandle Estuarine Restoration Team
PDO	Perdido
PLACE:SLR	Program for Local Adaptation to Climate Effects: Sea-Level Rise
PNJ	Pensacola News Journal
PNS	Pensacola
POP	Project Oyster Pensacola
PPBEP	Pensacola & Perdido Bays Estuary Program
PROS	Plastic-free Restoration of Oyster Shorelines
QAPP	Quality Assurance Project Plan
QMP	Quality Management Plan
RAE	Restore Americas Estuaries
RESTORE	Resources and Ecosystem Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast
RFP	Request for Proposal
SALT	South Alabama Land Trust
SAV	Submerged Aquatic Vegetation
SLR	Sea Level Rise
SIMM	Seagrass Integrated Mapping & Monitoring
SOP	Standard Operating Procedures
SPI network	Sediment Profile Imaging network
SR Gazette	Santa Rosa Gazette
SSO	Sanitary Sewage Overflows
SWG	Stakeholder Working Group
SWIM	Surface Water Improvement and Management
SWMP	Strategic Water Management Plan
TBEP	Tampa Bay Estuary Program
TC	
TN	Total Nitrogen
TNC	The Nature Conservancy
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TSS	Total Suspended Sediments
UF	University of Florida
UMP	Multi-Unit Management Plan
UNO	University of New Orleans
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Service
USM	University of Southern Mississippi
UWF/ UWF CEES	University of West Florida/ University of West Florida Community Engagement and Environmental Science
WBID	Water Body Identification number
WFRPC	West Florida Regional Planning Council
WMP	Watershed Management Plan
WQ	Water Quality
WQLM	Water Quality and Land Management Division
WRC	Warrington Revitalization Committee
WUWF	University of West Florida NPR Station
WWTP	Wastewater Treatment Plant

PENSACOLA
& PERDIDO BAYS
ESTUARY PROGRAM

Darryl Boudreau