FROM HEARTLAND TO COAST

Protecting our water, wildlife, and future

2025 Comprehensive Conservation and Management Plan for the CHNEP Area in Central and Southwest Florida

The CHNEP Comprehensive Conservation and Management Plan (CCMP) was first adopted in 2000, then updated in 2008 and 2013, with most recently being substantially revised in 2019. It was developed in part with funds provided by the U.S. Environmental Protection Agency.

This 2019–2024 CCMP Update was developed by CHNEP staff and Management Conference, with assistance from Shafer Consulting. It is available as an environmentally-friendly PDF at www.chnep.org.

COASTAL & HEARTLAND NATIONAL ESTUARY PARTNERSHIP
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Uniting Central and Southwest Florida to protect water and wildlife

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Protecting our water, wildlife, and future

2025 Comprehensive Conservation and Management Plan

for the CHNEP Area in Central and Southwest Florida

The COASTAL & HEARTLAND NATIONAL ESTUARY PARTNERSHIP (CHNEP) is a partnership of citizens, elected officials, resource managers, scientists, and commercial and recreational resource users who are working to improve the water quality and ecological integrity of the CHNEP area. A cooperative decision-making process is used within the partnership to address diverse resource management concerns in the 5,416-square mile CHNEP area.

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Ms. Jennifer Codo-Salisbury - Central Florida Regional Planning Council
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Mr. Chauncey Goss - South Florida Water Management District

CHNEP SENIOR STAFF

Ms. Jennifer Hecker - Executive Director
Ms. Nicole Iadevaia - Director of Research & Restoration

PREFACE

In the three decades since the Coastal & Heartland National Estuary Partnership (CHNEP) was established, much progress has been made—as evidenced by the expanding range of the endangered Florida panther (which currently resides almost exclusively in this region) and the permanent protection of hundreds of thousands of additional acres of environmentally sensitive lands. Through the hard work of the prior CHNEP Directors and staff, partners, and volunteers, we have made great strides towards improving environmental conditions in many areas of the CHNEP.

However, many significant challenges remain. Some areas have experienced seagrass losses, increased harmful algal blooms, wetland and upland habitat losses, and hydrologic alteration. Sea level rise is resulting in saltwater intrusion and higher "king tides" that are inundating communities. Record-setting temperatures and storm events are resulting in severe fires and flooding. Some previously identified actions still need to be completed and additional actions undertaken to address new threats and challenges.

In recent years, changes to weather and climate have manifested in unprecedented events and impacts to the CHNEP area. The devastating near category 5 Hurricane Ian brought storm surges over fifteen feet and inland extreme rainfall and flooding that caused the Peace River to rise nineteen feet higher than ever recorded. It was the third costliest natural disaster in United States' history (Blake and Gibney 2011) and resulted in the loss of over 145 lives. Communities throughout the CHNEP area were affected, including the Town of Fort Myers Beach and Sanibel Island being nearly decimated. Cars, boats, houses, and other types of physical debris went into rivers and estuaries, along with untreated wastewater, stormwater, and chemicals. The toll this and other climate-related events have had on our waters, wildlife, and environmental lands has been significant. In response, CHNEP and partners participated in emergency water quality sampling immediately after the event, synthesizing the data for dissemination to assist in their recovery efforts. CHNEP organized and facilitated meetings with the federal Interagency Recovery Coordination Team and Management Conference Committee members to discuss needs and resources for recovery. What has become very clear is the urgency for building enhanced community and environmental resiliency has never been greater.

CHNEP continues to be uniquely positioned to assist our governmental and non-governmental partners in working collaboratively to meet these challenges and help solve these problems. Our science and consensus-based approach allows all stakeholders to guide and participate in regional protection and restoration efforts. Our team of outstanding partners, committee members, staff, and volunteers are enthusiastically committed to carrying forth and building the good work of the organization. Accordingly, this updated 2025 Comprehensive Conservation and Management Plan (CCMP) was drafted collectively and represents a shared strategic vision of what is needed to protect the water and wildlife in this region.

Thank you to all CHNEP partners who contributed input and committed themselves to implementing the CCMP over the next five years. To those who are not yet CHNEP partners, please join us. It is only through combining our voices, knowledge, manpower, and resources that we will be able to preserve the environment and quality of life we all enjoy.

[Insert Jennifer Hecker Signature]

Executive Director

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EXECUTIVE SUMMARY

Central and Southwest Florida are celebrated for their waters. The interconnected water-based ecosystems stretching from inland lakes and rivers to the estuaries and Gulf of Mexico support diverse and abundant fish and wildlife. From Heartland to Coast, the environmental health of these systems underlies our quality of life and economy.

Over the years, the Coastal & Heartland National Estuary Partnership (CHNEP) office and its partners have successfully collaborated to protect and restore water quality and flows, habitats, and the fish and wildlife they support. As we celebrate our successes, we remain focused on the many challenges in our area. Continued rapid population growth, development, agriculture, and mining activities have transformed the landscape of Central and Southwest Florida. Declining water quality and supply, as well as fish and wildlife population declines continue to be issues in some areas.

Climate change, including rising sea levels, warmer air and water temperatures, and more intense storms are exacerbating impacts. Priority environmental concerns include water pollution and altered natural flows, as well as habitat fragmentation, deterioration, and loss. CHNEP began integrating climate change into all its priority Comprehensive Conservation and Management Plan (CCMP) actions in 2019. This five-year strategic plan, the 2025 CCMP, is designed to build on the principles that CHNEP was founded on—working on water quality, hydrology, habitats, fish and wildlife, and public engagement, while continuing to tackle new challenges including the rapidly intensifying effects from changes to our climate and weather. The four Action Plans in the 2025 CCMP are interconnected and synergistic. Each includes a Vision, Goal, Objective, and a Strategy of Actions and Activities to accomplish them.

The vision of the **WATER QUALITY IMPROVEMENT ACTION PLAN** is for waters to meet their designated human uses for drinking, shellfish harvesting, or swimming and fishing, while supporting appropriate and healthy aquatic life. Our strategy prioritizes five actions and multiple activities to support comprehensive and coordinated water quality monitoring programs and projects and programs that reduce pollution. Water Quality Improvement Actions are:

- Action 1 Support a comprehensive and coordinated water quality monitoring and assessment strategy
- Action 2 Develop water quality standards, pollutant limits, and cleanup plans
- Action 3 Reduce urban stormwater and agricultural runoff pollution.
- Action 4 Reduce wastewater pollution
- Action 5 Reduce harmful algal blooms

The vision of the **HYDROLOGIC RESTORATION ACTION PLAN** is to provide appropriate freshwater flow to support healthy wetlands, rivers, and estuaries. Our strategy focuses on three Actions to support data-driven watershed planning and hydrologic restoration projects to protect and restore natural flow regimes and provide sufficient fresh surface water and groundwater to natural systems. Hydrologic Restoration Actions are:

- Action 1 Conduct data collection, modeling, and analyses to support hydrologic restoration

- Action 2 Increase fresh surface water and groundwater availability to support healthy ecosystems
- Action 3 Protect and restore natural flow regimes

The vision of the **FISH, WILDLIFE, and HABITAT PROTECTION ACTION PLAN** is a diverse environment of interconnected, healthy habitats that support natural processes and viable, resilient native plant and animal communities. Our strategy highlights three Actions to promote and facilitate permanent acquisition and effective protection and management of critical natural habitats including wildlife dispersal areas, movement and habitat migration corridors, wetlands, flowways, and environmentally sensitive lands and estuarine habitats. Fish, Wildlife, and Habitat Protection Actions are:

- Action 1 Protect, monitor, and restore estuarine habitats
- Action 2 Protect, monitor, and restore environmentally sensitive lands and waterways including critical habitat areas
- Action 3 Assess and promote the benefits of land, waterway, and estuary protection and restoration

The vision of the **PUBLIC ENGAGEMENT ACTION PLAN** is an informed, engaged public making choices and taking actions that increase protection and restoration of estuaries and watersheds. Our strategy calls for four Actions to promote environmental awareness, understanding, and stewardship to the general public, new target audiences, and policymakers; and strengthen non-profit partner collaboration in education and engagement programs. Public Engagement Actions are:

- Action 1 Promote environmental literacy, awareness, and stewardship through expanded education and engagement opportunities for the general public
- Action 2 Expand reach of education and engagement opportunities to new target audiences
- Action 3 Strengthen non-profit partner collaboration in education and engagement programs
- Action 4 Increase outreach to interested policymakers to enhance understanding and support for CCMP implementation

The CHNEP continues to be uniquely positioned to assist our governmental and non-governmental partners in working collaboratively to solve problems by bringing these entities together to address regional environmental issues. Our non-regulatory, science, and consensus-based approach allows all stakeholders to participate in regional natural resource protection and restoration efforts.

ABOUT THE CHNEP

The U.S. National Estuary Program (NEP) was established by Congress in 1987 under the Clean Water Act and is administered by the US Environmental Protection Agency (EPA) to protect and restore estuaries along the coast of the United States. In 1995, former Governor Lawton Chiles submitted a nomination that 4,700 square miles of Central and Southwest Florida, including multiple estuaries and watersheds from Venice to Bonita Springs to Winter Haven, be designated as *Estuaries of National Significance.* This nomination was accepted into the NEP as the Charlotte Harbor National Estuary Program (CHNEP) on July 6, 1995. In 2019, the CHNEP area was expanded by 716 square miles to include the upper Caloosahatchee River basin, and the program name was changed to the Coastal & Heartland National Estuary Partnership (CHNEP) to better reflect the multiple estuaries and inland communities it serves (Figure 1). CHNEP is one of 28 NEPs throughout the United States, and one of four in Florida (along with Tampa Bay, Sarasota Bay, and Indian River Lagoon NEPs).

The 28 NEPs nationwide each develop and implement Comprehensive Conservation and Management Plans (CCMPs), which are long-term strategic plans that contain actions to address water quality and living resource challenges and priorities as defined by local, city, state, federal, private, and non-profit stakeholders. The CCMP is the strategic plan that guides the development of annual work plans and budgets to fulfill the purpose of a National Estuary Program, to protect and restore the water quality and ecological integrity of estuaries of national significance. The first CHNEP CCMP was approved in 2000 and updated in 2008, 2013, and 2019.

Each NEP has a Management Conference (MC) that consists of diverse stakeholders and uses a collaborative, consensus-building approach to implement the CCMP. Moreover, each MC ensures that the CCMP is uniquely tailored to the local environmental conditions and is based on local input, thereby supporting local priorities. CHNEP brings together local public and private organizations and citizens into a formal partnership charged with developing and implementing its CCMP to address environmental issues throughout the CHNEP area. In this way, the Partnership is designed to ensure it serves its governmental partners as well as the communities in its service area at large.

Figure 1. The CHNEP area extends 5,416 square miles from Florida's Gulf Coast to Florida's Heartland, including all or part of ten Counties.

The Management Conference

The CHNEP is organized as a Management Conference of four Committees and CHNEP staff (Figure 2). Each Committee serves a specific purpose and brings together a diverse collective of expertise, interest, and perspective.

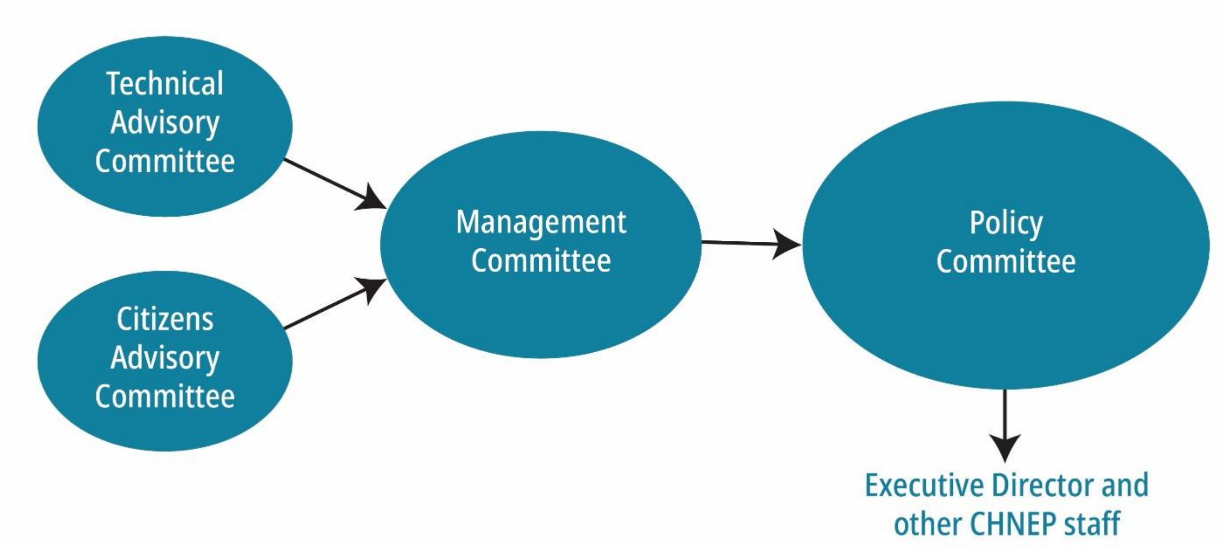


Figure 2. Organizational diagram of the CHNEP Management Conference.

The **Policy Committee** establishes general policy for the CHNEP and has ultimate authority in Program direction and administration. The Policy Committee appoints members to other committees and approves budgets and work plans. Policy Committee members represent agency and elected leaders from the CHNEP area.

The **Management Committee** serves the important role of considering input from the Citizens Advisory Committee and Technical Advisory Committee, determining consensus, and advising the Policy Committee. The Management Committee reviews work plans, contract proposals, grants, work schedules, and products. Management Committee members are appointed by Policy Board members from their respective organizations.

The **Citizens Advisory Committee** (CAC) provides the critical link between the Partnership and the public, providing input about public concerns and ideas. The CAC is also an essential mechanism for sharing program information and resources with key community organizations and individuals that may not be directly involved with the Partnership.

The **Technical Advisory Committee** (TAC) provides scientific knowledge and technical expertise to CHNEP and its projects. The TAC identifies scientific problems and potential solutions. It is a forum to bring, vet, and share the latest research and restoration information that is foundational to the Partnership's work.

The **CHNEP Staff** works to enhance existing natural resource management efforts and to improve coordination among the many active organizations in the region. The CHNEP staff supports the Management Conference structure and activities, prepares the annual work plan, allocates and obtains funding for project implementation, and assists with CCMP implementation. To monitor progress, the CHNEP staff coordinates long-term monitoring and data management and supports its integration and dissemination to the public. The staff also supports and engages in public outreach and offers educational resources and programming.

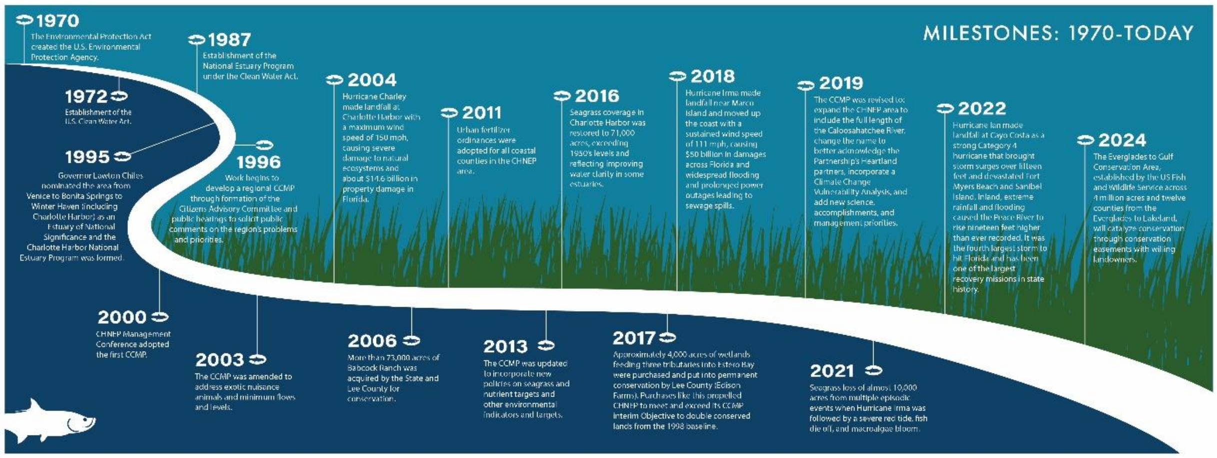
Management Conference Members and Partners

CHNEP focuses efforts on the region's most important environmental issues and encourages public agencies and private organizations to work together to protect and restore critical natural resources within the CHNEP area. The CHNEP area includes all or part of ten counties, including over two dozen incorporated cities, towns, and villages. The CHNEP area spans two water management districts, two regional planning councils, includes eight federal agencies (including the EPA that administers the NEP), and 26 Divisions of eight state agencies that also have resource management responsibilities in the CHNEP area. In addition, there are more than 80 special districts, including coastal navigation, aquatic plant control, community development, conservation and easement, soil and water conservation, and water control authorities (Table 1). The Partnership also includes public and private universities and research institutes, as well as non-profit environmental land trust, education, and advocacy organizations

Table 1. CHNEP Management Conference Municipal and Agency Members. Policy Committee Members are designated with an asterix.

COUNTIES & MUNICIPALITIES	AGENCIES
Charlotte County*	Central Florida Regional Planning Council*
DeSoto County*	Florida Department of Agriculture & Consumer Services
Glades County*	Florida Department of Environmental Protection*
Hardee County*	Florida Fish & Wildlife Conservation Commission*
Hendry County*	Gasparilla Island Conservation & Improvement Association
Highlands County*	Lee County Hyacinth/Mosquito Control District
Lee County*	National Oceanic and Atmospheric Administration
Manatee County*	Peace River Manasota Regional Water Supply Authority
Polk County*	Sanibel-Captiva Conservation Foundation
Sarasota County*	Sarasota-Manatee Metropolitan Planning Organization
City of Arcadia*	South Florida Water Management District*
City of Bartow*	Southwest Florida Regional Planning Council*
City of Cape Coral *	Southwest Florida Water Management District*
City of Fort Myers*	U.S. Army Corps of Engineers
City of Lakeland*	U.S. Environmental Protection Agency Region 4*
City of North Port*	U.S.D.A. Natural Resource Conservation Service
City of Punta Gorda*	U.S. Fish & Wildlife Service
City of Sanibel*	West Coast Inland Navigation District
City of Venice*	
City of Winter Haven*	
Town of Fort Myers Beach*	

Milestones in CHNEP History



Major Accomplishments (2019-2024)

ABOUT THE CHNEP AREA

The CHNEP area extends 5,416 square miles across eight complete watershed basins along Florida's Gulf Coast from Venice to Bonita Springs and in Florida's Heartland from Lake Hancock to Lake Okeechobee (Figure 3). Extending over 130 miles north to south, the CHNEP area is defined by subtle topography, subtropical climate, diverse subtropical plant communities, and above all—abundant water above and below ground. The rivers in the CHNEP area often start far inland as headwater wetlands, lakes, creeks, and groundwater that combine and meander downstream. They flow through cities and towns, cattle pastures and citrus groves, pine flatwoods and cypress swamps. Along the coasts, they become tidal and pass through water control structures and conveyances as they wind through urbanized areas. Then they flow into bays, coastal waters, and out into the Gulf of Mexico. Where the freshwater rivers and creeks meet the salty water of the Gulf of Mexico, they form estuaries, which are one of the most productive natural systems on earth and spectacular havens for birds, fish, and other wildlife. A series of distinct, but related bays and estuaries make up the coastal environment of Southwest Florida. These bays and estuaries include Dona and Roberts Bays, Upper and Lower Lemon Bays, Charlotte Harbor, Pine Island Sound, San Carlos Bay, and Estero Bay.

Figure 3. The CHNEP area covers eight basins in five watersheds. The five watersheds include the three coastal watersheds of Dona and Roberts Bay, Lemon Bay, and Estero Bay, and the two large riverine watersheds of Charlotte Harbor and Caloosahatchee. The Charlotte Harbor Watershed includes the Myakka River Basin, the Peace River Basin, and Charlotte Harbor Basin. The Caloosahatchee Watershed includes the Pine Island Sound Basin and the Caloosahatchee River Basin.

The Charlotte Harbor Aquatic Preserves are six contiguous aquatic preserves within the greater Charlotte Harbor estuary complex designated by the state Legislature for inclusion in the aquatic preserve system under the Florida Aquatic Preserve Act of 1975. From north to south, the preserves include Lemon Bay Aquatic Preserve, Cape Haze Aquatic Preserve, Gasparilla Sound–Charlotte Harbor Aquatic Preserve, Matlacha Pass Aquatic Preserve, Pine Island Sound Aquatic Preserve, and Estero Bay Aquatic Preserve (Figure 4).

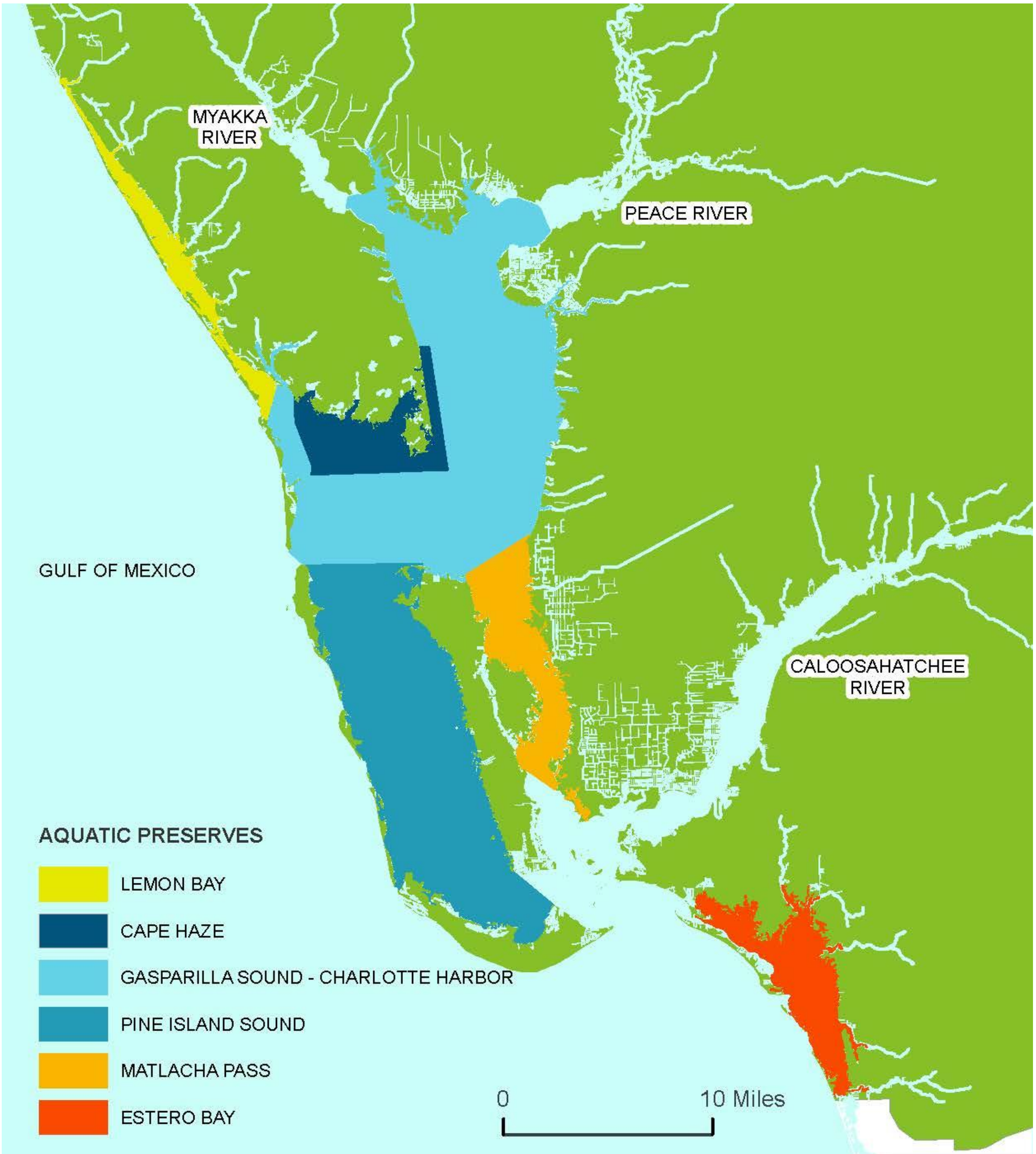


Figure 4. The Charlotte Harbor Aquatic Preserves are six contiguous aquatic preserves within the greater Charlotte Harbor estuary complex designated by the state legislature for special protection | *FDEP 2024*.

Dona and Roberts Bays Watershed

The Dona & Roberts Bay watershed spans 145 square miles and contains 64 named lakes/ponds, 26 named rivers/streams/canals, and 6 named bays/bayous. The basin connects one of the five major drainage basins in Sarasota County to the Gulf of Mexico via the Venice Inlet. Significant modifications have been made to the drainage basins, principally to the main tributaries. Many of the creeks have been dammed in order to inhibit upstream flow of salt water. They are also deepened or lengthened to allow better drainage. These have resulted in a complex sedimentation and erosion pattern with substantial anthropogenic influences. As of the last finalized assessment available (FDEP 2020-2022 Biennial Assessment), 77% of the watershed area is impaired for at least one water quality parameter, including high levels of nutrients, bacteria, and mercury (CHNEP Water Atlas). The historical watershed is highly altered from agricultural drainage projects, but the Dona Bay Restoration project seeks to restore hydrology through the diversion and slowing of flow of water through wetlands before reaching the bays.

Lemon Bay Watershed

The Lemon Bay watershed spans 132 square miles and extends from South Venice to the Gasparilla Island Causeway. The basin contains 29 named lakes/ponds, 48 named rivers/streams/canals, and 2 named bays/bayous. Due to high amounts of urban land use, the basin has been impacted by stormwater runoff, channelization of natural streams, increase of impervious surfaces, and conversion of natural habitat to other land uses. The tributaries to the estuary have also been transformed by ditching for mosquito control and development activities. As of the last finalized assessment available (FDEP 2020-2022 Biennial Assessment), 48% of the watershed area is impaired for at least one water quality parameter, with high levels of heavy metals, specifically mercury, high nutrient concentrations, and low levels of dissolved oxygen (CHNEP Water Atlas). There are five tidal creeks that drain into Lemon Bay: Alligator Creek, Woodmere Creek, Forked Creek, Gottfried Creek, and Ainger Creek. While the coastal fringe is developed with Old Florida neighborhoods.

Charlotte Harbor Watershed

The Charlotte Harbor watershed spans 350 square miles and contains 13 named lakes/ponds, 21 named rivers/streams/canals, and 5 named bays/bayous. The Charlotte Harbor Watershed encompasses 3 major drainage basins, including the Charlotte Harbor Basin, Peace River Basin, and Myakka River Basin. Fresh water from the Peace and Myakka rivers mixes with salt water coming through Boca Grande Pass from the Gulf of Mexico to form the Charlotte Harbor Estuary.

Myakka River Basin

The Myakka River basin spans 598 square miles and contains 30 named lakes/ponds, 133 named rivers/streams/canals, and 2 named bays/bayous. The basin is fairly undeveloped compared to other river basins nearby. As of the last finalized assessment available (FDEP 2020-2022 Biennial Assessment), 34% of the basin area is impaired for at least one water quality parameter, including high levels of nutrients, bacteria, and metals and low dissolved oxygen (CHNEP Water Atlas).

The Myakka River basin has the largest contiguous wetland landscape of the seven river watersheds. The 66-mile Myakka River begins its southerly flow from headwaters in Manatee and Hardee counties. After following a narrow floodplain forest corridor, the river slows and enters a series of lakes in Myakka River State Park, the largest state park in Florida. Deer Prairie Creek and Big Slough feed the river as it widens and enters Charlotte Harbor. The 34-mile portion of Myakka River in Sarasota County is designated a “Florida Wild and Scenic River.”

Cattle ranching dominates most of the watershed, especially upstream of Myakka River State Park. To satisfy the need for range and pastureland, much of the watershed was drained and diverted. These alterations enabled some drainage area to be used for row crops and citrus groves. Other parts of the upper and central Myakka River basin have been acquired for state management and protection.

In the lower portion of the Myakka River basin, urban development is replacing agriculture. Former grazing lands along the banks of the lower Myakka River are now being converted to urban uses, mostly homes. Construction is occurring on the vast inventory of lands that were platted in the 1960s. At that time, those plats replaced agriculture in western Port Charlotte and in the City of North Port. Myakkahatchee Creek, a tributary of the Myakka River, is now an important source of drinking water to some North Port residents.

Peace River Basin

The Peace River basin is located within CHNEP and spans 2,335 square miles. The basin contains 288 named lakes/ponds, 131 named rivers/streams/canals, and 3 named bays/bayous. The Peace River Basin is the largest and most diverse in the CHNEP area. As of the last finalized assessment available (FDEP 2020-2022 Biennial Assessment), 35% of the basin area is impaired for at least one water quality parameter, including high nutrients, bacteria, and metals and low dissolved oxygen (CHNEP Water Atlas).

From its headwaters in Polk County, the Peace River meanders through swamps, pine flatwoods, hardwood hammocks and marshes before it fans out into the Charlotte Harbor Watershed. The rate of flow is directly proportional to groundwater levels. Underground and overland flows follow natural and altered paths through canals, flood control structures, former and active phosphate mines, wetlands, and Lake Hancock. South of Lake Hancock, canals and tributaries combine to define the main channel of the Peace River that eventually flows more than 100 miles southwest to Charlotte Harbor.

The Peace River is also the largest freshwater contributor to Charlotte Harbor. It is a source of drinking water for more than 90,000 people in Charlotte, DeSoto and Sarasota counties. With the effects of reduced rainfall, combined with mining, agriculture and municipal water uses, freshwater flows have declined, threatening the ecology of the river system and Charlotte Harbor.

Phosphate mining has been a major land use in the Polk County headwaters of the Peace River for more than a century, altering the hydrology, flora, and fauna of the landscape. State law requires all lands mined after July 1, 1975 to be reclaimed. In addition, the adoption of a state trust fund in 1977 allowed a portion of areas mined prior to 1975 to be voluntarily reclaimed. Phosphate mining continues to expand in this basin. Citrus, cattle ranching, and row crop farming also are prevalent in Polk, Hardee, DeSoto, and Highlands counties.

Charlotte Harbor Proper Basin

The Charlotte Harbor basin is 350 square miles and contains 13 named lakes/ponds, 21 named rivers/streams/canals, and 5 named bays/bayous. Charlotte Harbor is the second-largest estuary in Florida and the largest, deepest, and most diverse of the five Charlotte Harbor Aquatic Preserves, encompassing the Gasparilla Sound-Charlotte Harbor Aquatic Preserve (Figure 4). As of the last finalized assessment available (FDEP 2020-2022 Biennial Assessment), 53% of the basin area is impaired for at least one water quality parameter, including high nutrients, bacteria, and metals (CHNEP Water Atlas).

Freshwater from the Peace and Myakka rivers mixes with saltwater coming through Boca Grande Pass from the Gulf of Mexico. The salinity regime of the Harbor changes dramatically with the season. Tides from the Gulf of Mexico affect water levels far up the Myakka and Peace Rivers. During low river-flow periods, saltwater migrates up the river; during higher river flows, freshwater lowers salinities in the rivers and lower Harbor.

Although the Harbor has an area of about 130 square miles, much of it is very shallow. Areas of deep Harbor water extend up into the lower Myakka and Peace Rivers. Sandy shelves make up the Harbor "walls," including Cape Haze on the western and Punta Gorda and Cape Coral on the eastern walls. These east and west walls are covered by seagrass beds—essential habitat for young fish and other wildlife. In addition to the designated Gasparilla Sound-Charlotte Harbor Aquatic Preserve and the Cape Haze Aquatic Preserve, the public owns many of the wetlands, mangrove forests, and salt marshes surrounding the Harbor. Very large buffer areas of mangrove islands and part of the Charlotte Harbor Preserve State Park are also publicly owned.

Pine Island Sound Watershed

The Pine Island Sound watershed spans 800 square miles and contains 109 named lakes/ponds, 105 named rivers/streams/canals, and 7 named bays/bayous, including Matlacha Pass and San Carlos Bay. The Pine Island Sound watershed encompasses 2 major drainage basins, including the Caloosahatchee River basin and the Pine Island Sound basin. Pine Island Sound receives tidal flushing from nearby Boca Grande, Captiva, and Redfish Pass, and contains the Pine Island Sound Aquatic Preserve. Matlacha Pass Aquatic Preserve (divided from Pine Island Sound by Pine Island itself) and San Carlos Bay are influenced by inputs from the Caloosahatchee River and Punta Rasa Pass to the south (Figure 4).

Caloosahatchee River Basin

The Caloosahatchee River basin spans 425 square miles from Lake Okeechobee to San Carlos Bay and contains 62 named lakes/ponds, 92 named rivers/streams/canals, and 2 named bays/bayous. The historically shallow and meandering Caloosahatchee River has been deepened, straightened, and widened into a highly managed and regulated waterway. The river and estuary's ecosystems are significantly altered, as watershed runoff and discharges from Lake Okeechobee have impacted the water quality and salinity regimes. Much of the western portion of the watershed has been urbanized by the growth of Fort Myers and Cape Coral, while the eastern portion is dominated by large agricultural land use. Historic dredging, ongoing development, and freshwater discharge from Lake Okeechobee have greatly changed the flow regime of the area, adding more freshwater and nutrients to the system and reducing historic wetlands and mangrove habitats by 63%.

Historically, the Caloosahatchee River originated as overland flow through marshlands and swamp forest until it was connected to Lake Okeechobee in 1881. The U.S. Army Corps of Engineers (USACE) converted the upper river into a canal, connected the lake to the river, and controls discharge by structures and locks. Today, Franklin Lock in Lee County separates the freshwater of the river from the saltwater of the estuary. The lock also marks the beginning of the 30-mile tidal watershed of the Caloosahatchee River that starts at the lock and continues to the Gulf of Mexico.

Twentieth century transportation, drainage, irrigation, and waste disposal have greatly altered the Caloosahatchee River and its watershed. Its historical headwaters at Lake Hicpochee were drained when the C-43 canal was dug through it to connect the Caloosahatchee River to Lake Okeechobee. Its channels were straightened, shorelines hardened, and oyster reefs dredged. Remnants of the old river course, termed "oxbows," were cut off from the main river stem when it was straightened. Many uplands and wetlands east of Franklin Lock have been converted to intensive agricultural uses. Today, the river often receives too much or too little flow of polluted water.

In addition to the upstream channel, small creeks and tributaries contribute significant volumes of freshwater to the river. The Orange River is a tributary of the Caloosahatchee River, located in Lee County. Part of the Great Calusa Blueway, the brackish Orange River starts out wide and deep, flowing through stretches of natural habitats. Upstream, the river gets narrower, shallower, and clearer. Widely spaced homes are sited along its entire length, but there is little boat traffic since the river is a no wake zone. Considerable freshwater runoff also enters the river and estuary from an extensive network of manmade navigation and drainage channels.

The priority concerns for the watershed include habitat loss and poor water quality, leading to loss of submerged aquatic vegetation and shellfish, and frequent, harmful, blue-green algae blooms. As of the last finalized assessment available (FDEP 2020-2022 Biennial Assessment), 67% of the basin area is impaired for at least one water quality parameter, including high nutrients, bacteria, and metals and low dissolved oxygen (CHNEP Water Atlas).

Pine Island Sound Basin

The Pine Island Sound basin spans 375 square miles and contains 47 named lakes/ponds, 13 named rivers/streams/canals, and 5 named bays/bayous, including Matlacha Pass and San Carlos Bay, as well as the bay and barrier islands of Pine Island, Cayo Costa, Captiva, North Captiva, and Sanibel. Pine Island Sound receives tidal flushing from nearby Boca Grande, Captiva, and Redfish Pass, and contains the Pine Island Sound Aquatic Preserve. Matlacha Pass and Aquatic Preserve (divided from Pine Island Sound by Pine Island itself) and San Carlos Bay are influenced by inputs from the Caloosahatchee River and Punta Rasa Pass to the south.

The Sanibel Slough/River on Sanibel Island is a unique feature—one that is not present on most barrier islands. Dredging in the 1950s changed the slough's course and the island's historic wetland habitats. Pine Island separates Pine Island Sound from Matlacha Pass and provides both areas with limited freshwater from small creeks and wetland areas. Direct rainfall and runoff from western Cape Coral are the major freshwater inputs to the system. Periodically, during large freshwater releases from the Caloosahatchee River, outflow can discharge through San Carlos Bay into southern Pine Island Sound and southern Matlacha Pass. Dredging and altered timing and volumes of freshwater discharges from the Caloosahatchee River system have harmed the estuary.

While the Pine Island Sound watershed has 69% of its historic coastal wetlands, upland development has degraded water quality mainly from residential stormwater and septic/sewage pollution, agricultural runoff, and Caloosahatchee River discharge. Water quality impairments, particularly high levels of metals and low dissolved oxygen, remain a concern. The area is important habitat for over 450 different species of fish, invertebrates, and birds. As of the last finalized assessment available (FDEP 2020-2022 Biennial Assessment), 85% of the basin area is impaired for at least one water quality parameter, including high nutrients and bacteria and low dissolved oxygen (CHNEP Water Atlas).

Estero Bay Watershed

The Estero Bay watershed spans 360 square miles from Fort Myers south to Bonita Springs and contains 46 named lakes/ponds, 17 named rivers/streams/canals, and 2 named bays/bayous, including Estero Bay. The western border consists of a chain of six barrier islands: Estero Island, Lovers Key, Long Key, Black Island, Big Hickory Island, and Little Hickory Island. The watershed has significant freshwater inputs from small rivers and weak tidal exchange due to the restricted size of the four main inlets. Although the estuary is separated from the Charlotte Harbor estuary, it does receive water indirectly from the Caloosahatchee River through San Carlos Bay.

Extensive seagrass beds in its shallow waters support juvenile fish and crabs, and numerous mangrove islands support large bird rookeries. The Estero Bay Aquatic Preserve was Florida's first aquatic preserve, dedicated in December 1966. The state also designated the tributaries in the Estero Bay watershed as Outstanding Florida Waters. Many of the wetlands, mangrove forests, and salt marshes surrounding the bay are publicly protected.

The coastal side of the watershed is highly developed with inland areas continuing to grow. Freshwater input is fed by various smaller creeks and two minor rivers: the six and a half mile Estero River and the nine-mile Imperial River in southern Lee County. Nutrient runoff and upland discharge remain a priority concern, especially because low freshwater input makes the watershed highly sensitive to surface runoff. Poor water quality, altered hydrology, and boater damage have also caused a loss in historic seagrass and oyster coverage.

As of the last finalized assessment available (FDEP 2020-2022 Biennial Assessment), 57% of the basin area is impaired for at least one water quality parameter, including high nutrients, bacteria, metals, and low dissolved oxygen (CHNEP Water Atlas).

The Gulf of Mexico

While outside of the CHNEP area, the Gulf of Mexico is critically linked to the health of its estuaries. Warm water temperatures in the Gulf create ideal conditions for powerful hurricanes, which can cause extensive damage to human and natural environments in the estuaries and watersheds of the CHNEP area. In 2004, Category 4 Hurricane Charley struck the northern tip of Captiva Island near Cayo Costa with peak winds of 150 mph and made landfall in Punta Gorda. The storm caused severe damage to natural ecosystems and about $14.6 billion in property damage in Florida. In 2018, Hurricane Irma struck Southwest Florida with sustained winds of 111 mph, causing widespread flooding and power outages leading to sewage spills and $50 billion in property damage across Florida. Hurricane Ian made landfall in 2022 at Cayo Costa as a strong Category 4 (nearly 5) hurricane that brought storm surges over fifteen feet and devastated Fort Myers Beach and Sanibel Island and took 145 lives. Inland, extreme rainfall and flooding caused the Peace River to rise to a historic high mark. The loss of property made it the third costliest natural disaster in United States' history (Blake and Gibney 2011).

About half the Gulf's area is comprised of shallow continental shelves, many of which are utilized by offshore oil rigs. In 2010, the Deepwater Horizon oil platform exploded causing an oil slick that expanded over hundreds of square miles of ocean surface, significantly harming marine life and coastal wetlands. Fortunately, the spill did not reach the Charlotte Harbor region but its impact on water quality and wildlife did. Although oil spills of such large magnitude are relatively rare, the National Response Center reports that there are thousands of minor accidents in the Gulf every year. While offshore oil drilling does not occur directly off Florida's coasts, there remains interest in oil exploration and extraction here.

Harmful red tide algal blooms form in the Gulf of Mexico and can be swept into Southwest Florida beaches and estuaries by currents and winds. Once inshore, red tide outbreaks can be prolonged by high nutrient concentrations in waterways. Red tide kills birds, fish, turtles, marine mammals, and other aquatic life, and can cause respiratory problems for humans.

The Gulf produces more shellfish, finfish, and shrimp annually than major fishery areas in New England, Chesapeake, and the south- and mid-Atlantic combined. Many offshore fishery species, like gray snapper and gag grouper, use estuaries for critical early stages of their life history.

From Heartland to Coastal communities, environmental quality defines quality of life. The rich diversity of interconnected ecosystems stretching from the inland riverine headwaters to the estuaries and Gulf of Mexico support agriculture, fishing, mining, recreation, and tourism valued annually in billions of dollars. Through time, humans transformed the landscape, creating legacy challenges for environmental protection and restoration. The large size and diversity of the CHNEP area creates challenges for managers and citizens alike. The work of CHNEP, guided by its CCMP, plays a critical role in improving regionally coordinated management, as well as public education about the natural resources we treasure.

ABOUT THE CCMP VISION AND STRATEGY

This update to the CHNEP CCMP was developed over a 6-month period through a strategic planning process with the CHNEP Management Conference. Collectively, more than 130 citizen volunteers, scientists, engineers, resources managers, and elected officials contributed their time, essential knowledge, and informed opinions throughout the updating process.

The four Action Plans, with their 15 Actions, 32 Activities, and 35 Performance Measures, are measurable and achievable by CHNEP partners and/or CHNEP staff within the 5-year timeframe of the 2025-2029 CCMP.

Supporting Documents

Several important documents supplement this CCMP Update by providing additional detailed strategies for CCMP implementation:

- **Monitoring Strategy** (2020) outlines methodologies for tracking Performance Measures that indicate changes within the CHNEP area and the effectiveness of CCMP Actions and is relevant across all Action Plans.
- **Finance Strategy** (2020) describes the strategy for long-term financial sustainability to implement the CCMP through diverse resources and partners.
- **Communication and Outreach Strategy** (2020) specifies guiding principles and tactics for implementing the Public Engagement Action Plan to ensure community involvement and ownership in CCMP implementation.
- **Habitat Restoration Needs Plan** (2019/2021) provides analysis and recommendations on habitat restoration priorities to help implement the Fish, Wildlife, and Habitat Protection Action Plan, including climate change considerations. The Plan guides habitat conservation, restoration, sustainability, resiliency, and connectivity throughout the CHNEP area.
- **CHNEP Climate Change Vulnerability Analysis** (2018) analyzes climate change induced risks to implementing CHNEP programs and achieving CCMP goals and objectives. Program specific findings from the Analysis are incorporated throughout all Action Plans.
- **Policy Review Procedures** (2018) outlines the CHNEP Policy Committee’s role in policy and details procedures to develop and transmit CHNEP policy positions.
- **CHNEP Water Atlas** is a publicly accessible data hub for regional water resource data sharing and analysis, as well as information about watersheds and ecosystems in the CHNEP area. CHNEP Water Atlas features a user-friendly interface accessing water quality data, interactive maps, graphs and charts, and easy-to-understand explanations of environmental science. In 2024, a redeveloped CHNEP Water Atlas was launched,

involving 630+ new waterbody pages, as well as basin and watershed pages with respective interactive mappers of water quality, hydrology, habitat, and climate change data on each page.

- **Equity Strategy** (2023) outlines how CHNEP is advancing equity in using federal funding through the Federal Bipartisan Infrastructure Law to sustain and increase investments in disadvantaged communities.

STRATEGIC LENSES

The 2025 CHNEP CCMP Update is informed by and benefits from multiple strategic lenses, including nature-based solutions, resiliency, environmental justice, bioindicators, and climate change.

Nature-Based Solutions

Protection and restoration of estuaries and their watersheds simultaneously benefits nature and humans. Nature-based solutions (NBS) refer to the use of natural approaches or methods that mimic nature to address diverse human socio-economic-environmental issues, including public health, water and food security, climate change adaptation and mitigation, economic opportunities, poverty-reduction, and disaster risk reduction.

Throughout this CCMP, there are activities that deliver nature-based solutions that simultaneously benefit nature and humans. For example, improving surface and groundwater quality (Water Quality Improvement Action Plan) not only benefits natural ecosystems, but also potable drinking water, fish and shellfish food safety, public health, property values, and tourism. Restoring natural hydrology (Hydrologic Restoration Action Plan) can recharge groundwater aquifers for drinking water, reduce flooding, and provide nursery habitat for sustaining fisheries. Restoring coastal habitats like oyster reefs and mangrove forests (Fish & Wildlife Habitat Protection Plan) can help defend coastlines against storms, sequester carbon, and reduce coastal erosion.

Resilient Systems

Building resilience into natural and human systems is essential for protecting them against major disruptions and facilitating their recovery and return to a stable state in an acceptable timeframe. Additionally, healthier ecosystems are more resilient ecosystems. A resilient systems approach to managing coastal ecosystems and communities relies on optimizing system properties of resistance, reliability, redundancy, and response/recovery.

Scientists, managers, and decision-makers work in an environment with imperfect knowledge of the complex dynamics of systems already challenged with multiple interacting stressors related to population growth and development. Compounded by climate stressors, the consequences of chronic and episodic disruptions on system stability and vulnerability to tipping points cannot be predicted with any meaningful accuracy. As a result, today's challenges can no longer be responsibly met with management approaches that strive to maintain systems at levels just sufficient to deliver desired performance during average conditions or derived from historical conditions. A resilient systems approach is better suited to managing present and future risks by building buffers into environmental and human systems, wherever and whenever feasible, to optimize sustainability during changing conditions and resilience during extremes.

Climate Change

The U.S. EPA set a goal for all National Estuary Programs to be "climate ready" by 2020. CHNEP did this by conducting the CHNEP Climate Change Vulnerability Analysis in 2018, where after consulting with stakeholders and management conference members, it identified four primary climate stressors that created 48 specific climate risks within the listed priority areas. CHNEP then integrated and addressed these risks through adding resiliency aspects to its CCMP priority actions in 2019. As Central and Southwest Florida continue to experience climate change, further vulnerability assessments and adaptation plans are crucial to address and minimize related adverse effects to coastal and inland systems.

Since 2019, CHNEP has moved into implementing activities to support the collection of additional climate change data. Recent projects include identifying needs for monitoring the progression and impacts of ocean acidification on coastal habitats (Hall et al. 2024) and developing models for hydrologic restoration initiatives that incorporate future projected climate change scenarios. CHNEP has also created climate change data interactive mappers on its new CHNEP Water Atlas redeveloped data hub website. Seeing a need for information sharing and problem solving around climate change issues affecting local communities and natural resources, CHNEP organized the first annual Southwest Florida Climate Summit in 2021 for the public and practitioners alike and has hosted the regional event annually ever since. Additionally, it is now embarking in assisting all ten counties in its service area in creating more in-depth Comprehensive Vulnerability Assessments that will identify critical assets inventories and assess the vulnerabilities and risks to such assets for the purposes of preparing adaptation measures and projects to reduce those vulnerabilities and risks.

Bioindicators

CHNEP and partners use bioindicators to complement traditional chemical and physical analyses to achieve a more holistic understanding of ecosystem health, as well as to inform management priorities and actions from the estuaries to the uplands. Examples from partners include the Florida Ecological Report Cards for Terrestrial, Freshwater, Estuarine and Marine Habitats from Florida Fish and Wildlife Conservation Commission (FWCC) as well as the expansion of redfish and snook management region metrics, the Southwest Florida Water Management District (SWFWMD) Surface Water Improvement (SWIM) Plan, and the South Florida Water Management District (SFWMD) Comprehensive Everglades Restoration Planning Framework. Considering the myriad biological, chemical, and physical factors that can be measured and require interpretation in an environment, sometimes aquatic organisms can be the most direct and effective measure of environmental health and response to stress (Holt and Miller 2010).

Biological systems are sensitive to biological, chemical, and physical changes in the environment, which can affect an organism’s ability to survive, growth, and reproduce, that in turn can affect population and community dynamics. As a result, certain biological processes, species, populations, and communities can be used as bioindicators of ecosystem status and trends. For example, algal blooms, including macroalgae, can indicate excess nutrient supply. Oysters can accumulate and concentrate pollutants in a specific location, such as trace metals and polyfluoroalkyl (PFAS). Seagrasses can be used as an indicator of water clarity, which can be diminished by suspended sediments, particles, and nutrient-fueled algal blooms. Upstream, benthic macroinvertebrates can indicate a healthy freshwater creek.

Throughout the 2025 CCMP Update, we identify key bioindicators that are useful for assessing environmental health and briefly discuss how they can be used to monitor the effectiveness of management response. The Water Atlas is also now bringing together bioindicators and chemical indicators of water quality along with FDEP impairment assessment to create a holistic ecosystem health indicators tool.

Environmental Justice

CHNEP encompasses urbanized and rural communities, affluent and underserved communities, and communities that are primarily senior as well as those that are mixed-age. Some areas are ethnically diverse, whereas other areas are predominantly Caucasian. Several of the counties in the CHNEP area are coastal with economies centered primarily on tourism and real estate, while most inland counties have agricultural-based economies. Serving such a diverse population brings unique challenges that the CHNEP is committed to overcoming. Throughout this CCMP, there are activities aimed at serving our diverse community and prioritizing equitable allocation of staffing and resources to provide more support to underserved communities.

Focusing on providing information in multiple ways, conducting environmental education out in the various communities CHNEP serves, and providing small Conservation Grant assistance to new groups and partners are some of the ways we intend to "level the playing field" for access to the services and resources the CHNEP offers. Our Equity Strategy (CHNEP 2023) outlines how CHNEP is using Federal Bipartisan Infrastructure Law (BIL) funds to sustain and increase investments in disadvantaged communities, and the benefits that flow to them. The Strategy identifies disadvantaged communities and ensures that at least 40% of BIL funding goes to projects that benefit those areas. Additionally, CHNEP strives for environmental and economic equity in forging shared solutions where disparate interests and viewpoints are heard and mutually satisfying outcomes are achieved. This not only is the right path forward, but ultimately will broaden the base of public support needed for environmental protection for generations to come.

Our Strategic Plan

The four Action Plans of the CCMP are interconnected and synergistic. Each includes a Vision, Goal, Objective, and a Strategy of Actions and Activities to accomplish them (see Action Plans At A Glance).

Water Quality Improvement	Hydrologic Restoration	Fish, Wildlife, and Habitat Protection	Public Engagement
VISION: Waters that meet their designated human uses for drinking, shellfish harvesting, or swimming and fishing, while supporting appropriate and healthy aquatic life.	**VISION:** Appropriate freshwater flow across the landscape to sustain healthy wetlands, rivers, and estuaries.	**VISION:** A diverse environment of interconnected, healthy habitats that support natural processes and viable, resilient native plant and animal communities.	**VISION:** An informed, engaged public making choices and taking actions that increase protection and restoration of estuaries and watersheds.
GOAL: Water quality improvement.	**GOAL:** Enhanced and improved waterbodies with more natural hydrologic conditions.	**GOAL:** Natural habitat protection and restoration.	**GOAL:** Public education and engagement.
OBJECTIVE: Meet or exceed water quality standards for designated uses of natural waterbodies and waterways with no degradation of Outstanding Florida Waters.	**OBJECTIVE:** Adequate aquifer recharge and freshwater volume and timing of flow to support healthy natural systems, meet water quality criteria, and protect the designated use.	**OBJECTIVE:** Permanently acquire, connect, protect, manage, and restore natural terrestrial and aquatic habitats.	**OBJECTIVE:** Increase the proportion of the population that supports and participates in actions to protect and restore estuaries and watersheds.
STRATEGY: Support comprehensive and coordinated water quality monitoring programs and projects and programs that reduce pollution and pollutants entering waterways.	**STRATEGY:** Support data-driven watershed planning and hydrologic restoration projects to protect and restore natural flow regimes and provide sufficient fresh surface water and groundwater to natural systems.	**STRATEGY:** Promote and facilitate permanent acquisition and effective protection and management of critical natural habitats including wildlife dispersal areas, movement and habitat migration corridors, wetlands, flowways, and environmentally sensitive lands and estuarine habitats.	**STRATEGY:** Promote environmental awareness, understanding, and stewardship to the general public, new target audiences, and policymakers; and strengthen non-profit partner collaboration in education and engagement programs.

WATER QUALITY IMPROVEMENT ACTION PLAN

VISION: Waters that meet their designated human uses for drinking, shellfish harvesting, or swimming and fishing, while supporting appropriate and healthy aquatic life.
GOAL: Water quality improvement.
OBJECTIVE: Meet or exceed water quality standards for designated uses of natural waterbodies and waterways with no degradation of Outstanding Florida Waters.
STRATEGY: Support comprehensive and coordinated water quality monitoring programs, and projects and programs that reduce pollutants entering waterways.

ACTION 1: Support a comprehensive and coordinated water quality monitoring and assessment strategy
ACTION 2: Develop water quality standards, pollutant limits, and cleanup plans
ACTION 3: Reduce urban stormwater and agricultural runoff pollution
ACTION 4: Reduce wastewater pollution
ACTION 5: Reduce harmful algal blooms

GENERAL BACKGROUND:

This Water Quality Improvement Action Plan addresses aspects of water quality specific to waters meeting their designated human uses for drinking, shellfish harvesting, or swimming and fishing, while supporting appropriate and healthy aquatic life. Water quality and hydrology are interrelated, involving the science of the physical and chemical properties of surface and groundwater, the occurrence and movement of water, and its relationship with the living and non-living environment (Bales 2015). Aspects of flow dynamics and surface and groundwater levels are addressed in the Hydrologic Restoration Action Plan.

Central and Southwest Florida are celebrated for their waters and abundant aquatic life, recreational opportunities, and economic activities they support. While CHNEP and its partners have enjoyed many successes in protecting and restoring water quality in some waterbodies, continued water quality challenges exist. Priority challenges for water quality improvements involve protecting and restoring waters that have deteriorated from inadvertent impacts caused or induced by human (anthropogenic) activities. Additionally, alteration of natural landscapes by anthropogenic activities like agriculture, mining, and residential and commercial development has interrupted the natural flow of water and changed water chemistry and quality. These activities release pollutants onto land and into waterbodies, decrease pervious land surface, increase pollutant laden runoff, and reduce the value and function of ecosystems for water filtration and recharge.

Agriculture is an economic engine in the area, second only to tourism. Citrus and beef cattle are the main agricultural products. In addition to feeding a nation, agricultural lands can provide many beneficial ecosystem services. For example, they can contain natural cypress heads and sloughs providing natural floodwater retention and treatment. Over time, agricultural land clearing, leveling, and drainage have transformed habitats. Advances in agricultural best management practices (BMPs) have reduced some environmental impacts; however, challenges remain. For example, operations not following BMPs can pollute surface water and groundwater with fertilizers, pesticides, and animal waste. Transformation of former ranches and farms in coastal counties to more intensive uses, such as residential and commercial developments, creates new challenges.

Mining and reclamation processes have significantly changed the landform of large areas within the CHNEP area, primarily phosphate and rock mining. The “Bone Valley” phosphate deposit extends over 500,000 acres and lies mainly within the Peace River basin. Expansion of phosphate mining is a significant management concern, as well as management of existing older mines and their settling ponds. Limestone and sand mining also occur in South Florida. Mining operations can negatively affect water quality, disrupt wildlife habitats, and change the way water flows and is stored on land. Reclamation, off-site mitigation, and preservation can reduce some of the negative environmental impacts associated with mining.

Residential and commercial development have dramatically and permanently changed the character of the CHNEP watershed. Pastures, croplands, and natural areas were drained and cleared, and coastal lowlands were dredged and filled to create tens of thousands of home sites. Shoreline development transformed mangrove fringe and other wetland systems through construction of canals, seawalls, and riprap. Existing coastal residential centers expanded and became denser, resulting in increased stormwater and wastewater, and decreased function of coastal habitats to absorb and filter pollutants. Development has dramatically reduced pervious surfaces that once allowed water to be stored and recharge underground aquifers. Modern stormwater treatment practices have improved retention and treatment in some developed areas, but wet treatment systems like stormwater ponds still treat less than 40% of the nitrogen and 65% of the phosphorus generated—contributing to downstream water quality issues (Harper 1999). Mitigation can help resolve some of the environmental impacts due to development, but non-point source pollution and increased runoff remain serious challenges.

Threats to Water Quality

There are multiple threats to water quality in the CHNEP area, including excess nutrients, bacteria, low dissolved oxygen, reduced water clarity, toxins, plastics, and hydrologic alteration.

Excess Nutrients

Living things require nutrients to survive, grow, and reproduce. However, excess nutrients, including nitrogen and phosphorus, can feed harmful algal blooms, which can deplete dissolved oxygen and create toxins harmful to aquatic life and human health.

Excess nutrients in urban, agricultural, and industrial runoff are one of the leading threats to water quality in the CHNEP area (Figure 5). Scientists, managers, and policymakers need to gain a better understanding of the relative contributions of different sources of nutrient loadings to water bodies.

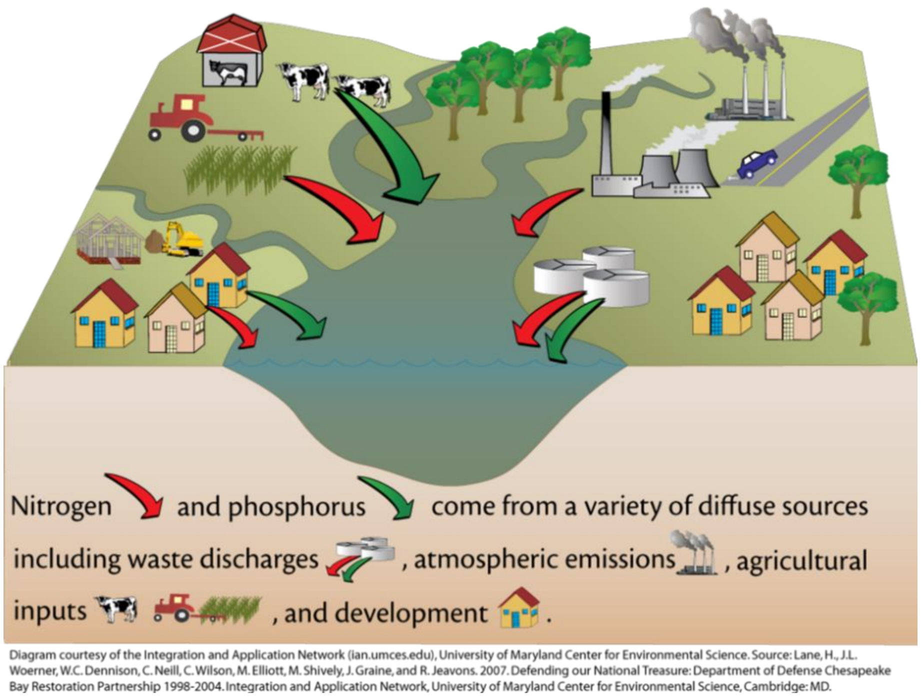


Figure 5. Nitrogen and phosphorus come from a variety of sources in the watershed | *Lane et al. 2007; courtesy of the Integration and Application Network (ian.umces.edu) University of Maryland Center for Environmental Science.*

Wastewater treatment plants remove many harmful elements of wastewater, but treated wastewater can still contain a significant nutrient load. Treated wastewater can be disposed through different pathways, including discharge into surface waters, injection into underground wells and aquifers, release to infiltration basins and spray fields, or delivery to reuse irrigation systems. Onsite Sewage Treatment and Disposal Systems (OSTDS), like septic systems, are common in the CHNEP area where central sewage treatment is not available. When these systems malfunction, even one household can become a large local source of nutrients and bacteria.

Industries such as citrus processing, phosphate mining, fertilizer manufacturing, and animal feedlots are also sources of excess nutrients. Their discharges are regulated and permitted to meet federal and state standards. However, agricultural runoff from operations not sufficiently employing agricultural BMPs and mining settling ponds that overflow or leak still pose threats to water quality of surface and groundwater resources.

Stormwater runoff can carry pollutants to waterways and waterbodies. Pollutants in stormwater are challenging to control because there is often no single identifiable point source. Stormwater pollutants can include fertilizers and pesticides from residential/commercial lawns, golf courses, and agricultural operations; litter, oil and toxins from roadways and parking lots; and waste from livestock, pets, and septic systems. Many residents and homeowner associations are unfamiliar with best management practices for their stormwater treatment ponds, and treatment effectiveness is highly variable. Low impact development and more stormwater retention and treatment in design of new systems are needed.

The atmosphere also accepts, transports, and deposits nutrients. Locally, nutrients are released into the air from vehicles and power plants. Pollutants can also be transported from distant sources into the CHNEP area by wind and deposited either directly into waters or indirectly through deposition in the watershed and carried by stormwater to waterways.

Bacteria

Bacterial contamination can affect our ability to use water for drinking, swimming, and shellfish harvesting. State of Florida water quality standards establish bacteria limits for different designated uses. For example, because bivalves like clams and oysters are filter feeders, they can accumulate and concentrate bacteria in their body tissues. If eaten raw, they can cause serious illness or even death. Therefore, only regularly monitored waters with low levels of bacteria are opened for shellfish collection. Less stringent standards apply for aquatic recreation like swimming and fishing.

Bacterial contamination comes from a variety of sources, but of most concern is fecal waste from humans and other animals. Sources of fecal bacteria include septic systems, leaking sanitary sewer systems, confined animal feedlots, untreated waste from wastewater plant overflows and backups, and overflows from wastewater conveyance infrastructure like manholes and lift stations. Urban pet waste is another significant source of contamination. After heavy rainfalls, stormwater can carry bacteria from these sources to waterways and bays. Consequently, many approved shellfish harvest areas are closed after heavy rainfalls and swimming areas may be posted as unsafe for water recreation.

Low Dissolved Oxygen

Dissolved oxygen (DO) is an important indicator of water quality, as low DO can result in the death of fish and other aquatic organisms. Sources of aquatic oxygen include plant photosynthesis and wind-driven surface-air mixing. Oxygen is consumed by animal and plant respiration and decomposition. Factors that control dissolved oxygen levels are complex and can vary throughout the day and year and with water temperature and salinity. Low DO conditions can occur naturally in some habitats, such as in warm shallow waters of tidal creeks. Low DO can also occur in shallow estuarine waters during the rainy season when large volumes of freshwater runoff or discharge can create a freshwater lens that reduces the mixing of oxygen into deeper water. Excess nutrients in runoff can cause algal blooms, which can deplete DO when algae die and decompose. Nutrients and bacteria in sediments can also stimulate oxygen demand, leading to low DO. Suspended sediments and other particulate matter in the water can limit the availability of sunlight, which can decrease oxygen production by photosynthetic organisms.

Reduced Water Clarity

Water clarity is a measure of how far light penetrates through water. Reduced water clarity can indicate sedimentation, eutrophication, and other pollutants in the water column. Sunlight can be absorbed or scattered in the water column when it interacts with suspended sediments and particles, phytoplankton, and dissolved materials. Reduced sunlight at depth can limit the area of suitable bottom habitat available to seagrasses, one of several important bioindicators of estuary health. Due to high spatial and temporal variability, long-term water quality monitoring is necessary to detect trends in water clarity. Because seagrass requires suitable water clarity to flourish, the sustained presence or absence of seagrass can be an important long-term bioindicator. Thus, seagrass acreage targets established for each CHNEP estuary are an important water quality management tool.

Toxins and Contaminants of Emerging Concern

Aquatic environments are the ultimate reservoirs for many toxic human-made chemicals. Toxins include heavy metals like lead and mercury, as well as pesticides and industrial chemicals like dichloro-diphenyl-trichloroethane (DDT), chlordane, dieldrin, and polychlorinated biphenyls (PCBs). These toxins are well-known to impact environmental and human health, including reproductive and developmental impairments, chronic diseases including cancer, and death. Sources of these toxins are numerous and expensive to monitor. Toxins can be released into the air from power plants, manufacturing facilities, or vehicles. They can be deposited on land and water through home, garden, auto, and boat maintenance activities, illegal dumping, and accidental spills. Stormwater can carry oil, heavy metals, lawn chemicals, and waste into waterbodies. Some toxic chemicals can accumulate in the sediments of lakes and estuaries, allowing their impact to continue for extended periods of time.

In addition to classes of environmental toxins that are well-understood, there are others for which less is known about their impacts to environmental and human health. These “contaminants of emerging concern” include endocrine disrupting compounds, such as polybrominated diphenyl ethers (PBDEs, used as a flame retardant), bisphenol A (BPA, used to make plastic), and ethinyl estradiol (EE2, a synthetic estrogen used in oral contraceptives). Known as ecoestrogens, these compounds are also found in pesticides, insecticides, and fungicides. A wide variety of pharmaceuticals and personal care products—including lotions, shampoos, sunscreens, perfumes, and cosmetics—contain constituents such as phthalates, parabens, glycol ethers, ultraviolet filters, polycyclic musks, and antimicrobials. These constituents are linked to adverse endocrine or reproductive effects in animals, whose tissues can accumulate toxins, making shellfish and fish harmful to humans. Toxins from pharmaceuticals and personal care products are present in treated wastewater discharges. For example, research in Tampa Bay has documented the presence of ecoestrogens in treated wastewater effluent (Cook 2015). Between 2006–2009, CHNEP sponsored several studies to investigate pharmaceuticals in tidal rivers. At that point, ecoestrogens, steroids, impotence treatments, lipid-lowering drugs, and anti-depressant chemicals were either undetectable or at near-detectable levels (Gelsleichter 2008).

Another large class of contaminants of emerging concern include per- and polyfluoroalkyl substances (PFAS), which have been used in consumer products since the 1950s—including chemicals to make clothes and carpets resistant to stains, keep food from sticking to packaging or cookware, and make fire-fighting foam more effective. These so-called forever chemicals are highly resistant to breaking down naturally and are found nearly everywhere, including in humans. Adverse health effects in humans can include reproductive and developmental impacts, liver and thyroid impairments, and cancer. While the production of some PFAS in the United States has declined, other PFAS variations have taken their place. There are nearly 15,000 PFAS chemicals.

Federal regulatory actions to safeguard communities from PFAS are underway. In 2021, USEPA announced the Agency's PFAS Strategic Roadmap, which describes actions and timelines for taking steps to safeguard communities from PFAS contamination (SEPA 2021). Also in 2021, USEPA published the fifth Unregulated Contaminant Monitoring Rule (UCMR5) to collect data for contaminants suspected to be in drinking water but do not yet have health-based standards set under the Safe Drinking Water Act. In Spring 2024, USEPA finalized a rule to designate two widely used PFAS as hazardous substances and issued the first drinking water standards that would limit contamination from six PFAS compounds by requiring water utilities to test for their presence and then take action to remove the toxins if contamination is detected above the new regulatory limit of 4 parts per trillion.

Microplastics are another contaminant of emerging concern. Microplastics do not break down, they only continue to break apart. They can also absorb chemical contaminants and become incorporated into sediments and embedded in the tissue of living things. They are commonly derived from the disintegration of larger plastic debris down to a size of 1–5 millimeters. In addition, microbeads from cleansers and cosmetics and microfibers from the laundering of synthetic clothing can pass untreated through septic systems and wastewater treatment plants and contaminate the environment. NOAA (IMDCC 2024) provides an overview of microfiber pollution, including a proposed definition of a microfiber, an assessment of the problem, and recommendations for measuring and reducing microfiber pollution. It also outlines a plan with five goals for federal agencies to reduce microfiber pollution in coordination with stakeholders.

CHNEP is a partner organization of the Citizen Science Marine Debris Monitoring and Outreach project funded by the Gulf of Mexico Alliance (GOMA) Gulf Star Program grant. The GOMA project team trained CHNEP staff to collect and analyze water and sediment samples to identify microplastics, and in turn, CHNEP trained local organizations and volunteers to collect data. More information continued to be needed to better understand how microplastics enter waterways, how they are distributed, what types are most common, and what impacts they may have on aquatic organisms.

Because conventional wastewater treatment does not remove most contaminants of emerging concern, surface water discharges of treated wastewater can deliver these pollutants directly to waterbodies. Reuse of treated wastewater for irrigation can introduce these pollutants to watershed areas, including residential yards, athletic fields, golf courses, and farms. Further research is needed to understand toxicity levels of emerging contaminants of concern, protective thresholds, and the efficacy of various wastewater treatment technologies at removing these contaminants prior to discharge or reuse.

Management efforts to reduce or eliminate environmental toxins in CHNEP watersheds and waters need to be responsive to known toxins, contaminants of emerging concern, and those that emerge in the future. Management must also be adaptive to revising priorities and incorporating new understandings and technologies.

Hydrologic Alteration

Hydrologic alteration, defined as “the manmade or man-induced alteration of the chemical, physical, biological, and radiological integrity of water” (Clean Water Act Section 502(19)), is viewed as a form of pollution under the Clean Water Act (Novak et al. 2016). Alterations in the timing, volume, velocity, and location of fresh surface water and groundwater flows can interact with and alter nutrient and bacteria concentrations, dissolved oxygen, sediment loads, salinity, and other aspects of water quality—negatively impacting biological aquatic systems. This CCMP addresses alteration of flows and levels of water in its Hydrologic Restoration Action Plan.

Climate Change

Climate stressors, including more intense storms and precipitation events, warmer air and water temperatures, and rising sea levels will exacerbate threats to water quality arising from anthropogenic stressors associated with population growth, development, agriculture, mining, and industry. Climate stressors will likely increase nutrient pollution, increase bacteria contamination, reduce dissolved oxygen levels and pH, reduce water clarity, increase toxins and emerging contaminants of concern, and increase harmful algal blooms. Ocean acidification is a threat to water quality because it poses a unique challenge to the health and viability of shellfish and calcifying corals, algae, and plankton, as well as some fish, especially in juvenile stages. Ocean acidification occurs when seawater absorbs excess carbon dioxide from the atmosphere and undergoes a chemical reaction that increases acidity (lowers pH) and reduces availability of carbonate—an essential building block for shell forming and calcifying animals. Excess carbon dioxide is also produced in coastal waters by microbial respiration (and eutrophication) and mixing of fresh and saltwater. These threats are discussed in greater detail in the Action sections of this Water Quality Improvement Action Plan.

Bioindicators

CHNEP and partners use bioindicators to complement traditional chemical and physical analyses to achieve a more holistic understanding of water quality and to inform management priorities and actions. For example, algal blooms, including macroalgae, indicate excess nutrients (Lapointe 1985). Oysters can concentrate pollutants, such as trace metals and PFAS (Lemos et al. 2022), allowing managers to detect issues that may not be apparent in water samples. Upstream in the watershed, bioindicators such as benthic macroinvertebrates indicate the health of freshwater flowing streams. Used together, a suite of indicators such as seagrass quantity and quality, macroalgae, water clarity, and water chemistry trends provide a more holistic and accurate approach to evaluating ecosystem health of estuaries. In particular, seagrass protection and restoration targets have been developed for 14 designated seagrass management segments in the CHNEP area. Because seagrass requires adequate water clarity to allow penetration of sunlight at depth, water clarity targets were also developed as one among a suite of physical and chemical and biological indicators (Dixon and Wessel 2014). Bioindicators such as abundance and type of macroalgae, seagrass patchiness, and seagrass condition also help CHNEP and its partners to better understand and manage water quality and habitat factors to attain desired seagrass and other ecosystem targets in each management segment (see Fish, Wildlife, and Habitat Protection Action 1).

Water Quality Challenges and Management Actions

Challenges in water quality management include:

- Translating water quality monitoring data into management action: Iterative and adaptive water quality modeling is needed to identify gaps in monitoring, assess water quality status and trends, and evaluate efficacy of pollutant management programs and projects.
- Determining appropriate nutrient limits: Establishing and reevaluating numeric nutrient criteria for all freshwaters, estuaries, and tidal creeks to achieve ecosystem health and ensure safety for their designated use.
- Resolving competing funding demands: Funding for water quality management competes with other public policies, necessitating the need to find consensus and resources for water quality projects and programs.
- Balancing strategies for voluntary prevention versus mandatory correction: Failure to voluntarily use best management practices can degrade area-wide water quality. The cost-benefit of voluntary pollution prevention compared to additional regulations

requires further evaluation. Proactive approaches involving regulatory limitations on pollution are often more cost effective than trying to address pollution and related problems after they have manifested themselves.

- Coordinating intergovernmental support of common goals: Federal, state, regional, and local governments operate under complex governing statutes, ordinances, policies, and budgetary rules. Despite common goals for improving and maintaining water quality, individual organizational priorities and actions may not always align well; thereby, coordination to promote complimentary priorities and actions is sometimes needed.
- Developing adaptive management capacities that can not only respond to legacy water quality issues but anticipate and prevent future issues associated with continued population growth, development, and climate change. This is necessary to ensure future management actions are appropriate for changing conditions and will be successful in producing the intended benefits.
- Incorporating water quality improvement into the design and build of residential, commercial, and industrial projects—including supporting infrastructure. This allows for multiple benefits to be gleaned and ensures water quality is improved where there are opportunities to do so.

The CHNEP Management Conference has identified five major actions to improve water quality: Action 1 calls for a comprehensive and coordinated water quality monitoring and assessment strategy; Action 2 focuses on developing water quality standards, pollutant limits, and cleanup plans; Action 3 aims to reduce urban stormwater and agricultural runoff pollution; Action 4 seeks to reduce wastewater pollution; and Action 5 works towards reducing harmful algal blooms.

Water Quality Improvement Action 1: Support a comprehensive and coordinated water quality monitoring and assessment strategy

OBJECTIVES:

Continue to assist with collection of water quality data throughout the CHNEP area and support uploading and archiving of data into standard common public databases. Continue to analyze and identify water quality status and trends with appropriate modeling methods and tools. Identify water quality sampling gaps to ensure adequate consistent sampling across the CHNEP area. Identify, study, and monitor pollutants of emerging concern.

BACKGROUND:

CHNEP continues to build upon accomplishments to monitor, analyze status and trends, and protect and restore water quality. A major activity of the CHNEP is assisting partners with collecting, sharing, analyzing, mapping, and conveying complex technical information about water quality status and trends in an understandable manner. Water quality data are used by partners to assess resources and implement effective and efficient pollutant management programs and projects (see Water Quality Improvement Action 2).

Water Quality Monitoring

Identifying waterbody impairments, establishing pollutant limits, and monitoring progress of corrective management actions all depend on the availability of accurate high-quality data. Protocols and procedures must be employed to ensure that data are properly collected, handled, processed, used, and maintained at all stages of the data life cycle.

CHNEP coordinates the Coastal Charlotte Harbor Monitoring Network (CCHMN), a partnership of agencies initiated in 2001 that collects monthly water quality data using consistent, technically sound sampling design. Long-term random sampling of strategically located stations allows scientific assessment of status and trends. CCHMN field and laboratory partners collect and analyze water samples from 60 randomly selected field sites throughout 10 waterbodies each month, including Lemon Bay, Cape Haze/Gasparilla Sound, Charlotte Harbor, Pine Island Sound, Matlacha Pass, San Carlos Bay, Estero Bay, and the Tidal Myakka, Peace, and Caloosahatchee Rivers (Figure 6). Fifteen water quality parameters are measured and analyzed using consistent field and laboratory methods (CHNEP 2023).

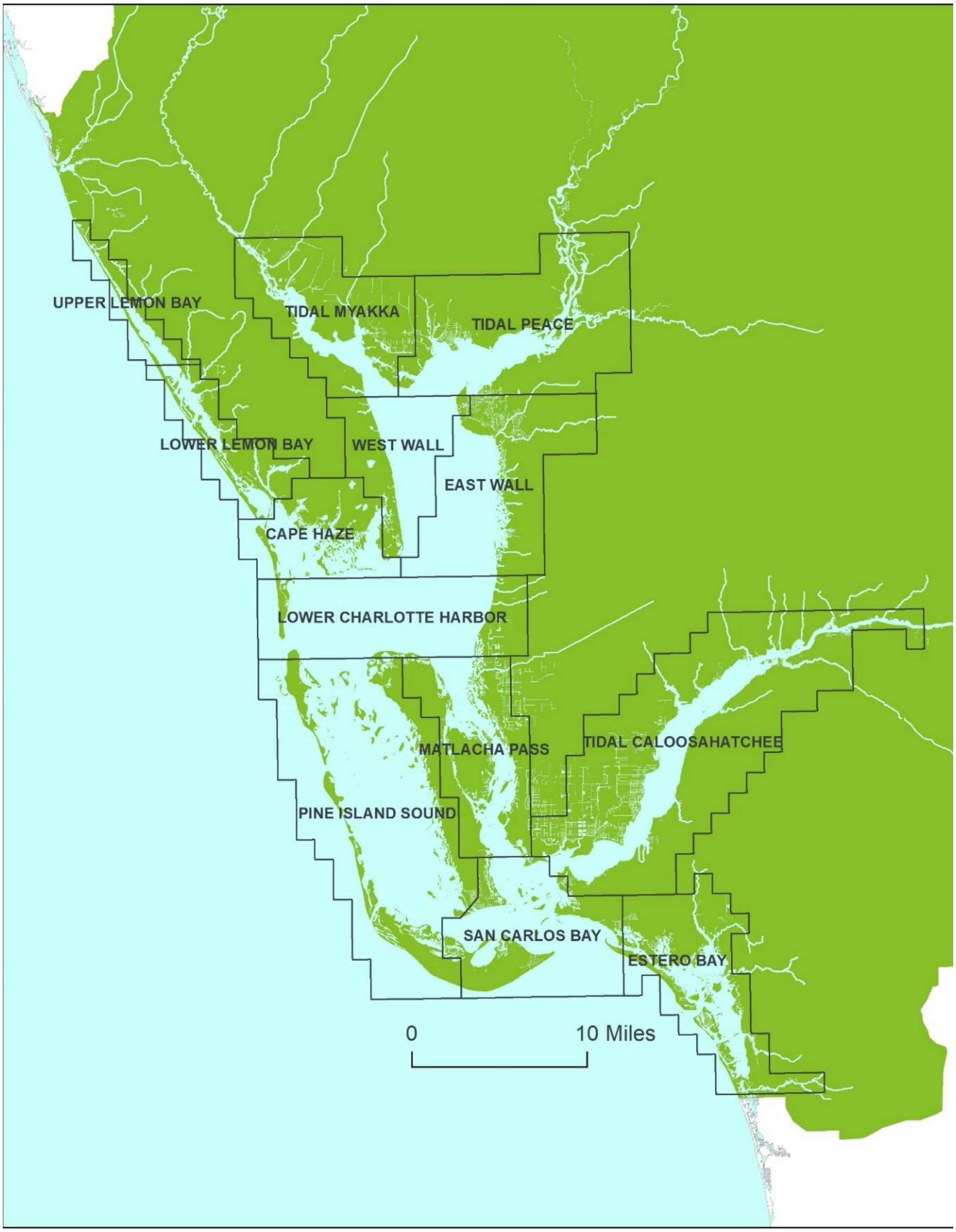


Figure 6. Coastal Charlotte Harbor Monitoring Network (CCHMN) water quality sampling strata. CCHMN field and laboratory partners collect and analyze water samples from 60 randomly selected field sites throughout 10 waterbodies each month.

Data are uploaded biannually by partners to WIN (Watershed Information Network), a standard, common public database maintained by the Florida Department of Environmental Protection (FDEP). The WIN database includes data from 2016-present, historic data (1988-2016) can be accessed from a prior database that is still publicly available - STORET (Storage and Retrieval). In addition, all contributing CCHMN laboratories and field monitoring agencies participate in annual field audits and meetings ensuring region-wide data and methodology comparability for field sampling methods. Similarly, for comparability of laboratory practices and analyses, CCHMN members are also required to attend Southwest Florida Regional Ambient Monitoring Program (SWF RAMP) quarterly meetings. The SWF RAMP serves as a quality assurance forum for comparing split-sample laboratory results, resolving inconsistencies in results, and discussing pertinent water quality monitoring issues throughout the region.

CHNEP activities to support the CCHMN include developing and updating Standard Operating Procedures and field Quality Assurance (QA) Plans, conducting annual field audits, contracting field water quality sampling, hosting annual meetings, and participating in quarterly SWF RAMP quality assurance meetings. These activities are conducted to be consistent with FDEP QA Rules (62-160, F.A.C.).

CCHMN supplements other ongoing water quality monitoring programs implemented by partners, including ongoing fixed station monitoring by counties, cities, agencies, and citizen scientists. One of these programs is the Charlotte Harbor Estuaries Volunteer Water Quality Monitoring Network (CHEVWQMN), a volunteer-based sampling program coordinated by FDEP Charlotte Harbor Aquatic Preserves (CHAP) and Estero Bay Aquatic Preserve (EBAP). Volunteers collect field measurements and water quality data for 13 parameters at 46 fixed sites on the same day each month within one hour of sunrise. Nine waterbodies across the estuary are sampled, including Lemon Bay, Cape Haze/Gasparilla Sound, Charlotte Harbor, Pine Island Sound, Matlacha Pass, San Carlos Bay, Estero Bay and the Tidal Peace and Myakka Rivers.

CHNEP supports CHEVWQMN by providing access to data through the CHNEP Water Atlas, including CHEVWQMN data in analysis, as well as maintaining Aquatic Preserves pages on the site. Other partner-led volunteer sampling programs in the region include Lee County Hyacinth Control District's Pond Watch and Cape Coral's Canal Watch, which engage homeowners to collect water samples from neighborhood ponds, lakes, and canals. Water quality analysis is performed by the sponsoring agency, and results are reported back to the volunteers. CHNEP provides access to this data through the CHNEP Water Atlas and maintains pages for each of these programs on the site.

CHNEP partners (including those who participate in the CCHMN) have also assisted with water sampling during disaster response. For example, immediately following Hurricane Ian in 2022, CHNEP partners contributed staff time to coordinate and assist with field and lab sampling.

CHNEP funding was used to fill sampling and data analysis gaps in instances where partners were unable to access their own funds during a state of emergency for such purposes.

The CHNEP Water Atlas

CHNEP maintains the CHNEP Water Atlas to ensure that area scientists, resource managers and users, elected officials, and the public can access water quality data and other technical information. Launched in 2011, the CHNEP contracts the University of South Florida in Tampa to aid continued development of and to maintain the site. The CHNEP Water Atlas is a user-friendly web-based tool that uses geographic information systems, a massive database of a variety of data, and custom analytical tools. The CHNEP Water Atlas displays data using maps, dashboards, and charts; making data easier to visualize and understand. Data are available for 704 groundwater stations and 10,969 surface water stations from 131 different data sources, including biannual updates of CCHMN data from WIN (Figure 7). Cape Coral Canal Watch the Lee County Hyacinth District Pond Watch and other non-WIN sampling programs also provide data to the CHNEP Water Atlas. From 2019 to 2024, 2,864 new sampling stations and more than 98.3 million new samples were added.

CHNEP Water Atlas users can access pages for individual waterbodies—including lakes, ponds, bays, rivers, and streams to view associated water quality data. The Data Download tool allows users to view and graph data or to download raw data. The Real-Time Data Mapper tool has hundreds of stations that perform near-real time monitoring of water quality, weather/rainfall, water flow, and water levels, with some sampling intervals as short as 15 minutes. The CHNEP Water Atlas also has pages dedicated to clam habitat suitability, fishery conservation, seagrass, coastal conditions, and habitat resiliency.

In 2024, a redeveloped CHNEP Water Atlas was launched, involving a complete redesign of the website built around 600+ waterbody pages as well as basin and watershed pages, with respective new interactive mappers added on each page. A Water Quality Snapshot dashboard was added to display the most current water quality data and compares them to water quality indicator thresholds for chlorophyll a, phosphorus, nitrogen, *E. coli* and Enterococcus bacteria, and dissolved oxygen percent saturation in the form of easy-to-understand dials. The four new interactive mappers for water quality, hydrology, habitat (both terrestrial and aquatic), and climate change data show categorized data layers, that can be turned on and off by the user to allow them to be compared and used collectively. CHNEP continues to expand the data and tools available on the CHNEP Water Atlas, as well as other types of sophisticated numerical and spatial modeling techniques (e.g., pollutant load models) for protecting and restoring water quality.

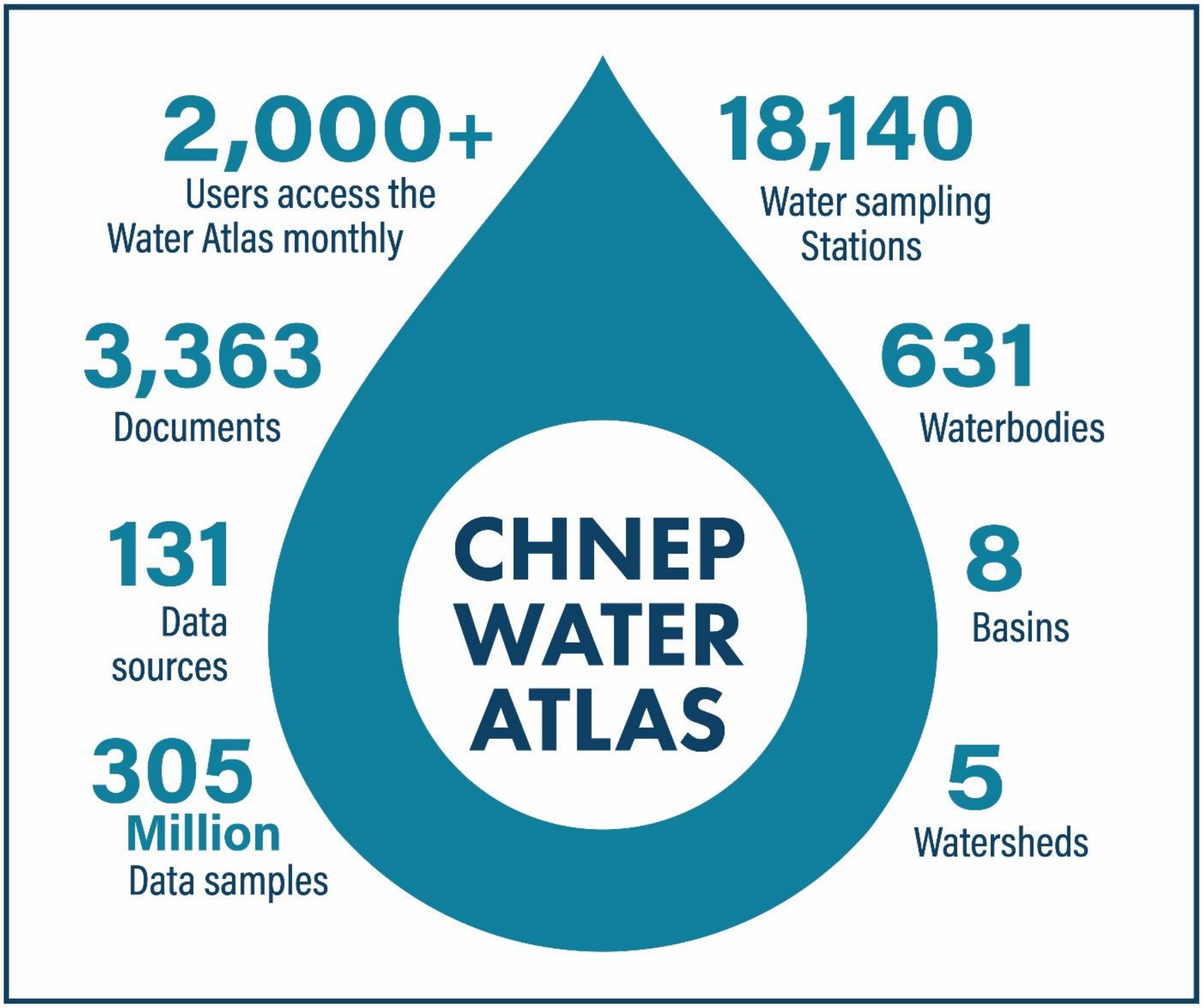


Figure 7. The CHNEP Water Atlas provides continuous access to all publicly available water quality data as well as other technical information for area scientists, resource managers and users, elected officials, and the public to utilize. *http://chnep.wateratlas.usf.edu.*

A core objective of CHNEP is to translate water quality data collected by CCHMN and other programs into actions aimed at protection and restoration. Analysis of water quality status and trends is essential to identify major sources of pollutants, provide more accurate measures of pollutant load limits, develop a basis for management plans, and evaluate effectiveness of management practices (see Water Quality Improvement Action 2). Previous analyses have led to development of water quality targets (CHNEP 2005) and numeric nutrient criteria for the estuary (Janicki Environmental 2010a), as well as periodic watershed reports (CSWF 2005, CSWF 2011, CHNEP 2011, CSWF 2017). More recently, CHNEP has begun creating Water Quality Fact Sheets that summarize and synthesize the data by each of the basins, making it available on the CHNEP website for partners to access and share. Annually, CHNEP's county and municipal partners also evaluate water quality data from fixed-point monitoring programs to identify trends and corrective actions.

Overall, the long-term monitoring strategy of CHNEP and its partners provides regional, technically sound, and timely data and analyses that can identify water quality and habitat status and trends for specific waterbodies. This enables scientists, managers, and policymakers to develop regular reports of estuary and ecosystem health, as well as to evaluate management actions and know how water quality trends are measuring up against FDEP rules for water quality standards and assessment methods (62-302 and 62-303, F.A.C., respectively). As environmental conditions change due to anthropogenic and climate stressors, water quality sampling gaps may emerge. There is also a need to continually identify gaps where data are insufficient to meet FDEP quality assurance or quality control (QA/QC) requirements for impairment determination, as well as for Total Maximum Daily Load (TMDL) and Basin Management Action Plan (BMAP) development and compliance (see Water Quality Improvement Action 2) so that those gaps may be addressed. The CHNEP continues to coordinate and adapt, working with partners to identify emerging needs and seek funding, equipment, volunteers, and other resources to enable additional sampling in essential areas.

STATUS:

Ongoing.

RELATED ACTIONS:

- Water Quality Improvement Action 2: Develop water quality standards, pollutant limits, and cleanup plans
- Fish, Wildlife, and Habitat Protection Action 1: Protect, monitor, and restore estuarine habitats

STRATEGY:

Activity 1.1: Assist with the consistent and efficient collection of technically sound long-term water quality data throughout the CHNEP area, including supporting key programs like the Coastal Charlotte Harbor Water Quality Monitoring Network, partners' long-term fixed stations, and volunteer monitoring programs like the Charlotte Harbor Estuaries Volunteer Monitoring Network, Lee County Pond Watch, and the Cape Coral Canal Watch programs. Work with partners to obtain additional resources, increase efficiencies, and identify and fill sampling gaps.

Location: CHNEP area sampling stations throughout CHNEP area.
Responsible parties: CHNEP (Lead for coordination and collection in Charlotte Harbor), SWFWMD, SFWMD, FDEP (Lead for data sufficiency and QA/QC), FWC, CHAP, EBAP, SCCF, FGCU, County and Municipal governments, NOAA, USGS, FDOH, and PRMRWSA.

Timeframe: Ongoing; Monitoring Strategy and Communication and Outreach Strategy adopted in 2020.
Potential annual cost and funding sources: $1M–10M/Section 320 Funds, additional CCHMN funding from SWFWMD, in-kind support from SFWMD, FDEP, FWC, CHAP, EBAP, SCCF, Calusa Waterkeeper, County and Municipal governments, NOAA, USGS, FDOH, and PRMRWSA.
Benefits: Sufficient long-term technically-sound data to support identification of waterbody improvements or impairments, pollutant limits, and corrective management actions to improve water quality.
5-year Performance measure: Maintenance or increase of the current spatial and temporal extent of ambient water quality monitoring data collection in accordance with appropriate QA/QC standards.

Activity 1.2: Support uploading and archiving of data in standard common public databases, including FDEP's database and the CHNEP Water Atlas.

Location: CHNEP area.
Responsible parties: CHNEP (Lead for data input to the CHNEP Water Atlas), SWFWMD (Lead for data input to SWFWMD database), SFWMD (Lead for data input to SFWMD database), FDEP (Lead for data input to FDEP database), FWC, CHAP, EBAP, SCCF, Calusa Waterkeeper, County and Municipal governments.
Timeframe: Ongoing; Monitoring Strategy adopted in 2020.
Potential annual cost and funding sources: $100,000–$499,999 /Section 320 Funds, in-kind support from SWFWMD, SFWMD, FDEP, FWC, CHAP, EBAP, SCCF, Calusa Waterkeeper, County and Municipal governments.
Benefits: Publicly accessible comprehensive database of water quality in waterbodies throughout the CHNEP area.
5-year Performance measure: Updates of water quality data to the CHNEP Water Atlas at least twice per year, and continuous public online access to water quality data via the CHNEP Water Atlas.

Activity 1.3: Assess and report water quality status and trends to identify water quality.

Location: CHNEP area.
Responsible parties: CHNEP (Lead for the CHNEP Water Atlas), FDEP (Lead for TMDL/BMAP), FWC, SWFWMD, SFWMD, County and Municipal governments.
Timeframe: Ongoing; Monitoring Strategy and Communication and Outreach Strategy adopted in 2020.
Potential annual cost and funding sources: $100,000–$499,999/Section 320 Funds.
Benefits: Readily accessible and reliable index of water quality status and trends.

5-year Performance measure: Maintain CHNEP Water Atlas capabilities that assess and report water quality status and trends.

Activity 1.4: Identify, study, and monitor new pollutants of emerging concern and their potential sources.

Location: Targeted areas in the CHNEP area.
Responsible parties: Florida Sea Grant, UF/IFAS Extension, NOAA, FDEP, Universities, CHNEP, County and Municipal governments.
Timeframe: Ongoing; Monitoring Strategy adopted in 2020.
Potential annual cost and funding sources: $25,000–$99,999/Grants from EPA, NOAA, GOMA.
Benefits: Baseline data on the presence and distribution of emerging pollutants.
5-year Performance measure: Establishment of sampling and analysis protocols; periodic water sampling using established sampling and analysis protocols at targeted locations.

Water Quality Improvement Action 2: Develop water quality standards, pollutant limits, and cleanup plans

OBJECTIVES:

Support development by FDEP of measurable and enforceable water quality criteria and targets, Total Maximum Daily Load (TMDL) pollutant limits, and Basin Management Action Plans (BMAPs) or Reasonable Assurance Plans (RAPs) to reduce pollutant loading in waterways.

BACKGROUND:

The CHNEP and its partners have a long-standing goal to establish and maintain water quality at a standard necessary to sustain natural communities and their designated human uses (CHNEP 2013). Multiple threats to water quality exist in the CHNEP area, including excess nutrients, harmful bacteria, eutrophication, metals, dissolved solids, pharmaceuticals, plastics, anthropogenic hydrologic alteration, and harmful algal blooms. To establish and maintain water quality necessary to sustain natural communities, the CHNEP partners:

- Classify waters according to their intended designated human and aquatic life uses
- Establish meaningful water quality standards and targets to protect intended uses
- Identify impaired waterbodies not meeting those standards
- Develop and implement management plans and actions to correct impairments and adaptively manage them to achieve water quality standards

Designated Beneficial Uses and Water Quality Standards

The federal Clean Water Act (CWA) is the primary federal law governing water quality standards for surface waters of the United States and the impacts of pollution and pollutants discharges into them. Its main objective is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. In Florida, the CWA is primarily administered by the FDEP with U.S. Environmental Protection Agency's (EPA) oversight.

The CWA requires that states classify surface waters according to their highest designated beneficial use—such as drinking water, recreation, aquatic life and fisheries, agriculture, or industry—and develop water quality standards to support each designated use (Table 2). Most surface waters in the CHNEP area are classified Class III waters, although many are classified as Class II and some even as Class I. Numerous waterbodies in the CHNEP area are also classified as Outstanding Florida Waters (OFWs), designated as such with the intent to protect them from any water quality degradation.

Table 2. Florida water classifications for beneficial use. Florida’s water quality standards are developed by the EPA in cooperation with FDEP.

Class	Designated Use
I	Potable (drinking) water supplies
II	Shellfish propagation or harvesting
III	Fish consumption; recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife
III-Limited	Fish consumption; recreation or limited recreation; and/or propagation and maintenance of a limited population of fish and wildlife
IV	Agriculture
V	Navigation, utility, and industry

In 2009, EPA determined that Florida’s existing narrative water quality standards were insufficient to meet requirements of the CWA, requiring water quality numeric nutrient criteria (NNC) be developed. FDEP submitted and EPA approved NNC for springs, lakes, and flowing waters in Florida. In 2011, CHNEP partnered with Tampa Bay Estuary Program (TBEP) and Sarasota Bay Estuary Program (SBEP) to assist FDEP in developing estuary-specific NNC for chlorophyll a, nitrogen, and phosphorus based on seagrass light requirements and water clarity for estuary segments in the respective NEP estuaries (Janicki Environmental 2011). These recommended NNC were adopted by FDEP in 2012, approved by the U.S. EPA, and became effective under Florida law in 2015 (Table 3).

Table 3. Numeric Nutrient Criteria for Estuary Segments within the CHNEP Area | *Florida Administrative Code 62 304.800(2)*.

Estuary Segment	Total Phosphorous	Total Nitrogen	Chlorophyll a
1. Dona and Roberts Bays[1]	0.18 mg/L	0.42 mg/L	4.9 µg/L
2. Upper Lemon Bay[1]	0.26 mg/L	0.56 mg/L	8.9 µg/L
3. Lower Lemon Bay[1]	0.17 mg/L	0.62 mg/L	6.1 µg/L
4. Charlotte Harbor Proper[1]	0.19 mg/L	0.67 mg/L	6.1 µg/L
5. Pine Island Sound[1]	0.06 mg/L	0.57 mg/L	6.5 µg/L
6. San Carlos Bay[2]	0.045 mg/L	0.44 mg/L	3.7 µg/L
7. Tidal Myakka River[1]	0.31 mg/L	1.02 mg/L	11.7 µg/L
8. Tidal Peace River[1]	0.50 mg/L	1.08 mg/L	12.6 ug/L
9. Matlacha Pass[1]	0.08 mg/L	0.58 mg/L	6.1 µg/L
10. Estero Bay[1]	0.07 mg/L	0.63 mg/L	5.9 µg/L
11. Upper Caloosahatchee River Estuary[2]	0.086 mg/L	0.72 mg/L	4.2 µg/L

12. Middle Caloosahatchee River Estuary[2]	0.055 mg/L	0.53 mg/L	6.5 µg/L
13. Lower Caloosahatchee River Estuary[2]	0.040 mg/L	0.45 mg/L	5.6 µg/L

[1] annual mean [2] long-term average

Tidal waterbodies had been exempted from NNC in 2012 and are currently regulated by the narrative criterion to protect waters from an imbalance of flora and fauna as defined by Florida Administrative Code. This was due to the need to develop water quality standards and numeric nutrient criteria using data from tidal creeks. Florida's three Gulf Coast NEPs and partners from county governments recently developed a Tidal Creek Water Quality Assessment Framework to develop nutrient thresholds for prioritizing management actions (Wessel et al. 2022). The Framework includes:

- Tidal creeks thresholds for certain tidal creeks between Tampa Bay and Estero Bay
- An assessment of nutrient conditions in those tidal creeks relative to regional numeric nutrient criteria developed for contributing freshwater creeks
- Identification of site-specific water quality indicators of tidal creek condition
- An online open science dashboard that visualizes the assessment framework and provides access to information relevant to its implementation

The Framework provides site-specific indicator results that reveal insights into drivers of tidal creek condition, as well as a prioritized list of tidal creeks requiring further research and potential management action.

[INTERNAL NOTE: CSWF Report Card Page Removed as no recent one available to replace with]

Pollutant Cleanup Plans

A waterbody that does not meet water quality standards is designated as impaired for the pollutant of concern. FDEP is periodically required to compile a list of impaired waters in Florida and report them to the EPA. A Total Maximum Daily Load (TMDL) is the amount of a given pollutant that an impaired waterbody can absorb and still meet water quality standards for its designated beneficial uses. Under the CWA and the Florida Watershed Restoration Act (FWRA), TMDLs must be developed for all verified impaired waters—unless it can be demonstrated that an existing management program is expected to correct the problem or if the impairment is due to a naturally occurring condition that cannot be corrected by a TMDL. Once a TMDL is developed, FDEP allocates "allowable" pollutant loads from the TMDL budget to sources of pollution discharging into the waterbody. Sources can be identifiable and discrete (point sources) or broad and not attributable to one source (nonpoint sources). Point source pollution permits, including those for stormwater discharge, are administered through the National Pollutant Discharge Elimination System.

Reasonable Assurance Plans (RAPs) and Basin Management Action Plans (BMAPs) are comprehensive pollutant cleanup plans that consolidate existing efforts and set a course for water quality restoration. They describe management strategies of existing water quality programs, timelines, tracking, and funding. BMAPS are measurable, enforceable plans that include all necessary stakeholders and are created by the FDEP to achieve water quality standards. RAPs are also enforceable plans, but they are created voluntarily by interested stakeholders to achieve water quality standards (e.g., Shell, Prairie, and Joshua Creeks Watershed Management Plan Stakeholders Group 2004).

FDEP maintains an online interactive map of impaired waters, those with TMDLs, and those included in a BMAP. As of May 2024, there are 161 impaired waterbodies (WBIDs) across the eight basins within CHNEP—half the total area is impaired for at least one pollutant. There are 49 TMDLs that are DEP-adopted and EPA-approved for impaired waterbodies in the CHNEP area (Figure 8). Ten more TMDLs are on the planning list for 2024. Eight TMDL waterbodies are addressed under the Caloosahatchee Estuary Basin BMAP and two are addressed under the Everglades West Coast BMAP. The Sanibel Slough TMDL is addressed by the Sanibel Comprehensive Nutrient Management Plan. The CHNEP Management Conference aims to bring all impaired waterbodies in the CHNEP area under a TMDL and associated cleanup plan (BMAP or RAP), especially Outstanding Florida Waters.

In addition to TMDLs developed by FDEP, further TMDLs were developed for the CHNEP area by the EPA as a result of the 1998 Florida TMDL Consent Decree. These TMDL documents can be found on the EPA's ATTAINS website. However, these EPA TMDLs are not being implemented presently; instead, only FDEP TMDLs are being enforced and apply in Florida.

Other Water Quality Management Rules, Plans, and Tools

The Surface Water Improvement and Management (SWIM) Act was created in 1987 by the Florida Legislature to protect, restore, and maintain Florida's threatened water bodies. Under the Act, the Southwest Florida Water Management District (SWFWMD) identified Charlotte Harbor as a priority water body for protection and restoration and adopted the Charlotte Harbor SWIM Plan in 2000 with an update in 2020 (SWFWMD 2020a). SWFWMD works with CHNEP, FDEP, and local governments to implement projects from the 2020 SWIM Plan to reduce water pollution and improve habitat quality.

First published in 2021 by the Gulf Coast Community Foundation, the Community Playbook for Healthy Waterways is a comprehensive online manual for 43 recommended activities to reduce and remove manmade nutrient pollution in the region's waterways and sustain those improvements in the future. Topics range from central wastewater management and stormwater system maintenance to fertilizer use and wetlands restoration. While the Playbook focuses on Sarasota County, the proposed activities can be adapted, transferred, and customized to other coastal Florida communities.

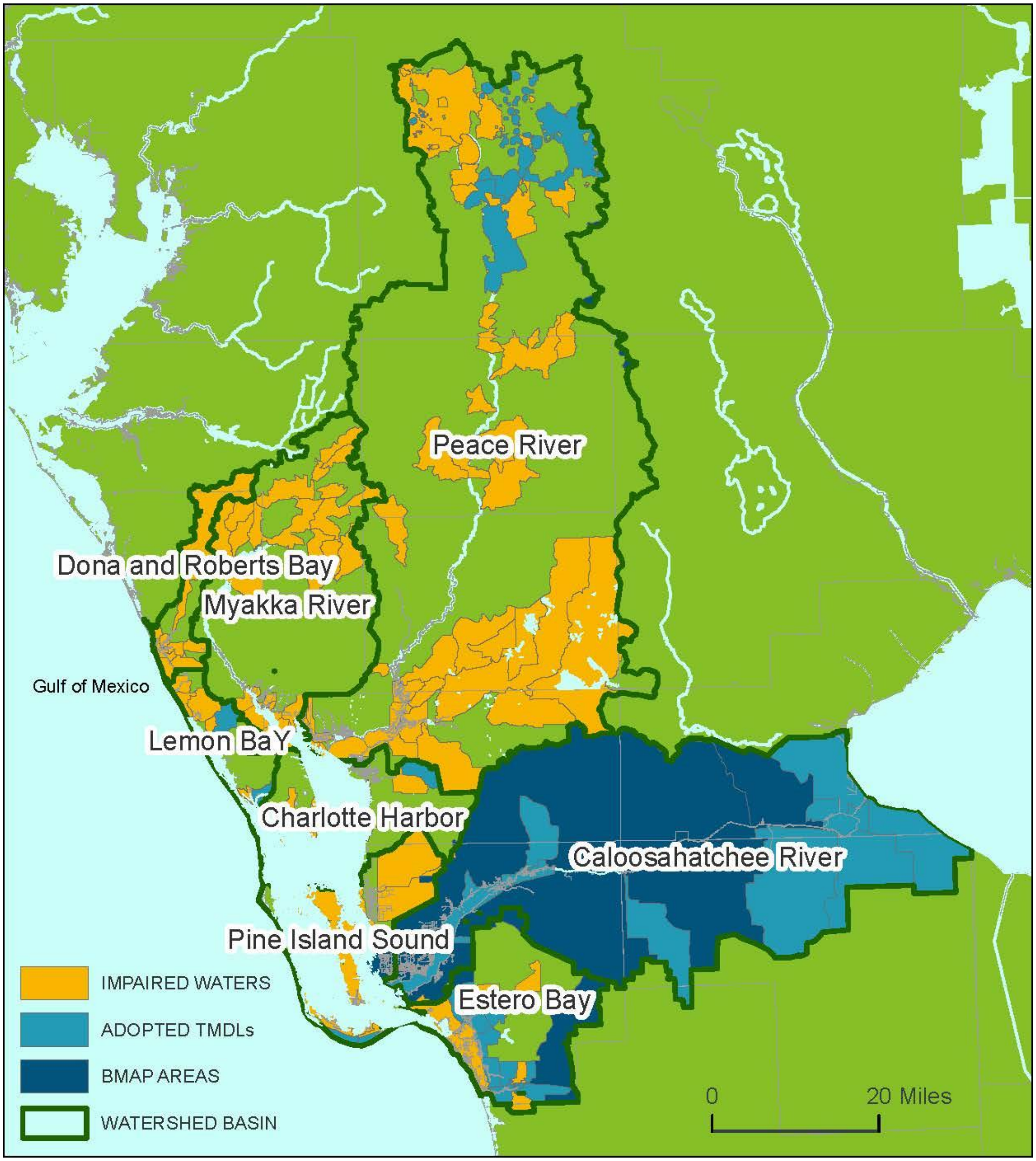


Figure 8. All eight basins of the CHNEP area have waterbodies identified as impaired for one or more water quality standards. Total Maximum Daily Loads (TMDLs) have been developed for some impaired waters. Basin Management Action Plans have been developed for several TMDLs in the Caloosahatchee River Basin | *FDEP Spring 2024.*

Examples of water management plans from municipal partners include the City of Winter Haven's innovative One Water planning approach aims to build a sustainable, economically thriving community with a paradigm shift in how water is managed: from water as waste to water as resource. One Water Winter Haven is a comprehensive plan that addresses the fundamental relationship between the built environment and the stewardship of water resources. The plan crosses all aspects of natural resources, infrastructure, land development, conservation, health, recreation, and quality of life to ensure a sustainable future for the "Chain of Lakes City."

STATUS:

Ongoing.

RELATED ACTIONS:

Water Quality Improvement Action 1: Support a comprehensive and coordinated water quality monitoring and assessment strategy

STRATEGY:

Activity 2.1: Encourage review, development, and implementation of additional water quality criteria and targets, pollutant limits, and clean-up plans that correct impairment, protect aquatic life, and prevent degradation of all surface waters, particularly Outstanding Florida Waters.

Location: All Class I, II, III, and III-L surface waters in the CHNEP area, particularly Outstanding Florida Waters.
Responsible parties: FDEP (State of Florida regulatory lead for establishing thresholds), EPA (federal regulatory oversight lead), CHNEP (provide data and technical comment as appropriate), County and Municipal governments, SWFWMD, and SFWMD.
Timeframe: Ongoing.
Potential annual cost and funding sources: Development and implementation of TMDLs, BMAPs, RAs: $500,000–$999,999/FDEP, SWFWMD, SFWMD, County and Municipal governments.
Benefits: Improved water quality supportive of living resources; development of accurate nutrient loading rates from various land uses; and identification of sources of bacteria, nutrients, and other indicators in waterbodies.
5-year Performance measure: Restoration of water quality in impaired waterbodies.

Water Quality Improvement Action 3: Reduce urban stormwater and agricultural runoff pollution

OBJECTIVES:

Support projects to increase use of stormwater best management practices (BMPs) to adequately retain stormwater and reduce stormwater pollution loadings, including in new and retrofit projects. Support green infrastructure techniques to offset man-made impacts and improve water quality and flows. Encourage implementation of FDACS BMPs, including support for regional cost-sharing programs and other incentives for implementing them.

BACKGROUND:

Rainfall can percolate into the ground, accumulate onsite, or run off developed areas to become stormwater runoff. Historical stormwater management in Florida focused on rapidly moving rainwater away from development to reduce flooding. As it flows, stormwater can accumulate pollutants, including nutrients, bacteria, sediments, debris, metals, plastics, pesticides, and petroleum products. If untreated, pollutants can reach waterways and waterbodies, impacting fish, wildlife, and habitats—and damaging economic and recreational opportunities. Modern stormwater management considers rainwater to be an asset with nature-based solutions. Best management practices work to replicate the function of natural systems, preventing pollutants from entering stormwater runoff or allowing pollutants in runoff to be removed by soils and plants with the cleansed water percolating back into the ground to recharge aquifers or to flow to downstream receiving waters.

Stormwater management is becoming more challenging with changes in rainfall patterns due to climate change. Generally, increased water vapor resulting from warming air and water temperatures is increasing the frequency and intensity of precipitation extremes—creating drier dry periods and wetter wet periods (Easterling et al. 2017). The stormwater created by the first rain after prolonged dry periods has higher concentrations of nutrients and possibly bacteria. Increased storm intensity is increasing erosion and sediment loading in stormwater. Larger freshwater pulses to the estuary can increase stratification in the water column and decrease dissolved oxygen at depth. Warmer, wetter conditions can facilitate the growth and persistence of bacteria and algae, as well as increase toxicity of stormwater pollutants (Lovett 2010). Impacts will be more severe in older coastal neighborhoods where older insufficient stormwater retention and treatment infrastructure exists, resulting in potential flooding and stormwater pollution to flow directly into natural waterbodies.

Saltwater intrusion, heavier rain events, or longer droughts with warmer temperatures may negatively affect the biological and mechanical functions of stormwater infrastructure, such as diminishing vegetated swales and stormwater detention ponds' ability to filter sediment, toxins, trash, and nutrients from stormwater and/or to appropriately modulate the flow of freshwater to the estuary. Rising sea levels are interfering with the function of some gravityfed canal systems and coastal detention ponds, creating more nuisance flooding in those areas. The extent of critical coastal habitats such as mangroves and salt marsh, and their effectiveness to naturally filter stormwater, may also be impacted. For example, sea level rise can cause coastal squeeze, where saltwater wetland habitats erode or die out due to coastal structures blocking their natural upland migration (Torio and Chmura 2013).

Urban Stormwater Runoff

Southwest Florida is one of the fastest-growing areas in the country. Development to support the growing population commonly converts pervious surfaces to impervious ones, resulting in the creation of more stormwater. Stormwater is the largest contributor of pollutants to waterbodies in the CHNEP area (Janicki Environmental 2010b). It is the largest source of total nitrogen (TN, 70 percent); total phosphorus (TP, 68 percent); total suspended solids (TSS, 95 percent); and biochemical oxygen demand (BOD, 90 percent) to area watersheds. Only about six percent of TN loading comes from atmospheric deposition. Industrial point sources account for 20 percent of TN, 28 percent of TP, three percent of TSS and seven percent of BOD. There will be a continued need to update pollutant load estimates based on future land use maps.

Reducing stormwater runoff and pollution are important management activities in the CHNEP area. One way to reduce stormwater pollution is to reduce the availability of pollutants to stormwater. Residential fertilizer ordinances restricting the use of nitrogen fertilizer during the rainy season are adopted by all coastal cities and all counties in the CHNEP area. Education and outreach campaigns to reduce stormwater pollution include UF/IFAS's Florida Friendly Landscaping™ program, Watershed Education Training Ponds Lakes and Neighborhoods (WETPLAN), and pet waste education (see Public Engagement Action 1). The Healthy Ponds Guide (healthyponds.org) is an award-winning resource for property, condo, and homeowner associations to maintain their stormwater ponds' function to store and treat stormwater, while improving aquatic habitat for Florida's wildlife and enhancing neighborhood aesthetics. This How To Guide—developed by UF/IFAS Extension Sarasota County, Sarasota County Stormwater, Solutions To Avoid Red Tide, and Science and Environment Council of Southwest Florida—provides step-by-step expert guidance on how to assess, improve, and protect stormwater ponds.

In June 2024, Florida adopted a new Statewide Stormwater Treatment Law (Chapter 62-330 of the Florida Administrative Code) to protect water quality. The new law increases the level of nutrient removal required from stormwater treatment systems in new and re-development projects. It establishes a standard such that post-development nutrient loads do not exceed pre-development (existing land use) loads or are reduced by a significant percentage, whichever is greater (Table 4). Best Management Practices are recommended for achieving the required minimum standards, including use of green stormwater infrastructure and low impact design.

Percentages are determined for total phosphorus (TP) and total nitrogen (TN) based on whether the site is near Outstanding Florida Waters (OFW), impaired waters, or other waters and whether the standard is applied to new development or redevelopment.

Table 4. 2024 Florida Statewide Stormwater Rule nutrient load reductions.

Site Location	Required % Reduction	
	TP	TN
OFW	90	80
Impaired Waters	80	80
Impaired OFW	95	95
Redevelopment (nonimpaired waters)	80	45
Redevelopment OFW	90	60
All other sites	80	55

The new law also:

- Requires applicants to demonstrate through modeling and calculations based on local conditions and annual runoff volumes that their proposed stormwater treatment system is designed to discharge to the required treatment level
- Creates new requirements for periodic inspections and the operation and maintenance of stormwater treatment systems
- Provides new permitting criteria applicable to the construction of new dams or alteration of existing dams

Design of new stormwater systems should also consider additional retention and treatment capacity to accommodate projected climate change scenarios, such as rising seas and more intense precipitation events.

Large Capital Improvement Projects and Green Infrastructure

New and retrofit, and centralized and decentralized infrastructure improvement projects are being developed and implemented to better process stormwater in the CHNEP area. Large capital improvement projects typically require extensive planning and construction. Where large projects are impractical or too expensive, a series of smaller green infrastructure practices can be implemented. Green infrastructure practices, also known as Low Impact Development or Low Impact Design (LID), work with nature to reduce and treat stormwater at its source, minimizing the volume of water and pollution emanating from the constructed environment and reducing impacts on surface and groundwater (Figure 9).

Green infrastructure is designed to mimic natural ecosystem services by capturing and storing water, filtering pollutants, and recharging underground aquifers. The best designed systems can simulate the pre-development hydrologic regime of an area and can reduce project costs compared to using traditional gray infrastructure, like sewers and pipes. In addition to cost savings, other benefits of LID can include improved aesthetics, recreational opportunities, fish and wildlife habitat, and property values. Retrofitting older developments using green infrastructure is particularly effective, and a series of different best management practices can be linked together to form an effective treatment train. Barriers to implementing green infrastructure include limited education and training opportunities, Homeowner Association rules and deed restrictions, and conflicting language in comprehensive plans and development codes.

In addition, data are needed on nutrient removal efficiencies of living shorelines, oyster reefs, seagrasses, and other BMPs for which data is lacking, so they can be assigned credits as BMPs.

Examples of green infrastructure practices include:

- ***Canopy trees and green roofs*** to intercept rainfall before it hits the ground
- ***Rainwater harvesting systems***, such as rain barrels and cisterns, to capture rainfall and store it for later use
- ***Vegetative buffers and littoral zones around shorelines, ponds, and waterways*** to filter pollutants and litter from runoff before it enters a waterbody
- ***Pervious surfaces for parking areas, walkways, and drives—like pavers, bricks, or gravel***, to reduce runoff after light rainfalls, allowing gradual infiltration of rainfall into underlying soils
- ***Rain gardens, vegetated swales, and recessed tree islands*** to capture runoff and allow it to evaporate, percolate into the ground, or be used by vegetation
- ***Stormwater parks*** to combine recreational opportunities, public amenities, wildlife habitat, flood protection, and stormwater storage and treatment into one area

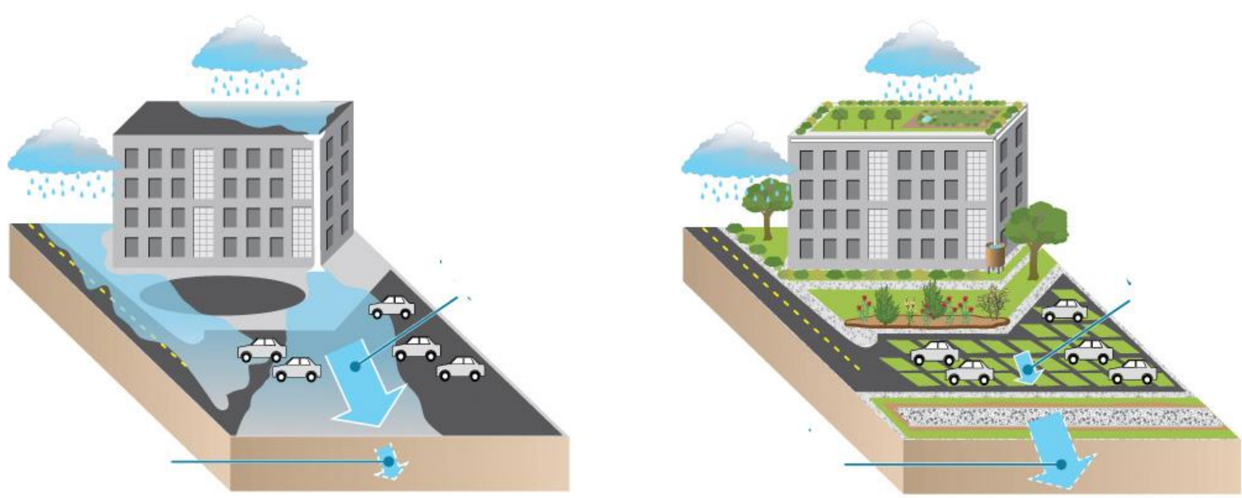


Figure 9. Impervious 'hard' surfaces (roofs, roads, large areas of pavement, and asphalt parking lots) increase the volume and speed of stormwater runoff. This swift surge of water

erodes streambeds, reduces groundwater infiltration, and delivers pollutants and sediment to downstream waters. Pervious 'soft' surfaces (green roofs, rain gardens, grass paver parking lots, and infiltration trenches) decrease volume and speed of stormwater runoff. The slowed water seeps into the ground, recharges the water table, and filters out many pollutants and sediment before they arrive in downstream waters | *Chesapeake and Atlantic Coastal Bays Trust Fund, courtesy of Integration and Application Network (ian.umces.edu) University of Maryland Center for Environmental Science.*

Dozens of stormwater reduction projects have been implemented in the CHNEP area since the last 2019 CHNEP-CCMP Revision. Notable examples include:

- **Lake Conine Wetland Treatment Project** in Winter Haven to restore wetlands on a 50-acre property by creating a series of wetland chambers to enhance water quality of runoff draining from surrounding area
- **Lake Hancock Shoreline Restoration Project** in Polk County to repair and replant the shoreline damaged by Hurricane Irma to restore its water quality enhancement function
- **Alligator Creek Restoration Project** in Sarasota County to complete surveys and hydrologic modelling that will inform the design phase of the 40-acre restoration running through residential neighborhoods
- **Jordan Treatment Marsh** on Sanibel Island to provide nutrient removal for the eastern basin of Sanibel Slough to help meet TMDL requirements
- **Felts Avenue Bio-Reactor Project** in City of Bonita Springs to withdraw and treat water from the Imperial River to create a continuous flow treatment system
- **North LaBelle Water Quality Project** to treat stormwater along Mohawk Avenue prior to discharging into the Roy Brown Canal and flowing into the Caloosahatchee River
- **Deep Lagoon Preserve** in Lee County to create a BMP treatment train including retention ponds, channel/ditch modifications, ditch blocks, and pumped solutions
- **Powell Creek/Old Bridge Park and Lakes Park** in Lee County to create filter marshes to capture and treat stormwater

Agricultural Stormwater Runoff

Runoff from agricultural land uses can carry excess nutrients from fertilizer and animal waste, bacteria from animal waste, and harmful chemicals from herbicides and pesticides to waterbodies. For the purposes of the Florida Department of Agricultural and Consumer Services (FDACS) BMP Program, the term best management practice means a practice or combination of practices determined by the coordinating agencies (FDACS, FDEP, and Water Management Districts), based on research, field-testing, and expert review, to be the most effective and practicable on-location means, including economic and technological considerations, for improving water quality in agricultural discharges. BMPs must reflect a balance between water quality improvements and agricultural productivity.

FDACS works closely with the FDEP, water management districts (WMDs), industry experts, and academic institutions to understand the environmental and agronomic effects addressed by BMPs. Newly proposed BMPs are initially verified as effective by the FDEP based on underlying research and best professional judgement. These are then adopted by reference in the applicable agricultural commodity manual under Title 5M, Florida Administrative Code (F.A.C). FDACS has adopted ten separate BMP manuals that cover nearly all major agricultural commodities in Florida (Table 5). FDACS also plans to develop a small farms manual that will incorporate practices for smaller farms and for livestock that are not yet included in an adopted manual.

Table 5. Adopted farm BMP manuals | *FDACS.*

Commodity	**Year Adopted**
Silviculture (Forestry)	2017
Sod	2008
Cow/Calf	2009
Specialty Fruit and Nut	2011
Equine	2012
Citrus	2013
Nursery	2014
Vegetable and Agronomic Crops	2015
Aquaculture	2023
Dairies	2016
Poultry	2016

Farms with large numbers of livestock in a confined area, known as animal feeding operations (AFOs), and concentrated animal feeding operations (CAFOs) are not regulated by FDACS. Instead, FDEP regulates AFOs under its industrial wastewater rules and CAFOs under its NPDES program. Hobby farmers are not currently enrolled in the FDACS BMP Program; however, FDACS plans to develop and adopt manuals for these operations.

Farmers who implement FDACS-adopted BMPs benefit from a presumption of compliance with state water quality standards for pollutants that the BMPs address. Farming operations in BMAP areas are required to implement FDACS-adopted BMPs; otherwise, they must conduct prescribed water quality monitoring that is approved by FDEP or a Water Management District to demonstrate compliance with water quality standards.

Effective July 1, 2020 under the Florida Clean Water Act, FDACS' Office of Agricultural Water Policy (OAWP) is required to visit all BMP enrolled operations once every two years to ensure that agricultural landowners and producers are properly implementing the applicable BMPs for their property. The site visit includes: the review of nutrient records that producers must maintain to demonstrate compliance with the BMP Program; verification that all applicable BMPs are being properly implemented; verification that cost share practices or projects are being properly implemented; and identification of other potential cost share practices or projects that may be available. During the site visit, FDACS representatives also identify opportunities for achieving greater nutrient, irrigation, or water resource management efficiencies, and further opportunities for water conservation.

Based on FDACS agricultural land use data, within the CHNEP area, there are approximately 1,364,539 acres of agriculture. As of May 2024, 73%, of the agricultural lands within CHNEP are enrolled in the FDACS BMP program. Most agricultural operations within the CHNEP area are enrolled in the Cow/Calf manual, multiple manuals, or the Citrus manual (Table 6).

Table 6. Acres of farms enrolled in the FDACS BMP program by commodity. For updated BMP enrollment information provided by FDACS, please visit the FDACS BMP Enrollment by Commodity GIS map. Go to fdacs.gov and search for "Agricultural Best Management Practices" | *FDACS 2024.*

Commodity	**Acres Enrolled**
Cow/Calf	461,455
Multiple Commodities	187,787
Citrus	175,440
Row/FIeld Crop	110,665
Conservation Plan	44,083
Fuit/Nut	4,024
Sod	3,807
Nursery	3,023
Temporarily Inactive	2,427
Dairy	618
Equine	219
Poultry	57
Total	**993,606**

Cost-Sharing Incentives for Participation

The FDACS BMP cost share program enhances the implementation of BMPs and other practices and makes innovative agricultural production and nutrient use efficiency methods more affordable for producers so that they can meet water quality goals while remaining financially viable. FDACS available cost share funds depend on annual appropriations by the Florida Legislature, thus the amount available can vary each year. Cost share applications may be submitted once a producer has enrolled in the BMP Program and has been assigned a NOI number. Cost share practices are categorized as nutrient management, irrigation management, or water resource protection. BMPs, other practices, and projects eligible for cost share funding may include precision agriculture technologies, variable rate irrigation methods, water control structures, and tailwater recovery systems.

FDACS and Water Management Districts incentivize adoption of BMPs through partnerships, such as SWFWMD's Facilitating Agricultural Resource Management Systems (FARMS) program and mini-FARMS program and SFWMD's Dispersed Water Management Program, making it more feasible for farmers to implement new technologies. FARMS is a cost-share reimbursement program that incentivize site-specific implementation of agricultural BMPS that focus on water quantity reductions through conservation and alternative water supply BMPs. In addition to water quantity BMPs the SWFWMD Governing Board expanded the program to allow water quality BMPS to supplement the water quantity BMPs. The primary water quality BMP incentivized are fertigation systems used with an alternative water supply project or other conservation project. Since 2003, FARMS has funded 147 projects in the Peace and Myakka Watersheds. These projects are estimated to reduce groundwater use by 24.7 million gallons per day (MGD) and reduce nutrient loading by nearly 2,000 pounds per year.

The mini-FARMS program originated as a partnership of FDACS and SWFWMD to provides reimbursement to farmers for smaller projects than the FARMS program. Mini-FARMS will reimburse up to 75% of the cost (not to exceed $10,000) to implement water conservation or water quality improvement BMP projects. Farmers must be enrolled in the FDACS BMP Program to be eligible for mini-FARMS grants. The SWFWMD has funded more than 200 projects in the CHNEP watershed, with an estimated groundwater reduction of more than 0.64 mgd. More than 600 acres of permanent "fertigation" (fertilizer and irrigation reduction) BMPs and 100 acres of water conservation BMPs have been implemented at more than a dozen citrus groves and row crop farms in the CHNEP area.

The Florida Farm Bureau's County Alliance for Responsible Environmental Stewardship (CARES) program publicly recognizes farmers and ranchers that are enrolled with the FDACS BMP Program and remain in good standing with the FDACS Implementation Assurance Program. UF/IFAS Extension Agents provide outreach to both commercial and non-commercial operators to encourage BMP adoption.

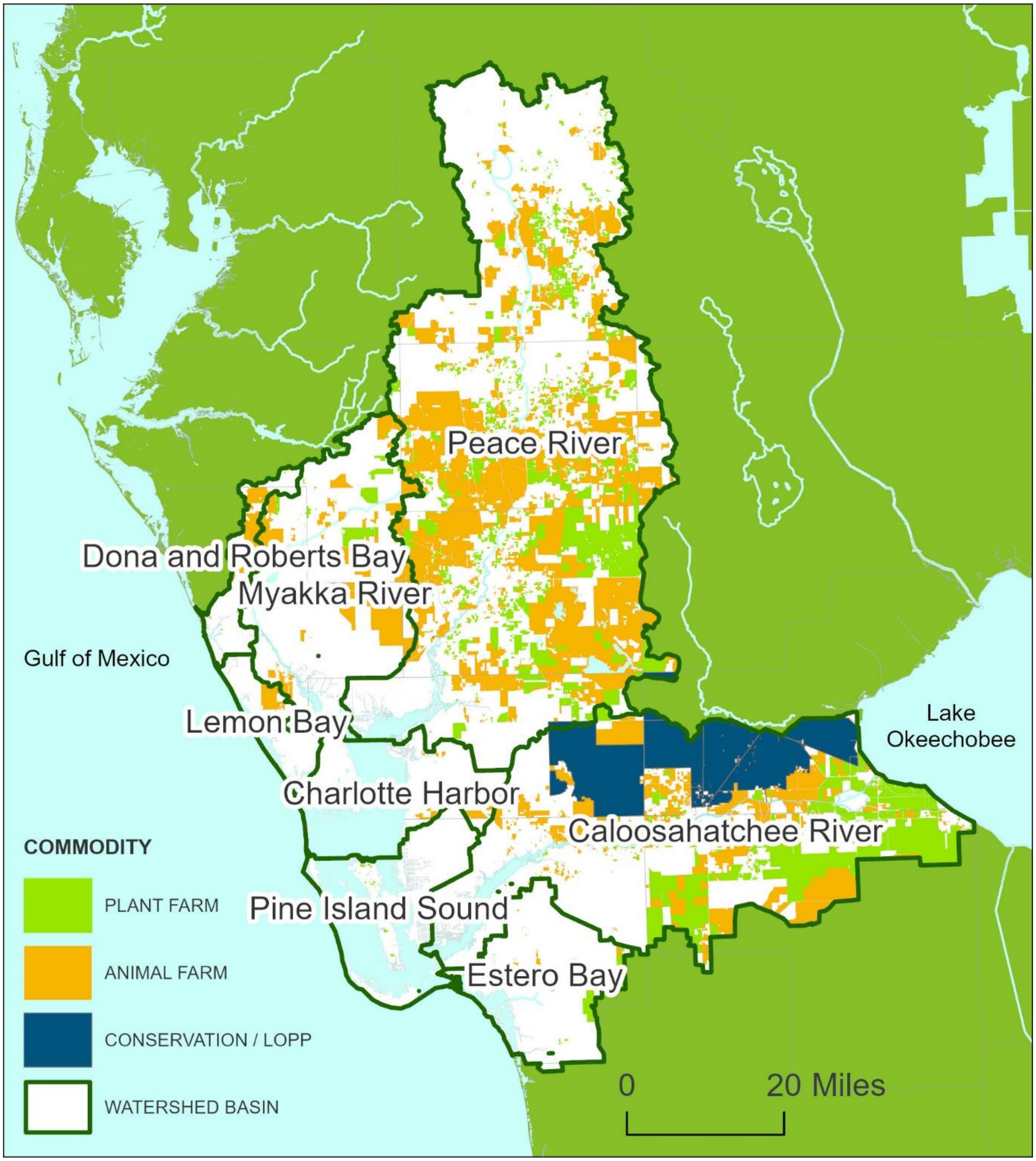


Figure 10. More than a million acres of farms across the CHNEP area are enrolled in FDAC's BMP program, most of which are cow/calf operations, citrus, and row/field crops | *FDACS May 2024.*

STATUS:

Ongoing.

RELATED ACTIONS:

- Water Quality Improvement Action 4: Reduce wastewater pollution
- Water Quality Improvement Action 5: Reduce harmful algal blooms
- Fish, Wildlife, and Habitat Protection Action 1: Protect, monitor, and restore estuarine habitats

STRATEGY:

Activity 3.1: Support urban BMPs that return freshwater inputs to receiving waters to a more natural pattern of quantity, timing, and distribution and that reduce pollutant loadings. Identify locations to install stormwater treatment areas and pursue installation in priority areas. Support new and retrofit projects to increase stormwater retention and reduce pollution loadings. Support development and implementation of green infrastructure practices, including reducing impervious surfaces.

Location: CHNEP area, especially portions of it near impaired waters.
Responsible parties: FDEP (State of Florida regulatory lead), County and Municipal governments (capital improvement projects, adapting comprehensive plans and development codes to facilitate implementation of green infrastructure practices), SWFWMD, SFWMD, UF/IFAS Extension, CHNEP, private sector.
Timeframe: Ongoing.
Potential annual cost and funding sources: Capital improvement projects: $500,000–$999,999/County and Municipal governments, Section 319 Funds, SWFWMD, SFWMD; Green/LID infrastructure projects: $500,000–$999,999/County and Municipal governments, SFWMD; BMP research, development, and implementation: $25,000–$99,999/Grants, UF/IFAS Extension.
Benefits: Reduced pollutant loading and improved water quality necessary to support living things.
5-year Performance measure: Increased number of green infrastructure projects developed and implemented.

Activity 3.2: Support agricultural BMPs and projects to increase retention of agricultural runoff and reduce pollutant loadings, including new and retrofit projects. Encourage implementation of FDACS Agricultural BMPs, including support of regional cost-sharing programs and other incentives for their implementation.

Location: CHNEP area, especially portions of it near impaired waters.
Responsible parties: FDEP (State of Florida regulatory lead), FDACS (Agricultural BMPs), SWFWMD-FARMS, SFWMD, UF/IFAS Extension, CHNEP.
Timeframe: Ongoing.

Potential annual cost and funding sources: Agricultural BMP implementation: $1M–10M/FDACS, SWFWMD-FARMS, SFWMD; BMP research and development: $500,000–$999,999/grants.
Benefits: Reduced pollutant loading and improved water quality necessary to support living things.
5-year Performance measure: Increased agricultural stakeholders enrolled in SWFWMD-FARMS, USDA NRCS, and FDACS BMP Programs.

Water Quality Improvement Action 4: Reduce wastewater pollution

OBJECTIVES:

Support wastewater conveyance and treatment improvements to upgrade wastewater facilities to Advanced Wastewater Treatment (AWT), as well as conversion of septic systems to centralized sanitary sewer where feasible. Expand reuse water where appropriate, ensuring there is sufficient treatment of it prior to discharging to surface waters. Continue to assess impacts of septic systems, sewer overflows, and reuse water to water quality of surface water and groundwater, in order to recommend effective corrective action.

BACKGROUND:

Untreated or partially treated wastewater contains nutrients, bacteria, chemicals, and pharmaceuticals harmful to the environment and public health. Chronic and episodic high bacteria levels in waters are problematic for shellfish harvesting (see Fish, Wildlife, and Habitat Protection Action Plan) and other beneficial uses like swimming, fishing, and drinking. This Action describes challenges and improvements to wastewater collection and treatment, including central sanitary sewer systems and Onsite Sewage Treatment and Disposal Systems (OSTDS), like septic systems.

Wastewater produced in the CHNEP area is either treated in large, centralized Wastewater Treatment Plants (WWTPs) or small, private OSTDS. Depending on the county, either septic systems or centralized WWTPs are the dominant treatment pathway. The Florida Department of Health (FDOH) continues to update its 2016 statewide inventory of OSTDS. The most recent 2023 inventory shows that they are more common in DeSoto, Hendry, Hardee, and Glades counties, whereas central sewer systems are more common in Polk, Manatee, Sarasota, Charlotte, and Lee counties (FDOH 2023). Although the accuracy of data is unverified and DeSoto and Lee counties have large data gaps, the general trends are believed to be likely correct (Table 7).

Table 7. Percentage of parcels known or likely using centralized sewer versus septic system for wastewater treatment in the CHNEP area | *FDOH 2023.*

County	Sewer	Septic	Undetermined	Number Evaluated
Polk	50%	41%	9%	255985
Hendry	26%	66%	7%	13798
Hardee	38%	57%	5%	8873
Glades	10%	86%	4%	5259
Desoto	10%	36%	54%	11316
Manatee	82%	9%	9%	173401
Sarasota	85%	15%	0%	234880
Charlotte	59%	35%	6%	107074

Lee	47%	27%	26%	360452
Total Number	**709,963**	**313,454**	**147,621**	**1,171,038**

Central Sanitary Sewer System

In central sewer systems, wastewater is collected at its source, conveyed to a WWTP, and treated. Treated wastewater can be discharged into surface waters, injected into underground wells and aquifers, released to infiltration basins and spray fields, or reused as it is subject to water quality standards for beneficial uses (Figure 11). The solid waste byproduct remaining in the WWTP, called biosolids or sewage sludge, is commonly used as a fertilizer or soil amendment, subject to regulations established to protect public health and the environment (62-640 F.A.C.). Regulations include pollutant limits, requirements to destroy harmful microorganisms, and management practices for land application sites. Biosolids may be used as soil amendments on farms and ranches, forest lands, public parks, or in land reclamation projects and are a source of nutrients in CHNEP area watersheds (Figure 11). Potential impacts from dispersed biosolids containing unregulated pollutants such as PFAS, microplastics, ecoestrogens, and pharmaceuticals in treated effluent and biosolids are an emerging concern.

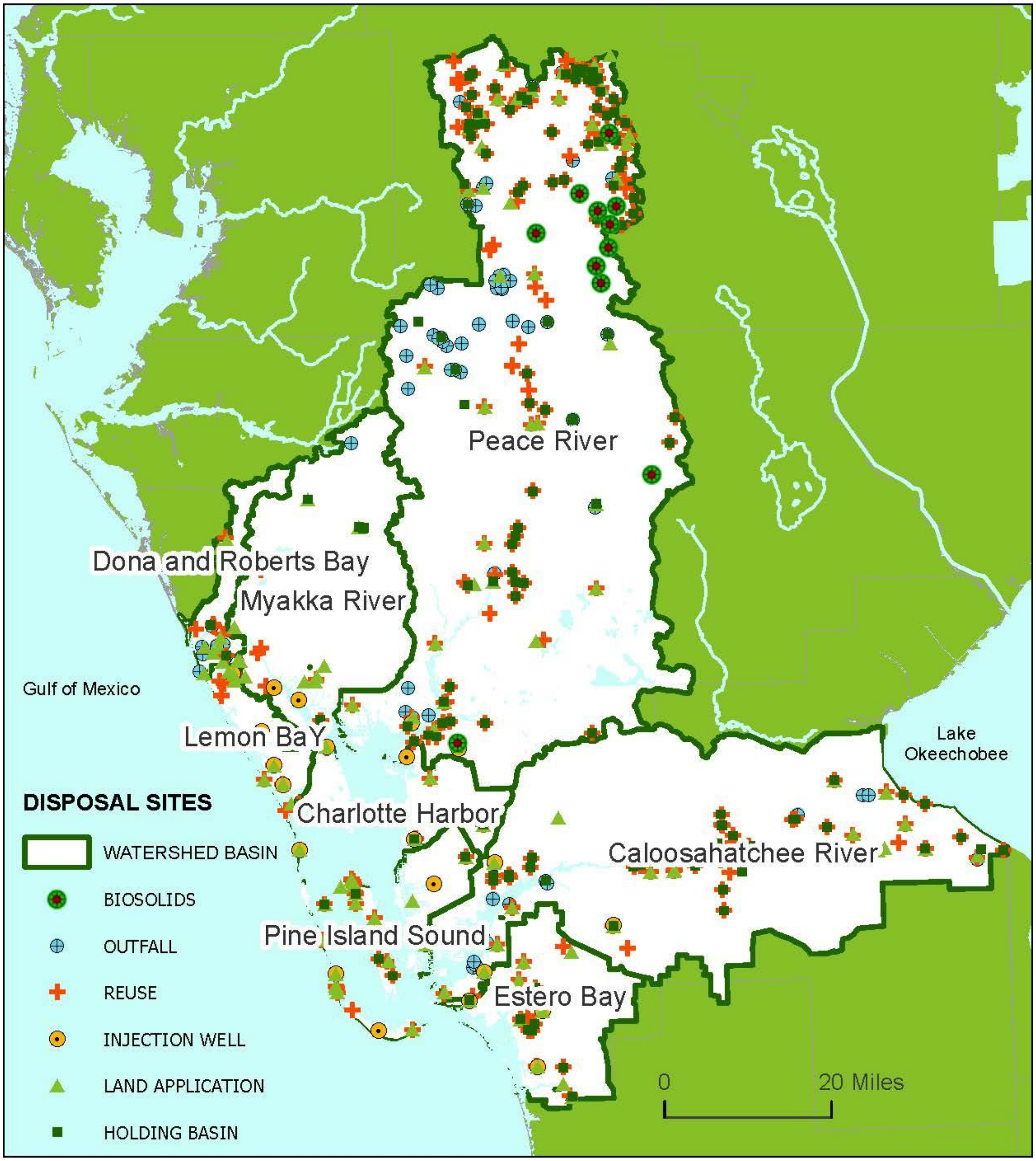


Figure 11. Discharge sites for treated wastewater and application sites for treated biosolids associated with FDEP regulated Wastewater Facility Regulation facilities | *FDEP May 2024.*

Nutrient concentrations vary in treated wastewater according to the level of treatment (Table 8). Whereas Advanced Wastewater Treatment (AWT) reduces Total Nitrogen (TN) concentration to 3 mg/L, state requirements for Secondary Wastewater Treatment do not address TN. In fact, effluent from Secondary Treatment can have TN concentrations of 20 mg/L or higher. As a result, eliminating surface discharges of treated wastewater, especially wastewater only undergoing Secondary Treatment, is an important water quality strategy in Southwest Florida.

Table 8. State of Florida standards for Biological Oxygen Demand (BOD), Total Suspended Solids (TSS), Total Nitrogen (TN), and Total Phosphorus (TP) in treated wastewater effluent, according to treatment level.

Contaminant	**Wastewater Treatment Level**		
	Advanced	Advanced-Secondary	Secondary
BOD	5 mg/L	10 mg/L	20 mg/L
TSS	5 mg/L	10 mg/L	20 mg/L
TN	3 mg/L	20 mg/L	N/A
TP	1 mg/L	10 mg/L	N/A

The Grizzle-Figg Act as amended (2023: Florida Statute 403.086) requires wastewater to be treated to AWT standards before it can be discharged into Lemon Bay, Charlotte Harbor, and their direct tributaries, or (after January 1, 2033) any waterbody determined by FDEP not to be attaining nutrient standards or subject to a BMAP or RAP. Furthermore, the Act stipulates that any discharge of AWT-water will not:

- By itself cause considerable impacts to an Outstanding Florida Water or to other waters
- Substantially impact an approved shellfish harvesting area or water used as a domestic water supply
- Seriously alter the natural fresh-salt water balance of the receiving water after reasonable opportunity for mixing

The Act provides exceptions for WWTPs permitted by February 1, 1987, and which discharge Secondary Treated effluent followed by water hyacinth treatment, to tributaries of tributaries of Lemon Bay and Charlotte Harbor Bay, and for WWTPs which are permitted to discharge into the non-tidally influenced portions of the Peace River.

WWTPs discharge more than 15 Million Gallons per Day (MGD) of treated wastewater into surface waters of the CHNEP area, including Fort Myers Central, Fort Myers South, and Fiesta Village, which discharge into the Caloosahatchee River Estuary (SFWMD 2022); and the City of Winter Haven WWTP #3, which discharges into the Peace Creek Canal, a tributary of the Peace River. This volume of surface water discharge is projected to be reduced to only 0.12 MGD by 2040 as water reuse projects are completed.

Under the Grizzle-Figg Act, WWTPs that provide reuse water may also, pursuant to permit, be allowed to discharge Secondary Treated wastewater to surface waters during periods of reduced demand. These “backup discharges” may increase nutrient loading to surface waters if, for example, demand drops due to communities rejecting nutrient-rich reuse water. One alternative to backup discharges and generally releasing Secondary Treated wastewater to surface waters that are not specifically protected by the Grizzle-Figg Act is to reuse the water for other beneficial uses.

Currently, about 72 percent of treated wastewater from the ten-county CHNEP area is reused. By 2045, reuse is projected to be 92 percent (Table 9). Common uses include irrigation of residential and commercial landscapes, golf courses, and agricultural crops, groundwater recharge, industrial uses, and environmental enhancement. Examples of current and planned reuse water projects in the CHNEP area include:

- City of North Port project to expand its reuse water system to allow for reuse water conveyance to parks, commercial, and condominium properties for irrigation
- West Villages Improvement District project to expand reuse water system to convey reuse water to expanding residential areas
- City of Arcadia project to expand reuse water system for storage and conveyance of reuse water to golf courses
- Charlotte County Town and Country WTTP at Babcock Ranch project to expand project to expand supply of reuse water for commercial property and primarily for golf course irrigation
- City of Venice aquifer storage and recovery project at the City's Eastside Advanced Wastewater Reclamation Facility
- Polk County project to expand its reuse water system to almost 6000 new residential customers
- City of Winter Haven project to construct reuse water rapid infiltration basins to recharge the aquifer and avoid surface water discharge
- Lee County project for Fort Myers Beach/Fiesta Village to construct a reuse aquifer storage and recovery well to store excess reuse water to avoid surface water discharges
- Construction of a reuse water supply connection across the Caloosahatchee River linking City of Cape Coral with City of Fort Myers systems to create additional reuse capacity and avoid surface water discharge

In Lee and Charlotte counties alone, seventeen reuse water projects are proposed between 2020 and 2045 to treat and distribute an additional 39.7 MGD for reuse at a cost of $588 million (SFWMD 2022).

Table 9. Projected changes in reuse water use in the CHNEP area (Million Gallons per Day, MGD), by county | *SWFWMD 2020b, SFWMD 2022.*

County	**Actual 2015/2020 (MGD)***			**Projected 2040/2045 (MGD)***		
	WWTF Flow	Reuse Flow**	% Reuse	WWTF Flow	Reuse Flow**	% Reuse
Charlotte	14.74	6.74	46%	14.21	11.3	80%

DeSoto	1.42	0.66	46%	1.46	1.09	75%
Glades	0.23	0.23	100%	0.23	0.23	100%
Hardee	1.21	0.77	64%	1.25	0.94	75%
Hendry	2.01	2.01	100%	3.81	2.59	68%
Lee	50.42	53.97	100%	104.95	135.94	100%
Polk	36.62	20.43	56%	48.29	44.55	92%
Sarasota	26.12	13.99	54%	31.7	23.77	75%
Total	**132.77**	**98.8**	**72%**	**205.9**	**220.41**	**92%**

No Manatee County WWTPs in CHNEP study area
*SWFWMD Actual 2015, Projected 2040; SFWMD Actual 2020, Projected 2045
** May include wastewater blended with supplemental sources

While proper reuse in appropriate areas is very important to water conservation, ensuring that reuse water is not inappropriately applied too close to waterways or at rates that generate nutrient-laden runoff to waterbodies is an important water quality strategy. This should be considered in the planning of future reuse projects or the retrofitting of existing ones and can entail techniques like storing excess reuse water produced during the wet season when demand is low to recover it in dry season when irrigation demand is high, rather than having to discharge that reuse water during the wet season to downstream surface waters. Because some of the reuse water widely dispersed for irrigation in the CHNEP area only undergoes the minimum required Secondary Treatment, there is a critical need to assess water quality impacts due to its reuse and to consider cost-benefits of upgrading plants to Advanced Wastewater Treatment. Potential changes in seasonal rainfall patterns due to climate change may also alter demand for reuse water, so that would need to be assessed in the cost-benefits analysis as well.

Another critical need is to reduce the occurrence and severity of sanitary sewer overflows (SSOs). Frequent failures of sanitary sewer systems remain a challenge, resulting in releases of untreated sewage into the environment. Sanitary sewer systems can fail for a variety of reasons, including design flaws and over-capacity, aging infrastructure, line blockages and breaks, stormwater infiltration and inflow, and equipment and power failures. Rapid population growth can lead to waste volumes that exceed original system capacity. Aging infrastructure can deteriorate and fail over time. Pumps, check valves, and other moveable parts can wear out leading to mechanical failure. Storms can cause electrical failures at lift stations, resulting in overflows. Blockages can occur due to incursion of tree roots or improper disposal of items into sanitary drains, including fats, oils, grease, and sanitary products. Blockages can also produce a series of cascading failures due to added hydraulic stress. These failures can be reduced with proper routine maintenance, cleaning, rehabilitation, or replacement.

Sanitary sewers in Southwest Florida were not designed to transport groundwater and stormwater; when they do, they can backup, overflow, and cause emergency discharges at WWTPs. Infiltration occurs when groundwater enters sanitary sewer systems through defective, permeable, or broken pipes. Inflow occurs when stormwater enters the sanitary system through unauthorized connections (e.g., yard and roof drains, and submersible pumps). Sanitary sewer overflows due to infiltration and inflow are most commonly associated with rainstorms. Infiltration and inflow can be reduced with regular inspection, rehabilitation, and maintenance of broken or failing infrastructure owned by utilities or private property owners. Construction inspections can assist in identifying and preventing illicit connections to sanitary sewer systems.

Under Florida's Public Notice of Pollution Act effective July 1, 2017, all reportable pollution release events require public notice within 24-hours of the incident. From July 2017 to June 2024, 1,959 events were reported in nine counties of the CHNEP area (FDEP 2024). Based on a search of keywords used in the incident reports, at least 623 events involved release of sewage. These overflows were primarily caused or exacerbated by aging sewer infrastructure and storm related flooding, notably Hurricane Ian. Between September 28 and October 1, 2023, spill reports of sewage totaled almost 14 million gallons.

Climate stressors will further strain aging wastewater infrastructure. For example, anticipated increases in storm intensity may increase inflow and infiltration and overwhelm sewer system capacity. Rising sea levels can elevate groundwater and increase infiltration, corrode infrastructure, and alter the effectiveness of wastewater treatment. Increased intensities of precipitation and rising groundwater levels can saturate soils and reduce storage capacities of wet basins and spray fields to absorb reuse water. Rising groundwater or flooding stormwater enters the sanitary sewer system through leaky pipes can lead to backups and accidental overflows of untreated wastewater at lift stations and sewer manholes, or emergency discharges at wastewater treatment plants. Once released, impacts from harmful nutrients, bacteria, and viruses can be magnified by warmer temperatures (Lovett 2010). As a result of these stressors and others, climate vulnerabilities should be considered when planning new or retrofitting existing wastewater infrastructure to increase capacity, upgrade, and repair pipes, and relocate lift stations to higher elevation.

Solutions include retrofitting systems with larger pipes, bigger interceptors, greater storage, or WWTP treatment capacity. Addressing these challenges through regular inspection and maintenance, capital improvement projects, education, and enforcement will help reduce the incidence of failures.

Septic Systems

Conventional septic systems use a tank to trap solids, as well as perforated pipes and a drainfield to remove water and treat contaminants as the water percolates through soil layers (Figure 12). Drainfield treatment effectiveness depends on having a sufficient volume of unsaturated soil for microbes to break down bacteria and nutrients before wastewater reaches groundwater. Even when operating properly, conventional septic systems only remove 30–40% of nitrogen, meaning 60–70% of nitrogen can reach groundwater (Toor et al.

2011). They also provide little to no treatment of most contaminants of emerging concern like PFAS, pharmaceuticals, or microplastics.

Figure 12. Conventional residential septic systems are currently designed to treat bacteria. Because they only treat 30–40% of nitrogen input, they can be a source of nitrogen pollution in the watershed | *www.ourwatershed.ca.*

Conventional septic systems have a functional lifespan of about 25 years, although many systems in the CHNEP are older. A variety of issues can reduce septic system performance, including aging equipment, compacted or saturated soils, high groundwater levels, climate stressors, lack of inspections or maintenance, and misuse. Southwest Florida has a significant number of areas with relatively shallow water tables and soils that become saturated during the wet season. Lack of regular inspection and maintenance can further degrade septic system performance. In particular, if undigested solids and scum in the tank are not physically removed every 3–5 years, clogs, backups, and drainfield damage can occur. Also, roots from shrubs and trees can interfere with drainfield operation. Finally, improper disposal of undigestible items can clog systems and harmful substances can reduce the effectiveness of bacteria. Climate factors, including rising sea levels and more intense storms can further magnify these issues (Cooper 2016) with rising water tables and increased flooding.

Management of pollutant loading from septic systems focuses on understanding where septic systems exist in the watershed and their condition, encouraging proper maintenance and use of systems, and converting failing systems to advanced septic systems or replacing them with connections to central sewer. Analysis of historical data and new sampling indicated that septic systems contributed significantly to nutrient and bacterial pollution of surface waters and groundwater (Lapointe et al. 2016). High concentrations of nitrogen and bacteria were consistently found down gradient from septic systems. Moreover, stable nitrogen isotope ratios in macroalgae, oysters, and hydroids indicated that wastewater, rather than fertilizer, was the dominant nitrogen source from the Port Charlotte Area into Charlotte Harbor. The presence of sucralose, something only humans consume, in surface waters and groundwater also confirmed contamination from septic systems and the connection to prolonged and intensified harmful algal blooms downstream (Brewton et al. 2022). Following septic to sewer conversion in coastal neighborhoods, it can take 2-3 years for shallow groundwater to convey 50% of the legacy nitrogen to coastal waters, and 8-10 years to clear 90%. Canals can convey nitrogen from septic tanks to coastal waters much faster than submarine groundwater discharge (Buszka and Reeves 2021).

Knowledge of the known or likely location of septic systems in the CHNEP Area over the past five years has greatly improved (Figure 13), although significant uncertainty remains (Table 7). To try to address this uncertainty, in 2019 state legislators filed House Bill (HB) 85 and Senate Bill (SB) 214 to identify and map all septic systems in the state though neither bill made it out of committee. Known use of septic systems compared to central sewer for wastewater treatment ranges from 60 percent in Polk and Hardee Counties to 18 percent in Sarasota County. More work is needed to reduce uncertainty in the location of septic systems and to assess their operating condition.

We do not know how many septic systems are regularly inspected, maintained, and pumped in the CHNEP Area. Recognizing the need to ensure septic systems were operating in ways protective of the environment and public health, Florida adopted a statewide mandatory septic system evaluation and maintenance requirement in 2010. In 2012, the legislature repealed the requirement. The requirement was again introduced in 2019 through HB 85 and SB 214, but both bills failed to make it out of committee. In 2021, responsibility for implementing Florida Statutes and regulations for septic systems was transferred from Florida Department of Health to the Department of Environmental Protection. Individual County health Departments continue to conduct permitting and inspection for septic systems.

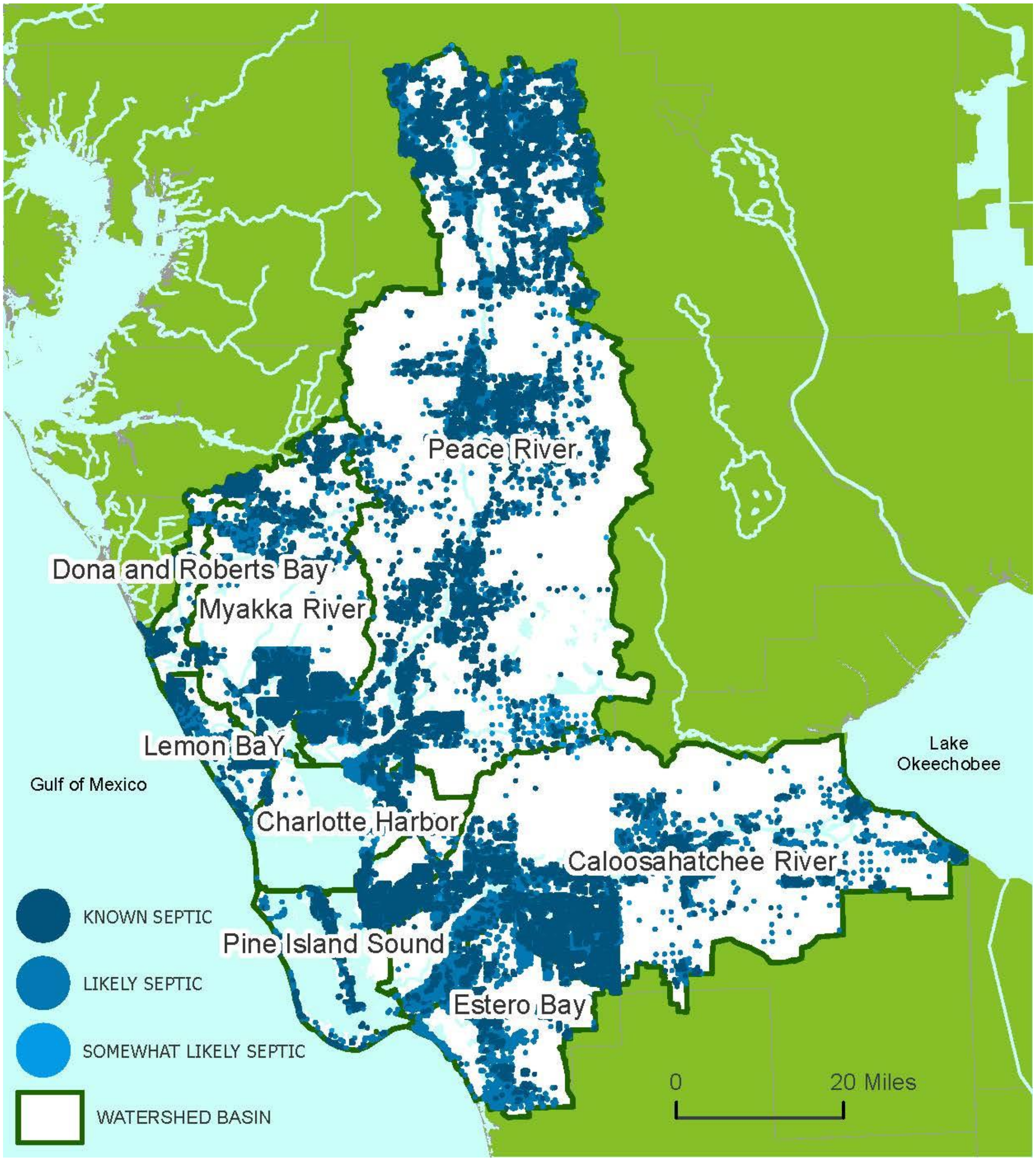


Figure 13. An inventory of known, likely, or somewhat likely onsite sewage treatment disposal systems (OSTDS) in the CHNEP area reveals hotspots near Charlotte Harbor and the Lakes Region. Locations may include planned but not yet constructed septic systems | *FDOH 2023.*

In areas near priority waterbodies or where soil is increasingly oversaturated due to flooding or groundwater levels are too high to support effective drainfield treatment, parcels using septic systems can be connected to central sewer instead. Examples of projects to convert septic to sewer systems in the CHNEP area include:

- Charlotte County El Jobean Septic to Sewer Wastewater Expansion Project to provide central wastewater service to approximately 300 properties in the El Jobean area
- Charlotte County Ackerman Septic to Sewer Wastewater Expansion Project to provide central wastewater service to the area south of Edgewater Drive within the drainage basin of Ackerman and Countryman Waterways
- Lehigh Acres Septic-to-Sewer Project, which will convert approximately 300 existing septic tanks to central sewer in the Lehigh Acres service area
- North Fort Myers Septic-to-Sewer Project, which will convert of approximately 300 existing septic tanks to central sewer in the North Fort Myers service area
- City of Bonita Springs, Lakes of Sans Souci Septic-to-Sewer and Sun Village Septic-to-Sewer Projects
- City of Cape Coral, North 1 Utilities Extension Septic-to-Sewer Project

In areas where costs are prohibitive or where existing central sewer service is too distant, underperforming or failing septic systems can be replaced or upgraded with advanced nutrient removal technologies. In 2023, Florida approved HB1379, mandating that new construction permits for septic systems on lots of one acre or less in BMAP areas, as well as in Reasonable Assurance Plan (RAP) and Pollution Reduction Plan (PRP) areas, must now include Enhanced Nutrient Reduction Onsite Sewage Treatment and Disposal Systems (ENR-OSTDS). Approved systems include in-ground nitrogen-reducing biofilters, nitrogen reducing aerobic treatment units, and nitrogen-reducing performance-based treatment systems. These systems often require routine inspections to ensure they are properly maintained and functions and Charlotte County for instance, requires biannual inspections and annual permit renewals for aerobic treatment septic units it permits.

STATUS:

Ongoing.

RELATED ACTIONS:

- Water Quality Improvement Action 3: Reduce urban stormwater and agricultural runoff pollution
- Water Quality Improvement Action 5: Reduce harmful algal blooms
- Fish, Wildlife, and Habitat Protection Action 1: Protect, monitor, and restore estuarine habitats

STRATEGY:

Activity 4.1: Support wastewater treatment to AWT standards, encourage proactive inspection, maintenance, and replacement of failing or underperforming sanitary sewer infrastructure, including reduction of inflow and infiltration. Encourage, expand, and incentivize use of reuse water, where appropriate, focusing on reuse of AWT wastewater, which is more protective of water quality and the natural hydrology in nearby waterways. Reduce discharges of treated wastewater to surface waters. Support additional wastewater treatment capacity to prevent overflows and other impacts to wastewater infrastructure and performance due to climate stressors.

Location: CHNEP area.
Responsible parties: County and Municipal Governments (Leads), FDEP, FDOH, SWFWMD, SFWMD, CHNEP.
Timeframe: Ongoing.
Potential annual cost and funding sources: Studies to understand pollutant loading from reuse water: up to $99,999/Section 320 Funds, grants; Improvements to sanitary sewer operation and maintenance: $1M–10M/County and Municipal Governments, Section 319; Development of reuse water: $1M–10M/County and Municipal Governments, SWFWMD, SFWMD, FDEP.
Benefits: Reduction in nutrient and bacteria loading in CHNEP area waterbodies. Improved water quality to support natural communities.
5-year Performance measure: Reduced sanitary sewer system overflows and releases.

Activity 4.2: Continue to inventory and map septic systems in the CHNEP area. Support conversion of septic systems to centralized sanitary sewer systems. Support increased sanitary sewer capacity to handle new inflows from conversions. Encourage regular maintenance and inspection of septic systems. Support studies to better understand pollutant loading from septic systems. Encourage evaluation and adoption of new nitrogen-reducing septic system technology.

Location: CHNEP area, especially portions designated as impaired for nutrients or bacterial contamination.
Responsible parties: County and Municipal Governments (Leads), FDEP, FDOH, CHNEP.
Timeframe: Ongoing.
Potential annual cost and funding sources: Inventory septic systems and track septic to sewer conversion: $100,000–$499,999/Section 319 Funds, County and Municipal Governments; Studies to understand pollutant loading from septic systems: $100,000–$999,999/Section 320 Funds, grants; Septic to sewer conversion: $1M–10M/County and Municipal Governments, State of Florida; Improvements to septic system siting, design, and maintenance: $500,000–$999,999/grants.
Benefits: Reduction in nutrient and bacterial contamination in CHNEP area waterways. Improved water quality to support living resources.

5-year Performance measure: Reduced number of septic systems and small package plants threatening surface water and groundwater.

Water Quality Improvement Action 5: Reduce harmful algal blooms

OBJECTIVES:

Support measures to reduce harmful algal blooms, including studying the natural phytoplankton and macroalgae composition and background levels, and relationships between algal blooms and nutrient loading and limitation, physical conditions like circulation, rainfall, and freshwater pulses, trophic dynamics with zooplankton and fish, and impacts of blooms on ecosystems and community socio-economics.

BACKGROUND:

Harmful algal blooms (HABs) are the excess proliferation of harmful or nuisance algae. HABs can be generated by microscopic single-celled microalgae or larger multicellular macroalgae (Figure 14). HABs can reduce water quality, smother aquatic vegetation and hardbottom habitats, reduce sunlight availability for seagrasses, and kill aquatic invertebrates, fish, seabirds, turtles, and marine mammals. HABs can also impact public health via release of airborne toxins or bioaccumulation of toxins in edible seafood and can impact recreational and economic activities. HABs have generally increased in frequency, extent, and duration throughout the world's waters (Anderson et al. 2002) and are a priority management concern in the CHNEP area.

Anthropogenic and Natural Drivers of HABs

Anthropogenic (human caused) and natural drivers of the initiation, growth, and maintenance of HABs are complex, vary by location, species, and bloom event, and can interact in a number of different ways (Anderson et al. 2012, 2021). Excess nutrients from anthropogenic activities can intensify and prolong HABs (Heil et al. 2014, Medina et al. 2022, 2022, Beck et al. 2022, Tomasko et al. 2024). For example, in March–April 2021, an estimated 186 metric tons of total nitrogen from phosphate mining wastewater and marine dredge were released into lower Tampa Bay from the Piney Point phosphogypsum stacks. A bloom of diatoms occurred in April, followed by HABs of filamentous cyanobacteria (*Dapis spp.*) and red tide (*Karenia brevis*) and significant fish kills (Beck et al. 2022). Other work has documented that nutrient loading from the Caloosahatchee River can intensify red tide (Medina et al. 2022). More recently, researchers developed a predictive and quantifiable relationship between nitrogen loading from the Caloosahatchee River and red tide duration (Tomasko et al. 2024).

HABs are also influenced by water temperature, salinity, light availability, rainfall, pH, water circulation and biotic interactions—such as competition with other algae and grazing by zooplankton and shellfish (Smayda 2008). In addition to directly impacting ecosystems by blocking sunlight and releasing toxins, when algae die and decay, they deplete dissolved oxygen in the water, resulting in additional mortality of aquatic life. These cascading mortality events provide additional nutrition to sustain blooms. HABs can also alter nutrient cycling, primary productivity, competing algal communities, and cause cascading food chain effects (O'Brien et al. 2016).

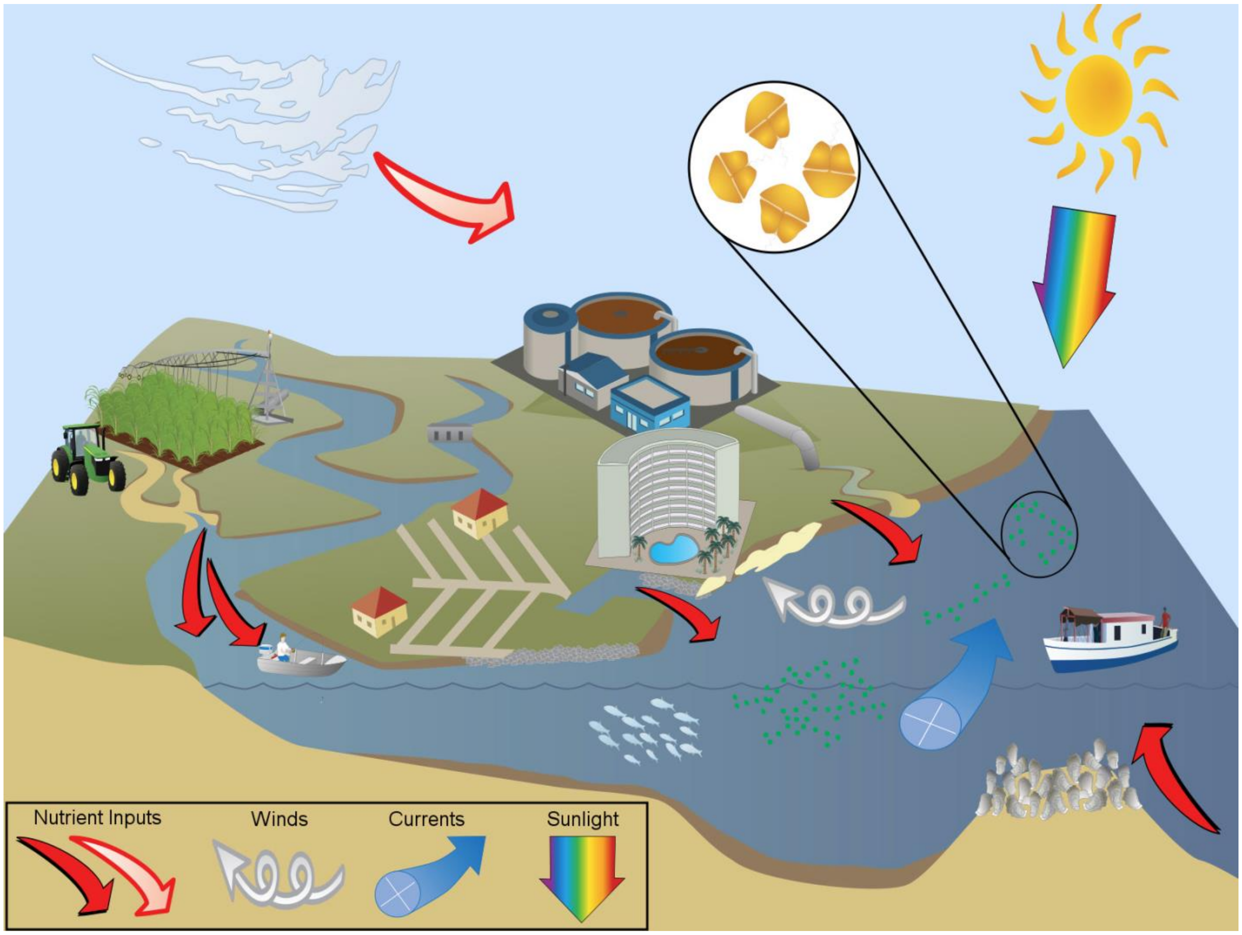


Figure 14. Formation of harmful algal blooms (HABs) is a complex interaction of physical, biological, and human factors that affect their timing and severity | *FWRI*.

Climate stressors can exacerbate HABs in a variety of ways (Gobler 2020). For example, warmer waters can increase HAB growth rates if current temperatures are below those associated with maximum growth rates. Intensification of rainfall events and rising sea levels can lead to increased nutrient loading to waterbodies through underperforming or failing wastewater systems and increased stormwater runoff. Through habitat loss, rising sea levels can also diminish the capacity of coastal systems to remove nutrients. Harmful algae may have a competitive advantage over non-harmful species under conditions of warmer temperatures, higher nutrients, and ocean acidification (Paerl and Huisman 2008). Our limited understanding of the response of marine microalgae to physiochemical climate drivers—for example, whether their geographic range will expand or whether they will become increasingly toxic—requires more monitoring and study. Together, climate change and HABs can interact in complex ways to be co-stressors on ecosystems already stressed by anthropogenic activities (Griffith and Gobler 2020).

Blue-Green Algal Blooms

A common freshwater HAB in the CHNEP area is produced by the toxin-producing, single-celled blue-green algae (cyanobacteria) *Microsystis*. The most common species is *Microsystis aeruginosa*, which has small gas spaces in its cell that causes it to float to the top of the water column. This ability allows it to block sunlight to other phytoplankton and monopolize nutrients. Its blooms are characterized by a thick, paint-like green slick, and can grow rapidly until they either run out of nutrients or encounter adverse environmental conditions like increasing salinity. Upon death, Microcystis releases toxins called microsystins, which can persist in the water for weeks to months. Microcystin can also bioaccumulate in aquatic animals and be transferred through the food web to higher trophic levels, including humans (e.g., Smith and Haney 2006). In addition to their environmental impacts, microsystins can cause abdominal pain, headache, nausea, vomiting, liver and kidney damage, and potential tumor growth promotion in humans. Microsystins are listed on the EPA's third drinking water Candidate Contaminant list (EPA 2014), and the International Agency for Research and Cancer has classified Microcystin-LR as a possible human carcinogen. Pathways of human exposure include swallowing, skin contact, or inhalation of contaminated water.

In the summer of 2018, a large Microcystis HAB formed in Lake Okeechobee. The bloom was fueled by sunlight, warm temperatures, and high levels of nitrogen and phosphorus from agricultural runoff. In anticipation of the summer hurricane season, the US Army Corps of Engineers released large quantities of polluted water and Microcystis from Lake Okeechobee downstream to the St. Lucie Estuary on the east coast and to Charlotte Harbor on the west coast. In the Caloosahatchee River, the bloom further benefited from Caloosahatchee River basin runoff—allowing the bloom to extend from the Lake along the entire length of the Caloosahatchee River into downtown Fort Myers. The toxic blue-green HAB caused significant environmental and economic damage on both coasts and prompted a state of emergency to be declared for seven Florida counties: Lee, Hendry, Glades, Martin, Okeechobee, St. Lucie, and Palm Beach. Lake Okeechobee blue-green algae blooms and periodic discharges of bloom-laden waters being released downstream to the Caloosahatchee Rivers continues to present day.

Florida Red Tide

Florida red tide, formed by the dinoflagellate *Karenia brevis*, is a common saltwater HAB in the CHNEP area. *K. brevis* produces neurotoxins that can bioaccumulate and kill fish, seabirds, turtles, and marine mammals. In addition to ecosystem impacts, red tide can impact human health and coastal economies. For example, aerosolized brevetoxins can cause eye, nose, and throat irritation and more serious consequences for people with existing respiratory issues, like asthma (Kirkpatrick et al. 2004, Watkins et al. 2008). Consumption of shellfish exposed to red tide can cause neurotoxic shellfish poisoning and rotting aquatic life in the water and along the shoreline can pose additional health threats.

Scientists characterize the life cycle of red tide blooms as having four stages: initiation, growth, maintenance, and termination (Steidinger 1975). *K. brevis* is commonly found in background concentrations throughout the Gulf of Mexico. Initiation typically occurs in deeper water 10–40 miles offshore (Steidinger 2009, Weisberg et al. 2019). *K. brevis* grows slowly and can utilize low concentrations of a broad range of organic and inorganic nutrients. Blooms can be transported inshore by currents and winds, where they can be maintained and intensified by land-based nutrients. Though red tide blooms have long impacted Florida's west coast, their frequency and severity are increasing (Brand and Compton 2007). Recent scientific evidence confirms the role of anthropogenic nutrients on the intensity and duration of red tide blooms once they encounter coastal waters (Medina et al. 2020, 2022, Beck et al. 2022, Tomasko et al. 2024). In low-nutrient environments, cells can also be supported by recycling or regenerating nutrients.

Termination of a red tide bloom may result from a variety of stressors including changing nutrient ratios and nutrient limitation, dilution of water masses, or suboptimal temperatures or salinities. In the field, *K. brevis* can survive in water temperatures between 48–91 degrees F and is largely absent from brackish waters with salinities lower than 24 parts per thousand (PPT) of salt (Steidinger 2009).

The 2017–2019 red tide bloom outbreak in west Florida persisted for over 15 months and littered creeks, bays, and beaches with dead marine life. By January 2019, Manatee County picked up 316 tons and Sarasota County picked up 255 tons of dead aquatic life. FWC attributed over 589 sea turtle and 213 manatee deaths to the bloom and NOAA attributed over 127 bottlenose dolphin deaths to it. Impacts of the 2017–2019 bloom to beach-goers, boaters, charters, and fishers were severe, resulting in estimated impacts to the regional economy of over $300 million (Court et al. 2021). CHNEP collaborated to create an interactive online dashboard to communicate these impacts and assess the value of restoration and management actions to reduce impacts (CHNEP 2019a). Another more recent study forecasted that if HAB events similar to those experienced in 2005/6 and 2018 were to occur again, that Charlotte, Lee, and Collier Counties would lose over $460 million in commercial and recreational fishing, over 43,000 jobs, $5.2 billion in economic output, $60 million in property tax revenue, and $8.1 billion in the value of outdoor recreation (Greene Economics 2023).

These documented impacts highlight the need for continued investments to identify and reduce HAB drivers and mitigate their impacts. Growing understanding of red tide blooms suggests that reducing anthropogenic nutrient sources can decrease the intensity and duration of blooms once they start, and the ability to translate reductions of nitrogen loading in terms of reductions in the intensity and duration of red tide events can be an important tool to help managers better understand and communicate the cost-benefits of ongoing and future nitrogen reduction strategies (Tomasko et al. 2024).

Macroalgal Blooms

Red, green, and brown macroalgae, commonly referred to as seaweed, are multicellular algae that can drift or attach to substrate. Like seagrasses, they are primary producers, provide food and habitat, and can stabilize and accrete sediments. Harmful blooms of macroalgae can decrease light availability to seagrasses, resulting in lower seagrass productivity, higher mortality, and loss of seagrass habitat. When algae die, they can smother benthic habitat, deplete oxygen as they decompose, and kill sensitive species. Large drifts of macroalgae can also wash onto beaches. As they decompose, they can increase bacteria loading to nearby waters and interfere with recreation and tourism.

Macroalgae abundance is increasing in multiple locations throughout the CHNEP Area. For example, FWC biologists documented an increase in the abundance of filamentous green macroalgae in 2012 in Charlotte Harbor (SWFWD 2020a). In 2019, Charlotte Harbor Aquatic Preserves also reported increasing abundances of macroalgae along the east wall of Charlotte Harbor. Hotspots of increasing macroalgae include the upper portions of Charlotte Harbor near the confluence of the Peace and Myakka Rivers and the Eastern Branch of Coral Creek. Other areas include Upper and Lower Lemon Bay, Gasparilla Sound, Cape Haze, Pine Island Sound, Matlacha Pass, San Carlos Bay, and the Caloosahatchee River (CHNEP).

Nutrient pollution is a significant driver of harmful macroalgae blooms in CHNEP waters, making their blooms effective biological indicators of impairment (Water Quality Improvement Action 2). The potential of macroalgae to hold significant stores of nutrients and rapidly release them during mass mortality events, makes it important to understand their status and trends in a waterbody. Combining macroalgae monitoring with traditional water column chemistry monitoring may yield a more holistic understanding of nutrient loads in a waterbody.

In 2021, Florida's four National Estuary Programs (including the CHNEP), Florida Sea Grant, University of Florida Extension, Harbor Branch at Florida Atlantic University, and the Southwest Florida and St. John's River Water Management Districts convened a macroalgae workshop to share information, identify gaps in data and knowledge, facilitate future collaborations, and guide management actions. Nearly 200 people from government, industry, academia, nonprofit organizations, and the public participated. There was strong support among participants for continued and expanded monitoring of macroalgae and research relating to potential drivers of its overabundance in Florida's estuaries.

HAB Monitoring

A variety of organizations collaborate to monitor and share HAB data, including:

- FWC monitors red tide events, publishes status reports, and coordinates routine and event-response monitoring with state agencies, local governments, and Mote Marine Laboratory. They also provide data to the University of South Florida (USF) College of

Marine Sciences, which forecasts red tide movements using the West Florida Shelf Regional Ocean Modeling System; to NOAA's Harmful Algal Bloom Observing System, which helps visualize blooms and changes in environmental conditions; and to NOAA's Harmful Algal Blooms Operational Forecast System, which shares information to other groups.

- Mote Marine Laboratory manages a Beach Conditions Reporting System that reports on red tide impacts, including dead fish and respiratory irritation at local beaches.
- FDEP monitors cyanobacteria blooms, collects citizen reports of algal blooms, and coordinates sampling among agencies. The Department also maintains a cyanobacteria dashboard with weekly updates.
- USF generates red tide maps using NASA and NOAA data and provides them to FWC to inform bloom assessments and sampling strategies.
- Eyes on Seagrass, a community science-driven program created by Florida Sea Grant and conducted with partners in all coastal counties, monitors macroalgae coverage (Public Engagement Action Plan).

Mitigation of HAB Impacts

Prevention of nutrient pollution is the primary strategy for mitigating the environmental and socio-economic impacts of HABs in CHNEP waterbodies. Identifying and reducing pollution closest to its source yields the greatest benefits to creeks, rivers, estuaries, and marine waters. However, once blooms occur, a variety of physical and chemical damage-control strategies may be useful in limiting bloom intensification, duration, and spread. However, some of these strategies, especially those involving chemicals, could have unintended ecosystem impacts—so need to be thoroughly researched and tested prior to large-scale deployment. Physical strategies include aeration, hydrologic and bio-manipulation, mechanical mixing, surface skimming, ultrasound, and reservoir desiccation. Chemical strategies include use of algaecides, barley straw, coagulation, and chemical or clay flocculation.

Several initiatives are underway to test solutions for mitigating HABS, including:

- The Florida Red Tide Mitigation and Technology Development Initiative, a partnership between FWC and Mote Marine Laboratory, works to develop prevention, control, and mitigation approaches and technologies to decrease environmental and economic impacts of red tide in Florida. The Initiative has created an experimental facility at the Mote Aquaculture Research Park in Sarasota, convened Technical Advisory Council meetings, examined over 100 potential mitigation compounds for testing, and launched over 20 projects.
- AquaFlex® Pilot Project, funded by CHNEP to use an open-cell foam technology, to absorb and remove excess nutrients, cyanobacteria, and microsystins. The City of Cape Coral did further testing of this technology in canals and golf course ponds.
- Mote Marine Laboratory Lake Guard® Dew Project, testing of a water-probe detection device that floats at the surface, detects cyanobacteria, and slowly releases a

mitigation product over time to reduce nutrients. They are also testing technology called the Aquastream Cyto-Bot, that autonomously removes cyanobacteria cells and toxins from waterbodies. In addition, Mote is testing a natural non-toxic product called Xtreme for reducing cyanobacteria cells and toxins, which has already been shown to have potential for Florida red tide mitigation.

These are just some of the HAB mitigation technologies being tested, with more research continuing to find the most effective methods and means to deploy at a large-scale.

Management Needs

Continued effort is needed to research and monitor climate change impacts to, as well as taxonomic composition, severity (cell concentration), extent, and duration of blooms of *K. brevis*, blue-green algae, macroalgae, filamentous green algae, and other HABs of concern. Identification and reduction of anthropogenic nutrient pollution is the more cost-effective way to reduce the impacts of HABs. Continuing to document the environmental, social, and economic impacts of harmful algal blooms is an important management tool for decision-makers to assess cost-benefits of HAB management investments. Targeted communication of scientific results to the public will improve understanding of HABs and build support to reduce anthropogenic influences. Finally, continued research to improve our capacity to prepare, respond, and recover from HABS, including the role of climate stressors on their growth and ways to improve the resiliency of affected environments is needed.

STATUS:

Ongoing.

RELATED ACTIONS:

- Water Quality Improvement Action 3: Reduce urban stormwater and agricultural runoff pollution
- Water Quality Improvement Action 4: Reduce wastewater pollution
- Fish, Wildlife, and Habitat Protection Action: 1 Protect, restore, and monitor estuarine habitats

STRATEGY:

Activity 5.1: Support Harmful Algal Bloom (HAB), including macroalgae, research and monitoring and measures to proactively reduce their drivers through the reduction of anthropogenic nutrient pollution and other contributors.

Location: CHNEP area.
Responsible parties: FWC (Lead), FDOH, FDEP, Florida Sea Grant, Colleges and Universities, Mote Marine Laboratory, CHNEP, SFWMD, Calusa Waterkeepers,

and SWFWMD (potentially for water quality monitoring and source tracking studies).
Timeframe: *Ongoing.*
Potential annual cost and funding sources: $1M–10M/grants, State of Florida.
Benefits: Improved knowledge of HABs and reduced severity, extent, duration, and frequency of harmful effects, including macroalgae, phytoplankton, and periphyton, through the identification and reduction of anthropogenic influences.
5-year Performance measure: Tracking and dissemination of information about occurrences and reduction of harmful effects from algal blooms, including influencing factors and impacts of climate stressors on HABs.

Activity 5.2: Support development of methods for early identification of HABs as well as best practices and technologies to reduce or mitigate their harmful environmental, social, and economic impacts.

Location: CHNEP area.
Responsible parties: FWC, FDEP, Florida Sea Grant, Mote Marine Laboratory, academic institutions, and industry.
Timeframe: *Ongoing.*
Potential annual cost and funding sources: $1M–10M/grants, State of Florida.
Benefits: Reduced or mitigated harmful effects of HABS through early identification and development and deployment of best practices and technologies.
5-year Performance measure: Additional best practices and technologies developed and tested for early identification of blooms and reduction or mitigation of harmful effects.

HYDROLOGIC RESTORATION ACTION PLAN

VISION: Appropriate freshwater flow across the landscape to sustain healthy wetlands, rivers, and estuaries.
GOAL: Enhanced and improved waterbodies with more natural hydrologic conditions.
OBJECTIVE: Adequate aquifer recharge and freshwater volume and timing of flow to support healthy natural systems, meet water quality criteria, and protect the designated use.
STRATEGY: Support data-driven watershed planning and hydrologic restoration projects to protect and restore natural flow regimes and provide sufficient fresh surface water and groundwater to natural systems.

ACTION 1: Conduct data collection, modeling, and analyses to support hydrologic restoration
ACTION 2: Increase fresh surface water and groundwater availability to support healthy ecosystems
ACTION 3: Protect and restore natural flow regimes

GENERAL BACKGROUND:

Hydrology is the science of the physical and chemical properties of surface and groundwater, the occurrence and movement of water, and its relationship with the living and non-living environment (Bales 2015). The CCMP Hydrologic Restoration Action Plan addresses flows and levels of surface and groundwater in the CHNEP area. Aspects of water quality related to waters supporting aquatic life, while meeting their designated human uses for drinking, shellfish harvesting, or swimming and fishing, are addressed in the CCMP Water Quality Improvement Action Plan, though Hydrology and Water Quality are very interrelated.

In natural systems, a spectrum of salinity-based aquatic habitats exists from freshwater wetlands, lakes, and rivers—to brackish (mixed salinity) waters in estuaries and tidal rivers and creeks—to full strength seawater. Within ranges of tolerance, aquatic organisms are optimally adapted to particular salinity zones. For example, low-salinity habitats (0.5–5 parts per thousand (PPT) of salt), like upper tidal rivers and creeks, are important nursery areas for many fishes and invertebrates (Peebles 2005, Krebs et al. 2007). Moderate-salinity habitats (5–18 PPT) are important for oysters and a variety of fishes, including the endangered smalltooth sawfish *(Pristis pectinata)*. Higher-salinity habitats (18–32 PPT), like those found in estuaries are important for juvenile fish, such as gag grouper *(Mycteroperca microlepis)*. Many species, such as snook *(Centropomus undecimalis)*, utilize different salinity waters during different life history stages. For these species, connectivity between freshwater and saltwater habitats is important.

Altered volume, velocity, timing, and location of freshwater flows

Variability in the timing, volume, velocity, and location of fresh surface water and groundwater flows can regulate the suitability of an area to sustain salinity-sensitive biological communities

(Estevez et al. 1991, Morrison and Greening 2011). Rapid population growth in Southwest Florida and associated commercial and residential development, agriculture, and mining have profoundly, and in some places irreparably, altered the area’s hydrology. These alterations have changed the dynamics of freshwater flows, which have impacted water quality, aquatic and riparian habitats, and the living things they support.

When streamflow volume is chronically reduced so that tidal saltwater replaces the historical freshwater regime, freshwater biological communities may be displaced. Similarly, if too much freshwater chronically floods a traditionally high-salinity habitat, biological communities requiring saline waters may be displaced. Some species can tolerate physiological stress related to suboptimum salinity regimes for limited durations; however, if the alteration becomes chronic or permanent—they too will be displaced.

For example, volumes of freshwater flow in the upper Myakka River and some of its tributaries have increased due to runoff from irrigated agricultural crops, negatively impacting Flatford Swamp and other riverine wetlands. In contrast, natural flows have been reduced in the lower Myakka River. Blackburn Canal and Cowpen Slough were modified to carry water away from the Myakka River towards Roberts and Dona Bays—reducing the historical flow of the Lower Myakka River by almost nine percent. Excess freshwater flows have occasionally caused these small bays to receive triple their historical water flows. Sarasota County and SWFWMD are working to restore more natural flow volume and timing to Dona Bay (see Hydrologic Restoration Action 3) and SWFWMD is implementing a project at Flatford Swamp to utilize excess runoff to restore the Upper Floridan Aquifer through wells. Locations of other altered flows can be identified by comparing historical watershed boundaries with those of today and can assist in developing water budgets and restoration priorities (Figure 15).

Straightening rivers and streams and connecting new areas through canals and pipes can increase the amount of freshwater flow to a river and estuary and change the timing and location of its effect. For example, the Caloosahatchee River was channelized through a canal that connected it directly to Lake Okeechobee. Water control structures, including dams and locks, were constructed along it to control water for flood protection, irrigation, and navigation. These structures deprive the Caloosahatchee Estuary of necessary freshwater during dry periods and flood it with too much freshwater during the wet season. This alteration of flow has had catastrophic, cascading impacts on biological communities in the Caloosahatchee River and Estuary. Various governmental entities are presently working to restore a more natural hydrology to the Caloosahatchee River and Estuary (see Hydrologic Restoration Action 2), including through the Comprehensive Everglades Restoration Plan C-43 West Basin Storage Reservoir Project which will store high-flow waters to return to the river during low-flow periods.

Figure 15. Historically, drainage projects to dry the land for agriculture and urban development rerouted surface water via canals to the closest waterbody, resulting in hydrologic shifts to the historical boundaries of watersheds and their sub-basins | *CHNEP 2013.*

Call-Out Box:

Hydrologic Alterations of Freshwater Flows in the CHNEP area include:

- Draining and filling wetlands
- Damming, diking, straightening, widening, and deepening rivers and creeks
- Diverting natural waterways into different watersheds and waterbodies
- Hardening natural pervious areas that previously recharged groundwater
- Withdrawing from surface water and groundwater systems for consumptive uses
- Connecting isolated waterbodies with canals
- Dredging and filling tidal waters and estuaries

Surface Water and Groundwater Levels

Aquifers are bodies of permeable rock that can contain or transmit groundwater. In Southwest Florida, there are three main aquifers: the Surficial Aquifer System (SAS), Hawthorn (Intermediate) Aquifer System, and the Floridan Aquifer System. The Floridan Aquifer underlies all of Florida and areas of Alabama, Georgia, and South Carolina and is one of the main sources of withdrawals for consumptive use in the CHNEP area. Where waters in the Floridan Aquifer System are brackish, the Hawthorn Aquifer System is the main source of aquifer water supply for Sarasota, Charlotte, and Lee Counties.

When surface water levels are higher than surrounding groundwater, surface water can percolate into the ground and recharge the SAS aquifer. In areas where aquifer water levels are higher than surrounding surface waters, groundwater can discharge into surface water. As a result, groundwater levels in aquifers can affect the base flow of water in springs and streams, and water levels in lakes and wetlands. They can also maintain a positive head pressure to hold back saltwater intrusion into aquifers.

An aquifer becomes stressed if the amount of groundwater withdrawn for consumptive use exceeds the amount of recharge. Over-stressing can cause saltwater intrusion or groundwater levels to decline significantly—which can reduce discharges into surface waters. For example, groundwater pumping in the upper Peace River Watershed contributed to cessation of flow of Kissengen Springs and other minor springs into the Peace River (PBS&J 2007). Lowered groundwater levels can result in decreased stream flows and lake levels and losses of plant and animal habitat. Reduced freshwater flows alter salinity gradients and make certain habitats no longer suitable for plants and animals. Reduced water levels in tidal creeks can also create barriers for mobile aquatic organisms and increase the predation efficiency on aquatic species by birds and other predators. Shallow water systems are susceptible to wider temperature variations, whereby warmer temperatures can stimulate algal blooms, reduce dissolved oxygen levels, and increase mortality of aquatic organisms. In addition, because coastal aquifers are commonly surrounded by saltwater, reduced aquifer water levels can cause saltwater to intrude into the aquifer. Saltwater intrusion has significant environmental repercussions for waterbodies that receive groundwater discharge and greatly increases the costs of treating water for consumptive uses. Rising sea levels increase saltwater intrusion into coastal aquifers, potentially impacting surface waters and groundwater supply for consumptive uses.

Climate Change

Maintaining or restoring more natural hydrology is complicated by climate stressors like more intense storms and precipitation events, increased air temperature, and rising sea levels, which compound with anthropogenic stressors associated with population growth and land use changes. Climate stressors will likely increase flooding events and prolong periods of drought, creating even more extreme conditions of too much or too little water. Consideration of climate-related changes in extreme conditions (i.e., wetter wet seasons and drier dry seasons) is important for planning, as opposed to sole reliance on average annual statistics. Climate stressors can create more frequent flooding and could increase demand for further alteration and drainage, making restoring natural hydrologic conditions more challenging. Rising sea levels will alter the timing, depth, and duration of saltwater inundation and salinity gradients, impacting isohaline zones in rivers and creeks and saltwater intrusion into coastal aquifers. These threats are discussed in greater detail in the Action sections of this Hydrologic Restoration Action Plan. Overall, climate change is impacting hydrologic conditions and therefore needs to be incorporated into current and future hydrologic restoration initiatives.

Bioindicators

To complement traditional hydrologic analyses, CHNEP and partners also use bioindicators to achieve a more holistic understanding of hydrology and to inform management priorities and actions. For example, the presence of healthy oysters and seagrasses can be used as an indicator of sedimentation, salinity, and flow regimes and minimum flows. Fish can be an indicator of salinity, dissolved oxygen, habitat availability, and hydrologic connectivity conditions. In wetlands, hydroperiod and measured water elevations can be used to determine if conditions are supportive of the biological communities present. South Florida wetland communities have optimum wetland hydroperiods and average wet season water depths (Figure 16) (Duever & Roberts 2013). Using bioindicators gives a more complete and accurate picture of the ecological health of a system.

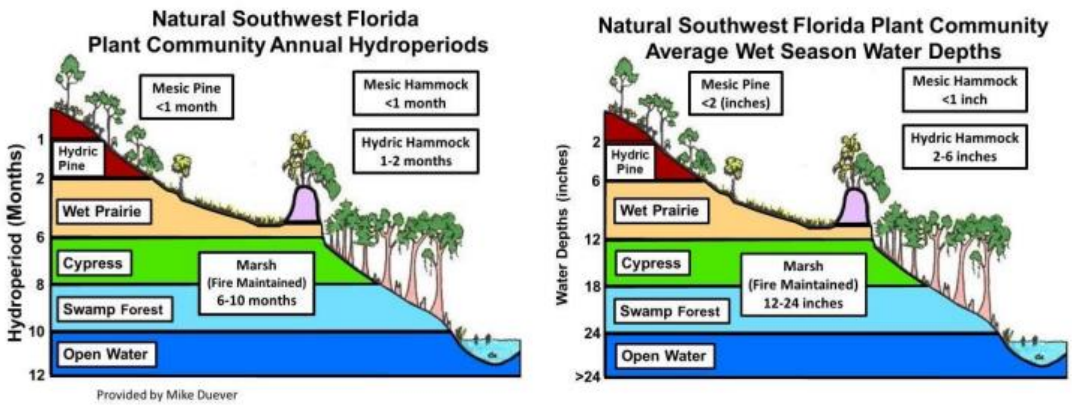


Figure 16. Healthy Southwest Florida wetlands require certain hydroperiods and water depths, thus wetland condition can be used as a bioindicator of overall hydrologic ecosystem function | *Duever & Roberts 2013*.

Hydrologic Restoration Challenges and Management Actions

Restoring the natural hydrology of estuaries is critical to their protection and restoration. Significant challenges remain to reverse damage and balance limited water resources between people and natural ecosystems. Water resources do not usually follow jurisdictional lines of local, regional, and state governments, and the cumulative impact of many small land and water-related decisions may remain unnoticed until hydrologic alterations become significant. Furthermore, limited surface water and groundwater data exacerbate challenges for supporting restoration actions. Since resources are affected by management at all levels of government, cross-jurisdictional landscape-level data collection and watershed planning are important to the long- term health of the rivers, lakes, and aquifers feeding estuaries.

The CHNEP Management Conference has identified three major hydrologic restoration actions to support the goal of enhanced and improved waterbodies with more natural hydrologic conditions: Action 1 calls for continued data collection, modeling, and analysis to support hydrologic restoration; Action 2 aims to increase fresh surface water and groundwater availability to support healthy natural systems; and Action 3 seeks to preserve and restore natural flow regimes.

Hydrologic Restoration Action 1: Conduct data collection, modeling, and analyses to support hydrologic restoration

OBJECTIVES:

Conduct data collection, modeling, and analysis of historic, current, and projected hydrologic conditions to identify needs and guide hydrologic restoration.

BACKGROUND:

Aquatic systems are complex. Effective hydrologic restoration plans must integrate natural system preservation, water supply, water quality, and flood protection. Continuous scientific data collection of surface water and groundwater levels, flow rates, and surface water levels are crucial to understand spatial and temporal variations in hydrologic conditions and conduct effective science-based hydrologic restoration planning. Hydrologic data collection, analysis, and modeling are prerequisites for successful hydrologic restoration.

Data Collection

To document changes in surface water flows and patterns due to hydrologic alterations, we need to develop and maintain accurate, long-term databases for all watersheds within the CHNEP area. The U.S. Geological Survey (USGS) currently operates hundreds of monitoring sites in Florida to collect information on surface water, groundwater, water quality, and precipitation. Many sites are equipped with satellite telemetry, which allows data to be posted online for public dissemination. Frequency of data collection ranges from 15 minutes to daily. Many of these stations are available on the CHNEP Water Atlas Real-Time Data Mapper. For example, in the CHNEP area, collaboration between USGS and Lee County has yielded important data for hydrologic modeling and assessment of flood conditions in South Lee County flowways.

South Florida Water Management District (SFWMD) and Southwest Florida Water Management District (SWFWMD) also operate large monitoring networks to measure rainfall, stream flow, spring discharge, and surface water and groundwater levels. Frequency of data collection and reporting ranges from current status to monthly. Data are collected, processed, analyzed, and uploaded to publicly accessible, searchable online databases (SWFWMD's Water Management Information System and SFWMD's DBHYDRO database). Radar-based rainfall estimates from Doppler weather radar images are calibrated and mapped over 2x2 km grid cells and available for GIS download on the CHNEP Water Atlas.

CHNEP collaborates with partners to collect data necessary to inform hydrologic modeling and assessment for the development of Watershed Management Plans. For example, CHNEP procured and shared management of project that collected geotechnical and survey data to assist with the restoration of the hydrologic function of the Yucca Pens area of the Babcock-

Webb Wildlife Management Area for the Charlotte Harbor Flatwoods Initiative.

While many areas within the CHNEP have extensive historical hydrologic records, other areas lack them. For these areas, we need to determine the minimum number and appropriate locations of gages to close these data gaps. Improved monitoring of flow, salinity, and indicator species data will provide a stronger scientific basis to establish minimum flows and levels and assess future changes related to projected development and consumptive uses (see Hydrologic Restoration Action 2).

Modeling

Accurate data-driven water budget modeling is required to effectively manage and balance the water demands of people for drainage, drinking water, navigation, and recreation while preserving the ecological health of natural systems. It is especially important to develop water budgets that predict future water demands and supplies under climate change scenarios. Hydrologic interactions among factors such as evapotranspiration, precipitation, ground-water pumping, wastewater reuse, watershed connections, impermeable surfaces, constructed conveyances, barriers, and reservoirs—in addition to future water demands due to population growth—also need to be modeled.

Hydrologic models are most effectively used for restoration in conjunction with ecological and water quality models to determine how much water an ecosystem needs, where water is located, how it can be safely distributed to those areas of need, and how water quality can be protected and improved in the process. For example, the City of Winter Haven is developing a regional hydrologic/hydraulic model to assist with future water use planning as part of the One Water Master Planning effort. The City's innovative One Water approach aims to manage water as a resource—not waste—by integrating all aspects of water use for natural resources, infrastructure, land development, conservation, health, recreation.

CHNEP collaborates with partners to develop hydrologic models to inform restoring more natural water flows, improving water quality and environmental conditions, and increasing natural storage and moderation of flooding events. For example:

- **Charlotte Harbor Flatwoods Initiative (CHFI):** CHNEP and SFWMD partnered to obtain NRDA RESTORE funds which CHNEP used to collect data and conduct hydrologic modeling for natural and current flow conditions in the CHFI region Hydrologic Restoration Action Plan Action 3). The work produced an important science-based, data-driven Strategic Hydrologic Planning Tool to guide data collection, modelling, evaluation, planning, management, and restoration for the CHFI (CHNEP and Water Science Associates 2023).
- **South Lee County Watershed Initiative (SLCWI):** CHNEP provided funding and project management for the development of an integrated surface and ground water hydrologic model to guide the appropriate restoration and management of surface waters flowing from the SLCW and discharging into the Estero Bay Aquatic Preserve.

The new tool can be used by restoration partners to determine the timing, distribution, quantity, and quality of water necessary to improve surface water flows (CHNEP and LAGO 2021). Results from the CHNEP-led study are now being folded into the Corkscrew Water Initiative, a three-year planning study to develop a comprehensive strategy to achieve ecological restoration of the Corkscrew system by improving wetland hydroperiods and natural flows, while reducing flood risk in nearby flood-prone areas without adversely impacting the water supply and water management needs of the Corkscrew Watershed.

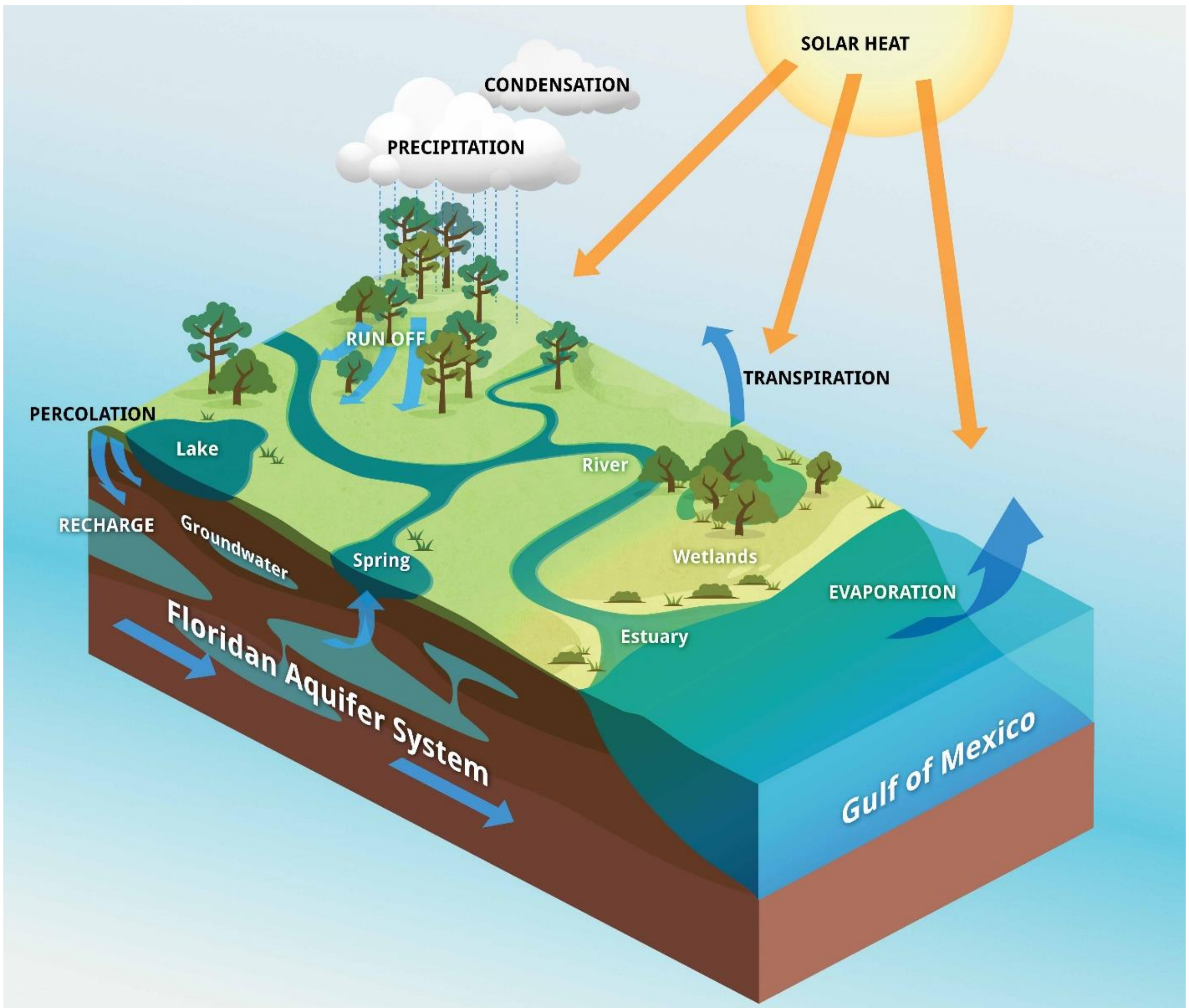


Figure 17. The hydrologic cycle | *James Seaman, courtesy of ClipPix ETC, Florida Center for Instructional Technology, USF.*

Groundwater models typically include basic components of the hydrologic cycle along with the physical properties of the aquifer and stresses to the system, such as pumping and saltwater intrusion (Figure 17). For example, SWFWMD developed a saltwater intrusion model for the

Most Impacted Area of the Southern Water Use Caution Area (SWUCA) to support SWUCA Recovery (see Hydrologic Restoration Action 2). The model represents and predicts changes to the saltwater-freshwater interface associated with the changes in climate, sea level, and groundwater levels.

Groundwater flow is influenced by surface waterbodies. Models have been developed to better understand how base flows, infiltration, and evaporation can affect surface water flows and levels during wet and dry periods. Sophisticated surface water and groundwater models have been developed to evaluate flood levels and the effects of flood protection management measures as they relate to base flows, water quality, water supply, and the health of ecosystems.

This work aims to continually update, refine, and develop new models to better inform and guide hydrologic restoration projects—especially under changing climatic conditions that could significantly impact freshwater flows, increase saltwater intrusion, and further alter drainage patterns and hydroperiods.

STATUS:

Ongoing.

RELATED ACTIONS:

- Hydrologic Restoration Action 2: Increase fresh surface water and groundwater availability to support healthy natural systems
- Hydrologic Restoration Action 3: Protect and restore natural flow regimes

STRATEGY:

Activity 1.1: Review existing data collection and identify gaps. Conduct data collection, modeling, and analyses of historic, current, and projected hydrologic conditions to identify needs and guide hydrologic restoration, including:

- water budget modeling including projected supply demands and natural system needs
- estuary mixing models
- impacts of manmade barriers to historical flows
- relationship between reservoir and downstream resources
- integrated surface-groundwater models that consider climate change.

Location: CHNEP area.
Responsible parties: SWFWMD and SFWMD (Leads responsible for MFLs focused on water withdrawal impacts), CHNEP, County and Municipal Governments, FDEP, USGS, Research Institutions, Conservation NGOs.

Timeframe: Ongoing; Monitoring Strategy adopted in 2020.
Potential annual cost and funding sources: $1M–10M/Section 320 Funds, Grants, SWFWMD, SFWMD.
Benefits: Increased knowledge of historic, current, and projected hydrologic conditions to better inform and guide hydrologic restoration.
5-year Performance measures:

- Updated estuarine mixing, surface water, and groundwater models to support MFL development and recovery strategies and creation of regional watershed restoration plans, where needed.
- Increased number of surface water and groundwater level and flow gages in areas with limited data to monitor natural variations in flow and impacts of manmade barriers and alterations (including mining, ditching, channelizing, and damming).

Hydrologic Restoration Action 2: Increase fresh surface water and groundwater availability to support healthy ecosystems

OBJECTIVES:

Develop, reevaluate, and implement scientifically-sound minimum flows and levels in surface water and groundwater, and implement recovery strategies to meet levels in order to prevent degradation of ecosystems, increase aquifer recharge, and encourage conservation, efficient water use, and use of alternative water supply sources, when and where appropriate.

BACKGROUND:

Timing, volume, and distribution of freshwater flows are critical ecological structuring elements for wetlands, lakes, rivers, and estuaries. Throughout the CHNEP area, water flows have been dramatically altered from their historical natural states—flooding some areas with too much water and starving others or alternately flooding and starving the same area—degrading waterbodies and their ability to sustain ecosystems. Similarly, surface water and groundwater levels have been lowered, impacting their functional capacity to support healthy natural systems. Climate stressors could further exacerbate shortages of fresh surface water and groundwater availability for healthy natural systems. Hydrologic restoration should balance flood protection and water supply for built communities with natural systems' water supply, level, and flow needs.

Water Management District Regulatory Mechanisms

Multiple stakeholders compete with the natural environment for use of fresh surface water and groundwater including agriculture, residential and commercial development, industry, and mining. Florida's Water Management Districts (Districts) are responsible for allocating freshwater to consumptive uses, water storage, and flood control—while protecting water quality, natural systems, recreational opportunities, navigation, and public health and safety. Allocation of freshwater to meet human and environmental needs is challenged by a rapidly growing population and complicated by temporal and spatial variability in rainfall across seasonal, inter-annual, decadal, multi-decadal, and longer climatic timescales (Misra et al. 2017). Regulatory requirements are enacted to protect water and ecosystems from potential harm caused by surface water and groundwater withdrawals through multiple regulatory mechanisms, including minimum flows and levels (MFLs), restricted allocation areas, and water reservations.

Minimum Flows and Levels (MFLs)

Florida law (Chapter 373.042, Florida Statutes) requires the state Water Management Districts or the Florida Department of Environmental Protection (FDEP) to establish minimum flows for rivers, streams, and estuaries and minimum water levels for lakes, wetlands, and aquifers.

MFLs are used to plan for current and future water needs, which include the need to offset groundwater use through projects that encourage conservation and provide alternative water supplies. MFLs are also an important tool for District water use and environmental permitting programs to ensure that withdrawals do not exceed an established MFL and cause significant harm. MFLs provide regulations to protect springs, spring runs, rivers, lakes, wetlands, and aquifers from ground and surface water withdrawals that would cause “significant harm” to the water resources or ecology of the area. The term "significant harm" is not defined by statute; however, there are environmental values, such as fish and wildlife habitat and scenic attributes, as well as methods and criteria in rule that must be considered and used when establishing MFLs.

MFLs are determined by scientists who consider the ability of aquatic ecosystems and groundwater systems to adjust to changes in hydrologic conditions. For each MFL priority waterbody, Districts study and collect a large amount of information such as historical water levels and flow rates, soils and vegetation data, water quality data, wildlife variety and abundances, and other pertinent information. As each natural system is unique, District scientists and other experts in the field have developed a variety of methods for setting MFLs using the best available science and advanced computer models. An essential component of the MFL process includes the use of peer review, where a panel of independent scientists review and comment on proposed MFLs, including underlying data and methods used for their development. Other local, state, and federal agencies and the public have opportunities to review and comment as well. A public meeting is held to explain the proposed MFL and to record public comments. All comments are read and considered by staff before they make a recommendation to the District’s Governing Board. Once MFLs are adopted by Governing Boards, they are implemented through District consumptive use permitting and water supply planning programs. If an MFL waterbody does not or is not expected to meet proposed MFL criteria during the planning horizon, Districts must also develop an appropriate recovery or prevention strategy.

In Depth: MFL Criteria

Section 373.042, Florida Statutes (F.S.), provides that the minimum flow for a given watercourse is the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area. This section of the statutes also indicates that minimum flows (or minimum water levels) shall be calculated using the best information available, that the Governing Board shall consider and may provide for non-consumptive uses in the establishment of minimum flows, and when appropriate, minimum flows may be calculated to reflect seasonal variation. The statutes also require that when establishing minimum flows and levels, changes and structural alterations to watersheds, surface waters, and aquifers shall also be considered (Section 373.0421, F.S.).

The State Water Resource Implementation Rule (Chapter 62-40, Florida Administrative Code) includes additional guidance for establishing minimum flows and levels, providing that consideration shall be given to natural seasonal fluctuations in water flows or levels, nonconsumptive uses, and environmental values associated with coastal, estuarine, riverine, spring, aquatic, and wetlands ecology, including:

- Recreation, in and on the water
- Fish and wildlife habitats and the passage of fish
- Estuarine resources
- Transfer of detrital material
- Maintenance of freshwater storage and supply
- Aesthetic and scenic attributes
- Filtration and absorption of nutrients and other pollutants
- Sediment loads
- Water quality
- Navigation

Guidance provided by this Rule should be considered when establishing MFLs.

Water Reservations

A water reservation is a legal mechanism Districts can use to set aside water for maintaining the ecological health of a waterbody. Water reservations protect quantities and timing of water flows at specific locations. For example, SFWMD adopted a water reservation rule for the Caloosahatchee River West Basin Storage Reservoir (see Caloosahatchee Case Study).

Restricted Allocation in Water Use Caution Areas

In areas where water withdrawals are impacting or may impact water resources, natural resources, or the public interest, Districts may designate Water Use Caution Areas (WUCA).

Management activities in WUCAs include funding projects, developing alternative water supplies, recovering resources, and implementing regulatory requirements and restrictions. For example, the Southern Water Use Caution Area (SWUCA) was designated in 1992 to address reduced flows in the upper Peace River, reduced lake levels in the Ridge Lakes area, and saltwater intrusion into the Upper Floridan aquifer. SWFWMD implements a cooperative funding program for local governments to fund alternative water supply conservation and restoration projects.

The first five-year assessment of the SWUCA strategy reported that SWFWMD and its partners met water supply needs, reduced groundwater withdrawal from the Upper Floridan aquifer by more than their targeted 50 MGD and made progress toward achieving minimum flows set for the Upper Peace River. The Lake Hancock Lake Level Modification Project was designed to help achieve low minimum flows by replacing a water control structure to raise water levels by 1.3 feet—allowing more water to be stored in the lake during the wet season and released during the dry season (see Hydrologic Restoration Action 3). Flows and levels are trending upwards, but there is more work to be done in the SWUCA. According to the 2017-2021 5-year SWUCA update, 23 of the 32 adopted MFLs for lakes are being met, while all 13 MFLs set for freshwater river, estuarine, and springs are being met (SWFWMD 2023b).

Case Study Box: Caloosahatchee River and Estuary

Historically, the Caloosahatchee River was a shallow, meandering river starting at Lake Hicpochee and flowing to the Caloosahatchee Estuary. Beginning in the 1880s, the freshwater segment of the river was straightened, deepened, widened, and connected to Lake Okeechobee and the Kissimmee Chain of Lakes for water supply, flood control, and navigational purposes. These alterations significantly changed the timing, distribution, and amount of freshwater delivered to the estuary. For example, the Franklin Lock and Dam at the head of the Caloosahatchee River Estuary eliminated the historical estuarine gradient of salinity upstream of the dam during the dry season. Increased water withdrawals to meet agricultural and urban demand reduced dry season flow to the river and estuary downstream of the dam. During the wet season, water that once evaporated or percolated into wetland soils now runs into the estuary in higher quantities over shorter time periods — often carrying excessive nutrients from Lake Okeechobee and the river watershed.

To recover degraded habitats and displaced communities of salinity-sensitive organisms, SFWMD established a Caloosahatchee River MFL in 2001. MFL criteria were based on the distribution and density of tape grass, a salinity-sensitive keystone estuarine species. An independent scientific review of the original MFL concluded that significant science gaps prevented a thorough evaluation as to whether the MFL would prevent significant harm to the river and estuary (Edwards et al. 2000). A reevaluation of the MFL in 2003 indicated that the MFL criteria would likely be exceeded on a regular and continuing basis until new storage was developed to supply additional water needed during dry periods (SFWMD 2003). In the years since, tapegrass populations in the estuary have suffered extensive losses. Based on additional science, modeling, and community input to address science gaps, the new Caloosahatchee River MFL adopted in 2019 includes a multi-component recovery strategy. These components include: completion of the C-43 Reservoir with a water control plan and reservation of all C-34 water for the protection of fish and wildlife, plus implementation of a research and monitoring plan, evaluations and completion of additional storage projects as needed, and a recovery strategy timeline (SFWMD 2021).

In 2024, USACE revised its Lake Okeechobee System Operating Manual (LOSOM) with the intent to better manage the timing and flow of lake releases to the Caloosahatchee River to be more supportive of healthy river and estuarine ecology. The CHNEP Water Atlas maintains a Lake Okeechobee and Caloosahatchee Estuary tracker that displays recent levels of the lake and rates of discharge to the river, in relation to the LOSOM water management bands.

Increase Groundwater Recharge

Groundwater and surface waters interact in important ways to maintain the ecological health of Florida's springs, lakes, rivers, wetlands, and estuaries. Aquifer levels can decline due to reduced rainfall associated with climate variability, overdraft for consumptive use, and loss of recharge areas. Reduced aquifer levels can negatively impact water flows in springs and streams, water levels in lakes and wetlands, and saltwater intrusion.

Development commonly converts pervious surfaces to impervious ones, reducing the surface area available to recharge aquifers (Figure 18). This unwelcome trend can be slowed down by decreasing impervious surface areas used in development.

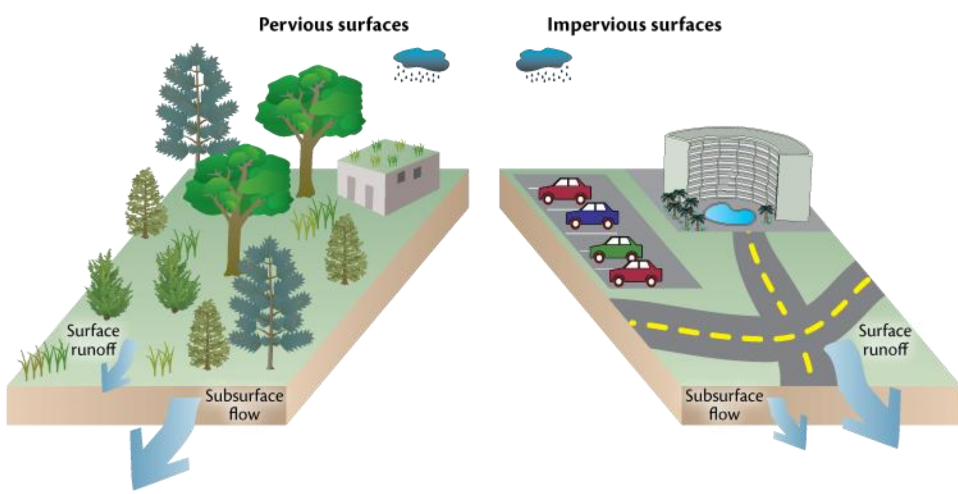


Figure 18. Development converts pervious to impervious surfaces that impede percolation of rainwater into the ground | *Maryland Coastal Bays Program, courtesy of Integration and Application Network (ian.umces.edu) University of Maryland Center for Environmental Science.*

Green infrastructure, also known as Low Impact Development or Low Impact Design (LID), can be used to mimic natural ecosystem services by capturing and storing water—reducing the impacts of high-volume runoff events and allowing water to percolate into the ground (Figure 19). Designing infrastructure that works with nature instead of against it is an effective and efficient strategy for improving hydrology (see Water Quality Improvement Action 3).

Examples of green infrastructure include:

- Canopy trees and green roofs that can intercept rainfall before it hits the ground
- Rainwater harvesting systems like rain barrels and cisterns that can capture rainfall and store it for later use
- Pervious pavers, bricks and gravel that can facilitate infiltration of rainfall into underlying soils
- Rain gardens and vegetated swales that can capture runoff and allow it to evaporate, be taken up by vegetation, or percolate into the ground

The best designed green infrastructure systems can approximate the pre-development hydrologic regime of an area. Barriers to implementing green infrastructure include limited education and training opportunities, Homeowner Association rules and deed restrictions, access to the technology, and conflicting language in comprehensive plans and development codes.

Figure 19. Green infrastructure techniques using Florida-Friendly Landscaping™ can capture and store water on residential lots | *Puget Sound Partnership and WSU Extension.*

Acquisition of environmentally sensitive land and conservation easements on private lands are also important tools for protecting water resources and facilitating recharge. For example, Lee County purchased Edison Farms, part of the 60,000+ acre Corkscrew Region Ecosystem Watershed, for $42.2 million in 2017 through its Conservation 20/20 Land Acquisition Program. The property is located within a Density Reduction/Groundwater Resource Area, designated to help store and protect critical water supplies for the region. Edison Farm's vast wetlands store and filter water, allowing it to percolate into soils and recharge aquifers. In addition, the property provides important flood protection for the City of Bonita Springs and Village of Estero, and hosts critical wildlife habitat, including designated primary habitat for Florida panthers and foraging habitat for imperiled wood storks.

Where artificially high flows exist, excess surface water can be used to recharge aquifers. The Saltwater Intrusion Minimum Aquifer Level (SWIMAL) recovery project at Flatford Swamp in Manatee County is examining the potential to use excess surface water inflow to the Swamp to recharge the Upper Floridan aquifer. If feasible, the fully operational project will help restore the natural hydrologic period and vegetation in the swamp while recovering groundwater levels and reducing the rate of saltwater intrusion in SWUCA's Most Impacted Area.

Reduce Future Demands on Surface Water and Groundwater Sources

Agricultural irrigation and public water supply are the two leading consumptive water uses in the CHNEP area (**Error! Reference source not found.**20). Demand for surface water and groundwater withdrawals can be reduced by conservation, more efficient use of water, and use of alternative water supply sources other than surface water and groundwater.

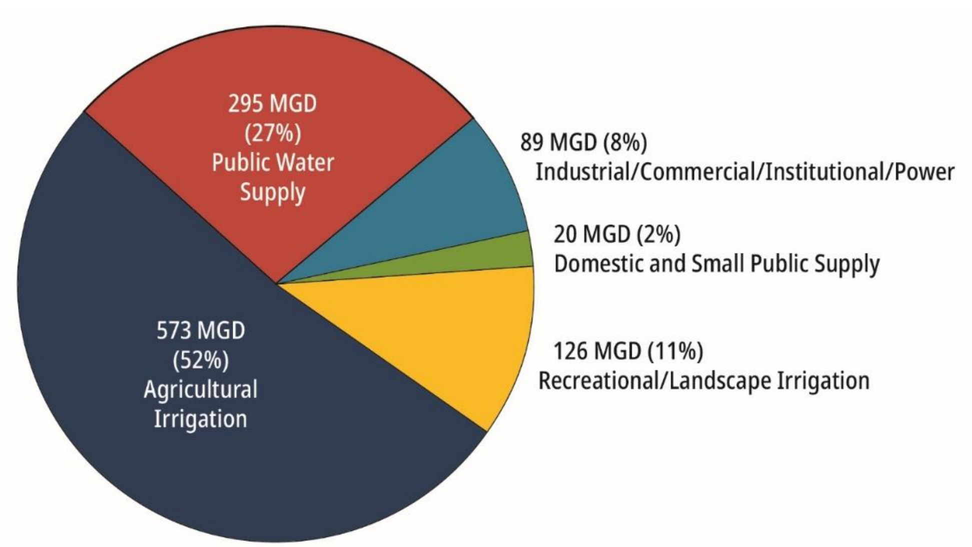


Figure 20. Total water use (Million Gallons per Day, MGD) by category in counties within the CHNEP area for 2022 | *SWFWMD 2023a (Table 9), SFWMD 2024 (Table 10).*

Water Conservation

A variety of water conservation resources are available to homeowners and businesses detailing choices of appliances, plumbing fixtures, irrigation systems, and landscaping plants. Examples in the CHNEP area include:

- The Florida Water Star℠ Program is a voluntary certification program for residential and commercial construction. The average Florida Water Star homeowner can expect to save up to 20 percent of water use annually.
- The Water Conservation Hotel and Motel Program (Water CHAMP℠) helps hotels and motels save water by encouraging guests to use towels and linens more than once during their stay.
- SWFWMD offers useful water savings tips to restaurants covering back of house, restrooms, building maintenance, and landscaping.
- The University of Florida Institute of Food and Agricultural Sciences (UF/IFAS) promotes water-saving Florida-Friendly Landscaping™ (FFL) for Florida homes and businesses. Florida-friendly plants require less fertilizer, pesticides, herbicides, and water than plants adapted to other climates. UF/IFAS offers free online resources detailing FFL principles and how to apply them to your own yard, including a list of plants adapted to the CHNEP area (Figure 19).

EPA has also developed Best Management Practices to help water utilities and governments to assess whether savings from future water conservation and more efficient water use can minimize the need to develop costly new water supplies (EPA 2016a). The tool focuses on six complementary practices including: 1) supply side and demand side accounting, 2) leak management, 3) metering, 4) conservation rate structure, 5) end use water conservation and efficiency analysis, and 6) water conservation and efficiency planning. Each practice includes descriptions with examples, metrics, benchmarks, deliverables, and resources for more information.

Additionally, advancements in agricultural BMPs are now available to improve watering efficiency and conservation on farms, including:

- Tailwater recovery or surface water irrigation pump stations
- Conversion of existing irrigation systems to more efficient ones
- Weather stations
- Soil moisture sensors
- Water-control structures
- Reuse water connections
- Automated pumps and valves
- Rainwater harvesting systems

The Facilitating Agricultural Resource Management Systems (FARMS) Program is a public-private partnership developed by SWFWMD and the Florida Department of Agriculture and

Consumer Services. FARMS is a cost-share reimbursement program designed to incentivize farmers to reduce groundwater withdrawals from the Upper Floridan aquifer system through BMPs addressing conservation, alternative water supplies, and nutrient application reduction. Over 184 FARMS Program projects are operational in the SWUCA, which collectively reduce groundwater withdrawals from the Upper Floridan aquifer system by 28 million gallons per day (MGD) and reduce nutrient application by 2,905 pounds per year. The FARMS Program aims to reduce withdrawals by a total of 40 MGD. In the Myakka River basin, thirteen projects conserve 6.7 MGD through reuse of tailwater recovery and other conservation measures. FARMS Program BMPs also yield improvements to water quality and natural systems (see Water Quality Improvement Action 3).

Alternative Water Supplies

The Peace River Regional Water Supply Authority, created in 1982, provides drinking water to the City of North Port plus all of DeSoto, Manatee, and Sarasota Counties and parts of Charlotte County, under the jurisdiction of SWFWMD (Peace River Manasota Regional Water Supply Authority 2017). The Authority is an independent special district pursuant to Florida Statutes and established by interlocal agreement among its member Counties. The Authority works to maximize the development of water resources while reducing adverse environmental effects. Among its many collaborative and coordinating roles, the Authority aims to diversify the region's water supplies, increase water conservation and wastewater beneficial reuse, and support protection and enhancement of water-dependent natural resources.

Decreased withdrawals from surface water and groundwater sources can be achieved through developing and promoting alternative supply sources, including captured stormwater, potable water aquifer storage and recovery, seawater desalination, farm tailwater recovery, and beneficial reuse of appropriately treated wastewater. Today, approximately 72 percent of treated wastewater is reused in CHNEP's area; by 2045 approximately 92 percent is projected to be reused (SWFWMD 2020b, SFWMD 2022) (see Water Quality Improvement Action 4). For example, the City of Cape Coral has reduced irrigation-related demands on the Mid Hawthorne Aquifer by using reclaimed water from the City's two wastewater facilities, supplemented with freshwater pumped from a 300-mile canal system.

Climate Change

Stresses on ecosystems due to increased demands for consumptive water use and altered hydrology are expected to be exacerbated by climate change. Rising sea levels will alter the timing, depth, and duration of saltwater inundation and salinity gradients. Maintaining locations of isohaline zones in rivers and creeks may require additional volumes of freshwater to be reserved for natural systems. Rising sea levels will also increase saltwater intrusion into coastal aquifers, potentially impacting surface waters where they interact with groundwater and water supply for consumptive uses.

Climate change is also expected to alter precipitation patterns in Southwest Florida (Easterling 2017). Reduced rainfall during the dry season, combined with greater evaporation due to warmer air temperatures and increased water demand for agriculture and urban development, will compound existing problems. Increased flooding during more intense rainfall events may flood natural areas and overwhelm infrastructure designed to manage stormwater. Changes of freshwater input into creeks and bays will alter their chemical, physical, and ecological characteristics—further disrupting salinity zonation important as nursery and forage areas for fish and invertebrates. Overall, climate stressors will likely make increasing fresh surface water and groundwater availability to meet both growing human and environmental needs more challenging.

STATUS:

Ongoing.

RELATED ACTIONS:

- Hydrologic Restoration Action 1: Conduct data collection, modeling, and analyses to support hydrologic restoration
- Hydrologic Restoration Action 3: Protect and restore natural flow regimes
- Water Quality improvement Action 3: Reduce urban stormwater and agricultural runoff pollution
- Water Quality improvement Action 4: Reduce wastewater pollution

STRATEGY:

Activity 2.1: Participate in development, reevaluation, and implementation of scientifically sound freshwater Minimum Flows and Levels (MFLs) for surface water and groundwater resources that consider climate stressors, and recovery strategies to meet MFLs in order to prevent degradation of natural systems.

Location: CHNEP area, focusing on minimum aquifer levels for the Floridan aquifer system and minimum flows for waterways, as needed.
Responsible parties: SWFWMD and SFWMD (leads), FDEP (regulatory lead), USACE, County and Municipal Governments, Water Utilities, CHNEP.
Timeframe: Ongoing.
Potential annual cost and funding sources: Reevaluation $1M–10M; Implementation >$10M/SWFWMD, SFWMD, USACE, County and Municipal Governments.
Benefits: Increased availability of fresh surface water and groundwater to support natural systems.
5-year Performance measure: Increased number of recovery strategies and projects to reduce or eliminate MFL exceedances.

Activity 2.2: Increase aquifer recharge by supporting local plans and codes that decrease impervious surfaces; incorporate green infrastructure practices; protect recharge and wellfield areas; and protect and restore wetlands; and support and encourage communities to use low impact design and nature-based solutions.

Location: CHNEP area.
Responsible parties: County and Municipal Governments, SWFWMD, SFWMD, UF/IFAS Extension, CHNEP, FDEP, USACE, private sector.
Timeframe: Ongoing; Communication and Outreach Strategy adopted in 2020.
Potential annual cost and funding sources: \$25,000–\$99,999/County and Municipal Governments.
Benefits: Increased freshwater availability to support natural systems, restored hydrology, and improved water quality.
5-year Performance measure: Increased long-term annual average levels in groundwater levels and aquifers.

Activity 2.3: Encourage conservation and efficient water use and promote aquifer recharge through construction of green infrastructure projects where appropriate, adoption of agricultural irrigation BMPs, and promotion of alternative water supply sources, including increased appropriate reuse of treated wastewater.

Location: CHNEP area.
Responsible parties: County and Municipal Governments, SWFWMD, SFWMD, FDACS, UF/IFAS Extension, Water Utilities, FDEP, CHNEP, USDA, private sector.
Timeframe: Ongoing; Communication and Outreach Strategy adopted in 2020.
Potential annual cost and funding sources: \$500,000–\$999,999/County and Municipal Governments, SWFWMD, SFWMD, FDEP, USDA, FDACS.
Benefits: Increased freshwater availability to support natural systems and conserve water supply sources.
5-year Performance measure: Increased water conservation.

Hydrologic Restoration Action 3: Protect and restore natural flow regimes

OBJECTIVES:

Support integrated and coordinated watershed management planning and project implementation that protects headwaters, restores flow courses and floodplains, and reestablishes flow volume and timing to historical receiving waters, where possible. Accommodate and mitigate impacts on flow regime anticipated from climate change.

BACKGROUND:

Development in Central and Southwest Florida has altered historical natural watershed flow regimes. Natural watershed flows, volumes, and timing have been redirected, impeded, or accelerated by efforts to quickly drain water off the landscape to protect development from flooding. Natural streams were channelized straighter and deeper, wetlands were ditched, and cross-basin channels were dug, resulting in a loss of natural water recharge and water quality treatment functions, as well as bird, fish, and other wildlife habitat. Engineered inter-basin water transfers have in some areas resulted in surface flows no longer contributing to their historical watersheds and other areas where flows contribute too much. In some areas, hydrologic alterations have caused significant changes in both the amount and seasonal characteristics of flows of major rivers and creeks, leading to increased and excessive wet season discharges to the coastal environment. These excessive discharges often contain higher pollutant loads and create high volume freshwater pulses that alter and impact estuarine and marine habitats—a problematic condition known as flashiness.

Watershed Management Planning

Comprehensive watershed management plans identify human and ecological water requirements for major watersheds and establish goals and objectives to meet those needs. By focusing attention and resources on an overall watershed strategy, restoration projects can yield greater cost-benefits. Watershed initiatives are a way to build partnerships, leverage funding, and address complex problems. Initiatives in the CHNEP area include the Upper Peace Initiative (SWFWMD), the Myakka River Initiative (SWFWMD), the Charlotte Harbor Flatwoods Initiative (SFWMD), the LeHigh Headwaters Initiative (SFWMD), the South Lee County Watershed Initiative (SFWMD), and the Corkscrew Watershed Initiative (SFWMD). Additionally, the Comprehensive Everglades Restoration Plan (CERP) provides a framework and guide to protect and restore the water resources with the Greater Everglades footprint, which includes portions of central and southern Florida.

FDEP Basin Management Action Plans (BMAPs) consolidate and coordinate water pollution reduction across jurisdictions (see Water Quality Improvement Action 2), which in some cases can have watershed restoration components to store and treat more stormwater. There are many opportunities for hydrologic improvements to watersheds that provide multiple benefits of flood protection in conjunction with wetland restoration, increased recreational opportunities, improved water quality (see Water Quality Improvement Action 3), and water supply enhancement (see Hydrologic Restoration Action 2).

Hydrologic Restoration

Protecting and restoring headwater tributaries and reestablishing flows to their historical receiving waterbodies are restoration priorities that can benefit the entire watershed. Sometimes, it is not feasible to return altered waterways to their original natural state. In those cases, water conveyances, barriers, and reservoirs can be built or restored to mimic natural function; for example, canals can incorporate shallow, broad, vegetated, and serpentine stream-like components. Estuarine and freshwater wetland areas can be restored by backfilling ditches, removing spoil piles, and eliminating exotic vegetation.

Poorly constructed stream crossings can be a significant barrier to natural flow and aquatic life passage. They have been found to be a significant contributor to increased flooding and damage during extreme weather events and hurricanes. CHNEP encourages inclusion of adequate stream crossing in all new construction to facilitate natural flow and aquatic life passage. Problems with existing culverts should also be addressed.

Dams that no longer serve a functional purpose should be evaluated for removal. By removing obsolete dams, communities can make significant gains in water quality, ecological restoration, economic development, flood control, recreational opportunities, restoration of fish spawning and migration, and public safety (EPA 2016b).

Retrofitting and restoring important ecosystem services lost due to historical development activities can be costly. It is more desirable and cost-effective to protect natural flowways and waterbodies during development planning than to try to restore them post-impact. Remaining natural flowways require attention in order to remain unaltered by future development projects.

Many coordinated and strategic multi-benefit hydrologic restoration projects have been completed or are underway across the CHNEP area:

- Caloosahatchee River West Basin Storage Reservoir Project (C-43 Reservoir) is an 18-square-mile project designed to store up to 55 billion gallons water during wet periods and later release it to the Caloosahatchee River Estuary during dry periods to improve salinity balance, flow, and storage capacity (USACE & SFWMD 2010, SFWMD 2017) (see Hydrologic Restoration Action 2). Contractors completed a pump station in 2023 that will be able to push 1,500 cubic feet per second into the reservoir once it's completed in 2025.
- The Dona Bay Watershed Restoration Program is an ongoing Sarasota County project cofounded by the SWFMD, FDEP, and the Gulf Coast Consortium (RESTORE Act). The first two phases of the project are complete and feature a conveyance system that

diverts flow from the Cow Pen Slough Canal through over 1,000 acres of interconnected treatment ponds, wetlands, and borrow pits. The project improves water quality through nutrient removal and watershed attenuation. It reduces large freshwater pulses to the downstream estuary and provides freshwater wetland habitat. Future phases will include aquifer recharge and a further reduction of excess freshwater flows from Blackburn Canal to the Dona and Roberts Bay estuary.

- Charlotte Harbor Flatwoods Initiative is a 90-square-mile multi-partner restoration project in the Charlotte Harbor, Gator Slough, and Caloosahatchee River watersheds lead by SFWMD and FWC. The ongoing project aims to restore natural drainage across the Gator Slough Watershed with water that has been unnaturally impounded on the Fred C. Babcock–Cecil M. Webb Wildlife Management Area (BMWWA) and diverted from the Yucca Pens Unit WMA, Caloosahatchee River, and tidal creeks to Charlotte Harbor.
- Pine Lake Preserve/Kehl Canal is a hydrologic restoration project completed in 2021 in the City of Bonita Springs and Lee County. The project reestablished hydraulic connectivity between the Imperial River and its historic watershed to the east to better match natural "pre-development" conditions. Surface waters now sheet flow through Pine Lake Preserve into two ponds that now outfall via sheet flow into the upper reaches of the Imperial River.
- Warm Mineral Springs Creek Restoration Project is a hydrological restoration project completed in 2023, to aid population recovery and stability of the imperiled Florida manatee. The North Port project improves six acres of freshwater spring-fed creek habitat downstream from Warm Mineral Springs—an area considered to be the most important natural warm-water refuge for manatees during colder months in Southwest Florida. The project improved manatee access, increased the volume of warm-water habitat, removed excessive sediment, and stabilized banks. Partners included FWC, USACE, Sarasota County Government, TNC, CHNEP, the City of North Port, NWF, and the Gulf Coast Community Foundation.
- Alligator Creek Stream Restoration is an ongoing stream restoration project to restore approximately 1.5 miles of Alligator Creek in Sarasota County. This project naturalizes a channelized trapezoidal canal into a more meandering, natural stream. The project stabilizes banks to minimize erosion and features many hydrologic restoration co-benefits, including improved water quality and climate resilience, invasive exotic plant removal, improved fisheries habitat for red drum, striped mullet, snook, and other species, and enhanced recreational opportunities. The lower reaches of the creek are designated Outstanding Florida Waters and include a portion of the Lemon Bay Aquatic Preserve.
- South Lee County Watershed and Corkscrew Watershed Initiatives are ongoing regional multi-partner efforts to restore more natural water flows, improve water quality and environmental conditions, and increase natural water storing while moderating flooding events in the South Lee County / Corkscrew. The watershed includes the Estero River, Spring Creek, and Imperial River that flow into the Estero Bay Aquatic Preserve in Lee County, as well into the Cocohatchee Canal that flows out through the

Cocohatchee River to Wiggins Pass in Collier County.

Due to the large scale, complexity, and cost of ongoing projects, most are multi-partner, multi-phase, and multi-year and will continue for years. The CHNEP Management Conference supports effective coordination between the local, state, and federal government permitting and capital programs affecting hydrologic flow, water storage, flood control, and water quality. CHNEP encourages incorporation of co-benefits of water quality improvement into hydrologic restoration design whenever feasible. Priority should be given to implementing additional hydrologic protection and restoration projects, especially for basins that include or flow to Outstanding Florida Waters.

SWFWMD completed replacement of Structure P-11 at the outfall from Lake Hancock in 2013. The new structure increases storage in the lake to provide increased flow downstream to the Peace River in the dry season | *SWFWMD.*

Climate Change

Climate-related impacts to natural hydrology from rising seas, increasing air and water temperatures, and changing precipitation and storm patterns may reduce capacity for natural systems to uptake excess nutrients, regulate water flows, and support native vegetation, birds, fish, and other wildlife (CHNEP 2018a). Wetland locations, quality, and types may be affected by changes in precipitation patterns and water availability because of increased evapotranspiration and increased water demand with higher temperatures (FWC 2016). Changes to wetlands will in turn affect freshwater flows and watershed boundaries. Potential effects of climate change on hydrology, like seasonal shifts in flow, flashiness from increased storm intensity, saltwater intrusion, and shifting isohaline zones may make restoration of historical flowways and watershed boundaries difficult, and in some areas unattainable (Twilley 2001). Nevertheless, reestablishing landscape-scale flowways and protecting tidal tributary isohaline zones is a management priority. Ongoing and future comprehensive watershed restoration planning and project design should consider projected climate change impacts on water availability and flow regimes. For example, hydrologic models can simulate alternate future climate change scenarios (see Hydrologic Restoration Action 1) to be used in future hydrological restoration planning.

STATUS:

Ongoing.

RELATED ACTIONS:

- Hydrologic Restoration Action 1: Conduct data collection, modeling, and analyses to support hydrologic restoration
- Hydrologic Restoration Action 2: Increase fresh surface water and groundwater availability to support healthy natural systems
- Water Quality Improvement Action 3: Reduce urban stormwater and agricultural runoff pollution

STRATEGY:

Activity 3.1: Support integrated and coordinated watershed management planning to protect headwaters, restore and reduce channelization and barriers to fish and wildlife passage in flowways, restore floodplains and increase connectivity, and reestablish historical flow direction, volume, and timing to receiving waters. Incorporate a resilient systems approach that integrates nature-based solutions and improvements to critical infrastructure to increase resiliency of hydrologic systems to future climate stressors.

Location: CHNEP area.
Responsible parties: FDEP (State of Florida regulatory lead), EPA (federal regulatory lead), SWFWMD and SFWMD (implementation facilitators), USACE, County and Municipal Governments, FDACS, CHNEP, private sector.
Timeframe: Ongoing; Climate Change Vulnerability Analysis adopted in 2018.

Potential annual cost and funding sources: $1M–10M/FDEP, SWFWMD, SFWMD, USACE, USDI, USDA, Section 320 Funds, County and Municipal Governments.
Benefits: Integrated watershed management plan components that are coordinated across agency, local government, and private sector activities and lead to more comprehensive hydrologic watershed protection and restoration in support of natural systems.
5-year Performance measure: Increased number of completed plans with hydrologic restoration projects that are ready for implementation.

Activity 3.2: Support implementation of projects to reestablish and protect wetlands and hydrologic watersheds and other projects to build or remediate flowways, barriers, and water storage that mimic and restore natural flow conditions necessary to support healthy ecosystem function and account for anticipated climate change stressors. Support projects that maintain limited connections between upstream coastal ponds and estuaries to ensure appropriate delivery of freshwater flows and seasonally limited connections appropriate for fish habitats.

Location: CHNEP area.
Responsible parties: CHNEP (implementation facilitator), FDEP, County and Municipal Governments, SWFWMD, SFWMD, USACE, FWC, USFWS, USDI (NPS and other USDI), USDA, FDOT, NGOs, FDACS, Private sector.
Timeframe: Ongoing; Climate Change Vulnerability Analysis adopted in 2018; Habitat Restoration Needs Plan Phase I and II adopted in 2019 and 2021.
Potential annual cost and funding sources: $500,000–10M/Section 319 Funds, USACE, FWC, USFWS, USDI (NPS and other USDI), USDA, FDOT, NGOs, County and Municipal Governments, SWFWMD, SFWMD, RESTORE Act, FDACS, Grants.
Benefits: Improved natural hydrologic flow and watershed boundaries for surface waterbodies, especially Outstanding Florida Waters.
5-year Performance measure: Increased acres or linear miles of hydrologically restored or reconnected habitat that maintain or improve water quality and flood protection.

Activity 3.3: Develop and support implementation of vulnerability assessment recommendations to protect water quality and hydrology. Participate in regional collaborations to address vulnerabilities identified in vulnerability assessments and increase resiliency.

Location: CHNEP area.
Responsible parties: CHNEP (implementation facilitator), FDEP, County and Municipal Governments, Regional Planning Councils, SWFWMD, SFWMD, USACE, FWC, USFWS, USDI (NPS and other USDI), USDA, FDOT, NGOs, FDACS,

Private sector.
Timeframe: Ongoing.
Potential annual cost and funding sources: $1M–10M/Section 319 Funds, USACE, FWC, USFWS, USDI (NPS and other USDI), USDA, FDOT, NGOs, County and Municipal Governments, SWFWMD, SFWMD, FDACS, Grants.
Benefits: Improved protection and resiliency of natural hydrology.
5-year Performance measure: Implementation of projects and measures to further implementation of vulnerability assessment recommendations to protect water quality and hydrology.

FISH, WILDLIFE & HABITAT PROTECTION ACTION PLAN

VISION: A diverse environment of interconnected, healthy habitats that support natural processes and viable, resilient native plant and animal communities.
GOAL: Natural habitat protection and restoration.
OBJECTIVE: Permanently acquire, connect, protect, monitor, restore, and manage natural terrestrial and aquatic habitats.
STRATEGY: Promote and facilitate permanent acquisition and effective protection and management of critical natural habitats including wildlife dispersal areas, movement and habitat migration corridors, wetlands, flowways, and environmentally sensitive lands and estuarine habitats.

ACTION 1: Protect, monitor, and restore estuarine habitats
ACTION 2: Protect, monitor, and restore environmentally sensitive lands and waterways including critical habitat areas
ACTION 3: Assess and promote the benefits of land, waterway, and estuary protection and restoration

The CHNEP area is renowned for its spectacular birds, fish, and other wildlife. The rich diversity and abundance of these species requires a diverse environment of interconnected habitats that support natural processes and viable, resilient native plant and animal communities—including lakes, creeks, rivers, swamps, marshes, bays, and uplands. Since the 1950s, many of these habitats have become fragmented, degraded, or lost due to human activities related to urban development, agriculture, transportation, and mining. These anthropogenic (manmade) impacts are further exacerbated by climate stressors. In recent decades, more upland forest habitat and salt marsh have been lost (Table 10).

Table 10. Habitat losses and gains within the CHNEP area as of 2019 | *SFWMD, SWFWMD.*

Habitat	Land Cover Codes	Total 1999	Total 2019	Acreage (Loss)/Gain	% Change
Upland Scrub and Prairie	3100, 3200, 3300	331,563	207,370	(124,193)	-37%
Upland Forest	4100, 4200, 4300	374,366	276,255	(98,111)	-26%
Wetland Forested	6100, 6200, 6300	296,057	288,724	(7,333)	-2.5%
Wetland Non-forested	6400	247,761	297,658	49,897	20%
Mangrove	6120	59,461	61,656	2,196	3.7%
Saltmarsh	6420	12,359	12,311	(48)	-0.4%

Preserving the diversity of birds, fish, and other wildlife requires protection and restoration of priority habitats and natural corridors that connect them. This is especially true for managing threatened and endangered species. Adaptive management must consider how habitats may change in the future to meet both current and future needs. CHNEP's Habitat Restoration Needs Plan (HRN) (CHENP 2019b, 2020) is informed by the Habitat Resiliency to Climate

Change Project (HRCC) (CHNEP 2019c), which was completed in 2019 using in-depth spatial analysis to examine the projected effects of sea level rise on future habitat conditions. The HRCC Project aimed to understand existing and future habitat connectivity to provide informed resiliency solutions, such as proposed habitat migration corridors.

Priority habitats in the CHNEP area include:

- Seagrass meadows and other submerged aquatic vegetation
- Submerged and intertidal non-vegetated bottom
- Emergent tidal wetlands including mangrove forests and salt marshes
- Clam beds and oyster reefs
- Tidal tributaries and rivers
- Freshwater wetlands
- Native uplands and scrub

Seagrass Meadows and Other Submerged Aquatic Vegetation

Submerged aquatic vegetation includes marine and estuarine vascular plants, like seagrasses and macroalgae, as well as freshwater vascular plants. Seagrasses are underwater flowering plants that live in shallow marine and estuarine environments. Six species of seagrass are found in the CHNEP area; each has different ecological attributes and requirements (Figure 21). Turtle grass (*Thalassia testudinum*), shoal grass (*Halodule wrightii*), manatee grass (*Syringodium filiforme*), and tape grass or eel grass (*Vallisneria americana*) are the most common, while widgeon grass (*Ruppia maritima*), paddle grass (*Halophila decipiens*), and star grass (*Halophila engelmannii*) are ephemeral. Some types of macroalgae, such as *Caulaerpa spp.* and *Sargassum*, can provide many benefits to the estuary, such as providing oxygen, food, and shelter for marine animals.

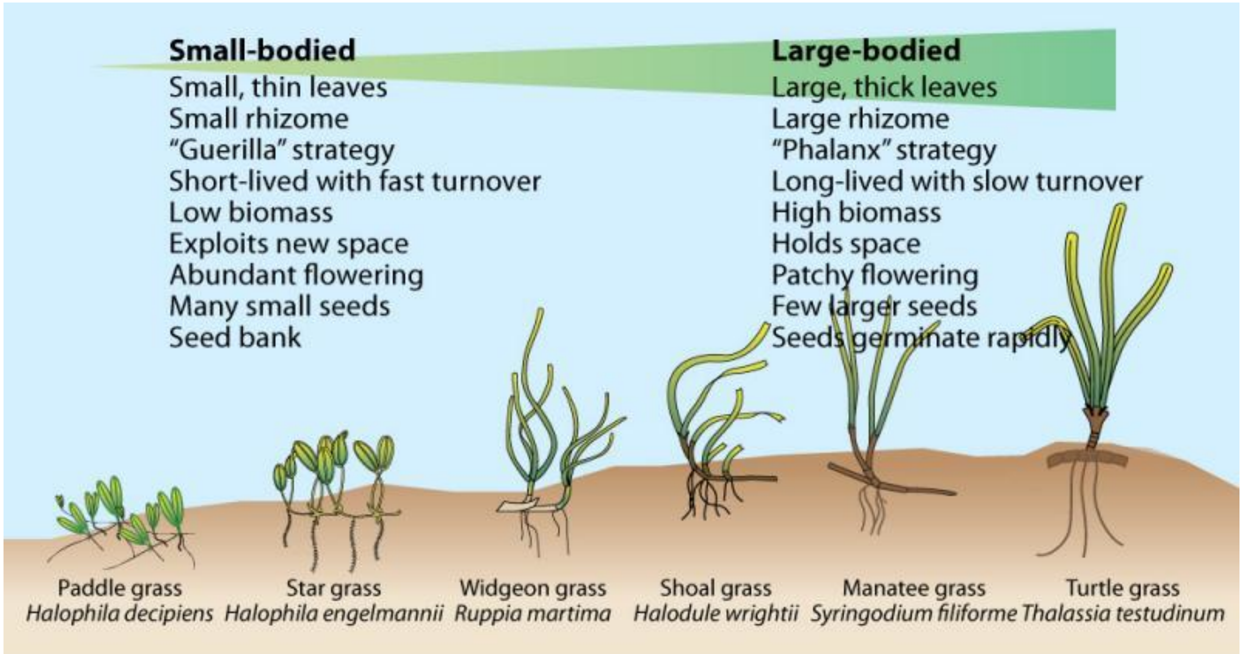


Figure 21. Morphology of seagrasses of Southwest Florida | *Integration and Application Network (ian.umces.edu) University of Maryland Center for Environmental Science.*

Shoal grass is a narrow-bladed seagrass found in dynamic areas like river mouths, where salinity and light fluctuate, in shallow waters exposed during extreme low tides, and in deep light-limited waters. It has a relatively rapid growth rate, is usually first to colonize disturbed areas, and tends to hold most of its biomass in its leaves. Turtle grass is a wide-bladed species found in estuarine areas where salinity and light are more stable. Manatee grass is commonly found in areas with higher salinity and can tolerate relatively low levels of light. Both turtle grass and manatee grass tend to grow more slowly than shoal grass and hold most of their biomass in their roots. Tape grass (or eel grass) is a freshwater species that can tolerate salt. Tape grass leaves can be an inch wide and several feet long.

Seagrasses are considered "keystone" species because of the important habitat-creating role they play in the estuary (Dawes et al. 2004). Seagrasses stabilize sediments, filter nutrient pollution, reduce wave action and coastal erosion, and serve as an important food source for many aquatic organisms. They also store carbon, and in some areas, may buffer waters from ocean acidification (Figure 22). About 80 percent of commercially and recreationally important fish and shellfish utilize seagrass habitat during their life cycle (Dawes et al. 2004). Some fish, like spotted seatrout (*Cynoscion nebulosus*), spend their entire life in seagrass meadows.

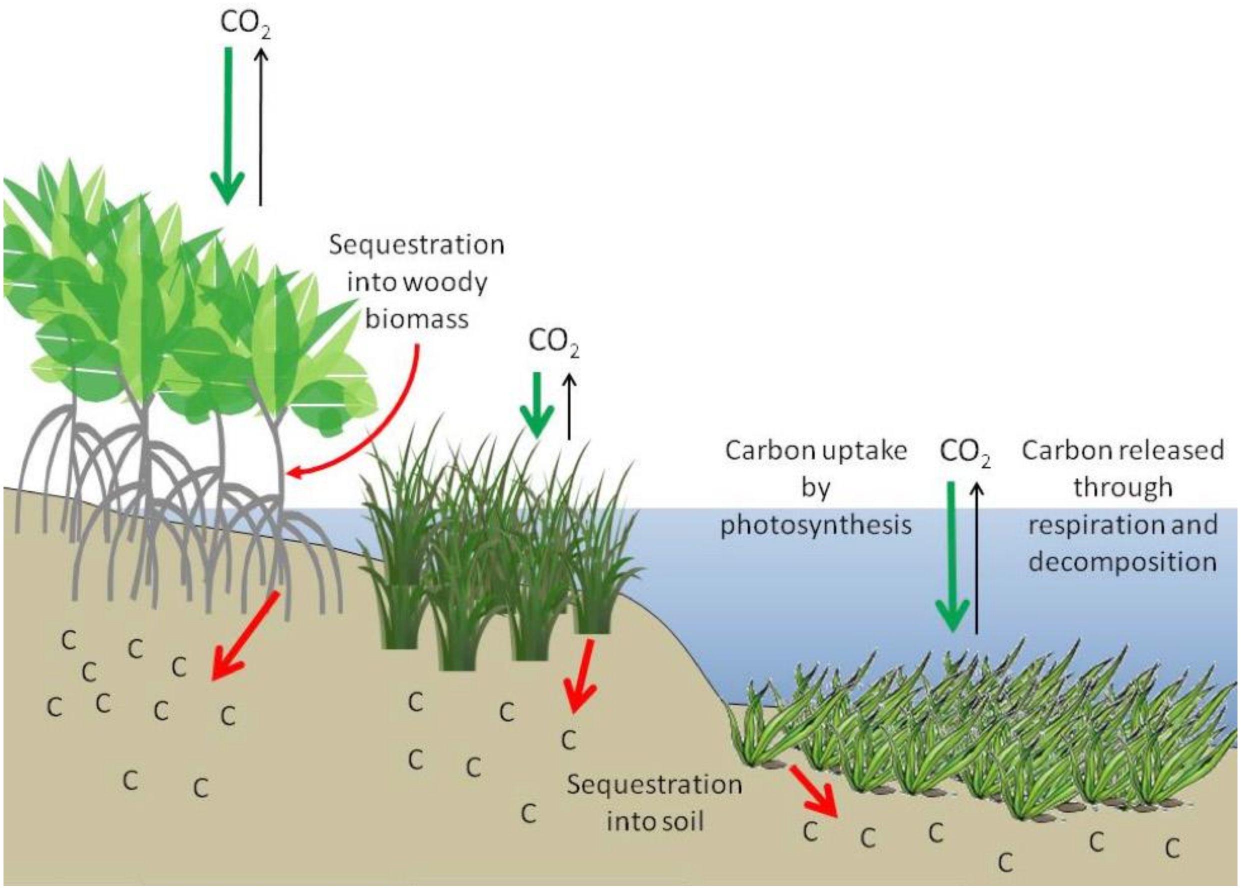


Figure 22. Mangroves, marshes, and seagrasses take up carbon dioxide from the air and water through photosynthesis and store it as “blue carbon” in plant biomass and wet soils | *Howard et al. 2017.*

Seagrass distribution and abundance varies by season and by year, but is generally dependent on water clarity, salinity, temperature, and rainfall. Seagrasses generally grow in waters less than six feet deep, but in the clear waters around Boca Grande Pass they can be found in waters 8–10 feet deep.

Reduced water clarity from sedimentation, nutrient pollution, color changes, and excessive algal growth threatens seagrass. Algal growth is related to nitrogen concentrations, making it a nutrient of primary concern for seagrass management (see Water Quality Improvement Action Plan). Seagrasses require adequate water clarity because they require sunlight for photosynthesis. As a result, they can serve as an important biological indicator of water quality and bay health. Seagrass-based water quality targets were developed throughout the Charlotte Harbor region based on seagrass light requirements, water depth at the deep edge of seagrass beds, and the historical acreage of seagrass (see Water Quality Improvement Action 2).

Storms can increase suspended sediments and sedimentation, decrease salinity favorable for seagrass, or uproot grasses. The increased stormwater runoff can also carry pollutants, including in large storm events, partially or untreated sewage. For example, seagrass in San Carlos Bay is stressed by large unnatural freshwater discharges from the Caloosahatchee River (Orlando et al. 2013). In the CHNEP area, climate change is expected to intensify storms during the summer and prolong periods of drought in the winter (CHNEP 2018a), potentially changing salinity regimes favorable for seagrass growth. Furthermore, rising sea levels may increase bottom depths beyond where adequate sunlight can reach existing seagrass meadows. Similarly, dredging can bury seagrasses, block sunlight with suspended sediments, and increase bottom depths beyond the reach of adequate sunlight to support seagrasses.

Loss of seagrass by boat propeller scarring is a significant issue. Seagrass beds in Pine Island Sound and Matlacha Pass in Lee County have experienced the most damage (Madley et al. 2004). Docks and boats can shade seagrass, reducing or eliminating sunlight. Increased boating activity due to growing population numbers and tourism is a growing challenge.

After major seagrass losses in the late-20th century due to development, dredging, and water pollution, seagrass coverage throughout the CHNEP area improved. However, in 2018, seagrass began to significantly decline after impacts from Hurricane Irma were followed by a major red tide event and then a macroalgae bloom. The combination of decaying seagrass and dead fish resulted in a significant and acute pulse of ammonium to Charlotte Harbor, which then triggered a major macroalgae bloom. In 2014, seagrass acreage across the Charlotte Harbor region from Lemon Bay to Estero Bay was about 71,000 acres, and by 2022, seagrass acreage dropped to less than 61,000 acres (Table 11). Seagrass coverage across Charlotte Harbor, Lemon Bay, Dona and Roberts Bays, Matlacha Pass and Estero Bay is below historical estimates of seagrass from the 1950s (68,000 acres). Acreage of the freshwater tape grass (*Vallisneria americana*) in the Caloosahatchee River has declined. Over two thousand acres of freshwater tape grass in the upper Caloosahatchee Estuary have been lost since 2001. Management activities to maintain and enhance seagrass coverage in the CHNEP area are detailed in Fish, Wildlife, and Habitat Restoration Action 1.

Table 11. Seagrass coverage by sampling area in the Charlotte Harbor region in 2014, 2018 and 2021/2022 compared to seagrass management targets | *CHNEP.*

Sampling Area	2014 (acres)	2018 (acres)	2021/2022 (acres)	Target (acres)
Dona and Roberts Bays	103	120	34	112
Lemon Bay	4,203	3,763	3,108	3,891
Tidal Myakka River	399	378	171	456
Tidal Peace River	652	654	278	975
Gasparilla Sound-Cape Haze	6,953	7,105	5,993	6,998
Charlotte Harbor	10,101	9,833	7,105	9,346
Pine Island Sound-Matlacha Pass	37,282	no data	35,088	36,152

San Carlos Bay	7,166	no data	6,102	4,372
Tidal Caloosahatchee River	475	no data	142	93
Estero Bay	3,666	no data	2,826	3,662
TOTAL	71,000		60,803	66,057

Bivalves: Oysters, Clams, and Scallops

Bivalves are important components of Southwest Florida coastal ecosystems and provide multiple nature-based benefits for stabilizing shorelines, reducing erosion, filtering particulates and nutrients from water, sequestering carbon, and providing habitat and food to invertebrates, fish, and birds. Climate stressors are expected to exacerbate the effects of other ongoing stressors to bivalve health and production. For example, increasing ocean acidification resulting from rising atmospheric carbon dioxide concentrations will negatively affect formation of bivalve shells. More research is needed on the progression of acidification in CHNEP coastal waters and its likely impacts on bivalve species and the communities that rely on them for harvest (Hall et al. 2024).

Oysters (*Crassostrea virginica*) provide many valuable economic and ecosystem services. They are designated Essential Fish Habitat and are protected under state and federal regulations, including the Magnuson-Stevens Fishery Conservation and Management Act. Oyster reefs form by the cumulative buildup of successive generations of oyster shells, predominately in shallow estuarine areas near creek and river mouths. They also grow readily on mangroves, seawalls, and other natural and artificial hard structures.

Optimal hydrologic conditions are important for sustainable oyster populations. They require sufficient water flow to bring oxygen and food and carry away wastes, but too much flow can flush larvae away from suitable settlement habitat. In Southwest Florida, the optimal salinity range for oysters is 14–28 practical salinity units (PSU), though they can live in salinities ranging from 5–40 PSU (GSMFC 2012). Adult oysters can survive in low salinity waters (e.g., 2 PSU) only up to a month. In addition to suboptimal freshwater flow, threats to oyster reefs include altered shorelines and development, poor water quality, sedimentation, disease, dredging, and overfishing. Ocean acidification, sea level rise, more intense rainfall events, prolonged droughts, and altered flowways arising from coastal morphology changes will affect salinity levels and impact growth and survival of oysters (Tolley et al. 2010).

Oyster reefs have been a dominant feature in the Charlotte Harbor region for at least the past 470 years (Savarese et al. 2004). Prior to European colonization of Southwest Florida, Native Americans utilized oysters as a food source and large mounds of discarded oyster shells remain today throughout the area. Reports from the late 1800s indicate oyster reefs were extensive, but already degraded. By the early 1970s, over 11,000 acres of oysters were impacted by development of Port Charlotte, Punta Gorda, Cape Coral, Fort Myers, and Sanibel and large areas were closed to harvest due to pollution (Taylor 1974).

The earliest quantitative estimate of historical oyster habitat comes from 1950s aerial photographs. Interpretation of these early surveys is limited due to lack of ground-truthing, low-resolution imagery, uncertainty of the depth to which oysters were detected, and the inability to estimate abundance of oysters associated with mangroves or small reefs (Boswell et al. 2012). With these caveats in mind, a comparison of oyster acreage from the 1950s to 1999 shows a 2,450 acre—or 90% loss in the Charlotte Harbor watershed (Avineon 2004). These limited studies, together with anecdotal information, suggest that thousands of acres of oysters have been lost in the CHNEP area (Boswell et al. 2012).

Clams inhabit mostly sandy coastal habitats, often associated with seagrass and sometimes oyster reefs. As filter feeders, they require adequate water circulation to deliver food and oxygen and remove waste products. Clams provide multiple ecosystem services (Baker et al. 2015). They remove nutrients from the water as well as phytoplankton and other particulates, improving water clarity for seagrasses. They also stabilize sediments and store carbon in their shells, which can be removed from the system through harvesting.

Hard clams *(Mercenaria spp.)* have been harvested from Charlotte Harbor since at least 300–500 AD (Thompson et al. 2016). Multiple stressors, including hydrologic changes, habitat loss, overharvesting, sedimentation, and disease have contributed to declining abundances in CHNEP waters. In the more recent past, oysters, hardshell clams (*Mercenaria spp.*), and bay scallops (*Argopecten irradians*) were harvested commercially and recreationally throughout Lemon Bay, Gasparilla Sound, Charlotte Harbor Proper, and Pine Island Sound. The heyday of the bivalve industry in the Charlotte Harbor area occurred during the 1940s. Since then, commercial harvest of shellfish has been declining with the disappearance of the scallop fishery in Pine Island Sound by the early 1960s.

Marine bivalve aquaculture in the Charlotte Harbor region is based primarily on hardshell clams. The southern hard clam *(Mercenaria campechiensis)* is indigenous while the northern hard clam *(Mercenaria mercenaria)* was likely introduced for aquaculture. UF/IFAS has created a Florida Clam Farm Benefits Calculator that can be used as a starting point for understanding the environmental benefits farms provide to coastal waters. Florida Department of Agriculture and Consumer Services (FDACS) designates Aquaculture Use Zones and processes applications for existing vacant parcels or for proposed new locations. In 2023, FDACs published the Aquaculture Best Management Practices (BMPs) Manual, which details aquaculture BMPs necessary to protect water and habitat quality (FDACS 2023).

Bivalves are a reliable bioindicator of the environmental health of an estuary. As filter feeders, bivalves assimilate and concentrate materials carried in the water. They require proper salinity, oxygen, and nutrients to grow, as well as good water quality to be safe to eat. In water free from bacteria, red tide, and other pollutants, bivalves can generally be safely eaten throughout the year (Figure 23). In areas affected seasonally by red tide or nearby urban areas, they may not be safe to eat (see Water Quality Improvement Action 5). Monitoring the status and trends of bivalves in CHNEP waters can provide invaluable insights into ecosystem integrity, function, and services and inform more holistic management approaches to improving resilience of coastal systems. Management activities to improve oyster and clam populations in the CHNEP area are detailed in Fish, Wildlife, and Habitat Protection Action 1.

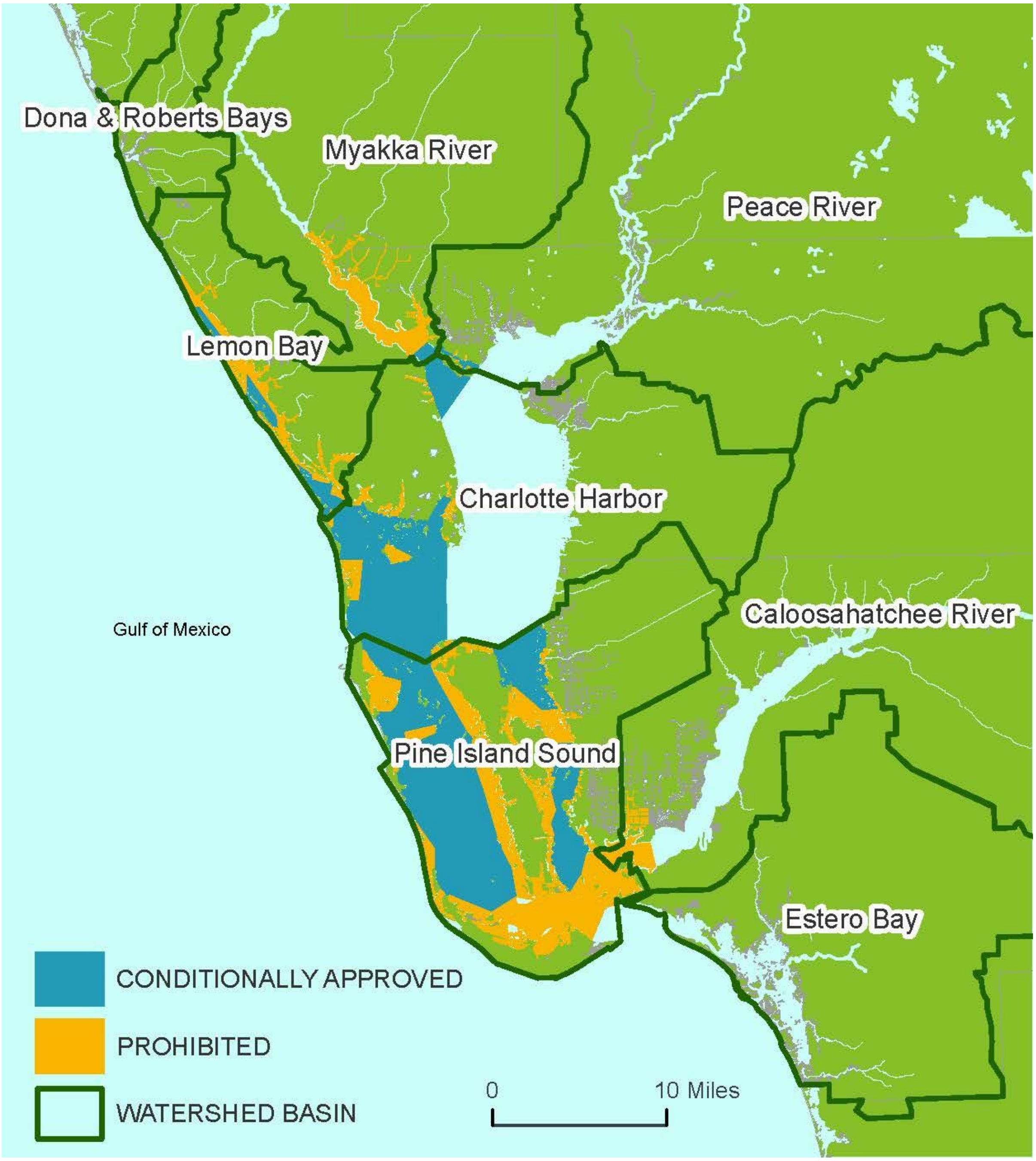


Figure 23. Many areas of the Charlotte Harbor region are conditionally approved for shellfish harvest by the Florida Department of Agriculture and Consumer Services, though are subject to temporary closures when water quality conditions are not met. Some areas close to shore are permanently prohibited | *FDACS 2024.*

Mangrove Forests and Salt Marshes

Coastal wetlands are extremely productive ecosystems made up of mangrove forests and salt marshes. They provide essential habitats for various species of fish, crustaceans, and coastal birds, stabilize shorelines, and filter pollutants from runoff. Salt marshes occur in low-energy intertidal zones and are dominated by specially-adapted salt-tolerant plants, such as black needle rush (*Juncus roemerianus*) and cordgrasses (*Spartina spp.*). Although almost 74% of remaining salt marsh habitat is protected in the CHNEP area, it remains threatened by impacts from development including altered hydrology, pollution, and by sea level rise where upland habitat migration is blocked (Stewart and Radabaugh 2024).

Mangrove forests are common in Southwest Florida and form a broad margin around their estuaries (Beever et al. 2016). They cover more than 60,000 acres in the CHNEP area and can extend inland several miles from open water. Mangrove forests are characterized by six geomorphic types, including overwash island, fringe, riverine, basin, hammock, and scrub. Southwest Florida mangrove species include red (*Rhizophora mangle*), black (*Avicennia germinans*), and white (*Laguncularia racemosa*) mangroves and the mangrove-like buttonwood (*Conocarpus erectus*). Mangroves perform vital, irreplaceable roles in providing food for species such as striped mullet (*Mugil cephalus*) and pink shrimp (*Farfantepenaeus duorarum*), habitat for birds and wildlife, and buffer inland areas from storm surges. Mangrove systems have the highest annual productivity of any system measured in the world and are critical to the world's carbon balance because they can store large amounts of carbon in the living and decomposing litter and soils that accumulate around their roots.

Natural threats to mangroves include high winds from tropical storms, lightning strikes, wave erosion, freezing, root and leaf predation, guano burial, and sea level rise. Hurricane Ian caused immediate widespread losses, but mangrove mortality continued to accrue even 10 months after the storm due to storm surge deposit and altered hydrology smothering or drowning the trees (Stewart and Radabaugh 2024). Human-related threats include coastal hardening, insufficient culverting and elimination of tidal creek circulation, development and road construction, direct fill with spoil or channelization for mosquito-control ditches, dredging, pollution, and excessive trimming (Beever et al. 2016). The high cost of these impacts to mangrove habitat is ultimately paid by taxpayers in terms of flood damage, shoreline erosion, water quality corrections, and other lost ecosystem services.

Sea level rise further stresses coastal wetlands like mangrove forests and salt marsh. Coastal wetlands are vulnerable to erosion, inundation, and drowning if the rate of natural soil accumulation cannot keep pace with sea level rise. Artificial structures such as roads, sea walls, and other flood protection structures can impede natural upland migration of coastal wetlands and result in habitat loss as sea level rises (Twilley 2007).

Management activities to maintain and enhance mangroves and other saltwater wetland habitats in the CHNEP area are detailed in Fish, Wildlife, and Habitat Protection Action 1.

Tidal Creeks

Tidal Creeks are “manmade or natural water conveyance channels with fluctuations in salinity caused by exchange of fresh and estuarine waters” (Janicki and Mote 2016). They support fisheries production, nutrient cycling, wading bird foraging, water retention, and flood prevention. A collaborative study of all three Florida Gulf Coast National Estuary Programs (Tampa Bay, Sarasota Bay, and Coastal & Heartland) identified a total of 306 creeks in Lee, Charlotte, Sarasota, Manatee, Hillsborough, and Pinellas counties (Figure 24). In a representative subset of these creeks, researchers found that creek segments with low dissolved oxygen and high chlorophyll levels can still support high densities of juvenile fishes and baitfish (Janicki and Mote 2016). Large differences among creeks suggested that no single optimum water quality criterion may be appropriate for setting nutrient targets and thresholds to maintain ecological health for all creeks (see Water Quality Improvement Action 2). Instead, the study provided differing thresholds for tidal creeks in the CHNEP area, suggesting that the status of juvenile fishes utilizing the creeks is also a reliable indicator of ecological health.

Threats to tidal creeks include dredging and draining, shoreline hardening for development, road construction, channelization for flood control, manmade barriers to prevent salinity intrusion upstream, nutrient pollution, bacterial pollution, and sedimentation. Climate change stressors including warming air and water temperatures, increased intensities of rainfall and storms, prolonged winter droughts, and rising sea levels will further magnify stresses to these systems. For example, rising sea levels or reduced flow due to extended drought will shift tidally influenced portions of creeks and rivers upstream—lengthening the upstream reach of stratified estuarine conditions and compressing the upper isohaline zones. Isohaline zones create important refuge habitat for plankton, macroinvertebrates, and fishes (Jassby et al. 1995). Management activities to maintain and enhance tidal creeks and associated habitats and fisheries in the CHNEP area are detailed in Fish, Wildlife, and Habitat Protection Action 1.

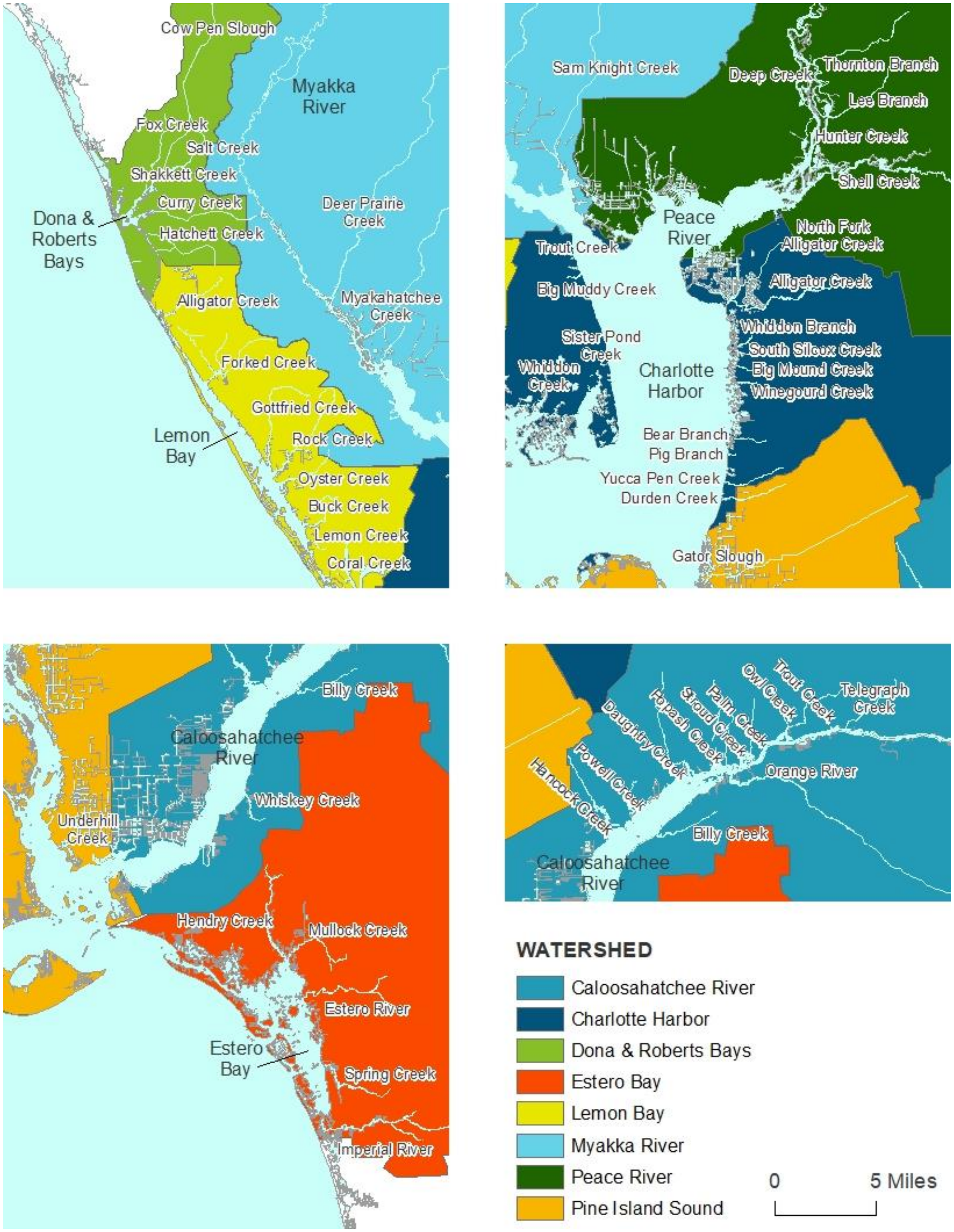


Figure 24. (left and right). More than 55 tidal creeks drain into the coastal bays and estuaries of the CHNEP area from Venice to Bonita Springs. Tidal creeks support fisheries production, nutrient cycling, wading bird foraging, water retention, and flood prevention.

Freshwater Wetlands

Freshwater wetlands are highly productive ecosystems that are either permanently or seasonally inundated with water. They include ponds, sloughs, swamps, and marshes. They naturally occur where the water table is at or near the land surface, resulting in soils that are either permanently or seasonally saturated by water, with low or no oxygen. Wetland habitats provide important ecosystem services including water purification and nutrient cycling, water storage and flood control, groundwater recharge, shoreline stability, and carbon sequestration. They support a wide range of plant and animal life and are integral to naturally functioning ecosystems in Southwest Florida.

As of approximately a decade ago, the CHNEP area had already lost more than 43 percent of its original wetland habitat—mostly to agricultural drainage, mining, and urban development (CHNEP 2013). Land drained by connector ditches for farming accounts for the largest loss of freshwater wetlands. Prior to 1975, phosphate companies strip-mined land without always restoring wetlands, especially along tributaries of the Peace River in Polk County when mining was a leading economic force. Urban and rural development also damages and destroys wetlands. All impacts to or loss of wetlands go through a permitting process requiring mitigation; however, some wetland losses still occur where mitigation measures are unsuccessful (Beever et al. 2011). Climate stressors also threaten wetlands, including reduced rainfall during extended droughts and greater evaporation due to higher temperatures.

Coastal Strand

In Southwest Florida, little of the original coastal strand ecosystem remains. While residential and urban development converted most of the original coastal strand community, sections remain in the undeveloped barrier islands in Lee County, particularly Cayo Costa and the Stump Pass area of Charlotte County. This plant community consists of long, narrow bands of well-drained sandy soils affected by salt spray along Gulf and estuarine waters. Vegetation includes low-growing grasses, sea grape (*Coccoloba uvifera*), prickly pear cactus (*Opuntia humilis*), cabbage palm (*Sabal palmetto*), and live oak (*Quercus virginiana*). Coastal strands provide invaluable habitat to sea turtles, shorebirds, and amphibians.

Pine Flatwoods

Until the 1920s, the CHNEP area hosted large areas of pine flatwoods. One or more pine species grow on these nearly level lands, accompanied by understory wax myrtle (*Myrica cerifera*), and saw palmetto (*Serenoa repens*). Pines were intensively logged for a period extending through World War II until they were commercially exhausted. By 1987, pine flatwoods had been reduced significantly, with area coverage less than grasslands, cypress swamp, dry prairies, freshwater marsh, and urban areas. Throughout the CHNEP area, improved pasture, citrus, vegetable farms, and urban development have commonly replaced pine flatwoods. Displaced animal inhabitants include the pileated woodpecker (*Dryocopus* *pileatus*), American kestrel (*Falco sparverius*), sandhill crane (*Grus canadensis*), Florida black bear (*Ursus americanus floridanus*), Florida panther (*Puma concolor coryi*), Eastern indigo snake (*Drymarchon corais couperi*), and gopher tortoise (*Gopherus polyphemus*).

Oak Scrub and Scrubby Flatwoods

Within the CHNEP area, both oak scrub and scrubby flatwood ecosystems provide animal habitat similar to pine flatwoods. Various species of oak, as well as saw palmetto (*Serenoa repens*), Florida rosemary (*Ceratiola ericoides*), and fetterbush (Lyonia lucida) dominate oak scrub habitat. Groundcover is generally sparse and is dominated by grasses, herbs, and ground lichens. Occurring along coastal shorelines, ridges, tributaries, and rivers, it has been vulnerable to urban development.

The CHNEP area also includes scrubby flatwoods. Similar to sand pine scrub, the South Florida slash pine (*Pinus elliottii densa*) generally dominates this community. Typical understory consists of wiregrass (Aristida stricta) and herbs. Remaining stands of scrubby flatwood have been severely depleted by selective- or clear-cutting pines. Due to the flatwood's rapidly percolating soils and high elevations, citrus groves and residential development commonly displace this habitat. Scrubby flatwoods are the preferred habitat for the endemic Florida scrub jay (*Aphelocoma coerulescens*)—the only bird in Florida that occurs nowhere else in the world.

Species of Special Management Concern

Preserving the rich diversity of birds, fish, and other wildlife in the CHNEP area requires protection and restoration of priority habitats and natural corridors that connect them. Species of special management concern include invasive species, threatened or endangered species, and species of commercial and recreational value.

Invasive species

Invasive species can outcompete and displace native plants and animals and damage native habitats. Our vision for the CHNEP area is to stop new infestations and reduce current infestations to manageable levels, especially on publicly owned lands. A total of 67 exotic pest plant species have been identified in the CHNEP area. The Florida Exotic Pest Plant Council maintains a database of sightings and locations. Climate induced changes in physical habitat characteristics due to changes in temperature, pH, sea level, and precipitation may expand the range of invasive species and reorganize community interactions—shifting dominance of some species and causing local extinction of others.

A partial list of invasive plants and animals includes:

Australian pine (*Casuarina equisetifolia*) is a pine-like tree introduced a century ago for windbreaks and erosion-control along coastlines. It is toppled by strong winds, displaces coastal vegetation and associated native wildlife, and spreads easily.

Brazilian pepper (*Schinus terebinthifolius*) is a holly look-alike tree introduced to Manatee and Charlotte counties in the 1920s. It forms dense stands, displaces native plants and associated native wildlife, encroaches into wetlands, and is easily spread by wildlife.

Melaleuca (*Melaleuca quinquenervia*) is a fast-growing, white-barked tree introduced to Florida in 1906 for windbreaks and to drain wetlands. It forms dense thickets, displaces native plants and wildlife, and is progressively spreading northward.

Hydrilla (*Hydrilla verticillata*) is an aquatic plant that entered Tampa through the aquarium trade in the 1950s. It grows dense strands of whorled leaves that chokes water bodies, depletes oxygen, and displaces native plants and fish. Control efforts are making steady progress against this threat.

Water hyacinth (*Eichhornia crassipes*) is a large floating plant with dark green leaves and lavender flowers. It was introduced in the 1800s, slows water flow and boats, and depletes oxygen. Efforts are increasing to control it.

Cogongrass (*Imperata cylindrica*) is a grass introduced in 1911 for cattle forage and soil stabilization, though it was later found to be not good forage for cattle. In contrast, it has been very good at invading native habitats, agricultural forests, roadsides, altered phosphate mining lands, and pinelands—displacing entire communities of native species.

Invasive animal species are also present in the CHNEP area, including:

Cane toad (*Rhinella marinus*) is a large omnivorous toad that eats insects, vegetation, small birds, other toads or frogs, lizards, small mammals, and snakes. Their skin-gland secretions are highly toxic and can sicken or even kill animals that bite or feed on them. It was first introduced to Florida in the 1930s to control agricultural pests.

Cuban tree frog (*Osteopilus septentrionalis*) is widespread in wooded, wetland, and suburban habitats in southern Florida. It preys upon smaller native tree frogs and their noxious skin secretions make it unpalatable to many predaceous birds and snakes. They were accidentally introduced to Florida in the 1920s through shipping and packing materials.

Nile monitor lizard (*Varanus niloticus*) was first identified in Cape Coral and preys on native animals and small pets. Growing up to two meters in length, it was first introduced to Florida as an escaped or released pet.

Lionfishes (*Pterois volitans* and *Pterois miles*) are popular ornamental aquarium fishes that were probably released or discarded by hobbyists. They were first reported off Florida's

Atlantic Coast in 2002; by 2009 they had invaded the Gulf of Mexico. They are predatory reef fishes that compete with native fishes like grouper and snapper, and impact other native species that serve important ecological roles like keeping algae in check.

Feral hog (*Sus scrofa*) eats a variety of native plants and animals and causes significant environmental damage by "rooting" up soil and groundcover searching for food. It was likely introduced to Florida by Spanish slaver and conquistador Hernando DeSoto as early as 1539.

Threatened and endangered species

The CHNEP area supports more than 40 species listed as Threatened or Endangered by the United States Fish and Wildlife Service (USFWS) or listed as Threatened or Species of Special Concern by FWC (Table 12). In addition to habitat protection and restoration, management of these species requires assessment and monitoring, law enforcement, and education. Protecting and restoring priority habitats, including nesting and nursery areas, seasonal refuges, and critical corridors among habitats, is foundational to protecting threatened and endangered species (CHNEP 2019b).

In 2016, FWC adopted a new comprehensive Imperiled Species Management Plan (ISMP) which became effective January 2017 and was updated in 2022. The ISMP features species-specific Action Plans with targeted conservation goals, objectives, and actions. In addition, the ISMP describes integrated conservation strategies to benefit multiple species and their shared habitats. It lists 134 imperiled species in Florida, and more than half the listed reptiles and birds are found in the CHNEP area.

Table 12. Partial listing of Endangered, Threatened, and Species of Special Concern occurring in the CHNEP area. On this page and opposite | *FWC 2022.*

	Common Name	**Scientific Name**	**Status**
BIRDS	American oystercatcher	*Haematopus palliatus*	ST
	Audubon's crested caracara	*Polyborus plancus audubonii*	FT
	black skimmer	*Rynchops niger*	ST
	Everglades snail kite	*Rostrhamus sociabilis plumbeus*	FE
	Florida burrowing owl	*Athene cunicularia floridana*	ST
	Florida grasshopper sparrow	*Ammodramus savannarum floridanus*	FE
	Florida sandhill crane	*Grus canadensis pratensis*	ST
	Florida scrub jay	*Aphelocoma coerulescens*	FT
	least tern	*Sternula antillarum*	ST
	little blue heron	*Egretta caerulea*	ST
	piping plover	*Charadrius melodus*	FT
	red knot	*Calidris canutus rufa*	FT
	red-cockaded woodpecker	*Picoides borealis*	FE
	reddish egret	*Egretta rufescens*	ST

	roseate spoonbill	*Platalea ajaja*	ST
	snowy plover	*Charadrius nivosus*	ST
	Southeastern American kestrel	*Falco sparverius paulus*	ST
	tricolored heron	*Egretta tricolor*	ST
	wood stork	*Mycteria americana*	FT
MAMMALS	Big Cypress fox squirrel	*Sciurus niger avicennia*	ST
	Florida bonneted bat	*Eumops floridanus*	FE
	Florida panther	*Puma (=Felis) concolor coryi*	FE
	Homosassa shrew	*Sorex longirostris eionis*	SDL
	West Indian manatee	*Trichechus manatus*	FT
	Sanibel [Island] rice rat	*Oryzomys palustris sanibeli*	ST
REPTILES	American crocodile	*Crocodylus acutus*	FT
	bluetail mole skink	*Plestiodon egregius*	FT
	Eastern indigo snake	*Drymarchon couperi*	FT
	Florida pine snake	*Pituophis melanoleucus mugitus*	ST
	gopher tortoise	*Gopherus polyphemus*	ST
	green sea turtle	*Chelonia mydas*	FE
	hawksbill sea turtle	*Eretmochelys imbricata*	FE
	Kemp's ridley sea turtle	*Lepidochelys kempii*	FE
	leatherback sea turtle	*Dermochelys coriacea*	FE
	loggerhead sea turtle	*Caretta caretta*	FT
	sand skink	*Neoseps reynoldsi*	FT
	short-tailed snake	*Lampropeltis extenuata*	ST
FISH	Atlantic sturgeon (Gulf subspecies)	*Acipenser oxyrinchus (=oxyrhynchus) desotoi*	FE
	smalltooth sawfish	*Pristis pectinata*	FE

FT = Federally Listed Threatened
FE = Federally Listed Endangered
ST = State Listed Threatened
SSC = State Listed Species of Special Concern
SDL = State Delisted Species

Commercial and recreational fisheries

Charlotte Harbor is a nursery ground for important commercial and recreational marine and estuarine species. Up to 90 percent of commercial and 70 percent of recreational species caught in Florida spend all or part of their lives in estuaries.

The bountiful waters of the Charlotte Harbor watershed provide some of the best saltwater sportfishing in the world, including snook, tarpon, redfish, and spotted seatrout. Charlotte Harbor and surrounding areas derive substantial economic benefits from the maintenance of healthy fisheries. For example, in the four coastal counties surrounding the Charlotte Harbor region, active locally-licensed saltwater anglers numbered 67,936 in 2009–2010. Tarpon anglers alone spent $63 million in direct expenditures in 2010 with a total economic impact of $108 million (Fedler 2011). Recreational fishing in freshwater creeks, rivers, and lakes is a popular pastime in inland areas. Snook are caught as far upstream as Fort Meade. Freshwater fish such as largemouth bass (*Micropterus salmoides*), black crappie (*Pomoxis nigromaculatus*), and Florida gar (*Lepisosteus platyrhincus*) are also highly prized game fish throughout the CHNEP area.

Florida Fish and Wildlife Research Institute’s Fisheries-Independent Monitoring (FWRI-FIM) Program regularly samples fish throughout coastal waters of the Charlotte Harbor region and in estuaries around the State (Figure 25). The goal of the FWRI-FIM program (initiated in Charlotte Harbor in 1989) is to provide high quality fisheries data to managers regarding fish abundance and population trends. A variety of techniques and sampling gears (e.g., seine nets and otter trawls) are used by the FWRI-FIM program to ensure that the wide range of species, sizes, and ages necessary for stock management are sampled during each monthly survey. Analyses of FWRI-FIM program data are used by resource managers to assess abundance trends for resource species, define essential fish habitat, and describe life-history parameters such as age, growth, and age at maturity. It is important to support continued or expanded monitoring in CHNEP estuaries, as fish abundance and diversity are indicators of the health of water bodies, and robust data sets are needed to establish trends. FWRI-FIM program data is also frequently used to assess the impact of environmental perturbations such as red tides, extreme cold events, and oil spills.

Callout Box: Commercially and Recreationally Important Fishery Species in the CHNEP Area Include: striped mullet (*Mugil cephalus*), spotted seatrout (*Cynoscion nebulosus*), red drum (*Sciaenops ocellatus*), black drum (*Pogonias cromis*), kingfish (*Menticirrhus spp*), Gulf flounder (*Paralichthys albigutta*), blue crab (*Callinectes sapidus*), pink shrimp (*Farfantepenaeus duorarum*), stone crab (*Menippe mercenaria*), Southern hardshell clam (*Mercenaria campechiensis*), common snook (*Centropomus undecimalis*), tarpon (*Megalops atlanticus*), groupers (*Epinephelus spp* and *Mycteroperca spp*), black sea bass (*Centropristis striata*), snappers (*Lutjanus spp*), Florida pompano (*Trachinotus carolinus*), bluefish (*Pomatomus saltatrix*), sand seatrout (*Cynoscion arenarius*), Spanish and king mackerel (*Scomberomorus maculatus* and *S. cavalla*), sheepshead (*Archosargus probatocephalus*), and several species of sharks.

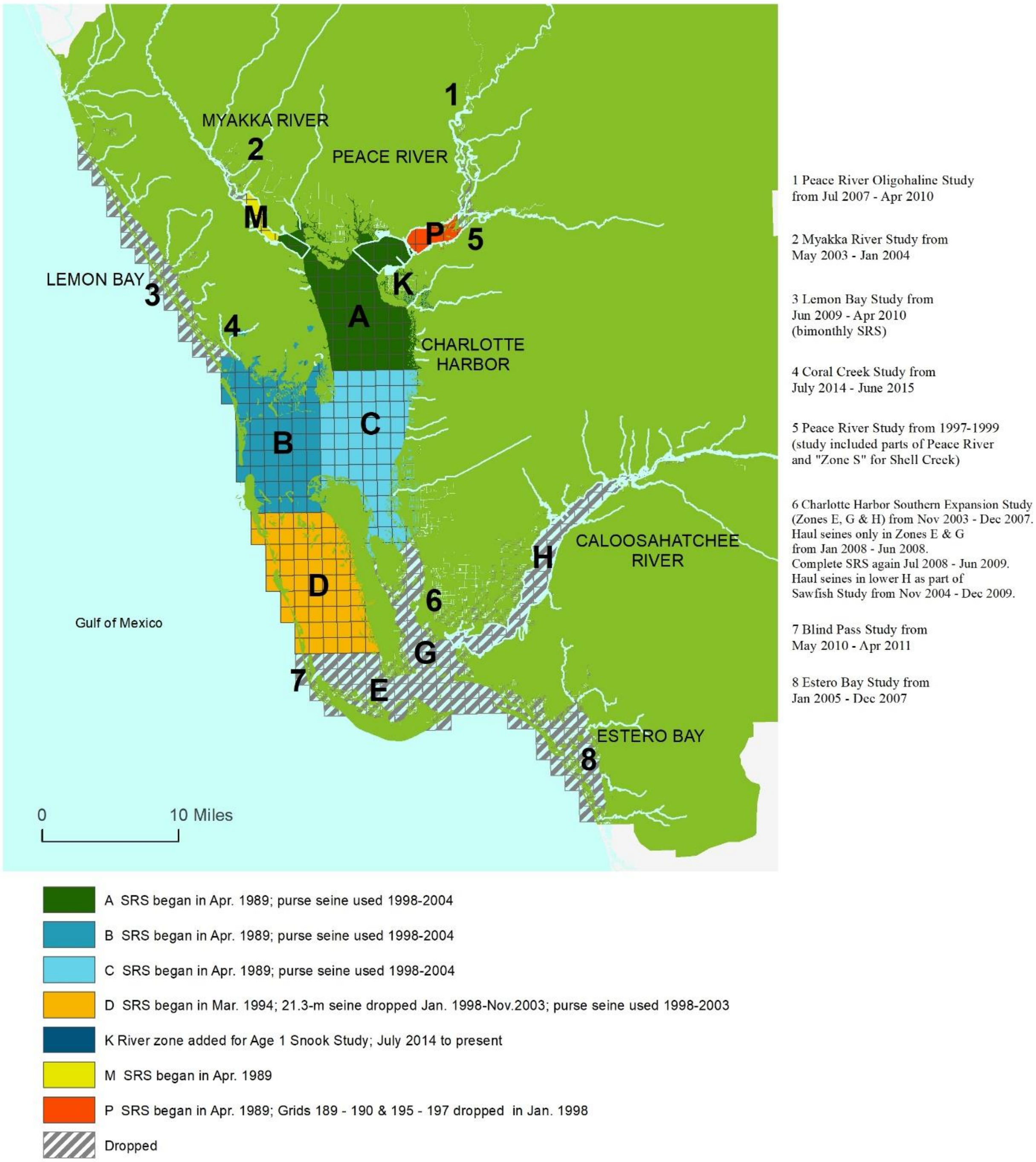


Figure 25. Map of the sampling universe and efforts for Florida Fish and Wildlife Conservation Commission's Fisheries-Independent Monitoring (FIM) program in the CHNEP area. Monthly stratified-random sampling (SRS) is occurring in Zones A–D. SRS in the Caloosahatchee River estuary (Zones G, E, and H) occurred during 2004-2007, in Estero Bay 2005–2007, and for one year in Lemon Bay during 2009–2010. A one-year sampling study was also conducted in Dona and Roberts Bays | *FWRI-FIM.*

Climate Change

Fish, wildlife, and habitat protection and restoration efforts must continue to prioritize climate change adaptation and long-term ecosystem resilience under changing conditions, as well as look at opportunities to conserve and restore corridors to enable habitat migration. Intensifying climate stressors such as increasing air and water temperatures, extreme rain and drought, sea level rise, and ocean acidification must be incorporated into restoration project prioritization, design, implementation, and maintenance. Sea level rise coupled with hardened shorelines can drive coastal wetland deterioration and loss, so conservation of upland migration corridors will be necessary for mangrove and salt marsh to migrate. Increasing seasonal high water temperatures are driving growth of macroalgae and cyanobacteria that can have a negative impact on aquatic habitats—particularly seagrasses. Ocean acidification will impact the production and long-term viability of shellfish communities. Climate change could complicate seagrass restoration efforts, even with concurrent water clarity improvements due to warming temperatures, changing salinities, and other factors. Invasive species are establishing new ranges and outcompeting natives, changing the species compositions and ecosystem services of key estuarine and watershed habitats (Osland et al. 2020). Strategies to sustain fisheries and wildlife populations through creating larger, connected, and healthy restored habitat areas are paramount in order to enhance their resiliency.

Bioindicators

In addition to traditional habitat analyses, CHNEP and partners use bioindicators to achieve a more holistic understanding of fish, wildlife, and habitats and to inform management priorities and actions. For example, healthy populations of Florida scrub-jays suggests that scrub habitat preserves have sufficient size and connectivity to other scrub habitats. Movements of larger animals like Florida panther and Florida black bear can inform where habitat and wildlife corridors need to be preserved. Benthic macroinvertebrates can indicate the health of a freshwater stream. High coverages of healthy seagrasses indicate water quality is adequate and inversely, loss of seagrass can indicate where water quality improvements are needed. Oysters can indicate that adequate freshwater flows are available, and sedimentation is within a tolerated range. Fish can indicate habitat connectivity, salinity, dissolved oxygen, and food availability. Dolphins can indicate availability of prey species. These are some of many examples of how bioindicators provide critical information needed to sustain healthy fisheries and wildlife populations.

Fish, Wildlife, and Habitat Protection Challenges and Management Actions

Protecting and restoring bird, fish, and other wildlife habitat, particularly critical areas and corridors, is essential to sustaining viable communities of plants and animals. Many estuarine waters in the CHNEP area are designated aquatic preserves and are considered public property to be managed for the public. While significant tracts of land within the CHNEP area are publicly owned, many areas of important terrestrial habitats exist on private property. Progress has been made in acquiring and protecting conservation lands, but challenges from development pressure and climate stressors remain. Cooperation among agencies at all levels of government, private land trusts, and landowners is essential. The best habitat management incorporates effective management of large contiguous public lands along with cooperative management on private lands.

The CHNEP Management Conference has identified three major Actions for Fish, Wildlife, and Habitat Protection: Action 1 calls for protecting and restoring estuarine habitats, including seagrasses and submerged aquatic vegetation, oysters, tidal creeks, and coastal wetlands; Action 2 aims to protect and restore environmentally sensitive lands and waterways, including critical upland and freshwater wetland habitat areas; and Action 3 focuses on promoting the benefits of land, waterway, and estuary protection and restoration.

Fish, Wildlife, and Habitat Protection Action 1: Protect, monitor, and restore estuarine habitats

OBJECTIVES:

Protect, restore, and monitor seagrasses, oyster reefs, and coastal wetlands; and research and promote best management practices for canals, tidal creeks, rivers, and dredged channels that support habitats and native aquatic life, including installation of living shorelines.

BACKGROUND:

Since the Charlotte Harbor region was designated as an Estuary of National Significance in 1995, CHNEP and its partners have made significant progress in protecting and restoring estuarine habitats. Maintaining these gains in the face of population growth, dramatic land-use changes, and climate change will be an ongoing challenge for generations to come.

Many estuarine waters in the CHNEP area are designated aquatic preserves, including Gasparilla-Charlotte Harbor, Cape Haze, Matlacha Pass, Pine Island Sound, Lemon Bay, and Estero Bay. The Florida Coastal Office of FDEP maintains management responsibility for these preserves.

Seagrasses and other Submerged Aquatic Vegetation

Seagrass Restoration Targets

Seagrass protection and restoration targets have been developed for 14 designated seagrass management segments in the CHNEP area. Because seagrass requires adequate water clarity to allow penetration of sunlight at depth, water clarity targets were developed as one among a suite of physical and chemical and biological indicators (Dixon and Wessel 2014). Bioindicators such as abundance and type of macroalgae, seagrass patchiness, and seagrass condition also help CHNEP and its partners to better understand and manage water quality and habitat factors to attain desired seagrass targets in each management segment. See Water Quality Improvement Action 2.

Seagrass Monitoring

Southwest Florida Water Management District (SWFWMD) and South Florida Water Management District (SFWMD) conduct regular aerial mapping of seagrass meadow locations and acreage throughout the CHNEP area. SWFWMD maps seagrass every two years in five waterbodies, including Lemon Bay, Cape Haze/Gasparilla Sound, Charlotte Harbor, and the Tidal Myakka and Peace Rivers. SFWMD maps seagrass every five years in six waterbodies, including Charlotte Harbor, Pine Island Sound, Matlacha Pass, San Carlos Bay, Estero Bay, and the Tidal Caloosahatchee River. Researchers identify and map continuous seagrass, patchy seagrass, unvegetated tidal flats, and oyster reefs using ground-truthing and photo-interpretation of aerial images. In the most recent surveys (2021/2022), seagrass coverage in the Charlotte Harbor region was less than 61,000 acres, about 10,000 acres less than 2014. Only two of fourteen sampling areas have seagrass coverage meeting their management targets (Table 11). Improved coordination of the mapping schedules of SWFWMD and SFWMD could allow for full coverage of CHNEP estuaries more often.

FDEP, Charlotte Harbor Aquatic Preserves (CHAP), and Estero Bay Aquatic Preserve (EBAP) conduct annual in-water seagrass monitoring along permanent transects extending from shore to the deepest edge of seagrass meadows. Aquatic Preserves staff and staff from other agencies, cities, and counties monitor ten waterbodies, including Lemon Bay, Cape Haze/Gasparilla Sound, Charlotte Harbor, Pine Island Sound, Matlacha Pass, San Carlos Bay, Estero Bay, and the Tidal Myakka, Peace, and Caloosahatchee Rivers. Species presence, abundance, blade length, shoot counts, epiphyte abundance, sediment type, and water depth are monitored. Sarasota County, Sanibel-Captiva Conservation Foundation, the South Florida Water Management District, and Florida Sea Grant's Eyes On Seagrass volunteer monitoring program also conduct in-water seagrass monitoring. CHNEP provides public access to these data through the CHNEP Water Atlas.

Partners should continue to monitor seagrass status and trends in spatial coverage in addition to seagrass protection and restoration targets (Yarbro and Carlson 2016). They should consider documenting seagrass quality in addition to quantity. For example, programs should evaluate trends in sparce versus continuous seagrass distribution as well as shifts in dominant seagrass species in priority areas. Seagrass trends should also be evaluated within the context of competing macroalgae trends (Water Quality Improvement Action Plan Action 5).

Seagrass Restoration

Projects to restore seagrass focus on improving water quality (see Water Quality Improvement Action Plan), stabilizing sediments, promoting natural recruitment, and directly planting seagrass. For example, the Caloosahatchee Citizen Seagrass Gardening Project, funded by a grant from NOAA and FDEP, restored populations of tape grass (*Vallisneria americana*) and widgeon grass (*Ruppia maritima*) in the tidal Caloosahatchee by establishing seed-source colonies protected from herbivores. Successful restoration protocols were documented for use in other areas. CHNEP also created a volunteer manual of standard operating procedures to assist in training citizens participating in the Seagrass Gardening Project (CHNEP 2018b).

Following these pilot studies in 2018, a 20-acre tape grass restoration was initiated in the Caloosahatchee estuary through a public/private/academic partnership funded by the Florida Legislature through FDEP. The Angler Action Foundation is administering the project with installation and enclosure cage maintenance support from Sea and Shoreline LLC. Biological monitoring support, including fisheries, macroinvertebrates, and submerged aquatic vegetation (SAV) is conducted by Ceilley Aquatic Science & Ecology LLC, in partnership with Florida Gulf Coast University's Water School. As of 2024, a renewed appropriation for $3.5 M was awarded; maintenance and monitoring of success across 60 acres are ongoing, with plans for expanding the restoration across another 40 acres (Brett Fitzgerald, pers. com.).

Ecosphere Restoration Institute is leading a $5 M state-wide seagrass restoration project funded in 2022 by the Florida Legislature through FDEP. Seagrass will be replanted in areas where they have been lost or severely impacted by red tides and other harmful algal blooms. The goal is to jump start recovery so that natural colonization can occur. Sites in Tampa Bay and Sarasota Bay will be the first to be planted.

Other Management Activities

CHNEP convened the Caloosahatchee River SAV Targets Working Group in 2013 to develop sound SAV targets for tidal and some oligohaline reaches of the Caloosahatchee River. CHNEP also participates in the Southwest Florida Seagrass Working Group and FWC Seagrass Integrated Monitoring and Mapping technical team. In addition, Charlotte Harbor and Estero Bay Aquatic Preserve staff have been documenting macroalgae since 1999 during annual fixed seagrass transect monitoring.

Bivalves: Oysters and Hard Clams

CHNEP's management goal for oysters and clams is to enhance and restore self-sustaining oyster and clam habitat and related ecosystem services throughout the CHNEP area. Management activities include research, mapping, and restoration.

Oysters

In 2012, the CHNEP Management Conference approved the Charlotte Harbor Oyster Habitat Restoration Plan, created by CHNEP, The Nature Conservancy (TNC), and the Southwest Florida Oyster Working Group, a diverse group of representatives from state and federal agencies, municipalities, non-profits, academia, and civic organizations. The Plan identifies oyster habitat restoration goals, methods, and partnerships using a technically-sound, consensus-based approach (Boswell et al. 2012). The Plan features a Restoration Suitability Model to map locations of suitable restoration areas based on five criteria: bathymetry, tidal river salinity isohalines, seagrass persistence, proximity to boat channels, and presence of aquaculture lease areas. The model identified over 40,000 acres of highly suitable areas for oyster restoration within the CHNEP area. The Plan set an oyster restoration target of 1,000–6,000 acres of oyster habitat based on the proportional extent of oyster coverage in suitable habitat areas of natural reference sites and the amount of suitable habitat areas in the CHNEP area.

To accomplish this target, the CHNEP Management Conference and its partners support the Oyster Habitat Restoration Plan's recommended actions to:

- Map oyster habitats by type within the CHNEP
- Design, implement, and monitor the success of pilot oyster restoration projects in a variety of habitats in 50% of CHNEP estuary segments

- Increase public awareness of the ecosystem value of native oyster habitats by including community stewardship components in each oyster restoration project
- Assist partners in seeking state, federal, and organizational funding opportunities to support oyster habitat restoration projects

The plan also provides guidance on permitting, success criteria, monitoring, funding opportunities, and incorporating community stewardship opportunities into restoration projects.

Examples of oyster mapping and monitoring in the CHNEP area include:

- Florida Gulf Coast University's Oyster Monitoring Network for the Caloosahatchee Estuary, funded by SFWMD, conducts oyster monitoring in the Caloosahatchee Estuary and Estero Bay (1999-present) in support of the Comprehensive Everglades Restoration Plan.
- Sarasota County has an oyster mapping program and has monitored oysters in Dona and Roberts Bays since 2003.
- Oyster reefs were monitored in the Pine Island Sound area in 2010–2011 as part of a broader study to determine possible effects from the Deepwater Horizon spill. Even though oil never reached the Pine Island Sound, the study provided important baseline information on oyster densities, growth rates, and genetic connectivity among sites in Florida (Proffitt et al. 2013).

To date, oyster restoration projects in the CHNEP area have focused on shallow and intertidal waters of less than four feet. The Oyster Habitat Restoration Plan identified a need to study project successes at different depths to better guide future restoration efforts. In 2016, TNC, CHNEP, and FDEP-CHAP completed the Trabue Harborwalk Oyster Habitat Restoration Project, which featured nine oyster habitat restoration sites located along tidal portions of the Peace River in the City of Punta Gorda. To monitor progress, CHNEP created the Volunteer Oyster Habitat Monitoring Program (VOHMP), which trained participants in water quality monitoring, oyster counting and measuring, water bird surveys, and data entry. VOHMP volunteers and over 1,300 community volunteers contributed almost 3,000 hours to construct and monitor reefs.

Other examples of oyster restoration in the CHNEP area include:

- The Coastal Watershed Institute at FGCU and their partners conduct community-based restorations of oyster reefs, including reefs in the Caloosahatchee River/lower San Carlos Bay, Estero Bay, and Henderson Creek (in Collier County). More than 600 volunteers have donated over 4,300 hours of time to reestablish 23 oyster reefs.
- Sanibel Captiva Conservation Foundation began a research-based oyster restoration project in 2010 to build oyster reefs in Clam Bayou on Sanibel Island. The collaborative efforts continued with volunteer-assisted oyster restorations at City of Sanibel Boat Ramp, and locations around the Causeway Islands and Tarpon Bay using discarded oyster shell collected from local restaurants. Seven complete oyster reefs totaling

approximately four acres have been created in the Caloosahatchee Estuary as of 2018.

Hard Clams

Efforts are underway to restore hard clam populations on Florida's west coast by multiple organizations, including All Clams on Deck, SCCF, and Sarasota Bay Watch.

Local hard clam aquaculture operations are operating clam farm leases in Pine Island, Matlacha Pass, and Gasparilla Sounds (CHNEP Water Atlas). Red tide, fishery closures, and other disturbances can sometimes make farmed clams unmarketable. Though not suitable for human consumption, these clams are still viable and could be relocated to restoration sites supportive of their long-term survival and propagation.

In 2021 the Florida Department of Agriculture and Consumer Services, Division of Aquaculture (FDACS) amended Florida Administrative Code Rule 18-21, which governs the use of sovereignty submerged lands, to allow the limited use of state-owned submerged lands for restoration aquaculture, when commercial production is not the primary purpose. The new Rule allows for "public-private partnerships" for demonstration and pilot scale programs that provide a public benefit, allowing governmental and private education and research institutions to work with the aquaculture industry. Restoration Aquaculture can also take place within aquatic preserves, research reserves, marine sanctuaries and state parks provided they are consistent with the applicable management plan, or, where there is no plan with "applicable management policies." In 2023, FDACs published the Aquaculture Best Management Practices (BMPs) Manual, which details aquaculture BMPs necessary to protect water and habitat quality (FDACS 2023).

Clam farmers and scientists from FDEP, FWC, and SCCF formed a working group to assess the potential for using unmarketable clams for restoration projects. To help identify optimal areas in Charlotte Harbor for siting clam restoration projects, Thompson et al. (2021) created a habitat suitability map based on multiple environmental factors known to be supportive of hard clam growth, survival, and reproduction (available on the CHNEP Water Atlas). Using the map together with logistical factors and discussions with stakeholders, potential restoration sites were identified and surveyed for suitable characteristics, including the presence of adult clams. Three sites were identified as being most likely to support successful clam restoration with a number of others identified for further study.

A study examining the effects of hard clam (*M. campechiensis*) restoration on water quality and seagrass in Tampa Bay calculated the amount of nitrogen and phosphorus removed from the environment and sequestered in clam tissue and shell (Gulf Shellfish Institute 2019). At the study scale, they found no difference in total suspended solids and total chlorophyll in the water column over restored clam beds compared a control area without clams. They did find that total organic matter in the sediments of the clam bed were significantly greater than in bare sand; however, they did not observe increases in seagrass coverage near the clam beds. Researchers speculated that it was likely that increases in organic nutrients deposited into sediments will be available to augment seagrass growth in the future.

Mangroves

To better understand saltwater wetland loss, CHNEP conducted research to define the distribution, abundance, and composition of saltwater wetlands, with a focus on mangrove ecosystems throughout the CHNEP area (Beever et al. 2016). CHNEP staff mapped mangroves by location and species for Charlotte Harbor proper (including the tidal Peace and Myakka Rivers). Mapped information and site data were used in combination with satellite imagery to develop mangrove community and species interpretations for the entire CHNEP area. The results offered a sensitive and detailed accounting of mangrove distribution, giving clues to underlying hydrology difficult to map from aerial photography and LiDAR digital elevation models alone.

The study overturned the classic paradigm of mangrove ecology that held that mangrove communities were organized according to a landward zonation pattern of red mangroves, black mangroves, white mangroves, and buttonwood. Instead, mixes of mangrove species were far more common than classic mangrove zonation would suggest. The highlight of the project was the use of the Green Normalized Difference Vegetation Index (Pastor-Guzman et al. 2015) to identify areas of poor mangrove condition and excellent mangrove condition using Landsat satellite spectral imagery data. The 2015 index was coupled with 1985 Landsat data to develop mangrove condition trend maps, which were used to identify 90 potential restoration opportunities throughout the CHNEP area. The study also identified sites with poor or declining condition due to natural causes, where there was no remedy or where restoration was already in progress.

The Mangrove Condition and Change Tool brings new management capacity to the CHNEP area, as the technique requires no pre-restoration monitoring because of the ongoing collection and archiving of Landsat data by the Unites States Geological Survey (USGS). The tool can also be used to assess the fate of mangrove systems as they respond to human-caused hydrologic and climate change stressors, identify mangrove forest die-offs and locations of potential future loss, document changes in the position, composition, and health of the landward and waterward edges of fringing mangrove ecosystems, and document changes in the relative proportions of mangrove ecosystem types in Southwest Florida.

Efforts to restore estuarine shorelines are ongoing in the CHNEP area. For example, in 2011–2012, Lee County 4-H Trailblazers teamed with local agencies to plant Red Mangrove propagules on Lee County Conservation 20/20 property at Smokehouse Bay on Pine Island to help restore mangrove fringe along the estuarine shoreline. Smokehouse Bay, on the north end of Pine Island, is part of the Conservation 20/20 program, which purchased parcels of land in 1999 and 2007. The 268 acres were dramatically altered five decades ago when cleared for a mosquito ditch, intended to drain standing water.

Living Shorelines

While much of the estuarine shoreline in the CHNEP area remains natural, the rivers, creeks, and canals along urbanized waterfronts are largely hardened (Figure 26). These artificial shorelines increase erosion, harm water quality, magnify storm damage and flooding, provide poor habitat for birds, fish, and other wildlife, and may cause coastal squeeze of habitats subject to sea level rise (Figure 27) (RAE 2015).

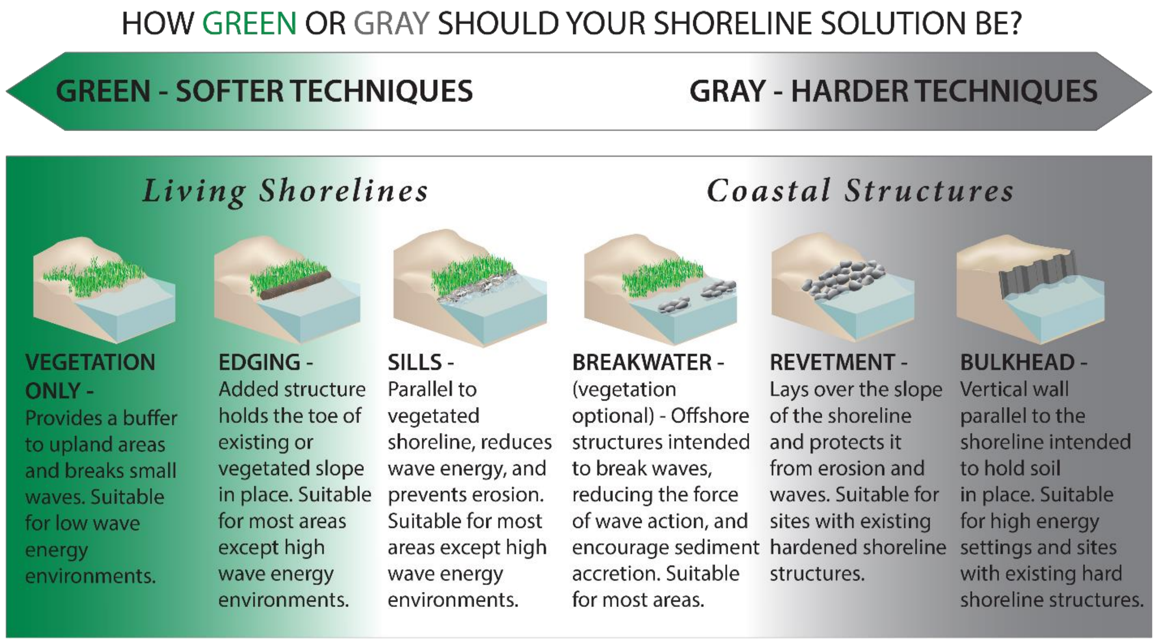


Figure 26. A continuum of shoreline types from natural to hardened | *NOAA Office of Habitat Conservation.*

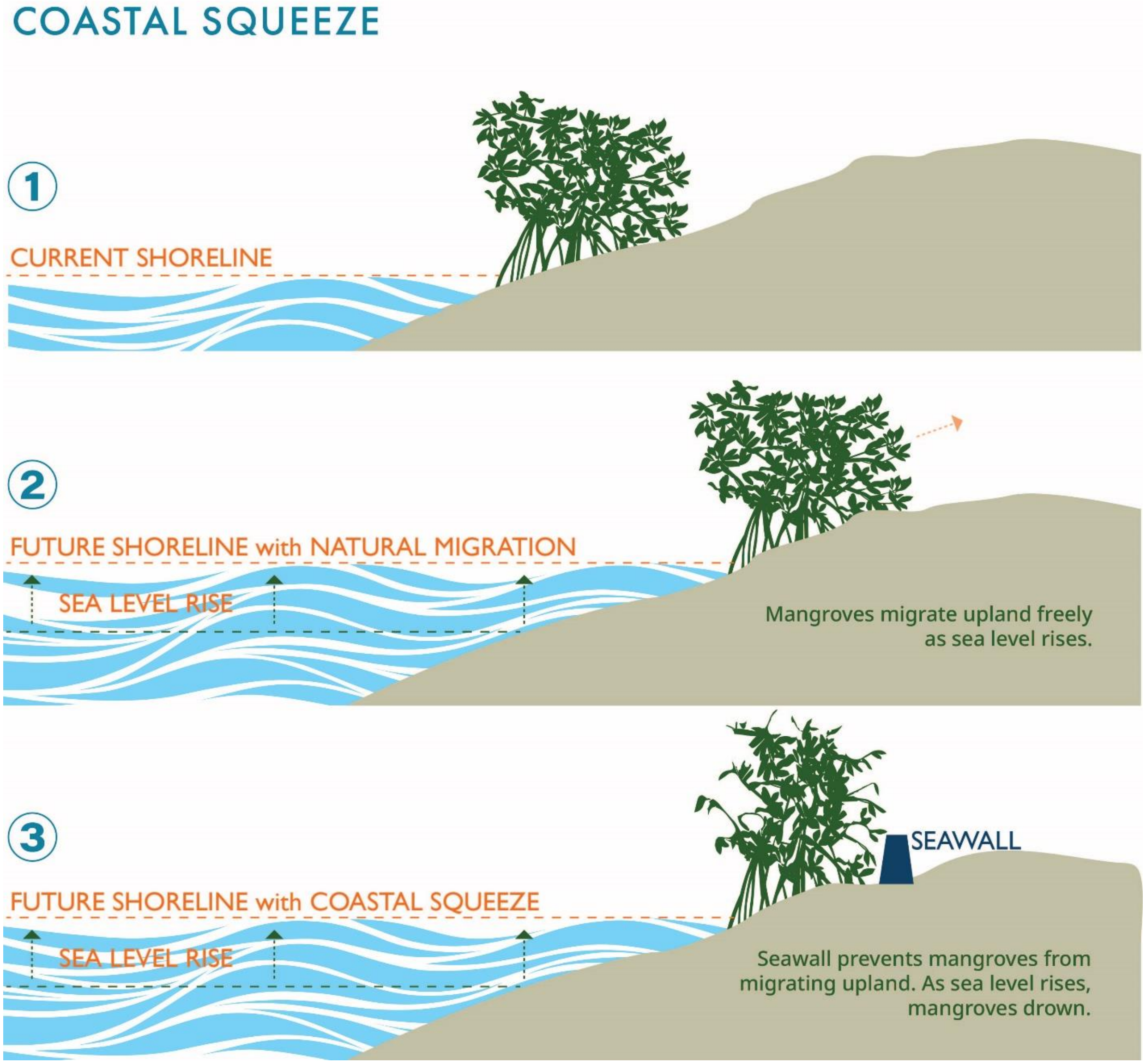


Figure 27. Coastal squeeze occurs when upslope migration of habitat is impeded by development.

In contrast, nature-based solutions, like living shorelines utilize “softer,” sloped, more natural materials that buffer wave action, absorb storm impacts, filter nutrients and other pollutants, increase aesthetic value and privacy, and provide food and shelter for fish, shellfish, and wading birds. As a resilient systems approach, living shorelines may also help increase resiliency to impacts associated with climate change and sea level rise by buffering the effects of increased storm and floods. They protect dunes, mangrove forests, and other coastal habitats that in-turn shield manmade infrastructure, support wildlife, and add aesthetic value. CHNEP supports consideration and utilization of living shorelines in addition to, or as an alternative to traditional seawalls to promote natural wildlife habitat resiliency and migration in response to sea level rise (CHNEP 2019b).

Installation of living shorelines in the CHNEP Area is ongoing. The City of Sanibel installed a hybrid living shoreline in 2022 to protect Woodring Road from erosion. The FDEP-funded project utilized concrete pipes and reef balls to dissipate wave energy, stabilize sediments, and serve as substrate for oysters and mangroves to grow. In early 2019, the City of Punta Gorda and partners completed conceptual designs for a living shoreline project on the Peace River along the seawall area of the Four Points Sheraton Hotel. Partners for the Tiki Point at Harborwalk Living Shoreline Project include the City of Punta Gorda, CHNEP, TNC, FDEP, Four Points Sheraton, and Jacobs Engineering. In the next project phase, partners with funding from the CHNEP are undertaking the final design, permitting, and construction. When completed, the project will increase resilience and mitigate flooding risks using a hybrid nature-based solution to improve water quality and habitat, reduce erosion, and buffer storm effects.

CHNEP and its partners will continue to support research and restoration projects to improve habitat capacity and resiliency to preserve and enhance native populations of birds, fish, and other wildlife.

Tidal Creeks and Fisheries

Tidal creeks and their associated coastal ponds rank among the most productive estuarine habitats and serve as essential juvenile fish nursery areas in southwest Florida (Blewett et al. 2023, Wilson et al. 2023). CHNEP supports tidal creek research and restoration across the region to advance understandings of how fish use these areas and how best to restore hardened and degraded shorelines for maximum productivity.

CHNEP recently worked with Florida's two other Gulf Coast NEPs and partners to develop a Tidal Creek Water Quality Assessment Framework to prioritize management actions in tidal creeks between Tampa Bay and Estero Bay (see Water Quality Improvement Action Plan) (Wessel et al. 2022). This and earlier studies (Janicki and Mote 2016) confirmed that important estuarine sport fish, including red drum *(Sciaenops ocellatus)*, common snook *(Centropomus undecimalis)*, striped mullet *(Mugil cephalus)*, and sheepshead *(Archosargus probatocephalus)* rely on Florida tidal creeks as critical nursery areas.

CHNEP partnered with project leads FWC and Bonefish & Tarpon Trust to develop a plan to advance research and promote actions to protect juvenile tarpon *(Megalops atlanticus)* and common snook critical habitat (Janicki Environmental 2022). This effort was motivated by research showing that juveniles of both species commonly utilize small ephemerally-connected shallow ponds within intertidal wetlands of Charlotte Harbor, and that these habitats are increasingly vulnerable to rapidly advancing development (Blewett et al. 2023). Protecting the tidal creek habitat use by juvenile snook—known to occur even tens of kilometers upstream—protects an ecologically important fish assemblage of more than 55 native species as well as the ecosystem services provided by the habitat itself (Wilson et al. 2023). Because snook support an economically important recreational fishery, plans to protect snook can help leverage collaboration between recreational fishery stakeholder and the agencies tasked with management.

A dozen stakeholder partners completed a facilitated co-production process to develop the plan (Janicki Environmental 2022), which features research and policy recommendations and defines linkages supporting science-based natural resource protections in Charlotte Harbor. The plan identified research needs necessary to refine an existing habitat characterization matrix, including additional fish surveys, water quality assessments, fish tracking studies, and an evaluation of potential restoration practices. It also identified the need to develop a Vulnerability Index and model to evaluate existing zoning and permitted land use and the potential effects of sea level rise on these habitats. Potential solutions included establishing rolling easements, an overlay district, permit modifications, and social marketing targeted outreach.

Research on habitat-use patterns of the endangered smalltooth sawfish (*Pristis pectinata*) has provided valuable information for their management. Sawfish are known to use multiple Southwest Florida estuaries as juveniles. Researchers found they have affinities for brackish waters less than a meter deep, warmer than 24 degrees C, and with dissolved oxygen levels greater than 4 mg/L (Huston et al. 2017).

Differences in distribution and abundance of common snook, Florida gar, and largemouth bass in the Peace and Myakka Rivers appear to be related to habitat differences in dissolved oxygen (Blewett et al. 2017b). Lower dissolved oxygen (less than 3 mg/L) was suggested to be a contributing factor to lower bass abundance in the Myakka River, whereas the abundance of snook and Florida gar in the Myakka River was comparable to the Peace River. Low DO in the Myakka River was found to occur downstream of a large marsh, prone to large mortality events. Improved understandings of the ways natural habitats can affect water quality can better improve management expectations.

New research into the ecological requirements for snook and tarpon nursery habitats holds promise for better understanding how these fishes are impacted by habitat quality. Scientists from the Bonefish and Tarpon Trust and FWC have analyzed statewide maps of juvenile snook and tarpon locations and assembled a list of habitat characteristics common to successful nursery habitats (Wilson 2017). Mote Marine Laboratory conducted a study in Sarasota County to determine shoreline habitat preference of snook in tidal creeks. They found that areas with curved channels, wetland plants, or slower moving waters, tend to have more fish, as these sections better resemble natural creeks. They also found more fish associated with natural vegetated shorelines than hardened ones. Stormwater conveyances can be designed or retrofitted with weirs and fish ladders to encourage fish passage and migration (see Hydrologic Restoration Action 3).

STATUS:

Ongoing.

RELATED ACTIONS:

- Water Quality Improvement Action 1: Support a comprehensive and coordinated water quality monitoring and assessment strategy
- Water Quality Improvement Action 2: Develop water quality standards, pollutant limits, and cleanup plans
- Water Quality Improvement Action 3: Reduce urban stormwater and agricultural runoff pollution
- Water Quality Improvement Action 5: Reduce harmful algal blooms
- Hydrologic Restoration Action 2: Increase fresh surface water and groundwater availability to support healthy natural systems
- Hydrologic Restoration Action 3: Protect and restore natural flow regimes

STRATEGY:

Activity 1.1: Protect, monitor, and restore beneficial submerged aquatic vegetation, including seagrasses, oysters, and coastal wetlands, to establish status and trends as a biological indicator of ecosystem health and fisheries as well as to manage and enhance ecosystem services.

Location: CHNEP area.
Responsible parties: CHNEP, County and Municipal Governments, FDEP, SWFWMD, SFWMD, FWC, USFWS, NOAA, USACE, CHAP, EBAP, SCCF, Florida Sea Grant, J.N. “Ding” Darling NWR Complex, Calusa Waterkeeper, Land Conservation NGOs.
Timeframe: Ongoing; Climate Change Vulnerability Analysis adopted in 2018; Habitat Restoration Needs Plan Phase I and II adopted in 2019 and 2021; Monitoring Strategy adopted in 2020.
Potential annual cost and funding sources: $1M–10M/SWFWMD, SFWMD, County and Municipal Governments, NOAA, FDEP, FWC, 320 Funds.
Benefits: Improved habitat capacity and resiliency to support sustainable native populations of birds, fish, and other wildlife.
5-year Performance measure: Increased created and restored oyster reefs, living shorelines, and seagrass meadows.

Activity 1.2: Research and promote best management practices for tidal creeks, rivers, canals, dredged channels, and stormwater conveyances that support habitats and native aquatic life.

Location: CHNEP area.
Responsible parties: County and Municipal Governments, SWFWMD, SFWMD, FDEP, FDACS, FWC, WCIND, USACE, USFWS, NOAA, UF/IFAS, Research Institutions, NGO Neighborhood Groups.
Timeframe: Ongoing; Monitoring Strategy adopted in 2020.

Potential annual cost and funding sources: $500,000–$999,999/CHNEP, County and Municipal Governments, FDACS, FDEP, SWFWMD, SFWMD, Florida Sea Grant.
Benefits: Improved BMPs resulting in improved resource protection.
5-year Performance measure: Improved understanding and additional data on habitat condition and function for supporting native aquatic life.

Activity 1.3: Protect, monitor, and restore shoreline habitats, including mangroves and salt marshes, to establish status and trends as a biological indicator of ecosystem health and fisheries, and to track changes that are due to sea level rise and shoreline hardening.

Location: CHNEP area.
Responsible parties: FWC, FDEP, Colleges and Universities, Counties and Municipalities.
Timeframe: Initiate by 2026.
Potential annual cost and funding sources: $1,000,000–$2,500,000/CHNEP, Grants, FDEP, Counties and Municipalities.
Benefits: Improved habitat capacity and resiliency of mangrove and salt marsh habitat to support sustainable native populations of birds, fish, and other wildlife.
5-year Performance measure: Documented status and trends of mangrove and salt marsh habitat to inform more holistic management of coastal ecosystem health and fisheries.

Fish, Wildlife, and Habitat Protection Action 2: Protect, monitor, and restore environmentally sensitive lands and waterways including critical habitat areas

OBJECTIVES:

Continue to encourage and support the permanent conservation of environmentally sensitive lands and critical habitat areas through land acquisition and conservation easements, and encourage management activities to protect, restore, and create thriving native plant and animal communities.

BACKGROUND:

CHNEP's vision for land conservation is to protect and restore flowways and corridors that allow movement of birds, fish, wildlife, and water, and to protect uplands adjacent to coastal and riparian habitats that allow habitat migration due to sea level rise. Many of these wetland and upland habitats are fragmented, degraded, or locally lost due to activities related to urban development, agriculture, transportation, and mining (see Hydrologic Restoration Action 3).

For habitats that remain, many areas have been extensively impacted and altered by invasive exotic vegetation such as cogongrass, Old World climbing fern, and Brazilian pepper; and exotic nuisance animals such as feral hogs, apple snails, Cuban tree frogs, and monitor lizards. Spread of invasive species and pathogens, both native and non-native, is increasing with increasing temperatures, fewer extreme cold events, and habitat shifts resulting from climate change (Osland et al. 2020). More catastrophic events, such as droughts, floods, and intense storms, could create opportunities for colonization by more exotics. Biodiversity could change as flora and fauna geographical ranges change, shifting dominance of some species and causing local extinctions of others.

Fire is a natural and necessary feature of many upland habitats. Climate change may result in more frequent or intense droughts, causing temporal and spatial characteristics of natural fire regimes to shift and increasing the possibility of more intense and long-burning wildfires. There may be increased burn risk for desiccated wet mesic or hydric habitats that are not well-adapted to frequent wildfire. As a result, use of prescribed fire as a landscape management tool to maintain habitat conditions for plants and animals may become more difficult and riskier in some locations (Scott 2008).

Land Acquisition

Land acquisition to protect wildlife habitat, water flows, and water quality has been a major objective of CHNEP and its partners. Together, significant progress has been made in protecting and restoring priority habitats. Since CHNEP's inception in 1994, the acreage of conservation land in the CHNEP area has tripled. In 1994, CHNEP's area included 187,000 acres of managed conservation lands. The 2013–2018 CCMP set targets to conserve 25% more acreage than the 1998 baseline by 2018 and 100% more by 2025. In 2024, over 1.2 million acres in the counties within the CHNEP area are under conservation, exceeding the target set for 2025 (Table 13) (FNAI 2024). Between 2019 and early 2024, more than 87,000 acres have been conserved within the CHNEP area through fee simple and conservation easement (Figure 28) (FNAI 2019, 2024).

These protected lands support threatened and endangered species, including 300,000 acres of Panther Focus Area, 37,000 acres of Florida scrub Jay habitat, 11 woodstork nesting locations, nine gopher tortoise recipient sites, and 372 red-cockaded woodpecker observation sites (CHNEP 2019b). Large-scale conservation is critical for sustaining Florida's water resources (Graham et al. 2023), providing flood hazard protection, and preserving critical linkages to maximize wildlife resilience under the stress of climate change (Polsky et al. 2024). Over time, sea level rise will force some conservation lands to transition to submerged or intertidal habitats, resulting in a net loss of conservation land and less land available for strategic acquisition to connect existing conservation lands through habitat corridors.

Land conservation is a significant and essential undertaking in Florida. Large-scale coordinated acquisition projects have been very successful. The Florida Wildlife Corridor (FLWC) identifies 18 million acres of critical habitat spanning from the Everglades to the northwestern-most part of the Panhandle with almost 10 million acres already protected. The Florida Wildlife Corridor Act, adopted by law in 2021, directs FDEP to encourage and coordinate all state, regional, and local agencies that acquire lands to do so in FLWC opportunity areas. Similarly, the Everglades to Gulf Conservation area, established by the US Fish and Wildlife Service in 2024, identifies 4 million acres across twelve counties from Naples to Lakeland, to catalyze conservation through conservation easements with willing landowners.

Steady gains have been achieved by the sustained efforts of municipal, county, state, and federal governments, water management districts, and a variety of non-governmental entities over decades (Table 13). These entities own and manage, often jointly, the mosaic of conservation lands in the CHNEP area, including parks, preserves, reserves, refuges, forests, and private lands.

State Parks, like the 42,500-acre Charlotte Harbor Preserve State Park that serves as a coastal buffer to much of Charlotte Harbor, are managed by FDEP. The Florida Forest Service of the Department of Agriculture and Consumer Services manages primary state forests in the Charlotte Harbor region, including the Myakka State Forest and the Peace River State Forest.

Table 13. Managed conservation lands (acres) in the counties of the CHNEP area include public and some privately-owned lands | *Florida Natural Areas Inventory. Florida Conservation Lands, updated March 2024.*

County	Local	State	Federal	Private	Total	County Area	% County Conserved
Charlotte	5,008	176,777	616	59	182,460	464,944	39%

DeSoto	225	64,893	3,049	1,919	70,086	409,261	17%
Glades	206	152,681	1,822	29,582	184,292	631,606	29%
Hardee	0	20,222	1,431	485	22,138	408,539	5%
Hendry	0	140,917	41,490	3,730	186,138	761,487	24%
Lee	43,126	54,722	7,834	4,050	109,733	537,801	20%
Manatee	27,245	36,410	1,828	1,512	66,994	488,377	14%
Polk	19,243	205,784	57,685	23,944	306,656	1,286,679	24%
Sarasota	52,619	69,511	6	885	123,021	370,432	33%
TOTAL	**147,672**	**921,918**	**115,761**	**66,165**	**1,251,516**	**5,359,125**	**23%**

Wildlife Management Areas, such as the 80,000-acre Fred C. Babcock/Cecil M. Webb Wildlife Management Area, are managed by Florida Fish and Wildlife Conservation Commission (FWC). FWC also manages Critical Wildlife Areas (CWA), like Little Estero Island and a small island in the Myakka River critical to wood stork breeding, for the protection of endangered species. In 2016, six CWAs critical to threatened colonial nesting birds were added in the CHNEP area, including three in Pine Island Sound (Broken Islands, Useppa Oyster Bar, and Hemp Key) and three in Estero Bay (Matanzas Pass Island, Big Carlos Pass, and Coconut Point East).

The South and Southwest Florida Water Management Districts own and manage numerous preserves throughout the area with their county partners, such as the Circle B Bar Reserve with Polk County and Six Mile Cypress Slough Preserve with Lee County. The U.S. Department of the Interior (USDI) through the National Wildlife Refuge System also has holdings in Southwest Florida, including the J. N. “Ding” Darling National Wildlife Refuge Complex.

Counties in the CHNEP area also purchase and manage conservation lands (Table 13). Lee, Charlotte, Sarasota, Manatee, and Polk Counties all have conservation land acquisition programs approved by voter referendum and financed through dedicated ad valorem property tax revenue and other sources. Cities also support local recreational, ecological, conservation, and environmental parks—many located along the waterfront.

In addition to public initiatives, private groups provide leadership and initiate conservation land acquisitions. The Florida Wildlife Corridor Foundation, the Calusa Land Trust and Nature Preserve of Pine Island, Inc., the Sanibel-Captiva Conservation Foundation (SCCF), the Lemon Bay Conservancy, the CREW Land and Water Trust, Conservation Foundation of the Gulf Coast, and others all help to plan, acquire, manage, and preserve in perpetuity environmentally sensitive or historically important land.

In many cases, private lands are protected through purchase of conservation easements, rather than outright fee-simple purchase. A conservation easement is a legal agreement between a property owner and a qualified conservation organization, such as a land trust or government agency. The easement usually contains permanent restrictions on the use or development of land in order to protect its conservation values. These easement restrictions vary greatly for each agency or organization, as do landowner interests in conservation easements. There are many advantages to conservation easements. The property remains in private ownership and contributes to the tax base, and the owner can glean property tax reductions, charitable tax deductions, and estate tax reductions.

Acquisitions of conservation lands (2019–2024) include:

- Oak Hammock Preserve is a 427-acre property that adds to an existing assemblage of conservation lands in northeast Lee County stretching nearly six miles wide and three miles long. The property provides significant opportunities for water resource protection due to its proximity to the headwaters of Hickey Creek, including the potential to provide flooding relief to nearby residential neighborhoods.
- Four Mile Cove Eco Park Addition adds 194 acres to the existing 365-acre preserve and represents one of the largest remaining undeveloped properties in Cape Coral along the Caloosahatchee River. It is habitat for manatees, smalltooth sawfish and gopher tortoises) and helps protect water quality in the river and reduce impacts of storm surge/flooding.
- Peace River Refuge is 771 acres in DeSoto County purchased through the Florida Forever Program. Flanking both sides of the Peace River for about 6 miles and the east side for another four miles, the property's hardwood forested uplands buffer and help preserve the water quality and habitat of the Peace River and its creeks.
- Bob Janes Preserve grew by 175 acres and 99 acres with the addition of two properties adjacent to the south of the Preserve in Alva. The properties provide critical wildlife corridor for Florida black bear and Florida panther, as well as providing significant potential for the rehydration of the sandstone and water table aquifers and water quality benefits.
- Scrubby Flatwoods habitat with an active population of Florida scrub-jays was conserved on six residential lots assembled in North Port by the Environmental Conservancy of North Port. The properties also provide critical habitat for Northern bobwhite quail, gopher tortoise, and bobcat in a neighborhood with little native vegetation. CHNEP assisted with a Conservation Grant for additional native plantings.

Additional conservation easements acquired (2019–2024) include: Caloosahatchee-Ecoscape (19,623 acres); Horse Creek Ranch (11,958 acres); Fisheating Creek Ecosystem (6,865 acres); Carlton Horse Creek Ranch (4,357 acres); G-3 Ranch (3,634 acres); Grubb Ranch (555 acres); Myakka Ranchlands (1,611); Charlie Creek Cattle Company (1,027 acres); Murphy Marsh (534 acres); and Lake Wales Ridge (354 acres).

CHNEP continues to assist in these efforts by providing letters of support and comments at public meetings, providing technical comments to lead agencies, hosting presentations at CHNEP conferences, supporting private land trust projects, and promoting existing federal, state, water management district, and local conservation land acquisition programs, such as:

- Florida Forever
- Florida Communities Trust

- Florida Rural and Family Land Protection Program
- Florida Wildlife Corridor
- U.S. Fish and Wildlife Service Land and Water Conservation Fund
- U.S. Fish and Wildlife Service Everglades to Gulf Conservation Area
- U.S. Department of Agriculture National Resources Conservation Service
- Florida Save our Rivers Programs administered by the state Water Management Districts

In addition, CHNEP provides funding support for local conservation efforts, assists with the formation and maintenance of local land trusts, provides information and education on behalf of local conservation efforts, and facilitates strategic regional planning for land acquisition targets, including annually gathering environmental land acquisition and restoration projects completed in the CHNEP area to input into a master national restoration database for reporting to the U.S. Environmental Protection Agency and to the U.S. Congress.

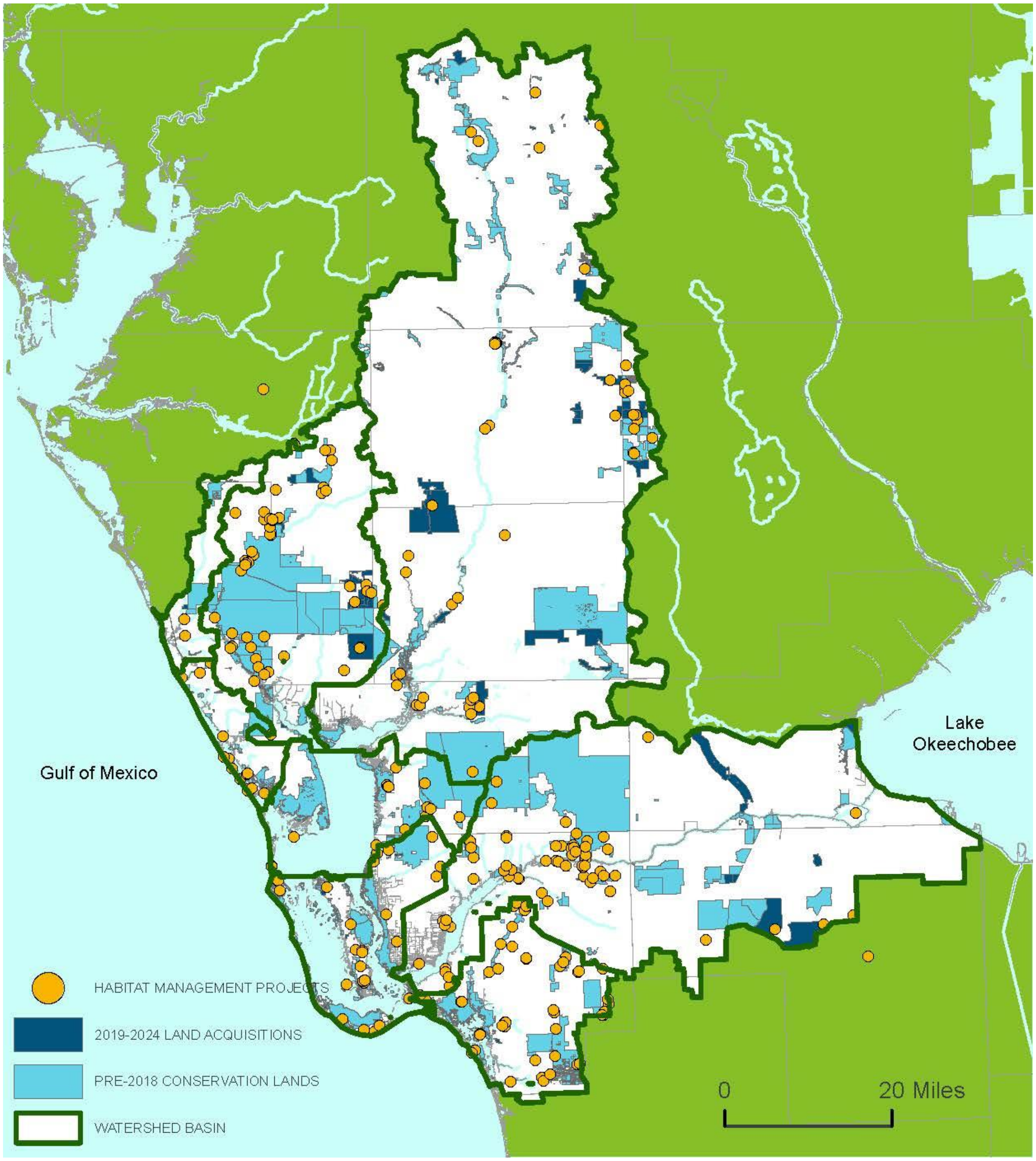


Figure 28. From 2019 to 2024, 87,329 acres were added to the Florida Natural Areas Inventory of conservation lands within the CHNEP area. Two-hundred eighty-eight restoration and habitat management projects, including prescribed burns, invasive plant removal, and native plantings were completed by CHNEP partners during the same period | *FNAI 2019, March 2024. CHNEP-EPA NEPORT.*

Land Management and Restoration

Once acquired for protection, conservation sites often require restoration. For example, the 432-acre Myakka Headwaters Preserve was purchased by the Conservation Foundation of the

Gulf Coast to benefit water resources and wildlife. However, the property suffered significant loss of hardwood tree cover, degraded by prior cattle grazing and hydrologic alteration. In 2022-2023 in partnership with SWFMWD and CHNEP, the Conservation Foundation planted almost fifteen thousand plants of 27 species, including twelve species of trees and shrubs. Another 40,000 pop ash trees will be planted in late 2024.

Some habitats are not self-sustaining in the absence of natural fire and must be cleared or burned to reestablish stable and functional communities of native plants and animals. For example, a Myakka River State Park Prairie Restoration included 2,278 acres of roller chopping to reduce saw palmetto density and shrub height and increase density of herbaceous vegetation. At Highlands Hammock State Park, a Scrubby Flatwoods Restoration included removing 10,277 sand pines across 1,063 acres to reduce fuel load and increase optimum habitat for threatened Florida scrub-jays.

Fire management occurs regularly across CHNEP area watersheds, with partners cooperating to carry out prescribed burns to reduce fuel load and restore species diversity. Between 2015 and 2017, more than thirty prescribed burn projects were carried out on more than 67,000 acres of conservation lands in the CHNEP area, including major annual burns at Myakka River State Park and Charlotte Harbor Preserve State Park.

Invasive exotic species removal is an ongoing management activity on conservation lands. Hundreds of feral hogs are removed regularly from State Parks and Preserves to reduce impacts of rooting, including disruptions to water flow and damage to native vegetation that makes areas more susceptible to rapid recolonization by exotic vegetation. Thousands of acres of conservation lands across the CHNEP area are treated each year for invasive vegetation like cogongrass and Brazilian pepper trees.

Restoration opportunities are not limited to large acreages in rural areas. Removal of invasive species, planting native vegetation, and installing low impact development (LID) solutions for stormwater in urban and suburban areas (see Water Quality Improvement Action 2) can improve habitat value, hydrology, and water quality. From backyards to neighborhood parks, the benefits of small-scale restoration projects can add up, especially when they create a mosaic of habitats that function as wildlife corridors.

Restoration Planning

CHNEP's Habitat Restoration Needs (HRN) Plan (CHNEP 2019b, 2020) guides habitat preservation/conservation, connectivity, management, restoration, sustainability, and resiliency throughout the CHNEP area.

The Plan identifies preservation/conservation and reservation opportunities, as well as management/enhancement and restoration targets, in each area (Table 14). Full implementation of the Plan will have substantial positive impacts on the long-term sustainability of water quantity, water quantity, natural systems, and species populations. The

Plan articulates CHNEP's habitat restoration vision for the next 50 years of "A diverse environment of interconnected, healthy habitats that support natural processes and viable and resilient native plant and animal communities."

The overarching goal of the Plan is to increase the acreages of native habitats in the CHNEP area, both strategically and opportunistically. In support of this goal, several alternative approaches to developing quantitative habitat targets were assessed and evaluated. Several types of information were considered including habitat status and trends analysis; existing preservation and conservation lands; proposed land acquisition priorities; listed species critical habitats and migratory corridors; river floodplain functions; long-term trends in freshwater flows; historical soils distributions; projected sea level rise; and modeled coastal habitat migration in response to sea level rise.

Major recommendations include:

- Increase existing acreage of preservation and conservation areas to 627,102 acres
- Reserve less than one percent of the watershed, or 1,590 acres, to accommodate future coastal habitat migration due to sea level rise
- Increase restored areas by 121,272 acres and increase managed or enhanced areas to 494,791 acres in order to offset projected habitat losses due to development, climate change and sea level rise, and other stressors

The HRN will coordinate with FWC's Critical Habitat Conservation Plan to identify multi-partner opportunities and priorities, and it will assist local, regional, state, and federal agencies, and organizations to identify, plan, and implement habitat restoration and land acquisition projects needed to achieve CHNEP habitat restoration goals and vision.

Table 14. Habitat restoration opportunities and targets for the CHNEP area by major habitat type | *CHNEP 2019b, 2020.*

	Opportunities for Unprotected Lands with Habitat Value	**Targets for Protected Lands**		
Major Habitat Types	**Preservation / Conservation Opportunities**	**Management/ Enhancement Targets for Native Habitats**	**Restoration Targets for Non-Native Habitats**	**Reservation Targets for Coastal Open Space**
Uplands	192,396	228,757	88,767	N/A
Freshwater Wetlands	214,066	207,332	32,419	N/A
Tidal Wetlands	11,854	58,702	86	N/A
Non-Native	468,450	N/A	N/A	1,590
Total	**627,102**	**494,791**	**121,272**	**1,590**

STATUS:

Ongoing.

RELATED ACTIONS:

- Hydrologic Restoration Action 2: Increase fresh surface water and groundwater availability to support healthy natural systems
- Hydrologic Restoration Action 3: Protect and restore natural flow regimes

STRATEGY:

Activity 2.1: Encourage and support the permanent conservation of environmentally sensitive lands and critical habitat areas through land acquisition and conservation easements held in perpetuity, including freshwater wetlands, flowways, corridors, and uplands adjacent to coastal habitats necessary for habitat resilience and migration.

Location: CHNEP area with a focus on protecting habitats and migration corridors as recommended by HRN.
Responsible parties: County and Municipal Governments, Florida Forever, SWFWMD, SFWMD, Land Conservation NGOs, FWC, USFWS, NOAA, FDACS, FDEP, USDA-NRCS.
Timeframe: Ongoing; Habitat Restoration Needs Plan Phase I and II adopted in 2019 and 2021; Monitoring Strategy adopted in 2020.
Potential annual cost and funding sources: >$10M/State of Florida: Florida Forever and other programs, County and Municipal Governments, Land Conservation NGOs, Landowners, SWFWMD, SFWMD, USFWS, FWC, NOAA, FDACS, FDEP, USDA-NRCS.
Benefits: A diverse environment of interconnected, healthy habitats that support natural processes and viable and resilient native plant and animal communities.
5-year Performance measures:

- Updated and adopted Habitat Restoration Needs Plan that includes priority projects.
- Increased acreage of conserved land.

Activity 2.2: Encourage management of public lands and private lands with public conservation easements to protect, restore, and create native plant and animal communities, including eradication of invasive exotic species, prescribed fire, and other appropriate management activities.

Location: CHNEP area with a focus on protecting habitats and migration corridors as recommended by HRN.

Responsible parties: County and Municipal Governments, Land Conservation NGOs, Landowners, FWC, USFWS, SWFWMD, SFWMD, FDACS, FDEP, USDA-NRCS.
Timeframe: Ongoing; Habitat Restoration Needs Plan Phase I and II adopted in 2019 and 2021; Monitoring Strategy adopted in 2020.
Potential annual cost and funding sources: $1M–10M/County and Municipal Governments, FDEP, FWC, USFWS, SWFWMD, SFWMD, FDACS, USDA-NRCS.
Benefits: Effective management practices resulting in improved resource protection.
5-year Performance measure: Increased acres of restored aquatic, wetland, and upland habitat and habitat under maintenance phase management.

Activity 2.3: Implement the Habitat Restoration Needs Plan in facilitating habitat restoration and migration in current and future scenarios.

Location: CHNEP area.
Responsible parties: County and Municipal Governments, Land Conservation NGOs, Landowners, FWC, USFWS, SWFWMD, SFWMD, FDACS, FDEP, USDA-NRCS.
Timeframe: Ongoing.
Potential annual cost and funding sources: $1M–10M/County and Municipal Governments, FDEP, FWC, USFWS, SWFWMD, SFWMD, FDACS, USDA-NRCS.
Benefits: Improved natural habitats and resilience to current and future scenarios.
5-year Performance measure: Increased acres of restored aquatic, wetland, and upland habitat and habitat under maintenance phase management.

Fish, Wildlife, and Habitat Protection Action 3: Assess and promote the benefits of land, waterway, and estuary protection and restoration

OBJECTIVES:

Assist in assessing and promoting the economic, social, and environmental benefits of land protection and habitat restoration.

BACKGROUND:

Conservation, preservation, and stewardship of environmentally sensitive lands provides significant economic, social, and environmental benefits to local and regional areas in the form of ecosystem services. Florida communities with the most expansive areas of conservation lands tend to enjoy both an increased quality of life and an enhanced tax base from adjacent private lands.

An economic valuation of the CHNEP area reported that an estimated $92 million spent annually by local government and partners on natural resource protection in the CHNEP area provides returns at a rate of 3.4:1 (Cortez et al 2020). Natural resources in the area generate economic benefits of $13.6 billion annually, including values from recreation, restoration, research, and education, agricultural production, and commercial fishing. Annual economic output includes $3.8 billion regional income, $146 million in local and state tax revenue, plus support for over 148,000 jobs (Table 15). Proximity to natural areas adds a premium of $381 million to real estate values.

Table 15. Economic value of natural resources by basin in the CHNEP area (in millions of dollars) | *Cortez et al. 2020*.

Basin	Total Economic Impact	Property Value Premiums	State and Local Tax Revenue
Caloosahatchee	$ 2,820.00	$ 2,054.75	$ 33.72
Charlotte Harbor	$ 493.90	$ 776.00	$ 8.02
Dona & Roberts Bay	$ 607.00	$ 266.96	$ 8.62
Estero Bay	$ 1,480.00	$ 964.10	$ 23.85
Lemon Bay	$ 496.80	$ 268.81	$ 8.01
Myakka River	$ 702.60	$ 156.51	$ 8.49
Peace River	$ 3,240.00	$ 402.33	$ 32.94
Pine Island & Matlacha	$ 1,350.00	$ 1,461.16	$ 21.93
Total	$ 11,190.30	$ 6,350.62	$ 145.58

Conversely, poor environmental conditions can harm the broad economy. The 2018 severe red tide event resulted in estimated economic losses of hundreds of millions of dollars to the fishing community and billions of dollars to the broader community in Charlotte, Lee, and Collier Counties (Greene Economics LLC 2023).

The presence of conservation lands can reduce infrastructure needs, including transportation, health care, public safety, and utility services—saving local governments and taxpayers millions of dollars in capital improvements and operating costs. Conservation and agricultural lands generate net positive revenue through associated taxes, fees, and tourism support. Hunting, fishing, and non-consumptive outdoor recreational activities are major contributors to the region's tourism industries. For example, the one-time purchase price of conservation lands in the Estero Bay Basin is equivalent to one-third of tourist spending related to those lands in a single year (Beever 2013). The economic, social, and environmental benefits of land conservation and habitat restoration should continue to be assessed and promoted (see Public Engagement Action Plan).

STATUS:

Ongoing.

RELATED ACTIONS:

- Fish, Wildlife, and Habitat Protection Action 1: Protect, restore, and monitor estuarine habitats
- Fish, Wildlife, and Habitat Protection Action 2: Protect, restore, and monitor environmentally sensitive lands and waterways including critical habitat areas
- Public Engagement Action 1: Promote environmental literacy, awareness, and stewardship through expanded education and engagement opportunities for the general public
- Public Engagement Action 4: Increase outreach to policymakers to enhance understanding and support for CCMP implementation

STRATEGY:

Activity 3.1: Assist in assessing and promoting the economic, social, and environmental benefits of land protection and habitat restoration, including as a response to climate stressors.

Location: CHNEP area.
Responsible parties: CHNEP, Land Conservation NGOs, NOAA, Colleges and Universities, SWFRPC, FDEO, County Visitors Bureaus, County Land Conservation Programs.
Timeframe: Ongoing; Climate Change Vulnerability Analysis adopted in 2018; Communication and Outreach Strategy adopted in 2020. Economic Valuation Study completed in 2020.
Potential annual cost and funding sources: \$100,000–\$499,999/CHNEP, Land

Conservation NGOs, Visit Florida, SWFRPC, FDEO, County Visitors Bureaus, County Land Conservation Programs.
Benefits: Increased public support for land protection and habitat restoration. Recognition of the social and economic benefits of nature-based tourism and recreation.
5-year Performance measure: Technical support and comments provided in support of land conservation initiatives to advance implementation of HRN.

PUBLIC ENGAGEMENT ACTION PLAN

VISION: An informed, engaged public making choices and taking actions that increase protection and restoration of estuaries and watersheds.
GOAL: Public education and engagement.
OBJECTIVE: Increase the proportion of the population that supports and participates in actions to protect and restore estuaries and watersheds.
STRATEGY: Promote environmental awareness, understanding, and stewardship to the general public, new target audiences, and policymakers; and strengthen non-profit partner collaboration in education and engagement programs.

ACTION 1: Promote environmental literacy, awareness, and stewardship through expanded education and engagement opportunities for the general public
ACTION 2: Engage underrepresented and underserved communities, businesses, and other priority stakeholders in estuary and watershed protection activities and educational programs
ACTION 3: Strengthen non-profit partner collaboration in education and engagement programs
ACTION 4: Increase outreach to interested policymakers to enhance understanding and support for CCMP implementation

GENERAL BACKGROUND:

The Goals and Objectives of the CCMP are rooted in sound science and measured results; but for the general public, scientific information is often difficult to access and understand. CHNEP and its partners work to present technical information and science-based initiatives toward accomplishing the CCMP Goals and Objectives in ways that are meaningful and easy to understand by all stakeholders, including policymakers who can utilize it to advance CCMP Actions and Activities. Implementation of the CCMP is only successful if initiatives and results are understood, valued, and used by public officials, educators, and private citizens. Sharing effective public outreach methods increases environmental knowledge and awareness exponentially across partner networks.

Many issues addressed in this CCMP’s Action Plans for Water Quality Improvement, Hydrologic Restoration, and Fish, Wildlife, and Habitat Protection require effective public communication and engagement. Increased public understanding of these issues, together with opportunities for public participation in their solutions, can lead to better individual choices and actions that increase protection and restoration of estuaries and watersheds.

Southwest Florida is one of the fastest growing regions in one of the fastest growing states in the entire nation. Over the last fifty years, the population of the CHNEP area has more than tripled, with the greatest percent growth occurring in the coastal counties of Charlotte and Lee (Table 16). Polk County in Central Florida’s Heartland is projected to be the most populous county in the CHNEP region by 2035. Polk County added more than half a million residents in the last 50 years. Rapid growth and development in the area are expected to continue, with the total population of the CHNEP area projected to grow by 15% in the next decade.

Table 16. Population growth and projections for the seven counties in the CHNEP area | *U.S. Census Bureau data provided by the Florida Office of Economic and Demographic Research, April 2023.*

COUNTY	1977	1987	1997	2007	2017	2025	2035	2045
Charlotte	44,313	88,230	131,307	164,584	172,720	211,348	240,013	261,624
DeSoto	17,973	22,890	27,224	33,983	35,621	35,158	35,820	36,057
Glades	5,278	7,357	9,648	11,055	13,087	12,689	13,047	13,204
Hardee	17,407	22,095	22,447	27,520	27,426	25,684	25,787	25,855
Hendry	16,206	24,572	30,308	39,651	39,057	42,454	43,442	44,482
Lee	172,330	293,713	394,244	615,741	698,468	835,889	964,371	1,042,449
Manatee	129,313	181,684	241,422	315,890	368,782	459,471	540,062	592,175
Polk	279,574	389,056	459,010	581,058	661,645	832,384	972,557	1,064,286
Sarasota	170,621	251,253	311,043	387,461	407,260	478,983	536,139	575,683
TOTAL	**853,015**	**1,280,850**	**1,626,653**	**2,176,943**	**2,424,066**	**2,934,060**	**3,371,238**	**3,655,815**

Visitors further add to the total population and its impact on natural ecosystems, especially in the coastal counties. For example, in 2023 Lee County received 3 million visitors or 3.5 times the number of permanent residents. In 2023, total visitor economic impact in Lee County was $4.6 billion and total tax revenue to local government was over $115 million (Downs & St. Germain 2023). Many tourists and seasonal residents return to Central and Southwest Florida over many years, and some decide to move here permanently. These striking statistics point to both the impacts and opportunities for public engagement on environmental issues. CHNEP and its partners address the ongoing need and opportunity to reach these new residents and visitors where they live, work, and play.

Surveys indicate that beaches remain the top attraction for both domestic and international visitors. Other popular natural attractions include visiting parks and gardens, canoeing and freshwater fishing, camping in the area's numerous public and private campgrounds, boating and fishing, and shelling and bird watching. A growing population and tourism industry is creating greater demand for natural resource-related recreational opportunities. For instance, in 2024, there were over 168,000 registered boats in the CHNEP area (Table 17).

Table 17. Number of registered boats by county in the CHNEP area in 2023 | *Florida Department of Highway Safety and Motor Vehicles.*

		Boat Type		
County	**Pleasure**	**Commercial**	**Dealer**	**Total**
Charlotte	24,304	498	71	24,873
De Soto	2,497	90	2	2,589

Glades	1,387	22	1	1,410
Hardee	1,604	31	0	1,635
Hendry	3,083	81	13	3,177
Lee	49,922	1,129	211	51,262
Manatee	25,664	734	201	26,599
Polk	31,547	446	33	32,026
Sarasota	24,259	371	130	24,760
Total	**164,267**	**3,402**	**662**	**168,331**

The attraction to the outstanding natural environment of the area creates a tremendous outreach opportunity. Many new and seasonal residents may be familiar with common environmental issues and problems, but often can lack specific understanding of Florida's ecology and management requirements. Many residents do not see their personal connection to impacts or solutions. Understandably, it is difficult to envision the cumulative impacts of what seem to be isolated, individual actions.

Public exposure to environmental issues occurs most commonly through the media, such as when Red Tide washes tons of dead fish onto beaches, rivers are choked with neon-green algal blooms, beaches are closed with health warnings, or shellfish are contaminated and inedible. It is important to deepen and broaden public awareness and knowledge of these issues, as well as to promote how individual actions can improve or degrade the natural environment. Public education through outreach and volunteer engagement is an ongoing necessity as a steady stream of new residents continue to make Central and Southwest Florida their home every year.

Public education and volunteer engagement efforts typically target the general public. To address specific problems, information must be tailored to specific audiences associated with the solutions, for example specific industries, boaters, or fishers. Some important target audiences are difficult to reach. These underrepresented and underserved audiences can be engaged through more targeted outreach that meets them where they are and addresses their interests and values in easily understandable language.

Reaching different stakeholder groups requires the use of a variety of media and outreach methods, including:

- Websites and publications that can have a wide reach and effectively explore foundational concepts about watersheds and estuaries and how human activities play a role in their health
- Social media that offers useful ways to convey smaller amounts of information quickly and remind people about upcoming events, best practices, and CHNEP successes
- Events that offer person-to-person learning opportunities and community access to multiple organizations at the same time. They leverage and highlight partnerships, showcasing collaborative efforts and partner programs. They also allow for audience feedback through surveys and interviews

- Outdoor volunteer activities that offer hands-on exposure to the natural world, providing immersive educational opportunities for participants to see first-hand how they are connected to their watershed
- Workshops and conferences that bring experts, stakeholders, and interested residents together to learn about and discuss relevant issues and innovations. They can spark new ideas, partnerships, and action towards projects and solutions

As digital technology and norms about how people receive and share information continue to change, it will be essential to routinely reassess and adapt to use the best communication channels.

Often, gaps in stewardship are correlated with gaps in actionable information. Scientists need long-term monitoring and data management strategies in order to analyze changes to the environment. Resource managers need analysis of the best available actionable data to create sound management plans. Government leaders need trusted advisors and solid management plans to help them make effective policy decisions in a policy framework of competing community priorities. Residents need information that is compelling and useful to help make better choices that may be personally more expensive or less convenient. Effective stewardship requires more than just access to information—it requires translation and transfer of that information in ways that resonate with the community's identity, values, and sense of responsibility and pride.

Climate Change

As the growing impacts of climate change manifest locally, the public's understanding of climate change as a global phenomenon only of interest to scientists or activists is changing. With noticeable increases in water and air temperatures, more frequent severe weather and floods, and more rapid intensification of approaching hurricanes, firsthand experiences bring greater public understanding about the potential and real impact of climate change on people's daily lives. Continuing to provide accurate and reliable science-based information about climate change to the public, policymakers, and partners is a key priority for CHNEP. Further, CHNEP creates opportunities for residents to take proactive action or advocate for decisions that help avoid, adapt, or mitigate negative consequences of climate change in their community. Responding to already emergent and projected challenges will require ongoing convening of diverse stakeholders that builds knowledge, trust, and decisive action to best meet environmental, economic, and social needs in the face of climate change.

Public Engagement Challenges and Management Actions

Encouraging individual behaviors that reduce cumulative impacts is one of the most valuable ways to protect and restore estuaries and their watersheds. CHNEP plays an important role in promoting education and engagement opportunities across the entire community both directly and by building the capacity of local non-profit and community organizations to deliver collaborative programs in environmental education and citizen science.

This Public Engagement Action Plan focuses on the public education and outreach capabilities of CHNEP staff to implement four public engagement actions: Action 1 calls for promoting environmental literacy, awareness, and stewardship through expanded education and engagement opportunities for the general public. Action 2 aims to expand the reach of education and engagement opportunities to new target audiences. Action 3 works toward strengthening non-profit partner collaboration in education and engagement programs. Action 4 seeks to increase outreach to policymakers to enhance understanding and support for CCMP implementation.

Public Engagement Action 1: Promote environmental literacy, awareness, and stewardship through expanded education and engagement opportunities for the general public

OBJECTIVES:

Continue to support educational activities that focus on key messages communicated in readily understandable language related to priority issues, including water quality, hydrology, habitat, and wildlife. Provide the public with interest in volunteering with regular communications on ways they can participate in research, monitoring, restoration, and public outreach.

BACKGROUND:

Watershed-scale educational outreach is important for the CHNEP. The CHNEP area is vast and includes residents who may not implicitly realize their connection or impact to downstream waterways, habitats, and wildlife. Educating the general public about estuary and watershed issues through a variety of tools and distribution channels will expand awareness, create a sense of place, encourage stewardship, and empower communities to take positive environmental actions. CHNEP has a relatively small staff that must cover a large area. Supplementing staff initiatives with organized community-driven support and coordinating with the outreach programs of agencies, counties, and municipalities is vital for educational initiatives to promote healthy, well-functioning ecosystems.

Because population growth in Central and Southwest Florida increases the burden on local resources, reaching new residents in growing communities is a growing public engagement priority. To address this issue, members within the CHNEP have participated in materials to distribute to new residents and visitors with information about CHNEP area ecosystems and their stewardship. This information continued to be updated and redistributed by utilities, libraries, parks, and local civic and business organizations.

There is also an ongoing need to provide educational outreach to students, as many of them will play a key role in the future management and protection of Central and Southwest Florida ecosystems. There are 390,000 K–12 students enrolled in public and private schools throughout school districts in the CHNEP area (FLDOE 2024), and there are six public colleges and universities and many private ones as well. Non-profit and citizen organizations and government agencies also provide informal educational programming.

Events and Educational Content

CHNEP offers events and publications to increase environmental literacy among diverse stakeholder groups. The following examples of communication tools and partnerships help CHNEP leverage resources with its partners to increase overall reach.

Events

Attending partner events is also an important strategy for reaching diverse and underserved groups throughout the watershed. CHNEP hosted or attended over 100 events with partners from 2019 to 2024, including:

- CHNEP's annual Southwest Florida Climate Summit initiated in 2021 provides an opportunity for the public, local scientists, land managers, policy makers, and resource users to come together to share and engage on climate challenges impacting Central and Southwest Florida.
- CHNEP's triennial Watershed Summit (most recently held in 2023) hosts natural resource managers and the public to discuss research, restoration, and environmental issues in Central and Southwest Florida.
- CHNEP attends partner special events throughout the 10-county program area, such as the Chalo Nitka Festival in Moore Haven, the Swamp Cabbage Festival in La Belle, the Wild About Nature Festival in Osprey, and the Arcadia Rodeo.

Publications

CHNEP has created and distributes a variety of educational publications that provide resources for people to become more engaged with their local environment and CHNEP, including:

- Large format illustrated posters to help explain topics like estuaries, shellfish, water flow, and watersheds; and fact sheets on seagrass, water quality, and ongoing habitat restoration projects.
- A 12-page Kids Activity Book in English and Spanish offering education and activities on environmental topics from the water cycle and watersheds to biodiversity and sustainable fishing.
- An annual nature calendar with education inset and featuring donated photographs that highlight the beauty and natural wonder of local watersheds that goes out to tens of thousands across CHNEP's 10-county service area.

Website and Social Media

CHNEP curates its website to provide information about educational resources, current projects, meetings, grants, volunteer opportunities and other ways to get involved in restoration and protection activities. Website traffic since 2012 continues to grow with 71% of all visitors landing on the site in the last four years. From 2019 to 2024, the website had over 33,000 unique visitors and 60,000 site visits.

Educational information is also distributed on various social media channels including:

- Almost 300 videos and presentations on the CHNEP YouTube Channel with 10,851 views
- Events on Eventbrite
- Regular Instagram and Facebook updates about projects and other related topics with 596

Instagram Followers and 1,954 Facebook Followers (more than doubled since 2018)
- An active Constant Contact email list that notifiers subscribers about Management Conference meetings, events, and public-comment and draft report review requests—the list grew by 2,086 net new subscribers between 2020 and 2024

Additionally, CHNEP creates electronic communications content regularly, including:
- Electronic monthly subscriber newsletter that highlights news, programs, and events happening at the CHNEP as well as environmental topics related to CCMP implementation.
- An interactive GIS storymap of the popular children's book *Adventures in the Charlotte Harbor Watershed* that meets STEM K-12 curriculum requirements and can be accessed in English and Spanish from the CHNEP website.

Callout Box: THE CHNEP WATER ATLAS

chnep.wateratlas.usf.edu

CHNEP contracts with the University of South Florida (USF) to maintain and update the CHNEP Water Atlas, a data hub website of current and historical technical information, data, maps, photos, resource management reports, news, and volunteer opportunities related to watersheds in the CHNEP area.

The CHNEP Water Atlas is designed and maintained for scientists, resource managers, policymakers, and the public. The user-friendly site offers access to a clearinghouse of primary data that address water quality, hydrology, habitat, and public engagement initiatives.

From 2019-2023, the CHNEP Water Atlas recorded 280,796+ page views and 223,811+ unique page views, or about two to four thousand users per month.

Partner Educational Resources

CHNEP promotes its partners' programs that inform the public about priority issues, like fertilizer, pet waste pollution, Florida-friendly yards, and invasive species. There is an ongoing need to reinforce these issues and provide readily understandable content that informs people about these topics and offer solutions and resources to encourage behavior change.

The Florida Yards and Neighborhoods Program, developed by the University of Florida Institute of Food and Agricultural Sciences (UF/IFAS), encourages homes and businesses to reduce their water and chemical fertilizer needs by employing nine Florida-Friendly Landscaping™ principles. The program highlights the use of Florida native and Florida-friendly plants that are adapted to local climate and soil conditions. They provide online resources and a list of plants suitable for the CHNEP area.

There is also a need to update resources addressing exotic and invasive plants and animals that target both managers and the public, as well as a need for collaborative efforts focused on early detection, consistent messaging, and holistic, adaptive management strategies. Regional Cooperative Invasive Species Management Areas (CISMA) provide education, outreach, and leveraged resources to help minimize and eliminate impacts of invasive, non-native species on public and private lands. CISMA is a coalition of local, state, and federal agencies, local land conservancies, local chapters of the Audubon Society, U.S. Fish and Wildlife Service, Florida State Park Service, FDEP, SWFWMD and SFWMD, and the Florida Department of Agriculture. To date, CISMA outreach strategies have included an Exotic Pet Amnesty Day, workdays at parks and preserves in multiple counties, public workshops on invasive species, continuing education and training for field staff, and development of a clearinghouse for members' educational resources. Additional support for this volunteer-based coalition could help expand the group's capacity and contribute to consistent educational messaging to residents, especially those new to Florida, about problems associated with invasive species.

Citizen Science, Stewardship Training, and Volunteer Engagement

Hands-on environmental stewardship enhances understanding of human-nature connections through experiential learning and motivates individuals to be more environmentally mindful in their everyday lives. CHNEP aims to increase public understanding and responsibility for Central and Southwest Florida's environment by offering more opportunities, including citizen science activities, community cleanups, and workdays. Integrating stewardship into a weekend outing or a regular activity can strengthen the public's association between everyday behaviors and their impacts on nature.

CHNEP co-hosts, promotes, and provides grants for volunteer events to engage residents in stewardship activities and CHNEP projects. Examples include paddle and dive cleanups, bird surveys, invasive exotic plant removals, marsh plantings, seagrass monitoring, marine debris surveys, kid's fishing clinics, native planting workshops, and water quality sampling training where participants take home field kits to test and report about waterways in their neighborhoods.

Ongoing citizen science and stewardship training programs in the CHNEP area include:

- Florida Master Naturalist Program, offered by UF/IFAS Extension, that educates adults on environmental topics like coastal, freshwater, and upland systems, conservation science, environmental interpretation, habitat evaluation, and wildlife monitoring. This training combines classroom modules with field exercises to build foundational environmental knowledge and understanding, especially for those who serve as informal educators, tour guides, and natural resource managers.
- Watershed Education Training - Ponds, Lakes And Neighborhoods (WETPLAN), supported through Lee County Hyacinth Control District's Pond Watch and Cape Coral's Canal Watch programs, that helps homeowners enhance the health and quality of nearby stormwater ponds and lakes. Free workshops, tools, and resources inform residents how to maintain appropriate plants or trees along their ponds, restore shorelines to reduce erosion,

manage weeds, and foster increased water quality and habitat features to support local birds, fish, and other wildlife. Water samples collected by participants in the Pond Watch and Canal Watch programs are included on the CHNEP Water Atlas.
- Charlotte Harbor Estuaries Volunteer Water Quality Monitoring Network (CHEVWQMN), a monthly citizen science opportunity coordinated by FDEP-CHAP Estero Bay Aquatic Preserve (EBAP) for volunteers to monitor water quality and other field conditions for 46 sites in Lemon Bay, Cape Haze/Gasparilla Sound, Charlotte Harbor, Pine Island Sound, Matlacha Pass, San Carlos Bay, Estero Bay, and the Tidal Myakka and Myakka Rivers. CHNEP supports this effort through volunteer recruitment and training, sample transport, data access through the CHNEP Water Atlas, and participation in biannual Quality Assurance training sessions.
- Eyes On Seagrass, led by Florida Sea Grant and partners, that engages volunteers in all coastal counties with training to conduct independent field surveys of seagrass beds to help scientists assess the health of seagrass communities.

[GRAPHIC: 1,776 Volunteer hours donated from 2019 to 2024]

STATUS:

Ongoing.

RELATED ACTIONS:

- Public Engagement Action 2: Expand reach of education and engagement opportunities to new target audiences
- Public Engagement Action 3: Strengthen non-profit partner collaboration in education and engagement programs
- Public Engagement Action 4: Increase outreach to policymakers to enhance understanding and support for CCMP implementation

STRATEGY:

Activity 1.1: Support programs, events, presentations, and educational content that focus on key messages communicated in readily understandable language related to protection and restoration of estuaries and watersheds, including water quality, hydrology, habitat, and wildlife issues.

Location: CHNEP area.
Responsible parties: CHNEP.
Timeframe: Ongoing
Potential annual cost and funding sources: $25,000–$99,999/CHNEP, 320 Funds, Grants.
Benefits: Increased public environmental awareness, understanding, and

stewardship; increased support for management activities.
5-year Performance measure: 10 research, restoration, or outreach initiatives showcased in educational materials, presentations, or at public events annually.

Activity 1.2: Provide information to interested public about activities to participate in research, monitoring, and restoration.

Location: CHNEP area.
Responsible parties: CHNEP.
Timeframe: Ongoing.
Potential annual cost and funding sources: < $25,000/CHNEP, 320 Funds.
Benefits: Increased public environmental awareness, understanding, and stewardship; increased support for management activities; increased scientifically-sound monitoring data; increased support for partnership initiatives in the region, and improved water and habitat quality.
5-year Performance measure: Monthly mass communications to volunteer opportunities subscribers about volunteer opportunities.

Public Engagement Action 2: Expand reach of education and engagement opportunities to new target audiences

OBJECTIVES:

Engage underrepresented and underserved communities and other priority stakeholders in estuary and watershed protection activities and educational programs.

BACKGROUND:

Underrepresented and underserved segments of the population can be difficult to reach by traditional methods. Some are constrained by low income, language barriers, and cultural differences. Strategies for increasing educational outreach and engagement among these groups focus on connecting with them where they work and play and using their native or preferred language. Multilingual materials can help cross language barriers, and framing issues in terms of their values can help make messaging more relevant. Self-organized groups within minority communities—such as faith groups, community, and youth centers—can be engaged with specific events. Personal connections, especially with community leaders, are critical for establishing trust, maintaining outreach connections, and building CHNEP ambassadors. CHNEP aims to serve these communities by 1) creating additional multilingual educational publications, 2) continuing to attend existing community events that are not strictly environmental, and 3) to provide conservation grant funding and scholarships to community groups teaching environmental education or engaging in restoration in disadvantaged areas following CHNEP's Equity Strategy.

CHNEP's outreach to underserved communities occurs primarily through support of community groups through grants programs (see Public Engagement Action 3). CHNEP has supported youth experiences, such as Adventure Mentoring Program's LaBelle Fossil Camp, Lovers Key Eco-Arts Camp, Big Brothers Big Sisters of the Sun Coast's Cedar Point wading trip, Englewood Sailing Club's youth sailing camps, the "Reel in the Fun" Kids' Pier Fishing Tournament, and the Happe Teen River Lab and Eco Camp that hosted students from farm worker families. CHNEP has also helped fund larger projects serving minority communities, such as the Harlem Heights Elementary School Outdoor Classroom, which provides hands-on learning to 1,100 children by creating an outdoor learning environment in a mangrove forest. Habitat restoration projects funded in underserved communities include Green Horizon Land Trust's Pedersen Preserve Pine Restoration and supplemental wildlife habitat in urban areas within Polk County together with the local UF/IFAS Extension office.

Other priority target audiences include the business sector, farmers, fishers, boaters, environmental consultants, miners, farmers, developers, real estate agents, and hospitality workers. Some of these audiences may be difficult to reach because they have other priorities or interests and may not have strong connections with existing environmental messaging, spokespeople, or events. Economic reports on the community-wide value of protecting natural resources can serve as effective communication tools for CHNEP and its partners (Cortez et al. 2020). A study on the impacts of severe algal bloom events starkly links the impact of poor water quality with economic losses—hundreds of millions of dollars to the fishing community and billions of dollars to the broader community in Charlotte, Lee, and Collier Counties as a result of the 2018 red tide event (Greene Economics LLC 2023). Like underserved communities, these diverse stakeholders can be engaged where they work and play and with targeted messaging delivered by trusted sources that speak to their interests and values.

To help efficiently reach these priority audiences across a large geographic area, CHNEP offers outreach materials, such as CHNEP's Fact Sheets and Nature Calendars, to its partnering municipalities for distribution at their locations and local events. In turn, CHNEP shares partner events through its communications via email and social media. Some CHNEP members develop and distribute CHNEP educational materials to new boat owner registrants or new homeowners, with the added benefit of accruing outreach metrics for municipal NPDES permits and other reporting requirements.

Hotels and Marinas

A variety of targeted programs and educational resources are already available detailing environmentally friendly best management practices (BMPs) for hotels and marinas. Water conservation and pollution-reduction education programs focus on choices of appliances, plumbing fixtures, irrigation systems, landscaping plants, and waste disposal, including:

- The Water Conservation Hotel and Motel Program (Water CHAMP^{SM}) (SWFWMD) helps hotels and motels save water by encouraging guests to use towels and linens more than once during their stay.
- The Florida Green Lodging Program (FDEP) is a voluntary certification program offering hotels resources such as a BMP guide and green meeting guide to help conserve and protect natural Southwest Florida's environment.
- The Clean Marina Program (FDEP) is a voluntary certification program for marinas, featuring educational outreach, workshops, technical assistance, environmental compliance assistance, evaluation, and mentoring provided by the Clean Boating Partnership (Figure 29). The Partnership is a unique public-private partnership consisting of marina and boatyard operators, representatives from the Marine Industries Association of Florida and its local chapters, Florida Sea Grant Program, U.S. Coast Guard (USCG), USCG Auxiliary, USCG Sea Partners Program, Florida Fish and Wildlife Conservation Commission (FWC), and FDEP.

Figure 29. Locations of Clean Marinas certified by the Florida Department of Environmental Protection through the Clean Boating Partnership | *FDEP 2024.*

Boaters

Boating can frequently have unintended and unnecessary negative consequences on the environment. Seagrass prop scar severity and extent, water quality degradation, and marine mammal injuries all increase with increasing boater activity. Between 2017and 2024, more than 18,000 more boats were registered in counties within the CHNEP area, with an increase of 35% in Manatee County. The vast majority are small fishing and pleasure craft (Table 18).

Many organizations help educate boaters including FWC, Sea Grant, West Coast Inland Navigational District (WCIND), USCG, and boating clubs. The *Florida Boaters Guide*, produced by FWC, includes information on invasive aquatic plants, discharge of pollutants like oil, trash, sewage and waste, regulatory speed zones, and seagrass protection. It is published as a free e-book and is available in print for bulk purchase. Multiple agencies cooperate in producing *Boating and Angling Guides* for local waters of Sarasota County, Charlotte Harbor, and Lee County, which provide safe boating, ethical angling, marine resource protection guidance, and detailed navigation information. Possible means of reaching watercraft users with this information include Coast Guard auxiliaries, marine dealers, watercraft rental businesses, marinas, tackle shops, sporting goods stores, civic and business groups, schools, boating and fishing associations, and boat registration packages.

Table 18. Boat registrations by size and county in the CHNEP area in 2023 | *Florida Department of Highway Safety and Motor Vehicles.*

	Boat Size Class							
County	**< 12 ft**	**12-16 ft**	**16 - 26 ft**	**26-40 ft**	**40-65 ft**	**65+ ft**	**canoes**	**TOTAL**
CHARLOTTE	3,543	2,348	15,280	2,954	420	8	212	24,765
DESOTO	306	732	1,400	102	13	1	33	2,587
GLADES	89	354	897	48	7	1	13	1,409
HARDEE	143	526	901	37	1	0	27	1,635
HENDRY	462	634	1,671	298	55	16	28	3,164
LEE	7,869	4,724	29,407	7,576	902	79	494	51,051
MANATEE	4,542	3,568	14,203	3,214	559	70	242	26,398
POLK	5,419	6,629	18,497	953	165	15	315	31,993
SARASOTA	3,743	3,153	14,070	2,957	406	29	272	24,630
TOTAL	**26,116**	**22,668**	**96,326**	**18,139**	**2,528**	**219**	**1,636**	**167,632**

Fishers

Commercial and recreational fishers can be readily targeted through industry publications, fishing supply stores, fishing groups, marinas, boat ramps, and fishing piers.

Fishing Lines Field Guide was developed by FWC's Division of Marine Fisheries Management Outreach and Education Program as an educational resource on Florida's marine resources. The publication provides ethical and sustainable fishing guidance to fishers through engaging articles about marine angling, saltwater fishes and their habitats, and state efforts to enhance marine resources. Information is also included about fisheries management in Florida, the importance of catch and release, plus a field guide to help anglers and the public identify 145 of Florida's fishes. Hard copies of this and many other FWC fishing publications can be ordered online free-of-charge. FWC also offers one-day saltwater fishing clinics for kids and adults that introduce fishing and responsible marine resource stewardship.

Florida Sea Grant Agents target fishers with educational outreach about monofilament line and derelict fishing gear recovery, boating and waterways management, and marine habitat and species restoration. Lee County and Sarasota County also provide sustainable fisheries education targeted to underserved communities.

Farmers

Florida Department of Agriculture and Consumer Services and Water Management Districts provide outreach to farmers and incentivize adoption of BMPs through partnerships, such as SWFWMD's Facilitating Agricultural Resource Management Systems (FARMS) program, that make it more feasible for farmers to implement new technologies (see Water Quality Improvement Action 3). UF/IFAS Extension Agents working throughout the CHNEP area provide outreach to both commercial and non-commercial farm operators to encourage BMP adoption. Outreach to rural hobby operators (e.g., horse boarding facilities, alpaca ranches, rabbit breeding operations) and urban farmers (e.g., community gardens, backyard gardens, and chicken coops), especially those with property adjacent to waterways, should be a focus for education.

[GRAPHIC: 300+ Kids funded by CHNEP got to attend Environmental Camp or Fishing Clinics]

STATUS:

Ongoing.

RELATED ACTIONS:

Public Engagement Action 1: Promote environmental literacy, awareness, and stewardship through expanded education and engagement opportunities for the general public

STRATEGY:

Activity 2.1: Engage diverse stakeholders in estuary and watershed protection activities and educational programs.

Location: CHNEP area.
Responsible parties: CHNEP.
Timeframe: Ongoing.
Potential annual cost and funding sources: < $25,000/CHNEP, 320 Funds.
Benefits: Increased public environmental awareness, understanding, and stewardship; increased support for management activities.
5-year Performance measure: Annual public event that includes diverse

stakeholder perspectives and presenters.

Activity 2.2: Engage underrepresented and underserved communities in estuary and watershed protection activities and educational programs.

Location: Underrepresented and underserved communities in the CHNEP area.
Responsible parties: CHNEP.
Timeframe: Ongoing.
Potential annual cost and funding sources: < $25,000/CHNEP, 320 Funds.
Benefits: Increased public environmental awareness, understanding, and stewardship; increased support for management activities.
5-year Performance measures:

- An annual event or activity that focuses on underserved communities.
- Translation of educational materials into multiple languages or formats.

Public Engagement Action 3: Strengthen non-profit partner collaboration in education and engagement programs

OBJECTIVES:

Build and support capacity of non-profit and community partners to educate and engage volunteers in outreach and activities that further CCMP implementation.

BACKGROUND:

CHNEP plays a central role as convener and facilitator for learning, information sharing, and problem solving for watershed and estuary issues in the CHNEP area. CHNEP connects and collaborates with NGO partners, universities, and municipal Public Information Officers and outreach staff to expand CHNEP's abilities to complete outreach activities. By seeking out and collaborating with partners who are aligned on key education initiatives, CHNEP can help build their capacity to train and engage their volunteers in outreach and activities that further CCMP implementation.

In response to natural disasters and episodic events, CHNEP has coordinated member entities to gather and share information with each other and the public. For example, in response to Hurricane Ian in 2022, CHNEP immediately reached out to partners to offer support and helped coordinate, fund, and collect enhanced post-event water quality sampling. In the aftermath of the deadly and devastating storm, CHNEP developed a dedicated webpage to share hurricane assistance resources and a data dashboard documenting storm conditions and impacts.

CHNEP also plays a role in helping facilitate pilot or foundational programs that can be adopted and adapted by partners. CHNEP helps partners obtain training, funding, equipment, and other tools to do the research, restoration, and educational work needed to protect our waters. These partnerships amplify and expand the reach and effectiveness of CHNEP public education and engagement, while ensuring a strong scientific foundation. For example, CHNEP facilitated a project together with FWC, Bonefish & Tarpon Trust, Charlotte County, and others for the co-production of actionable science for fisheries management in Charlotte Harbor. The plan includes both research and policy recommendations and defines the linkages necessary to solidify science-based decisions on how to proceed with realistic options to implement natural resource protections in Charlotte Harbor (Janicki Environmental 2022).

In 2024, CHNEP facilitated information sharing and stakeholder feedback for the Southeast Ocean and Coastal Acidification Network (SOCAN) and Gulf of Mexico Coastal Acidification Network (GCAN) collaboration to support the NOAA Ocean Acidification Program. The CHNEP's Technical Advisory Committee and Citizens Advisory Committee participated in workshops to assess their understanding of acidification, then discuss their perception of the impacts of acidification on the environment and where they think future research and monitoring should focus (Hall et al. 2024).

Facilitating Networking and Professional Development

Organizing and hosting events that promote partner networking and professional development continues to be a priority. CHNEP organizes and hosts the four committees in the CHNEP management conference regularly to engage in discussion of topical issues. CHNEP also organizes large conferences to help communities organize and build capacity to solve local problems, while giving scientists a public venue to communicate recent findings. Event sponsors typically include CHNEP partners, as well as other organizations such as the local National Public Radio station. Presentations from CHNEP-hosted workshops and conferences are archived on the CHNEP website and on CHNEP's YouTube channel.

A regional Watershed Summit is organized by CHNEP every three years to exchange technical information on research, restoration, and management efforts throughout the CHNEP area. The event is open and promoted to the public, as well. Topics include a wide range of scientific disciplines, geographical locations, and critical environmental issues. The most recent Watershed Summit held June 21-22, 2023, featured 29 speakers from across Central and Southwest Florida. Leading researchers, resource managers, and educators presented on diverse topics covering hydrology, fisheries research, aquatic habitat restoration, water quality, public engagement as well as a unique session on the impacts of Hurricane Ian. The Watershed Summit is well attended by the community of practice and the general public. Proceedings, including abstracts, presentation slides, and video are archived on the CHNEP website.

In 2021, CHNEP organized the first annual Southwest Florida Climate Summit and has organized the popular event every year since. The Summit is open to the public, and attendees enjoy extensive interaction with speakers through question and answers and networking. This fosters greater public awareness and engagement on the local issues around climate change. Each year, the Climate Summit hosts prominent Federal and State officials, as well as university and NGO researchers, to report on the status of new regional climate science, management, and policy initiatives. Most recently in 2024, US Senator Marco Rubio gave a Keynote Address, as well as keynotes by US Department of the Interior Assistant Secretary for Fish, Wildlife and Parks Shannon Estenoz, Chief Resilience Officer for the State of Florida Dr. Wes Brooks, and Chief of Staff of the Miccosukee Tribe of Indians of Florida Curtis Osceola. Speakers shared the latest regional climate science, resilient water management, local resiliency planning, and innovations and opportunities for resilience. Video proceedings are archived on the CHNEP website.

Grant and Sponsorship Support

CHNEP awards grants to community groups to help build their capacity for environmental education and stewardship. This also helps increase community understanding and their support of CCMP goals.

As of 2024, CHNEP has awarded almost 900 community conservation grants (49 awards from 2019-2024) to help implement a variety of projects and programs. These awards of $500 to $9,999 are typically highly leveraged with project funding from other sources (on average about 3:1), extending both the capacity of partners to complete projects and the reach of CHNEP's assistance. Some examples of notable projects funded between 2019 and 2024 include:

- Sanibel-Captiva Conservation Foundation's aerial photography project to document the effect of Lake Okeechobee Releases and other watershed events on estuary conditions
- Church Environmental's Caloosahatchee River drone wading bird nest survey
- Bonefish & Tarpon Trust's post-restoration monitoring of juvenile tarpon and snook at Coral Creek Preserve
- Suncoast Reef Rover's derelict crab trap removal project in and around Venice nearshore reefs

CHNEP also offers sponsorships of $100–$1,000 to partners to support partner educational events, workshops, conferences, festivals, and projects that implement the CCMP. From 2019-2024, 32 sponsorships totaling $17,210 have been awarded.

In addition, CHNEP provides assistance to partners who request letters of support for grant funding of their projects. CHNEP also provide grant support by publishing a Funding Opportunity Fact Sheet that consolidates all state and federal grant opportunities for habitat, resiliency, and water quality restoration projects, organizing by chronological order of due date. This Funding Opportunities Fact Sheet is updated and distributed routinely to all CHNEP members.

[GRAPHIC: 1,060 people have attended CHNEP's Watershed Summit and annual Climate Summits since 2020]

STATUS:

Ongoing.

RELATED ACTIONS:

Public Engagement Action 1: Promote environmental literacy, awareness, and stewardship through expanded education and engagement opportunities for the general public

STRATEGY:

Activity 3.1: Build and support capacity of non-profit and community partners to educate and engage volunteers in outreach and activities that further CCMP implementation.

Location: CHNEP area.
Responsible parties: CHNEP, TNC, local land trusts, National Audubon, Audubon of Florida, Charlotte Harbor Environmental Center, SCCF (and Sanibel Sea School), Calusa Waterkeeper, Florida Sea Grant, UF/IFAS Extension, Colleges and Universities.
Timeframe: Ongoing; Finance Strategy adopted in 2020; Communication and Outreach Strategy adopted in 2020.
Potential annual cost and funding sources: $100,000–$499,999/CHNEP, 320 Funds, Grants.
Benefits: Improved access to and use of best available science and best management practices to promote protection and restoration of estuaries and watersheds.
5-year Performance measure: 5 new non-profit collaborative projects over 5 years.

Activity 3.2: Bring partners together, provide resources, and coordinate natural disaster and episodic events response and recovery efforts.

Location: CHNEP area.
Responsible parties: CHNEP.
Timeframe: Ongoing.
Potential annual cost and funding sources: $50,000–75,000/CHNEP, 320 Funds, State of Florida.
Benefits: Improved knowledge of and response to water and habitat quality degradation associated with natural disasters and harmful episodic events.
5-year Performance measure: Increased implementation of episodic event environmental sampling by CHNEP member entities.

Public Engagement Action 4: Increase outreach to interested policymakers to enhance understanding and support for CCMP implementation

OBJECTIVES:

Provide regular updates to policymakers showcasing use of best available science and examples of success to reinforce the relationship between land use, water resource management decisions, environment, economy, and community.

BACKGROUND:

Communicating the science-based strategies and data-driven recommendations of the CCMP to public officials is essential for encouraging adoption and implementation of effective environmental policy and sound decision-making in support of the CCMP. Showcasing CHNEP project results, especially the National Estuary Program (NEP) approach to leveraging federal dollars with other sources to have a more significant impact, is essential for continued legislative and public support of the CHNEP.

CHNEP staff travel to Washington DC annually to meet with federal agency and elected leaders and to inform them about science and consensus-based solutions for improving natural resources. Providing examples of successful projects and what new projects are needed is important to maintaining strong state and federal funding support for water resource restoration in our region. To help keep local policymakers informed on their role in regional natural resource issues, CHNEP reaches out to involve leaders with invitations to special events, information packets containing Fact Sheets about new projects in their area, and direct presentations to those who serve on the CHNEP Policy Committee. Every elected official in the CHNEP program area is mailed a desk copy of the CCMP as part of their introduction to the partnership.

CHNEP has a vital role to play in building community resiliency by bringing federal, state, and local governments together to share knowledge and technologies, request additional funding, and implement watershed restoration across jurisdictional boundaries. CHNEP is a collaborator, helping to identify, prioritize, and partially fund resiliency projects to address vulnerabilities identified in climate vulnerability assessments and restoration/resiliency plans. CHNEP also helps coordinate and communicate federal agency priorities and resources with state and local leaders. For example, in the aftermath of the deadly and devastating Hurricane Ian in 2022, CHNEP organized a Federal Interagency Recovery Coordination Team to travel to meet directly with CHNEP Management and Policy Committee members. CHNEP staff assembled Committee members' comments and requests and then worked to get federal agency written responses and contacts for follow-up.

CHNEP provides science-based review on important environmental issues, consistent with CHNEP Policy Review Procedures updated in 2018 by the Policy Committee. This capacity enables the CHNEP Management Conference to be used as a resource by local and federal policymakers and their staffs. CHNEP staff respond routinely to requests to review partner technical documents and provide technical comments. CHNEP staff also provide input on environmental science and policy matters as a member of various regional technical advisory committees, such as the Science Advisory Group to the South Florida Ecosystem Restoration Task Force on Everglades Restoration and the Environmental Advisory Committee to the Southwest Florida Water Management District.

Engaging with the network of other National Estuary Program entities and partners can be an effective way to amplify collective Program accomplishments and support. For example, CHNEP recently coauthored a scientific publication with staff from the Sarasota Bay Estuary Program about how nutrient loads from Southwest Florida estuaries have exacerbated red tide events in the region (Tomasko et al. 2024).

Bringing influential stakeholders in the Central and Southwest Florida region together to work collaboratively and speak with one voice increases opportunities for additional financial and policy support to solve complex, large-scale environmental challenges in our watersheds.

STATUS:

Ongoing.

RELATED ACTIONS:

- Fish, Wildlife, and Habitat Protection Action 1: Protect, monitor, and restore estuarine habitats
- Public Engagement Action 2: Expand reach of education and engagement opportunities to new target audiences

STRATEGY:

Activity 4.1: Provide regular updates to interested policymakers showcasing use of best available science and examples of success to reinforce the relationship between land use, water resource management decisions, environment, economy, and community.

Location: CHNEP area.
Responsible parties: CHNEP.
Timeframe: Ongoing; Finance Strategy adopted in 2020; Communication and Outreach Strategy adopted in 2020.
Potential annual cost and funding sources: $25,000–$99,999/CHNEP, 320 Funds.

Benefits: Increased environmental awareness, understanding, and leadership from policymakers; increased policy and policymaker support for CCMP goals and objectives.
5-year Performance measure: Annual communications with interested elected or appointed officials of governmental entities.

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ACRONYMS

AFO	Animal Feeding Operations
AWT	Advanced Wastewater Treatment
BESE-elements	Biodegradable Ecosystem Engineering elements
BMAP	Basin Management Action Plan
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
BPA	Bisphenol A
BSCD	Bonita Springs Community Development
CAC	Citizens Advisory Committee
CAFO	Concentrated Animal Feeding Operation
CARES	County Alliance for Responsible Environmental Stewardship
CCVA	Climate Change Vulnerability Analysis
CCHMN	Coastal Charlotte Harbor Monitoring Network
CCMP	Comprehensive Conservation and Management Plan
CERP	Comprehensive Everglades Restoration Plan
CFRPC	Central Florida Regional Planning Council
CHAMP	Conservation Hotel and Motel Program
CHAP	Charlotte Harbor Aquatic Preserves
CHEVWQMN	Charlotte Harbor Estuaries Volunteer Water Quality Monitoring Network
CHNEP	Charlotte Harbor National Estuary Program (1995-2019) or Coastal & Heartland National Estuary Partnership (after 2019)
CISMA	Cooperative Invasive Species Management Areas
CREW	Corkscrew Regional Ecosystem Watershed
CSWCD	Charlotte Soil and Water Conservation District
CWA	Clean Water Act
CWA	Critical Wildlife Area
DDT	Dichlorodiphenyltrichloroethane
DO	Dissolved Oxygen
EBAP	Estero Bay Aquatic Preserve
EE2	Ethinyl estradiol
EPA	United States Environmental Protection Agency
FARMS	Facilitating Agricultural Resource Management Systems
FDACS	Florida Department of Agriculture and Consumer Services
FDEO	Florida Department of Economic Opportunity
FDEP	Florida Department of Environmental Protection
FDOH	Florida Department of Health
FDOT	Florida Department of Transportation
FFL	Florida Friendly Landscaping
FGCU	Florida Gulf Coast University
FLWC	Florida Wildlife Corridor
FW	CCMP Fish, Wildlife, and Habitat Protection Action Plan
FWC	Florida Fish and Wildlife Conservation Commission

FWRA	Florida Watershed Restoration Act
FWRI	Florida Fish and Wildlife Research Institute
FWRI-FIM	Florida Fish and Wildlife Research Unit—Fisheries Independent Monitoring Program
GCAN	Gulf of Mexico Coastal Acidification Network
GICIA	Gasparilla Island Conservation and Improvement Association
GIS	Geographic Information Systems
GOMA	Gulf of Mexico Alliance
HAB	Harmful Algal Bloom
HOA	Homeowner Association
HR	CCMP Hydrologic Restoration Action Plan
HRCC	Habitat Resiliency to Climate Change Project
HRN	Habitat Restoration Needs Plan
ISMP	Imperiled Species Management Plan
LID	Low Impact Development/Design
MFL	Minimum Flows and Levels
MGD	Million Gallons per Day
MC	Management Conference
MPO	Metropolitan Planning Organization
NEP	National Estuary Program
NGO	Non-governmental Organization
NNC	Numeric Nutrient Criteria
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OAWP	Office of Agricultural Water Policy
OFW	Outstanding Florida Waters
OSTDS	Onsite Sewage Treatment and Disposal Systems
PBDE	Polybrominated diphenyl ethers
PCB	Polychlorinated biphenols
PE	CCMP Public Engagement Action Plan
PFAS	Per- and polyfluoralkyl substances
PPT	Parts Per Thousand
PRMSWSA	Peace River Manasota Regional Water Supply Authority
PSU	Practical Salinity Units
QA/QC	Quality Assurance/Quality Control
RAP	Reasonable Assurance Plan
SAS	Surficial Aquifer System
SAV	Submerged Aquatic Vegetation
SBEP	Sarasota Bay Estuary Program
SCCF	Sanibel-Captiva Conservation Foundation
SSO	Sanitary Sewer Overflow
SFWMD	South Florida Water Management District
SOCAN	Southeast Ocean and Coastal Acidification Network

SRS	Stratified Random Sampling
STORET	Storage and Retrieval (now Watershed Information Network, WIN)
SWFRAMP	Southwest Florida Regional Ambient Monitoring Program
SWFRPC	Southwest Florida Regional Planning Council
SWFWMD	Southwest Florida Water Management District
SWIM	Surface Water Improvement and Management Act
SWIMAL	Saltwater Intrusion Minimum Aquifer Level
SWUCA	Southern Water Use Caution Area
TAC	Technical Advisory Committee
TBEP	Tampa Bay Estuary Program
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TNC	The Nature Conservancy
TP	Total Phosphorous
TSS	Total Suspended Solids
UF/IFAS	University of Florida Institute of Food and Agricultural Sciences
USACE	U.S. Army Corps of Engineers
USDA	United Stated Department of Agriculture
USCG	United States Coast Guard
USF	University of South Florida
USDI	United States Department of the Interior
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VOHMP	Volunteer Oyster Habitat Monitoring Program
WCIND	West Coast Inland Navigation District
WETPLAN	Watershed Education Training Ponds Lakes and Neighborhoods
WIN	Watershed Information Network
WMA	Wildlife Management Area
WQ	CCMP Water Quality Improvement Action Plan
WQFAM	Water Quality Functional Assessment Method
WUCA	Water Use Caution Area
WWTP	Wastewater Treatment Plant

ACTION PLANS AT A GLANCE

Water Quality Improvement Strategy Matrix

Hydrologic Restoration Strategy Matrix

Fish & Wildlife Habitat Protection Strategy Matrix

Public Engagement Strategy Matrix

ACKNOWLEDGEMENTS

CHNEP thanks our dedicated Management Conference members who contributed to the CCMP Update.

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Greg Blanchard - Manatee County
Michelle Tickles - Mosaic
Mark Sramek - National Oceanic & Atmospheric Administration National Marine Fisheries Service
David Nellis - Nellis Enterprises
Shea Cunningham - Peace River Manasota Regional Water Supply Authority
Gregory Knothe - Polk County
Rick Bartleson - Sanibel-Captiva Conservation Foundation
Brooke Langston - Sarasota County
Paul Semenec - Sarasota County
Mark Barton - South Florida Water Management District
Mark Walton - Southwest Florida Water Management District
Chadd Chustz - Town of Fort Myers Beach
Erin Campbell - U.S. Army Corps of Engineers
Mike Taylor - U.S. Army Corps of Engineers
Dan Schabilion - U.S.D.A. Natural Resource Conservation Service
Kevin Kalasz - U.S. Fish & Wildlife Service
Jeff Devine - West Coast Inland Navigation District
Dave Sumpter - Wildlands Conservation

CITIZENS ADVISORY COMMITTEE MEMBERS 2023-2024

Tonya Bramlage
Danika Fornear
Nicole Johnson
Ernesto Lasso de la Vega
Julie Morris
Kayton Nedza
Debi Osborne
Tom Palmer
Harry Phillips
Pete Quasius
Church Roberts
Bridget Washburn
Robert Winter
Phyl Wojcik
Aaron Zimmerman