# Looking Ahead to 2030:

## A 10-Year Comprehensive Conservation and Management Plan for the Indian River Lagoon, Florida

ONE LAGOON

ONE COMMUNITY · ONE VOICE

INDIAN RIVER LAGOON
NATIONAL ESTUARY PROGRAM

*This Final Draft version of the **Indian River Lagoon Comprehensive Conservation and Management Plan (CCMP) – Looking Ahead to 2030** replaces the Preliminary Final Draft version and the original Draft version that were provided to the Indian River Lagoon National Estuary Program (IRLNEP) Management Conference and public on the IRL Council website, www.irlcouncil.com, to facilitate open access to the CCMP and encourage public comments. This Final Draft version will remain open on the IRLNEP website and available for comments until certification of the Final Draft is completed by the U.S. Environmental Protection Agency (USEPA), recommended changes are made (if necessary), and a Final USEPA certified CCMP is reviewed by the IRLNEP Management Conference and adopted by the IRL Council in 2019. All public comments have been and will be recorded and posted on the website.*

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# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AWT | Advanced Wastewater Treatment |
| BMAP | Basin Management Action Plan |
| BMP | Best Management Practice |
| CCMP | Comprehensive Conservation and Management Plan |
| CERP | Comprehensive Everglades Restoration Plan |
| DEO | Department of Economic Opportunity |
| DEP | Department of Environmental Protection |
| ECERT | East-Central Estuarine Restoration Team |
| FDACS | Florida Department of Agriculture and Consumer Services |
| FDOH | Florida Department of Health |
| FDOT | Florida Department of Transportation |
| FWC | Florida Fish and Wildlife Conservation Commission |
| FIT | Florida Institute of Technology |
| GIS | Geographic Information System |
| HAB | Harmful Algal Bloom |
| IRL | Indian River Lagoon |
| IRLI$^2$ | Indian River Lagoon Innovator and Investor (Network) |
| IRLNEP | Indian River Lagoon National Estuary Program |
| MFC | Marine Fisheries Council |
| mg/L | Milligrams per Liter |
| MRC | Marine Resources Council |
| MSD | Marine Sanitation Device |
| NASA | National Aeronautics and Space Administration |
| NEP | National Estuary Program |
| NERT | Northeast Florida Estuarine Restoration Team |
| NMFS | National Marine Fisheries Society |
| NOAA | National Oceanic and Atmospheric Administration |
| NPS | National Park Service |
| NRCS | Natural Resources Conservation Service |
| OAWP | Office of Agricultural Water Policy |
| ORCA | Ocean Research & Conservation Association |
| OSTDS | Onsite Sewage Treatment and Disposal System |
| PFAS | Perfluorinated Alkyl Substances |
| RAP | Reasonable Assurance Plan |
| SFWMD | South Florida Water Management District |
| ShORE | Sharing Our Research with Everyone |
| SJRWMD | St. Johns River Water Management District |
| SRF | State Revolving Fund |
| STEMAC | Science, Technology, Engineering, and Modeling Advisory Committee |
| SWIM | Surface Water Improvement and Management (Program) |
| TBD | To Be Determined |
| TMDL | Total Maximum Daily Load |
| UF-IFAS | University of Florida Institute of Food and Agricultural Sciences |
| USACE | U.S. Army Corps of Engineers |
| USCG | U.S. Coast Guard |
| USEPA | U.S. Environmental Protection Agency |
| USFWS | U.S. Fish and Wildlife Service |
| WMDs | Water Management Districts |
| WWTP | Wastewater Treatment Plant |

# IRL COUNCIL RESOLUTION AND ADOPTION

**WHEREAS**, the creation of the Indian River Lagoon (IRL) Council (an independent special district of the state of Florida) to serve as the host agency for the IRL National Estuary Program (IRLNEP) was driven by a common goal to improve communication, coordination, leadership, and investment among the federal, state, and local government agencies and private-sector organizations throughout the IRL watershed.

**WHEREAS**, this vision for change began at the local level on September 13, 2013 when representatives from the six counties along the IRL (Volusia, Brevard, Indian River, St. Lucie, Martin, and Palm Beach) met for the first time as the IRL Counties Collaborative to begin an organized local effort to respond more effectively to declining IRL water quality, recurring harmful algal blooms, and negative impacts to local economies. These discussions led to the creation of the IRL Council in February 2015. The Interlocal Agreement was last amended in 2017.

**WHEREAS**, the IRL Council began its first fiscal and operational year on October 1, 2015 and worked quickly and strategically to hire staff, relocate the IRLNEP headquarters to Sebastian, Florida, and establish a new IRL Management Conference of citizens, scientists, and community leaders to advise the IRL Council Board of Directors.

**WHEREAS**, IRL Council creation and IRLNEP reorganization provided an immediate benefit of increased and diversified financial support for IRL restoration from $600,000 of annual federal funding to $2,100,000 annually of mixed federal, state, and local funding. These new revenues allowed for continued and expanded funding for IRL restoration projects consistent with the 2008 IRL Comprehensive Conservation and Management Plan (CCMP).

**WHEREAS**, in fiscal year 2016–2017, the IRL Council and IRLNEP successfully completed and passed a mandatory five-year program evaluation with U.S. Environmental Protection Agency that is an obligation for continued federal funding and which re-aligned the IRLNEP brand to “One Lagoon – One Community – One Voice” to reflect the commitment to a program that is community-based and consensus-driven.

**WHEREAS**, the IRL Council and IRLNEP recognize that the IRL CCMP is a science-based pathway to restore ecosystem and economic health to the IRL that is long-term, non-regulatory, consensus-driven, and community-based.

**WHEREAS**, the IRL Council and IRLNEP Management Conference have adopted the following:

VISION: Healthy Ecosystem – Healthy Communities – Healthy Economy

MISSION: One Lagoon – One Community – One Voice

PROMISE: Clean Water for People and Nature

GOALS:

1. To attain and maintain water and sediment of sufficient quality to support a healthy estuarine lagoon ecosystem;
2. To attain and maintain a functioning, healthy ecosystem which supports endangered and threatened species, fisheries, commerce, and recreation;
3. To achieve heightened public awareness and coordinated interagency management of the IRL ecosystem; and
4. To identify and develop long-term funding sources for prioritized projects and programs to preserve, protect, restore, and enhance the IRL.

**NOW THEREFORE BE IT RESOLVED** that the IRL Council Board of Directors adopt this revised IRL CCMP (*Looking Ahead to 2030*) with support from our Management Conference advisory committees: Management Board; Science, Technology, Engineering, and Modeling Advisory Committee; and Citizens Advisory Committee. This final CCMP has been revised with input from citizens throughout the IRL watershed.

The IRL Council and IRLNEP will work with our citizens, cities, government agencies, academic institutions, and business community to seek expanded funding for implementation of the CCMP action recommendations.

**DONE, ORDERED, AND ADOPTED** by the IRL Council Board of Directors on this 14th day of December 2018.

| | |
|---|---|
| _____<br>Chris Dzadovsky, Chair<br>St. Lucie County Commission | _____<br>Deb Denys, Vice Chair<br>Volusia County Council |
| _____<br>Susan Adams, Secretary<br>Indian River County Commission | _____<br>Stacey Hetherington<br>Martin County Commission |
| _____<br>Bryan Lober<br>Brevard County Commission | _____<br>Drew Bartlett<br>Florida Department of Environmental Protection |
| _____<br>Doug Bournique<br>St. Johns River Water Management District | _____<br>Brandon Tucker<br>South Florida Water Management District |

# U.S. ENVIRONMENTAL PROTECTION AGENCY CONCURRENCE

Placeholder – USEPA concurrence email or letter

# MESSAGE FROM IRLNEP EXECUTIVE DIRECTOR

The Indian River Lagoon National Estuary Program (IRLNEP) Management Conference and staff are pleased to present this revised Comprehensive Conservation and Management Plan (CCMP) (*Looking Ahead to 2030*). This CCMP is supported by a Community and Citizen's Guide to the CCMP. The CCMP was developed with significant input from the IRLNEP Management Conference, stakeholders, local communities, and citizens. Thank you all for your thoughts, advice, and comments. This CCMP is a significant revision from the 2008 CCMP update. It responds to the dramatic water quality changes, seagrass losses, and declining fisheries that the Indian River Lagoon (IRL) has faced since the 2011 superbloom.

This IRL CCMP revision also looks beyond the defined IRL watershed to consider connected waters and watersheds more explicitly. This approach includes a formal boundary amendment adopted in 2016 that extends planning to include the southern portion of the Halifax River in Volusia County. This CCMP revision also looks westward at connections with the St. Johns River and connections between the St. Lucie Estuary, Lake Okeechobee, and Everglades restoration, as well as eastward to include inlets connecting the IRL to nearshore waters.

This CCMP revision has been developed in alignment with U.S. Environmental Protection Agency (USEPA) program performance criteria for National Estuary Programs (NEPs) and Section 320 of the 1987 Clean Water Act, as reauthorized by the U.S. Congress in 2016. NEPs promote comprehensive planning for long-term protection of nationally significant estuaries in the United States that are deemed to be threatened by pollution, development, or overuse. Restoration is implemented through collaborative and voluntary efforts by local, city, state, federal, private, and interest group stakeholders convened as a Management Conference. The purpose of the IRLNEP Management Conference is to:

- Assess trends in water quality, natural resources, and uses of the estuary.
- Collect, characterize, and assess data on harmful contaminants, nutrients, and natural resources within the estuarine zone to identify the form and causes of environmental problems.
- Clarify how pollutant loads from legacy (in-place), point, and nonpoint sources affect the estuary's potential uses, water quality, and natural resources viability.
- Develop a CCMP that recommends priority corrective actions and compliance schedules for addressing all sources of pollution and for restoring and maintaining the physical, chemical, and biological integrity of the estuary, including restoration and maintenance of water quality; balanced populations of indigenous shellfish, fish, and wildlife; recreational and commercial activities; and other designated uses of the estuary.
- Develop plans for the coordinated implementation of the CCMP by the federal, state, regional, and local partners participating in the Management Conference.
- Monitor the effectiveness of CCMP actions and track trends in conditions.
- Review all federal financial assistance programs and federal development projects in accordance with Clean Water Act requirements.

The IRL Council and IRLNEP Management Conference and our local community partners will work cooperatively to implement this CCMP revision. This plan recommends the following broad actions that will be necessary to restore and sustain IRL health:

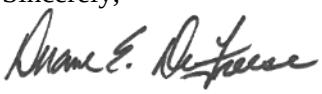
- Take individual and community ***RESPONSIBILITY*** for your impacts on the IRL. If you own or contribute to a problem, fix the problem. Each action decreases IRL vulnerability and builds IRL ***RESILIENCE***.
- ***REDUCE*** nutrients and other pollutants entering the IRL from all sources.

- ***REMOVE*** muck, nutrients, pollutants (including known surface water and groundwater pollutant or toxicant sources that threaten human or lagoon health), litter, invasive species, and human-built impediments to natural water circulation.
- ***REBUILD*** aging and/or inadequate wastewater and stormwater infrastructure to reduce loads of nutrients, other pollutants, and sediments to the IRL.
- ***RESTORE*** impaired natural IRL habitats with priority action for seagrasses, filter feeders, living shorelines, and wetlands with a spatial mosaic that supports biological diversity.
- Invest in scientific ***RESEARCH*** strategically targeted to improve restoration and stewardship of resources, with full support from comprehensive and integrated monitoring of conditions and progress throughout the lagoon.
- ***RESPOND*** to changes and new information quickly, responsibly, and with the best available science.
- Expand public participation, leadership, investment, and ***RESOLVE*** among diverse stakeholder groups throughout the IRL watershed to achieve our mission, "One Lagoon – One Community – One Voice."
- ***REPORT*** activities, projects, challenges, opportunities, and financial expenditures to document trends in the system, evaluate the progress of restoration, and provide transparency and accountability.

In support of this CCMP revision, the IRLNEP assembled a preliminary list of proposed projects that will improve wastewater infrastructure, reduce reliance on conventional septic systems, retain and treat stormwater, rehabilitate habitats, and enhance planning for resilient communities. This list was assembled from data provided by the partners in our Management Conference. This working list of projects will be evaluated and revised annually by the IRLNEP Management Conference to ensure that we have a pipeline of "shovel-ready" projects that can move forward to completion with available funding. The preliminary list of projects clearly demonstrates that IRL improvements will require multiple projects to move forward to completion at varying spatial and temporal scales. This will require proper alignment of project types to available and future funding streams, as well as expanded annual funding at local, state and federal levels.

None of the above actions will occur without public support for expanded and accelerated funding for IRL infrastructure, water quality improvement, and habitat restoration projects. The foundation for that support depends on well-informed and engaged citizens, partners, and policy-makers making sound financial investments in IRL restoration and stewardship. This is a long-term commitment to clean water. The future ecological health of the IRL, economic vitality of our communities, and quality of life depend on it.

Sincerely,



Duane De Freese, Ph.D., Executive Director
IRL Council and IRLNEP

A Call to Action:

***"…passionately continue the task of facing seemingly insurmountable challenges to do the right thing for our environment."***

Nathaniel "Nat" Pryor Reed (1933-2018)
Jupiter Island, Florida
October 2016
Travels on the Green Highway

# THE NATIONAL ESTUARY PROGRAM

The National Estuary Program (NEP) is a non-regulatory program established by the U.S. Congress and administered by the U.S. Environmental Protection Agency (USEPA). The NEP was authorized by Section 320 of the Clean Water Act in 1987. Each estuary in the NEP was designated by the U.S. Congress as an "Estuary of National Significance." Today, 28 estuaries located along the Atlantic, Gulf, and Pacific coasts and in Puerto Rico have been designated as estuaries of national significance.


NEPs reside in a variety of institutional settings, including state and local agencies, universities, and individual nonprofits. In overseeing and managing the national program, USEPA provides annual funding, national guidance, and technical assistance to the local NEPs.

The 28 NEPs develop and implement Comprehensive Conservation and Management Plans (CCMPs), which are long-term plans that contain actions to address challenges and priorities related to water quality and living resources. Work is focused within a study area that includes the estuary and its watershed. NEP challenges and priorities are defined by local, city, state, and federal public agencies, and private-sector and independent-sector interest groups. The NEP is a collaborative, effective, efficient, and adaptable coastal ecosystem-based network. With more than 20 years of experience implementing key provisions of the Clean Water Act, the NEP is the nation's principal watershed program—one that offers a viable, effective method for protecting and managing all types of watershed environments.

NEPs assist the nation in restoration and stewardship of 28 estuaries of national significance that represent a portfolio of natural and human-built assets that drive the coastal economy of the U.S. For example, in 2016, the National Ocean Economics Program estimated the U.S. coastal economy at $13.9 trillion or 83.7% of the U.S. gross domestic product for all coastal states based on 2013 data.[1]

[1] National Ocean Economics Program. 2016 Update. State of the U.S. Ocean and Coastal Economies. Available online at http://midatlanticocean.org/wp-content/uploads/2016/03/NOEP_National_Report_2016.pdf.

# INDIAN RIVER LAGOON

An estuary is a coastal waterbody where freshwater tributaries (rivers and streams) meet the waters of the sea. It is this subtle but important mixing of fresh and salt waters that make estuaries the most productive and fragile coastal ecosystems in the world. A lagoon is a special type of estuary that is oriented parallel to the coast and characterized by shallow coastal waters with restricted, but free, exchange with the adjacent open ocean. The Indian River Lagoon (IRL) is a microtidal system that has limited exchange with the ocean through five inlets (Ponce de Leon, Sebastian, Fort Pierce, St. Lucie, and Jupiter). Port Canaveral connects the ocean to the lagoon through an engineered lock system that is used for access by maritime vessels.

The distance between inlets and the small tidal range on the east coast of Florida limits exchange between the ocean and the IRL system. In fact, circulation of water in large portions of the IRL is driven primarily by wind. Because of the long residence times and flow restrictions from land-based development (i.e., causeways, wetland alterations, and past construction practices) in some locations, the IRL is highly sensitive to nutrient and pollutant loadings from the watershed. Inputs from the watershed have continued to increase during recent decades, causing declines in water quality and changes to the ecological and biological integrity of the ecosystem.[2]

The IRL system is composed of three distinct and connected estuaries: the Indian River Lagoon, Banana River Lagoon, and Mosquito Lagoon. The IRL system extends 156 miles from the Ponce de Leon Inlet to Jupiter Inlet. It spans three climate zones, from temperate to subtropical to tropical. It encompasses almost 40% of the east coast of Florida and connects five counties (plus an additional two counties, Palm Beach and Okeechobee, within the watershed), 38 incorporated cities, and approximately 1.6 million residents. The lagoon watershed covers 2,284-square miles, and the lagoon's waters span 353-square miles.

**Healthy estuaries provide many ecosystem services and support coastal assets of national significance:**

- Serve as centers of biological diversity.
- Provide essential natural habitats that support birds, mammals, fishes, and other wildlife.
- Support a complex food web upon which much marine life depends.
- Act as "bread baskets" for coastal oceans, providing productive nursery areas and habitats that support both commercial and recreational fisheries.
- Provide natural wetland buffers that reduce stormwater runoff, reduce flooding, and treat nutrients and runoff protecting coastal ocean water quality.
- Protect coastal areas from natural hazards, including storm surges, flooding, erosion, and impacts from sea level rise.
- Connect bodies of water for transportation and marine operations.
- Represent waters and complex watersheds that support many of the largest and oldest coastal cities with diverse historical, cultural, and environmental assets.
- Serve as centers of commerce with significant public and private infrastructure, including harbors and ports vital for shipping and transportation; tourism destinations; scientific research, restoration, and education centers; and military installations.
- Improve real estate values for properties on and near the estuary.
- Attract residents and visitors for recreational fishing, boating, swimming, and wildlife viewing.
- Provide many ecosystem services that support America's valuable coastal economy. Nurture an enviable, water-dependent quality of life.

The IRL is home to a rich array of plants and animals whose existence depends on the quality of water within the lagoon. More than 2,000 species of plants, 600 species of fish, 300 species of birds, and 50 threatened or endangered species inhabit the IRL for at least some portion of their lives. Scientists have shown the IRL to be a biologically diverse estuary with approximately 4,000 species documented. Visitors come from across the globe to see the large and diverse number of birds, manatees, and dolphins, or to fish the waters of the lagoon, which also make the IRL an economic driver for the five counties it borders.

[2] Sigua, G., Steward, J., & Tweedale, W. 2000. Environmental Management 25: 199. https://doi.org/10.1007/s002679910016.

A 2016 economic valuation study by the East Central Florida and Treasure Coast Regional Planning Councils estimated the total annual economic output (value received) from the IRL in 2014 was about $7.6 billion. This figure did not include the estimated $934 million in annualized real estate value for properties located on or near the IRL, nor does it include the economic contributions from estuarine-related resources in Volusia County north of the Ponce de Leon Inlet. When both of these economic contributions are considered, total economic output is valued at about $9.9 billion annually.

However, decades of land use activities throughout the IRL watershed have upset the natural balance of this delicate ecosystem. Stormwater runoff from urban and agricultural areas, wastewater treatment plant (WWTP) discharges, inadequate and failing septic systems, and excess fertilizer applications have led to harmful levels of nutrients and sediments entering the lagoon. In addition, these pollutants lead to muck accumulation on the lagoon bottom, which damages healthy sediments and increases internal nutrient exchange. These changes create a lagoon bottom that is not conducive to seagrass, shellfish, or benthic invertebrate growth. Land use changes and urban development have changed the size and drainage patterns of the IRL watershed with the addition of drainage canals, mosquito control ditches, impervious surfaces, and causeways. Development impacts are most pronounced along IRL shorelines where dredge and fill activities, hardened shorelines, and coastal development have altered natural upland-wetland-lagoon connections.

## 2016 EXPANSION OF THE IRLNEP PLANNING BOUNDARY

At the request of the Volusia County Council (Resolution 2015-133) and with support from the Indian River Lagoon National Estuary Program (IRLNEP) Management Conference, the IRL Council adopted a boundary amendment in 2016 to expand the planning boundary of the IRLNEP northward into the Halifax River (Resolution 2015-04). The addition extends the IRLNEP northern planning boundary by approximately 25 miles and incorporates an additional 198,678 acres of watershed, including six of Volusia County's 16 drainage basins.


The amended boundary acknowledged the benefits of considering connected waters and watersheds in a broad, holistic, and regional approach to ecosystem-based management. Ecosystem-based management is a comprehensive and integrated approach that considers entire ecosystems, including people and infrastructure. By considering the connections within and among coastal watersheds, this approach addressed the cumulative impacts of multiple activities across space and time. This comprehensive, ecological approach ensures the continued provision of services people want and need by maintaining healthy and productive connected ecosystems. The boundary amendment also provided opportunities to better understand and plan for how climate change (including sea level rise) might influence the connectivity of water and wildlife along a north-south gradient that spans the temperate, subtropical, and tropical climate zones. For example, the additional area is part of the Atlantic Flyway for birds and provides pathways for migration of fishes, manatees, and other estuarine species.

## IRLNEP MANAGEMENT CONFERENCE

Designation of the IRL as an "Estuary of National Significance," with authorization under Section 320 of the Clean Water Act, was first announced by President George H. W. Bush on Earth Day in 1990 and provided the catalyst for creating the IRLNEP and convening a Management Conference in 1991. The first CCMP was adopted by the Management Conference in 1996. The 1996 CCMP was then updated in 2008. From 1991-2015, the St. Johns River Water Management District (SJRWMD) served as the host agency for the IRLNEP. Dramatic changes to IRL health as the result of an unprecedented pico-cyanobacterial bloom in 2011 ("superbloom"), coupled with damaging seasonal freshwater releases from Lake Okeechobee to the southern IRL, heightened scientific and public concerns for the future of the IRL. These continuing and expanding threats resulted in a call to action from citizens; scientists; and local, state, and federal partners.

In 2013, the Indian River Lagoon Counties Collaborative met for the first time in response to the harmful algal blooms in 2011, 2012, and 2013. The Collaborative was initiated by Martin County Commissioner Ed Fielding, who was joined by Brevard County Commissioner Chuck Nelson, Indian River County Commissioner Peter O'Bryan, Palm Beach County Commissioner Hal Valeche, St. Lucie County Commissioner Chris Dzadovsky, and Volusia County Commissioner Joshua Wagner. The goals of the group were to better understand the causal agents of the algal blooms, create uniform water quality rules and regulations across county lines, and unify in the request for projects and funding from the state and federal legislatures for water quality issues. Over the months that followed, the collaborative engaged USEPA, Florida Department of Environmental Protection (DEP), SJRWMD, and South Florida Water Management District (SFWMD) in discussions to create a new, independent organization responsible for the IRLNEP. This initiative received both programmatic and technical best practices advice from the three other NEPs in Florida (Charlotte Harbor, Tampa Bay, and Sarasota Bay).

The new host agency for the IRLNEP, the IRL Council, was created by interlocal agreement on February 19, 2015, as an independent special district of the state of Florida. The partners to the interlocal agreement (DEP, SJRWMD, SFWMD, Volusia County, Brevard County, St. Lucie County, and Martin County) made commitments to provide annual funding contributions to the IRL Council. Pursuant to the interlocal agreement, IRL Council investors serve as the Board of Directors of the IRL Council and as the policy board of the IRLNEP. On September 8, 2015, an amended interlocal agreement was executed to extend IRL Council membership to include the Indian River County Lagoon Coalition, representing three cities in Indian River County (Vero Beach, Sebastian, and Fellsmere). The first operational fiscal year of the IRL Council began on October 1, 2015. On June 9, 2017, a second restated and amended interlocal agreement transferred representation from the Indian River County Lagoon Coalition to Indian River County Board of County Commissioners. The annual funding commitments from each of the IRL Council partners include $250,000 from DEP, $500,000 from SJRWMD, $500,000 from SFWMD, and $50,000 from each of the five counties (Volusia, Brevard, St. Lucie, Martin, and Indian River). In addition, USEPA contributes $600,000 per year, and the IRL license plate generates about $125,000 per year.

The driving force for the IRLNEP reorganization was a visionary and unified agreement among the participating IRL counties and cities that a new structure and business model for the IRLNEP was needed to achieve the following outcomes:

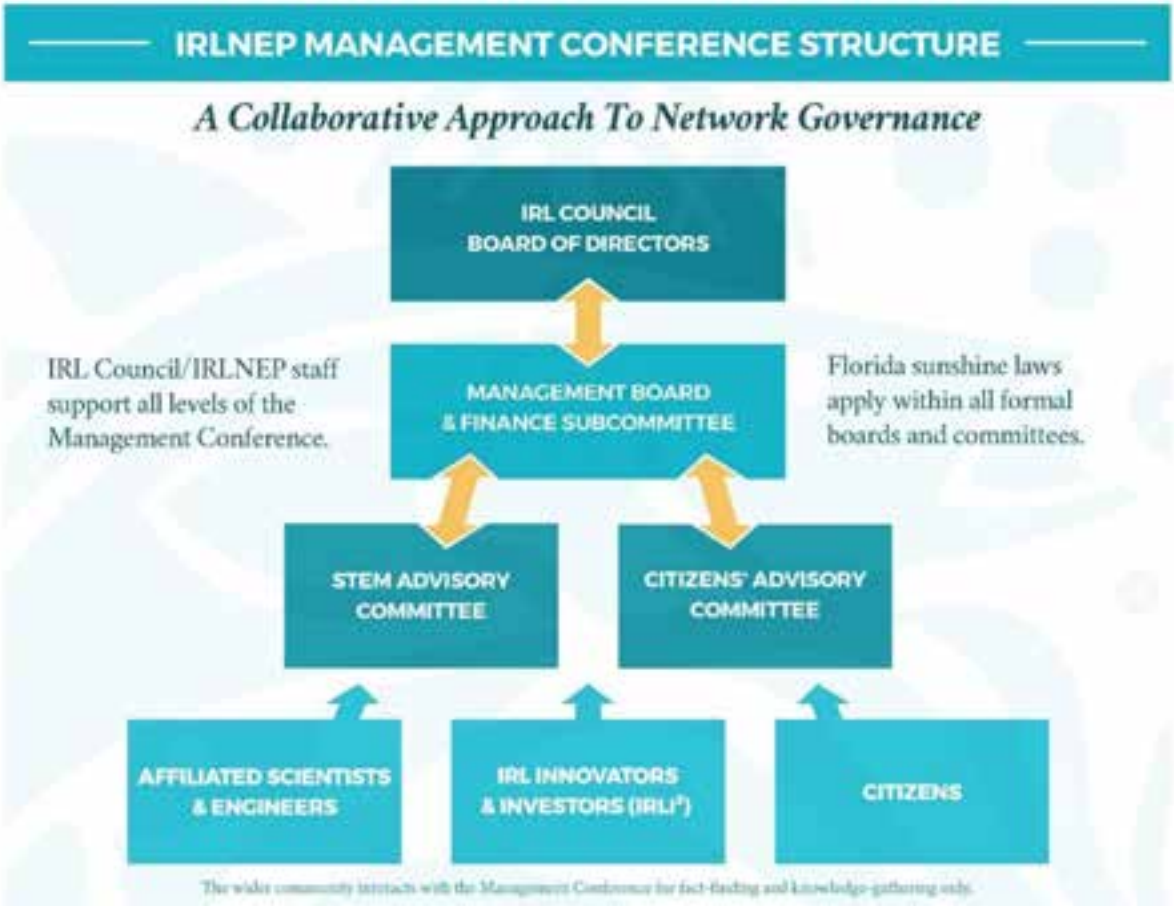
- Solve the urgent problems facing the IRL as a unified, focused, and science-based IRLNEP Management Conference.
- Ensure that the IRLNEP is a fully performing NEP based on USEPA performance measures.
- Enhance local community knowledge and engagement.
- Expand IRLNEP activities to be more inclusive of the entire IRL ecosystem, as well as adjoining systems that influence the lagoon watershed.
- Encourage greater participation from the private-sector.

- Expand and expedite funding for ecosystem restoration at all levels of the public-private-independent sector partnership.

The IRLNEP Management Conference is science-based, non-regulatory, collaborative, community-based, and consensus-driven. It is led by diverse interests from local, state, and federal agencies; academia; community and industry leaders; and citizens dedicated to developing and implementing the vision, mission, goals, and actions of the CCMP. The Management Conference recognizes that no individual organization, agency, or community can protect, restore, and manage the IRL watershed alone. Successful restoration and stewardship of the lagoon will require a common vision and unified effort among citizens and stakeholders throughout the IRL watershed.

The IRL Council created three advisory and oversight committees to provide advice and recommendations: (1) a Management Board comprising administrators and resource managers from local, regional, state, and federal government agencies and organizations, as well as a financial oversight sub-committee; (2) the Science, Technology, Engineering, and Modeling Advisory Committee (STEMAC) that provides scientific and technical expertise, guidance, and oversight from local academic and research institutions; and (3) the Citizens Advisory Committee comprised of local representatives (IRL Ambassadors) representing each of the five counties participating in the IRL Council who are responsible for ensuring that the IRLNEP is connecting to and communicating with local communities and citizens throughout the IRL region. In addition, the IRLNEP staff work directly with industry partners through the IRL Innovator and Investor (IRLI$^2$) Network.

USEPA serves in an advisory capacity to the IRL Council and is a voting member of the advisory Management Board. USEPA represents a major partner/investor to the IRLNEP consistent with Section 320 of the Clean Water Act and contingent upon Congressional reauthorization of Section 320 and annual Congressional appropriations for the NEP. USEPA also provides technical assistance and support to the IRLNEP Management Conference.



Together, the IRL Council and its Management Board and advisory and oversight committees represent the IRLNEP Management Conference. The Management Conference employs the network governance organizational model defined in Section 320 of the Clean Water Act. The IRLNEP Management Conference represents a more than 100-member citizen and scientist oversight committee that advises the IRL Council Board of Directors as they adopt policies and make annual budget and appropriation decisions to implement the CCMP actions. The IRL Council and IRLNEP staff acknowledge and thank all present and past members of the IRLNEP Management Conference for their support of the IRLNEP reorganization and CCMP revision. The current and former members of the Management Conference at the time of CCMP adoption are shown in the tables below.

| IRL Council Board of Directors | IRL Council Board of Directors (alternates) |
|---|---|
| Chris Dzadovsky (Chair), St. Lucie County Commission | Frannie Hutchinson, St. Lucie County Commission |
| Deborah Denys (Vice-Chair), Volusia County Council | Billie Wheeler, Volusia County Council |
| Susan Adams (Secretary), Indian River County Commission | Tim Zorc, Indian River County Commission |
| Bryan Lober, Brevard County Commission | Rita Pritchett, Brevard County Commission |
| Stacey Hetherington, Martin County Commission | Doug Smith, Martin County Commission |
| Drew Bartlett, DEP Deputy Secretary | Thomas Frick, DEP |
| Doug Bournique, SJRWMD | William Tredik, SJRWMD |
| Brandon Tucker, SFWMD | Kathy LaMartina, SFWMD |
| Cesar Zapata, USEPA Region 4 (Advisory) | Jennifer DiMaio, USEPA Region 4 (Advisory) |
| **Former IRL Council Board of Directors and Alternates** | |
| Doug Daniels, Volusia County (2015-2016) | Dick Winger (2016) |
| Kevin Powers, SFWMD (2015-2017) | Joel Tyson (2015-2017) |
| Richard Gillmore, Indian River County Lagoon Coalition (2015-2016) | Curt Smith, Brevard County (2015-2018) |
| Ed Fielding, Martin County (2015-2018) | |

| IRL Council Management Board | | | | | |
|---|---|---|---|---|---|
| Jeff Beal, Florida Fish and Wildlife Conservation Commission (FWC) | Anthony Catanese, Florida Institute of Technology (FIT) | Doug Gibson, Volusia League of Cities | Chuck Jacoby, SJRWMD | Mike Littell, Citizen (Financial Subcommittee) | Marty Smithson, Sebastian Inlet Tax District |
| Vanessa Bessey, Florida Department of Agriculture and Consumer Services (FDACS) | Frank Catino, Brevard County | Stu Glass, Space Coast League of Cities (Financial Subcommittee) | Greg Wilson, Riverside Conservancy (Financial Subcommittee) | Mike McCabe, Melbourne-Tillman Water Control District | Thomas Stratton, Citizen (Financial Subcommittee) |
| Brad Blais, Mead and Hunt, Inc. | Mark Crosley, Florida Inland Navigation District | Layne Hamilton, U.S. Fish and Wildlife Service (USFWS) | George Jones, Ocean, Research and Conservation Association (ORCA) | Kelli McGee, Natua Strategies (Financial Subcommittee) | Laurilee Thompson, Brevard County Tourism Development Council |
| Mel Bromberg, WaterSHED International LLC (replacing Jim David, 2016-2018) | Jennifer DiMaio, USEPA Region 4 | Clay Henderson, Stetson University | Bill Kerr, BKI, Inc. | Robert Musser, Canaveral Port Authority | William Tredik, SJRWMD |
| Thomas Campenni, Treasure Coast League of Cities (Financial Subcommittee) | Monte Falls, City of Vero Beach | Chris Hendricks, Sotheby's International Realty | Kathy LaMartina (Vice Chair), SFWMD | Judy Orcutt, Citizen | Robert Ulevich (Chair), Polymath Consulting Services, Inc. |
| Tom Carey, Volusia County | Joseph Falzone, Raymond James Financial (Financial Subcommittee) | Dianne Hughes, Martin County | Vince Lamb, Citizen | Lynne Phillips, National Aeronautics and Space Administration (NASA)/Kennedy Space Center | Charles Vogt III, Florida Department of Health (FDOH) |
| Paul Carlisle, City of Sebastian | Sara Davis, DEP (replacing Chris Ferraro, 2016-2018) | Mitch Hutchcraft, King Ranch | Barbara Lenczewski, Florida Department of Economic Opportunity (DEO) | Kevin Shropshire, City of Rockledge | |

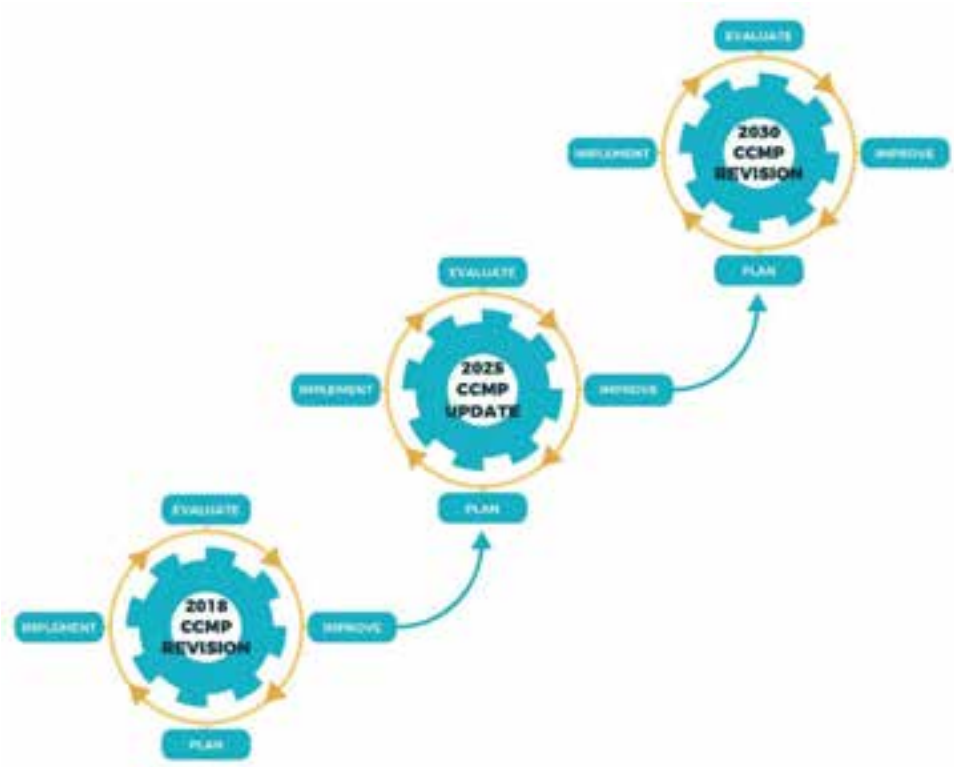
| STEMAC | | | | |
|---|---|---|---|---|
| Anne Birch, The Nature Conservancy | Patti Gorman, SFWMD | Mark Perry, Florida Oceanographic Society | Chris Bodisco, Stetson University | Chris Farrell, Florida Audubon |
| Mitch Roffer, Citizen | Adeljean Ho (replacing Hyun Jung Cho), Bethune-Cookman University | Chuck Jacoby (Chair), SJRWMD | Leesa Souto, Marine Resources Council (MRC) | Chad Truxall (Vice Chair), Marine Discovery Center |
| Kevin Johnson, FIT | Megan Stolon, Hubbs SeaWorld Research Institute | Kevin Cooper, Indian River State College | Andrei Ludu, Embry-Riddle Aeronautical University | Richard Paperno, FWC |
| David Cox, Indian River Soil and Water Conservation District | Dale McGinnis, Eastern Florida State College | Linda Walters, University of Central Florida | Debra Woodall, Daytona State College | Lisa Krimsky, University of Florida Institute of Food and Agricultural Sciences (UF-IFAS) |
| Edie Widder, ORCA | Bob Day, Citizen | Valerie Paul, Smithsonian Marine Station at Ft. Pierce | Dennis Hanisak, FAU/Harbor Branch Oceanographic Institute | |

| Citizens' Advisory Committee | | |
|---|---|---|
| Frank Brownell, Volusia County | Sam Lopez, Brevard County | Leesa Souto, Brevard County |
| Becky Bruner, Martin County | Jim Moir (Vice-Chair), Martin County | Heather Stapleton, Indian River County |
| Dave Carlson, St. Lucie County | Gary Ritter, Indian River County | Katie Tripp, Volusia County |
| Frank Catino (Chair), Brevard County | Billy Rotne, Volusia County | Cynthia Van de Voorde Hall, Indian River County |
| Mike Conneen, Brevard County | Gayle Ryan, Martin County | Jessy Whales, Volusia County |
| Ken Grudens, Indian River County | Adam Locke, St. Lucie County | Keith Winsten, Brevard County |
| Zack Jud, Martin County | Doug Patterson, Brevard County | Graham Cox, Indian River County |
| **Former Citizens' Advisory Committee Members** | | |
| David Brigida, St. Lucie County (2016-2018) | Dennis Dickerson, Volusia County (2016-2018) | Billy Gibson, St. Lucie County (2016-2018) |
| Crystal Lucas, Martin County (2016-2018) | | |

CCMP implementation requires coordination among a diverse network of individuals, communities, and organizations to integrate local-scale conservation activities with broad-scale goals. Sustained performance and success hinges on effective communication among scientists, resource managers, and policy makers. An effective IRLNEP will provide leadership that advances the shared interests of the Management Conference. There is no one-size-fits-all model for addressing IRL problems nor is there an easy “quick fix.” IRL restoration will require a long-term commitment among all stakeholders and partners to fund and implement restoration and stewardship projects. IRL restoration will require action based on science, evaluation, knowledge, and common sense.

# CCMP REVISION: IRLNEP RESPONDS TO A CHANGING LAGOON

This CCMP revision builds on the strengths of the 1996 CCMP and 2008 CCMP update. However, this CCMP revision makes significant changes from previous CCMP action plans to be more responsive to the needs of the IRL and more closely aligned with the NEP Program Evaluation Logic Model and Standardized Performance Measures. Specific CCMP changes since the 2008 CCMP update are documented in **Appendix A**. New CCMP action plan recommendations are identified as "NEW." Most importantly, this revised CCMP shifts its emphasis to an active water quality and habitat restoration focus.




NEPs strive to demonstrate progress on implementing CCMP action plans to meet the objectives of the Clean Water Act and achieve the long-term outcomes of restoring and maintaining the ecological integrity of estuaries of national significance. However, the strength and value of a NEP are tested most when a Management Conference must respond to a combination of factors that shift the trajectory of an estuary from what appeared to be improving health to declining health. Such a shift created the challenges and opportunities facing the IRLNEP today. Since the 2008 CCMP update, the IRLNEP and its Management Conference have been challenged by a combination of events that dramatically reinforced the scientific concerns about the health of the IRL. These events have increased the demands and opportunities for enhanced service and support that the IRLNEP is designed to provide to stakeholders, communities, and citizens.

This CCMP revision incorporates new scientific knowledge, addresses inadequacies of past strategies for restoration and intervention, and responds to new vulnerabilities and emerging threats. Key issues include:

**RESPONDING TO A TIPPING POINT:** The IRL experienced a dramatic shift from a system where benthic aquatic vegetation was expanding to one dominated by planktonic microalgae following an unprecedented algal bloom in 2011 (now referred to as the "2011 superbloom"). The post-2011 IRL is characterized by intense, recurring, and long-lasting algal blooms; widespread loss of seagrasses; and episodic wildlife mortality events. Ongoing blooms of picocyanobacteria, nanoplanktonic chlorophyte, and the brown tide species that plagued Texas, *Aureoumbra lagunensis*, now appear to be the "new normal" for the central and northern IRL. This shift emphasizes the need for improved scientific understanding of nutrient loads, nutrient cycling, and tipping points for the IRL.

**RESPONDING TO LAKE OKEECHOBEE RELEASE EVENTS:** Concurrent with these stress-response issues, the southern IRL is impacted seasonally by freshwater releases from Lake Okeechobee during times of high water. During the summers of 2013, 2016, and 2018, billions of gallons of freshwater were released through

the St. Lucie Estuary to the southern IRL. As a result, the St. Lucie Estuary and southern IRL experienced dramatic salinity shifts including sustained freshwater conditions. The combination of freshwater, high nutrients, sediments, and an inoculant of the cyanobacteria *Microcystis* from Lake Okeechobee, in addition to nutrients from the IRL watershed, fueled harmful algal blooms (HABs) in portions of the southern IRL. In 2013, 2016, and again in 2018, these releases initiated an intense *Microcystis* HAB, with reported concentrations of the toxin microcystin exceeding World Health Organization standards. These freshwater releases and HAB events highlight the importance of connections between the watersheds of the IRL and the Everglades and the need to address expansion of the natural boundaries of the IRL watershed as the IRLNEP adopts a revised CCMP. This CCMP revision considers the resource management implications of connected waters and watersheds more explicitly than in past plans.

**RESPONDING TO A NEED FOR INTEGRATED, SYSTEMATIC, AND SUSTAINED MONITORING, MAPPING, AND MODELING:** More than three decades of peer-reviewed scientific research and other scientific reports have documented the detrimental impacts on water quality generated by nutrients from wastewater treatment systems, septic systems, stormwater conveyances, fertilizers, and muck. This research communicated concerns that continued loading would shift the IRL from a mesotrophic, seagrass-dominated system to a eutrophic, microalgal dominated system. That tipping point may have been reached in 2011, but scientific evidence of a declining lagoon preceded the shift of 2011 by decades, and improvements observed in seagrass growth in the early 2000s may have been caused mostly by drought conditions. Given this ecological shift and the concerted efforts to reduce nutrient loads, there is a growing need to define, coordinate, integrate, and sustain the science that should inform management of the lagoon's water, habitat, living resources, and communities. For example, there is an urgent need to develop and improve lagoon-wide health assessments. There is also a need for ongoing scientific research to better understand the dynamics of the IRL to give policy makers betters options to respond to HABs, fish kills, and other emerging issues including human health threats.

**LEVERAGING THE KNOWLEDGE AND EXPERIENCE OF THE NEP NETWORK:** Evidence of successful restoration of water quality from other NEPs (Sarasota Bay, Tampa Bay, Puget Sound, Long Island Sound, and Narragansett Bay) as well as Chesapeake Bay provided important guidance for this IRL CCMP revision. The message is clear: focused and expanded efforts to reduce nutrient and other pollutant loads by refurbishing aging and inadequate wastewater systems; removing septic systems with connections to a sewer system or upgrading septic systems to enhanced treatment systems; improving treatment of water carried by large stormwater conveyances; implementing alternative solutions to the current practice of land applying biosolids in the watershed; diverting, consolidating, and treating water carried by small, dispersed urban stormwater conveyances; removing muck; and decreasing residential, commercial, and agricultural use of fertilizer and chemicals and managing yard waste will be required as part of a rigorous diet for the IRL. **Across the spectrum of external and internal sources of pollutant loads, a higher standard is required to rectify past loads, limit current loads, and prepare for the loads associated with growth of the human population that is yet to come.** Another critical next step is to restore filter feeders (clams and oysters), because these populations will have direct impacts on improving water quality. Although natural recovery of seagrasses and fisheries is expected with improved water quality and clarity, additional restoration efforts (seagrass replanting and fish-stock enhancement) may be required.

**EVALUATING RISKS ASSOCIATED WITH SEA LEVEL RISE AND CLIMATE CHANGE:** Over the next several decades, coastal communities will be challenged to understand and respond to vulnerabilities of natural resource assets, human-built infrastructure, and transportation/supply chains associated with climate change and sea level rise. Understanding potential risks is the critical first step for coastal communities seeking to implement adaptation strategies that decrease risks, build resilience, and in some cases, take advantage of new opportunities.

## PATHWAY TO IRL RESTORATION

Successful restoration of the IRL is not an easy target to identify, nor does it equate to reestablishing a single set of desired conditions. Broadly defined, ecosystem restoration attempts to remove or reduce human-induced stressors and return some measure of structural and functional integrity to the system. Due to shifting baseline stressors associated with factors such as human populations growth, coastal urbanization, climate change (including sea level rise), and loss of taxa, restoration of the IRL to an idealized past reference status after removal of human-induced pressure may be difficult to achieve[3]. For this CCMP revision, a healthy IRL provides essential ecosystem functions that deliver sustainable ecosystem services to society. The overarching goal for IRL restoration is to improve water quality and biodiversity as evidenced by a stable range of indicators, discussed below in the Measuring Changes in IRL Vital Signs section.

If you are a citizen, industry leader, regulated stakeholder, community decision-maker, scientist, or government agency, you and all the IRLNEP's many partners have an opportunity to restore the IRL. This CCMP revision represents a non-regulatory restoration plan that is dependent on each individual stakeholder and partner taking the actions necessary to reduce human-impacts to the IRL and its watershed. It is a plan that will require annual evaluation, with USEPA required updates and revisions in the future.

## TAKING ACTION

This CCMP revision identifies 10 broad categories of actions that can be considered and implemented by citizens and all IRL stakeholders and partners. They were first envisioned by the Brevard County Save Our Indian River Lagoon Project Plan in 2016 as *REMOVE, REDUCE, RESTORE,* and *RESPOND*. This CCMP revision expands the list of actions to reflect the comprehensive nature of the "One Lagoon – One Community – One Voice" mission of the IRLNEP. This focus of this mission is to approach lagoon restoration with a more unified voice.


[3] Duarte, C. M. et al. 2009. Return to Neverland: Shifting baselines affect eutrophication restoration targets. Estuaries and Coasts 32, 29-36.

## IRLNEP: CORE VALUES

In April 2017, the IRL Council and IRLNEP Management Conference adopted the following vision, mission, promise, and goals. Success for a healthy IRL system will only be achieved if the "One Lagoon – One Community – One Voice" mission is successful.

**Vision:**

*Healthy Ecosystem – Healthy Communities – Healthy Economy*

**Mission:**

*One Lagoon – One Community – One Voice*

**Promise:**

*Clean Water for People and Nature*

**Goals:**

*To attain and maintain water and sediment of sufficient quality to support a healthy estuarine lagoon ecosystem;*

*To attain and maintain a functioning, healthy ecosystem which supports endangered and threatened species, fisheries, commerce and recreation;*

*To achieve heightened public awareness and coordinated interagency management of the IRL ecosystem; and*

*To identify and develop long-term funding sources for prioritized projects and programs to preserve, protect, restore and enhance the IRL.*

# IRLNEP: MEASURING PERFORMANCE AND PROGRESS

To assess NEP progress in achieving long-term CCMP and program goals, USEPA conducts quarterly and annual progress reporting. Every five years, a comprehensive program evaluation is conducted by USEPA for each NEP. USEPA developed NEP Program Evaluation Guidance to assess the effectiveness of NEP actions. The guidance includes performance measures, describes a process for conducting site visits, and provides a feedback loop to help ensure that recommendations for improvement are implemented. This revised CCMP is structured to align with the USEPA Evaluation Model for NEPs and specific Standardized Performance Measures for NEP Core Elements and Sub-Elements:

**NEP Performance Measures - Core Elements**:

Program Implementation and Reporting

*Financial Management – Program Planning and Administration – Outreach and Public Involvement*

Ecosystem Status and Trends

*Research – Assessment and Monitoring - Reporting*

Each activity of a NEP is evaluated based on outputs and outcomes. Outputs represent the deliverables from the workplan and CCMP activities (i.e., products, services, methods, and approaches). Outcomes are the results, impacts, and accomplishments. When possible, outcomes are quantified as measurable changes. USEPA considers three timelines for outcomes:

- Short-term (1 – 2 years) outcomes revolve around improved knowledge.
- Medium-term (3 – 4 years) outcomes revolve around behavioral change.
- Long-term (5 – 10+ years) outcomes revolve around restoration and maintenance of the ecological integrity of estuaries of national significance so that they meet their defined uses.

# ROLE OF THE IRLNEP

Throughout this revised CCMP, specific IRLNEP responsibilities will be identified that align with three broad categories of program commitment or action (coordinate, collaborate, and conduct).

| Actions | Engagement |
|---|---|
| Coordinate | Convene partnering entities, ensure open communication to minimize conflicts and/or redundancies, and maximize efficiencies through cooperative ventures. |
| Collaborate | Join forces with partner agencies and invest staff time and funding into projects. |
| Conduct | Invest staff time and funding as the lead agency conducting an IRL initiative defined in the IRLNEP Annual Business Plan, budget, and USEPA workplan identifying federally-funded projects. |

Over the next decade, the IRLNEP will join with partners in its Management Conference to advance initiatives and actions that restore the IRL, enhance long-term stewardship of the system, and align with authority, vision, mission, promise, and goals of the Clean Water Act. Realization of the complete benefits of the IRL Council Interlocal Agreement and development of the IRLNEP as a fully performing estuary program that represents the entire IRL watershed will require significant and sustained program support (both human and financial resources). IRLNEP leadership actions identified in this CCMP revision represent specific and strategic IRLNEP outputs (deliverables). These actions will be represented as project deliveries in annual USEPA workplans, as well as IRLNEP business plans and budgets. Each IRLNEP leadership action addresses a program need and is an essential prerequisite for effective, science-based ecosystem restoration. When viewed collectively, these leadership actions combine with others that have been completed or are already in progress to form a solid foundation for successful restoration and stewardship of the IRL. Most importantly, the IRLNEP will strive to implement an IRL ecosystem-wide restoration initiative that is effective, efficient, transparent, and inclusive.

| IRLNEP Mission | IRLNEP Deliverables from the Action Plans | Tentative Target Date |
|---|---|---|
| **ONE LAGOON** | Annual CCMP project funding and implementation (projects identified and prioritized for IRL Council/IRLNEP funding annually) | Annual; recurring |
| | Lagoon-wide geographic information system (GIS) asset mapping | Annual; recurring |
| | *Looking Ahead – Science 2030 Report* that identifies gaps in knowledge, emerging issues and innovation opportunities | 2019; update as needed |
| | IRL Habitat Restoration Plan anchored by a network of four Regional Restoration Centers identified for IRL restoration, research, citizen engagement, and education (Marine Discovery Center in Volusia County, Brevard Zoo in Brevard County, Harbor Branch Oceanographic Institution in Indian River and St. Lucie Counties, Florida Oceanographic Society in Martin County) | 2019-2020 |
| | Climate Ready Estuary Report (risk-based vulnerability assessment and adaptation plan funded by USEPA, in development) | 2018-2019 |
| | CCMP Update (USEPA mandate every five years, as needed) | 2025 |
| | CCMP Revision (USEPA mandate every 10 years) | 2030 |
| | Expanded funding for cost-share projects from local, state, regional, federal, and private funding sources | Annual; recurring |
| | IRL Projects Plan | 2019; update annually |
| **ONE COMMUNITY** | Update of 2016 IRL Economic Analysis | 2019-2020; update as needed |
| | Update Boaters Guide to the Indian River Lagoon | To be determined (TBD) |
| | Emergency Incident Preparation and Response Plan | TBD |
| | Expansion of IRLI[2] network (IRLNEP leadership to promote and cultivate water and clean technology innovation, technology development, and private-sector industry solutions to IRL and Florida water quality challenges) | Annual; recurring |
| | Direct support (IRLNEP staff and funding resources) for three established annual lagoon-wide symposia:<br>EDUCATION: ShORE (Sharing Our Research with Everyone) education/research conference hosted by Daytona State College<br>RESEARCH: IRL Science Symposia hosted by Florida Atlantic University/Harbor Branch Oceanographic Institute<br>TECHNOLOGY: IRL Research Institute TechCon hosted by FIT coupled with industry-led incubator/accelerator partnerships for innovation development | Annual; recurring |
| **ONE VOICE** | IRL Monitoring Plan | 2019-2020 |
| | IRL Communications Plan | 2019; update annually |
| | IRLNEP "One Community – One Voice" Initiative | 2019-2020 |
| | "State of the Lagoon" Technical Report (synthesizing the science, identifying stressors, and responding to emerging threats) | Begin initiative in 2019-2020; tentative target for report in 2025 |

# IRL VITAL SIGNS

The Puget Sound Partnership is one of the nation's 28 NEPs, and they developed a Vital Signs wheel that communicated the health of the Puget Sound in a way that was scientifically valid and resonated with the public.[4] The IRLNEP recognized the value and success of the Puget Sound Partnership Vital Signs wheel and applied a similar approach for the IRL. The IRL Vital Signs represent different CCMP action plans or the overarching

[4] Puget Sound Partnership. Vital Signs Website: http://www.psp.wa.gov/vitalsigns/.

measures for determining the health of the IRL. New CCMP action plans or Vital Signs that have been added as part of this CCMP revision are identified as “NEW” in the tables of actions for each Vital Sign.

## HOW TO USE THE VITAL SIGNS WHEEL

The IRL Vital Signs wheel presents 32 Vital Signs for IRL health that align with the "One Lagoon – One Community – One Voice" mission of the IRLNEP. Each Vital Sign is important:

- One Lagoon – Water quality, habitat restoration, and living resources issues and actions reside within the One Lagoon segments of the wheel.
- One Community – Community planning, economic development, and coastal resilience issues reside within the Healthy Communities segments of the wheel.
- One Voice – Strategic IRLNEP activities authorized by Section 320 of the Clean Water Act reside within the Communicate, Collaborate, and Coordinate segments of the wheel. Specific outputs (deliverables) and outcomes from this segment represent essential CCMP implementation and financial activities that will drive restoration and stewardship of the IRL.

Every citizen, scientist, local community, public agency, and stakeholder can view Vital Signs individually and collectively as an IRL “Call to Action.” All point inwardly towards the center of the wheel and a healthy lagoon. Identify which Vital Sign(s) correspond to your responsibility, authority, or opportunity. If you are responsible or interested in solving a problem within a Vital Sign, take action and fix the problem. This individual ownership approach respects local home-rule decisions of our communities and allows adaptive and strategic management decisions to be made at all levels of the Management Conference partnership.

## MEASURING CHANGES IN IRL VITAL SIGNS

An adage by Peter Drucker is, "*You cannot manage what you do not measure*." Measuring all possible indicators at all times and in all locations would be cost prohibitive and impossible. Nevertheless, measuring key indicators at multiple locations on a frequency that captures important changes and evaluating the data relative to appropriate targets represent a cost-effective approach to documenting status and trends and demonstrating the effectiveness of management actions.

For each of the 32 Vital Signs, specific indicators were identified and will be measured to assess the condition of the Vital Sign (its status) and document how that condition changes through time (any trend). The selection and monitoring of indicators represents a complex process and challenging process. Appropriate and consistent indicators should convey complex information as simple and useful measures of status and trends. Some indicators presented in this CCMP revision have been well studied with ample information available to describe status and trends, whereas other indicators are not well understood. Therefore, some indicators may be reconsidered, modified, or replaced as new information becomes available. The IRLNEP will work with the Management Conference and our partner scientists, managers, and practitioners to advance appropriate indicators and to better understand stressor-response relationships. Overall, indicators can provide:

- Fundamental information on the health of a system.
- Essential measures of the success of management actions and valuable guidance for course corrections including identification of degrading trends that can be or should be reduced or reversed and improving trends that can be or should be facilitated or accelerated.
- Qualitative and quantitative metrics that can provide useful comparisons through time on local, regional, or national scales.
- Easy to understand information that communicates clear messages to diverse target audiences including managers, scientists, and the public.

The following tables show how the IRLNEP mission, Vital Signs, indicators, and targets are related. The most important aspect of CCMP implementation will be to evaluate trends for each Vital Sign, as appropriate, to document improvement or decline in lagoon conditions over time. Identification and quantification of appropriate indicators and targets will be an ongoing challenge and opportunity for the IRLNEP over the next decade.

| IRLNEP Mission | Vital Sign Category | Vital Signs | Indicators: The Measures | Targets |
|---|---|---|---|---|
| ONE LAGOON | Water Quality | Impaired Waters | Total maximum daily loads (TMDLs), basin management action plans (BMAPs), reasonable assurance plans (RAPs), applicable water quality criteria including numeric nutrient criteria, biological response | Total phosphorus, total nitrogen, chlorophyll-a, fecal coliform, metals; BMAP or RAP compliance; meeting water quality criteria and removal from impaired waters list |
| | | Wastewater | WWTP discharge quality; number of septic conversions to advanced septic or sewer; biosolids and reclaimed water nutrient management | Advanced wastewater treatment (AWT); connection of septic systems near surface waters; total phosphorus, total nitrogen, fecal coliform, metals, and pollutant load reductions |
| | | Stormwater | Stormwater discharge to IRL; urban, recreational, and agricultural fertilizer use reductions (pounds or tons); urban and agricultural best management practices (BMPs) implementation; light attenuation coefficient in the lagoon | Freshwater, total phosphorus, total nitrogen, salinity, sediment, fecal coliform, and metal load reduction; annual reductions in fertilizer use; acres treated by BMPs; pre-development runoff equal to post-development runoff; percent light reaching lagoon substrate |
| | | Hydrology and Hydrodynamics | Surface water volume restored to natural flow, groundwater and internal water flows and loads | Hydrologic targets identified and achieved |
| | | Legacy Loads and Healthy Sediments | Healthy sediments; location, acreage, volume, and nutrient loads/flux from muck | Total phosphorus, total nitrogen, hydrogen sulfide, pH, sediment toxicity |
| | | Atmospheric Deposition | Wet-dry atmospheric deposition of nitrogen and pollutants | Total nitrogen and contaminants |
| | | Contaminants of Concern | Types, concentrations, and loads of contaminants of concern | Thresholds levels identified by water quality criteria for human and wildlife health, contaminant concentration, and contaminant load |

| IRLNEP Mission | Vital Sign Category | Vital Signs | Indicators: The Measures | Targets |
|---|---|---|---|---|
| ONE LAGOON | Habitat Quality | Seagrasses | Coverage (acres), density, and species diversity; coverage (acres), density, and species diversity of other benthic habitats | Recovery to scientifically defensible reference target; TMDL targets for seagrass |
| | | Filter Feeders | Coverage (acres), density, and condition of live target species in conservation and/or commercial production | Recovery to scientifically defensible reference target |
| | | Living Shorelines | Expansion of functional living shoreline habitats based on quantitative shoreline restoration coupled with evaluation of natural habitat quality and functionality; miles of living shoreline, miles of buffer zone | Miles of eroded or hardened shoreline planted, miles of buffer zones around waterbodies |
| | | Wetlands and Impounded and Altered Marshes | Acres in conservation and management | Acres acquired and conserved, natural wetland functions restored and managed |
| | | Spoil Islands | Islands in conservation, management, and public use | Islands restored, enhanced, and managed |
| | | Land Conservation | Acres in conservation, management, and public use | Acres restored and managed for ecosystem integrity |
| | | Connected Waters and Watersheds | Regional watershed planning and project integration | Volume or area of unimpeded circulation in the IRL, restored flows to St. Johns River, volume retained to groundwater |

| IRLNEP Mission | Vital Sign Category | Vital Signs | Indicators: The Measures | Targets |
|---|---|---|---|---|
| ONE LAGOON | Living Resources | Biodiversity | Pelagic and benthic community diversity, population status, and trends; grazers; aquatic trophic cascade | Target complex, not yet established; maintain biodiversity of region |
| | | Species of Concern | Rare, threatened, endangered, and endemic species identification, population trends, and recovery | Targets for species recovery are population, location, and removal from listing |
| | | Invasive Species | Invasive species population reduction and removal | 100% removal |
| | | Forage Fishes | Population status and trends | Targets for sustainable populations looking at presence of breeding grounds, species population, and species location |
| | | Commercial and Recreational Fisheries | Population status and trends | Targets for sustained and robust commercial and recreational fishing, sustainable yields and catch, presence of breeding grounds, and species population and location |
| | | HABs | Annual incidence of toxic and non-toxic HAB events | Target reductions for number, intensity, and duration of blooms |
| | | Climate Ready Estuary | Risk-based vulnerabilities identified | Adaptation strategies identified and adopted, projects implemented |

| IRLNEP Mission | Vital Sign Category | Vital Signs | Indicators: The Measures | Targets |
|---|---|---|---|---|
| ONE COMMUNITY | Healthy Communities | Vibrant 21st Century Communities | Communities with vision and sustainability plans | Inventory of plans developed and shared |
| | | Trash-Free Waters | Weight/volume of trash recovered annually and hotspots for trash identified | Trash-Free Lagoon by 2030 |
| | | Marinas and Boating | Number of clean marinas, number of derelict boats, number of moored vessels | Expanded clean marinas and compliance, 100% reduction in derelict boats, no discharge zone throughout IRL |
| | | Distinctive Lagoon Communities | Urban waterfronts, working waterfronts, and Environmental Justice communities identified | Full engagement between communities and IRLNEP Management Conference |
| | | Emergency Preparation and Response | Emergency preparation and response | Emergency preparation and response plans in place |

| IRLNEP Mission | Vital Sign Category | Vital Signs | Indicators: The Measures | Targets |
|---|---|---|---|---|
| ONE VOICE | Communicate – Collaborate – Coordinate | Monitoring and Data Sharing | Monitoring Plan developed and implemented | Comprehensive and integrated lagoon-wide sampling, monitoring and data sharing network and plan in place, economic value of IRL quantified and updated regularly |
| | | State of the Lagoon | Comprehensive, integrated, multi-disciplinary State of the Lagoon Technical Report | Delivery of State of the Lagoon Technical Report every 10 years |
| | | Technology Innovation | Science Plan developed and implemented | Science and technology advancements support and improve resource protection management and environmental resource-based economic stability |
| | | CCMP Implementation and Financing | CCMP revised, funded, and projects tracked and implemented | CCMP restoration project implementation and return on investment |
| | | Citizen Engagement and Education | Communication Plan developed and implemented | Citizen knowledge, engagement, and behavior change to improve lagoon health increases over time |
| | | Federal, State, and Local Policy Opportunities | Local, state, and federal policies align with IRLNEP vision, mission, and goals | Number of policy opportunities and roadblocks identified and altered |

## IRL HEALTH CONCERN LEVELS

Each IRL Vital Sign was ranked by the IRLNEP Management Conference based on one of four levels of ecosystem health concern.

Levels are shown with this icon  and are color-coded as red, dark orange, light orange, and blue and include the level number:

**LEVEL 1: CRITICAL –** Condition threatens immediate and long-term prognosis for lagoon health. Indicators are unfavorable. Trend is negative. Immediate and aggressive intervention is urgently needed to stop and reverse trend.

**LEVEL 2: SERIOUS –** Condition threatens long-term prognosis for lagoon health. Trend is unfavorable or uncertain. Favorable outcome is not expected without strategic intervention and long-term stewardship.

**LEVEL 3: UNDETERMINED** – Insufficient knowledge is available to inform decision-making and resource management for the Vital Sign. Research needs to be identified, funded, and applied to resource management.

**LEVEL 4: STABLE OR IMPROVING TREND –** Vital Sign is stable or trending towards improvement. Continued intervention is needed. Long-term stewardship efforts are expected to deliver favorable outcomes.

# HOW TO USE THIS PLAN

For each Vital Sign, the following information is provided:

- Goals: The specific goals that will be achieved by implementing the actions for the Vital Sign.
- Issue Summary: Description of the issues facing the IRL system for the Vital Sign, using the best available information.
- Strategies: Approaches that should be implemented to achieve the goals for the Vital Sign.
- Action Plan Outputs (Deliverables): Specific deliverables including the responsible and partner entities, estimated costs, potential funding sources, and the IRLNEP role in delivering the output.
- Outcomes: Short-, medium-, and long-term outcomes expected from implementation of the outputs.
- Challenges to Success: Potential challenges to achieving the goals of the Vital Sign.
- Citations: Literature referenced in the above items for each Vital Sign.

The information in the following sections guides the IRL Council and Management Conference in achieving the vision, mission, promise, and goals established for the IRL system.

# IMPAIRED WATERS


## Goals:

**Achieve water quality standards to remove waterbodies from the Impaired Waters list.**

# ONE LAGOON

## WATER QUALITY

### *Impaired Waters (Including TMDLs, BMAPs, and RAPs)*

**GOALS:** ***REMOVE*** **or** ***REDUCE*** **anthropogenic pollutant and nutrient loading to the IRL watershed to meet the regulatory targets established by TMDLs, BMAPs, and/or RAPs; achieve the intended biological response criteria; and achieve applicable water quality criteria to** ***REMOVE*** **the waterbody from the Impaired Waters designation list.**

**ISSUE SUMMARY:** Waters that do not meet state and federal water quality standards for one or more parameters are determined to be "impaired." Under the federal Clean Water Act, this determination requires the development of TMDLs for pollutants causing impairment to the waterbody. For identified pollutants, TMDLs must specify reductions to achieve water quality standards.


As of 2018, the IRL system has verified impairments of water quality standards for nutrients, fecal coliform bacteria, and metals. In March 2009, DEP adopted TMDLs for the IRL watershed, which was determined to be impaired due to excessive amounts of total nitrogen and total phosphorus.[1] The TMDLs focused on the water quality conditions necessary for seagrass regrowth at the depth limits where seagrass historically grew in the watershed, based on a multi-year composite of seagrass coverage. The median depth limits of seagrass coverage in the IRL system have decreased over the years because of deteriorating water quality conditions. In 2013, additional TMDLs were adopted for dissolved oxygen and nutrients for eight tributary segments to the IRL.[2] TMDLs were established in 2008 for dissolved oxygen, total nitrogen, and total phosphorus for the St. Lucie River and Estuary Basin, located at the southern end of the IRL.[3] In addition, DEP adopted nutrient numeric criteria for the entire IRL for total nitrogen, total phosphorus, and chlorophyll-a.

Following TMDL adoption, DEP worked with IRL partners to develop BMAPs to implement the actions needed to achieve the IRL TMDLs. A BMAP is a "blueprint" for restoring impaired waters, and it represents a comprehensive set of strategies—permit limits on wastewater facilities, urban and agricultural BMPs, conservation programs, and financial assistance—designed to implement pollutant reductions established by the TMDLs. BMAPs are adopted by DEP Secretarial order and are enforceable. BMAPs were adopted for the North IRL,[4] Central IRL,[5] and Banana River Lagoon[6] portions of the IRL system in February 2013 and the St. Lucie River and Estuary in June 2013.[7] Revisions to the IRL TMDL and associated model are currently underway.[8,9]

DEP identified the Mosquito Lagoon and Loxahatchee River as impaired, but a TMDL is not required for these waterbodies because partners in these areas are working with DEP to develop RAPs.[10,11] RAPs are similar to BMAPs in that they identify strategies and projects that affected stakeholders will implement to achieve water quality standards within a specified timeframe; however, the RAP is intended to provide reasonable assurance to DEP and USEPA that these pollution control mechanisms will result in reasonable progress toward attainment of

water quality standards and bring these waters into compliance with state and federal criteria in the future so that a TMDL is not needed.

## STRATEGIES:

- Participate in TMDL, BMAP, and RAP processes and work to expand partnerships, identify and implement pollutant reduction projects, and obtain funding to meet and work to surpass minimum water quality standards to achieve restoration goals.
- Continue to identify and implement scientific *RESEARCH* projects to better understand nutrient cycles and flux in the IRL to advise revisions of TMDLs, BMAPs, and RAPs.
- Evaluate and achieve stakeholder support for future IRLNEP activities that can help TMDL, BMAP, and RAP implementation and success.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action Plan Outputs | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Impaired Waters-1: Support implementation, review, and update of IRL TMDLs as needed and as best available science evolves.** | Use best available science to revise TMDL targets, as needed. | DEP | BMAP partners, IRLNEP Management Conference | TBD | DEP, local governments | Coordinate |
| **Impaired Waters-2: Work with BMAP partners and DEP to support implementation of BMAPs and track progress, compliance, and implementation challenges.** | Implement water quality improvement projects with a goal to *REMOVE* waterbody from impaired list. | DEP | BMAP partners, IRLNEP | $4.6 billion* | DEP, local governments, water management districts (WMDs), Florida Legislature | Collaborate |
| **Impaired Waters-3: Support the partners and DEP in the development, adoption, and implementation of the Mosquito Lagoon and Loxahatchee River RAPs. (NEW)** | Adopt RAPs for Mosquito Lagoon and Loxahatchee River to guide water quality restoration. | RAP partners | DEP, IRLNEP | Mosquito Lagoon: $39 million; Loxahatchee River: $90 million | DEP, local governments, Florida Legislature | Collaborate |
| **Impaired Waters-4: Evaluate opportunities to incentivize, monetize, and expedite nutrient reduction policies and actions, including water quality credit trading. (NEW)** | Expedite water quality improvements. | IRLNEP Management Conference, local governments | DEP | $4.6 billion* | Private investments, local governments, DEP, WMDs, Florida Legislature | Coordinate |

*Estimate for Banana River Lagoon, North IRL, Central IRL, and St. Lucie River and Estuary BMAPs.[11]

## OUTCOMES:

- **Short-term (1 – 2 years):** Increase local partner participation in these watershed restoration processes.
- **Medium-term (3 – 4 years):** Implement projects and programs to work towards five-year nutrient reduction targets specified in the BMAPs.
- **Long-term (5 – 10+ years):** Meet five-year and ten-year nutrient reduction targets specified in the BMAPs. Meet the five-year targets identified in the Mosquito Lagoon and Loxahatchee River RAPs. Evaluate seagrass response and make recommendations as necessary to revise BMAP activities and TMDL targets. *REMOVE* the waterbody from the Impaired Waters designation list.

## CHALLENGES TO SUCCESS:

- Inadequate funding and project ideas to meet required reductions.
- Lack of incentive for regulated stakeholders to surpass required nutrient reductions.
- Legacy loading in the watershed may mask progress towards achieving water quality standards.
- Limited understanding by some of the public on how individual actions impact the lagoon water quality.
- Inadequate data on appropriate spatial and temporal scales, need for multiple lines of evidence, and complexity of modeling and model construction, testing, and validation.
- Lack of planning that results in reactive or hastily implemented projects that may not benefit lagoon water quality.
- Inadequate long-term support for real-time monitoring to assess if water quality targets and standards are being achieved.

## CITATIONS:


1. Gao, X. 2009. TMDL Report: Nutrient and Dissolved Oxygen TMDLs for the Indian River Lagoon and Banana River Lagoon. Florida Department of Environmental Protection.
2. Gao, X. and Rhew, K. 2013. TMDL Report: Dissolved Oxygen and Nutrient TMDLs for Eight Tributary Segments of the Indian River Lagoon. Florida Department of Environmental Protection.
3. Parmer, K., Laskis, K., McTear, R., and Peets, R. 2008. TMDL Report: Nutrient and Dissolved Oxygen TMDL for the St. Lucie Basin. Florida Department of Environmental Protection.
4. DEP. 2013. Basin Management Action Plan for the Implementation of Total Maximum Daily Loads for Nutrients Adopted by the Florida Department of Environmental Protection in the Indian River Lagoon Basin North Indian River Lagoon.
5. DEP. 2013. Basin Management Action Plan for the Implementation of Total Maximum Daily Loads for Nutrients Adopted by the Florida Department of Environmental Protection in the Indian River Lagoon Basin Central Indian River Lagoon.
6. DEP. 2013. Basin Management Action Plan for the Implementation of Total Maximum Daily Loads for Nutrients Adopted by the Florida Department of Environmental Protection in the Indian River Lagoon Basin Banana River Lagoon.
7. DEP. 2013. Basin Management Action Plan for the Implementation of Total Maximum Daily Loads for Nutrients and Dissolved Oxygen by the Florida Department of Environmental Protection in the St. Lucie River and Estuary Basin.
8. Harper, H.H. and Baker, D.M. 2016. Refining the Indian River Lagoon TMDL-Technical Memorandum Report: Assessment and Evaluation of Model Input Parameters.
9. Janicki Environmental and Applied Technology and Management. 2012. Nutrient Loading Estimates for the Indian River Lagoon TMDL Load Revision. Brevard County. http://www.brevardfl.gov/NaturalResources/WatershedProgram.
10. Mosquito Lagoon Reasonable Assurance Plan website: http://publicfiles.dep.state.fl.us/DEAR/Mosquito%20Lagoon%20RA/.
11. Loxahatchee River Reasonable Assurance Plan website: http://publicfiles.dep.state.fl.us/DEAR/Loxahatchee_RA_Plan/.

# WASTEWATER

Loxahatchee River District

## Goals:

**Improve wastewater infrastructure to increase capacity and treatment. Achieve advanced wastewater treatment.**


# ONE LAGOON

## WATER QUALITY

### *Wastewater*

**GOALS: Improve municipal and industrial wastewater infrastructure throughout the IRL watershed to achieve AWT standards to *REDUCE* or *REMOVE* loads of human and industrial pollutants to the IRL. *REDUCE* vulnerability to WWTP overflows to the IRL. Expand WWTP capacity to accommodate septic to sewer conversions and the region's growing human population.**

**ISSUE SUMMARY:** The 2017 Bureau of Economic and Business Research estimates the population of the five IRL region counties will increase up to 27% between 2017 and 2030.[1] This projected population increase presents various challenges including how to treat and transport increased wastewater with an aging and limited infrastructure. Sea level rise will place additional stress on centralized sewer systems, pipes, and septic systems in low elevation and high-water table areas. Nutrient and other pollutant loads come from various wastewater sources in the IRL, including WWTPs, septic systems, reclaimed water, and biosolids. Each of these sources has its own challenges with respect to waste treatment and management.[2]

**WWTPs.** Direct WWTP discharges to the lagoon were largely removed because of the federal Clean Water Act (1972) and the Indian River Lagoon System and Basin Act of 1990 (Chapter 90-262, Laws of Florida). The Indian River Lagoon System and Basin Act had three stated goals: (1) elimination of surface water discharges, (2) investigation of feasibility of reuse, and (3) centralization of wastewater collection and treatment facilities. This Act also required local governments to identify areas where package treatment plants and septic systems posed threats to the IRL and implement plans to provide centralized sewage treatment to these areas. Many of the small package WWTPs were removed throughout the basin in response to the Act. In recent years, public concerns have focused on accidental wastewater discharge events associated with hurricanes, tropical storms, heavy rain events, and line breaks. These discharges are associated with aging pipe infrastructure and leaks and/or cracks in underground wastewater lines. These increasing common failures highlight the vulnerability of the aging and inadequate wastewater infrastructure to water inflow/infiltration, wastewater pipe failures, and lift station failures. Conversion of septic systems to centralized sanitary sewer systems will further burden existing aging wastewater infrastructure. Infrastructure improvements to municipal and private WWTPs present multiple community benefits in addition to IRL protection. It is recommended that domestic WWTPs meet AWT standards of 3 milligrams per liter (mg/L) for total nitrogen and 1 mg/L for total phosphorus in the treated effluent. In addition to the domestic WWTPs, there are industrial WWTPs throughout the IRL watershed. Industrial wastewater sources include manufacturing, commercial businesses, mining, agricultural production and processing, and cleanup of petroleum- and chemical-contaminated sites. Industrial wastewater discharges in Florida must provide reasonable assurance for meeting water quality standards for surface water or groundwater to receive a discharge permit from DEP. Maps of the domestic and industrial WWTPs in the IRL watershed are provided in **Appendix B**.

**Septic Systems or Onsite Sewage Treatment and Disposal Systems (OSTDS).** A 2015 study found that the approximately 300,000 septic systems in the IRL watershed contribute a large nitrogen load to the lagoon.[3] Maps of the OSTDS in the IRL watershed based on FDOH data are provided in **Appendix B**. Storm events also affect septic systems, especially systems that are old, poorly maintained, and/or sited near the IRL and its major tributaries where high water tables may compromise septic system drainfield functions. Sea level rise, changing rain patterns, and elevated water tables will further reduce efficiencies and place additional burdens on OSTDS.[2, 3] In combination, more than 50% of the households in Volusia, Indian River, and Martin Counties are served by OSTDS, as shown in the table below.[4] Traditional septic systems, as well as old or failed systems, provide little or no treatment for nutrients. In addition, failing systems may provide little or no treatment for pathogens. It is recommended that traditional septic systems not be used near the IRL and its tributaries and major canals. In

October 2018, the Brevard County Commission passed an ordinance that requires alternative septic systems on the barrier island and within an identified overlay zone along the IRL.

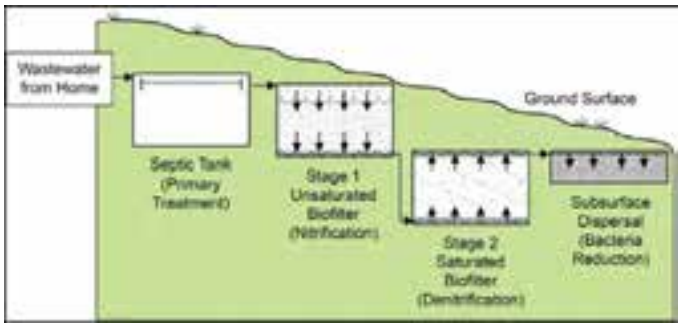
Advanced OSTDS can be used to reduce the nutrient contribution to groundwater. On July 31, 2018, FDOH adopted revised OSTDS rules to authorize in-ground nitrogen reducing biofilters and other "alternative systems." The rule authorizes alternative systems in circumstances where standard systems are not suitable or where alternative systems are more feasible.

| County | OSTDS | Municipal | Proportion OSTDS |
|---|---|---|---|
| Volusia | 102,831 | 102,413 | 50% |
| Brevard | 91,630 | 117,797 | 43% |
| Indian River | 30,574 | 25,968 | 54% |
| St. Lucie | 34,364 | 70,649 | 33% |
| Martin | 29,864 | 26,201 | 53% |

Source: Barile 2018.


Source: http://www3.epa.gov/npdes/pubs/homeowner_guide_long_customize.pdf

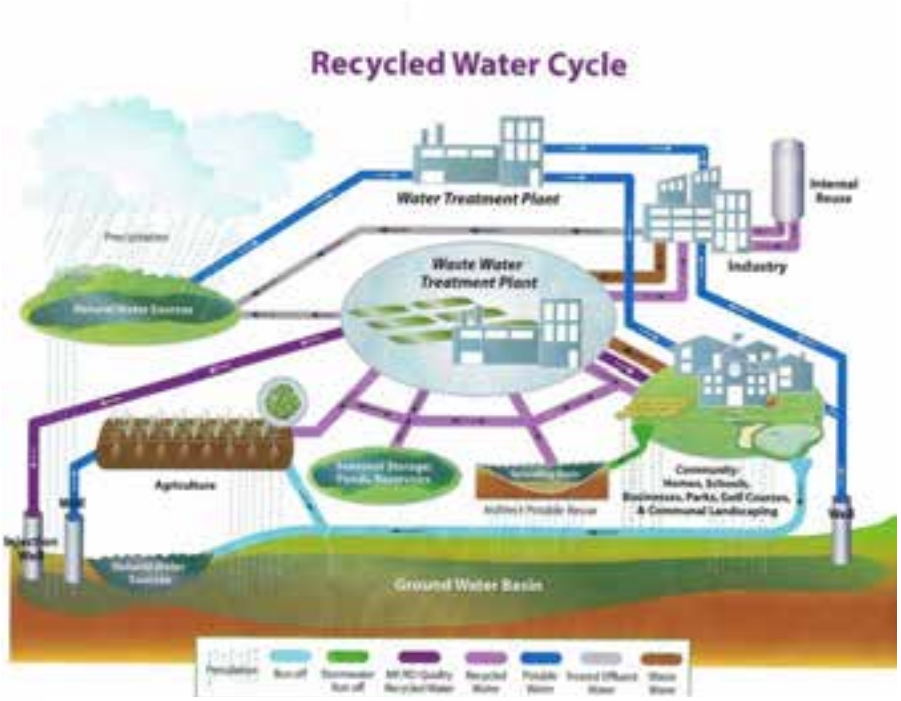
**Conventional OSTDS**




Source: Hazen and Sawyer[5]

**Passive Nitrogen Reduction System**

**Reclaimed Water.** Today, many WWTPs use their treated effluent for irrigation although other options for reclaimed water disposal exist as shown in the graphic. While the use of reclaimed water for irrigation is an excellent approach to conserving potable water, if the reclaimed water is high in nutrients, irrigation with reclaimed water can result in nutrients leaching into the groundwater. Currently, no regulations exist for the concentration of total nitrogen and total phosphorus in reclaimed water for irrigation. In the IRL watershed, reuse discharges from WWTPs range from average annual total nitrogen concentrations of 0.22 to 29.40 mg/L and average annual total phosphorus concentrations of 0.17 to 9.47 mg/L. As part of the




Source: http://ramirezholmes.blogspot.com/2013/07/celebrating-central-dublin-recycled.html

public education and outreach efforts, customers who use reclaimed water for irrigation should be informed of the nutrient content in the reuse water because they can and should eliminate or reduce the amount of fertilizer added to their lawn and landscaping.

**Biosolids.** Biosolids are the solid, semisolid, or liquid residue generated during the biological wastewater treatment process. Land application of biosolids is allowed on permitted sites at controlled rates in accordance with DEP-established site restrictions and site management requirements. All biosolids applied to land application sites must meet the pathogen reduction requirements for Class AA, Class A, or Class B biosolids. No treatment requirements exist for nutrients when producing biosolids, which may lead to biosolids with high nutrient concentrations being applied in the IRL watershed. As a result, it will be important to track where biosolids are being applied, determine the nutrient content, if possible, and track levels of nutrients in the soil. Chapter 62-640, Florida Administrative Code, does not authorize the land application of biosolids in the St. Lucie River, Lake Okeechobee, and Caloosahatchee River watersheds unless the applicant for a site permit can demonstrate that the nitrogen and phosphorus in the biosolids will not add to nitrogen and phosphorus loadings in the watershed. There is growing public concern that more protective measures are required within the IRL watershed, as well as statewide, to ensure that biosolid nutrient loading to both surface waters and groundwater is strictly managed and controlled. Additional concerns are associated with emerging pollutants that may be present in the biosolids waste stream. DEP recently created a Biosolids Technical Advisory Committee to evaluate current management practices and potential opportunities for enhancements to better protect Florida's water resources. The Technical Advisory Committee includes seven members, who represent academia (two representatives), small utilities, large utilities, environmental interests, agriculture, and haulers.

## STRATEGIES:

- Improve existing wastewater infrastructure to accommodate transfer of septic systems.
- Explore new technologies for AWT, such as those that generate power, *REMOVE* contaminants of emerging concern, and reclaim nitrogen and phosphorus separately. Conduct a cost-benefit analysis for these technologies.
- Review permit data to establish current baseline for permitted wastewater discharges into the IRL.
- Refine scientific knowledge about anthropogenic sources, e.g., use of biogeochemical tracers to identify human wastewater sources.
- Implement an OSTDS inspection program to identify and prioritize areas where OSTDS are having the greatest impact and to determine if the OSTDS can be connected to the sewer system or upgraded to an advanced OSTDS.
- Continue to *REDUCE* density of septic systems in the IRL watershed, particularly in high vulnerability and high impact areas. Where connection to centralized sewer is not practical or possible, policies should require use of nitrogen reduction treatment systems in areas that impact IRL surface or groundwater.
- Provide funding for innovative technologies to improve nutrient treatment efficiencies and decrease costs for nitrogen reduction systems where connection to sewer is not possible.
- Work with local governments to create rules and ordinances requiring connection of septic systems to the sewer system within a certain time after sewer is made available, and to allow access by utilities for maintenance of advanced OSTDS.
- Develop strategies and policies to identify areas not suitable for conventional septic systems where alternative systems would be more feasible, and to incentivize or require alternative systems in areas where wastewater treatment is not available.

- *REDUCE* excess use of reclaimed water that supersaturates soils and pollutes groundwater within the IRL watershed.
- Identify new uses for reclaimed water to *REDUCE* discharges.
- Conduct *RESEARCH* to track where all classes of biosolids are being applied and to determine the nutrient and other pollutant content.
- Identify and evaluate alternative technologies for the handling, processing, and disposal of biosolids.
- Conduct *RESEARCH* to quantify nutrient loading associated with application of reclaimed water for irrigation purposes and implement associated fertilizer reductions.
- *REDUCE* and strictly control nutrient and other pollutant loads to surface and ground waters within the IRL watershed from applications of biosolids and use and management of reclaimed water.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Wastewater-1: Ensure compliance with the IRL Act (Chapter 90-262, Laws of Florida, 1990).** | Ensure that no nutrients or pollutants from the human waste stream are discharged directly into the IRL or indirectly through groundwater or tributary surface waters. | DEP, local governments | WMDs, interest groups | Staff time from DEP and local governments | Local governments, public and private utility fees, infrastructure improvement funds, State Revolving Fund (SRF) loans | Coordinate and collaborate |
| **Wastewater-2: *REDUCE* or *REMOVE* all wastewater discharges to the IRL (including direct, indirect through reuse, and emergency loadings of nutrients and other pollutants).** | Discharge directly from a WWTP or through reuse should not exceed AWT standards. Reclaimed water education, outreach, and enforcement. | Local governments | WMDs, DEP, interest groups | TBD | Local governments, public and private utility fees, infrastructure improvement funds, SRF loans | Coordinate and collaborate |
| **Wastewater-3: *RESEARCH*, identify, and recommend funding sources and alternatives for upgrading WWTP infrastructure and to *REDUCE* or *REMOVE* domestic and industrial effluents.** | Expand funding for wastewater infrastructure improvements and *REDUCE* pollutants. | DEP and utilities | USEPA, WMDs, local governments | $40 million for CCMP projects | Local governments, public and private utility fees, infrastructure improvement funds, SRF loans | Coordinate and collaborate |
| **Wastewater-4: Promote the connection of areas served by OSTDS to central sewer or, where connection is not feasible, use of nutrient removing systems in areas identified as "problem" or "potential problem."** | Improve the regional wastewater treatment network through innovation, regional consolidation, and strategic transition away from OSTDS. | FDOH, local governments | DEP, WMDs, Natural Resources Conservation Service (NRCS), academia, interest groups | $392 million for CCMP projects | Local governments, public and private utility fees, infrastructure improvement funds, SRF loans | Coordinate and collaborate |

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Wastewater-5: Develop and implement an OSTDS inspection program and education program within the five IRLNEP counties.** | Mandatory inspection for all OSTDS. | FDOH, local governments | NRCS, DEP, WMDs, local governments | TBD | Local governments, public and private utility fees, infrastructure improvement funds, SRF loans | Coordinate and collaborate |
| **Wastewater-6: Undertake further studies to quantify the impacts of OSTDS on the IRL with a focus on identifying high priority "problem" and "potential problem" areas.** | Evaluate nutrient loads, vulnerabilities, and risks to establish priorities for septic to sewer conversion. | Local governments, DEP | Academia, WMDs | TBD | Local governments, public and private utility fees, infrastructure improvement funds, SRF loans | Coordinate and collaborate |

## OUTCOMES:

- **Short-term (1 – 2 years):** Map problem areas and secure funding to upgrade WWTPs to AWT to *REDUCE* nutrients in direct discharges and reuse and/or increase capacity. Begin WWTP retrofits, septic to sewer connections, and septic system upgrades.
- **Medium-term (3 – 4 years):** Continue WWTP upgrades, septic to sewer connections, and septic system upgrades.
- **Long-term (5 – 10+ years):** 100% of WWTPs have been upgraded to AWT standards. Septic to sewer connections and septic system upgrades completed in problem areas.

## CHALLENGES TO SUCCESS:

- Lack of adequate recurring cost-share funding for human waste stream infrastructure improvements, such as septic to sewer conversions and WWTP upgrades.
- Inadequate regulatory, non-regulatory, and financial incentives to compel infrastructure improvements.
- Developers and permit agencies may not be familiar with advanced, nutrient reduction OSTDS that would better treat nutrients.
- Inadequate regulatory standards for nutrients in reclaimed water for irrigation, disposal of reclaimed water, and biosolids management and application.

## CITATIONS:

1. Bureau of Economic and Business Research. 2018. Projections of Florida Population by County, 2020–2045, with Estimates for 2017.
2. LaPointe, B.E., Herren, L.W., Debortoli, D.D., and Vogel, M.A. 2015. Evidence of sewage-driven eutrophication and harmful algal blooms in Florida's Indian River Lagoon. Harmful Algae 43: 82–102.
3. LaPointe, B.E., Herren, L.W. and Paul, A.L. 2017. Septic systems contribute to nutrient pollution and harmful algal blooms in the St. Lucie Estuary, Southeast Florida, USA. Harmful Algae 70:1–22.
4. Barile, P.J. 2018. Widespread Sewage Pollution of the Indian River Lagoon System, Florida (USA) Resolved by Spatial Analyses of Macroalgal Biogeochemistry. *Marine Pollution Bulletin* 128: 557–574.
5. Hazen and Sawyer. 2015. Evaluation of Full Scale Prototype Passive Nitrogen Reduction Systems and Recommendations for Future Implementation. Report to the Florida Department of Health.

# STORMWATER

Indian River County

## Goals:

**Reduce stormwater runoff entering the IRL and improve the quality of runoff that enters the lagoon.**

# ONE LAGOON
## WATER QUALITY
### *Stormwater*

**GOALS:** ***REDUCE*** **unnatural fresh and surface water discharges to the IRL from both large stormwater conveyances and dispersed urban and residential sources.** ***RESTORE*** **water quality in the IRL system. Conduct** ***RESEARCH*** **to better understand natural hydroperiods of the IRL watershed.**

**ISSUE SUMMARY:** Stormwater contributes significantly to pollutant loads entering the IRL. Multiple factors affect stormwater loading to the IRL including:

- **Land Use Change.** The population in the five-county lagoon region has grown from 743,000 people in 1980 to almost 1.76 million in 2017, which led to an increase in coastal development and urbanization, particularly in the last 100 years.[1, 2, 3, 4] Between 1920 and 1990, the estimated average annual runoff increased 113% in the IRL watershed, and this increase is mostly the result of urbanization.[2]
- **Hydrologic Changes.** Coastal impoundments of marshes, ditching to manage mosquitoes, and ditching to manage water for agricultural, road drainage, flood prevention, and other uses have changed the landscape. Other practices, such as expansion of impermeable surfaces, stormwater diversion and channelization, direct stormwater discharges to the IRL, and riparian and wetland habitat alteration and loss have led to changes in the natural hydrology of the watershed.
- **Nutrient Loads.** As the human population increased, so have the nutrient loads associated with fertilizer use by residential and agricultural stakeholders, as well as other lawncare chemicals, pond maintenance herbicides, and pesticides for homes and businesses.[4]

Each of these factors has reduced the water holding capacity of the IRL watershed resulting in increased flood risks; lowered surface water quality due to runoff of sediments, nutrients, and other pollutants; and resulting negative impacts to IRL living resources from declines in water quality. In addition, considerable economic costs are associated with attempts to manage and reduce the negative impacts of these factors over a range of spatial scales.

**Urban Stormwater.** A 2017 report produced by SJRWMD and DEP in support of the IRLNEP recommended nine large, regional stormwater project priorities (from over 40 potential projects that were evaluated lagoon-wide). These projects represent high-value priorities to improve stormwater management and water quality in the IRL.[5] The recommended projects are listed in the separate Projects Plan.

A more challenging aspect of stormwater mitigation arises from smaller, dispersed stormwater impacts associated with urban and suburban landscapes. These are best addressed by local BMPs. Stormwater BMPs are designed to treat rain where it falls to address four criteria that are critical to managing urban and dispersed stormwater runoff:

1. Volume: Reduce or delay the volume of stormwater that enters the drainage system.
2. Peak Discharge: Reduce the maximum flow rate into the system by decreasing the stormwater volume and lengthening the duration of discharge.
3. Water Quality: Improve water quality through volume reduction, filtering, and biological and chemical processes.
4. Maintenance: Sustainable practices to ensure proper functioning of BMPs. Grass clippings and cut vegetation should not be allowed to enter BMPs or natural waterbodies and applications of fertilizers, pesticides, and herbicides should occur with a buffer around the BMP or natural waterbody. Where possible, use mechanical harvesting instead of herbicide control for invasive vegetation in waterways.

By constructing small-scale, distributed stormwater management systems at individual sites, stormwater BMPs have the capability to meet multiple stormwater management objectives. Stormwater BMPs use unit processes of the hydrologic cycle, such as infiltration, detention, and evapotranspiration, to meet these objectives. One approach that has shown excellent results is the application of low impact development/green infrastructure stormwater BMPs. The goal of these BMPs is to meet stormwater management objectives by replicating natural elements of the hydrologic cycle that have been lost in urban areas.

**Agricultural Stormwater.** The Florida Watershed Restoration Act of 1999 directed DEP, FDACS, and WMDs to work together to reduce pollution in Florida's waters, citing BMPs as the best way to accomplish this task for agricultural stormwater. In areas with adopted BMAPs, agricultural producers must either implement FDACS-approved BMPs or conduct water quality monitoring to demonstrate compliance with water quality standards. Agricultural BMPs are guidelines to assist producers in managing water, nutrients, and pesticides to minimize the impact on the state's natural resources. Maps of properties that are enrolled in the FDACS BMP Program within the IRL watershed are provided in **Appendix C**. When properly designed and implemented, agricultural BMPs are practical, cost-effective actions that agricultural producers can take to conserve water and reduce the amount of pesticides, fertilizers, and animal waste that enter surface and ground water resources. BMPs can benefit water quality and water conservation while maintaining or even enhancing agricultural production. Typical agricultural BMPs include:

- Nutrient management to determine nutrient needs and sources and manage nutrient applications (including manure) to minimize impacts to water resources.
- Irrigation management to address the method and scheduling of irrigation to reduce water and nutrient losses to the environment.
- Water resource protection using buffers, setbacks, and swales to reduce or prevent the transport of sediments and nutrients from production areas to waterbodies.

## STRATEGIES:

- Support IRL partners to fund, design, engineer, construct, and manage stormwater capture and treatment projects identified in the SJRWMD feasibility study to enhance water quality discharged to the IRL.
- Implement, track, and measure performance outcomes and *REPORT* on BMP activities and projects listed in the BMAPs, RAPs, and IRLNEP Projects Plan throughout the IRL watershed.
- Educate and engage agricultural producers in issues surrounding BMAPs, proper agricultural BMP implementation, and cost-share opportunities.
- Design, deliver, and refine BMPs for both agricultural and urban landscapes to improve stormwater management. Encourage augmentation of BMPs using practices such as littoral zones and aeration.
- Evaluate opportunities for reduction and reuse of stormwater such as through aquifer storage and recovery and deep-water storage.
- Educate urban, recreational, and agricultural landowners on proper use and application rates for fertilizer and chemical applications to reduce excess use.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Stormwater-1: Design, engineer, construct, and manage stormwater capture and treatment projects identified in the SJRWMD feasibility study to enhance water quality discharged to the IRL. (NEW)** | Reduced large-volume pulsed stormwater discharges to the IRL and their associated nutrient, sediment, and pollutant loads. | SJRWMD, SFWMD, water control districts, local governments | DEP | $48.8 million – $1.68 billion | DEP, WMDs, local governments | Coordinate and collaborate |
| **Stormwater-2: Develop, improve, and implement BMPs and education programs for stormwater management and freshwater discharges for urban, agriculture, and dispersed residential landscapes.** | Encourage effective and responsible design and delivery of BMPs, and education programs for fertilizer use, landscaping, proper use and disposal of chemicals, etc. | FDACS, WMDs, NRCS, DEP, UF-IFAS, local governments | Academia, consultants/ private industry | TBD | DEP, WMDs, FDACS, IRLNEP, local governments | Coordinate and collaborate |
| **Stormwater-3: Update and maintain comprehensive drainage maps of the IRL watershed.** | Update drainage maps to reflect changing land use patterns and development patterns. | WMDs, water control districts, local governments | NRCS, IRLNEP | TBD | WMDs, local governments | Coordinate and collaborate |
| **Stormwater-4: Continue reviews of reclamation plans for water control districts and the standard operating procedures and project works of each large drainage system.** | Develop and implement strategies to *REDUCE* discharges and pollutant loadings to the IRL from these sources. | Local governments | N/A | TBD | WMDs, local governments | Coordinate and collaborate |
| **Stormwater-5: Upgrade existing urban and agricultural stormwater infrastructure networks to *REDUCE* freshwater discharges, nutrient loads, and other pollutant loads to the IRL.** | Improve stormwater network to *REDUCE* loads and be able to *RESPOND* to expected population growth and climate change impacts. | DEP, FDACS, local governments | USEPA, U.S. Department of Agriculture, UF-IFAS, WMDs, interest groups | $508 million for CCMP projects | WMDs, local governments | Coordinate and collaborate |

## OUTCOMES:

- **Short-term (1 – 2 years):** Begin implementation of CCMP projects listed in the BMAPs, RAPs, and IRLNEP Projects Plan.
- **Medium-term (3 – 4 years):** Continue implementation of CCMP, BMAP, and RAP projects.
- **Long-term (5 – 10+ years):** Meet BMAP five- and ten-year targets and RAP targets. Make significant progress in decreasing stormwater pollution to the IRL system.

## CHALLENGES TO SUCCESS:

- Need for training and implementation of safe and effective BMPs.
- Drainage and estuary characteristics vary significantly from south to north along the IRL; therefore, a one-size-fits-all management approach cannot be taken in the IRL.
- Inadequate funding to implement all necessary projects, including both urban and agricultural BMPs.
- Urban and agricultural BMPs do not always meet the assumed reduction rates for pollutants.

- Lack of planning that results in reactive and costly large-scale projects that provide intermittent benefit to lagoon water quality.
- Desire for a sod only lawn may prevent people from implementing practices that would help to improve the IRL, such as using landscaping that would require minimal fertilizer and irrigation.

## CITATIONS:


1. Kim, Y., Engel, B.A., Lim, K.J., Larson, V., and Duncan, B. 2002. Runoff Impacts of Land-Use Change in the IRL Watershed. *Journal of Hydrologic Engineering*.
2. Graves, G.A., Wan, Y., and Fike, D.L. 2004. Water Quality Characteristics of Storm Water from Major Land Uses in South Florida. *Journal of the American Water Resources Association.* 1405–1419.
3. Sayemuzzaman, M., Ye, M., Zhang, F., and Zhu, M. 2018. Multivariate Statistical and Trend Analyses of Surface Water Quality in the Central Indian River Lagoon Area, Florida. *Environmental Earth Sciences* 77: 127.
4. LaPointe, B.E., Herren, L.W., Debortoli, D.D., and Vogel, M.A. 2015. Evidence of sewage-driven eutrophication and harmful algal blooms in Florida's Indian River Lagoon. Harmful Algae 43: 82–102.
5. SJRWMD. 2017. Indian River Lagoon Stormwater Capture and Treatment Feasibility Analysis.

# HYDROLOGY AND HYDRODYNAMICS

## Goals:

**Improve understanding of lagoon hydrology and hydrodynamics to improve decision-making and management.**

# ONE LAGOON

## WATER QUALITY

### *Hydrology and Hydrodynamics*

**GOALS: Conduct *RESEARCH* to improve understanding of the IRL watershed, groundwater, and hydrology and hydrodynamics to improve decision-making for management of land use impacts to water and reduction of loads of nutrients and other contaminants.**

**ISSUE SUMMARY:** Hydrology is the study of the movement, distribution, and quality of surface and ground waters, and hydrodynamics is the study of the internal circulation of the waters and effects on water quality.

By its very nature as a coastal lagoon, the IRL is a narrow, shallow estuarine system with minimal connection and exchange with the open ocean. The IRL is a complex system that is divided into sub-basins because of inlets and causeways located along its extent. These sub-basins are characterized by different residence/ocean exchange rates based on the ocean tides, weather patterns, and seasons.[1, 2] These sub-basins are also affected by 12 causeways, which create compartments within the IRL.[3] Studies have shown that the removal of extended causeways can improve water quality and acreage available for seagrass.[4,5] Groundwater levels also vary seasonally within the lagoon.[6] Its hydrology has been significantly altered as the area's population continues to grow.[1] Surface water flows and groundwater discharges have been altered by land use changes. It is estimated that groundwater and sub-surface discharge may contribute 45–60% of the total nitrogen and total phosphorus loading to the IRL.[7] Thus, it is important that the IRLNEP and partners continue to work towards a better understanding of the hydrological features of the IRL, including hydrodynamics within the waterbody.

The watershed has been highly altered due to ditching, draining, and impounding for urban, industrial, and agricultural purposes as well as for management of mosquitoes and flood control. In addition, man-made inlets, stabilized inlets, navigational canals, and causeways have also altered the hydrology. It is unlikely that these alterations will be removed completely from the landscape. More importantly, climate change and sea level rise impacts will further alter hydrologic functions throughout the IRL and its watershed in complex ways. Therefore, it is important to understand how the IRL hydrologic system currently operates and develop predictive models to better inform decision making.

Existing reasearch and management documentation from studies in the area could help inform restoration efforts throughout the IRL. For instance, the Comprehensive Everglades Restoration Plan (CERP) IRL-South Feasibility Study, Loxahatchee River Watershed Restoration Plan, and minimum flows and levels for the St. Lucie River and Loxahatchee River provide good examples of using hydrologic modeling to set specific performance measures. Other major waterbodies in the IRL watershed could benefit from this type of planning effort.

## STRATEGIES:

- Refine scientific knowledge about IRL hydrology and hydrodynamics to better identify restoration strategies and inform decisions about development.
- Review and revise, as needed, hydrologic and hydrodynamic models used to guide IRL restoration and stewardship decisions and to set performance measures for landscape-level projects.

- Integrate models to better understand interactions of surface water, groundwater, and internal flow characteristics and incorporate findings into management decisions.
- Continue to investigate potential connections and interactions among transportation infrastructure, groundwater flow, surface water flow, and internal flow on IRL water quality and health.
- Convene a project team to develop scope of work for a science-based pilot study to better understand the physical, chemical, and biological implications, benefits, risks, and expected outcomes of using oceanic exchange as an intervention to enhance IRL internal water flow and *REDUCE* residence time.
- Develop and refine quantitative performance measures for physical and chemical components of regional-scale projects.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Hydrology-1: Support advancements in hydrological model development, verification, and application. (NEW)** | Improve understanding of IRL hydrology and water circulation. | IRLNEP Management Conference, Academia | IRLNEP, DEP, WMDs | TBD | IRLNEP, Florida Legislature, academia, DEP | Coordinate and collaborate |
| **Hydrology-2: Apply the best available models to better evaluate connectivity between IRL sub-basins. *REDUCE* negative impacts of road corridors and causeways. (NEW)** | Mitigate for human-built interruptions of natural water circulation in the IRL. | IRLNEP Management Conference, academia, Florida Department of Transportation (FDOT), water control districts, local governments | IRLNEP, WMDs | TBD | IRLNEP, Florida Legislature, academia, DEP, FDOT | Coordinate and collaborate |
| **Hydrology-3: Continue evaluation of options to enhance water flow through engineering solutions that have well defined water quality and ecological outcomes. (NEW)** | Identify engineering and technology options to *REDUCE* IRL residence time and enhance water flow. | IRLNEP Management Conference, academia, FDOT, water control districts, local governments | IRLNEP, WMDs | TBD | IRLNEP, Florida Legislature, Academia, DEP, FDOT | Coordinate and collaborate |

## OUTCOMES:

- **Short-term (1 – 2 years):** Identify funding sources for *RESEARCH* on IRL hydrology and hydrodynamics and the complex influence on the IRL water quality and health. Conduct one public education workshop to improve public understanding.
- **Medium-term (3 – 4 years):** Implement CCMP projects from the Projects Plan to ensure that human-caused hydrological impacts are reduced and natural hydrological functions of the IRL watershed are optimized.
- **Long-term (5 – 10+ years):** Incorporate enhanced understanding of IRL hydrology and hydrodynamics and expected changes to hydrological functions into IRL management decisions and actions.

## CHALLENGES TO SUCCESS:

- Difficult to model the highly-altered landscape of the IRL watershed.
- Inadequate funding for *RESEARCH* and projects.
- Difficulty in retrofitting infrastructure that effects hydrology and hydrodynamics within established communities.

## CITATIONS:


1. Smith, N.P. 1993. Tidal and Non-tidal Flushing of Florida's Indian River Lagoon. Estuaries 16 (4): 739–746.
2. Smith, N.P. 2016. Transport Pathways through Southern Indian River Lagoon. Fla. Sci. 79 (1): 39–50.
3. Bilskie, M.V., Bacopoulos, P., and Hagen, S. 2017. Astronomic Tides and Nonlinear Tidal Dispersion for a Tropical Coastal Estuary with Engineered Features (Causeways): Indian River Lagoon System. *Estuarine, Coastal, and Shelf Science*. 1–17.
4. FDOT District 7. 2015. Old Tampa Bay Water Quality Improvements, Phase I: Feasibility Study.
5. FDOT District 6. 2009. Responses of Water Quality and Seagrass Coverage to the Removal of the Lake Surprise Causeway.
6. Swarzenski, P.W., Martin, J.B., and Cable, J.C. 2001. Submarine Groundwater Discharge in Upper Indian River Lagoon, Florida. Geological Survey Karst Interest Group Proceedings, Water-Resources Investigations Report 01-4011: 194–197.
7. Janicki Environmental and Applied Technology and Management. 2012. Nutrient Loading Estimates for the Indian River Lagoon TMDL Load Revision. Brevard County. http://www.brevardfl.gov/NaturalResources/WatershedProgram.

# LEGACY LOADS AND HEALTHY SEDIMENTS


## Goals:

**Remove muck in the IRL to reduce nutrient loads and improve water clarity.**


# ONE LAGOON

## WATER QUALITY

### *Legacy Loads and Healthy Sediments*

**GOALS: *REMOVE* and/or *REDUCE* muck in the IRL to REDUCE the legacy load of nutrients and contaminants and improve water clarity. *RESTORE* healthy natural sediments to support seagrasses and associated communities, shellfish, and healthy benthic communities.**

**ISSUE SUMMARY:** The IRL was once a sandy bottom estuary with a modest accumulation of organic detritus from losses of shoreline and aquatic vegetation. As much as 10-20% of the lagoon bottom is now covered with a layer of fine silt and sediment called "muck" that has accumulated over years of excess sedimentation. Muck is defined as black, organic-rich (greater than 10% organic matter), mud-rich (greater than 60% silt + clay), high water content (greater than 75% water by weight, greater than 90% water by volume) sediments. Earlier studies in the IRL reported muck, as defined above, to be most prevalent in the mouths of creeks (e.g., Crane Creek and Turkey Creek), Intracoastal Waterway, and deeper pockets of water near tributaries.[1] A 1989 muck survey of the IRL from the Ponce de Leon Inlet to St. Lucie Inlet concluded that the spatial occurrence of muck was limited to less than 10% of the lagoon[1]. Today, muck flux in the IRL contributes 582 metric tons of total nitrogen (essentially all as dissolved ammonium) and 87 metric tons of total phosphorus (essentially all as dissolved phosphate) that accounts for approximately 37% and 44% of the annual total nitrogen and total phosphorus loads, respectively, in the Banana River Lagoon, North IRL, and Central IRL.[2] Large quantities of muck are also present in the St. Lucie River and Estuary and its major tributaries.

The source of muck is fine sediments and fine biological particles carried in by tributaries, canals, and stormwater systems. The biological material accumulates on the bottom and decomposes. The muck in the lagoon increases turbidity, promotes oxygen depletion in sediments and the water above, stores and releases nutrients, covers the natural bottom, and destroys healthy communities of benthic organisms.[2, 3] Muck builds up in channels and deep pockets where it can reach depths of up to 15 feet. The muck sediment contains nutrients and serves as an internal "legacy load" of nutrients that releases (fluxes) nutrients back into the water column. The Brevard County Save Our Indian River Lagoon Project Plan (2016) estimated that the annual release of nutrients from decaying muck is almost as much as the annual external loading delivered by stormwater and groundwater baseflow combined. The muck deposits in Brevard County alone cover an estimated 15,900 acres of the lagoon system.[4]

Understanding nutrient flux dynamics and the role of legacy nutrients in algal blooms is complex. Organic as well as inorganic nutrients must be considered.[5] Other eutrophication stressors, such as loss of benthic habitat, loss of filter feeders, development of hypoxia/anoxia, and alterations in food webs are additional considerations for resource managers as well as the environmental impacts of these blooms. An emerging concern with the expansion of IRL anoxic muck sediments is the production of hydrogen sulfide as a potential stressor for seagrasses,[6] macrobenthos,[7] and calcium-carbonate shell forming organisms, such as clams and oysters.[8] The relationships among eutrophication, increased temperatures, microbial respiration, dissolved oxygen, and pH (aragonite saturation) are poorly understood for the IRL. There is growing evidence that coastal acidification represents a significant but previously underappreciated environmental threat that requires monitoring and management. Nutrient management plans in acidified estuaries should consider the level of nutrient load reduction required to alleviate low pH conditions and the associated impacts on marine life.[9]

Because of the inorganic/organic composition and desire to remove legacy nutrients from fluxing internally in the IRL, muck dredging is currently the most cost-effective way to address this internal legacy load. The focus for muck removal projects for this CCMP revision is to align with the Brevard County Save Our Indian River Lagoon Project Plan[4] and the muck removal component of the CERP IRL-South project. Emphasis is on large deposits of

muck in open water sites, main canals, navigational canals, and the Intracoastal Waterway and tributaries that may be transporting upstream legacy loads of muck to seagrass and shellfish areas in the main body of the IRL. In Turkey Creek, a tributary to the IRL, about 300 metric tons of nitrogen and 70 metric tons of phosphorus were removed with 160,000 cubic meters of wet muck and sand via environmental dredging during 2016 and 2017. Dredging removed nutrients, fine sediments, and increased water depth and basin volume with positive increases in both salinity and the total inventory of dissolved oxygen.[10]

Muck flux can be a complex biogeochemical process to understand. Ongoing research associated with muck dredging projects suggest that careful consideration of muck location, volumes, area of coverage, and nutrient variability should guide site selection and expected outcomes from muck dredging. Prioritization of project funding, timing, and implementation of source reduction projects versus legacy load reduction projects will prove challenging. The four goals of muck management include: (1) decrease turbidity, (2) restore bottom habitats, (3) improve oxygen content of lagoon water, and (4) decrease nutrients released from muck. Brevard County is using a goal of reducing nutrients from muck flux by 25%,[4] and this is also the goal for this CCMP revision.

## STRATEGIES:

- *REDUCE* organic and inorganic sources on land that contribute to muck in the IRL. Harvest floating aquatic vegetation to *REMOVE* this material as a source of muck.
- *REMOVE* high-nutrient legacy loads and muck in high-priority locations both within the lagoon and major canals and tributaries to the lagoon.
- Evaluate opportunities for muck capping and sediment traps instead of dredging.
- Conduct *RESEARCH* to better understand muck nutrient flux and cycling in the lagoon and other eutrophication stressors that may be associated with muck (i.e., micronutrients).
- Conduct *RESEARCH*, including modeling, to understand efficacy, benefit, and risk of muck removal.
- Develop muck maps that include priority areas and *RESEARCH* findings.
- Prioritize, simplify, and expedite restoration project permits, including expanding eligible project types that qualify for general permit consideration.
- Identify beneficial uses for dredged materials to limit the area needed for storage.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Legacy Loads-1: Complete muck mapping of the entire IRL, prioritize muck dredging projects, and *REDUCE* source contributions of sediment and biomass that result in muck formation. (NEW)** | Improve knowledge about muck distribution, abundance, and sources and *REDUCE* loading. | Local governments, academia | WMDs, local partners | $35 per cubic yard of muck[4] | Florida Legislature | Coordinate and collaborate |
| **Legacy Loads-2: Continue to couple scientific evaluation and assessment of muck dredging projects to evaluate and optimize the dredging process. (NEW)** | Gain knowledge from muck dredging projects to advise decision making and muck management and disposal process. | Local governments, academia | WMDs, local partners | TBD | Florida Legislature | Coordinate and collaborate |

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Legacy Loads-3: Track emerging technologies, innovative approaches or alternatives to dredging, muck capping, upstream controls of muck transport, more efficient approaches to dewatering, enhanced pollutant removal in post-dredge water, and enhanced muck management to improve process efficiency, *REDUCE* costs, and identify beneficial uses of muck residuals. (NEW)** | Identify new and emerging technologies to enhance performance, improve efficiency, decrease cost, and decrease risks with muck dredging and management. | Academia, local governments | DEP, IRLNEP, WMDs, local governments, academia, FWC, Florida Inland Navigation District | TBD | TBD | Coordinate and collaborate |

## OUTCOMES:

- **Short-term (1 – 2 years):** Muck removal plan is developed, and priority locations are identified.
- **Medium-term (3 – 4 years):** Muck removal is underway in priority locations.
- **Long-term (5 – 10+ years):** Muck is removed from all priority locations to *REDUCE* internal nutrient loads.

## CHALLENGES TO SUCCESS:

- Difficulty in addressing sources of muck (i.e., source control, street sweeping, aquatic weed control practices by some local entities and Chapter 298 Districts, lawn care management, and large network of urban stormwater conveyances).
- Cost of muck removal and management.
- Logistics and challenges associated with muck handling, storage, dewatering, and transport.
- Limited land area available for muck storage and management and local community concerns about locations and potential community impacts.
- Difficulties in permitting muck removal projects.
- Inefficiencies in removal of dissolved organic fraction and nutrients in water returned to the lagoon during dredging.
- Continued inputs of muck from incomplete dredging and upland sources.

## CITATIONS:


1. Trefry, J.H., Metz, S., Trocine, R.P., Iricanin, N., Burnside, D., Chen, N-C, and Webb, B. 1990. Design and Operation of a Muck Sediment Survey. Special Publication SJ 90-SP3, St. Johns River Water Management District, 62 pp.
2. Trefry, J.H. and Fox, A.L., 2017. Internal Loading of Nutrients to the Indian River Lagoon (Muck Flux). Presentation.
3. Trefry, J.H. 2013. Presentation on Sediment Accumulation and Removal in the Indian River Lagoon. Presentation to the Environmental Preservation and Conservation Senate Committee. Marine and Environmental Systems, Florida Institute of Technology.
4. Tetra Tech, Inc. and Closewaters, LLC. 2016. Save Our Indian River Lagoon Project Plan for Brevard County, Florida. Report to Brevard County Natural Resources Management Department. http://www.brevardfl.gov/SaveOurLagoon/Home.

5. Heisler, J., Gilbert P., Burkholder, J., Anderson, D., Cochlan, W., Dennison, W., Gobler, C., Dortch, Q., Heil, C., Humphries, E., Lewitus, A., Magnien, R., Marshall, H., Sellner, K., Stockwell, D., Stoecker, D., and Suddleson, M. 2008. Eutrophication and Harmful Algal Blooms: A Scientific Consensus. Harmful Algae 8(1): 3-13.
6. Kilminster, K., Forbes, V., and Holmer, M. 2014. Development of a 'sediment-stress' functional-level indicator for the seagrass *Halophila ovalis*. Ecological Indicators 36: 280–289.
7. Kanaya, G., Uehara, T., and Kikuchi, E. 2016. Effects of sedimentary sulfide on community structure, population dynamics, and colonization depth of macrozoobenthos in organic-rich estuarine sediments. Marine Pollution Bulletin 109: 393–401.
8. Gazeau, F., Parker, L.M., Comeau, S. Gattuso, J-P., O'Conner, W.A., Martin, S., Portner, H-O., and Ross, P.M. 2013. Impacts of ocean acidification on marine shelled molluscs. Marine Biology 160:2207–2245.
9. Wallace, R.B., Baumann, H., Grear, J.S., Aller, R.C., and Gobler, C.J. 2014. Coastal ocean acidification: The other eutrophication problem. Estuarine, Coastal and Shelf Science 148:1-13.
10. Fox, A.L. and Trefry, J.H. 2018. Environmental Dredging to Remove Fine-Grained, Organic-Rich Sediments and Reduce Inputs of Nitrogen and Phosphorus to a Subtropical Estuary. Marine Technology Society Journal, Volume 52, Number 4.

# ATMOSPHERIC DEPOSITION

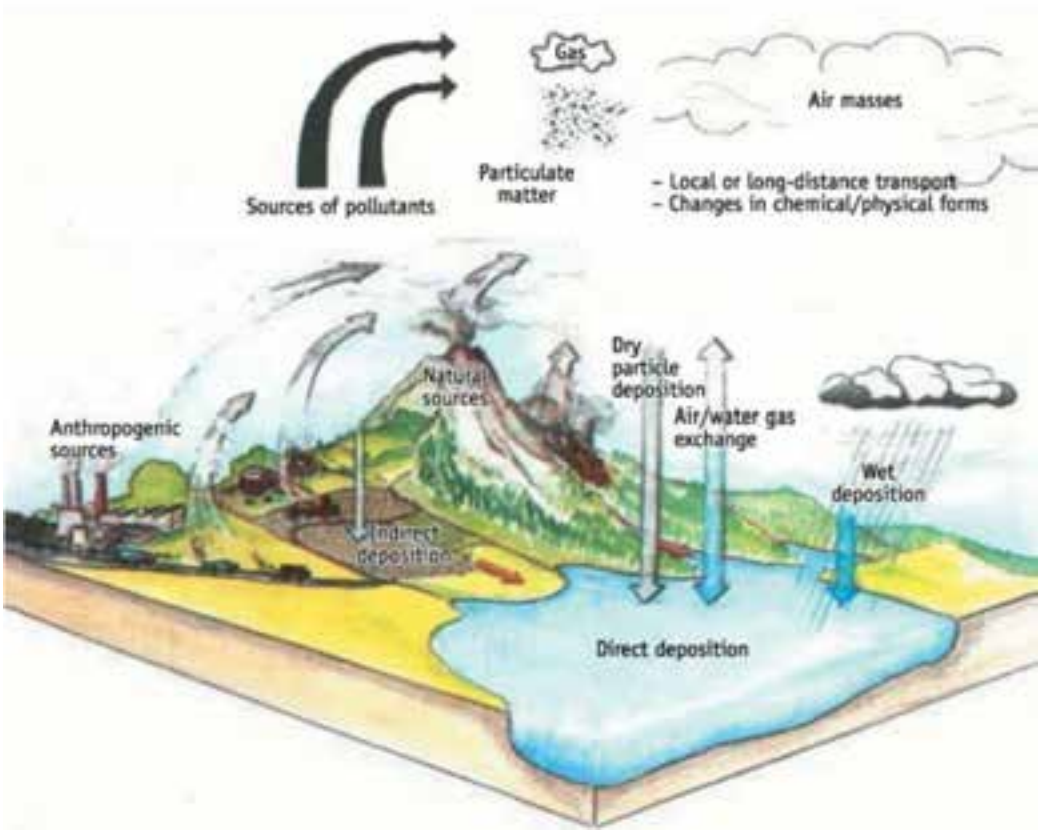

## Goals:

**Research and monitor atmospheric deposition of nutrients in the IRL to improve management and advise TMDLs and BMAPs.**

# ONE LAGOON
## WATER QUALITY
### *Atmospheric Deposition*

**GOALS: Monitor and conduct *RESEARCH* on atmospheric deposition of nutrients and pollutants. Develop and implement strategies to *REDUCE*, *REMOVE*, and *RESPOND* to these impacts.**

**ISSUE SUMMARY:** Atmospheric deposition is a source of nutrients, pollutants, and fine sediments from power plants, cars, and land use activities that fall on the IRL watershed, as shown in the figure below. These atmospheric nutrients and pollutants fall onto the watershed at differing rates during wet and dry seasons. Because of atmospheric conditions and weather patterns, not all nutrients from atmospheric deposition are generated within the watershed, and this factor adds complexity to management of atmospheric deposition sources.




Source: USEPA (2001)[1]

Over recent decades, scientific interest has focused on wet and dry deposition of nitrate stemming from combustion of fossil fuels. Successful decreases in nitrogen oxides emissions in the United States have substantially decreased nitrate deposition. By contrast, emissions of ammonia, an unregulated air pollutant, and resulting deposition of ammonium have grown.[2] Expanded observations demonstrate that deposition of reactive nitrogen in the United States has shifted from a nitrate-dominated to an ammonium-dominated condition.[3] Trends in atmospheric ammonium deposition for the IRL are not well known. A better understanding of status and trends will be an important consideration for refinement of IRL nutrient budgets, TMDLs, and water quality management strategies.

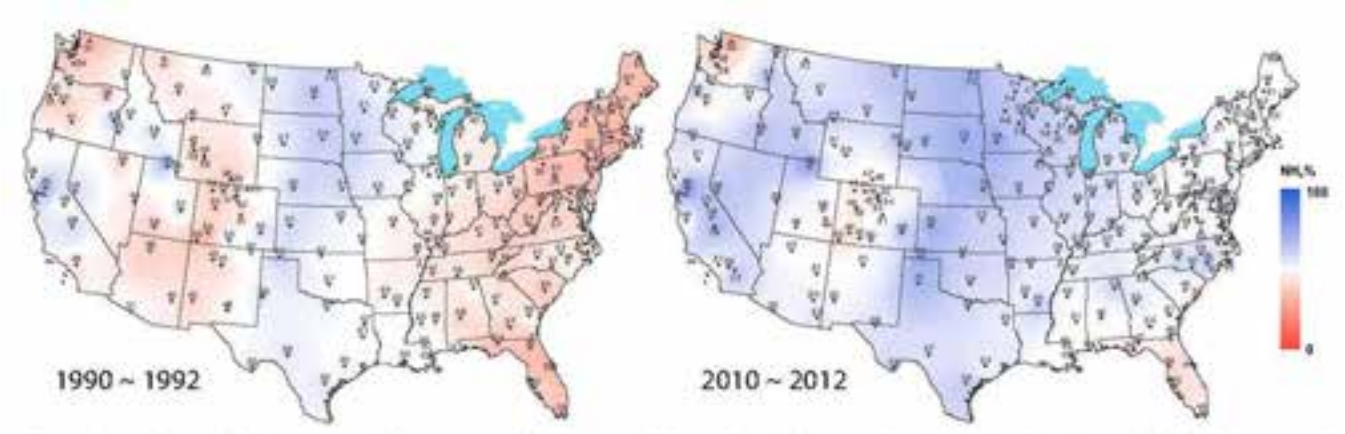



**Fig. 1.** Comparisons of the 3-y average $NH_4^+$ percentage of wet inorganic nitrogen deposition across the United States in 1990–1992 (*Left*) and 2010–2012 (*Right*). To help visualize spatial patterns, isopleths were produced by interpolating $NH_4^+$ mole percentages at individual monitoring sites using a cubic inverse-distance weighting of sites within 500 km of each observation station. The black dots on the map represent locations of sites with 3-y data available for each time period. The $NH_4^+$ percentage on a molar basis $[(NH_4^+\%) = (NH_4^+)/(NO_3^- + NH_4^+) \times 100\%]$ is noted at each site.

In 2018, only a single continuous monitoring station for meteorological conditions and wet/dry deposition of total nitrogen and total phosphorus exists along the IRL. This station is at a former Clean Air Status and Trends Network station (IRL141) located at Coconut Point near Sebastian Inlet (latitude 27.849; longitude -80.4554). SJRWMD funded the station for many years, but funding responsibility transferred to the IRLNEP in 2018 with strong science support from IRLNEP partners at SJRWMD, Wood Group, and Indian River County Health Department.

These data are essential to estimate nutrient loads from atmospheric deposition. As documented in a stakeholder-driven study of IRL TMDL allocations and the Mosquito Lagoon RAP development, atmospheric loads of total nitrogen can represent a sizable portion of the total loads to the IRL.[4, 5] The relative contributions of direct atmospheric deposition of nutrients onto the lagoon varies in different portions of the system depending on the size of the waterbody in that area. Recent research highlights the need to better understand atmospheric nitrogen deposition, impacts and trends on the IRL nutrient budget and potential new implications associated with external nutrient loads that drive HABs.

## STRATEGIES:

- Continue to monitor wet/dry atmospheric nutrient deposition along the IRL to advise restoration and management strategies. Expand scope to include additional data for ammonium and estimates of biological fixation and removal of nitrogen versus industrial/anthropogenic nitrogen fixation.
- Determine appropriate monitoring station locations in the southern IRL.
- Evaluate the need for expansion of atmospheric deposition monitoring along the IRL to better understand nutrient deposition (including ammonium) spatial and temporal variability.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Atmospheric Deposition-1: Determine the impacts of atmospheric deposition of nutrients and other pollutants on the nutrient budget, water quality, and resources of the IRL.** | Continue data acquisition and analysis for atmospheric nutrient deposition to the IRL to inform nutrient budget refinement and nutrient reduction strategies. | IRLNEP Management Conference | USEPA, DEP, WMDs, academia, local governments, interest groups | TBD | DEP, Florida Legislature | Coordinate and collaborate |
| **Atmospheric Deposition-2: Evaluate need for additional wet and dry atmospheric monitoring stations. (NEW)** | Conduct a gap analysis for atmospheric deposition data and make recommendations in the IRL Monitoring Plan. | IRLNEP Management Conference | Academia, WMDs, DEP | TBD | DEP, Florida Legislature | Coordinate and collaborate |

## OUTCOMES:

- **Short-term (1 – 2 years):** Develop a plan with recommendations on the scale and scope of an IRL atmospheric nutrient deposition monitoring network required for effective IRL management. Seek funding to expand the network as needed.
- **Medium-term (3 – 4 years):** Implement the recommendations for the atmospheric nutrient deposition monitoring network and collect data to evaluate trends.
- **Long-term (5 – 10+ years):** Synthesize available data to evaluate trends. Use improved understanding of atmospheric wet/dry nitrogen deposition trends to the IRL watershed to revise actions, as needed.

## CHALLENGES TO SUCCESS:

- Long-term stable funding for IRL monitoring network equipment and operations and maintenance.
- Identification of a primary scientific investigator to lead the data acquisition, synthesis, and analysis effort over the next decade.

## CITATIONS:


1. USEPA.2001. Frequently Asked Questions about Atmospheric Deposition. EPA-453/R-01-009.
2. Gruber, N. and Galloway, J.N. 2008. An Earth-System Perspective of the Global Nitrogen Cycle. Science 451: 293–296.
3. Li, Y., Schichtel, B.A., Walker, J.T., Schwede, D.B., Chen, X., Lehmann, C.M. B., Puchalski, M.A., Gay, D.A., and Collett, J.L. Jr. 2016. Increasing importance of deposition of reduced nitrogen in the United States. Proceedings National Academy of Sciences. May 24, 2016. 113 (21): 5874-5879.
4. Janicki Environmental, Inc. 2018. Determination of Mosquito Lagoon Nutrient Loading Targets. Prepared for Volusia County and Mosquito Lagoon RAP Stakeholder Group.
5. Janicki Environmental and Applied Technology and Management. 2012. Nutrient Loading Estimates for the Indian River Lagoon TMDL Load Revision. Brevard County. http://www.brevardfl.gov/NaturalResources/WatershedProgram.

# CONTAMINANTS OF CONCERN


## Goals:

**Identify contaminant sources to better understand human health and wildlife risks. Remediate contaminated sites.**

# ONE LAGOON
## WATER QUALITY
### *Contaminants of Concern*

**GOALS: Conduct *RESEARCH* to identify sources and loads of known contaminants and contaminants of emerging concern to better understand potential ecological, wildlife, and human health risks. Identify mechanisms to *REDUCE* or *REMOVE* these contaminants from the system. *REPORT* findings and *RESPOND* to protect human health and wildlife. Identify and remediate contaminated sites.**

**ISSUE SUMMARY:** Estuaries with large human influences, like the IRL, are vulnerable to chemical contaminants that are delivered through surface and ground water from multiple sources.


Cuyahoga River Fire

In 1969, the Cuyahoga River was so contaminated from discharges from adjacent industry that the river caught on fire. As a result of this incident, degradation of waterbodies throughout the U.S., and a new understanding of the effects human interaction has on the environment, the Clean Water Act was promulgated in 1972. Prior to this legislation, many industrial contaminants of concern were discharged to the ground or directly into our waterways. In 1987, the National Pollution Discharge Elimination System was established to regulate all point source discharges. Under this program, pollutants such as heavy metals, pH, nitrogen, and industry-specific pollutants are monitored for compliance. Even with the Clean Water Act and the regulations that followed, historical and modern-day discharges from gas stations, dry cleaners, industrial facilities, agricultural, and Department of Defense sites continue to seep into the IRL through contaminated groundwater. Some known contaminants of concern, while regulated under the Clean Water Act, do not have defined cleanup criteria or specific regulations for cleanup; therefore, the investigation and remediation of these chemicals are unenforced.


One such class of chemicals is perfluoroalkyl substances (PFAS), which are synthetic chemicals that have been used in fire-fighting foam and other industrial and household products for more than 50 years. They have been identified in the plasma of dolphins and alligators in the IRL as well as fish tissue in waters across the U.S.[1] These chemicals have been shown to cause liver, immune, and developmental toxicity in animals. They bioaccumulate and biomagnify, are persistent in the environment, and have shown negative health effects at very low doses. PFAS are still not well understood and are considered contaminants of emerging concern.

The term “contaminant of emerging concern” is used by USEPA and other agencies to identify chemicals and other substances that have no regulatory standard, have been recently “discovered” in natural waterways (often because of improved analytical chemistry detection levels), and potentially cause harmful effects in aquatic life at environmentally relevant concentrations. They are pollutants not currently included in routine monitoring programs and may be candidates for future regulation depending on their (eco)toxicity, potential health effects, public perception, and frequency of occurrence in environmental media. Contaminants of emerging concern are not necessarily new chemicals. They include

pollutants that have often been present in the environment but whose presence and significance are only now being evaluated.[2]

| Contaminants of Emerging Concern | | |
|---|---|---|
| **Industrial Chemicals** | **Agricultural Chemicals** | **Pharmaceuticals** |
| Polybrominated diphenyl ethers (flame retardants, furniture foam, and plastics) | Organochlorine pesticides | Blood pressure medicines |
| Perfluorooctane sulfonate | Alkylphenols | Antidepressants |
| Perfluorooctanoic acid | Glyphosate | Ibuprofen |
| Other PFAS chemicals | Antibiotics | Antibiotics |
| Nano-scale chemicals | | Endocrine disrupters |

Microplastics are another contaminant of emerging concern in the IRL. Generally, between 0.04–0.2 inches in size, microplastics are small plastic particles usually derived from the breakdown of larger plastic marine debris. Another source is from the direct manufacture of microfibers used in synthetic clothing and microbeads, such as those found in cleansers and cosmetics. The Microbead-Free Waters Act of 2015 banned the manufacturing and delivery of rinse-off cosmetics with microbeads, so this source of microplastics will be reduced over time.[3]

A study published in 2018, quantified the amount and diversity of microplastics in water and soft tissues of eastern oysters (*Crassostrea virginica*) and Atlantic mud crabs (*Panopeus herbstii*) in Mosquito Lagoon. One-liter water samples had an average of 23.1 microplastic pieces, and microplastics were also found in crabs and adult oysters.[4] Recognition that microplastics represent a threat to ocean and estuarine environments, both from particulate pollution and potential toxicity, suggests that further research is needed in the IRL. The properties of plastics also allow for adsorption of persistent organic pollutants,[5] and concentration of toxins and heavy metals.[6,7] These plastics also include biofilms, which can carry HAB species and pathogenic microbes.[8,9]

In addition, two other categories of environmental contaminants receiving considerable public attention and concern are pesticides and herbicides, especially the active biocide glyphosate found in common weed killers. With these two categories of compounds, concerns about environmental and human health remain controversial and are in continuous scientific and public debate. The application of any potential toxicant near the surface waters of the IRL must follow label instructions for safe application, and chemicals should only be applied when necessary. For products containing the biocide glyphosate, two recent peer-reviewed scientific papers suggest that residential and commercial applicators should take special precautions when applying these products near surface waterbodies. Wang, et al.[10] concluded from lab experiments with phytoplankton that glyphosate could be used as a phosphorus source by some species, is toxic to some other species, and may have no effects on others. These differential effects suggest that the continued use of glyphosate and increasing concentration of this herbicide in coastal waters will likely have a significant impact on coastal marine phytoplankton community structure. Mercurio et al.[11] demonstrated that glyphosate was moderately persistent in marine waters under low light conditions and is highly persistent in the dark. The authors concluded that little degradation would be expected during flood plumes, which could potentially deliver dissolved and sediment bound glyphosate far from shore.

Glyphosate is not generally considered in most marine monitoring programs despite being one of the most widely used herbicides in the IRL watershed. Recent work has also reported that surfactants and wetting agents in commercial glyphosate formulations are themselves more toxic or increase the bioavailability and toxicity of glyphosate to non-target species.[12,13] Changes in agricultural production, such as reductions in citrus, throughout the IRL watershed may result in changes in the amount of these chemicals used.

An additional, and often overlooked, pollutant of emerging concern is thermal pollution from urban/suburban runoff from roadways and parking lots and industrial sources (primarily power plant cooling water discharges). Temperature governs the rates of biological organization at all levels (e.g., from biochemical reactions to metabolism of whole organisms). Therefore, changes in temperature associated with thermal pollution can influence the IRL at the species level, such as manatee migrations, all the way to rates of ecosystem processes and

functions (i.e., nutrient cycling and decomposition). Recent studies have shown that increasing temperature can influence harmful cyanobacteria blooms.[14]

## STRATEGIES:

- Educate the public about IRL contaminants and best practices to *REDUCE* contaminant loads by funding projects, programs, and/or campaigns to increase public awareness.
- Identify, *RESEARCH*, and *REDUCE* sources and impacts of contaminants of emerging concern.
- Seek innovative and cost-effective wastewater treatment technologies to *REDUCE* the pollutant waste load to surface and ground waters.
- Ensure all IRL counties have an active Small Quantity Generator Assessment, Notification, and Verification Program.
- Seek innovative and cost-effective wastewater treatment technologies to *REDUCE* the pollutant waste load to surface and ground waters.
- Evaluate opportunities to implement a program to promote xeriscaping to *REDUCE* the use of pesticides and herbicides, with a possible monetary incentive for changing lawn to xeriscape.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Contaminants of Concern-1: Monitor and *RESEARCH* to better understand contaminants of concern within the IRL system. (NEW)** | Increase knowledge about contaminant types, sources, transport, pathways, loads, and wildlife burdens. | DEP, FWC, FDOH | IRLNEP, local governments, WMDs | TBD based on extent and type of monitoring implemented | USEPA, WMDs, DEP, FWC, grants | Coordinate and collaborate |
| **Contaminants of Concern-2: Implement actions to *REMOVE* or *REDUCE* contaminant loads to the IRL system. (NEW)** | Decrease known contaminant loads from all sources. | DEP, federal land managers, wastewater utilities, commercial industry, agriculture | Local governments, homeowners | TBD based on the types of actions needed to reduce the source of contaminants | Federal, state, and local governments; industries; grants; loans | Coordinate and collaborate |

## OUTCOMES:

- **Short-term (1 – 2 years):** Sources of pollutants are known and action plans to *REDUCE* the sources and alleviate the impacts are in place and prioritized.
- **Medium-term (3 – 4 years):** Action plans are implemented to *REDUCE* pollutants in the IRL system.
- **Long-term (5 – 10+ years):** Pollutants affecting the IRL are significantly reduced from current conditions.

## CHALLENGES TO SUCCESS:

- Funding to adequately assess the concentrations of contaminants of concern within the IRL system, and appropriate monitoring tests to measure the low concentrations of contaminants.
- Sufficient *RESEARCH* on the impacts of these contaminants and how to properly remediate them.
- Lack of understanding on the effects of complex mixtures of organic chemicals on plants, animals, and the IRL system.
- Communication opportunities to reach a majority of the public.

## CITATIONS:


1. Bangma, J.T., Reiner, J.L., Jones, M., Lowers, R.H., Nilsen, F., Rainwater, T.R., Somerville, S., Guillette, L.J., and Bowden, J.A. 2017. Variation in perfluoroalkyl acids in the American alligator (Alligator mississippiensis) at Merritt Island National Wildlife Refuge. Chemosphere Volume 166, 72-79.
2. USEPA. 2008. White Paper: Aquatic Life Criteria for Contaminants of Emerging Concern, PART I, General Challenges and Recommendations. Prepared by the OW/ORD Emerging Contaminants Workgroup.
3. U.S. Food and Drug Administration. The Microbead-Free Waters Act: FAQs. https://www.fda.gov/Cosmetics/GuidanceRegulation/LawsRegulations/ucm531849.htm.
4. Waite, H.R., M.J. Donnelly, and L.J. Walters. 2018. Quantity and types of microplastics in the organic tissues of the eastern oyster *Crassostrea virginica* and Atlantic mud crab *Panopeus herbstii* from a Florida estuary. Marine Pollution Bulletin 129: 179-185.
5. Wang, J., Tan, Z., Peng, J., Qui, Q., and Li, M. 2016. The behaviors of microplastics in the marine environment. Mar. Environ. Res. 113, 7–17.
6. Kowalski, N., Reichardt, A.M., and Waniek, J.J. 2016. Sinking rates of microplastics and potential implications of their alteration by physical, biological, and chemical factors. Mar. Pollut. Bull. 109, 310–319.
7. Avio, C.G., Gorbi, S., and Regoli, F. 2016. Plastics and microplastics in the oceans: from emerging pollutants to emerged threat. Mar. Environ. Res. 1, 1–21.
8. Keswani, A., Oliver, D.M., Gutierrez, T., and Quilliam, R.S. 2016. Microbial hitchhikers on marine plastic debris: human exposure risks at bathing waters and beach environments. Mar. Environ. Res. 118, 10–19.
9. Vermeiren, P., Munoz, C., and Ikejima, K. 2016. Sources and sinks of plastic debris in estuaries: a conceptual model integrating biological, physical and chemical distribution mechanisms. Mar. Pollut. Bull. 113, 7–16.
10. Wang, C., Lin, X., Li, L., and Lin, S. 2016. Differential Growth Responses of Marine Phytoplankton to Herbicide Glyphosate. PLoS ONE 11(3): e0151633. doi:10.1371/journal.pone.0151633. 20p.
11. Mercurio, P., Flores, F., Mueller, J.F. Carter, S., and Negri, A.P. 2014. Glyphosate persistence in seawater. Marine Pollution Bulletin. 85:385-390.
12. Pérez, G.L., Vera, M.S., and Miranda, L.A. 2012. Effects of herbicide glyphosate and glyphosate-based formulations on aquatic ecosystems. Herbicides—Properties, Synth. Control Weeds, 334–368.
13. Stachowski-Haberkorn, S., Becker, B., Marie, D., Haberkorn, H., Coroller, L., and de La Broise, D. 2008. Impact of Roundup on the marine microbial community, as shown by an in-situ microcosm experiment. Aquat. Toxicol. 89, 232–241.

    O'Neill, J.M., Davis, T.W., Burford, M.A., and Gobler, C.J. 2012. The rise of harmful cyanobacteria blooms: The potential roles of eutrophication and climate change. Harmful Algae (14):313-334.

# SEAGRASSES


## Goals:

**Implement a comprehensive strategy to remove seagrass stressors, restore seagrasses, and sustain seagrass-dependent species.**

# ONE LAGOON

## HABITATS

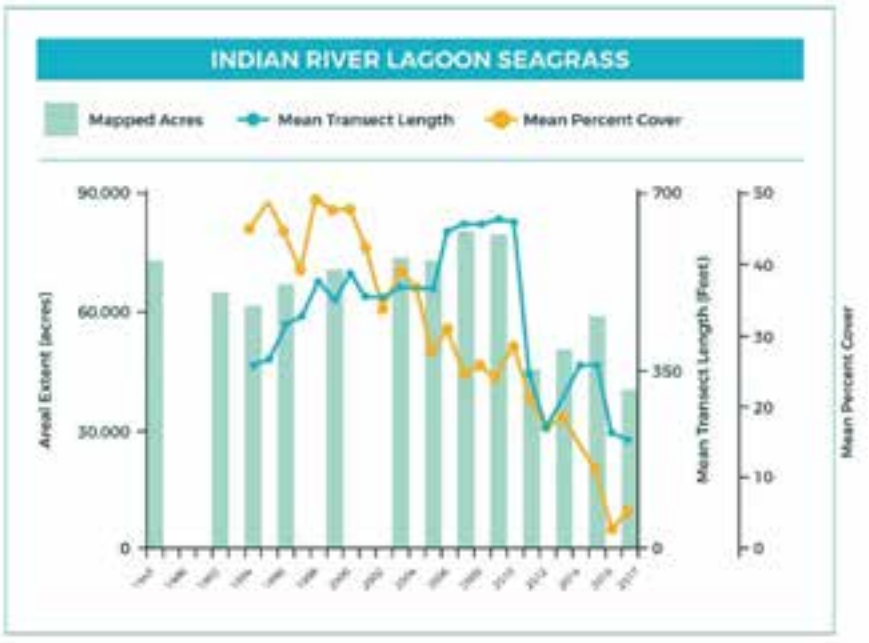
### *Seagrasses*

**GOALS: Implement a comprehensive, coordinated, and integrated IRL strategy to *REMOVE* stressors to seagrasses in the IRL and *RESTORE* seagrass habitats to support and sustain healthy water quality and seagrass dependent species.**

**ISSUE SUMMARY:** Seven species of seagrasses are found in the IRL: turtle grass (*Thalassia testudinum*), shoal grass (*Halodule wrightii*), manatee grass (*Syringodium filiforme*), Johnson's seagrass (*Halophila johnsonii*), star grass (*Halophila engelmannii*), paddle grass (*Halophila decipiens*), and widgeon grass (*Ruppia maritima*).[1] Each has subtle but different optimum salinity requirements. These seven species of seagrasses each have unique survival strategies for growth.

For more than 25 years, seagrass distribution, area coverage, and health have been considered a barometer of IRL health. Within seagrass communities, a single acre of seagrass can produce over 10 tons of leaves per year. This vast biomass provides food, habitat, and nursery areas for a myriad of adult and juvenile vertebrates and invertebrates. Further, a single acre of seagrass may support as many as 40,000 fish and 50 million small invertebrates. Because seagrasses support such high biodiversity, and because of their sensitivity to changes in water quality, they have become recognized as important indicator species that reflect the overall health of coastal ecosystems.[2] In addition, seagrass adds dissolved oxygen during daytime photosynthesis, is important in nutrient cycling, and recent studies seem to indicate that they can buffer the system from ocean acidification.[1,2,3] Therefore, seagrasses are a key component not only in the IRL system but in waterbodies throughout the state. DEP has estimated that each acre of seagrass in Florida has an economic value of approximately $20,500 per year, which translates into a statewide economic benefit of $55.4 billion annually. However, since the 2011 superbloom, the IRL has experienced extensive seagrass loss with the figure below documenting 52% less acreage than was present in 2009.[4,5] In addition, seagrass beds do not extend as far offshore, with seagrass transects in 2017 being 70% shorter than they were in 2009.[5]

The IRL system has seagrass targets for Banana River Lagoon, North IRL, and Central IRL,[6] as well for the southern IRL,[7] which are based upon light penetration in the lagoon and associated water quality parameters. These targets are not being achieved with the current conditions in the lagoon system.




Although seagrass recovery will begin when water quality, sediment quality, and the microbial biome improve in the IRL, many seagrasses are slow to recolonize. Proactive planting is a restoration technique that can complement and enhance natural recovery. Whether it is the relocation of an entire bed or removal

of random plugs from an existing bed, the use of donor beds may help with seagrass restoration. Nutritional improvements, wave protection, and herbivore exclosures can also be used to help with restoration. To date, seagrass restoration within the IRL has been limited, small in scale, and costly. The size of restoration may change in the future based on seagrass response to improving conditions. The IRLNEP Management Conference recognizes the potential need for seagrass restoration intervention. IRLNEP will work with science and restoration partners (including industry) to identify and evaluate new techniques to enhance and expedite seagrass restoration success.

## STRATEGIES:

- Ensure that monitoring, mapping, and modeling are coordinated lagoon-wide to provide a clear picture of seagrass and epiphytes abundance, distribution, and trends.
- Improve water clarity and quality in the IRL to sustain IRL seagrass recovery.
- Develop and assess seagrass nursery techniques and planting strategies in strategic areas to determine the feasibility of accelerating recovery.
- Implement a program of protection from human activity, restoration, and management activities needed to maintain, protect, and *RESTORE* the IRL seagrass community.
- Evaluate new seagrass restoration techniques by funding innovative pilot projects and partnerships.
- Prioritize, simplify, and expedite restoration project permits including expanding eligible project types that qualify for general permit consideration.
- Evaluate the current state of IRL feedback mechanisms and nutrient cycling to assess the ability of the system to function as a coastal filter.[8]
- Refine the existing IRL seagrass restoration targets using new technology for measuring light attenuation.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Seagrass-1: Implement a program of protection, restoration, and management activities.** | Maintain, protect, and *RESTORE* the IRL seagrass community. | DEP, FWC, WMDs, IRLNEP Management Conference | Local governments, interest groups | Planting costs range from $10,000 to $200,000 per acre depending on conditions[9]; additional costs for stock, staff time, and monitoring | DEP, FWC, USFWS, National Park Service (NPS), academia, interest groups | Coordinate and collaborate |
| **Seagrass-2: Ensure that monitoring, mapping, and modeling are coordinated lagoon-wide. (NEW)** | Provide a clear picture of seagrass abundance, distribution, and trends. | DEP, FWC, WMDs, IRLNEP Management Conference | IRLNEP Management Conference partners, FIT, Florida Oceanographic Society, Harbor Branch Oceanographic Institute | $250,000-$300,000 annually | DEP, WMDs, FWC, USFWS, NPS, academia, interest groups | Coordinate and collaborate |
| **Seagrass-3: Fund innovative pilot projects and partnerships. (NEW)** | Evaluate new seagrass restoration techniques. | IRLNEP, academic research partners, private companies | WMDs | Planting costs range from $10,000 to $200,000 per acre depending on conditions[9]; additional costs for stock, staff time, and monitoring | DEP, FWC, USFWS, NPS, academia, interest groups | Conduct, coordinate, and collaborate |

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Seagrass-4: Develop a Habitat Restoration Plan for the IRL system. (NEW)** | Prepare a Habitat Restoration Plan to meet USEPA performance measures for NEPs. | IRLNEP Management Conference | Local governments, WMDs, FWC, academia, Northeast Florida Estuarine Restoration Team (NERT), East-Central Estuarine Restoration Team (ECERT) | $50,000 | IRLNEP | Conduct, coordinate, and collaborate |

## OUTCOMES:

- **Short-term (1 – 2 years):** Evaluate ongoing monitoring and ensure efforts are coordinated. Begin seagrass restoration in key areas of the IRL, where possible.
- **Medium-term (3 – 4 years):** Observe seagrass recovery and expansion of its distribution in sub-basins of the IRL with improving water quality. Evaluate the need for a seagrass nursery to assist with restoration.
- **Long-term (5 – 10+ years):** *RESTORE* IRL seagrasses to targets in the relevant BMAPs.

## CHALLENGES TO SUCCESS:

- Water clarity and quality will determine seagrass recovery timeline.
- Muck removal is required in many areas to provide adequate substrate for seagrass recovery and expansion.
- Impact of climate change on IRL water quality and depth will increase restoration challenges.

## CITATIONS:


1. Yates, K.K., Moyer, R.P., Moore, C., Tomasko, D., Smiley, N., Torres-Garcia, L., Powell, C.E., Chappel, A.R., and Bociu, I. 2016. Ocean acidification buffering effects of seagrass in Tampa Bay. pp.273-284 in Burke, M. (ed.). Proceedings, Tampa Bay Area Scientific Information Symposium, BASIS 6: 28-30 September 2015. St. Petersburg, FL.
2. Sherwood, E.T., Greening, H.S., Johansson, R, Kaufman, K., and Raulerson, G.E. 2017. Tampa Bay (Florida, USA): Documenting Seagrass Recovery since the 1980's and Reviewing the Benefits. Southeastern Geographer 57(3):294-319. DOI: 10.1353/sgo.2017.0026.
3. Sherwood, E.T., Greening, H.S., Janicki, A.J., and Karlen, D.J. 2015. Tampa Bay estuary: Monitoring long-term recovery through regional partnerships. Regional Studies in Marine Science 4:1-11. DOI: 10.1016/j.rsma.2015.05.005.
4. Rey, J.R. and Rutledge, C.R. 2013. Seagrass Beds of the Indian River Lagoon. UF-IFAS Extension.
5. Morris, L., Hall, L., Chamberlain, R., and Jacoby, C. 2018. Summary report for the Northern Indian River Lagoon. Seagrass Integrated Mapping and Monitoring Report No. 3. Fish and Wildlife Research Institute Technical Report TR-17 version 3, Florida Fish and Wildlife Conservation Commission, St. Petersburg, Florida. http://myfwc.com/media/4489960/simm3-northern-indian-river-lagoon.pdf.
6. Steward, J.S., Virnstein, R.W., Morris, L.J., and Lowe, E.F. 2005. Setting Seagrass Depth, Coverage, and Light Targets for the Indian River Lagoon System, Florida. Estuaries 28(6): 923-935.
7. Crean, D.J., Robbins, R.M., and Iricanin, N. 2007. Water quality target development in the southern IRL. Florida Scientist 70:522-531.
8. McGlathery, K.J., Sundback, K., and Anderson, I.C. 2007. Eutrophication in shallow coastal bays and lagoons: the role of plants in the coastal filter. MEPS 348:1-18.
9. FWC. 2003. Florida Seagrass Manager's Toolkit. Florida Marine Research Institute, St. Petersburg, FL.

# FILTER FEEDERS

## Goals:

**Better understand shellfish stressors, restore filter feeders, and maintain healthy water quality to sustain fisheries.**

# ONE LAGOON

## HABITATS

### *Filter Feeders*

**GOALS: Conduct *RESEARCH* to better understand stressors and root causes for the decline of filter feeders in the IRL. *RESTORE* selected bivalve populations, with a focus on restoring oyster and clam populations to support and sustain goals for both habitat conservation and sustainable commercial harvests.**

**ISSUE SUMMARY:** Reef-forming oysters have declined globally by approximately 85%,[1] and the abundance and extent of oyster reef habitat (*Crassostrea virginica*) in the IRL is likely even further depleted. Similarly, the abundance of the hard clam, *Mercenaria mercenaria*, has declined precipitously following two significant peaks in fishery landings in the 1980s and 1990s.[2]

The loss of large bivalves from estuarine and lagoon systems results in a diminished level of overall ecosystem benefits, including water column filtration, denitrification in surrounding sediments, and production of reef-associated species that support recreational and commercial fisheries.[3] Filtration pressure is considered an important driver of benthic and water coupling,[4] and as such, it plays a critical role in maintaining water quality in estuarine systems at various scales. It is likely that filtration pressure at local scales (feet to tens of feet) can improve water clarity and support growth of seagrass and benthic microalgae, while filtration at estuarine scales (miles to tens of miles) has historically been an important mechanism for removing particulate organic material and moving nutrients into the benthos for processing at scales that match watershed inputs.[5]

Several recent studies in Mosquito Lagoon have been conducted to evaluate the benefits of oysters on lagoon water quality. One study investigated key biogeochemical properties (e.g., nutrient pools and microbial community size and activity) in the sediments of dead reefs; 1-, 4-, and 7-year old restored reefs; and natural reference reefs of the eastern oyster, *Crassostrea virginica*. The study found that measured biogeochemical properties increased significantly by one-year post restoration, relative to dead reefs, and then remained constant as the reefs continued to age. The study demonstrated the role of live intertidal oyster reefs as biogeochemical hotspots for nutrient cycling and burial.[6] Another study measured denitrification rates and nutrient sequestration and bioavailability of oyster beds. The study found that denitrification rates are higher underneath restored oyster reefs and that oyster reefs provide nitrogen retention. Oysters provide a continuous mechanism for nitrogen removal and have the potential to increase IRL resiliency to nutrient loads and mitigate internal nutrient loads.[7]

IRL shellfish populations can be impacted by several stressors. These stressors include poor water quality, poor sediment quality, harmful algal blooms, changes in food types and availability, changes in predator populations, salinity changes, overexploitation, and ocean acidification. These stressors and their synergistic actions are complex, and they are likely to influence species differently at each stage of their life cycles. A better understanding of these stressors and conditions is essential to optimize the siting, timing, and scale of projects to restore filter feeders.

## STRATEGIES:

- Conduct mapping and condition analysis of existing habitats, delineate the areas suitable for restoration, and establish targets for key ecosystem services using a lagoon-wide filter feeder suitability analysis.[3]
- Quantify ecological and socioeconomic benefits associated with restoring oyster reef habitat, hard clams, and other bivalve populations.[8,9]
- Develop a comprehensive filter feeder management plan, using data from the above ecological and socioeconomic benefits such as filtration capacity, denitrification, and fisheries enhancement to inform restoration and management goals and that address multiple objectives of ecosystem value (habitat), commercial fisheries yield, genotypic variation, and aquaculture.
- Prioritize, simplify, and expedite restoration project permits, including expanding eligible project types that qualify for general permit consideration. Evaluate need for a restoration-only permit to streamline the permitting process.
- Understand the historic and current oyster and clam distribution and abundance throughout the lagoon through communications and data sharing among scientists, wild shellfish harvesters, and aquaculture lease holders. Integrate science-based and experienced-based IRL conditions and trends for successful filter feeder restoration.
- Consider a strategic and diversified approach to filter feeder restoration that integrates site selection (including watershed and shoreline influences), water quality, water flow, water depth, natural and artificial substrates, and traditional wild harvest techniques like relaying.
- Assess and expand existing bivalve nursery operations for the benefit of commercial and restoration purposes and conduct research regarding culture and out planting techniques.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Filter Feeders-1: *RESEARCH* spatially explicit data on the extent and condition of existing filter feeder habitat. (NEW)** | Identify the extent and condition of existing filter feeder habitat. | DEP, USFWS, FWC | IRL Management Conference partners, academia, WMDs | TBD | DEP, local governments, IRLNEP | Coordinate and collaborate |
| **Filter Feeders-2: *REPORT* spatially-explicit data on denitrification potential associated with existing natural and restored filter feeder habitat, incorporated into maps and online platforms. (NEW)** | Identify spatially-explicit data on denitrification potential associated with existing natural and restored filter feeder habitat. | DEP, USFWS, FWC | IRL Management Conference partners, WMDs | TBD | DEP, local governments, IRLNEP | Coordinate and collaborate |
| **Filter Feeders-3: Develop a filter feeder management plan working with public, private and independent sector partners. (NEW)** | Identify goals for management and restoration of filter feeder habitat to assist with restoration of recreational and commercial fisheries. | DEP, FDACS USFWS, FWC | NERT, ECERT, WMDs, IRL Management Conference partners | TBD | DEP, local governments, IRLNEP, Florida Inland Navigation District (funding for reef balls) | Coordinate and collaborate |

## OUTCOMES:

- **Short-term (1 – 2 years):** Determine the quantitative basis for measuring denitrification and filtration benefits from filter feeders.

- **Medium-term (3 – 4 years):** Develop a nitrogen budget and spatially-explicit nitrogen accounting framework to support the use of denitrification in overall nutrient management at the watershed scale.
- **Long-term (5 – 10+ years):** Filter feeders restored across a broad spatial distribution that supports a sustainable oyster fishery and aquaculture endeavors.

## CHALLENGES TO SUCCESS:

- Continued water quality/quantity issues not suitable to sustain oyster/shellfish populations in some parts of the IRL.
- Availability of adequate, stable recurring funding for effective, efficient, and timely program and project implementation.
- Complexity of management of the shellfish resource.
- Availability of dry goods and supply chain of shell and spat needed for projected scale of restoration.

## CITATIONS:


1. Beck, M.W., Brumbaugh, R.D., Airoldi, L., Carranza, A., Coen, L.D., Crawford, C., Defeo, O., Edgar, G., Hancock, B., Kay, M., Lenihan, H., Luckenbach, M., Toropova, C., Zhang, G., and Guo, X. 2011. Oyster reefs at risk and recommendations for conservation, restoration and management. Bioscience 61(2): 107-116.
2. Arnold, W.S., Marelli, D.C., Parker, M., Hoffman, P., Frischer, M., and Scanlon, J. 2002. Enhancing hard clam (*Mercenaria* Spp.) population density in the Indian River Lagoon, Florida: A comparison of strategies to maintain the commercial fishery. *J. Shellfish Res.* 21(2): 259-672.
3. Zu Ermgassen, P., Hancock, B., DeAngelis, B., Greene, J., Schuster, E., Spalding, M., and Brumbaugh, R. 2016. *Setting objectives for oyster habitat restoration using ecosystem services: A manager's guide*. The Nature Conservancy, Arlington, VA. 76 pp.
4. Dame, R.F. 2011. *Ecology of Marine Bivalves: An Ecosystem Approach*. CRC Press, Boca Raton, FL. 269 pp.
5. Dame, R.F., Zingmark, R.G., Stevenson, L.H., and Nelson, D. 1980. Filter feeder coupling between the estuarine water column and benthic subsystems, p. 521-526. In V. C. Kennedy (ed.), Estuarine Perspectives. Academic Press, New York.
6. Chambers L.G., Gaspar, S.A., Pilato, C.J., Steinmuller, H.E., McCarthy, K.J., Sacks, P.E., and Walters, L.J. 2017. How Well Do Restored Intertidal Oyster Reefs Support Key Biogeochemical Properties in a Coastal Lagoon? Estuaries and Coasts. DOI 10.1007/s12237-017-0311-5.
7. Schmidt, C. and Gallagher, S. 2017. Final Report: The denitrification potential and ecosystem services from ten years of oyster bed restoration in the Indian River Lagoon. Prepared for the Brevard County Board of County Commissioners, Natural Resources Department, 2013 Urban and Community Forestry Program.
8. Baggett, L.P., Powers, S.P., Brumbaugh, R.D., Coen, L.D., DeAngelis, B.M., Greene, J.K., Hancock, B.T., Morlock, S.M., Alen, B.L., Breitburg, D.L., Bushek, D., Grabowski, J.H., Grizzle, R.E., Grosholz, E.D., LaPeyre, M.K., Luckenbach, M.W., McGraw, K.A., Piehler, M.F., Westby, S.R., and zu Ermgassen, P.S.E. 2015. Guidelines for evaluating performance of oyster habitat restoration. *Restoration Ecology*. 23(6): 737-745.
9. Zu Ermgassen, P.S, Spalding, M.D., and Brumbaugh, R.D. 2015. Estimates of historical ecosystem service provision can guide restoration efforts. Chapter 9 *in:* Marine Historical ecology in Conservation: Applying the Past to Manage for the Future. Kittenger, J.N., L. McClenahan, K.B. Gedan, and L. K Blight, eds. University of California Press. Pp. 187-206.

# LIVING SHORELINES


## Goals:

**Identify priority locations for living shoreline restorations and rebuild green infrastructure to contribute to coastal resilience.**

# ONE LAGOON

## HABITATS

### *Living Shorelines*

**ACTION: Conduct *RESEARCH* to identify key locations along the IRL and tributaries that would benefit from living shorelines. *RESTORE* natural shorelines. *REBUILD* both natural and hardened shorelines that have been impacted by erosion or storm surge. Incorporate living components into armored shorelines where a hybrid solution is feasible and amenable to the owner. *REPORT* the performance, value, and cost-benefit of living shorelines as natural infrastructure that decreases storm surge vulnerability and contributes to coastal *RESILIENCE*.**

**ISSUE SUMMARY:** Historically, efforts to protect shorelines have involved hardened structures, such as seawalls, rock revetments, or bulkheads, to dampen or reflect wave energy. However, shoreline hardening interrupts natural shoreline processes, reduces nursery habitat for marine species and foraging habitat for wading birds, degrades water quality, and can increase erosion processes. Hardened shorelines are often the default method of shoreline protection selected by property owners to "hold-the-line" along the edge of their properties.[1]


A more environmentally friendly option that provides similar benefits is a living shoreline. A living shoreline is a protected, stabilized coastal edge made of natural materials such as plants, sand, or rock. Unlike a hardened structure, which impedes the growth of plants and animals, living shorelines grow over time. Living shorelines are a natural shoreline management approach that provides erosion control benefits; protects, restores, or enhances natural shoreline habitat; and maintains coastal processes through the strategic placement of plants, stone, sand fill, and other structural organic materials. Living shorelines are an innovative and cost-effective technique for coastal management.[2]

A 2015 report by Restore America's Estuaries[3] found that living shorelines:

- Prevent erosion caused by everyday weather, boat wakes, and long-term sea level rise more effectively than hardened structures in many cases.
- Prevent catastrophic storm damage more effectively than hardened structures in many cases.
- Avoid many of the adverse effects that hardened structures usually have on the adjacent aquatic and terrestrial ecosystems and associated ecosystems services.
- Grow stronger over time through natural processes, while hardened structures often deteriorate and may, if not maintained, ultimately fail.

The use of living shorelines is being encouraged across the state. The Coastal Wildlife Conservation Initiative is led by FWC in partnership with multiple agencies to address coastal issues that affect wildlife and their habitats while considering human needs. One priority issue for the initiative is replacing traditional hardened methods of shoreline stabilization with more natural living shorelines that not only provide shoreline stabilization but also habitat for wildlife while maintaining natural coastal processes.[4] The Florida Master Naturalist Program through UF-IFAS has been holding special topic classes throughout the state including one on coastal shoreline restoration, which was recently completed in the IRL. This class provides training in the restoration of living shorelines, oyster reefs, mangroves, and marsh, with focus on ecology, benefits, methods, and monitoring techniques.[5]

Studies are also underway locally to determine the most effective living shoreline designs given conditions in the lagoon. One study evaluated the wave energy attenuation from four types of living shorelines: (1) a control with sediment only, (2) oysters, (3) cordgrass, and (4) a combination of oysters plus cordgrass. This study found that the combination of live oysters plus one-year old cordgrass was the most effective. This design reduced 67% of the wave energy created by a single recreational boat wake, compared to bare sediment.[6] Information from these types of studies will help to plan appropriate types of living shorelines throughout the lagoon system.

## STRATEGIES:

- Work with IRL restoration partners to implement a strategic, science-based and comprehensive living shoreline restoration program
- Support the planning, funding, implementation, and coordination of living shoreline projects throughout the IRL.
- Develop recommendations for site location, design, construction, and standardized metrics for projects to ensure consistent performance and monitoring.
- Coordinate the sharing and transfer of living shoreline information and tools to IRL partners, including resource managers, federal, state, and local agencies, contractors, and homeowners.
- Work with regulatory agencies at federal, state, and local levels to streamline permitting for living shoreline projects and incorporate living shorelines into local comprehensive plans as the preferred technique to stabilize shorelines.
- Prioritize, simplify, and expedite restoration permits including expanding eligibility for general permits.
- Implement a hybrid approach to combine living components with engineered structures where wave energy and shoreline configuration necessitate armor. These hybrid combinations provide ecosystem services for species that need habitat and improve coastal *RESILIENCE* to erosion.
- Develop comprehensive strategies throughout the IRL system, following a similar approach used by Brevard County[7] and Volusia County to assess shoreline hardening and plan for living shoreline projects.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Living Shorelines-1: *RESEARCH* and *REPORT* science-based siting, planning, design, and construction criteria. (NEW)** | Improve siting, design, and construction of living shorelines throughout the IRL. | IRLNEP, USFWS, FWC | Florida Master Naturalist Program, resource managers; federal, state, and local agencies; contractors; homeowners; Riverside Conservancy; academia; NERT; ECERT | TBD | DEP, WMDs, IRLNEP, local governments | Conduct, coordinate, and collaborate |
| **Living Shorelines-2: Develop standardized metrics and protocols for living shoreline projects. (NEW)** | Ensure consistent performance and monitoring. | NERT, ECERT | DEP, FWC, U.S. Army Corps of Engineers (USACE), WMDs, NERT, ECERT | TBD | DEP, WMDs, local governments | Coordinate and collaborate |
| **Living Shorelines-3: *RESEARCH* and *REPORT* on living shoreline information. (NEW)** | Provide resources to IRL partners. | IRLNEP | Florida Master Naturalist Program, resource managers; federal, state, and local agencies; contractors; homeowners; academia; NERT; ECERT | TBD | IRLNEP, local governments | Conduct, coordinate, and collaborate |
| **Living Shorelines-4: Streamline permitting for living shoreline projects. (NEW)** | Reduce barriers to project construction. | USACE, USFWS, DEP, FWC, WMDs, local governments | Federal, state, and local agencies; contractors; homeowners | TBD | USACE, USFWS, DEP, FWC, WMDs, local governments | Coordinate and collaborate |
| **Living Shorelines-5: Incorporate living shoreline guidance into local comprehensive plans. (NEW)** | Make living shorelines the preferred shoreline restoration approach. | Local governments | Landowners and developers, NERT, ECERT | TBD | Local governments | Coordinate and collaborate |

## OUTCOMES:

- **Short-term (1 – 2 years):** Promote living shoreline restoration in areas with high erosion and/or sediment loads to the IRL and as an alternative or hybrid solution for seawall replacement for waterfront homes.
- **Medium-term (3 – 4 years):** Continue living shoreline restoration projects throughout the IRL as identified in the CCMP and in other local and regional restoration plans.
- **Long-term (5 – 10+ years):** Continue to implement living shorelines projects as needed.

## CHALLENGES TO SUCCESS:

- Homeowner and community acceptance of living shorelines as a sufficiently protective and cost-effective alternative for bulkheads, sea walls, and rip rap.
- Limited knowledge of living shoreline techniques in coastal construction companies.
- Funding sources and manpower to complete projects.
- Sufficient dry goods and supply chain to meet needs.
- Local comprehensive plans and permitting.

## CITATIONS:

1. Florida Living Shorelines. Hardened vs. Soft Shorelines. Website: http://floridalivingshorelines.com/hardened-vs-soft-shorelines/.

2. National Oceanic and Atmospheric Administration (NOAA) Office of Habitat Conservation. 2017. Living Shorelines. Website: https://www.fisheries.noaa.gov/insight/living-shorelines.
3. Restore America's Estuaries. 2015. Living Shorelines: From Barriers to Opportunities. Arlington, VA.
4. FWC Coastal Wildlife Conservation Initiative. Website: http://myfwc.com/conservation/special-initiatives/cwci/faqs/.
5. UF-IFAS The Florida Master Naturalist Program. Special Topics Classes. https://masternaturalist.ifas.ufl.edu/about/special_topics.aspx.
6. Manis, J.E., Garvis, S.K., Jachec, S.M., and Walters, L.J. 2015. Wave attenuation experiments over living shorelines over time: a wave tank study to assess recreational boating pressures J Coast Conserv (2015) 19: 1. https://doi.org/10.1007/s11852-014-0349-5.
7. Donnelly, M., Kibler, K., Walters, L. 2017. Developing a Shoreline Habitat Restoration and Management Plan for Brevard County. Final Report Phase 1, 63pp.

# WETLANDS AND ALTERED MARSHES


## Goals:

**Restore and protect wetlands and refine wetland management strategies to support biodiversity and coastal resilience.**

# ONE LAGOON

## HABITATS

### *Wetlands and Impounded and Altered Marshes*

**GOALS:** ***RESTORE*** **and protect wetlands, wetland-upland transitions, and impounded or altered marshes throughout the IRL watershed.** ***RESPOND*** **to opportunities to refine wetland management strategies to support IRL biodiversity and coastal** ***RESILIENCE*****. Conduct** ***RESEARCH*** **and** ***RESPOND*** **to future wetland management challenges associated with sea level rise.**

**ISSUE SUMMARY:** Wetlands within the IRL region play a key role in maintaining a healthy ecosystem. They provide a wide variety of ecological functions, including serving as habitat for various species, providing water quality protection and improvement, supporting the food chain, providing flood storage, and buffering the lagoon from activities that occur on adjacent uplands.

Urban, industrial, and agricultural development have contributed to the loss of wetlands in the IRL region. By 1980, it was estimated that 8% of Florida's estuarine habitat had been lost to development.[1] Within the IRL region, 27% of the mangrove acreage in the Fort Pierce area alone was lost between 1940 and 1987.[2] It is likely that similar losses of wetlands occurred near other urban centers in the IRL region. Upland wetlands provide critical water storage that is important to hydrologic and salinity regimes, and they filter nutrients and suspended solids. These wetlands are under increasing pressure from upland development. In addition, tidal wetlands associated with tributaries are vulnerable to hydrologic changes, and these wetlands are important habitats for critical life stages of fishery species such as juvenile redfish, snook, and blue crabs. Some of these areas, such as along the North Fork of the St. Lucie River, have been examined for restoration efforts.[3]


E. Netterstrom

In addition to direct wetlands loss, more than 40,000 acres of wetlands were impounded or ditched for mosquito control purposes and isolated from the IRL.[4] A mosquito control impoundment is a salt marsh or mangrove forest with an earthen dike around the perimeter that allows the area to be artificially flooded during mosquito breeding seasons, and machines called draglines were used to dig ditches and create piles of spoil in other marshes, especially further north in the system. Both approaches were designed to reduce breeding by salt marsh mosquitoes because females will not lay their eggs in standing water or on dry soil in piles of spoil. They lay their eggs on moist soil, and the eggs hatch when flooded by tides or rainfall; therefore, holding water on marshes permanently or during their breeding seasons prevents mosquito production.[5] Both methods effectively controlled mosquitoes, but they also isolated the wetlands from the IRL or eliminated wetland plants. Thus, the water quality and habitat benefits of these wetlands to the IRL were largely lost.

The creation of the Subcommittee on Managed Marshes of the Florida Coordinating Council for Mosquito Control in 1986, and the allocation of funds for research on wetlands management by various entities including the Florida Coastal Management Program proved to be critical in advancing ecologically sound mosquito control in Florida without reverting to heavy reliance on pesticides. In fact, new approaches yield more functional wetland, without an increase in breeding by salt marsh mosquitoes. In recent decades, amphibious excavators have restored wetlands by replacing spoil in ditches dug by draglines and grading them to the elevation of nearby

marsh, and most impoundments have been managed by rotational impoundment management, breaching of dikes, or other means to fully or seasonally reconnect the marsh with IRL waters. In most of the lagoon, impoundments represent the majority of the restored wetlands.

Installing culverts through the dikes that isolate areas of wetlands in impoundments is the most cost-effective means for reintegrating wetlands into the IRL system. By using pumps, operable weirs, and one-way valves, these reconnected wetlands continue to provide seasonal control of mosquitos and support management actions designed to benefit wildlife of interest. For the impounded marshes within the SJRWMD jurisdiction, 98% of affected wetlands are targeted for rehabilitation, with reconnection completed for 79% of those wetlands. The remaining 2% of wetlands are unlikely to be rehabilitated, in large part because they are managed for specific purposes that are incompatible with reconnection, e.g., open water for waterfowl, or they are surrounded by developed areas. In addition, the St. Lucie County Mosquito Control District manages 4,000 acres of coastal mangrove swamps and salt marshes for mosquito control using an ecosystem management approach for salt marsh mosquito control that does not require pesticides.

| Sub-lagoon within SJRWMD | Mosquito Lagoon | Banana River Lagoon/ Newfound Harbor | North IRL | Central IRL | Total |
|---|---|---|---|---|---|
| Reconnected (Acres) | 5,360 | 3,722 | 14,801 | 3,150 | 27,033 |
| Targeted for Rehabilitation (Acres) | 1,396 | 1,257 | 4,227 | 124 | 7,004 |
| Not Targeted for Rehabilitation (Acres) | 0 | 100 | 740 | 0 | 840 |
| Total (Acres) | 6,756 | 5,079 | 19,768 | 3,274 | 34,877 |


Management of wetland impoundments has varied over time. For many years, most management activities in impoundments were limited to water level manipulations using pumps or artesian wells. In recent years, culverts have been installed in the dikes of most impoundments to re-establish the vital connection between the impounded marshes and the IRL. In certain situations, dikes have been entirely removed. Restoration of the connection between formerly impounded wetlands and the open waters of the lagoon not only benefits water quality but also improves the habitat quality of the formerly impounded wetlands, providing additional habitat to many IRL species dependent on coastal wetlands for all or a portion of their life cycles.

These revised management practices have not been implemented in all impounded marshes because many of the remaining impounded wetlands in the IRL are privately owned, and many of these landowners are reluctant to allow changes in current management practices. However, local, state, and federal regulation of development or construction within wetlands has reduced the rate of wetland loss.

The five lagoon counties have ordinances to reduce the impacts and/or loss of wetland acreage and function.

- **Volusia County**: https://www.volusia.org/core/fileparse.php/4742/urlt/Division11WetlandAlterationPermits1-30-2014.pdf
- **Brevard County:** http://www.brevardfl.gov/docs/default-source/natural-resources-documents/article-x-division-4-wetland-protection-2014-09.pdf
- **Indian River County**: http://indianrivercounty.elaws.us/code/coor_apxid487171_titleix_ch928
- **St. Lucie County:** https://library.municode.com/fl/st._lucie_county/codes/land_development_code?nodeId=CHVIREPRST_6.02.00ENSELA_6.02.03WEPR

- **Martin County**: https://library.municode.com/fl/martin_county/codes/land_development_code?nodeId=LADERE_ART4SIDEST_DIV1WESHPR_S4.2WEPRST

## STRATEGIES:

- Eliminate further destruction of wetlands through land acquisition of privately owned wetlands, ordinances, and other mechanisms.
- Identify opportunities for wetlands restoration for all types of hydrologic impact such as impounding, drag lining, ditching, berms, and tributary oxbow isolation. Work with private property owners to reconnect waters.
- Identify opportunities for mitigation banking and wetlands creation.
- Work with IRLNEP partners, the Sub-Committee on Managed Marshes, and mosquito control districts to continue responsible wetland and impoundment management to benefit the IRL, support IRL biodiversity and protect human health from insects.
- Re-evaluate wetland management strategies regarding key parameters such as dissolved oxygen, acidity, and primary and secondary production of fishery species.
- Work with county mosquito control districts to expand funding opportunities for living shoreline restoration when impoundment dikes require maintenance or repairs after post-storm erosion and storm surge events.
- Implement restoration of tidal wetlands in tributaries, focusing on rehydration and reconnection of historical flow and headwaters.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Wetlands-1: *RESEARCH* and develop new and improved wetland BMPs with a focus on understanding wetland responses to sea level rise and climate change.** | Understand wetland responses to sea level rise and climate change. | NRCS, DEP | WMDs, academia, interest groups, FWC, Subcommittee on Managed Marshes | TBD | NRCS, WMDs, DEP, academia, NOAA, National Fish and Wildlife Foundation | Coordinate and collaborate |
| **Wetlands-2: Establish or enhance wetland or shoreline setback buffers.** | Protect wetlands from development and invasive species. | Local governments | WMDs, academia, interest groups | TBD | Local governments | Coordinate and collaborate |
| **Wetlands-3: Implement innovative programs and incentives supporting wetlands protection and management on privately-owned lands and marshes managed by private, non-profit organizations. When necessary, acquire ownership or control of crucial wetlands.** | Create wetland opportunities on public and private land and create public/private partnerships. | Brevard Environmentally Endangered Lands Program, DEP's Division of State Land, Florida Forever | Local governments, forest and agricultural land owners, mosquito control districts, interest groups, NERT, ECERT | TBD | Florida Land Acquisition Trust Fund, local governments | Coordinate and collaborate |
| **Wetlands-4: Continue projects and programs to *RESTORE* shorelines with a focus on enhancing and managing mosquito impoundment dikes with living shoreline restoration.** | Create a more natural environment and enhance biodiversity. | FWC, DEP | WMDs, local governments, interest groups, NOAA, mosquito control districts, Subcommittee on Managed Marshes, NERT, ECERT | TBD | FWC, WMDs, DEP, local governments | Coordinate and collaborate |

## OUTCOMES:

- **Short-term (1 – 2 years):** Evaluate the status and needs of wetlands and impounded and altered marshes throughout the IRL.
- **Medium-term (3 – 4 years):** Implement CCMP projects to ensure IRL wetlands and marshes are restored and protected. Support the use of wetland sites as living laboratories for *RESEARCH* related to evaluating wetland changes and management needs (including BMPs) in response to climate change and sea level rise.
- **Long-term (5 – 10+ years):** Implement IRL wetland and marsh management as a coordinated network of BMPs to sustain diverse habitats and biodiversity in the IRL.

## CHALLENGES TO SUCCESS:

- Re-establishing functional wetlands is difficult and costly. Therefore, focus should be on protection of existing wetlands and natural wetland functions.
- Management approaches for mosquito impoundments and managed marshes must balance mosquito control with habitat restoration goals. A whole ecosystem perspective is needed to incorporate biological diversity and water quality into lagoon-wide marsh management.
- Inadequate long-term funding.
- Challenges of sea level rise to current and future management strategies.

## CITATIONS:

1. Brantly, R.M. 1980. The Changing Resource Scene in Florida. Transactions 45th North American Wildlife Conference: 5–10.
2. Hoffman, B.A. and Haddad, K.D. 1988. General Land Use and Vegetation Changes in the Indian River Lagoon System. In Indian River Lagoon Estuarine Monograph (Draft). D.D. Barile (ed.) Marine Resources Council of East Florida, Florida Institute of Technology. Melbourne, Florida.
3. Herren, L., Sharpe, B., Beal, J., Tucker, J., and Conrad, C. 2011. Hydrological Restoration of the North Fork St. Lucie River and Ten Mile Creek: 2011 Needs Update. DEP Report, 306 pp.
4. Rey, J.R. and Kain, T.1989. A Guide to Salt Marsh Impoundments of Florida. Florida Medical Entomological Laboratory, Publication. Vero Beach.
5. Rey, J.R., Carlson, D.B., Brockmeyer, R.E. 2011. Coastal wetland management in Florida: environmental concerns and human health. Wetlands Ecology and Management.

# SPOIL ISLANDS


## Goals:

**Update the Spoil Islands Management Plan for the IRL with a focus on improved public access, management, and water quality.**

# ONE LAGOON

## HABITATS

### *Spoil Islands*

**GOALS: Update and revise the IRL Spoil Islands Management Plan with a focus on maintenance, habitat *RESTORATION* and island enhancement, IRL water quality improvements, and provision of public access based on the best available science and sound habitat management principles.**

**ISSUE SUMMARY:** Spoil islands are human-made islands, often created as a byproduct of channel dredging. To promote boating and commerce throughout Florida, countless channels were dredged through the state's shallow inshore and coastal waters to provide enough depth for vessels. The material dredged to create these channels is called "spoil." In the past, the practice was to deposit the spoil in piles along the edge of the channels as the dredging operation progressed, which created spoil islands throughout the IRL.[1,2]

Although not natural, spoil islands have become an integral habitat type throughout the IRL ecosystem since their creation in the 1940s and 1950s. Spoil islands are often surrounded by seagrass beds and mangrove fringe, which provide habitat for a variety of organisms important to the ecology and economy of the region. Spoil island uplands can support a variety of flora and fauna, both native and invasive, as well as provide an opportunity for recreation by the public. Erosion, invasive species, human-use impacts, and sea level rise pose the most important threats to spoil islands in the IRL. In 1990, The Spoil Island Management Plan[2] was drafted by DEP (then Florida Department of Natural Resources) with support from the Florida Inland Navigation District. The plan was an assessment of the resources on each of the islands, with recommendations for management strategies based on designations that were suggested at the time and still in place today.

Spoil islands currently fall under three basic designations: recreation, education, and conservation. Recreation islands are further broken down into "active" and "passive." Detailed information on island designations and locations can be found online on the IRL Aquatic Preserves Spoil Island Project website.[3] The designations assigned to the islands managed by IRL Aquatic Preserves are not legally binding and are used as management decision tools. As the management plan is updated, many islands will undergo changes in their designations based on more current resource assessments and public use patterns.

Two spoil islands in the region have been designated by FWC as Critical Wildlife Areas, BC-49 in Brevard County and MC-2 in Martin County.[4] Lands designated as Critical Wildlife Areas are protected under the Florida Administrative Code and are closed to public access. Both islands are important bird rookeries that were impacted by human activities. The Critical Wildlife Areas designation provides an important layer of protection to these areas. As natural areas along the region are developed, the spoil islands will become more important to wildlife.

To date, successful spoil island restoration/enhancement projects include those conducted on SL-3 and SL-15 in St. Lucie County. The 5.7-acre SL-3 enhancement project involved the replacement of the Australian pine and Brazilian pepper community with native wetland and hammock plant species. The 10.5-acre SL-15 project entailed removal of exotic vegetation and 90,000 cubic yards of sediment to create coastal hammock, mangrove, and seagrass habitats. Large-scale projects such as island scraping can be coupled with muck capping projects as the islands represent a suitable sediment source.

**Spoil island restoration immediately post-project (left) and ten years later (right)**

**Spoil Island Working Group.** In 1997, the IRL Aquatic Preserves office created the Spoil Islands Working Group to coordinate IRL spoil island activities and research. The Working Group is composed of numerous stakeholders including federal, state, county, local interest groups, and university partners.[3] The Spoil Islands Working Group functions as an issue-specific working group of Florida's NERT and ECERT. All stakeholders work closely with the IRLNEP on habitat restoration issues for the IRL. A priority for the Working Group is to draft an updated IRL Spoil Islands Management Plan. The updated management plan, along with stakeholder input, will align management decisions with goals outlined in the IRL Aquatic Preserves approved management plan. The plan will also be aligned with this CCMP revision. Once completed, the updated Spoil Island Management Plan will provide an example for other spoil island managers throughout the state and country.

**Leave No Trace Program.** In 2017, the IRL Aquatic Preserves office partnered with the Leave No Trace Center for Outdoor Ethics to address impacts associated with recreational use of the spoil islands. The IRL and its spoil islands were designated as a 2017 hotspot. The Hot Spots Program identifies areas suffering from severe impacts of outdoor activities that can thrive again with Leave No Trace solutions. In 2017, week-long outreach activities were held in the region to educate recreational users and land managers about Leave No Trace principals and BMPs to help reduce impacts to the spoil islands and areas around the IRL. The main issue that the program aims to address is human waste left on spoil islands, which is both a social and water quality issue.

**Friends of the Spoil Islands.** Friends of the Spoil Islands is the approved Citizen Support Organization for the IRL Aquatic Preserves office. The Friends of the Spoil Islands is responsible for providing funds for the hosting and management of the Spoil Island Project website, financing a web-based public user survey account that gathers data on recreational use of spoil islands, financing the Leave No Trace Program, and holding public interest funds that are used throughout the aquatic preserves. The group has also created the only limited mobility access spoil island in the IRL region through a grant from the IRLNEP.

## STRATEGIES:

- Work closely with DEP, IRL Aquatic Preserves office, Florida Inland Navigation District, and Spoil Island Working Group to update the IRL Spoil Island Management and the DEP Aquatic Preserve's Island Designation System, as needed.
- Work closely with IRL Aquatic Preserves staff to implement and expand the Leave No Trace Program as part of the IRLNEP Trash-Free Waters Initiative.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Spoil Islands-1: Create a central electronic repository for spoil island maps, documents, sources. (NEW)** | Develop a repository and centralized electronic file location for spoil island information. | IRL Aquatic Preserves, Friends of the Spoil Islands Working Group, NERT, ECERT | IRLNEP Management Conference | $21,000 allocated by IRL Aquatic Preserves for a position | DEP, FWC | Coordinate and collaborate |
| **Spoil Islands-2: Update the IRL Spoil Management Plan and implement identified projects. (NEW)** | Update the IRL Spoil Island Management Plan and implement spoil island habitat restoration and enhancement and public access projects. | IRL Aquatic Preserves, Friends of the Spoil Islands Working Group, NERT, ECERT | IRLNEP Management Conference | $50,000 to update the plan; cost for projects to be determined based on plan update | DEP, FWC, Florida Inland Navigation District, IRLNEP | Coordinate and collaborate |

## OUTCOMES:

- **Short-term (1 – 2 years):** Revised IRL Spoil Island Management Plan is completed and adopted.
- **Medium-term (3 – 4 years):** High priority habitat restoration projects on IRL spoil islands are identified, funded, and underway.
- **Long-term (5 – 10+ years):** IRL spoil islands represent an integrated network of conservation, habitat restoration, and public recreation.

## CHALLENGES TO SUCCESS:

- Funding for habitat restoration and spoil island maintenance.
- Sea level rise will threaten the natural resources and public access values of spoil islands.
- Boat wakes erode the shorelines.
- Human use of island with bird rookeries conflicts with listed species protection.

## CITATIONS:

1. DEP. 2016. IRL Aquatic Preserves System Management Plan, Banana River; Indian River – Malabar to Vero Beach, Indian River – Vero Beach to Fort Pierce, and Jensen Beach to Jupiter Inlet Aquatic Preserves. www.aquaticpreserves.org.
2. Florida Department of Natural Resources. 1990. Indian River Lagoon spoil island management plan. Division of State Lands, Bureau of Submerged Lands and Preserves. Tallahassee, Florida.
3. IRL Aquatic Preserves. 2018. Spoil Island Project. www.spoilislandproject.org.
4. FWC. 2018. Critical Wildlife Areas. http://myfwc.com/CWA.

# LAND CONSERVATION


## Goals:

**Promote land conservation to provide water quality improvement, flood prevention, and restoration of natural hydroperiods.**

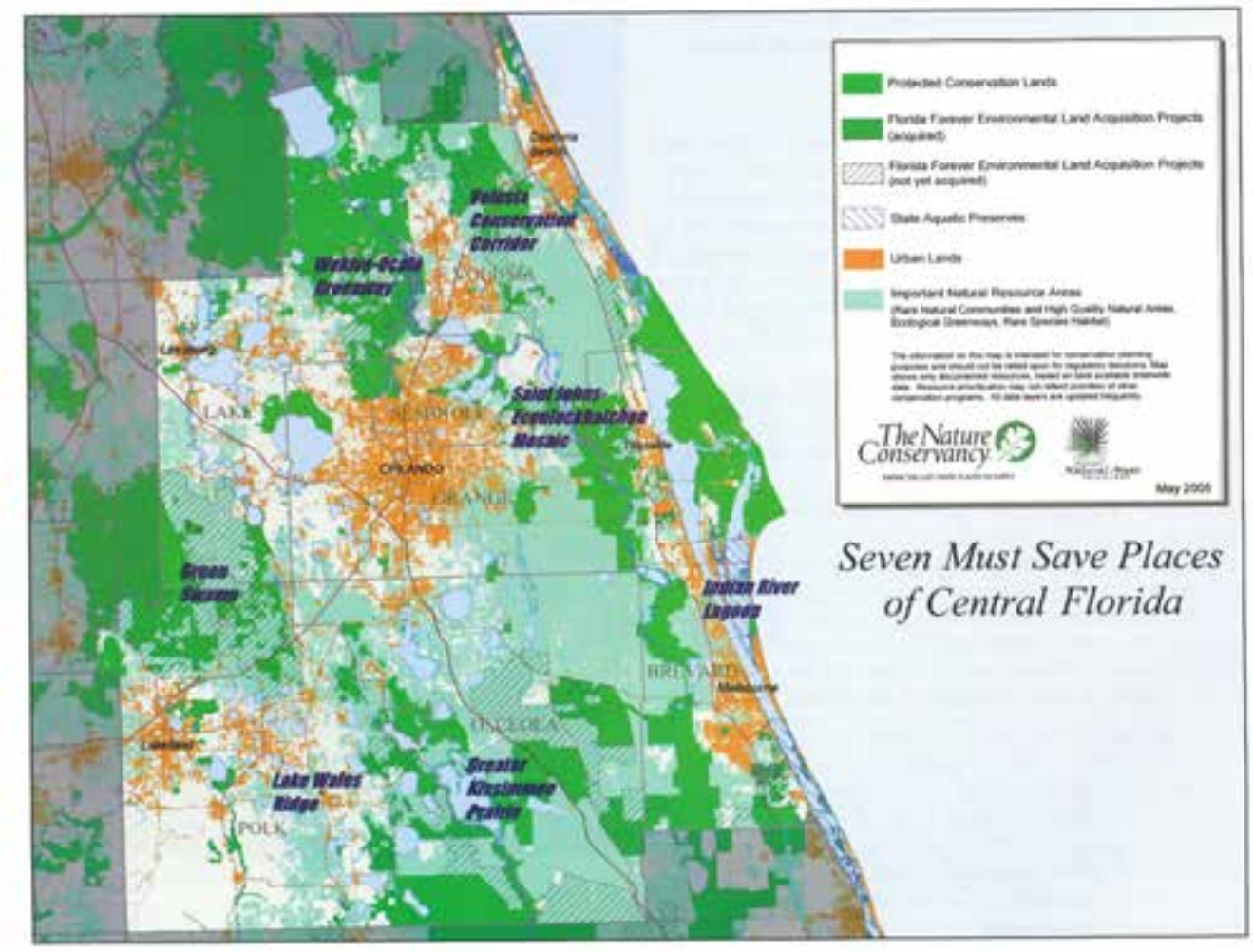
# ONE LAGOON

## HABITATS

### *Land Conservation*

**GOALS: Promote conservation of land. Pursue strategic initiatives that will *REDUCE* freshwater, sediment, nutrient, and pollutant loads to the IRL and *REBUILD* natural land-water connections to provide water quality improvement, provide flood prevention, and *RESTORE* natural hydroperiods.**

**ISSUE SUMMARY:** IRL water quality is directly affected by activities on the land surrounding the lagoon. Coastal development, stormwater runoff, and alteration or destruction of coastal and nearby habitats affect the natural and human-built assets of the IRL. Upland and wetland areas adjacent to the IRL serve as important travel corridors or habitat for many species. Protection of these upland-wetland-lagoon linkages is important to many of the region's biological resources, and it provides essential protective services to human-built communities along the IRL. In addition, in 2005, Naturally Central Florida recognized IRL as one of seven regional "jewels of our natural world" and "must save" places for Central Florida.[1]



Willing seller – willing buyer land acquisition is an important non-regulatory tool that respects private property rights. It is the most effective management tool to protect biological integrity and diversity in coastal estuary watersheds. Strategic acquisition of land for public use provides many benefits to the IRL and its coastal communities (i.e., protection of natural habitats and species, wetland areas for stormwater conveyance and treatment, groundwater recharge areas, public access and use areas, and coastal resilience to flooding and storm surge events). Land acquisition has supported the creation of more than 50 destinations for nature, heritage, and cultural tourism along the IRL.

Local land conservation programs can work in concert with state and federal initiatives.[2] The IRL watershed has a long and successful history of acquiring lands for conservation at private, local, state, and federal levels. Statewide programs, such as Preservation 2000 and Florida Forever, acquired 2.4 million acres statewide. Locally, Volusia, Brevard, Indian River, St. Lucie, and Martin counties adopted tax-supported land conservation programs in the 1990s. In 2014, Florida voters ratified the Florida's Water and Land Legacy amendment which dedicates more than $20 billion to land and water conservation over the next 20 years. Consistent with this, the Florida Legislature re-initiated Florida Forever and Florida Communities Trust funding in 2018. Among the Florida Forever projects is the Indian River Lagoon Blueway, which was placed on the list in 1998. The project area contains 27,451 acres in five counties. Over the last 20 years, 8,018 acres have been acquired at a cost of $45 million leaving 19,433 remaining to be acquired. Private, non-profit organizations have been significant and active land acquisition partners. The Nature Conservancy, The Trust for Public Land, The Richard King Mellon Foundation, and the Indian River Land Trust have provided considerable land acquisition support over the past decades. The Indian River Land Trust is one of the only private, non-profit organizations that acquires and manages lands along the lagoon. Since 2009, the Indian River Land Trust has acquired more than 925 acres and over 8.5 miles of IRL frontage.[3]

As a result of land conservation activities over multiple decades, there are now tens of thousands of acres of publicly owned lands and waters managed for conservation purposes, including five national wildlife refuges, one national seashore, seven state parks, and numerous county and municipal parks and preserves. Management of these lands should incorporate restoration goals for the lagoon as well as provision for public access.

Acquisition of fee-simple title is not the only pathway to manage lands for conservation and restoration purposes. Less than fee options, such as conservation easements, are powerful tools for conservation that allow private landowners to provide lands for conservation. The easement is either voluntarily donated or sold by the landowner and constitutes a legally binding agreement that limits certain types of uses or prevents development from taking place on the land in perpetuity while the land remains in private hands. Conservation easements protect land for future generation, while allowing owners to retain many private property rights and to live on and use their land, at the same time potentially providing them with tax benefits.

An innovative, cooperative land-use agreement being used in Florida is the Dispersed Water Management Program. This program encourages private property owners to retain water on their land rather than drain it, accept and detain regional runoff for storage and use, or provide both. Landowners typically become involved in the program through cost-share cooperative projects, easements, or payment for environmental services. Managing water on these lands is one tool that can accelerate water storage projects, reduce flood risks, and divert high-volume stormwater discharges away from coastal estuaries.

In addition, FDACS has the Rural and Family Lands Protection Program, which is an agricultural land preservation program designed to protect important agricultural lands through the acquisition of permanent agricultural land conservation easements. The program is designed to protect valuable agricultural lands, create easement documents that work together with agricultural production to ensure sustainable agricultural practices and reasonable protection of the environment without interfering with agricultural operations, and protect natural resources in conjunction with the economically viable agricultural operations. This program recognizes that a thriving rural economy with a strong agricultural base and viable rural communities is essential to Florida's future.

It also protects agricultural lands in the path of development so that Florida will continue to maintain a viable agricultural sector in our state's economic base, and the citizens of Florida can continue to enjoy rural landscapes and open space, and in so doing, provide simultaneous protection of environmentally significant areas.[4]

## STRATEGIES:

- Acquire sufficient lands through fee simple or less than fee simple acquisition strategies to achieve the intended outcomes for IRL restoration and ecosystem health.
- Develop and update lagoon-wide maps of publicly-owned conservation lands integrating existing and planned restoration projects to communicate a lagoon-wide picture of the network of conservation lands, ongoing site activities, and needs.
- Evaluate needs, opportunities, and funding sources to acquire environmentally-sensitive lands along the IRL with special focus on inholdings and additions on existing management units, opportunities and funding sources for less than fee conservation easements, opportunities and funding sources for dispersed water management on existing public and privately conservation lands, and development of a protocol for rapid buy-out response for high-risk, frequently flooded properties.
- Review and update Florida Forever Plans within the IRL watershed, including the Indian River Blueway Florida Forever Project.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Land-1: Continue coordination of efforts to identify, classify, acquire, and manage environmentally sensitive lands.** | Manage sensitive lands with strategic conservation outcomes throughout the IRL region. | Local governments, DEP, WMDs, private landowners | IRLNEP, Indian River Land Trust, interest groups, Riverside Conservancy | TBD | Florida Land Acquisition Trust Fund, local governments, private | Coordinate and collaborate |
| **Land-2: Support recurring funding of the Land Acquisition Trust Fund and other funding sources.** | Acquire and manage conservation lands for long-term land management and stewardship. | Florida Legislature | DEP, FWC, local governments, interest groups | TBD | Florida Land Acquisition Trust Fund, local governments | Coordinate and collaborate |
| **Land-3: Support public acquisition of environmentally sensitive lands that are deemed essential for long-term protection and management of IRL resources, CCMP implementation, and stormwater projects. (NEW)** | Help protected species and *REDUCE* risk vulnerability for natural and human-built infrastructure from storm events, erosion, or sea level rise. | Local governments, DEP, WMDs, private landowners | IRL NEP Management Conference | TBD | Florida Land Acquisition Trust Fund, local governments | Coordinate and collaborate |
| **Land-4: Develop and implement incentives to promote conservation of privately-owned environmentally sensitive lands and provision of cost-effective dispersed water management projects.** | Promote conservation of privately-owned sensitive lands and provision of cost-effective dispersed water management projects. | Local governments, DEP, WMDs, private landowners, water control districts, FDACS | IRL NEP Management Conference | TBD based on conservation method | Florida Land Acquisition Trust Fund, local governments | Coordinate and collaborate |
| **Land-5: Promote acquisition of lands for public access to the IRL.** | Create public access to the IRL. | Local governments, DEP, WMDs, private landowners | IRL NEP Management Conference | TBD | Florida Land Acquisition Trust Fund, local governments, private | Coordinate and collaborate |

## OUTCOMES:

- **Short-term (1 – 2 years):** Identify and target highest priority lands required for CCMP restoration project implementation. Integrate land acquisition considerations into coastal *RESILIENCE* and adaptation planning.
- **Medium-term (3 – 4 years):** Begin land acquisition activities as needed for CCMP implementation.
- **Long-term (5 – 10+ years):** Continue land acquisition along the IRL. Implement an acquisition strategy to prepare for sea level rise impacts to coastal areas.

## CHALLENGES TO SUCCESS:

- Lack of funding, including emergency response reserves, and/or willing sellers.
- Rapid population growth and coastal development may increase land prices beyond a cost-benefit threshold.
- Emergency "*REBUILD* quick" decisions are typically made without consideration for land acquisition as a strategy to address long-term risk exposure.

## CITATIONS:

1. Naturally Central Florida, Fitting the Pieces Together. 2005. Myregion.org and the University of Central Florida.
2. De Freese, D.E. 1995. Land Acquisition: A Tool for Biological Diversity Protection in the Indian River Lagoon, Florida. Bulletin of Marine Science 57 (1): 14–27.
3. Indian River Land Trust. Website: http://www.irlt.org/.
4. FDACS. Rural and Family Lands Protection Program. Website: https://www.freshfromflorida.com/Divisions-Offices/Florida-Forest-Service/Our-Forests/Land-Planning-and-Administration-Section/Rural-and-Family-Lands-Protection-Program2.

# CONNECTED WATERS AND WATERSHEDS

Sebastian Inlet District

## Goals:

**Improve understanding and management of waters influencing the IRL.**

# ONE LAGOON

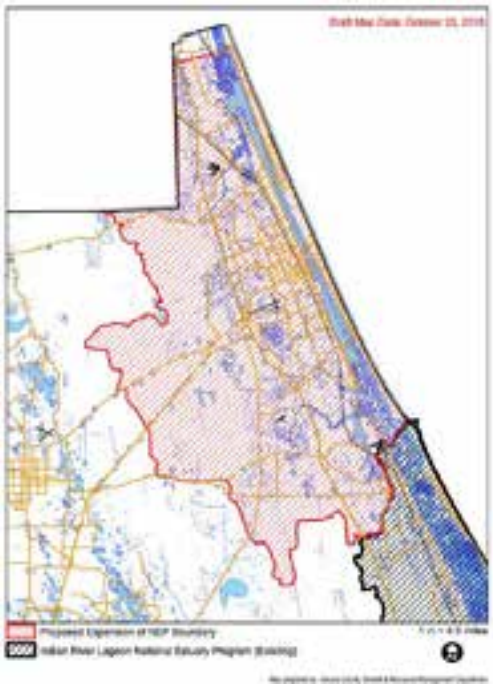
## HABITATS

### *Connected Waters and Watersheds*

**GOALS: Conduct and share *RESEARCH* to improve understanding and management of waters that influence the IRL. *RESTORE* natural connections and water flow to *REDUCE* freshwater discharges to the IRL. *REPORT* regularly to IRLNEP partners working in connected and adjacent waters and watersheds. *RESPOND* to opportunities for shared projects and potential threats.**

**ISSUE SUMMARY:** All of Florida's surface and groundwaters are connected either directly by natural or man-made connections or indirectly through the water cycle. Restoring the health of the IRL will require resource managers to look beyond watershed boundaries. Communication, cooperation, coordination, and collaboration among many resource managers and stakeholders will be essential. For the IRL, key surface water and watershed connections include Lake Okeechobee and the Everglades, St. Johns River, and Atlantic Ocean. To be effective at IRL ecosystem-wide restoration, the IRLNEP must communicate, cooperate, and coordinate with regional restoration initiatives on connected and adjacent waters and watersheds.

**IRL-Halifax Planning Boundary (2016).** In 2015, in response to a request by Resolution 2015-133 (November 5, 2015) of the Volusia County Council, the IRLNEP Management Conference evaluated and accepted an IRLNEP planning boundary amendment to include the southern section of the Halifax River north of Ponce Inlet in Volusia County. The boundary amendment extended the northern boundary of the CCMP planning boundary 25 miles north and included 198,678 watershed acres and 6,555 surface water acres. The IRL-Halifax Planning Boundary was reviewed and supported by IRLNEP Management Conference (i.e., Citizens Advisory Committee, STEMAC, and Management Board). Final IRL Council Board approval occurred on November 18, 2016. A number of considerations influenced the decision. IRLNEP targets a broad range of issues and engages local communities in the process to maintain the integrity of the whole system, which includes its chemical, physical, and biological properties, as well as its economic, recreational, and aesthetic values; six of Volusia County's 16 drainage basins contribute to the Halifax River, including the Outstanding Florida Waters of the Tomoka River and Spruce Creek; the Halifax River merges with Spruce Creek and the Mosquito Lagoon as an integrated estuarine system which requires a holistic approach to ensure the health and success of regional restoration and stewardship; and climate change and sea level rise compel coastal managers to look at large-scale features and changes to evaluate risk-based vulnerabilities and develop adaptation strategies.



**Everglades Restoration.** The Everglades is a World Heritage Site, an International Biosphere Reserve, and one of the world's largest ecosystem restoration projects. Today, the south Florida landscape is a highly altered system of canals and ditches that began to drain the land a century ago and pave the way for agriculture and urban development. To protect the region from flooding, Lake Okeechobee was connected to the IRL by the Okeechobee Waterway and the St. Lucie River, which is a major tributary to the southern IRL. During wet seasons, large freshwater discharges from the St. Lucie River watershed and from Lake Okeechobee are made to control water levels and offer flood protection across the SFWMD area.[1] A number of these high-volume

freshwater releases have occurred since the 2008 CCMP (2013, 2016, 2017, and 2018). These seasonally recurring releases drastically alter the normal IRL salinity regime. The release volume and duration determine the severity of the salinity impacts to the estuary and lagoon. These release events also convey large loads of sediment and nutrients to the system, and they can transport algae from Lake Okeechobee and watershed canals capable of triggering HABs. This happened in 2016 when 30.4% of the total inflow, 36.0% of the total nitrogen load, and 25.1% of the total phosphorus load to the St. Lucie Estuary came from Lake Okeechobee.[1] The releases triggered a severe bloom of *Microcystis* with associated production of the microcystin toxin that posed threats to the health of the ecology, livestock, and humans. A similar event occurred in 2018.

To reduce nutrient pollution to the St. Lucie Estuary and the IRL, SFWMD and USACE plan to implement the IRL-South project, part of CERP. The IRL-South project includes: (1) construction and operation of four new large-scale above-ground reservoirs to capture water from the C-23, C-24, C-25, and C-44 canals for increased storage; (2) construction and operation of four new stormwater treatment areas for the C-23/C-24 North, C-23/C-24 South, C-25, and C-44 basins; (3) restoration of about 92,100 acres of upland/wetland areas and habitat; (4) redirection of water from the C-23/C-24 basin to the North Fork of the St. Lucie River to attenuate freshwater flows to the estuary; (5) about 7.9 million cubic yards of muck removal from the St. Lucie River Estuary; and (6) about 900 acres of oyster shell, reef balls, and artificial submerged aquatic vegetation near muck removal sites for habitat improvement. The CCMP efforts should coordinate with CERP, such as with the C-44 Reservoir and Stormwater Treatment Area component of the IRL-South project that is under construction.[2]

**St. Johns River.** The St. Johns River begins its northerly journey to the Atlantic Ocean from a drainage basin west of the City of Vero Beach in Indian River County. The 2,000-square-mile basin that makes up the headwaters of the river is known as the Upper St. Johns River Basin. In the early 1900s, the upper basin was diked and drained for agricultural purposes. By the early 1970s, 62% of the marsh was gone, and canals were constructed for urban and agricultural purposes to divert water from the basin east to the IRL. The alterations diminished water quality in the lagoon and degraded the upper basin's remaining marshes. In 1977, SJRWMD and USACE began a long-term flood control project to revitalize the upper basin. The Upper St. Johns River Basin Project reclaimed drained marshlands by creating reservoirs and replumbing existing canals. The project goals included improving water quality, reducing freshwater discharges to the IRL, providing for water supply, and restoring and enhancing wetland habitat. The Upper Basin project was completed in May 2016, and the project is now subject to a long-term maintenance plan.[3] Projects have also been completed to re-divert C-54, C-10, C-1, and Crane Creek to restore freshwater flows to the St. Johns River and reduce freshwater discharges and associated pollutant loads from reaching the IRL.[3] Restoration efforts are also underway in both the Middle and Lower St. Johns River basins as part of existing TMDLs and BMAPs, as well as SJRWMD projects. Continued coordination is needed to ensure that the restoration goals for both the St. Johns River and IRL can be achieved.

**Ocean Inlets.** The IRL has five inlets that provide direct connections to the Atlantic Ocean, allowing for animal migration between the productive estuary and nearshore coastal waters, and provide tidal exchange of the lagoon system. Inlets have opened and closed over the long geological history of the lagoon. These inlets are important in controlling the residence time of water within lagoon segments and influence the transport of materials through the lagoon. These transport and exchange processes have presumably varied considerably over time as the number and arrangement of inlets changed. With coastal construction and inlet stabilization, the degree of variation in the IRL system has been lowered, although even today dredging and other modifications of the inlets influence water quality of the lagoon. The five inlets include:

- Ponce de Leon (Ponce) Inlet is the most natural inlet, which has been open since colonial times and has since been artificially stabilized.
- Sebastian Inlet is a man-made inlet that was constructed in 1924, closed by natural forces in 1941, and reopened in 1947.[4] It is now stabilized.
- Fort Pierce Inlet is a man-made inlet near the site of the Indian River Inlet and was dredged and stabilized in 1921.
- St. Lucie Inlet was built as a small connection between the IRL and ocean in 1844 and was later dredged in 1892.
- Jupiter Inlet is a natural inlet at the south end of the IRL that has been stabilized to eliminate migration.

| Segment | Average Residence Time (Days) |
|---|---|
| ***Mosquito Lagoon***[8] | |
| ML1 | 4 |
| ML2 | 8 |
| ML3-4 | 76 |
| ***Banana River Lagoon***[9] | |
| BR1-2 | 148 |
| BR3-5 | 96 |
| BR-6 | 11 |
| BR-7 | 3 |
| ***North IRL***[9] | |
| IR1-3 | 47 |
| IR4 | 3 |
| IR5 | 47 |
| IR6-7 | 30 |
| IR8 | 9 |
| IR9-11 | 35 |
| ***Central IRL***[9] | |
| IR12 | 12 |
| IR13 | 1 |
| IR14-15 | 6 |
| IR16-20 | 9 |
| IR21 | 1 |
| ***South IRL***[10] | |
| South IRL | 16 |

The natural opening and closing of these inlets was part of the coastal geological dynamics of eastern Florida. In this microtidal, high wave energy environment, natural sand transport favors long (20–60 mile) barrier islands with abundant wash over terraces and wash over fans and infrequent tidal inlets. Typically, temporary inlets caused by over wash during storm events are rapidly sealed by tidal and longshore current driven sand transport.[5]

In addition to these inlets, there are other connections. One connection to the ocean is at Port Canaveral, which was constructed between 1951 and 1955 in an area where no known inlet had previously existed. The connection consists of an engineered lock system that is used specifically for access by maritime vessels. This lock system limits the exchange of water between the Banana River Lagoon and ocean to times when the locks are open. Another connection is for the Mosquito Lagoon to the IRL through the man-made Haulover Canal, which was constructed during the 19th Century.

The Banana River Lagoon, North IRL, and southern Mosquito Lagoon do not have inlets and, therefore, they have long residence times, which create their valued ecology and means that water in these areas is not exchanged with the ocean rapidly, so nutrients can build up leading to algal blooms. One option to help this condition is to increase exchange by adding culverts, pumps, weirs, or inlets to provide new connections to the Atlantic Ocean. However, artificial exchange projects are expensive and complex. They can move nutrients, muck, and pollutants from one location to another without delivering intended water quality benefits. Local municipalities are concerned about shoreline erosion and stormwater infrastructure efficiency with enhanced circulation and elevated water levels. Because of the complex nature of biological response to changing water quality conditions, there are also concerns among the scientific community regarding unintended and undesirable consequences. The amount of exchange needed to have a beneficial impact on the system without causing harm is also unknown. One issue of concern is artificial shifting of salinity and nutrient regimes that might favor certain HAB species. SJRWMD has been conducting studies to evaluate potential options to provide additional exchange for the lagoon system.[6,7] The IRLNEP is pursuing discussions with IRL scientists and engineers to evaluate options and develop a scope of work for a pilot project designed to better evaluate costs, benefits, and associated risks. In addition, the IRLNEP is working with Port Canaveral and FIT to model IRL water flow and internal compartmentalization of water segments by causeways, bridges, and other human-built structures to advise future FDOT and local roadway, causeway, and bridge infrastructure improvement decisions.

## STRATEGIES:

- Seek opportunities to communicate, cooperate, and coordinate with agencies and partners in the connected watersheds of the IRL system to identify measures to achieve goals for both the IRL and its connected waters.
- Integrate the IRL-Halifax Planning Boundary into all IRLNEP and CCMP considerations and activities.
- Expand efforts with SFWMD and other partners in the IRL-South CERP project to support expanded and accelerated funding for water storage as part of Everglades restoration to *REDUCE* nutrient laden freshwater discharges to the IRL.
- Expand efforts with SJRWMD and other partners in the restoration of the St. Johns River to support funding for expanded efforts, with a focus on restoring a more natural drainage divide and flow of freshwater that includes using public and private lands to retain, treat and manage releases, with a goal to eliminate discharges to the IRL.
- Work with IRLNEP Management Conference and interested science and engineering partners to develop a detailed scope of work for a science-based pilot project to evaluate the effects of enhanced oceanic exchange for the IRL, where appropriate.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Connected Waters-1: Incorporate the IRL-Halifax Planning Boundary area into all IRLNEP discussions, CCMP action plans, and CCMP implementation activities. (NEW)** | Incorporate IRL-Halifax Planning Boundary into all IRLNEP discussions. | IRLNEP | Volusia County and local governments, SJRWMD, DEP | TBD | Local governments, IRLNEP | Conduct, coordinate, and collaborate |
| **Connected Waters-2: Support expanded and accelerated funding for Everglades restoration. (NEW)** | Significantly *REDUCE* or stop large volume freshwater releases from Lake Okeechobee and St. Lucie River watershed. | USACE, SFWMD | Local governments | $16.4 billion for CERP | Federal and state legislative appropriations | Coordinate and collaborate |
| **Connected Waters-3: Support expanded and accelerated funding to *RESTORE* the St. Johns River. (NEW)** | *RESTORE* freshwater flow direction, retention, treatment, and managed release. | SJRWMD, USACE | Local governments | Initially $105.2 million* | SJRWMD, state legislative appropriations | Coordinate and collaborate |
| **Connected Waters-4: Evaluate water quality habitats and species composition around inlets and develop management recommendations. (NEW)** | Implement projects that protect lagoon-nearshore ocean connections for species of concern, improve water quality, and support biodiversity. | IRLNEP, USACE | Canaveral Port Authority | TBD | State and federal grants, IRLNEP | Conduct, coordinate, and collaborate |
| **Connected Waters-5: Better understand the physical, chemical, and biological implications, benefits, risks, and expected outcomes of enhancing oceanic exchange and develop a pilot project, as appropriate. (NEW)** | Develop a pilot project to enhance oceanic exchange, as appropriate. | DEP | IRLNEP Management Conference, local governments, inlet districts | TBD based on connection type and location | IRLNEP Management Conference, state and federal grants | Coordinate and collaborate |

* For the Sottile Canal, C-54/Fellsmere Main Canal, C-1, C-10, and Crane Creek projects.

## OUTCOMES:

- **Short-term (1 – 2 years):** Enhanced communication, coordination, and cooperation among partners in connected watersheds. Complete enhanced water flow pilot project planning and, if scientifically feasible and supported by the IRL Management Conference and partners, seek funding to move forward with design and engineering work.
- **Medium-term (3 – 4 years):** Coordinated and cooperative efforts are successful in expanding and accelerating local, state, and federal cost-share funding for projects.
- **Long-term (5 – 10+ years):** Citizens, communities, and partners within the IRL watershed and connected waters and watersheds understand and appreciate the complex nature of the system and the opportunities and challenges.

## CHALLENGES TO SUCCESS:

- Cost of individual efforts and diversity of partners engaged in watershed restoration and management.
- Tendency for people and programs to think and prioritize with only a local perspective.
- The need to balance re-diversion and storage with maintaining flood protection.
- Climate change and increasing storm intensity add to the challenge of managing watershed connectivity.

## CITATIONS:


1. Zheng, F., Doering, P., Chen, Z., Baldwin, L., Orlando, B., Robbins, R., and Welch, B. 2017. Chapter 8C: St. Lucie and Caloosahatchee River Watershed Research and Water Quality Monitoring Results and Activities. *2017 South Florida Environmental Report-Volume I.* West Palm Beach, Florida.
2. USACE and SFWMD. 2018. Everglades Restoration Website: https://www.evergladesrestoration.gov/.
3. SJRWMD. 2018. Upper St. Johns River Website: https://www.sjrwmd.com/waterways/st-johns-river/upper/.
4. Stauble, D.K. 1988. The Geomorphology, Geologic History, Sediments and Inlet Formation of the Indian River Lagoon System. Volume I (Unpublished). The Marine Resources Council of East Central Florida. Edited by D. Barile. Melbourne, Florida.
5. Hayes, M. 1979. Barrier Island Morphology as a Function of Tidal and Wave Regime. Barrier islands: from the Gulf of St. Lawrence to the Gulf of Mexico. 1- 27.
6. CDM Smith and Taylor Engineering. 2014. Preliminary Concept Design for Artificial Flushing Projects in the Indian River Lagoon. Phase I – Literature Review/Preliminary Site Selection. Prepared for the St. Johns River Water Management District.
7. CDM Smith and Taylor Engineering. 2015. Preliminary Concept Design for Artificial Flushing Projects in the Indian River Lagoon. Phase II – Conceptual Design/Project Refinement. Prepared for the St. Johns River Water Management District.
8. Steward, J.S., Christian, D.J., Green, W.C., Lasi, M.A., and Miller, J.D. 2010. Using multiple lines of evidence for developing numeric nutrient criteria for Mosquito Lagoon, Florida. Department of Water Resources, St. Johns River Water Management District.
9. Applied Technology and Management and Janicki Environmental. 2011. Receiving Water Characterization Report Task 1.C: Indian River Lagoon Total Maximum Daily Load Revision. Prepared for Brevard County.
10. Kim, Y.T. 2003. Water balance and flushing time in the restricted Indian River Lagoon (IRL), Florida USA. Ocean and Polar Research March 2003. DOI: 10.4217//OPR.2003.25.1.075.

# BIODIVERSITY

R. Spratt

## Goals:

**Develop a long-term management strategy to restore and protect biological diversity in the IRL.**

# ONE LAGOON

## LIVING RESOURCES

### *Biodiversity*

**GOALS: Conduct comprehensive biodiversity *RESEARCH* to develop a long-term management strategy to *RESTORE, REBUILD,* and protect the biological diversity of the IRL.**

**ISSUE SUMMARY:** More than 4,000 species of plants and animals live in the IRL watershed, including more than 2,200 animal species and more than 2,100 plant species.[1] The IRL is one of the most biologically diverse estuaries in North America.[2]

The IRL and its surrounding region is a complex coastal landscape consisting of a broad variety of habitats that support many plant and animal species. Much of the biological diversity found in the region results from both physical features of the lagoon and the overlapping of the temperate and sub-tropical climate zones.[2,3] Additional influences from ocean inlets and the proximity to the Gulf Stream in the southern IRL also contribute to the rich biological diversity of the system.

The goal of biodiversity conservation has been described as the conservation of diversity at three levels: (1) ecosystem, (2) species, and (3) genetic.[3] Developing a representative system of protected areas is often considered an effective way to achieve this goal in the marine environment. For the IRL, habitat alteration and loss drive this management strategy towards the restoration of damaged habitats or creation/rehabilitation of damaged habitats.

Some species, communities, and habitats have been the subject of several studies, while little information is available on others. Numerous studies and several management activities have attempted to address the status and maintenance of biological diversity in the IRL region. In 1995, the IRLNEP hosted a lagoon-wide biodiversity science conference to better understand the biodiversity status of the IRL.[3]

A comprehensive biodiversity management strategy for the IRL region must focus on four broad objectives: (1) restoration of IRL water quality, (2) restoration of natural habitats that support water quality and species richness/abundance, (3) species-specific restoration actions for species of concern, and (4) implementation of management strategies to enhance resilience of the IRL system.

Protecting and managing biodiversity will require improved knowledge of the elements of this regional ecosystem and how these elements interact. Acquiring the necessary knowledge and developing and implementing a strategy to protect and manage regional biodiversity in the IRL will require the coordination, cooperation, and collaboration of a wide variety of entities ranging from academia to regulatory and management agencies to local governments to individuals residing in the region.

The IRLNEP has taken a first step towards building that lagoon-wide coalition by working with NERT.[4] NERT was created in 2010 as a voluntary, grassroots effort to bring partners together to develop regional landscape-level habitat initiatives focused on the restoration and enhancement of estuarine habitats. In 2015, NERT expanded its regional network of habitat restoration scientists to form ECERT. Together, these habitat restoration partners cover the full planning boundary of the IRLNEP.

## STRATEGIES:

- Improve scientific understanding through *RESEARCH* of IRL biodiversity and trends.
- Advise IRL restoration and management actions required to protect, maintain, and if needed, *RESTORE* IRL biodiversity.
- Work with the Smithsonian Marine Station at Fort Pierce to update and expand the online IRL Species Inventory that provides comprehensive information on all aspects of IRL biodiversity. It was first completed in 1995.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Biodiversity-1: Acquire and effectively manage the IRL network of conservation lands and wetlands as a tool to preserve, protect, and *RESTORE* the biological diversity, functional integrity, and productivity.** | Improve habitats to maximize species biodiversity. | Federal, state, and local agencies; private conservation groups | IRLNEP Management Conference | TBD | Federal, state, and local agencies; private conservation groups | Coordinate and collaborate |
| **Biodiversity-2: Work to continue, expand, update, and improve the IRL species inventory.** | Update knowledge of species within IRL watershed. | Smithsonian | IRLNEP Management Conference USFWS, Merritt Island Wildlife Association, Florida Audubon Society | TBD | Smithsonian, IRLNEP conservation groups | Coordinate and collaborate |
| **Biodiversity-3: Integrate biodiversity considerations in habitat restoration and planning activities.** | Increase biodiversity within IRL watershed. | NERT, ECERT, IRLNEP | IRLNEP Management Conference | TBD | IRNEP Management Conference | Coordinate and collaborate |

## OUTCOMES:

- **Short-term (1 – 2 years):** Create an updated IRL species inventory. Support efforts within the IRL science community to evaluate status and trends of IRL biodiversity.
- **Medium-term (3 – 4 years):** Evaluate status and trends of IRL biodiversity using data from the updated species inventory.
- **Long-term (5 – 10+ years):** Update actions based on latest data, status, and trends with consideration for long-term impacts of climate change, including sea level rise.

## CHALLENGES TO SUCCESS:

- Cost and time intensive to update inventory.
- Lagoon-wide studies of biological diversity are scientifically complex and often require a multi-disciplinary perspective at multiple spatial and temporal scales.
- Climate change (including sea level rise) and invasive species are causing shifts that may permanently change IRL biodiversity.

## CITATIONS:

1. IRL Species Inventory. 2018. http://www.sms.si.edu/IRLSpec/index.htm.
2. Swain, H.M., Breininger, D.R., Busby, D.S., Clark, K.B.., Cook, S.B., Day, R.A., De Freese, D.E., Gilmore, R. G., Hart, A.W., Hinkle, R.C., McArdle, D.A., Mikkelsen, P.M., Nelson, W.G., Zahorcak, A.J. (1995): IRL Biodiversity Conference. Bulletin of Marine Science 57(1): 1-7.
3. Ducrotoy, J.P. 2008. Conservation and restoration of coastal and estuarine habitats. http://www.coastalwiki.org/wiki/Conservation_and_restoration_of_coastal_and_estuarine_habitat.
4. NERT. 2018. https://sites.google.com/site/nertinfo/.

# SPECIES OF CONCERN


## Goals:

**Evaluate population trends. Manage to reduce stressors on species of concern. Take actions that sustain species to allow delisting.**

# ONE LAGOON

## LIVING RESOURCES

### *Species of Concern*

**GOALS: Conduct and/or continue *RESEARCH* to evaluate status and population trends of IRL species of concern. *REMOVE* and/or *REDUCE* stressors and threats to species of concern. *RESPOND* to opportunities for species-specific management action that will *RESTORE* sustainable levels for populations of species of concern.**

**ISSUE SUMMARY:** The IRL region has more than 50 species that are listed as endangered, threatened, or species of special concern, and more than 70 others that are considered rare. Included are a variety of plants and animals ranging from small, seldom-seen species, such as the mangrove rivulus fish *(Rivulus marmoratus)*, to large and well-publicized ones, such as the Florida manatee *(Trichecus manatus latirostris)*. Wildlife protection is covered by a number of laws at local, state, and federal levels.[1,2,3] Also included as federally protected species are marine mammals, including cetaceans (whales and dolphins), sirenians (manatees), and otters. The Endangered Species Act of 1973 is the primary legislation that provides a framework to conserve and protect species listed as endangered and threatened and their habitats.[1] The U.S. Marine Mammal Protection Act protects all marine mammals.[2] The Bald and Golden Eagle Protection Act also provides specific protection to the significant eagle population along the lagoon. In addition, FWC is authorized to list and protect imperiled species separate from the Endangered Species Act.

Several factors are responsible for the endangerment and diminishing numbers of species with special status. Habitat loss is a primary cause of declining population size for many species. As the IRL region developed, much of the habitat important to these species was destroyed or altered reducing habitat quality. While Endangered Species Act listings and federal regulation provide a level of regulatory protection for specific plants or animals that are deemed threatened or endangered, many rare or imperiled species are never listed. State, regional, and local conservation efforts are best positioned to implement proactive conservation and restoration strategies to protect rare, threatened, and endangered species. The IRL region has many significant conservation success stories that were driven by state and regional leadership (including recovery of the manatee, sea turtles, and several bird species). Unfortunately, dramatic water quality declines in the IRL, recurring algal blooms, loss of seagrasses, habitat alteration, habitat fragmentation, habitat degradation, invasive species, and complex stressors from sea level rise and other effects of climate change will challenge recovery efforts for some species. A list of species of concern can be found on the Smithsonian Marine Station at Fort Pierce[4] and USFWS websites.[5]

While individual species recovery plans continue to be developed as required by federal law, a trend has been to integrate these species recovery plans into a single ecosystem-based multi-species plan. Indian River, St. Lucie, and Martin Counties are within the South Florida Multi-Species Recovery Plan, which covers 68 federally listed species through efforts to protect 23 identified ecosystems.

## STRATEGIES:

- Implement action plans that align with and support recovery efforts for species of concern.
- Develop a comprehensive list of species of concern and track status and population trends.
- Identify habitat needs of species of concern and develop strategies to protect, *RESTORE*, and maintain those habitats.
- Develop a multi-species recovery plan for species of concern within the IRL.
- Develop a watch list of non-listed species with significant population declines.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Species of Concern-1: Identify IRL species of concern and track status and population trends.** | Track status and population trends for species of concern in IRL watershed. | IRLNEP Management Conference, The Nature Conservancy, USFWS, FWC | USFWS, National Marine Fisheries Society (NMFS), FWC, WMDs, local governments, Audubon Society | TBD | IRLNEP, The Nature Conservancy, USFWS, FWC | Coordinate and collaborate |
| **Species of Concern-2: Align the CCMP with adaptive management or recovery plans for species of concern.** | Refine understanding of species of concern in IRL watershed. | IRLNEP, USFWS, NMFS, FWC | DEP, academia, interest groups | TBD | IRLNEP, USFWS, NMFS, FWC | Conduct, coordinate, and collaborate |
| **Species of Concern-3: Improve enforcement of regulations for species of concern found in the IRL region.** | Improve enforcement for species of concern. | USFWS, NMFS, FWC | DEP, local governments | TBD | USFWS, NMFS, FWC | Coordinate and collaborate |
| **Species of Concern-4: Protect and manage natural habitats that support species of concern found within the IRL region.** | Manage habitats for species of concern. | IRLNEP Management Conference partners, agencies, private landowners, private land trusts | USFWS, NMFS, FWC, WMDs, local governments, interest groups | TBD | TBD | Coordinate and collaborate |

## OUTCOMES:

- **Short-term (1 – 2 years):** Improve public understanding of the importance and status of species of concern to the health and biodiversity of the IRL ecosystem and economy. Refer to CCMP action recommendations to species-specific recovery plans and plans available on the IRLNEP website.
- **Medium-term (3 – 4 years):** Implement CCMP water quality and habitat restoration projects that support and align with species recovery plans. Support scientific *RESEARCH* to better understand emerging risks, challenges to species recovery, and potential resource management conflicts.
- **Long-term (5 – 10+ years):** Work with IRL agencies and organizations involved in recovery of species of concern to evaluate and track progress and *REPORT* on trends to the public.

## CHALLENGES TO SUCCESS:

- Inadequate funding available to monitoring all the species of concern.
- The size and spatial/temporal complexity of the IRL can be a challenge for scientists conducting population assessments.
- Invasive species and climate change impacts.

## CITATIONS:


1. USFWS. 2017. https://www.fws.gov/endangered/laws-policies/.
2. NOAA. 2017. https://www.fisheries.noaa.gov/marine-mammal-protection-act.
3. Schaefer, J., Tucker, J., and McGuire, M. 2012. Laws that Protect Florida's Wildlife. Document WEC-48. Wildlife Ecology and Conservation Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. 5p. http://edis.ifas.ufl.edu.
4. Smithsonian Marine Station at Fort Pierce. Website: https://www.sms.si.edu/IRLSpec/ListedSpec.htm.
5. USFWS. Website: https://ecos.fws.gov/ecp0/reports/species-listed-by-state-report?state=FL&status=listed.

# INVASIVE SPECIES


## Goals:

**Remove invasive species and improve watershed management to support native habitats and communities.**

# ONE LAGOON

## LIVING RESOURCES

### *Invasive Species*

**GOALS:** ***REMOVE*** **invasive species from the IRL, its contributing waters, and its watershed. Conduct** ***RESEARCH*** **to improve management and understanding of invasive species in the IRL watershed to help** ***RESTORE*** **native habitats and communities. Be prepared to** ***RESPOND*** **quickly to eradicate newly introduced invasive species.**


NOAA

**ISSUE SUMMARY:** Non-native and non-indigenous are terms that have been used to describe plants and animals that are not native to an area. While many non-native species are relatively benign due to difficulties in reproduction or propagation, other species are characterized as invasive when they thrive in their new environment, reproducing, growing, and spreading rapidly or uncontrollably. This rapid growth and reproduction can have consequences for the health and biodiversity of the IRL, often resulting in invaders overwhelming native species, the loss or degradation of valuable habitats or the displacement or loss of native animal or plant species.

In 2006–2007, the authors of the IRL Species Inventory focused on assessing the status of nonindigenous species in the IRL region. They identified approximately 240 species in the region as exotic or cryptogenic, and of those, 170 species were new to the inventory.[1] When the species database was updated in 2014, approximately 215 non-native species were identified in the region.[1, 2]

## STRATEGIES:

- Establish a stand-alone Invasive Species Commission to coordinate invasive species inventory and eradication effort.
- Continue monitoring invasive species in IRL watershed. Assist partners in development and implementation of species eradication or control strategies. Work with partners to educate public about invasive species threats.
- Update IRL invasive species inventory and track eradication and control activities.
- Assist IRL Management Conference partners with communication and coordination about invasive species eradication and management, including opportunities for volunteering.
- Develop a citizen science and engagement campaign (“see something – say something”) to assist partners with early detection and rapid response that quickly address invasive species.
- Provide support to not-for-profit organizations that work to control invasive populations.
- Encourage the commercial harvest of invasive species as a management tool.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Invasive Species-1 Support the inventory and assessment of invasive fauna and flora within the IRL watershed.** | Improve understanding and management of invasive species. | DEP, FDACS, FWC, WMDs | USFWS, NMFS, academia, interest groups, local governments | TBD | DEP, FDACS, FWC, WMDs, USFWS | Coordinate and collaborate |
| **Invasive Species-2: Provide standardized information to IRL partners about invasive species and their eradication and management. Prepare an early detection and rapid response plan.** | Provide consistent information and plan for partners. | DEP, FDACS, FWC, WMDs | USFWS, NMFS, academia, interest groups, local governments | TBD | DEP, FDACS, FWC, WMDs | Coordinate and collaborate |

## OUTCOMES:

- **Short-term (1 – 2 years):** Identify IRL partners and programs involved in IRL invasive species eradication and control activities. Share opportunities to volunteer with the public.
- **Medium-term (3 – 4 years):** Document progress with eradication and control of invasive species in the IRL watershed.
- **Long-term (5 – 10+ years):** Quantify 10-year progress of invasive species eradication and control in IRL watershed.

## CHALLENGES TO SUCCESS:

- Management of invasive species can prove difficult as they are often prolific and can outcompete native species.
- Management of invasive plant species through chemical methods can add nutrients and chemicals to the lagoon system.
- Long-term, recurring funding will be required to sustain aggressive eradication and control activities.

## CITATIONS:

1. IRL Species Inventory. 2018. Website: http://www.sms.si.edu/IRLSpec/index.htm.
2. Smithsonian Institution. 2018. Website: https://www.sms.si.edu/IRLSpec/Nonnatives.htm.

# FORAGE FISHES

H. McVay

## Goals:

**Restore water quality and habitats to sustain abundant and diverse populations of forage fishes in the IRL.**

# ONE LAGOON

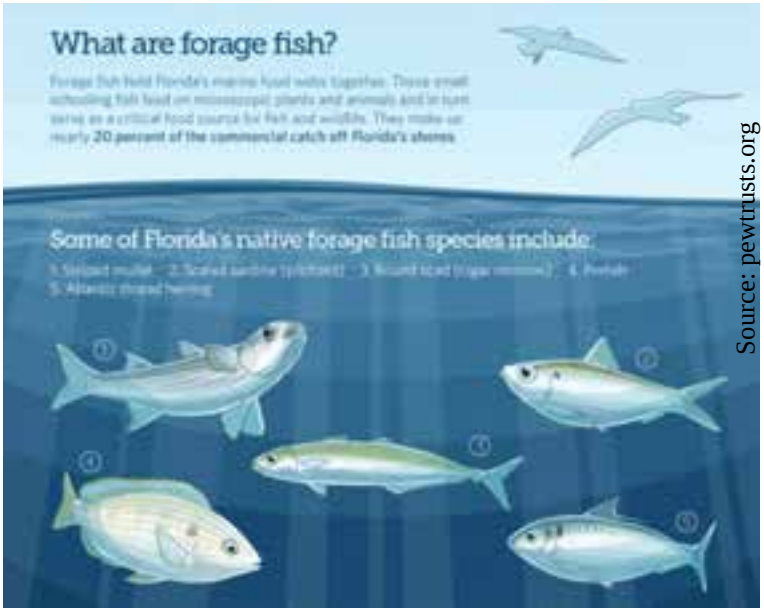
## LIVING RESOURCES

### *Forage Fishes*

**GOALS:** ***RESEARCH*** **forage fish abundance, trends, and threats.** ***RESTORE*** **water quality and natural habitats to sustain abundant and diverse forage fish populations and other species that depend on forage fish.** ***REPORT*** **the importance of forage fish and trends in their abundances to partners and stakeholders. Elevate public awareness and understanding of the importance of forage fish to a healthy IRL.**

**ISSUE SUMMARY:** It is estimated that between 75% and 90% of the original mangrove and salt marshes that bordered the IRL have either been lost or impacted, resulting in negative impacts to water quality and loss of habitat for fisheries.[1] The diverse fish fauna of the IRL and its coastal region has been a crucial factor leading to general recognition of the lagoon as a high diversity estuarine system.

Gilmore (1995) documented 782 species of fishes in 140 families in the IRL region with 397 species from the IRL system. Long-term quantitative studies of IRL fish communities reveal high species richness in specific habitats, such as estuarine-ocean inlet seagrass meadows and nearby ocean reef fish communities (214 species from seagrasses and 282 from ocean inlets).[2] Of these species, many forage fish species serve as an essential food resource for commercially and recreationally important predatory fish and other species of IRL wildlife, including many species of resident and migratory birds. As such, the proper management of forage fish species is critical sustaining the lagoon as a recreational and commercial centerpiece of the region.



Source: pewtrusts.org

Florida has been a leader in forage fish management. Forage fish fisheries in Florida's waters are relatively small, no fisheries that turn their catches into fish meal or oil are operational in the state, and gear limitations set in the mid-1990s have kept harvest levels low. Only small nets, less than 500 square feet, are allowed in nearshore and inshore waters, and entangling or gill nets are prohibited throughout state waters. Locally, commercial harvest of forage fishes represents an important commercial bait fishery for the recreational fishing industry with an estimated statewide economic value of $8 billion annually.

The most immediate threats to IRL forage species include declining water quality, HABs (especially the brown tide organism, *Aureoumbra lagunensis*, that impacts seagrasses and fishes), loss of essential natural habitats, and climate change.[3] On a global level, commercial demand is surging for forage fish, which are used for pet food, cosmetics, nutritional supplements, fertilizer, and feed for animals and aquaculture operations. The importance of effective forage fish management and conservation was recognized in 2015 by FWC in a formal resolution that proclaimed FWC will manage forage fishes to ensure sufficient abundance and diversity of their populations to sustain abundant fisheries stocks and other species that depend on forage fish and to maintain Florida's reputation as the "Fishing Capital of the World."[4] Restoring

healthy forage fish populations will also ensure that the IRL region remains a world-class destination for viewing birds and wildlife.

## STRATEGIES:

- Work closely with FWC and partners involved in commercial and recreational fisheries to ensure that populations of IRL forage fish remain diverse, abundant, and able to sustain IRL living resources, ecosystem health, and vibrant commercial and recreational fishing activities.
- Assess zooplankton populations and ecology in IRL watershed as food sources for forage fish.
- Identify and map essential habitats for forage fishes in the IRL to advise and assist water quality and habitat restoration strategies and prioritization of projects.
- Provide an updated inventory and a scientific assessment of the sizes and health of populations of forage fish in the IRL.
- Develop a science-based strategy for estimating the abundance and diversity of forage fishes required to support sustainable populations of other species (especially recreationally and commercially valuable fish species) in the IRL.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Forage Fishes-1: Support *RESEARCH* and assessments to identify and map suitable habitats and spawning habitats for forage fishes and track population size and health. (NEW)** | Identify suitable habitats for forage fishes and track the health of populations. | FWC | IRLNEP, academia | TBD | FWC, IRLNEP, grants, private-sector support | Coordinate and collaborate |
| **Forage Fishes-2: Continue to support scientific assessments of forage fish population size and health. (NEW)** | Improve understanding and management of IRL fisheries and consider restocking species where needed. | FWC | IRLNEP, academia | TBD | FWC, IRLNEP, grants, private-sector support | Coordinate and collaborate |

## OUTCOMES:

- **Short-term (1 – 2 years):** Improve public understanding of the importance of forage fishes and essential fish habitats to the health of the IRL system health and the regional economy. Implement water quality and habitat restoration projects in the CCMP to ensure IRL forage fish populations remain diverse, abundant, and sufficient to support IRL living resources.
- **Medium-term (3 – 4 years):** Continue water quality and habitat restoration projects in the CCMP to ensure IRL forage fish populations remain diverse, abundant, and sufficient to support IRL living resources. Improved water quality in the IRL system is supporting seagrass recovery, and important forage fish habitat.
- **Long-term (5 – 10+ years):** Water quality improvements can be documented throughout IRL watershed. Forage fish population recovery is underway.

## CHALLENGES TO SUCCESS:

- Declining water quality and HABs since 2011 appear to have shifted the IRL trophic structure with unknown consequences to larval and forage fishes.

- Poor water quality and recurring algal blooms have resulted in a historic loss of seagrasses, an essential fish habitat.
- Inadequate funding for expanded, long-term, lagoon-wide *RESEARCH* on the status and trends in populations of forage fish.

## CITATIONS:

1. Taylor, S.D. 2012. Removing the Sands (Sins?) of Our Past: Dredge Spoil Removal and Saltmarsh Restoration along the Indian River Lagoon, Florida (USA). *Wetlands Ecological Management* 20: 213–218.
2. Gilmore, R.G. 1995. Environmental and Biogeographic Factors Influencing Ichthyofaunal Diversity: Indian River Lagoon. July 1995. Bulletin of Marine Science, Miami, FL. 57(1):153-170.
3. Shenker, J.M. 2009. *Sustainability 2009: The Next Horizon*. G. L. Nelson and I. Hronszky, Editors. American Institute of Physics Conference Proceedings. Volume 1157. pp 39-47.
4. FWC. 2015. Resolution June 25, 2015. Sarasota, Florida.

# COMMERCIAL AND RECREATIONAL FISHERIES

Cox's Seafood Market

## Goals:

**Restore water quality in the IRL to support sustainable commercial and recreational fisheries.**

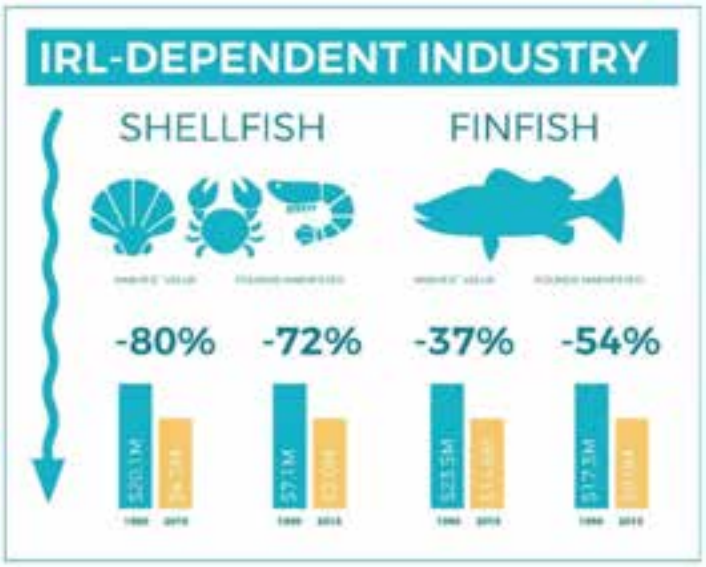
# ONE LAGOON

## LIVING RESOURCES

### *Commercial and Recreational Fisheries*

**GOALS: Conduct fisheries *RESEARCH* to help *REBUILD* IRL commercial and recreational fisheries. *RESTORE* IRL fish populations to support world-class recreational fishing and sustainable commercial harvest.**

**ISSUE SUMMARY:** In the IRL region, fishing has been a commercially valuable activity, a recreational pastime, and a means of subsistence for centuries. Fish populations in the IRL are some of the richest and most diverse in the United States with more than 700 species identified.




Data from a 2016 economic analysis conducted by Treasure Coast and East Central Florida Regional Planning Councils and funded by DEO reported that the IRL-dependent fishing industry was in decline. Commercially harvested clams, oysters, crabs, and shrimp were worth $12.6 million at the docks in 1994. Adjusted for inflation, this 1994 amount was $20.1 million in 2015 dollars. The overall value of the commercial clam, oyster, crab, and shrimp harvest for 2015 was $4.3 million, representing a nearly 80% decline since 1994.[1]

From approximately 1994 to 2015, shellfish harvest declined from 7.1 million pounds to 2 million pounds, or almost 72%. IRL counties showing the sharpest decline in value and pounds harvested were Volusia, Brevard, and Martin. The commercial fin fishery fared slightly better, but still showed significant declines in value and pounds landed. In 1990, the estimated value of commercial finfish landed was worth $13 million. Adjusted for inflation, this 1990 amount was $23.5 million in 2015 dollars. The overall value of the commercial finfish harvest for 2015 was estimated at $14.8 million—a decline of 37%. Pounds of finfish landed also declined during that same period, from 17.3 million pounds to 8 million pounds or almost 54%. IRL counties showing the sharpest declines in value and pounds harvested were Brevard, Indian River, and Martin.[1] However, it is important to note that in July 1995, an amendment to the Florida Constitution made it unlawful to use entangling nets, such as gill nets, and limited the use of other nets, such as seines, cast nets, and trawls in Florida waters. Therefore, the fishing industry was impacted by this change in allowable gear, which made staying in the industry cost prohibitive for some fisherman and impacted the amount of shellfish and finfish harvested.

FWC conducts Marine Fisheries-Dependent Monitoring and Marine Fisheries-Independent Monitoring. The Fisheries-Dependent Monitoring collects and analyzes catch-and-effort data to monitor trends in commercial and recreational fisheries throughout Florida. These data provide assessments of how management regulations affect harvest and fishers. The Fisheries-Independent Monitoring monitors the status and abundance of recreational and commercial fishes from six estuaries around the state.[2] Recent data from the Fisheries-Independent Monitoring Program generally show fisheries stocks in the IRL to be stable, although smaller than historical numbers have been observed. The data from this program allow the development of annual abundance models of juvenile fishes.

These models may be used to predict the availability of a species and provide the information needed to determine fisheries management measures and to assess the effectiveness of those measures after they are enacted.

Recreational fishing guides and commercial fishers throughout the lagoon have reported that poor water quality and declining fishery quality have impacted their ability to make a living. Seasonal large volume freshwater releases from Lake Okeechobee to the St. Lucie Estuary and southern IRL have catastrophic impacts to both the recreational fishing industry and regional tourism. Chronic, recurring algal blooms and poor water quality in the Banana River Lagoon and central-northern IRL have impacted recreational fishing and tourism since the algal superbloom in 2011. Over 30 fish mortality events were reported in the Mosquito Lagoon during the *Aureoumbra* bloom of 2012. Since that time, small recurring fish mortality events have been associated with algal blooms and low dissolved oxygen levels. In March 2016, an intensive and large fish mortality event co-occurred with an *Aureoumbra* bloom in the Banana River Lagoon that impacted hundreds of thousands of fish, multiple species and age classes, and many prized recreational fish species. The long-term impacts of these recurring algal blooms, loss of seagrasses, and fish mortality events are not well understood.

Saltwater recreational fishing in Florida is estimated at $8.0 billion annually and supports 114,898 jobs.[3] For the recreational fishing guide and commercial fisher making a living on the IRL, water quality and high-quality fishing are the foundation of their businesses. Ten years ago, the IRL was known as the "Redfish Capital of the World." Many redfish tournaments were held every year, and the IRL was featured on numerous televised fishing shows. It has been years since a redfish tournament was held in the IRL. Television's celebrity fishing guides have moved on to more productive areas, as have many of the local fishing guides.

Without water quality improvements, the IRL may never support a viable and sustainable recreational and commercial finfish and shellfish fishery. Most of the commercial fishers have been forced out of work or changed occupations, no longer able to make a living plying the once productive waters. Accelerated water quality and habitat restoration is required and, once achieved, a second-phase restoration effort may require fish stock enhancement. This will require proactive planning and capacity development for aquaculture facilities and fish stock breeding programs associated with the IRL regional restoration center network. Ultimately, a sustainable commercial fishing industry is the high-bar for clean water and estuary restoration. If fish and shellfish stocks can support sustainable healthy harvest, then those same stocks will support a robust recreational fishery.

## STRATEGIES:

- Improve IRL water quality to *RESTORE* oyster reefs, clam beds, seagrasses, and living shorelines.
- Determine if fish-stock enhancement may be necessary and take proactive steps to provide aquaculture facility support.
- Implement a strategic, coordinated, and science-based recovery plan for both recreational and commercial fisheries.
- Encourage catch and release management to aid with issues from fish population declines to potential safety issues from fish consumption.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Fisheries-1: Conserve, protect, *RESTORE*, and manage the commercial and recreational finfish and shellfish resources in the IRL region to support a sustainable harvest.** | *RESTORE*, protect, and manage commercial and recreational fisheries. | FWC, Marine Fisheries Council (MFC) | NMFS, USFWS, DEP, WMDs, Sea Grant, academia, interest groups, local governments | TBD | FWC, MFC, local governments | Coordinate and collaborate |

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Fisheries-2: Continue to support and expand *RESEARCH* initiatives and coordinated finfish and shellfish management strategies specific to the IRL.** | Expand *RESEARCH* to identify appropriate management strategies. | FWC, MFC | NMFS, USFWS, DEP, WMDs, Sea Grant, academia, interest groups, local governments | TBD | FWC, MFC, local governments | Coordinate and collaborate |
| **Fisheries-3: Improve effectiveness of fish habitat conservation and restoration efforts by identifying and characterizing critical spawning, nursery, and forage areas within the IRL and its tributaries. (NEW)** | Use existing and new tools to integrate information and conduct assessments to inform restoration and conservation efforts. | FWC, MFC | NMFS, USFWS, DEP, WMDs, Sea Grant, academia, interest groups, local governments | TBD | FWC, MFC, local governments | Coordinate and collaborate |
| **Fisheries-4: Identify, inventory, and assess finfish breeding and important habitats within the IRL.** | Implement appropriate management and restoration strategies for finfish. | FWC, MFC | NMFS, USFWS, DEP, WMDs, Sea Grant, academia, interest groups, local governments | TBD | FWC, MFC, local governments | Coordinate and collaborate |

## OUTCOMES:

- **Short-term (1 – 2 years):** Improve public understanding of the importance of commercial and recreational fishes and essential fish habitats to the health of the IRL ecosystem and economy. Improve communication and cooperation among the commercial and recreational fishing industry sectors.
- **Medium-term (3 – 4 years):** Implement CCMP water quality and habitat restoration projects to ensure that IRL commercial and recreational fish populations remain diverse, abundant, and sufficient to support IRL living resources.
- **Long-term (5 – 10+ years):** Water quality, habitat quality and fisheries quality have recovered to support a re-emergence of the IRL as a world-class fishery and the IRL commercial and recreational fishing industry as a sustainable, high-quality, community-supported multi-species fishery.

## CHALLENGES TO SUCCESS:

- Poor water quality and recurring algal blooms have resulted in a historic loss of seagrasses, an essential fish habitat. The timeline to recovery may be too long to save traditional commercial fishing and high-quality recreational fishing industry interests along some parts of the IRL.
- Inadequate funding for aggressive and strategic implementation of projects to improve water quality.
- Inadequate lagoon-wide monitoring.

## CITATIONS:

1. Treasure Coast and East Central Florida Regional Planning Councils. 2016. Indian River Lagoon Economic Valuation Update. Report available at www.onelagoon.org.
2. FWC Marine Fisheries Research. Website: http://myfwc.com/research/about/programs/mfr.
3. FWC. 2017. The Economic Impact of Saltwater Fishing in Florida. http://myfwc.com/conservation/value/saltwater-fishing/.

# HARMFUL ALGAL BLOOMS


## Goals:

**Advance understanding of the triggers for harmful algal bloom occurance and toxicity to reduce their frequency and intensity.**

# ONE LAGOON

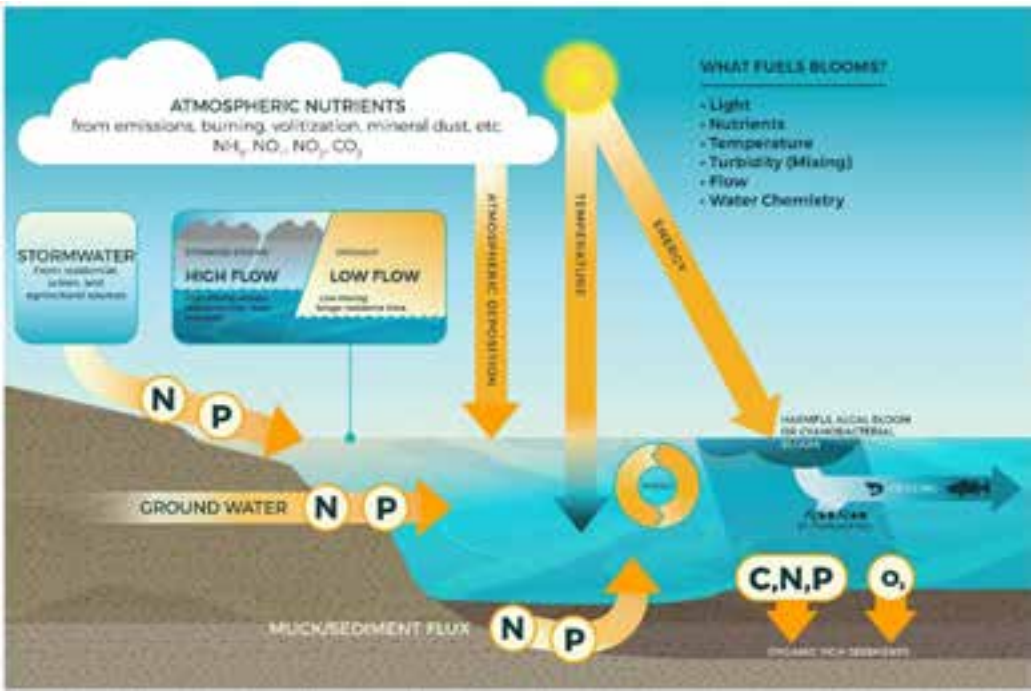
## LIVING RESOURCES

### *Harmful Algal Blooms (HABs)*

**GOALS: Advance *RESEARCH*, coordination, and understanding of the causes of HABs to *REDUCE* their frequency, intensity, and duration. Effectively and efficiently *RESPOND* to HAB emergence and secondary impacts including toxicity in some species, low dissolved oxygen concentrations as blooms decline, and associated fish and wildlife morbidity and mortality events. Improve scientific understanding of toxic algal blooms and human health risks. *REPORT* IRL algal bloom status and trends.**

**ISSUE SUMMARY:** This IRL CCMP revision applies a broad definition to IRL HABs. HABs occur when colonies of algae—microscopic plants that live in the sea and freshwater—grow out of control and sometimes produce toxic or other harmful effects on people, fish, shellfish, marine mammals, birds, seagrass, and other ecological components. Human illnesses caused by HABs are rare, but they can be debilitating or even fatal.[1] HABs are often associated with large-scale marine mortality events and have been associated with several types of shellfish poisonings.[2]

Since 1996, several additional events and discoveries have occurred that raised concerns about aquatic animal health and biotoxins associated with algal blooms in the IRL. In 2002, 19 cases of puffer fish poisoning were reported to state and federal health officials following consumption of puffers caught in the Titusville area. Subsequent investigation found that a common algal species in the lagoon was producing a toxin that entered the food chain, ultimately resulting in puffers becoming toxic. Microalgae and associated toxins were also thought to be implicated in a 2001 event where several dolphins died in the north-central IRL and Banana River Lagoon in what was termed an "unusual mortality event" as well as several fish kills, horseshoe crab mortalities, and similar events. Lesions on fishes in the southern IRL region have also caused public concern. These issues and incidents are reviewed in more detail in the 2006 publication *Indian River Lagoon Biotoxin & Aquatic Animal Heath: History and Background Report*.[3] To address these emerging issues, the IRLNEP and FWC jointly established the IRL Biotoxin and Aquatic Animal Health Working Group, which evaluated projects and actions to improve communications and coordination among the various individuals and organizations, enhance knowledge of HAB events, and determine the cause or causes of HAB events and management actions that may be taken to address them.



A dramatic ecological state-shift from a benthic aquatic vegetation system to one dominated by planktonic microalgae began in the IRL in 2011 with an unprecedented bloom of a nanoplanktonic green alga and picocyanobacteria (now referred to as the "2011 superbloom"). In response to the superbloom, SJRWMD convened a group of experts to evaluate the potential causes and to prepare a plan of investigation. The post-2011 IRL is now characterized by intense, recurring, and long-lasting algal bloom conditions of multiple species, widespread loss of seagrass habitat, and episodic wildlife mortality events. Ongoing blooms of pico-cyanobacteria, dinoflagellates, and the Texas brown tide species, *Aureoumbra lagunensis*, appear to be the "new normal" for the central and northern IRL. These ecosystem shifts challenge scientific understanding of nutrient enrichment thresholds, nutrient and carbon cycling, and tipping points for the IRL.[4,5]

Blooms in 2011, 2012, 2013, 2015-2016, and 2018 of small-celled phytoplankton in Mosquito Lagoon, North IRL, and Banana River Lagoon share conditions associated with prominent blooms of small-celled phytoplankton in other ecosystems, such as the brown tide events involving *Aureoumbra* in Texas[6] and picocyanobacteria blooms in Florida Bay.[7] Common characteristics include shallow restricted estuaries with long water residence times, varying salinity regimes, high-light attenuation caused by persistently high phytoplankton biomass, and declines in benthic primary producer biomass, such as seagrasses. The continuing and shifting character of phytoplankton blooms in Mosquito Lagoon, North IRL, and Banana River Lagoon provides some insights into future management challenges. Correlations between rainfall levels, external nutrient loads, and bloom activity support the hypothesis that reductions in anthropogenic nutrient sources have potential to reduce the frequency and intensity of blooms.[8]

Concurrent with these ecosystem-wide stress-response issues, the southern IRL was severely impacted by massive seasonal freshwater release events from Lake Okeechobee during times of high water. In summer 2013 (the "Lost Summer"), billions of gallons of freshwater were released east through the St. Lucie Estuary and southern IRL. As a result, the St. Lucie Estuary and southern IRL experienced catastrophic salinity shifts to sustained freshwater conditions. The combination of freshwater, high nutrients, and an inoculant of the cyanobacteria *Microcystis* from Lake Okeechobee fueled cyano-HABs of *Microcystis* in portions of the southern IRL. In 2016, large-volume, high-velocity freshwater releases from Lake Okeechobee from February through November ("the Lost Year") fueled an intense *Microcystis* cyanobacteria HAB, with reported microcystin toxin concentrations that greatly exceeded World Health Organization standards. A similar event occurred in 2018. The 2013, 2016, and 2018 events highlight the close watershed connections between the IRL and Everglades ecosystem and the need to look beyond the historic watershed boundaries of the IRL.

It is important to note that cyanobacteria interact with many bacterial members within their natural environment. For instance, the University of Central Florida recently found that the exact species that is causing the HABs in the IRL serves as "food" for the growth of other harmful microorganisms, such as the agent of cholera (*Vibrio cholerae*) and, based on preliminary data, *Vibrio vulnificus* (the flesh-eating bacterium that has caused problems in Florida before). In addition, it is possible that the changes in the IRL are not only directly fostering growth of cyanobacteria but also negatively affecting the survival or prevalence of bacterial species that might establish an antagonistic relationship with the cyanobacteria, which allows the HABs to grow unchecked. Monitoring the IRL bacterial communities could help to predict and prevent this from occurring.

## STRATEGIES:

- *REDUCE* nutrients from external and internal sources to decrease concentrations that fuel blooms.
- *RESEARCH* causation factors for IRL HABs and document progress towards decreasing occurrence.
- Continue to provide a forum for scientific discussions and management regarding IRL HABs and trends.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **HAB-1: Support continuation of the IRL 2011 Consortium, which would function as a formal task force supported by the IRLNEP and which would develop a HAB *RESEARCH* and Restoration Response Plan. (NEW)** | Prepare a *RESEARCH* and response plan. | IRLNEP | NMFS. USFWS, DEP, WMDs, Sea Grant, academia, interest groups | TBD | IRLNEP, local governments | Conduct, coordinate, and collaborate |
| **HAB-2: Seek partnerships and funding to pursue *RESEARCH* priorities identified by the IRL 2011 Consortium that align with IRLNEP Management Conference management priorities. (NEW)** | Improve knowledge and management of HABs in IRL watershed. | FWC, IRLNEP, academia | DEP, WMDs, FDOH, interest groups, local governments | TBD | DEP, WMDs, IRLNEP, local governments | Conduct, coordinate, and collaborate |
| **HAB-3: Continue funding and scientific partnerships to understand HABs toxicity and risks to human and wildlife health. (NEW)** | Improve knowledge of toxicity and health impacts | IRLNEP Management Conference, NOAA, DEP, FDOH | Academia, interest groups | TBD | NOAA, DEP, FDOH | Coordinate and collaborate |

## OUTCOMES:

- **Short-term (1 – 2 years):** Monitor and conduct *RESEARCH* on the causes and effects of IRL HABs.
- **Medium-term (3 – 4 years):** Incorporate new findings into management plans.
- **Long-term (5 – 10+ years):** Implement projects to *REDUCE* causative pollutants and factors for HABs.

## CHALLENGES TO SUCCESS:

- HABs and cyanobacterial blooms are carried with ocean currents, so they may occur in areas outside of the IRL watershed and then be transported into the area.
- Understanding of HABs, impacts, and toxicity.
- Interactions of trophic levels and the effects on naturally managing blooms is not well understood.
- Regime shifts to ecosystem domination by a lower trophic level are difficult and slow to overcome.

## CITATIONS:


1. NOAA. What is a HAB? Website: http://www.noaa.gov/what-is-harmful-algal-bloom.
2. Ehrhart, L.M. and Redfoot, W.E. 1995. Composition and Status of Marine Turtle Assemblage of the Indian River Lagoon System. Bulletin of Marine Science. 57:279 – 280.
3. Provancha and Van den Ende. 2006. Indian River Lagoon Biotoxin and Aquatic Animal Heath: History and Background Report.
4. De Freese, D.E. 2017. IRLNEP 5-Year Program Evaluation Report to the USEPA. Full report and support documents on-line at www.irlcouncil.com.
5. Phlips, E.J. and Badylak, S. 2013. Phytoplankton Abundance and Composition in the Indian River Lagoon 2011–2012. Annual Report 2012 for St. Johns River Water Management District. 29 pp.
6. Buskey, E.J., Liu, H., Collumb, C., and Guilherme, J. 2001. The Decline and Recovery of a Persistent Texas Brown Tide Algal Bloom in the Laguna Madre. Estuaries Vol. 24, No. 3, p. 337–346.
7. 2015 Indian River Lagoon Consortium. 2015. 2011 Superbloom Report: Evaluating Effects and Possible Causes with Available Data. St Johns River Water Management District Technical Document. 57 pp.
8. Phlips, E.J., Badylak, S., Christman, M., Wolny, J., Brame, J., Garland, J., Hall, L., Hart, J., Landsberg, J., Lasi, M., Lockwood, J., Paperno, R., Scheidt, D., Staples, A., and Steidinger, K. 2011. Scales of temporal and spatial variability in the distribution of harmful algae species in the Indian River Lagoon, Florida, USA. *Harmful Algae* 10: 277–290.

# CLIMATE-READY ESTUARY

FEMA

## Goals:

**Understand coastal vulnerabilities to climate change. Manage adaptively, and improve community resilence.**

# ONE LAGOON AND ONE COMMUNITY

## LIVING RESOURCES & HEALTHY COMMUNITIES

### *Climate Ready Estuary*

**GOALS:** ***RESEARCH*** **IRL risk-based vulnerabilities to climate change and sea level rise to make informed adaptation planning decisions.** ***RESPOND*** **to threats and opportunities. Make management decisions that improve IRL** ***RESILIENCE*** **to storm events and long-term risks.** ***REPORT*** **findings and scientific advancements to partners in the IRLNEP Management Conference and communities.**

**ISSUE SUMMARY:** The IRL is vulnerable to the impacts of climate change, including sea level rise. Climate stressors include changes in annual air and water temperatures, precipitation patterns, intensity of storms, ocean acidification, and sea level rise. These will cause changes to the IRL that will challenge resource management and stewardship. Most scientists agree that these impacts already are being felt.


Martin County

There are potential solutions that can improve resiliency and time is of the essence for these solutions to be realized. Identifying risks associated with climate change, including sea level rise, is the first step. The second phase is to adopt a plan to reduce potential impacts of these risks. The USEPA Climate Ready Estuaries Program has identified ten steps to help NEPs identify, analyze, prioritize, and reduce their climate change risks. These steps fall into two activity categories: (1) risk-based vulnerability assessment, and (2) action plan – determining a course of action.[1]


Anticipated risk-based vulnerabilities extend beyond the water quality and ecosystem health of the IRL to human-built infrastructure, transportation corridors, integrity of traditional supply chains for goods and services, human health, communication networks, and homeland security. The economy and quality of life of the IRL region is closely linked to its natural and human built assets. When discussing future climate change scenarios, human-built and natural assets need to be considered as one interdependent and integrated coastal ecosystem.[2,3,4] Anticipated risk-based vulnerabilities include the water quality and ecosystem health of the IRL, as well as all aspects of infrastructure, transportation corridors, supply chains for goods and services, human health, communication networks, and homeland security.

Adapting to these climate change stressors will require much wider consideration than

traditional hazard risk management. Adaptation involves integration of strategies for both the natural environment and human-built environment to be resilient to a range of future conditions. For this reason, adaptive management will require significant community engagement and a process for long-term strategic planning and decision-making. The figure provides a ten-step process structured around five broad questions.[5]

Some infrastructure assets for vulnerability consideration include:

- Transportation corridors (roadways, bridges, and rail).
- Kennedy Space Center and regional aviation and aerospace assets (such as Harris Corporation, Northrup Grumman, Space X, and Blue Origin).
- Military facilities and operations that support national defense and homeland security (U.S. Coast Guard (USCG) Stations at Ponce Inlet, Port Canaveral, and Fort Pierce; Naval Ordnance Test Unit at Cape Canaveral; Patrick Air Force Base; Cape Canaveral Air Force Station; 45th Space Wing; and 920th Rescue Wing).
- Ports (Port Canaveral, which is one of the busiest cruise ports in the world; Port of Fort Pierce, which has a vision for growth as a mega-yacht destination).
- Wastewater and stormwater infrastructure vulnerable to flooding and overflow to the IRL.

In addition to infrastructure, there will be changes to the natural environment (e.g., seagrass beds and mangroves), which should also be monitored over time.

The IRLNEP has initiated a risk-based vulnerability assessment (fiscal year 2017-2018) and adaptation planning process (fiscal year 2018-2019) as a result of grant awards from the USEPA Climate Ready Estuaries Program. Results of the risk-based vulnerability assessment identified 154 management objectives related to climate change. Five climate change stressors were evaluated based on impacts to IRL sediment and water quality, natural resources, and stakeholder engagement: (1) warmer temperature, (2) changing precipitation, (3) increased storminess, (4) acidification, and (5) sea level rise.[6] The vulnerability assessment and adaptation planning technical documents will be shared with the IRLNEP Management Conference and community partners to advise CCMP implementation.

## STRATEGIES:

- Develop a Risk-Based Vulnerability Assessment and Adaptation Plan for the IRL in alignment with the USEPA Climate Ready Estuary guidance.
- Rethink infrastructure design standards and locations to build *RESILIENCE* into coastal infrastructure (including bridges, causeways, WWTPs, road elevations, stormwater configurations, septic systems along low elevation shorelines, energy network and grids, and living shorelines instead of bulkheads).
- Encourage local government to adopt adaptation action areas within their comprehensive plans.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Climate Ready Estuary-1: Prepare a Risk-Based Vulnerability Assessment and Adaptation Plan for the IRL. (NEW)** | Prepare a plan and share findings with IRLNEP partners. | IRLNEP with contractor support | IRLNEP Management Conference | $100,000 | USEPA supplemental funding, IRLNEP Management Conference | Conduct, collaborate, and coordinate |
| **Climate Ready Estuary-2: Identify opportunities to integrate infrastructure *RESILIENCE* into community planning. (NEW)** | Work with IRL communities and partners to consider and integrate infrastructure ***RESILIENCE*** into community planning. | IRLNEP Management Conference | DEP Coastal Resilience Program, DEO, transportation planning organizations, economic development agencies, tourism industry, public and private-sector partners | N/A | USEPA, grants, private-sector support | Conduct, collaborate, and Coordinate |

## OUTCOMES:

- **Short-term (1 – 2 years):** IRLNEP Management Conference partners have improved awareness and understanding of climate change, including sea level rise, vulnerabilities and adaptation strategies.
- **Medium-term (3 – 4 years):** IRLNEP Management Conference partners begin implementation of adaptation plans to improve IRL *RESILIENCE*.
- **Long-term (5 – 10+ years):** Significant progress is made by IRLNEP Management Conference partners to position the IRL as a climate ready estuary.

## CHALLENGES TO SUCCESS:

- Insufficient data and/or lack of trust for science.
- Focus on challenges rather than opportunities.
- Lack of technical and financial resources.
- Perception that local community actions will have no impact.
- Existing legal and regulatory environment.
- Obtaining buy in from more local governments within the IRL watershed that climate adaptation and *RESILIENCE* planning is of vital importance and policies and projects should be coordinated.

## CITATIONS:


1. USEPA. 2014. Being Prepared for Climate Change: A Workbook for Developing Risk-Based Adaptation Plans. Office of Water EPA 842-K-14-002. 120p.
2. Nicholls, R.J. 2011. Planning for the impacts of sea level rise. *Oceanography* 24(2):144–157, doi:10.5670/oceanog.2011.34.
3. Ng, A.K.Y, Becker, A., Cahoon, S., Chen, S-L. Earl, P., and Yang, Z. 2016. Climate Change and Adaptation Planning for Ports. Edited book in the series, Routledge Studies in Transport Analysis. Routledge, NY. 286 p.
4. Lawrence, J., Bell, R., Blackett, P., Stephens, S., and Allan, S. 2018. National guidance for adapting to coastal hazards and sea-level rise: Anticipating change, when and how to change pathway. Environmental Science and Policy 82:100–107.
5. Bell, R., Lawrence, J., Allan, S., Blackett, P., and Stephens, S. 2017. Coastal Hazards and Climate Change. Ministry for the Environment. Government of New Zealand. 279 p.
6. RW Parkinson Consulting, Inc. and The Balmoral Group. 2018. Risk-Based Vulnerability Assessment of the Indian River Lagoon to Climate Change. Prepared for: Indian River Lagoon Council.

# VIBRANT 21ST CENTURY COMMUNITIES


## Goals:

**Rebuild infrastructure to be Lagoon-Friendly, sustainable, and resilient. Research economic value and trends.**

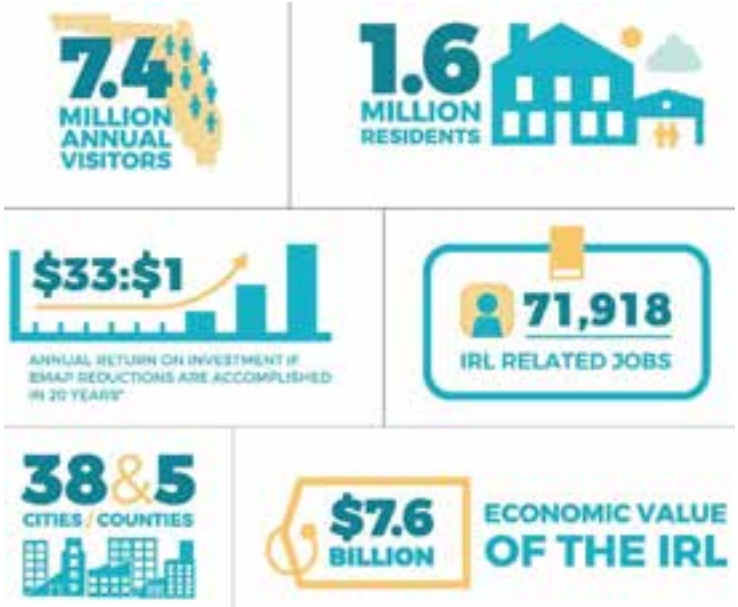
# ONE COMMUNITY

## HEALTHY COMMUNITIES

### *Vibrant 21st Century Communities*

**ACTION: Update *RESEARCH* on IRL economic value and trends, at least every five years or as needed, in response to abrupt economic changes, threats, and opportunities. *REBUILD* human-built infrastructure along the IRL to be more Lagoon-Friendly ™, more sustainable, and more resilient. *RESPOND* to 21st Century changing environmental, economic, and societal needs, challenges, and opportunities. *REPORT* regularly to the IRL regional business and economic development community to ensure that CCMP implementation advances the "One Lagoon – One Community – One Voice" Mission.**

**ISSUE SUMMARY:** IRL health and regional economic health are inter-dependent. News of poor water quality, HABs, and fish mortality events harm the regional tourism economy, threaten lagoon-related small businesses, impact commercial and residential property values, influence employee and employer recruitment success, and diminish the global brand of the region as a high value destination to live, work, and play. The IRLNEP recognized the essential need to have balanced participation and leadership from the public, independent, and private sectors to implement an effective and long-lasting restoration and stewardship plan for the IRL. For many years, active and engaged private-sector involvement in CCMP implementation was missing. This involvement was a strategic consideration of the IRL Council and reorganization of the IRLNEP in 2015–2016. The new IRLNEP Management Conference structure and network governance model was designed to encourage and cultivate increased participation from private-sector business and industry throughout the five-county IRL region.[1] This goal was achieved through strategic private-sector appointments by the IRL Council Board of Directors to the IRLNEP Management Conference and creation of the IRLI[2] Network.




The economic importance of estuaries to local communities, the state of Florida, and the nation cannot be overstated. In 2016, the economic value of the IRL was estimated at $7.6 billion annually with a return of $33 to every $1 invested.[2] An independent economic study by Brevard County through the Save Our Indian River Lagoon Project Plan in 2016 calculated return on investment by applying a net present value analysis.[3] It was estimated that at least a total present value of $6 billion was tied to restoration of the IRL of which approximately $2 billion in benefits were realized from restoration efforts and an estimated $4 billion in damages were anticipated if the IRL was not brought back to health during the next decade. If the restoration plan was viewed purely as a financial investment

that paid the $2 billion in benefits alone (i.e., not counting the avoidance of the $4 billion loss), the projected pretax internal rate of return was 10%, if the plan took 20 years to implement. However, if plan implementation could be accelerated to occur over 5 years instead of 20 years, the return on investment rose significantly to 26% because the benefits of restoration would begin to accrue much faster. This analysis demonstrated that an accelerated restoration timeline was a smart financial decision.

In addition to providing economic, cultural, and ecological benefits to communities, estuaries also deliver invaluable ecosystem services.[4] Ecosystem services include, but are not limited to, raw materials and food, coastal infrastructure protection and resilience, erosion control, water purification, maintenance of fisheries, carbon sequestration, aesthetic values, quality of life values, and support of estuary-dependent industry-sectors (i.e., tourism, recreation, education and research).

However, the IRL is a human-dominated ecosystem with many stressors directly linked to human-built infrastructure (i.e., inadequate and aging WWTPs and pipe networks, septic systems, stormwater conveyances, nutrient and pollutant impacts from reclaimed water and biosolid management, and impacts from transportation corridors, bridges, causeways and public access). IRL coastal communities are also vulnerable to tropical storm events and associated flooding, storm surge, and high winds. These risks and vulnerabilities are compounded by aging infrastructure and/or poorly planned, designed, and built infrastructure.

Twenty-first century planning for sustainable cities and communities is a complex process that must integrate economic, environmental, and societal considerations. Eight critical factors have been identified for smart city initiatives: (1) management and organization, (2) technology, (3) governance, (4) policy context, (5) people and communities, (6) economy, (7) built infrastructure, and (8) natural environment.[5] These factors, and others such as responding to climate change, form the basis of an integrative framework that can be used to examine how local governments envision and implement smart city initiatives, sustainability initiatives, green infrastructure, and Lagoon-Friendly ™ and resilient coastal infrastructure development.

## STRATEGIES:

- Coordinate, integrate, and communicate the connected environmental, economic, and quality of life values of the IRL to the regional businesses and industries. Seek opportunities to partner with the tourism industry, ports and maritime industries, commercial fishing industry, recreational fishing industry, aviation and aerospace industry, economic development organizations, and others to achieve Lagoon-Friendly ™ goals.
- Quantify and track the economic value of the IRL with special attention to estimating return on investment from restoration, IRL-dependent jobs, and the influence of clean water on corporate relocations, employee recruitment and retention, and residential/commercial development.
- Ensure that the IRL business community, including tourism industry, maritime industry and ports, commercial fishing industry, recreational fishing industry, aviation and aerospace, economic development organizations, real estate, and other interested private-sector partners are included and actively engaged in the IRLNEP Management Conference.
- Work with partners on the Management Conference and local elected officials to update the IRL Economic Analysis produced in 2016 by the Treasure Coast and East Central Florida Regional Planning Councils at a minimum of every five years, with special attention to include estimates for estuary-dependent industries, jobs, and return on investment.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Vibrant Communities-1: Work closely with the business community and industry clusters along the IRL to ensure effective cooperation and communication associated with CCMP implementation. (NEW)** | Engage the business community and industry clusters in CCMP implementation. | IRLNEP | DEO, Space Florida, Visit Florida, Enterprise Florida, CareerSource Florida, Port Canaveral, Port Fort Pierce, Treasure Coast and East Central Florida Regional Planning Councils, chambers of commerce, economic development commissions, tourist development councils | IRLNEP staff activity | IRLNEP | Conduct, Coordinate, and collaborate |
| **Vibrant Communities-2: Update the IRL economic analysis produced in 2016 by the Treasure Coast and East Central Florida Regional Planning Councils every five years. (NEW)** | Provide the latest economic information for the IRL watershed. | IRLNEP | DEO, Treasure Coast and East Central Florida Regional Planning Councils | $300,000 for IRL economic update every 5 years | IRLNEP | Conduct, coordinate, and collaborate |
| **Vibrant Communities-3: Promote lagoon-related nature and heritage tourism development for residents and visitors. (NEW)** | Promote efforts to advance appreciation and knowledge about the IRL through tourism activities, events, and volunteer activities. | Tourist development organizations, Brevard Zoo, not-for-profit organizations, IRL destinations | IRLNEP | N/A | IRLNEP | Coordinate and collaborate |
| **Vibrant Communities-4: Conduct community planning workshops to plan for Vibrant 21st Century communities. (NEW)** | Conduct community vision planning workshop(s). | IRLNEP | IRLNEP Management Conference Partners, local governments | $25,000–$50,000 | USEPA Section 320 | Conduct, collaborate, and coordinate |

## OUTCOMES:

- **Short-term (1 – 2 years):** IRLNEP is viewed by the regional business community as the leading lagoon-wide organization to promote and cultivate productive, effective, efficient, and cooperative partnerships with the private-sector. Quantify and track the economic value of the IRL with special attention to return on investment from restoration; IRL-dependent jobs; and the influence of clean water on corporate relocations, employee recruitment and retention, and residential/commercial development.
- **Medium-term (3 – 4 years):** Private-sector partnerships develop new revenue streams for CCMP implementation and support new technological innovations to advance IRL restoration and management. The IRLNEP is recognized as a successful bridge between industry and academic partners in the STEMAC to promote innovative industry-academic partnerships in applied research and development of new coastal restoration methodologies, technologies, and commercial products. Update the IRL Economic Analysis every five years to coincide with CCMP updates (five years) and CCMP revisions (10 years).
- **Long-term (5 – 10+ years):** The IRLNEP helps to advance the IRL region and the state of Florida as a national center of excellence for innovation in clean-water technologies and innovative coastal management strategies. For 2030, in advance of the next CCMP revision, evaluate long-term (10-year) economic trend for the IRL with special attention to restoration of the IRL watershed.

## CHALLENGES TO SUCCESS:

- Traditional communication challenges and presumed conflicts between industry and environmental interests.
- Water quality declines in the IRL can impact coordinated state and federal activities and assets (i.e., ports, expansion of commercial aviation and space ventures, Kennedy Space Center, and military bases and operations). To protect these commercial activities and assets, continue federal support for the IRLNEP funding appropriations as a non-regulatory core water program pursuant to Section 320 of the Clean Water Act.
- Funding for comprehensive, lagoon-wide economic analysis.
- Challenges to accurately quantify ecosystem services.
- Difficulty securing accurate economic metrics from the private sector.
- The North American Industry Classification System does not generally include government-owned establishments, even when their primary activity would be classified in industries covered by the economic census. Because of these exclusions, economic census data for industries in many sectors might appear to be incomplete. In addition, the job classifications often do not reflect 21st Century workforce changes and emerging workforce job categories.

## CITATIONS:

1. De Freese, D. 2016. Rethinking the Indian River Lagoon National Estuary Program: Challenges and Opportunities for Enhanced Ecosystem Restoration and Management. American Water Resources Association Annual Conference. Orlando, FL. Presentation online at: http://www.awra.org/meetings/Orlando2016/doc/powerpoint/Session%2044%20830%20de%20Freese.pdf.
2. Treasure Coast and East Central Florida Regional Planning Councils. 2016. Indian River Lagoon Economic Valuation Update. Report available at www.onelagoon.org.
3. Tetra Tech and Closewaters. Brevard County Save Our Indian River Lagoon Plan. 2016. Report available at www.onelagoon.org.
4. Barbier, E. B., Hacker, S.D., Kennedy, C., Koch, E.W., Stier, A.C., and Silliman, B.R. 2011. The value of estuarine and coastal ecosystem services. Ecological Monographs, 81(2), pp. 169–193.
5. Chourabi, H., Nan, T., Walker, S., Gil-Garcia, J.R., Mellouli, S. Nahon, K. Pardo, T.A., and Scholl, H.J. 2012. Understanding Smart Cities: An Integrative Framework. 45th Hawaii International Conference on System Sciences. System Sciences. pp 2289 – 2297.

# TRASH-FREE WATERS


Coastal Connections

## Goals:

**Implement a Trash-Free Lagoon campaign in all lagoon counties.**
**Enhance coordination, report hot spots, and successes.**

# ONE COMMUNITY

## HEALTHY COMMUNITIES

### *Trash-Free Waters*

**GOALS: *REDUCE* trash by implementing a lagoon-wide trash-free waters campaign, "Trash-Free Lagoon 2030." Enhance efforts to *REMOVE* trash by coordinating with local organizations and partners in the IRLNEP Management Conference. *REPORT* trash hotspots and trash removal success stories.**

**ISSUE SUMMARY:** Trash is a common and recurring problem in the waters of the IRL and along its shorelines. It is especially notable along causeways and certain "trash hotspots" where vehicle access and high-volume recreation occur. Plastic debris is much more than an aesthetic problem. Of all trash, plastic has the greatest potential to harm the environment, wildlife, and humans because of its persistence. It can be found floating at the surface, suspended in the water column, or deposited on or in bottom sediments. Discarded fishing line and rope can cause animal entanglements. Trash is transported by wind and currents throughout the IRL and out to the ocean though inlets. Once ingested, plastics and other debris can result in intestinal tract blockages causing animals to starve. Reports from animal necropsies (autopsies on dead animal) have found marine debris in the stomachs of sea turtles, birds, bottlenose dolphins, manatees, and oysters.

Photo of stomach contents of dead bottlenose dolphin in the Indian River Lagoon. Plastic bags, beach towels, food wrappers (Photo: Hubbs-SeaWorld Research Institute).

There is a growing awareness and concern about microplastics and microfibers in the lagoon and adjacent ocean waters. Microplastics come from a variety of sources, including from larger plastic debris that degrades into smaller pieces. One type of microplastic is microfibers, which are used to make mats, knits, and weaves for apparel, upholstery, industrial filters, and cleaning products. Microfibers are not biodegradable and when washed, can release microfibers that are then processed at WWTPs and discharged to waterbodies. Another type of microplastic is microbeads, which are very tiny pieces of exfoliants in health and beauty products, such as some cleansers and toothpastes. These tiny plastic particles are found in almost all species, including filter feeders like oysters. The particles are so small they pass easily through wastewater treatment systems. Recent research by the University of Central Florida has shown that Mosquito Lagoon oysters are already impacted by microplastic pollution.[1] Over a longer term, chemical breakdown products of plastics can concentrate toxic chemicals in animal tissues.[2]

## STRATEGIES:

- Work with local partners, municipalities, tourism development councils, restaurants and businesses, and organizations (such as Keep America Beautiful affiliates and other non-profits) to implement a strategic and coordinated Trash-Free Lagoon campaign.
- Identify and map trash hotspots throughout the IRL and identify opportunities to address through BMPs such as stormwater litter traps.

- Take actions, where necessary, to increase availability and management of trash containers, microfilament recycling bins, and pick-up spots in high-use areas.
- Implement a high-visibility, high-impact "Trash-Free Lagoon" public awareness campaign through videos, social media, and graphic imagery.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Trash-Free Waters 1: Identify and map IRL hotspots for trash, develop education projects that *REDUCE* and/or *REMOVE* trash, and seek funding for projects from the USEPA Trash-Free Waters Program. (NEW)** | Educate the community through the Trash-Free Lagoon campaign and provide funds for trash removal and abatement. | IRLNEP | USEPA, local organizations, Keep America Beautiful local affiliates | $25,000 for GIS mapping, $50,000 for Trash-Free Lagoon campaign | USEPA Trash-Free Waters Program, IRLNEP | Conduct, coordinate, and collaborate |
| **Trash-Free Waters-2: Identify and *REMOVE* derelict boats and fishing gear throughout the IRL. (NEW)** | *REMOVE* derelict vessels and fishing gear. | IRLNEP | DEP, FWC, Florida Department of Law Enforcement, USCG, Marine Cleanup Initiative Inc, 4Ocean | Derelict vessel removal cost averages $350 to $450 per vessel length | DEP, IRLNEP | Conduct, coordinate, and collaborate |

## OUTCOMES:

- **Short-term (1 – 2 years):** Communicate the impacts of trash on the IRL. Implement the Trash-Free Lagoon campaign with partners.
- **Medium-term (3 – 4 years):** Make progress towards achieving the goal of Trash-Free Lagoon by 2030.
- **Long-term (5 – 10+ years):** Trash is an unusual and rare occurrence along the IRL shorelines and in its waters. Trash Free Lagoon by 2030.

## CHALLENGES TO SUCCESS:

- Funding long-term programs and having the financial and human resources and reserves to be able to *RESPOND* to emergency situations.
- Keeping partners engaged and interested in trash removal.
- Changing culture to Lagoon-Friendly ™.

## CITATIONS:

1. Robbins, M. and Walters, L. 2018. Plastics Under a Microscope. Accumulation of Microplastics in Oyster Spat in the Mosquito Lagoon. Undergraduate research poster. Florida Undergraduate Research Conference. Eastern Florida State College. Melbourne, Florida.
2. USEPA. 2018. Trash-Free Waters Website: https://www.epa.gov/trash-free-waters.

# MARINAS AND BOATING


## Goals:

**Reduce negative impacts through boater education. Update the Boater's Guide to focus on good practices and safe recreation.**


# ONE COMMUNITY

## HEALTHY COMMUNITIES

### *Marinas and Boating*

**GOALS:** ***REDUCE*** **impacts from marina and boating activities. Educate boating population to take** ***RESPONSIBILITY*** **and be Lagoon-Friendly™. Update and re-publish the highly acclaimed IRLNEP** ***Boaters Guide to the Indian River Lagoon*** **to focus on boater waste management, safe boating practices, lagoon community boat ramps and recreational destinations, and emergency call contacts.**

**ISSUE SUMMARY:** Boating has been a traditional use of the IRL since Native Americans and early settlers used the lagoon as a primary route for travel and commerce. While the lagoon continues to be heavily used by boaters, today's boating is primarily a recreational activity with commercial activity mostly located on the Intracoastal Waterway.

The number of boats and boaters decreased following the 2008 recession; however, the boating industry has been growing rapidly in recent years. In 2016, 102,803 boats were registered in Volusia, Brevard, Indian River, Martin, and St. Lucie counties. While recreational use of the lagoon is important for the economy of the region, as well as for the enjoyment of its residents and visitors, heavy use can strain the sensitive natural resources of the lagoon.

While most boaters use great care in the operation and maintenance of their boats, some uses and behaviors may affect the health of the lagoon. Approximately 10% of the vessels registered in the IRL region are greater than 26 feet in length and are required to have some form of marine sanitation device (MSD) on board. In 1992, the Clean Vessel Act was signed into law to reduce water pollution by prohibiting vessels from discharging raw sewage into fresh water or coastal saltwater.[1] Discharges from MSDs, pollutants generated by fueling and operating boat motors, detergents from boat cleaning, and metals (especially copper) or other materials leaching from bottom paints can affect water quality. The impacts of these pollutants can range from slight perturbations to acute toxicity in the water column and sediments to threats to the public health.

Boat traffic itself can damage the lagoon. Boat wakes may erode shorelines and break up oyster reefs, and if care is not taken to avoid shallow areas, boat propellers may dig into the bottom, destroying seagrass and/or benthic habitat. In addition to possible damage to the boat, prop scars can be enlarged by scouring currents, leading to expanding seagrass loss and turbidity.

Other recreational impacts can include littering or improper disposal of trash. Manatees, sea turtles, dolphins, fish and birds can be injured or killed by ingesting or becoming entangled in discarded fishing line, nets, plastic bags or other debris.

Numerous marinas and similar facilities have been constructed along the IRL to provide services for boaters and access by the public. Because of their proximity to the lagoon, these facilities have a high potential to impact lagoon resources if they are not operated and managed carefully. Boaters, especially those on live-aboard boats, have a responsibility to comply with Florida law and be Lagoon-Friendly™. While the extent of the problem is not known, in May 2017 in response to multiple citizen complaints about irresponsible boat owners and captains, FWC enforcement officers issued 15 citations over a two-night detail for MSD violations, made an arrest on an outstanding warrant, and issued multiple warnings for other violations. Under Florida Statutes, violations relating to marine sanitation carry a civil penalty of $250 for a first offense, $750 for a second offense, and $1,000 for a third offense.

Boater education and engagement programs, such as the Florida Clean Boater, Clean Marina, and Clean and Resilient Marina programs, promote boater awareness and improved operation and maintenance of boats and marina facilities, bring boaters and marina operators the tolls needed to minimize their potential impacts on the IRL's resources.


## STRATEGIES:

- Provide education to boaters on Clean Boater Program and to marinas on the Clean Marina Program. Communicate about boating BMPs for marinas and boaters.
- Ensure that MSDs are working and pumped out properly. Discuss regulatory policy options with enforcement agencies.
- Develop an inventory and map of certified Clean Marinas along the IRL.
- Collect information on IRL boater education courses and help distribute materials that contain environmental awareness elements, updates on existing guides, and similar materials.
- Work with county partners to identify who has approved boat facility siting plans. Work with Brevard County to identify opportunities to review, update, or support their comprehensive maritime management master plan.
- Establish and maintain beneficial marine infrastructure to promote safe boating and habitat protection.
- Promote increasing the number of law enforcement staff assigned to patrol the IRL, and staff time committed to patrolling the IRL.
- Collect data as available on agency enforcement activities (i.e., resource evaluations, number of resource protection zones established, manatee strikes and prop scar data, impacts to seagrass beds and oyster reefs).

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Boating-1: Eliminate waste discharges and MSD impacts on the public health and IRL resources.** | Eliminate or *REDUCE* the nutrient and pathogen discharges to the IRL. | DEP, FWC, USCG, local governments | Florida Sea Grant, marine industry, USCG Auxiliary | TBD | DEP, FWC, USCG, local governments | Coordinate and collaborate |
| **Boating-2: Expand and coordinate enforcement of boating safety and resource protection regulations throughout the IRL and develop and distribute targeted public education and outreach products to *REDUCE* impacts.** | Provide for a safer IRL waterway and *REDUCE* impacts to IRL natural resources. | DEP, FWC, USCG, local governments | FWC, DEP, USCG Auxiliary, local governments, interest groups | TBD | DEP, FWC, USCG, local governments | Coordinate and collaborate |
| **Boating-3: Update and distribute the *Boaters Guide to the Indian River Lagoon*. (NEW)** | Update and distribute the guide. | IRLNEP | IRLNEP Management Conference, private industry partners | $50,000 - $100,000 | USEPA Section 320 funding | Conduct, coordinate, and collaborate |

## OUTCOMES:

- **Short-term (1 – 2 years):** Build stronger ties between the IRLNEP and the boating and marine industry sector. Assist DEP, FWC, USCG Auxiliary, and other maritime interests to assist expansion with boater education programs and outreach.
- **Medium-term (3 – 4 years):** Work with state and private partners to quantify improvements in boater and marina compliance. Elevate clean marinas with effective and efficient pump-out and waste management standards as a Florida brand for clean water excellence. Marine industry associations are a strong partner with IRLNEP.
- **Long-term (5 – 10+ years):** *REDUCE* impacts on IRL water quality and habitats from boating and marina activities.

## CHALLENGES TO SUCCESS:

- Inadequate funding for FWC enforcement coverage along the IRL.
- Diverse and independent nature of the boating and marina community.
- Inadequate local policies and regulatory oversight to prevent marinas from becoming live-aboard boat communities with insufficient wastewater pump-out facilities.

## CITATIONS:

1. DEP Clean Vessel Act Grant Program. Website: https://floridadep.gov/OSI/CVA.

# DISTINCTIVE LAGOON COMMUNITIES

Wild Ocean Seafood Market

## Goals:

**Respond to the the unique needs of communities having urban waters, working waterfronts, and environmental justice populations.**

# ONE COMMUNITY

## HEALTHY COMMUNITIES

### *Distinctive Lagoon Communities*

**GOALS:** ***RESPOND*** **to the unique needs of three categories of IRL coastal communities that contribute to the rich history, culture, human diversity, infrastructure, and economic value of the IRL watershed.**

**ISSUE SUMMARY:** Each of the 38 incorporated cities, numerous unincorporated communities and villages, and the counties have unique identities, histories, and connections to the IRL. However, there are three distinctive community categories within the IRL watershed that contribute in significant ways to the rich history, culture, human diversity, infrastructure, economic value, and coastal identity of the IRL watershed. Together, these communities form a foundation for the IRL's unique identity and brand.

**Urban Waters:** Cities share one key characteristic: they are full of people, buildings, and businesses. Because everyone shares the same relative space, air, and water, environmental impacts are concentrated in smaller areas, including waterways. In the decades to come, most of the mainland coast of the IRL will be characterized by high density development. Throughout the U.S. and Florida, urban waters receive large amounts of pollution from a variety of sources, including industrial discharges, mobile sources (e.g., cars/trucks), residential/commercial wastewater, trash, and polluted stormwater runoff from urban landscapes. This pollution creates public and environmental health hazards, such as waterbodies that are not safe for swimming. In addition, urban patterns of development often make waterways inaccessible to adjacent neighborhoods. Lack of access limits a community's ability to reap the benefits of living close to the water, whether through recreation, fishing, or access to real estate. IRL communities can make planning and development decisions to preserve community values for water access and use.

**Working Waterfronts:** The Waterfronts Florida Program offers help to coastal governments to revitalize their working waterfronts by providing resources for land acquisition and technical assistance for planning.[1] The Waterfronts Florida Partnership Program was created by the Florida Coastal Management Program in 1997 to address the physical and economic decline of traditional working waterfront areas. Since 1997, a total of 24 communities have received designation as Waterfronts Florida Partnership Communities. During the designation process, a community receives intensive technical assistance from DEO, resulting in a new or refined, community-designed vision plan (special area management plan) to guide the revitalization of the community's designated waterfront area. During the first phase of designation, a community establishes its Waterfronts Florida Partnership, prepares a community-designed vision plan to guide the revitalization of the traditional working waterfront area, and begins implementation of the vision plan, as appropriate. The visioning process and resulting document identify the community's issues and their plans for addressing the following priority areas: public access to the waterfront, hazard mitigation, environmental and cultural resource protection, and enhancement of

the viable traditional economy or economic restructuring. During the second phase, the community continues to implement its vision plan, focusing on incorporating its vision into the comprehensive plan and undertaking priority projects that will further its efforts to revitalize and preserve the working waterfront. The public dialogue and the partnerships developed with state agencies, private organizations, and other Waterfronts Florida communities across the state enable a designated community to identify proactive solutions to address community concerns and to implement them. Designated communities along the IRL and within the IRLNEP IRL-Halifax planning boundary include Daytona Beach (Volusia County), Oak Hill (Volusia County), Old Eau Gallie (Brevard County), and Port Salerno (Martin County). In addition, the Stan Mayfield Working Waterfronts Florida Forever grant program was created by the 2008 Legislature and is administered by Florida Communities Trust. To fund the program, the Legislature provided 2.5% of the total Florida Forever program appropriation. In the IRL watershed, the City of Sebastian, Blue Crab Cove (also known as Griffis Landing) on Merritt Island, and Port Salerno in Martin County have received grants towards creating Working Waterfronts.[2]

**USEPA Environmental Justice Communities:** Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. The 25th anniversary of the creation of USEPA's Office of Environmental Justice occurred in 2017, and it is a testament to the USEPA's commitment to furthering environmental justice by addressing the environmental and public health concerns of minority, low-income, tribal, and indigenous communities. USEPA has developed an environmental justice mapping and screening tool called EJSCREEN, which is based on nationally consistent data and an approach that combines environmental and demographic indicators in maps and reports.[3] Data from this tool can be used to implement the CCMP actions. This CCMP revision incorporates aspects of environmental justice throughout each of the action plans, as water quality, habitat, and living resources seek to be preserved for all communities to enjoy. Furthermore, there are CCMP actions that call for access to the lagoon, so that all can enjoy the IRL as One Community, as well as actions to monitor and report the status of all areas of the IRL, which will allow all communities to speak and be heard with One Voice.

## STRATEGIES:

- Provide technical assistance and support to distinctive IRL communities to assist with vision plan implementation, incorporating vision objectives into local comprehensive plans, and supporting local priority projects that revitalize and sustain community health and welfare.
- Look for opportunities to redevelop viable waterfront areas to create livable waterfront communities.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Distinctive Communities-1: For, Urban Waters, ensure the high density human population is Lagoon-Friendly ™. (NEW)** | Maintain sustainable, Lagoon-Friendly ™, and economically viable urban waters areas. | IRLNEP | DEO, DEP | TBD | USEPA, DEP, economic development councils | Conduct, coordinate, and collaborate |
| **Distinctive Communities-2: For Working Waterfronts, coordinate with local communities to maintain the commercial use. (NEW)** | Promote working waterfronts and help enhance communities by providing economic, educational, recreational, social, and employment opportunities. | IRLNEP | DEO, DEP | TBD | USEPA, DEP, economic development councils | Conduct, coordinate, and collaborate |

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Distinctive Communities-3: For Environmental Justice Communities, identify the unique challenges and opportunities along the lagoon for underrepresented and underserved communities. (NEW)** | Provide support and information to underrepresented and underserved communities to promote being Lagoon-Friendly ™. | IRLNEP | DEO, DEP | TBD | USEPA, DEP, economic development councils | Conduct, coordinate and collaborate |

## OUTCOMES:

- **Short-term (1 – 2 years):** Identify and map the locations of each distinctive community and working waterfront.
- **Medium-term (3 – 4 years):** Support the development of community action plans.
- **Long-term (5 – 10+ years):** Promote and enhance the quality of life in the distinctive communities in a Lagoon-Friendly ™ manner.

## CHALLENGES TO SUCCESS:

- Funding for community cost-share projects to preserve and revitalize working waterfronts.
- Challenges to rethink and redefine a sustainable working waterfront.
- Resources to provide project funding and education for underrepresented and underserved communities.
- Limited access to the shoreline and other IRL resources for distinctive communities creates a lack of ownership.

## CITATIONS:


1. DEO. 2018. Website: http://www.floridajobs.org/community-planning-and-development/programs/community-planning-table-of-contents/waterfronts-florida-program.
2. Lampl Herbert Consultants. 2010. Linking Commercial Fishing to Land Use Planning: The Stan Mayfield Working Waterfronts Florida Forever Grant Program. Research conducted under a grant from Gulf & South Atlantic Fisheries Foundation, Inc.
3. USEPA. EJSCREEN: Environmental Justice Screening and Mapping Tool. Website: https://www.epa.gov/ejscreen.

# EMERGENCY PREPARATION AND RESPONSE

NASA

## Goals:

**Identify the role of the IRLNEP during emergencies and develop coordinated plans with partners to respond to emergencies.**

# ONE COMMUNITY

## HEALTHY COMMUNITIES

### *Emergency Preparation & Response*

**GOALS: Identify the role of the IRLNEP during emergencies that impact the IRL and its communities. Develop coordinated plans with IRLNEP Management Conference partners and responsible local, state, and federal entities to prepare, *RESPOND,* and *RECOVER* after an emergency in the IRL watershed.**

**ISSUE SUMMARY:** In recent years, several environmental incidents have occurred with the potential to significantly affect the IRL's environmental resources. These incidents include HABs, unusual mortality events, seasonal releases from Lake Okeechobee, frosts and freezes, discovery of aquatic invasive species in various areas of the IRL (Australian spotted jellyfish, green mussel, lion fish, and Charru mussel [*Mytella charruana*]), land- or water-based pollutant spills, vessel stranding and abandonment, fish kills, and hurricanes and major storm events. These events have the potential to alter the character and biodiversity of the IRL's ecosystem and potentially impact the health and safety of people and their communities.

Most pollutant spills—oil, hazardous materials, wastewater—have an established notification and regulatory response that involves contacting the DEP Office of Emergency Response.[1] Other teams are established to respond to marine mammal and sea turtle strandings.[2] A hotline has been implemented for response to fish kills and algal blooms; however, emergency assessment for many other categories of environmental incidents is largely organized on an *ad hoc* basis.


To address the issue, an IRLNEP incident risk assessment and response workshop is proposed to discuss potential incident risks, identify key agency roles and responsibilities, develop a communication strategy, and define the IRLNEP role in providing emergency preparation, response, and recovery support to its Management Conference and community partners.

## STRATEGIES:

- Identify ways for the IRLNEP to aid and support in preparation for, response to, and recovery from emergency situations in the IRL to help understand the potential problems, identify key partners, gather resources and funding mechanism(s), and be a conduit for communication and consistency throughout the lagoon.
- Share an inventory of classes of incidents and events that could impact water and habitat quality or human health, safety, and welfare in the IRL to develop responses, as necessary, to *REDUCE* risks or *RESPOND* to events effectively and efficiently.
- Identify a pre-disaster emergency response and coordination plan, hazard mitigations, and a succession plan for continuity of operations.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Emergency-1: Evaluate the role and ability of the IRLNEP to assist local communities and emergency management agencies in times of emergencies that impact the IRL. (NEW)** | *REPORT* on the role of the IRLNEP in emergency planning and response. | IRLNEP Management Conference | Federal, state and local emergency planning and response agencies. | IRLNEP staff time | IRLNEP | Conduct, collaborate, and communicate |

## OUTCOMES:

- **Short-term (1 – 2 years):** Coordinate with partners and other NEPs about the role of IRLNEP in emergency management and develop a report with the IRLNEP's role.
- **Medium-term (3 – 4 years):** Coordinate with partners to quickly and efficiently *RESPOND* to emergencies in accordance with defined emergency response roles.
- **Long-term (5 – 10+ years):** Continue to assess and modify the plan to best address emergencies that arise.

## CHALLENGES TO SUCCESS:

- Coordination and communication among multiple agencies and organizations during an emergency.
- Limited staff and financial capacity of the IRLNEP.

## CITATIONS:

1. DEP State Office of Emergency Response. 2018. Website: https://floridadep.gov/OER.
2. FWC. 2018 Website: http://www.myfwc.com/seaturtle/.

# MONITORING AND DATA SHARING

Atkins

## Goals:

**Coordinate and integrate monitoring, data sharing, and mapping efforts throughout the IRL. Identify gaps and evaluate trends.**

# ONE VOICE

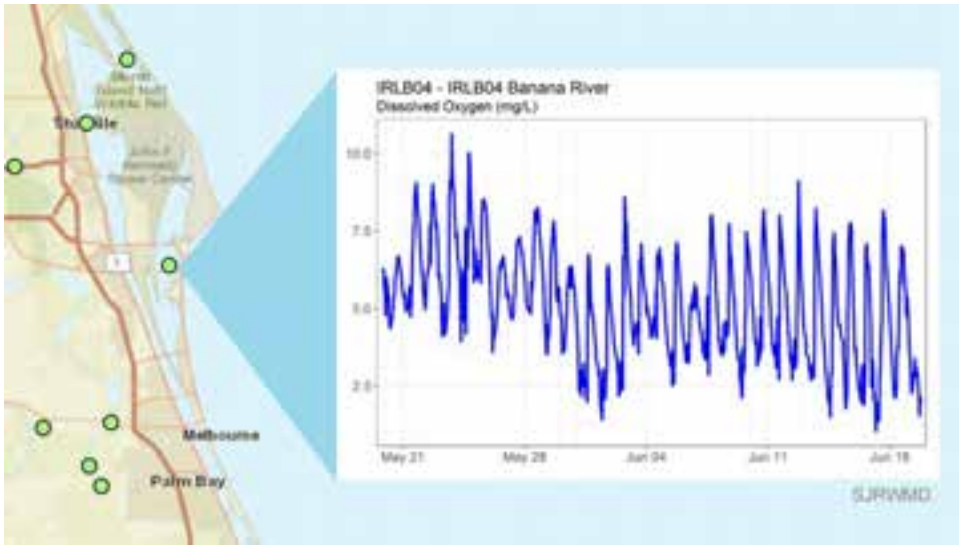
## COMMUNICATE – COLLABORATE – COORDINATE

### *Monitoring and Data Sharing*

**GOALS: Coordinate IRL monitoring, data sharing, and mapping throughout the IRL and its watershed. *RESPOND* to gaps in monitoring and data collection and the need to evaluate trends and changes. *REPORT* the shared findings from the IRL monitoring network to inform IRL partners and stakeholders about status and trends related to the health of the IRL.**

**ISSUE SUMMARY:** Monitoring the sediment, water quality, and biological resources of the IRL is important not only to determine the current condition of the estuary but also to ascertain the effectiveness of restoration. Having adequate and reliable data allows standards to be established and provides a framework for future comparisons. Monitoring networks must be in place and maintained before critical changes occur to the lagoon if we are to understand why and how the changes occurred. Mapping and GIS tools are a powerful way to convey these data quickly, and modeling can be used to evaluate future monitoring locations and parameters. Information gleaned from mapping and GIS evaluations should then be used to identify innovative technologies to address existing and newly identified problems, such as climate change impacts on the IRL. For these reasons, it is important to regularly monitor the conditions and resources of the IRL and evaluate these data.

Concerned citizens and agencies alike monitor the lagoon's water quality. A long-term comprehensive, coordinated network was established by the IRL Surface Water Improvement and Management (SWIM) Program in 1989,[1] including participants from Volusia, Brevard, and Indian River Counties; DEP; NASA; SFWMD; and SJRWMD. MRC, in partnership with DEP, established the IRL Watch Water Quality Monitoring Program in 1989.[2] The network consists of more than 90 stations located throughout the IRL that are monitored on a weekly basis. MRC and FIT are also under contract with Brevard County to probe the lagoon to identify the presence and depths of muck on the IRL floor. Many of the same entities involved in the IRL SWIM monitoring network also monitor or study the biological resources of the lagoon. Fixed seagrass transects located throughout the lagoon are monitored by SJRWMD, SFWMD, and partners to assess the health and extent of the seagrass community. Seagrasses in the IRL are mapped every two to three years through aerial photography to determine current seagrass extent and document any changes that occurred in the period between map developments. Several organizations, such as the University of Central Florida and the Brevard Zoo,[3] are contracted by Brevard County to monitor oyster survival and recruitment from restoration efforts. In the Southern IRL and St. Lucie River, the CERP Restoration Coordination and Verification Program has been monitoring oysters and benthic infauna on a regular basis since 2005.




Throughout the IRL watershed are numerous educational and research institutions that contribute to the body of scientific knowledge concerning the lagoon. Universities, such as FIT,

University of Central Florida, Florida Atlantic University, Stetson University, Bethune-Cookman University, University of Florida, and others conduct faculty and student research and monitoring. Research entities, such as Harbor Branch Oceanographic Institute, Smithsonian Marine Station, and ORCA, conduct ongoing research and monitoring.

This CCMP revision promotes scientific integrity, honesty, objectivity, and accountability, and it integrates science with the social, economic, and education needs and values of the community. Achieving these goals will be dependent upon the development of a coordinated, integrated, and well-managed IRL field research site network with access and support for facilities. It will be important to create central data repositories to ensure all data are coordinated and provided in a specific format. Existing databases, such as the Watershed Information Network maintained by DEP, water quality and environmental data maintained by SJRWMD, and DBHYDRO maintained by SFWMD can be used.

## STRATEGIES:

- Provide monitoring of the IRL and evaluate the data through maps and models to validate ongoing projects and identify potential problems and sources of problems in the IRL.
- Provide a consistent, long-term funding source to maintain the necessary monitoring network.
- Effect change in plans and practices through collection, analysis, and interpretation of data.
- Increase muck monitoring and mapping to better understand the amount and locations of muck and the potential for nutrient release to the water column, as well as turbidity caused by muck resuspension.
- Continue monitoring of biological resources, such as seagrasses and oysters, to evaluate the impacts of restoration.
- Provide funding and support for science symposia, outreach, technology transfer, workshops, and events.
- Consolidate data on a regular basis and in a standardized format into more user-friendly platforms using GIS, Environmental Visualization Software, Tableau, and other modeling and data management tools.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Monitoring 1: Develop a comprehensive IRL monitoring plan. (NEW)** | Evaluate roles and responsibilities and identify gaps, opportunities, and challenges to delivering a comprehensive monitoring network. | IRLNEP | IRLNEP Management Conference partners | $50,000 | USEPA Section 320 funds | Conduct, coordinate, and collaborate |
| **Monitoring-2: Monitor IRL indicators at appropriate spatial and temporal scales to understand the status and trends associated with key indicators of the system's health. (NEW)** | Obtain appropriate data to better understand the status and trends for key indicators. | IRLNEP Management Conference | 90+ partners including SJRWMD, SFWMD, DEP, MRC, Smithsonian Institute, ORCA, Harbor Branch Oceanographic Institute, interest groups, local governments | A minimum of $100,000 annually to coordinate and have a reserve for emergency monitoring need; additional $75,000–$100,000 if expanding the atmospheric monitoring station network. | IRLNEP Section 320 annual funding, partner support and grants | Coordinate and collaborate |

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Montioring-3: Support expansion of and adequate funding for the IRL Citizens Water Quality Monitoring Program.** | Data quality control, standardized methodology, and integration of data into IRL health status evaluations. | IRLNEP Management Conference | 90+ water quality monitoring and data user partners, MRC, Florida Oceanographic Society, Marine Discovery Center, Brevard Zoo, Counties, Water Control Districts | Included in Monitoring-2 | IRLNEP Section 320 annual funding, partner support and grants | Coordinate and collaborate |
| **Monitoring-4: Identify, develop, and apply next-generation smart sensors, remote sensing technologies, big data analytics, and surveillance components to monitor and deliver an IRL water quality dashboard in real time. (NEW)** | Create an IRL water quality dashboard. | IRLNEP Management Conference | ORCA, Harris Corporation, Embry-Riddle Aeronautical University, NOAA, academia, Cardinal Systems, HydroPlus Engineering, robotics groups | TBD | TBD | Coordinate and collaborate |
| **Monitoring-5: Advance the 10 scientific *RESEARCH* priorities identified by the STEMAC in the 2018 *Looking Ahead – Science 2030 Report*. Work with IRL partners to seek funding to implement priority *RESEARCH* projects within the 10 priorities. (NEW)** | Provide an annual update on how the 10 *RESEARCH* priorities were advanced and revise priorities as needed. | IRLNEP Management Conference | Agencies, academia, interest groups | TBD based on research needed for 10 priorities | Agencies, local governments | Coordinate and collaborate |

## OUTCOMES:

- **Short-term (1 – 2 years):** Evaluate existing monitoring projects and programs to ensure long-term viability of existing monitoring networks and prepare a monitoring plan that identifies responsible entities, gaps, and potential funding sources. Assemble issue-specific task forces to identify *RESEARCH* projects, responsible entities, and funding sources for each of the ten priorities identified by the STEMAC in the *Looking Ahead – Science 2030 Report*.
- **Medium-term (3 – 4 years):** Implement identified changes to the monitoring network. Add a monitoring requirement for projects funded through the IRLNEP, as appropriate. Begin implementation of *RESEARCH* projects for the ten priorities identified by the STEMAC in the *Looking Ahead – Science 2030 Report*.
- **Long-term (5 – 10+ years):** Create a real-time database and conduct real-time modeling to distribute available data to a larger group and understand what is happening and predict what will happen in the near- and long-term in the IRL. Complete the *RESEARCH* projects and incorporate findings into the next CCMP revision and into management of the IRL's resources.

## CHALLENGES TO SUCCESS:

- Money tends to be available for "shovel-ready projects" that can provide a more tangible benefit than data. Sediment, water quality, and biological data collected through monitoring provide the information required to evaluate what is happening, what needs to change, and what has changed because of actions.

A value needs to be placed on the data that provides efficiency and validity to projects and the dollars that fund them.

- Various entities collect data in the IRL system, and these efforts need to remain coordinated and collaborative so that they are efficient and effective. In addition, the increased concern about the health of the IRL system offers an opportunity to convey useful and actionable information in more effective ways to raise the level of coordination and integration of data to better *RESTORE* and sustain the health of the IRL.

## CITATIONS:

1. SJRWMD and SFWMD. 1989. Surface Water Improvement and Management (SWIM) Plan for Indian River Lagoon.
2. MRC. 2018. http://www.mrcirl.org/our-programs/indian-river-lagoonwatch.
3. Brevard Zoo. 2018. Restore Our Shores Program. https://restoreourshores.org/.

# STATE OF THE LAGOON


## Goals:

**Develop a "State of the Lagoon" Technical Report that addresses ecosystem status, stressors, trends, and emerging concerns.**


# ONE VOICE

## Communicate – Collaborate – Coordinate

## *State of the Lagoon*

**GOALS: Collect, synthesize, and analyze IRL data and *RESEARCH* findings to develop a "State of the Lagoon Technical Report" that addresses the health of the IRL, ecosystem stressors, indicators, and trends. *REPORT* the findings. Apply the findings to advise CCMP updates and revisions.**

**ISSUE SUMMARY:** One requirement of the Clean Water Act is to assess trends in water quality, natural resources, and uses of the estuary.[1] To meet this objective and to comply with USEPA core performance measures for NEPs regarding the reporting of ecosystem status and trends,[2] the IRLNEP will bring together Management Conference partners, including the IRL Science and Management Working Group, as well as other practitioners from universities, organizations, and agencies to develop a "State of the Lagoon Technical Report" in advance of ten-year CCMP revisions. The report will present and track appropriate IRL indicators and Vital Signs to evaluate key stressors to the IRL and its watershed; assess chemical, physical, and biological conditions; describe past and current trends; look ahead to potential future changes; and identify data and research essential to advancing understanding of changes and emerging issues.

## STRATEGIES:

- Create an IRL technical task force and fund the activities of the technical task force to develop a "State of the Lagoon Technical Report" with a target delivery date of 2025. That technical report will serve as the scientific foundation for advising the next revision of the CCMP due in 2030.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **State of the IRL-1: Provide support for a "State of the Lagoon Technical Report" to be released every ten years. (NEW)** | Produce a "State of the Lagoon Technical Report" in advance of 5-year CCMP updates and 10-year revisions. | IRLNEP Management Conference | Universities, organizations, and agencies | $450,000 (funded over 4 years) | IRLNEP and Management Conference | Conduct, coordinate, and collaborate |

## OUTCOMES:

- **Short-term (1 – 2 years):** Identify and *RESOLVE* data gaps and monitoring needs required to conduct effective ecosystem health analyses. Build a multi-disciplinary scientific and technical task force willing and able to implement and coordinate report development. Begin report development.
- **Medium-term (3 – 4 years):** Present a draft report for Management Conference review.
- **Long-term (5 – 10+ years):** Finalize report and publicly rollout report in conjunction with an IRLNEP Scientific Summit or Florida Atlantic University/Harbor Branch Oceanographic Institute IRL Science Symposium. Prepare an update to the "State of the Lagoon Technical Report" every ten years in advance of CCMP revisions.

## CHALLENGES TO SUCCESS:

- Gaps in monitoring and data make indicator identification and analysis challenging and sometimes impossible.
- Long-term studies with large data sets that have not been published in peer-reviewed journals may be difficult to access for use and analysis.
- Large trans-disciplinary teams and multi-agency partnerships face challenges in coordination, cooperation, and communication.
- Multi-year funding to support the comprehensive work needed to develop a strong science-based report based on leading-edge scientific knowledge.

## CITATIONS:

1. Federal Water Pollution and Control Act, as Amended through P.L. 107–303, November 27, 2002. 234 P. https://www.epa.gov/sites/production/files/2017-08/documents/federal-water-pollution-control-act-508full.pdf.
2. USEPA. 2016. National Estuary Program – Program Evaluation Guidance. https://www.epa.gov/sites/production/files/2015-09/documents/2011-final-nep-pe-guidance.pdf.

# TECHNOLOGY INNOVATION


## Goals:

**Research innovative technologies and emerging commercial opportunities that could assist in IRL restoration and stewardship.**

# ONE VOICE

## Communicate – Collaborate – Coordinate

### *Technology Innovation*

**GOALS:** ***RESEARCH*** **innovative technologies and emergence of commercial opportunities that will assist with restoration and stewardship of the IRL.** ***REPORT*** **findings.** ***RESPOND*** **to industry needs and desires to communicate more effectively with IRL partners. Work with industry and economic development partners to position Florida and the IRL region as a leader in clean water innovation, research, and technology development.**


**ISSUE SUMMARY:** Clean water is essential for the environment, industry, society, and individuals to survive and thrive. As coastal populations grow and existing water infrastructure ages and becomes inadequate, four areas of water innovation are needed: (1) talent, (2) technology, (3) infrastructure, and (4) investment.[1] The development and deployment of innovative technologies and processes; new applications of existing technology; production changes; and organizational, management, and cultural changes can improve the condition and sustainability of the IRL water resources.[2]

The fragmented framework governing the water sector in Florida and throughout the United States constrains innovation and commercialization by creating barriers to entry and reducing the viability and economic value of private-sector market development. During the highly publicized 2016 algal blooms and fish mortality events in the IRL, dozens of small business and technology companies approached the IRLNEP with innovative technology solution proposals. All discussed multiple challenges to market entry and commercial success, which included no central point for market entry, risk aversion by public agencies, distrust of for-profit companies, regulation and permit challenges, lack of financial support for pilot projects, lack of private-sector investment capital, and complex/slow governmental processes that eroded return on investment. For many of these corporate interests, quantitative data on performance and proof of efficacy were also lacking for one or several critical criteria, including effectiveness; efficiency; ability to scale; environmental safety; sustainability; capital, operational, and maintenance costs; and life-cycle costs compared to traditional and proven approaches.

**STRATEGIES:**

- Provide an objective and easy to access industry and technology directory on the IRLNEP website for existing and emerging water quality restoration, habitat restoration, and water quality monitoring technologies.
- Create a technology review panel to evaluate proposals received for new technologies.
- Develop a white paper on technological opportunities related to water and industry cluster (geographic concentration of interconnected institutions in a particular field) development for the IRL region.[3] Work with the FIT IRL Research Institute to expand its annual technical conference. Work with the Economic Development Commission of the Space Coast, DEO, and clean technology sector partners to promote *RESEARCH*, development, and commercialization of technologies related to water.
- Launch the IRLNEP water technology directory on the www.onelagoon.org website and update the directory on a regular basis.
- Advance an incubator program in partnership with Groundswell Startups and other interested partners to help commercialize the most promising technological opportunities that need pilot funding and third-party monitoring to move from the lab and bench-scale experiments to field applications.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Technology Innovation-1: Work with IRLNEP IRLI[2], industry leaders, economic development organizations, and startup incubators/accelerators to help drive IRL regional economic, technology, and talent development. (NEW)** | Support development of an IRL region and Florida water technology industry cluster. | IRLNEP Management Conference | FIT IRL Tech-Con, industry incubators, economic development organizations, DEO, USEPA | IRLNEP event sponsorship ($5,000–$10,000 annually) | IRLNEP, public- and private-sector sponsors | Conduct, coordinate, and collaborate |
| **Technology Innovation-2: Continue to support and develop a water technology directory for the www.onelagoon.org website. (NEW)** | Share technology knowledge and industry contacts with IRL resource managers and Association of NEPs. | IRLNEP Management Conference | Private-sector industry willing to submit directory information | IRLNEP staff time, possible student internships, estimated at < $5,000 annually | IRLNEP | Conduct, coordinate, and collaborate |
| **Technology Innovation-3: Evaluate options for a regular, sustainable, and cost-effective water quality monitoring network using autonomous sampling. (NEW)** | Evaluate and communicate about emerging monitoring technologies. | IRLNEP Management Conference | Embry-Riddle Aeronautical University, NOAA, academia, Cardinal Systems, HydroPlus Engineering, robotics interest groups | IRLNEP staff time (< $10,000 annually = 10% of Executive Director time) | Grants, National Science Foundation, NOAA, NASA, Office of Naval Research | Coordinate and collaborate |

## OUTCOME:

- **Short-term (1 – 2 years):** Launch the IRLNEP technology directory on www.onelagoon.org.
- **Medium-term (3 – 4 years):** Deliver a Florida water technology conference in the IRL region with partners from industry, academia, and state/regional economic development agencies.
- **Long-term (5 – 10+ years):** Build the IRL regional reputation as an industry cluster for technology, innovation and excellence related to water.

## CHALLENGES TO SUCCESS:

- Funding to evaluate and implement new technologies to improve water quality and to better understand the IRL system.
- Building industry and market trust in the IRLNEP directory.
- Providing third-party verified quantifiable value to IRL partners and industry partners.

## CITATIONS:

1. U.S. Council on Competitiveness. 2016. Leverage. Phase I Sector Study: Water and Manufacturing. 36p.
2. USEPA. 2018. Promoting Technology Innovations for Clean and Safe Water - Water Technology Innovation. https://www.epa.gov/sites/production/files/2014-04/documents/clean_water_blueprint_final.pdf.
3. De Freese, D. and Coffee, R. 2018. Viewpoint: Opportunities for Clean Water Technology and Innovation. IRLNEP White Paper in development.

# CCMP IMPLEMENTATION AND FINANCING


## Goals:

**Work with IRL partners to implement the CCMP. Fund projects and programs that restore the IRL to health.**


# ONE VOICE

## Communicate – Collaborate – Coordinate

### *CCMP Implementation and Financing*

**GOALS: IRL communities, partners, and citizens work in cooperation to align their individual and collective interests and actions to take *RESPONSIBILITY* to achieve the "One Lagoon – One Community – One Voice" Mission. Identify, fund, and implement CCMP projects and actions to *RESTORE* the IRL. Align CCMP activities to provide enhanced *RESILIENCE* for the IRL and its human communities.**

**ISSUE SUMMARY:** The IRLNEP is the only IRL organization with the responsibility to develop a long-term, watershed-based, non-regulatory, and community-driven CCMP for the IRL and to work with partners to implement the plan.[1,2]

For IRL ecosystem restoration and management to deliver on multiple environmental, infrastructure, and societal targets (i.e., water quality, habitat improvement, economic vitality, community resilience, and quality of life), the process of restoration and management must create a lagoon-wide, unified, and scale-dependent approach that applies and integrates the best available natural and social sciences to resource management with full participation, engagement, and support of IRL citizens, community leaders, scientists, resource managers, and policy makers.

For this CCMP to be successful, there is a need for stable, recurring funding to implement the actions, projects, research, monitoring, and reporting included in this plan. Without additional funding, the existing annual funding from the IRLNEP Management Conference plus the funding available to local entities is insufficient to achieve restoration at the scale and timeline needed for the IRL system to recover. Identifying additional source(s) of funding will be key to implementing the actions in this plan.

**STRATEGIES:**

- Implement and communicate the "One Lagoon – One Community – One Voice" mission as a foundation for building local, state, and federal support for IRL restoration and management with participation from the public, private, and independent sectors throughout the IRL region.
- Complete the CCMP revision in fiscal year 2018-2019. IRL Council formally adopts the CCMP revision after USEPA review and certification in early 2019.
- Fine tune CCMP targets and indicators as necessary, track performance, and communicate progress.
- Continue to identify and secure expanded and expedited cost-share funding for CCMP project implementation throughout the IRL watershed.
- Work with funding partners and investors to secure dedicated matching funds at a level commensurate with the needs of the IRL.
- Seek opportunities for funding IRL restoration through sources such as the Water and Land Legacy Amendment (often referred to as Amendment 1).
- Increase federal funding for each of the 28 NEPs authorized by Section 320 of the Clean Water Act with a goal of $1 million annual base funding per NEP to implement CCMP restoration actions.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Actions | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Implementation-1: Develop a finance plan for CCMP development and implementation, project and program funding, and program delivery with a focus on restoration, scientific *RESEARCH*, monitoring, and citizen engagement. (NEW)** | Deliver all USEPA performance measures representative of an "excellent" performing NEP. | IRLNEP Management Conference | Local IRL partners, federal partners, private-sector investors, and industry partners from tourism, real estate development, and other clean water-dependent industries | $2.1 million minimum base funding for IRLNEP pursuant to the 2015 IRL Council Interlocal Agreement, as amended from time to time; full CCMP project implementation is estimated at $1.5 billion | **Annual Funding**: USEPA ($600,000), SJRWMD ($500,000), SFWMD ($500,000), DEP ($250,000), Volusia County ($50,000), Brevard County ($50,000), Indian River County ($50,000), St. Lucie County ($50,000), Martin County ($50,000), IRL license plate ($125,000)<br>**Project Funding**: Priority need is a stable, recurring funding source for local-state cost-share projects | Conduct, coordinate, and collaborate |

## OUTCOMES:

- **Short-term (1 – 2 years):** Secure and expand funding that accelerates implementation of CCMP priority activities and partners' projects to include, but not be limited to, expanded IRL Council base annual funding and expanded local, state, and federal cost-share funding. All IRL partners and stakeholders are investing time, talent, and/or funds to fulfill CCMP actions to *RESTORE* and manage the IRL.
- **Medium-term (3 – 4 years):** Expansion of strategic partnerships and expansion/diversification of funding opportunities to implement priority projects and programs. IRL region is unified in its support of the CCMP for IRL restoration and stewardship.
- **Long-term (5 – 10+ years):** Document improvements in water quality and natural habitat improvements in the IRL based on Vital Signs and science-based indicators. Evaluate the return on investment for management practices implemented.

## CHALLENGES TO SUCCESS:

- Overcoming stakeholder's narrow spatial and short-term temporal perspectives to embrace "One Lagoon – One Community – One Voice" as a shared regional, statewide and national identity.
- Availability of adequate, stable recurring funding for effective, efficient, and timely program and project implementation.

# CITATIONS:

1. IRLNEP Management Conference governance model (www.onelagoon.org).
2. Clean Water Act. 40 Code of Federal Regulations 320 – of the Clean Water Act, as amended. https://www.gpo.gov/fdsys/granule/CFR-2002-title40-vol1/CFR-2002-title40-vol1-part35-subpart320.

# CITIZEN ENGAGEMENT AND EDUCATION

Florida Oceanographic Society

## Goals:

**Engage and educate the public about lagoon restoration.**
**Provide hands-on stewardship opportunities.**

# ONE VOICE

## COMMUNICATE – COLLABORATE – COORDINATE

### *Citizen Engagement and Education*

**GOALS:** ***REPORT*** **on needs and progress and educate and engage the public on the need to** ***RESTORE*** **and manage the IRL's natural resources.** ***RESPOND*** **to opportunities to fund and implement "hands on" opportunities for citizen engagement that promote and produce well-informed citizens and communities that become IRL ambassadors for Lagoon-Friendly ™ behaviors.** ***REBUILD*** **community-lagoon connections that promote the identity, well-being, and unique qualities of IRL communities.**

**ISSUE SUMMARY:** The recent fish mortality events and algal blooms have brought national attention to the IRL and highlighted a need to increase restoration activities. Federal, state, and local agencies charged with management of the lagoon's resources, as well as environmental groups, are working towards restoration, which includes actively seeking to educate and involve the public in the protection and enhancement of the estuary and its resources.

A key event in public involvement and education in the IRL region was the passage of the SWIM Act by the Florida Legislature in 1987. This legislation not only included the IRL in the SWIM program as a priority waterbody of state concern but also mandated a program to involve and educate the public about efforts to protect and restore SWIM waterbodies. The IRL SWIM public involvement and education efforts were coordinated by SJRWMD and SFWMD. In 1991, the IRLNEP was established. As the IRLNEP goals of citizen involvement and education are closely related to those of the SWIM program, IRLNEP joined the IRL SWIM program in their public involvement and education. Following the adoption of the IRL CCMP in 1996, the IRLNEP and IRL SWIM programs were merged to continue the implementation of public involvement and education efforts.

Maintaining and nurturing public interest and involvement in the protection and preservation of the IRL and its resources requires a substantial investment of money, time, and effort. These efforts must continue beyond the initial CCMP development and adoption phase to continue to promote implementation of CCMP actions. Several studies have been completed to evaluate the effectiveness of public education and outreach campaigns in the IRL watershed. One study conducted in the IRL found that physical and virtual field trips both promoted learning about the area.[1] In 2012, Good Education Solutions, under contract with Brevard County and nine of its municipalities, and in partnership with Keep Brevard Beautiful followed by partnership with the Brevard Zoo, created a public education campaign called "Blue Life."[2] The purpose of this campaign is to provide information to the public about sources of pollution and what lifestyle choices people can make to protect and improve water quality. To determine the effectiveness of this educational campaign on behavior changes, Brevard County contracted with Praecipio Economics Finance Statistics to conduct a survey before the campaign implementation in 2012 and after the campaign was in place for two years in 2015. When comparing the results from the 2012 and 2015 surveys, the study unambiguously showed that people in 2015 were better informed about stormwater issues than in 2012, and that behavior that affects water quality in the area has, in general, improved.[3]

In addition to the Blue Life education program, the Be Floridian Now program educates the public along the IRL and is the east coast version of the Be Floridian Program from the Tampa Bay Estuary Program.[4] This program was started in 2015 and focused on matching the right plants to the right places, using water wisely, and reducing or eliminating fertilizers and pesticides. Indian River County, Martin County, St. Lucie County, and Volusia County, as well as the City of Port St. Lucie, City of Stuart, City of Fort Pierce, and Town of Sewell's Point, participate in this program, which is coordinated by MRC.

The IRLNEP also recently launched the Lagoon-Friendly ™ education campaign to promote the "One Lagoon – One Community – One Voice" mission. This campaign promotes actions associated with landscaping, such as determining whether additional fertilizers or pesticides are needed, following package directions and using the proper amounts for the area being treated, spot-treating problem areas with pesticides rather than spreading them over the entire yard, using slow-release fertilizers and less toxic pest controls, using native plants in landscaping, and leaving a five-foot buffer zone around ponds free from fertilizers and pesticides. This campaign also includes actions for good housekeeping, including keeping trash, pet waste, and yard waste out of storm drains; taking waste motor oil, antifreeze, paint, or other hazardous household chemicals to proper collection sites; washing cars in a carwash rather than in a driveway; and repairing cars with oil leaks. In addition, this campaign includes clean boating practices, such as maintaining boat engines to prevent leaking of oils and fuels into the lagoon, keeping trash secured onboard and disposing of it properly on land, operating boats at speeds that protect wildlife and seagrasses and preventing shoreline erosion, and using MSDs properly and designated pump-out facilities instead of dumping untreated wastes overboard.

Engaging citizens in data collection and restoration enhances their understanding of lagoon threats and opportunities for improvement. MRC engages citizens in water quality monitoring. The Florida Institute of Oceanography engages the public in oyster restoration. Brevard County has invested in local not-for-profit organizations to build their capacity for engaging the public in citizen science. This investment includes initiating and funding a diverse array of programs, such as oyster gardening and oyster restoration on projects through Brevard Zoo, rain barrel workshops coordinated by MRC, muck finders training and field data collection guided by FIT and coordinated by MRC, and muck toxicity measurement coordinated by MRC and guided by ORCA. Brevard County continues to look for ways to engage the public in meaningful citizen science coordinated by grass roots, non-profit organizations.

Martin County and UF-IFAS Sea Grant Extension have partnered to implement the Water Ambassador training program. The purpose of this program is to increase awareness and foster behavioral changes related to the reduced use of fertilizer and pesticides. The program provides interested citizens with information on lagoon-friendly practices. Participants learn about Florida's drainage history, the nine principals of Florida Friendly landscaping, estuary friendly living, how/why to reduce stormwater in runoff from the homeowner's property, and the Martin County fertilizer ordinance. The goal of the program is to create Water Ambassadors, who take on the role of educator and activist within the community to help spread information on reducing pollutants in runoff and protecting local waterways.

Local conservation organizations and environmental education facilities are an important part of engaging the public to learn more about the lagoon and to participate in local restoration projects and citizen science. Examples include the Lagoon Academy, "shuck and share" oyster restoration projects, Audubon Advocates for the IRL, and "lagoon watch" citizen science program. Local facilities, such as the Marine Discovery Center in New Smyrna Beach, Brevard Zoo, MRC, Harbor Branch Oceanographic Institute, and Environmental Learning Center, promote environmental education, engage citizens, and promote citizen science.

New and important partners are emerging throughout the IRL region with strong interest in enhancing citizen knowledge, engagement, and behavior change. Recent changes in Florida Statutes in 2018 provided expanded flexibility in how tourist development taxes can be spent. In response, the Brevard County Tourist Development Council announced the availability of up to $900,000 in annual grant funds for projects that demonstrate a benefit to the health of the IRL and a positive impact to Brevard County tourism.

## STRATEGIES:

- Educate and engage the public about the challenges that the natural resources in the IRL face and what they can do to *RESTORE* and protect these resources.
- Implement additional surveys to determine which portions of the education campaigns are working and where changes need to be made in the messaging.
- Communicate a clear and unified message for IRL restoration that is compelling, factually accurate, and easy for the public to understand and embrace.

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Communicate-1: Facilitate implementation of the IRL CCMP consistent with "One Lagoon – One Community – One Voice" mission. (NEW)** | Fund and implement CCMP citizen science engagement projects. | IRLNEP Management Conference | DEP, FWC, Sea Grant, local governments, interest groups | IRLNEP staff time | IRLNEP | Conduct, coordinate, and collaborate |
| **Communicate-2: Develop and implement an IRLNEP multi-year Communication Plan.** | Develop a Communication Plan pursuant to USEPA NEP performance measures. | IRLNEP Management Conference | IRLNEP Management Conference partners | $150,000 per year | USEPA Section 320 funding; local, state, and federal funds; grants; private-sector support | Conduct, coordinate, and collaborate |
| **Communicate-3: Implement public education programs including the "One Community – One Voice" initiative to promote community place-based identities and Lagoon-Friendly ™ behaviors. (NEW)** | Develop and apply performance metrics to measure behavior change. | IRLNEP Management Conference | Local governments, interest groups | $50,000 per year | USEPA Section 320 funding; local, state, and federal funds; grants; private-sector support | Conduct, coordinate, and collaborate |

## OUTCOMES:

- **Short-term (1 – 2 years):** Provide support for existing education campaigns and ensure a clear and consistent message is provided throughout the IRL system. Incorporate the "One Lagoon – One Community – One Voice" mission into the education messaging.
- **Medium-term (3 – 4 years):** Increase public, private, and independent sector participation and involvement in Lagoon-Friendly ™ activities.
- **Long-term (5 – 10+ years):** Lagoon-Friendly ™ practices are consistently applied throughout the IRL watershed.

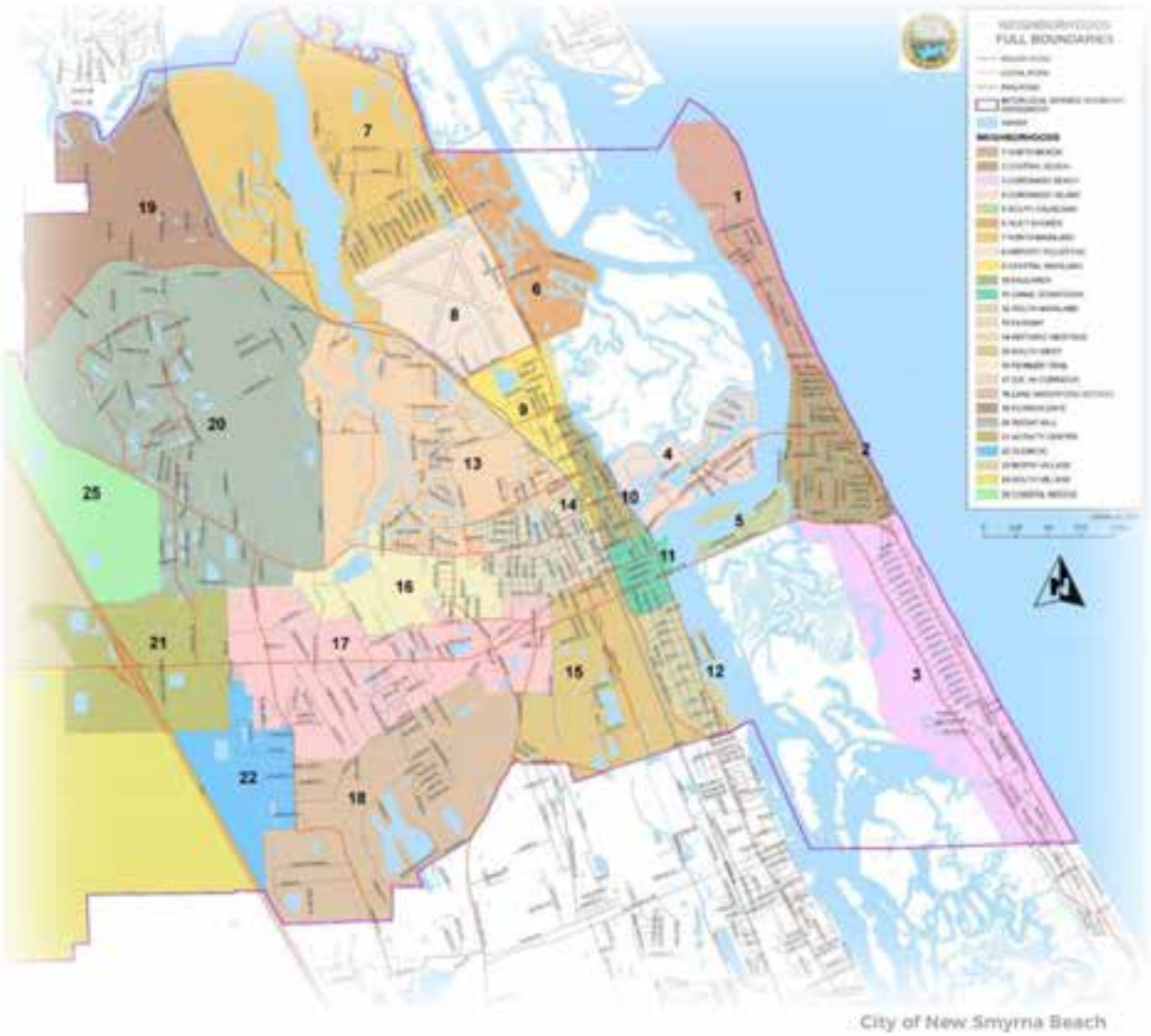
## CHALLENGES TO SUCCESS:

- Availability of funds to increase education, outreach, and engagement, and to evaluate existing programs to determine where modifications are needed.
- Delivering information effectively and in a way that will result in behavior changes and measuring those changes.
- Individuals desire for a sod only lawn may prevent them from implementing practices that would help to improve the IRL.

## CITATIONS:

1. Garner, L.C. and Gallo, M.A. 2005. Field Trips and their Effect on Student Achievement and Attitudes: A Comparison of Physical Versus Virtual Field Trips to the IRL. Journal of College Science Teaching.
2. Blue Life Florida. 2018. https://brevardzoo.org/conservation-programs/blue-life-florida/.
3. Praecipio Economics Finance Statistics. 2016. The Blue Life Campaign and its Impact on Stormwater-Related Knowledge, Familiarity, Information and Behavior: Evidence from a Survey-Based Analysis of Brevard County Residents (2012 & 2015). Prepared for Brevard County.
4. Be Floridian Now. 2018. http://befloridiannow.org/.

# POLICY OPPORTUNITIES




City of New Smyrna Beach

## Goals:

**Align the CCMP to local comprehensive plans and evaluate state and federal policies to determine opportunities to implement the CCMP.**


# ONE VOICE

## COMMUNICATE – COLLABORATE – COORDINATE

### *Federal, State, and Local Policy Opportunities*

**GOALS: Identify opportunities to align the CCMP with local comprehensive plans and land development regulations to more effectively *RESTORE* the IRL. Evaluate state and federal policies that may impact the ability to implement the CCMP actions and coordinate with agencies to determine policy opportunities moving forward. *RESPOND* to policy changes and new policy opportunities. *REPORT* policy best practices and success stories.**

**ISSUE SUMMARY:** While local comprehensive plans[1,2,3,4,5] are critical big-picture blueprints that set the direction for a community's growth, a diverse suite of tools, including land development regulations, guidance manuals, and codes of ordinances, are vital to implementing the broader vision. Enhanced restoration and protection could be achieved by incorporating CCMP actions directly into these existing planning tools. This CCMP revision provides multiple areas in which concrete, actionable guidance could be incorporated into both comprehensive plans and land development regulations. The IRLNEP can work with local governments to (1) prioritize CCMP actions that are suitable for inclusion in local government comprehensive plans, land development regulations, or other guidance documents; (2) identify relevant elements, goals, objectives, and policies in local government regulatory frameworks to serve as the most appropriate vehicle for incorporating CCMP priority actions; and (3) provide model language based on CCMP goals and actions for local government consideration.

At the state and federal level, policy decisions can have profound effects on resource management and restoration decisions, funding appropriations, and inter-agency coordination and cooperation. At the state level, continued implementation, regulatory oversight, and refinement of TMDLs, BMAPs, and water quality/land use regulations is essential for continued statewide water quality restoration. At the federal level, continued reauthorization of the Clean Water Act and the NEP are central to the IRLNEP restoration mission. Reauthorization of the Water Resources Development Act is essential to Everglades and southern IRL restoration. Authorization laws establish, continue, or modify federal programs, and they are often a prerequisite under House and Senate rules (and sometimes under statute) for Congress to appropriate budget authority for programs.

A broad range of state and federal agencies and programs have an impact on the lagoon and will be important to efforts to restore it. USACE and the Florida Inland Navigation District are responsible for maintaining the Atlantic Intracoastal Waterway which stretches the entire length of the IRL. NASA (Kennedy Space Center) is the largest property owner within the watershed, and 140,000 acres of Kennedy Space Center is managed as the Merritt Island National Wildlife Refuge. In addition, there are four other National Wildlife Refuges, Canaveral National Seashore, and seven state parks. USFWS, National Marine Fisheries, and FWC protect listed species. FDOT is responsible for multiple bridges and causeways, which divide the lagoon into segments. State organizations including DEP, FDOH, FDACS, and WMDs are also responsible for programs that affect the lagoon.

**STRATEGIES:**

- Work with local governments to identify and prioritize actions from the CCMP and incorporate actions into the appropriate elements of local comprehensive plans, land development regulations, codes of ordinances, or other guidance documents.
- Provide model language based on CCMP actions that can be adopted or adapted by local governments in their planning and guidance documents.

- Coordinate with state and federal agencies to retain existing policies that support IRL restoration, revise existing policies to enhance restoration performance, or develop new policies to assist with IRL restoration and stewardship efforts.
- Coordinate federal land and water management plans to seek cooperation between federal, state, and local agencies to promote policies and projects within the CCMP

## ACTION PLAN OUTPUTS (DELIVERABLES):

| Action | Output Intent | Responsible Lead Agencies or Organizations | Partner Agencies or Organizations | Estimated Cost | Funding Source | IRLNEP Role |
|---|---|---|---|---|---|---|
| **Policy Considerations-1: Work with local governments to identify and prioritize CCMP actions and incorporate into local planning regulations and documents. (NEW)** | Identify opportunities to align Lagoon-Friendly ™ practices with revised or new local comprehensive plan directives. | 5 counties and 38 municipalities | IRLNEP Management Conference | TBD based on extent of revisions | Local governments | Coordinate, collaborate, and conduct |
| **Policy Considerations-2: Evaluate state policies that affect the IRL system and work with state agencies to revise or develop new policies to promote restoration. (NEW)** | Identify opportunities to revise or develop new statewide policies to *RESTORE* water quality, *RESTORE* natural habitats, expand ecosystem monitoring, and fund IRL projects. | DEP, FWC, FDACS, FDOT, FDOH | IRLNEP Management Conference | TBD based on extent of revisions | State agencies | Coordinate, collaborate, and conduct |
| **Policy Considerations-3: Evaluate federal policies that affect the IRL system and work with federal agencies to revise or develop new policies to promote restoration. (NEW)** | Identify opportunities to revise or develop new federal policies to *RESTORE* water quality, *RESTORE* natural habitats, expand ecosystem monitoring, and fund IRL projects. | USEPA, NOAA, Department of Defense, NASA | IRLNEP Management Conference | TBD based on extent of revisions | Federal agencies | Coordinate, collaborate, and conduct |

## OUTCOMES:

- **Short-term (1 – 2 years):** Identify CCMP actions that are most appropriate for each local government to include in their local planning regulations. Evaluate existing state and federal policies that affect restoration and determine where revisions or new policies are needed.
- **Medium-term (3 – 4 years):** Begin to incorporate CCMP actions into local government planning regulations. Coordinate with state and federal agencies to incorporate revisions to existing policies and to develop new policies, where needed.
- **Long-term (5 – 10+ years):** Incorporation of CCMP actions into local, state, and federal planning efforts to improve restoration success.

## CHALLENGES TO SUCCESS:

- Local regulations from five counties and 38 municipalities may need to be modified to include CCMP actions, which requires coordination with numerous boards and councils.
- Support will be needed from local representatives to modify local, state, and federal policies, and changing these policies can be time consuming and difficult.

## CITATIONS:


1. Brevard County Comprehensive Plan. http://www.brevardfl.gov/PlanningDev/CompPlan.
2. Indian River County Comprehensive Plan. http://www.irccdd.com/planning_division/Comp_Plan.htm.
3. Martin County Comprehensive Plan. https://www.martin.fl.us/government/departments/growth-management-department/comprehensive-planning.
4. St. Lucie County Comprehensive Plan. http://www.stlucieco.gov/departments-services/a-z/planning-and-development-services/planning/comprehensive-planning.
5. Volusia County Comprehensive Plan. https://www.volusia.org/services/growth-and-resource-management/planning-and-development/long-range-planning/comprehensive-plan.stml.

# APPENDIX A. CCMP CHANGES 2008-2018

| 2008 CCMP Update | | | 2018 CCMP Revision | | |
|---|---|---|---|---|---|
| **Issue** | **Goal** | **Action** | **Issue** | **Goal** | **Action** |
| Point Source Discharges (PS) | To ensure compliance with the Indian River Lagoon Act and to reduce, eliminate or mitigate industrial wastewater discharges to the Indian River Lagoon. | PS-1: Ensure Compliance with the Indian River Lagoon Act (Chapter 90-262, Laws of Florida, 1990) | Wastewater | Improve municipal and industrial wastewater infrastructure throughout the IRL watershed to achieve AWT standards to REDUCE or REMOVE loads of human and industrial pollutants to the IRL. REDUCE vulnerability to WWTP overflows to the IRL. Expand WWTP capacity to accommodate septic to sewer conversions and the region's growing human population. | Wastewater-1: Ensure compliance with the IRL Act (Chapter 90-262, Laws of Florida, 1990). |
| | | PS-2: Ensure that any proposed changes or exceptions from the Indian River Lagoon Act are consistent with the original intent and purpose of the Act and will not reduce they effectiveness of the Act. | | | |
| | | PS-3: Reduce or eliminate industrial discharges to the IRL. | | | Wastewater-2: REDUCE or REMOVE all wastewater discharges to the IRL (including direct, indirect, and emergency loadings of nutrients and other pollutants). |
| | | PS-4: Investigate and recommend funding alternatives for the upgrading of WWTPs. | | | Wastewater-3: RESEARCH, identify, and recommend funding sources and alternatives for upgrading WWTP infrastructure and to REDUCE or REMOVE domestic and industrial effluents. |
| | | PS-5: Investigate and promote alternatives to deep well disposal of domestic and industrial effluents. | | | |
| On-Site Sewage Disposal Systems (OSDS) | Determine the impacts of OSDS on the resources of the Indian River Lagoon and to develop and implement strategies to address these impacts. | OSDS-2: Develop and Implement an OSDS inspection program within the six lagoon counties. | | | Wastewater-5: Develop and implement an OSTDS inspection program and education program within the five IRLNEP counties. |
| | | OSDS-3: Undertake further studies of the OSDSs in the region to quantify the impacts of OSDSs on the IRL and to further quantify the extent of the "problem" and "potential problem" areas. | | | Wastewater-6: Undertake further studies to quantify the impacts of OSTDS on the IRL with a focus on identifying high priority "problem" and "potential problem" areas. |
| | | OSDS-4: Promote the connection of areas served by OSTDS to central sewer service or, where connection to central sewer is not feasible, promote the development and use of alternative or advanced OSTDS technologies offering improved treatment in areas identified in the IRL SWIM studies as "problem" or "potential problem" for OSTDS. Identify and publicize potential funding sources that could be used to connect areas served by OSTDS to central sewer or support the development and use of alternative or advanced OSTDS technologies. | | | Wastewater-4: Promote the connection of areas served by OSTDS to central sewer or, where connection is not feasible, use of nutrient removing systems in areas identified as "problem" or "potential problem." |

| 2008 CCMP Update | | | 2018 CCMP Revision | | |
|---|---|---|---|---|---|
| **Issue** | **Goal** | **Action** | **Issue** | **Goal** | **Action** |
| Freshwater and Stormwater Discharges (FSD) | To develop and implement strategies to address the impacts of freshwater and stormwater discharges on the resources of the Indian River Lagoon. | FSD-1: Complete or continue the diagnostic, management or pilot projects related to stormwater or freshwater discharges being planned or undertaken by federal, state, regional and local governments. | Stormwater | REDUCE unnatural fresh and surface water discharges to the IRL from both large stormwater conveyances and dispersed urban and residential sources. RESTORE water quality in the IRL system. Conduct RESEARCH to better understand natural hydroperiods of the IRL watershed. | Stormwater-1: Design, engineer, construct, and manage stormwater capture and treatment projects identified in the SJRWMD feasibility study to enhance water quality discharged to the IRL. **(NEW)** |
| | | FSD-2: Continue implementation of the NPDES nonpoint source (stormwater) permitting program throughout the Indian River Lagoon region. | | | |
| | | FSD-3: Develop, implement and update pollutant load reduction goals (PLRGs) for all areas of the Indian River Lagoon. | | | |
| | | FSD-4: Develop and implement best management practices (BMPs) for the management of stormwater, agricultural and fresh water discharges. | | | Stormwater-2: Develop, improve, and implement BMPs and education programs for stormwater management and freshwater discharges for urban, agriculture, and dispersed residential landscapes. |
| | | FSD-5: Update and enhance comprehensive drainage maps of the Indian River Lagoon basin. | | | Stormwater-3: Update and maintain comprehensive drainage maps of the IRL watershed. |
| | | FSD-6: Reduce the impacts of muck on the Indian River Lagoon. | | | |
| | | FSD-7: Amend local government comprehensive growth management plans and land development regulations to incorporate the goals, objectives and actions found in the IRL CCMP. | | | |
| | | FSD-9: Strengthen existing stormwater or freshwater discharge management programs. | | | |
| | | FSD-10: Encourage the proper use of fertilizers, herbicides, pesticides and reuse water. | | | |
| | | FSD-11: Educate residents and property owners about the impacts of freshwater and stormwater discharges on the Indian River Lagoon and what they can do to reduce these impacts. | | | Stormwater-4: Continue reviews of reclamation plans for water control districts and the standard operating procedures and project works of each large drainage system. |

| 2008 CCMP Update | | | 2018 CCMP Revision | | |
|---|---|---|---|---|---|
| **Issue** | **Goal** | **Action** | **Issue** | **Goal** | **Action** |
| | | FSD-12: Continue reviews of plans of reclamation for water control districts and the standard operating procedures and project works of each large drainage system and agricultural drainage system. Develop and implement strategies to reduce discharges and pollutant loadings to the Indian River Lagoon from these sources. | | | Stormwater-5: Upgrade existing urban and agricultural stormwater infrastructure networks to REDUCE freshwater discharges, nutrient loads, and other pollutant loads to the IRL. |
| | | FSD-13: Upgrade existing urban and agricultural stormwater systems to reduce pollutant loadings to the Indian River Lagoon. | | | |
| | | FSD-14: Develop and implement appropriate mechanisms to fund and undertake the operation, maintenance and improvement of urban and agricultural stormwater management systems to reduce pollutant loadings. | | | |
| Marina and Boat Impacts (MB) | To reduce impacts to the Indian River Lagoon from boating activities and to engage the boating public and marine industries as active participants in the protection and restoration of Indian River Lagoon resources. | MB-1: Implement the Clean Marina Program throughout the Indian River Lagoon. | Marinas and Boating | Reduce impacts from marina and boating activities. Educate boating population to take responsibility and be Lagoon-Friendly™. Update and re-publish the highly acclaimed IRLNEP *Boaters Guide to the Indian River Lagoon* to focus on boater waste management, safe boating practices, lagoon community boat ramps and recreational destinations, safe boating practices, and emergency call contacts. | |
| | | MB-2: Implement boat facility siting plans and update these plans as new data and information are available. | | | |
| | | MB-3: Prevent pollutant spills and discharges and protect the resources of the Indian River Lagoon from the impacts of any spills or discharges. | | | |
| | | MB-5: Provide educational materials and programs, such as the Clean Boater Program and boater's guides, to owners and operators of boats and personal watercraft. | | | MB-5 combined with MB-6 in current Boating-2 |
| | | MB-6: Expand and coordinate enforcement of boating safety and resource protection regulations throughout the Indian River Lagoon. | | | Boating-2: Expand and coordinate enforcement of boating safety and resource protection regulations throughout the IRL and develop and distribute targeted public education and outreach products to reduce impacts. |
| | | MB-7: Eliminate the impacts of waste discharges and marine sanitation devices on the public health and Indian River Lagoon resources. | | | Boating-1: Eliminate waste discharges and MSD impacts on the public health and IRL resources. |

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| **Issue** | **Goal** | **Action** | **Issue** | **Goal** | **Action** |
| | | MB-8: Monitor boating impacts to Indian River Lagoon natural resources. Where appropriate, establish resource protection zones and monitor their effectiveness. | | | Boating-3: Update and distribute the *Boaters Guide to the Indian River Lagoon*. **(NEW)** |
| Atmospheric Deposition of Pollution (AD) | To determine the impacts of atmospheric deposition of pollutants on the resources of the Indian River Lagoon and to develop and implement strategies to address these impacts. | AD-1: Determine the impacts of atmospheric deposition of pollutants on the water quality and resources of the Indian River Lagoon. | Atmospheric Deposition | Monitor and conduct RESEARCH on atmospheric deposition of nutrients and pollutants. Develop and implement strategies to REDUCE, REMOVE, and RESPOND to these impacts. | Atmospheric Deposition-1: Determine the impacts of atmospheric deposition of nutrients and other pollutants on the nutrient budget, water quality, and resources of the IRL. |
| | | | | | Atmospheric Deposition-2: Evaluate need for additional wet and dry atmospheric monitoring stations. **(NEW)** |
| Total Maximum Daily Loads (TMDLs) | Full implementation of basin management action plans (BMAPs) to meet total maximum daily loads (TMDLs) developed for the Indian River Lagoon. | TMDL-1: Develop, implement, and update TMDLs for all areas of the Indian River Lagoon. | Impaired Waters (Including TMDLs, BMAPs, and RAPs) | REMOVE or REDUCE anthropogenic pollutant and nutrient loading to the IRL watershed toby meeting the regulatory targets established by TMDLs, BMAPs, and/or RAPs; achieving the intended biological response criteria; and achieving applicable water quality criteria to removing the waterbody from the Impaired Waters designation list. | Impaired Waters-1: Support implementation, review, and update of IRL TMDLs as needed and as best available science evolves. |
| | | TMDL-2: Coordinate development and implementation of BMAPs with Florida Department of Environmental Protection. | | | Impaired Waters-2: Work with BMAP partners and DEP to support implementation of BMAPs and track progress, compliance, and implementation challenges. |
| | | TMDL-3: Support implementation of Basin Management Action Plans (BMAPs) for all basins requiring TMDLs. | | | Impaired Waters-3: Support the partners and DEP in the development, adoption, and implementation of the Mosquito Lagoon and Loxahatchee River RAPs. **(NEW)** |
| | | | | | Impaired Waters-4: Evaluate opportunities to incentivize, monetize, and expedite nutrient reduction policies and actions including water quality credit trading. **(NEW)** |
| Biodiversity (BD) | Develop and implement a coordinated scientific conservation and management strategy to preserve, protect and restore biodiversity in the Indian River Lagoon. | BD-1: Coordinate biodiversity activities within the Indian River Lagoon region. | Biodiversity | Conduct comprehensive biodiversity RESEARCH to develop a long-term management strategy to RESTORE, REBUILD, and protect the biological diversity of the IRL. | Biodiversity-3: Integrate biodiversity considerations in habitat restoration and planning activities. |
| | | BD-2: Acquire and effectively manage environmentally sensitive lands as a tool to preserve, protect and restore the biological diversity, functional integrity and productivity of the Indian River Lagoon region. | | | Biodiversity-1: Acquire and effectively manage the IRL network of conservation lands and wetlands as a tool to preserve, protect, and restore the biological diversity, functional integrity, and productivity. |
| | | BD-4: Create and maintain a species inventory for the Indian River Lagoon. | | | Biodiversity-2: Work to continue, expand, update, and improve the IRL species inventory. |
| Seagrass Protection, Restoration And Management (SG) | To protect and restore seagrass integrity and functionality in the Indian River Lagoon by reducing anthropogenic impacts and | SG-1: Implement a program of protection, restoration and management activities needed to maintain, protect and restore the seagrass/SAV community of the Indian River Lagoon. | Seagrasses | Implement a comprehensive, coordinated, and integrated IRL strategy to REMOVE stressors to seagrasses in the IRL and RESTORE seagrass habitats to support and sustain healthy | Seagrass-1: Implement a program of protection, restoration, and management activities. |

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| | attaining and maintaining water quality capable of supporting a healthy, productive and sustainable submerged aquatic vegetation community meeting the seagrass coverage and depth targets developed by the water management districts for the Indian River Lagoon. | | | water quality and seagrass dependent species. | Seagrass-2: Ensure that monitoring, mapping, and modeling are coordinated lagoon-wide. **(NEW)** |
| | | | | | Seagrass-3: Fund innovative pilot projects and partnerships. **(NEW)** |
| | | | | | Seagrass-4: Develop a Habitat Restoration Plan for the IRL system. **(NEW)** |
| Wetlands (W) | Preserve, protect, restore and enhance the wetland resources of the Indian River Lagoon region. | W-1: Implement programs that protect the ecological services of wetlands. | Wetlands and Impounded and Altered Marshes | RESTORE and protect wetlands, wetland-upland transitions, and impounded or altered marshes throughout the IRL watershed. RESPOND to opportunities to refine wetland management strategies to support IRL biodiversity and coastal RESILIENCE. Conduct RESEARCH and RESPOND to future wetland management challenges associated with sea level rise. | |
| | | W-2: Regular review and updating of wetlands protection rules and regulations. | | | |
| | | W-3: Establish or enhance wetland or shoreline setback buffers. | | | Wetlands-2: Establish or enhance wetland or shoreline setback buffers. |
| | | W-4: Implement innovative programs and incentives supporting wetlands protection and management on privately owned lands. When necessary, acquire ownership or control of crucial wetlands. | | | Wetlands-3: Implement innovative programs and incentives supporting wetlands protection and management on privately-owned lands and marshes managed by private, non-profit organizations. When necessary, acquire ownership or control of crucial wetlands. |
| | | W-5: Continue the restoration and rehabilitation of impacted or impounded coastal wetlands. | | | |
| | | W-6: Continue projects and programs to restore shorelines. | | | Wetlands-4: Continue projects and programs to restore shorelines with a focus on enhancing and managing mosquito impoundment dikes with living shoreline restoration. |
| | | W-7: Promote the removal of trash and litter from wetlands, shorelines and islands. | | | |
| | | W-8: Undertake research to develop new and improved wetland management best management practices (BMPs). | | | Wetlands-1: RESEARCH and develop new and improved wetland BMPs with a focus on understanding wetland responses to sea level rise and climate change. |
| Land Acquisition And Protection (LA) | Develop and implement a coordinated strategy to protect environmentally endangered habitats within | LA-1: Continue coordination of efforts to identify, classify, acquire and manage environmentally sensitive lands throughout the Indian River Lagoon region. | Land Conservation | Promote conservation of land through acquisition and other forms of stewardship. Pursue strategic land acquisition initiatives that will REDUCE freshwater, sediment, | Land-1: Continue coordination of efforts to identify, classify, acquire, and manage environmentally sensitive lands. |

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| | the Indian River Lagoon basin through acquisition. | | | nutrient, and pollutant loads to the IRL and REBUILD natural land-water connections to provide both water quality improvement, provide flood prevention, and RESTORE natural hydroperiods. | Land-3: Support public acquisition of environmentally sensitive lands that are deemed essential for long-term protection and management of IRL resources, CCMP implementation, and stormwater projects. **(NEW)** |
| | | LA-3: Support continuation and expansion of state funding initiatives for long-term acquisition programs for conservation lands. | | | Land-2: Support recurring funding of the Land Acquisition Trust Fund and other funding sources. |
| | | LA-4: Develop and implement incentives to promote conservation of privately owned environmentally sensitive lands. | | | Land-4: Develop and implement incentives to promote conservation of privately-owned environmentally sensitive lands and provision of cost-effective dispersed water management projects. |
| | | LA-5: Promote the acquisition of lands for public access to the Indian River Lagoon. | | | Land-5: Promote acquisition of lands for public access to the IRL. |
| Endangered and Threatened Species (ETS) | Protect endangered and threatened species found in the Indian River Lagoon region. | ETS-1: Develop, implement, update or refine adaptive management or recovery plans for the endangered, threatened and species of special concern found in the Indian River Lagoon region. | Species of Concern | Conduct and/or continue RESEARCH to evaluate status and population trends of IRL species of concern. REMOVE and/or REDUCE stressors and threats to species of concern. RESPOND to opportunities for species-specific management action that will RESTORE sustainable levels for populations of species of concern. | Species of Concern-2: Align the CCMP with adaptive management or recovery plans for species of concern. |
| | | EYS-2: Improve enforcement of regulations protecting endangered, threatened or species of special concern in the Indian River Lagoon region. | | | Species of Concern-3: Improve enforcement of regulations for species of concern found in the IRL region. |
| | | ETS-3: Protect and manage the critical habitats of endangered, threatened or species of special concern found within the Indian River Lagoon region through land acquisition and other land protection measures. | | | Species of Concern-4: Protect and manage natural habitats that support species of concern found within the IRL region. |
| | | ETS-5: Encourage private land owners to manage lands for endangered species, threatened species, and species of special concern found within the Indian River Lagoon region. | | | |
| | | ETS-6: Identify endangered, threatened and species of special concern distribution and critical habitats throughout the Indian River Lagoon. | | | Species of Concern-1: Identify IRL species of concern and track recovery progress status and population trends. |

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| Fisheries (F) | Conserve, protect, and restore the fin and shellfish resources of the Indian River Lagoon. | F-1: Conserve, protect, restore and manage the finfish and shellfish resources in the Indian River Lagoon region. | Commercial and Recreational Fisheries | Conduct fisheries RESEARCH to help REBUILD IRL commercial and recreational fisheries. RESTORE IRL fish populations to support world-class recreational fishing and sustainable commercial harvest. | Fisheries-1: Conserve, protect, RESTORE, and manage the commercial and recreational finfish and shellfish resources in the IRL region to support a sustainable harvest. |
| | | F-3: Support and expand research initiatives and coordinated finfish and shellfish management strategies specific to the Indian River Lagoon. | | | Fisheries-2: Continue to support and expand research initiatives and coordinated finfish and shellfish management strategies specific to the IRL. |
| | | F-4: Identify, inventory and assess finfish and shellfish habitats within the Indian River Lagoon and implement appropriate management and restoration strategies. | | | Fisheries-4: Identify, inventory, and assess finfish breeding and important habitats within the IRL. |
| | | | | | Fisheries-3: Improve effectiveness of fish habitat conservation and restoration efforts by identifying and characterizing critical spawning, nursery, and forage areas within the IRL and its tributaries. **(NEW)** |
| Biotoxins and Aquatic Animal Health (BAH) | Improve knowledge of biotoxin and aquatic animal health issues to protect public health and the resources of the Indian River Lagoon. | BAH-1: Implement a lagoon-wide, multi-species, multi-disciplinary approach to determine the status of emerging infectious diseases in the Indian River Lagoon, assess trends and identify underlying causes. | Harmful Algal Blooms (HABs) | Advance RESEARCH, coordination, and understanding of the causes of HABs to REDUCE their frequency, intensity, and duration. Effectively and efficiently RESPOND to HAB emergence and secondary impacts including toxicity in some species, low dissolved oxygen concentrations as blooms decline, and associated fish and wildlife morbidity and mortality events. Improve scientific understanding of toxic algal blooms and human health risks. REPORT IRL algal bloom status and trends. | HAB-1: Support continuation of the IRL 2011 Consortium, which would function as a formal task force supported by the IRLNEP and which would develop a HAB Research and Restoration Response Plan. **(NEW)** |
| | | BAH-2: Continue support of the Biotoxin and Aquatic Animal Health Working Group and the goals of this working group. | | | HAB-2: Seek partnerships and funding to pursue research priorities identified by the IRL 2011 Consortium that align with IRLNEP Management Conference management priorities. **(NEW)** |
| | | BAH-3: Complete or continue the projects identified in the Preliminary Strategic Plan for Algal Toxins and Aquatic Animal Health in the Indian River Lagoon. | | | HAB-3: Continue funding and scientific partnerships to understand HABs toxicity and risks to human and wildlife health. (NEW) |
| Climate Change (CC) | Support and implement policies and strategies developed to address impacts resulting from climate change in the Indian River Lagoon. | CC-1: Track state, national and international actions and research concerning climate change issues that affect the Indian River Lagoon. | Climate Ready Estuary | RESEARCH IRL risk-based vulnerabilities to climate change and sea level rise to make informed adaptation planning decisions. RESPOND to threats and opportunities. Make management decisions that improve IRL RESILIENCE to storm events and long-term risks. REPORT findings and scientific advancements to partners in | Climate Ready Estuary-1: Prepare a Risk-Based Vulnerability Assessment and Adaptation Plan for the IRL. **(NEW)** |
| | | CC-2: Support Indian River Lagoon-based research that considers and integrates global climate change issues and seeks practical scientific, technological and public policy solutions. | | | Climate Ready Estuary-2: Identify opportunities to integrate infrastructure resilience into community planning. **(NEW)** |

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| | | CC-3: Provide information to local governments and residents of the Indian River Lagoon region about impacts of climate change and actions they can take to reduce these impacts. | | the IRLNEP Management Conference and communities. | |
| Invasive Fauna and Flora (IFF) | Identify, control or eradicate invasive, non-native fauna and flora in the Indian River Lagoon. | IFF-1: Support the inventory and assessment of non-native invasive fauna and flora within the Indian River Lagoon basin. | Invasive Species | REMOVE invasive species from the IRL, its contributing waters, and its watershed. Conduct RESEARCH to improve management and understanding of invasive species in the IRL watershed to help RESTORE native habitats and communities. Be prepared to RESPOND quickly to eradicate newly introduced invasive species. | Invasive Species-1 Support the inventory and assessment of invasive fauna and flora within the IRL watershed. |
| | | IFF-2: Support development and implementation of management plans for eradication or control of non-native invasive plants and animals found in the Indian River Lagoon region. | | | |
| | | IFF-3: Coordinate the formation of "Rapid Assessment" teams to assess the extent of recently discovered invasions and provide recommendations for management or eradication. | | | IFF-3 and IFF-4 combined into Invasive Species-2 |
| | | IFF-4: Engage residents in management and eradication of exotic invasive species by providing standardized information to residents of the Indian River Lagoon region about non-native invasive plants and animals and their management and eradication. | | | Invasive Species-2: Provide standardized information to IRL partners about invasive species and their eradication and management. Prepare an early detection and response plan. |
| Public Involvement and Education (PIE) | Facilitate implementation of the Indian River Lagoon (IRL) Comprehensive Conservation and Management Plan (CCMP) through public involvement and education. | PIE-1: Facilitate implementation of the Indian River Lagoon (IRL) Comprehensive Conservation and Management Plan (CCMP) through public involvement and education. | Citizen Engagement and Education | Report on needs and progress, and educate, and engage the public on the need to Restore and manage the IRL's natural resources. RESPOND to opportunities to fund and implement "hands on" opportunities for citizen engagement that promote and produce well-informed citizens and communities that become IRL ambassadors for Lagoon-Friendly ™ behaviors. REBUILD community-lagoon connections that promote the identity, well-being, and unique qualities of IRL communities. | Communicate-1: Facilitate implementation of the IRL CCMP consistent with "One Lagoon – One Community – One Voice" mission. (NEW) |
| | | PIE-2: Develop, implement and refine a communications plan to inform stakeholders and government officials about the resources of the Indian River Lagoon, the economic and ecological value of these resources and threats to the continued viability of these resources | | | Communicate-2: Develop and implement an IRLNEP multi-year Communication Plan. |
| | | PIE-4: Increase public and governmental involvement in activities designed to protect and restore the resources of the Indian River Lagoon. | | | |

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| | | PIE-5: Strategically prioritize and implement public education programs based on pollution potential, perceived likelihood for behavior change, resource availability, and opportunities that arise. | | | Communicate-3: Implement public education programs including the "One Community - One Voice" initiative to promote community place-based identities and Lagoon-Friendly™ behaviors. (NEW) |
| IRL CCMP Implementation (FI) | Establish a modified management structure that will oversee the implementation of the Indian River Lagoon Comprehensive Conservation and Management Plan (IRL CCMP) and provide for an organization to support its activities | FI-1: Continue the Indian River Lagoon Advisory Board's role of oversight, monitoring, and guidance of implementation of the IRL CCMP. | CCMP Implementation and Financing | IRL communities, partners, and citizens work in cooperation to align their individual and collective interests and actions to take RESPONSIBILITY to achieve the "One Lagoon – One Community – One Voice" Mission. Identify, fund, and implement CCMP projects and actions to RESTORE the IRL. Align CCMP activities to provide enhanced Resilience for the IRL and its human communities. | Implementation-1: Develop a finance plan for CCMP development and implementation, project and program funding, and program delivery with a focus on restoration, scientific research, monitoring, and citizen engagement. (NEW) |
| | | FI-2: Continue measurement of progress of CCMP implementation activities. | | | |
| Data And Information Management Strategy (DIM) | Develop and implement a strategy to coordinate the management and dissemination of data and information concerning the Indian River Lagoon | DIM-1: Continue projects and strategies related to data and information management. | Monitoring and Data Sharing | Coordinate IRL monitoring, data sharing, and mapping throughout the IRL and its watershed. RESPOND to gaps in monitoring and data collection and the need to evaluate trends and changes. REPORT the shared findings from the IRL monitoring network to inform IRL partners and stakeholders about status and trends related to the health of the IRL. | Monitoring 1: Develop a comprehensive IRL monitoring plan. **(NEW)** |
| | | | | | Monitoring-2: Monitor IRL indicators at appropriate spatial and temporal scales to understand the status and trends associated with key indicators of the system's health. **(NEW)** |
| | | DIM-3: Improve public access to published research and reports specific to the Indian River Lagoon. | | | Monitoring-4: Identify, develop, and apply next-generation smart sensors, remote sensing technologies, big data analytics, and surveillance components to monitor and deliver an IRL water quality dashboard in real time. **(NEW)** |
| | | DIM-4: Ensure appropriate water quality and benthic data and information concerning the Indian River Lagoon is entered into and available through the storage and retrieval (STORET) system or its successor. | | | Monitoring-5: Advance the 10 scientific research priorities identified by the STEMAC in the 2018 *Looking Ahead – Science 2030 Report.* Work with IRL partners to seek funding to implement priority research projects within the 10 priorities. **(NEW)** |
| Monitoring (MON) | To develop and maintain a monitoring network which will provide adequate and reliable data and information on water quality, sediment quality and the biological resources | MON-1: Continue projects related to monitoring the resources of the Indian River Lagoon and address gaps in data as needed. | | | |
| | | MON-2: Continue the Citizens Water Quality Monitoring Program. | | | Montioring-3: Support expansion of and adequate funding for the IRL Citizens Water Quality Monitoring Program. |

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| | of the Indian River Lagoon to support mapping, modeling and management decisions. | MON-3: Provide support for the development of a triennial report on the state of the Indian River Lagoon. | State of the Lagoon | Collect, synthesize, and analyze IRL data and RESEARCH findings to develop a "State of the Lagoon Technical Report" that addresses the health of the IRL, ecosystem stressors, indicators, and trends. REPORT the findings. Apply the findings to advise CCMP updates and revisions. | State of the IRL-1: Provide support for a "State of the Lagoon Technical Report" to be released every ten years. **(NEW)** |
| Indian River Lagoon Scientific Research (SR) | Development of a scientific research vision and implementation strategy for the Indian River Lagoon | SR-1: Create an Indian River Lagoon Science and Management Working Group charged with the development and implementation of a scientific research vision and implementation strategy for the Indian River Lagoon. This strategy should be consistent with and complimentary to statewide research strategies identified by the Florida Coastal and Ocean Resources Council and national coastal priorities. | Technology Innovation | RESEARCH innovative technologies and emergence of commercial opportunities that will assist with restoration and stewardship of the IRL. REPORT findings. RESPOND to industry needs and desires to communicate more effectively with IRL partners. Work with industry and economic development partners to position Florida and the IRL region as a leader in clean water innovation, research, and technology development. | Technology Innovation-1: Work with IRLNEP IRLI[2], industry leaders, economic development organizations, and startup incubators/accelerators to help drive IRL regional economic, technology, and talent development. **(NEW)** |
| | | SR-2: Include the value of scientific research in any studies of the Indian River Lagoon regional economy. | | | Technology Innovation-2: Continue to support and develop a water technology directory for the www.onelagoon.org website. **(NEW)** |
| | | SR-3: Expand and diversify funding for scientific research in the Indian River Lagoon. | | | Technology Innovation-3: Evaluate options for a regular, sustainable, and cost-effective water quality monitoring network using autonomous sampling. **(NEW)** |
| Environmental Incident Assessment And Response (EIAR) | Rapid assessment of and response to significant environmental incidents that may affect the resources of the Indian River Lagoon. | EIAR-1: Inventory existing rapid assessment and response programs within the Indian River Lagoon region and identify classes of incidents not addressed by these programs. | Emergency Preparation and Response | Identify the role of the IRLNEP during emergencies that impact the IRL and its communities. Develop coordinated plans with IRLNEP Management Conference partners and responsible local, state, and federal entities to prepare, Respond, and Recover after an emergency in the IRL watershed. | Emergency-1: Evaluate the role and ability of the IRLNEP to assist local communities and emergency management agencies in times of emergencies that impact the IRL. **(NEW)** |
| | | EIAR-2: Create and maintain an inventory of support services and equipment available within the Indian River Lagoon region. | | | |
| | | EIAR-3: Develop assessment and response strategies and protocols for significant environmental incidents not addressed by existing programs. | | | |
| Economic Analysis (EA) | | EA-1: Undertake an analysis of the economic benefits of the Indian River Lagoon to the economy of the region on a recurring basis. | Vibrant 21st Century Communities | Update RESEARCH on IRL economic value and trends, at least every five years or as needed, in response to abrupt economic changes, threats, and opportunities. REBUILD human-built | Vibrant Communities-1: Work closely with the business community and industry clusters along the IRL to ensure effective cooperation and communication associated with CCMP implementation. **(NEW)** |

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| | | | | infrastructure along the IRL to be more Lagoon-Friendly ™, more sustainable, and more resilient. RESPOND to 21st Century changing environmental, economic, and societal needs, challenges, and opportunities. REPORT regularly to the IRL regional business and economic development community to ensure that CCMP implementation advances the "One Lagoon – One Community – One Voice" Mission. | Vibrant Communities-2: Update the IRL economic analysis produced by the Treasure Coast and East Central Florida Regional Planning Councils every five years. **(NEW)** |
| | | | | | Vibrant Communities-3: Promote lagoon-related nature and heritage tourism development for residents and visitors. **(NEW)** |
| | | | | | Vibrant Communities-4: Conduct community planning workshops to plan for Vibrant 21st Century communities. **(NEW)** |
| | | | Hydrology and Hydrodynamics | Conduct RESEARCH to improve understanding of the IRL watershed, groundwater, and hydrology and hydrodynamics to improve decision-making for management of land use impacts to water and reduction of loads of nutrients and other contaminants. | Hydrology-1: Support advancements in hydrological model development, verification, and application. **(NEW)** |
| | | | | | Hydrology-2: Apply the best available models to better evaluate connectivity between IRL sub-basins. Reduce negative impacts of road corridors and causeways. **(NEW)** |
| | | | | | Hydrology-3: Continue evaluation of options to enhance water flow through engineering solutions that have well defined water quality and ecological outcomes. **(NEW)** |
| | | | Legacy Loads and Healthy Sediments | REMOVE and/or REDUCE muck in the IRL to REDUCE the legacy load of nutrients and contaminants and improve water clarity. RESTORE healthy natural sediments to support seagrasses and associated communities, shellfish, and healthy benthic communities. | Legacy Loads-1: Complete muck mapping of the entire IRL, prioritize muck dredging projects and site selection for seagrass and filter feeder restoration projects, and REDUCE source contributions of sediment and biomass that result in muck formation. **(NEW)** |
| | | | | | Legacy Loads-2: Continue to couple scientific evaluation and assessment of muck dredging projects to evaluate and optimize the dredging process. **(NEW)** |
| | | | | | Legacy Loads-3: Track emerging technologies, innovative approaches or alternatives to dredging, muck capping, upstream controls of muck transport, more efficient approaches to dewatering, enhanced pollutant removal in post-dredge water, and enhanced muck management to improve process efficiency, reduce costs, and identify beneficial uses of muck residuals. **(NEW)** |

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| | | | Contaminants of Concern | Conduct RESEARCH to identify sources and loads of known contaminants and contaminants of emerging concern to better understand potential ecological, wildlife, and human health risks. Identify mechanisms to REDUCE or REMOVE these contaminants from the system. REPORT findings and RESPOND to protect human health and wildlife. Identify and remediate contaminated sites. | Contaminants of Concern-1: Monitor and research to better understand contaminants of emerging concern within the IRL system. **(NEW)** |
| | | | | | Contaminants of Concern-2: Implement actions to REMOVE or REDUCE contaminant loads to the IRL system. **(NEW)** |
| | | | Filter Feeders | Conduct RESEARCH to better understand stressors and root causes for the decline of filter feeders in the IRL. RESTORE selected bivalve populations, with a focus on restoring oyster and clam populations to support and sustain both habitat conservation and sustainable commercial harvests. | Filter Feeders-1: RESEARCH spatially explicit data on the extent and condition of existing filter feeder habitat. **(NEW)** |
| | | | | | Filter Feeders-2: REPORT spatially-explicit data on denitrification potential associated with existing natural and restored filter feeder habitat, incorporated into maps and online platforms. **(NEW)** |
| | | | | | Filter Feeders-3: Develop a filter feeder management plan working with public, private and independent sector partners. **(NEW)** |
| | | | Living Shorelines | Conduct RESEARCH to identify key locations along the IRL and tributaries that would benefit from living shorelines. RESTORE natural shorelines. REBUILD both natural and hardened shorelines that have been impacted by erosion or storm surge. Incorporate living components into armored shorelines where a hybrid solution is feasible and amenable to the owner. REPORT the performance, value, and cost-benefit of living shorelines as natural infrastructure that decreases storm surge vulnerability and contributes to coastal RESILIENCE. | Living Shorelines-1: RESEARCH and REPORT science-based siting, planning, design, and construction criteria. **(NEW)** |
| | | | | | Living Shorelines-2: Develop standardized metrics and protocols for living shoreline projects. **(NEW)** |
| | | | | | Living Shorelines-3: RESEARCH and REPORT on living shoreline information. **(NEW)** |
| | | | | | Living Shorelines-4: Streamline permitting for living shoreline projects. **(NEW)** |
| | | | | | Living Shorelines-5: Incorporate living shoreline guidance into local comprehensive plans. **(NEW)** |
| | | | Spoil Islands | Update and revise the IRL Spoil Islands Management Plan for the IRL with a focus on maintenance, habitat | Spoil Islands-1: Create a central electronic repository for spoil island maps, documents, sources. **(NEW)** |

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| | | | | restoration and enhancement of islands, IRL water quality improvements, and provision of public access based on the best available science and sound habitat management principles. | Spoil Islands-2: Update the IRL Spoil Management Plan and implement identified projects. **(NEW)** |
| | | | Connected Waters and Watersheds | Conduct and share RESEARCH to improve understanding and management of waters that influence the IRL region. RESTORE natural connections and water flow to reduce freshwater discharges to the IRL. REPORT regularly to IRLNEP partners working in connected and adjacent waters and watersheds. RESPOND to opportunities for shared projects and potential threats. | Connected Waters-1: Incorporate the IRL-Halifax Planning Boundary area into all IRLNEP discussions, CCMP action plans, and CCMP implementation activities. **(NEW)** |
| | | | | | Connected Waters-2: Support expanded and accelerated funding for Everglades restoration. **(NEW)** |
| | | | | | Connected Waters-3: Support expanded and accelerated funding to restore the St. Johns River. **(NEW)** |
| | | | | | Connected Waters-4: Evaluate water quality habitats and species composition around inlets and develop management recommendations. **(NEW)** |
| | | | | | Connected Waters-5: Better understand the physical, chemical, and biological implications, benefits, risks, and expected outcomes of enhancing oceanic exchange and develop a pilot project, as appropriate. **(NEW)** |
| | | | Forage Fishes | RESEARCH forage fish abundance, trends, and threats. RESTORE water quality and natural habitats to sustain abundant and diverse forage fish populations and other species that depend on forage fish. REPORT the importance of forage fish and trends in their abundances to partners and stakeholders. Elevate public awareness and understanding of the importance of forage fish to a healthy IRL. | Forage Fishes-1: Support research and assessments to identify and map suitable habitats and spawning habitats for forage fishes and track population size and health. **(NEW)** |
| | | | | | Forage Fishes-2: Continue to support scientific assessments of forage fish population size and health. **(NEW)** |
| | | | Trash-Free Waters | REDUCE trash by implementing a lagoon-wide trash-free waters campaign – "Trash-Free Lagoon 2030." Enhance efforts to REMOVE trash by coordinating with local organizations | Trash-Free Waters 1: Identify and map IRL hotspots for trash, develop education projects that REDUCE and/or REMOVE trash, and seek funding for projects from the USEPA Trash-Free Waters Program. **(NEW)** |

| 2008 CCMP Update | | | 2018 CCMP Revision | | |
|---|---|---|---|---|---|
| **Issue** | **Goal** | **Action** | **Issue** | **Goal** | **Action** |
| | | | | and partners in the IRLNEP Management Conference. REPORT trash hotspots and trash removal success stories. | Trash-Free Waters-2: Identify and remove derelict boats and fishing gear throughout the IRL. **(NEW)** |
| | | | Distinctive Lagoon Communities | RESPOND to the unique community needs of three categories of IRL coastal communities that contribute to the rich history, culture, human diversity, infrastructure, and economic value of the IRL watershed. | Distinctive Communities -1: For, Urban Waters, ensure the high-density human population is Lagoon-Friendly ™. **(NEW)** |
| | | | | | Distinctive Communities-2: For Working Waterfronts, coordinate with local communities to maintain the commercial use. **(NEW)** |
| | | | | | Distinctive Communities-3: For Environmental Justice Communities, identify the unique challenges and opportunities along the lagoon for underrepresented and underserved communities. **(NEW)** |
| | | | Federal, State, and Local Policy Opportunities | Identify opportunities to align the CCMP with local comprehensive plans and land development regulations to more effectively RESTORE the IRL. Evaluate state and federal policies that may impact the ability to implement the CCMP actions and coordinate with agencies to determine policy opportunities moving forward. RESPOND to policy changes and new policy opportunities. REPORT policy best practices and success stories. | Policy Considerations-1: Work with local governments to identify and prioritize CCMP actions and incorporate into local planning regulations and documents. **(NEW)** |
| | | | | | Policy Considerations-2: Evaluate state policies that affect the IRL system and work with state agencies to revise or develop new policies to promote restoration. **(NEW)** |
| | | | | | Policy Considerations-3: Evaluate federal policies that affect the IRL system and work with federal agencies to revise or develop new policies to promote restoration. **(NEW)** |

# APPENDIX B. WASTEWATER MAPS


**Figure B-1: Overview of domestic and industrial WWTPs in the IRLNEP area**

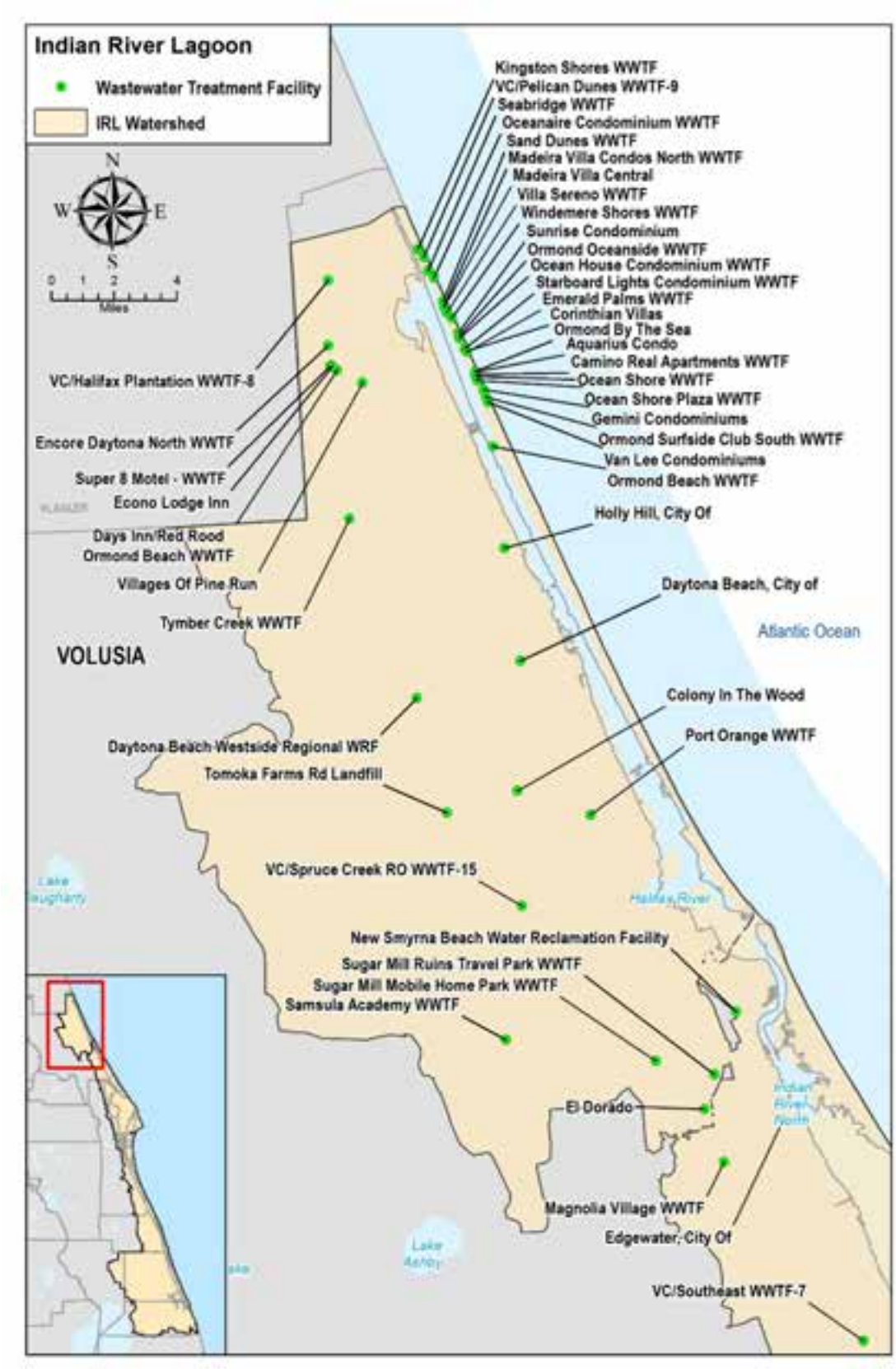


**Figure B-2: Domestic and industrial WWTPs in Volusia County in the IRLNEP area**

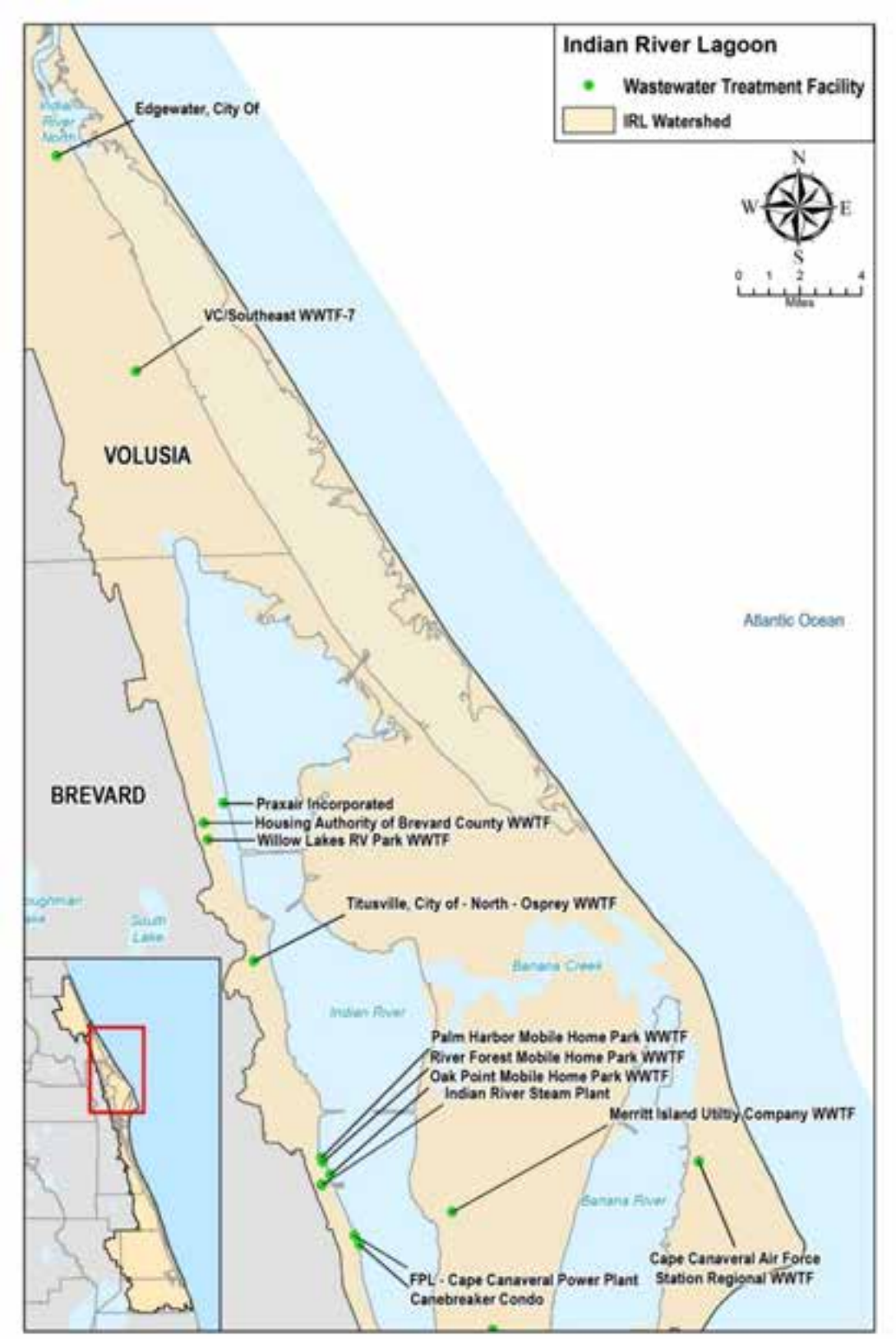


**Figure B-3: Domestic and industrial WWTPs in Volusia and northen Brevard Counties in the IRLNEP area**

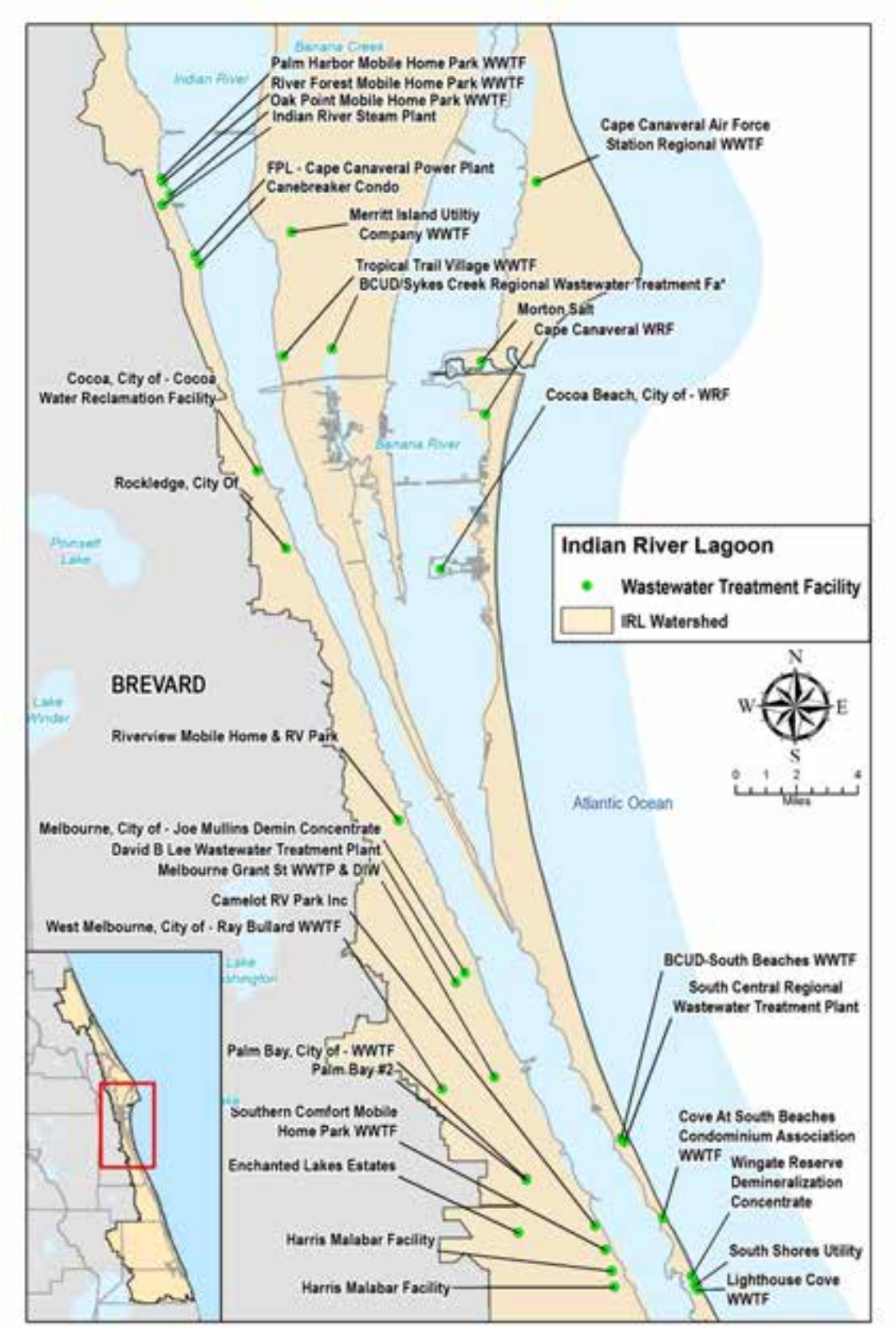


**Figure B-4: Domestic and industrial WWTPs in central Brevard County in the IRLNEP area**

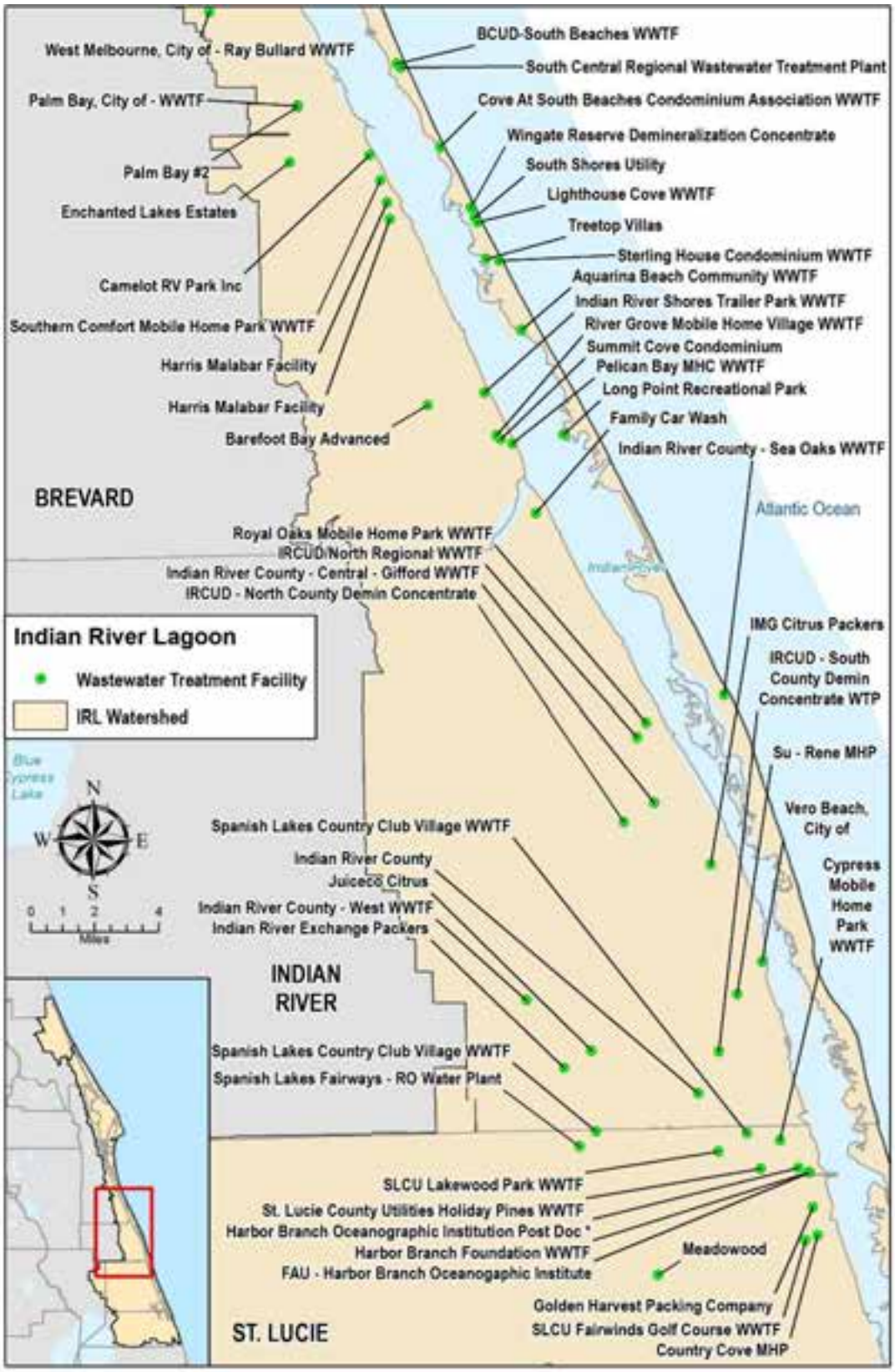


**Figure B-5: Domestic and industrial WWTPs in southern Brevard, Indian Rver, and northern St. Lucie Counties in the IRLNEP area**

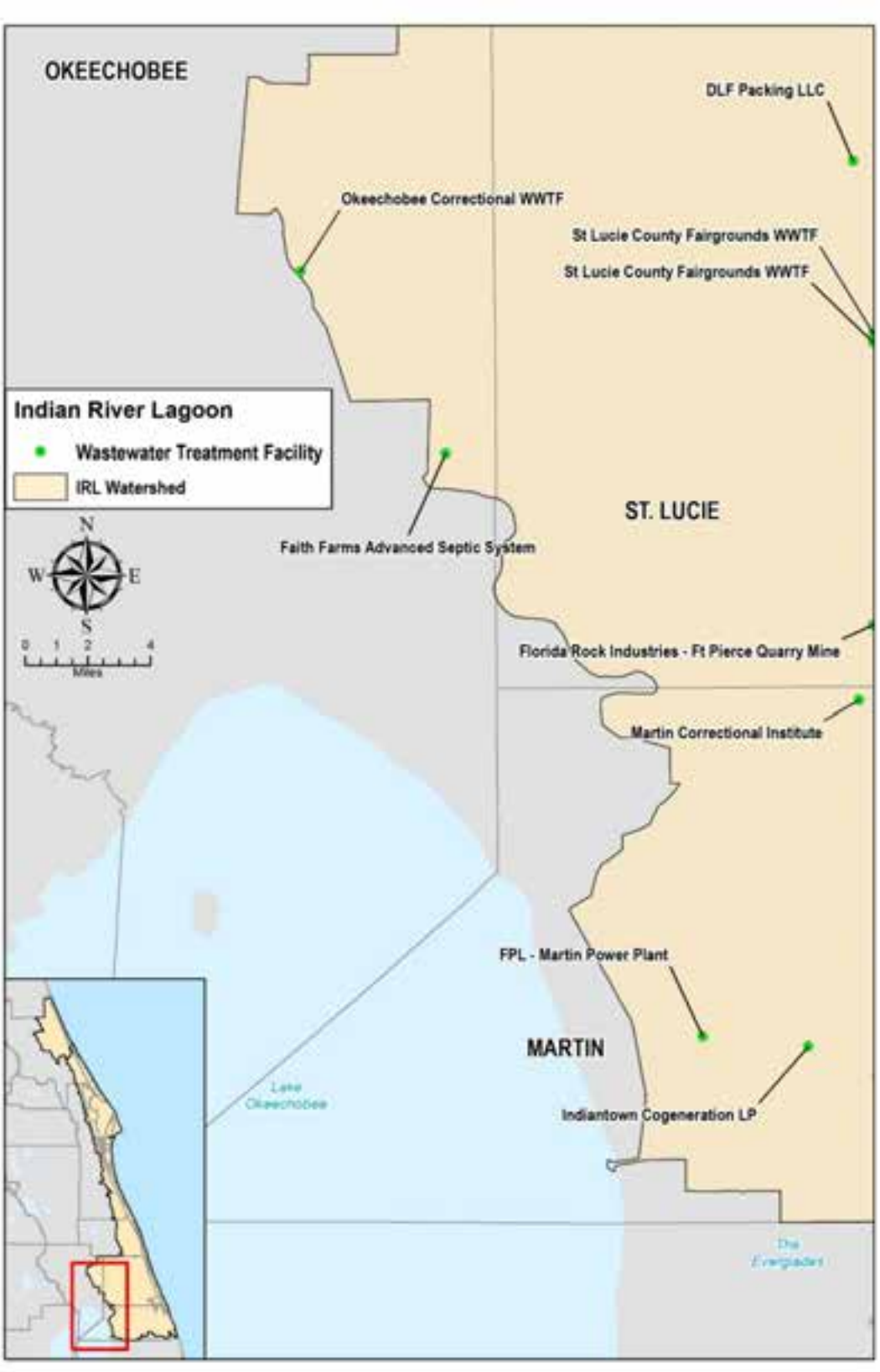


**Figure B-6: Domestic and industrial WWTPs in western St. Lucie, western Martin, and Okeechobee Counties in the IRLNEP area**

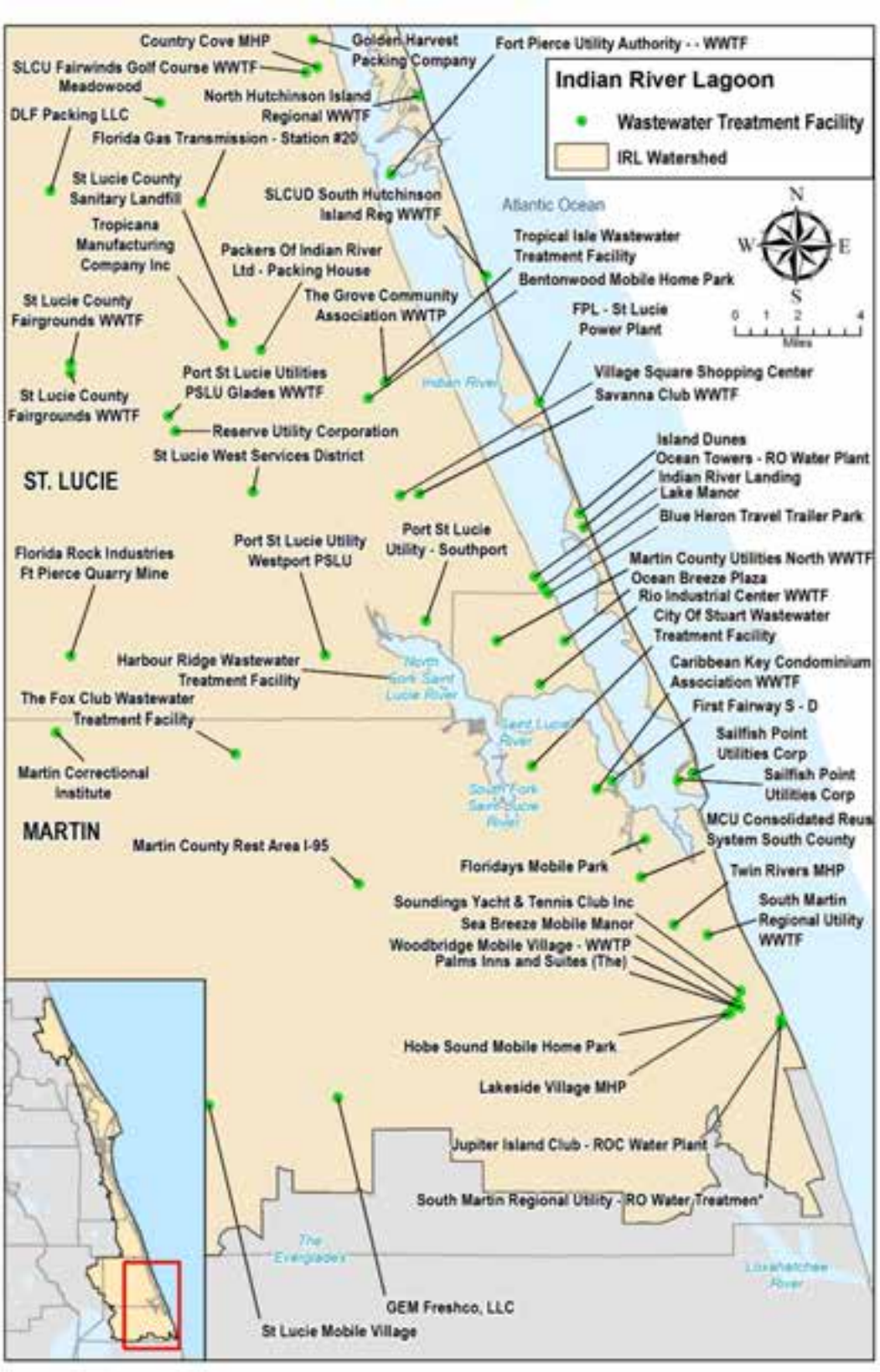


**Figure B-7: Domestic and industrial WWTPs in eastern St. Lucie and eastern Martin Counties in the IRLNEP area**

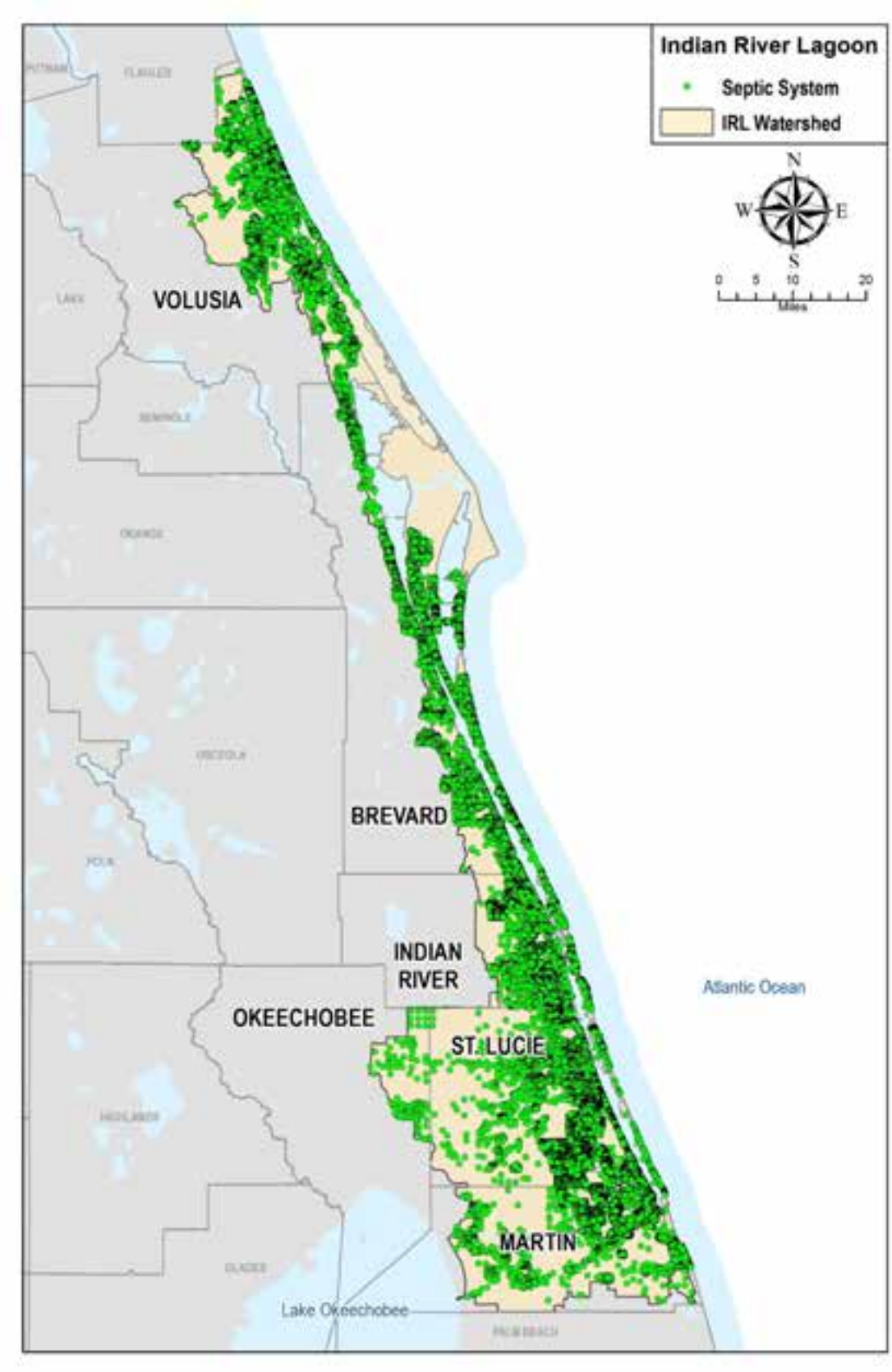


**Figure B-8: Overview of septic systems in the IRLNEP area**

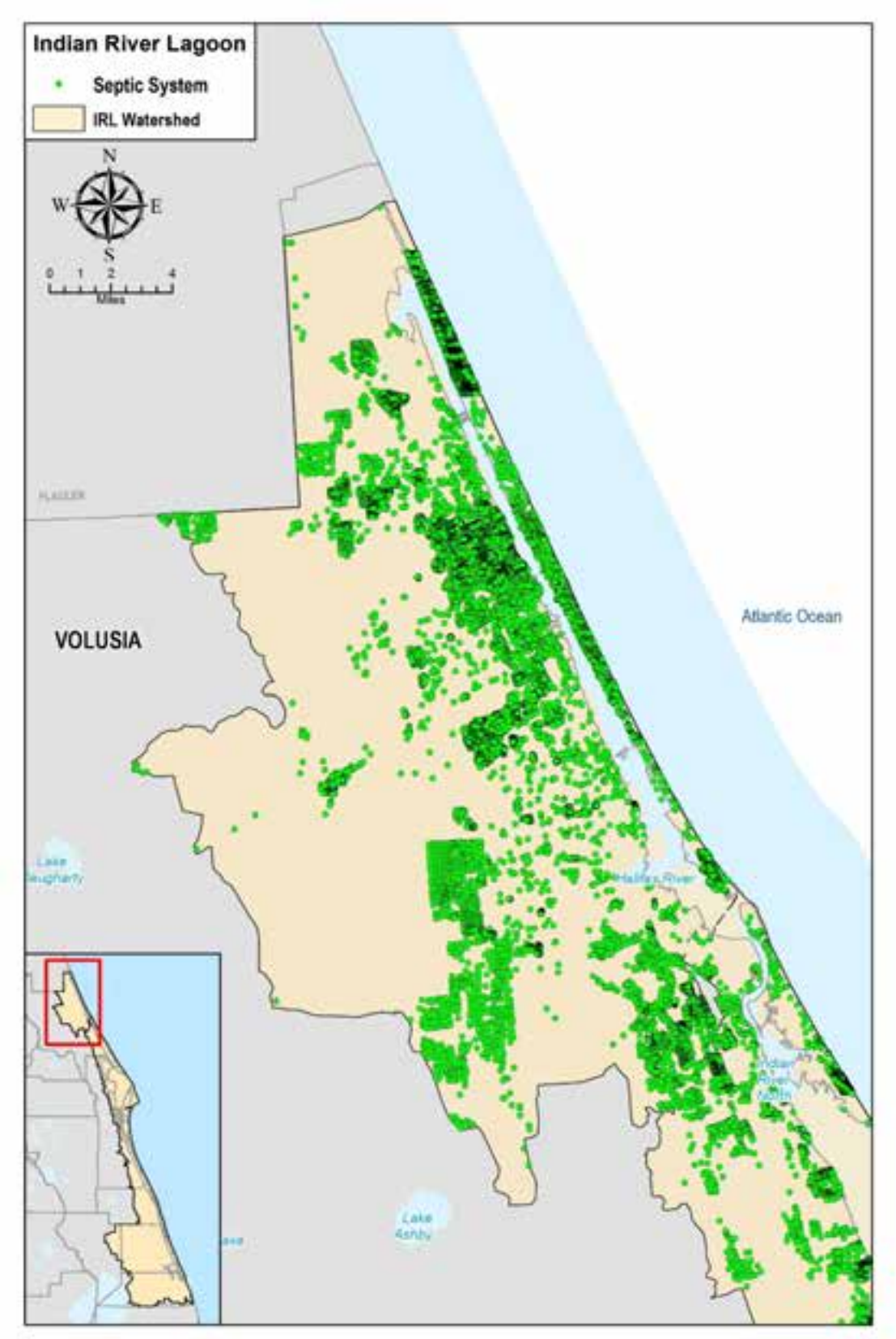


**Figure B-9: Septic systems in Volusia County in the IRLNEP area**

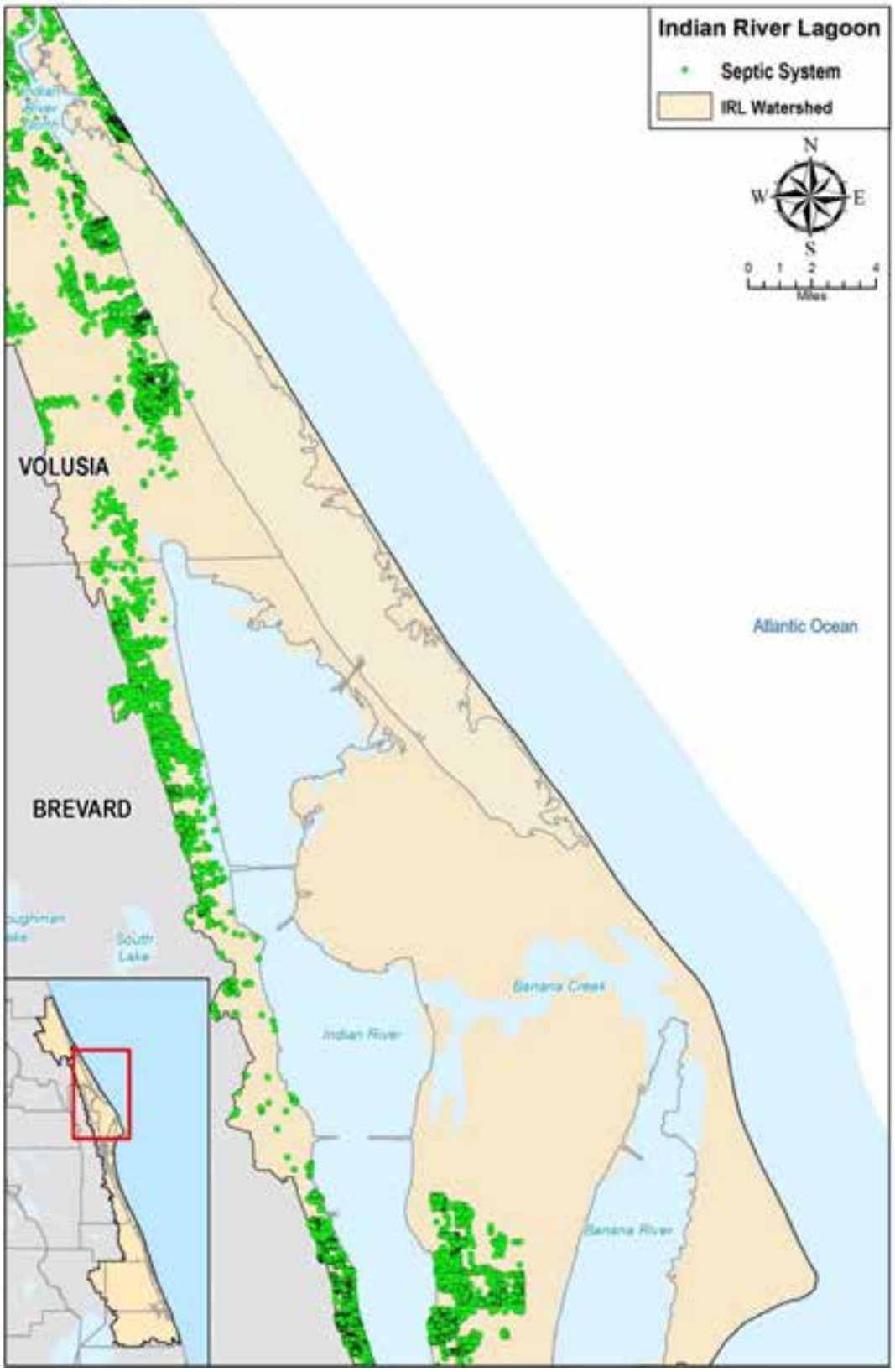


**Figure B-10: Septic systems in southern Volusia and northern Brevard Counties in the IRLNEP area**

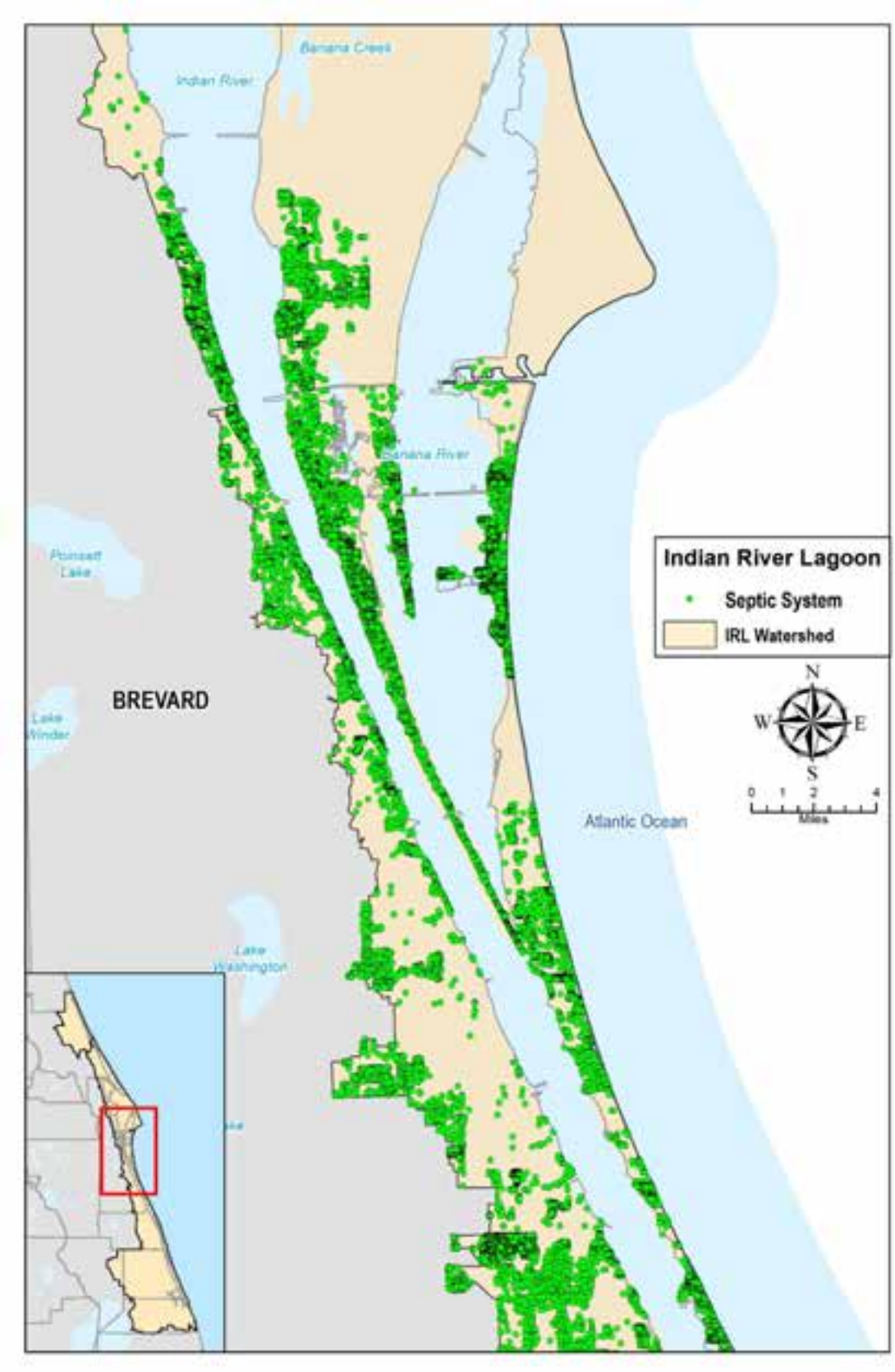


**Figure B-11: Septic systems in central Brevard County in the IRLNEP area**

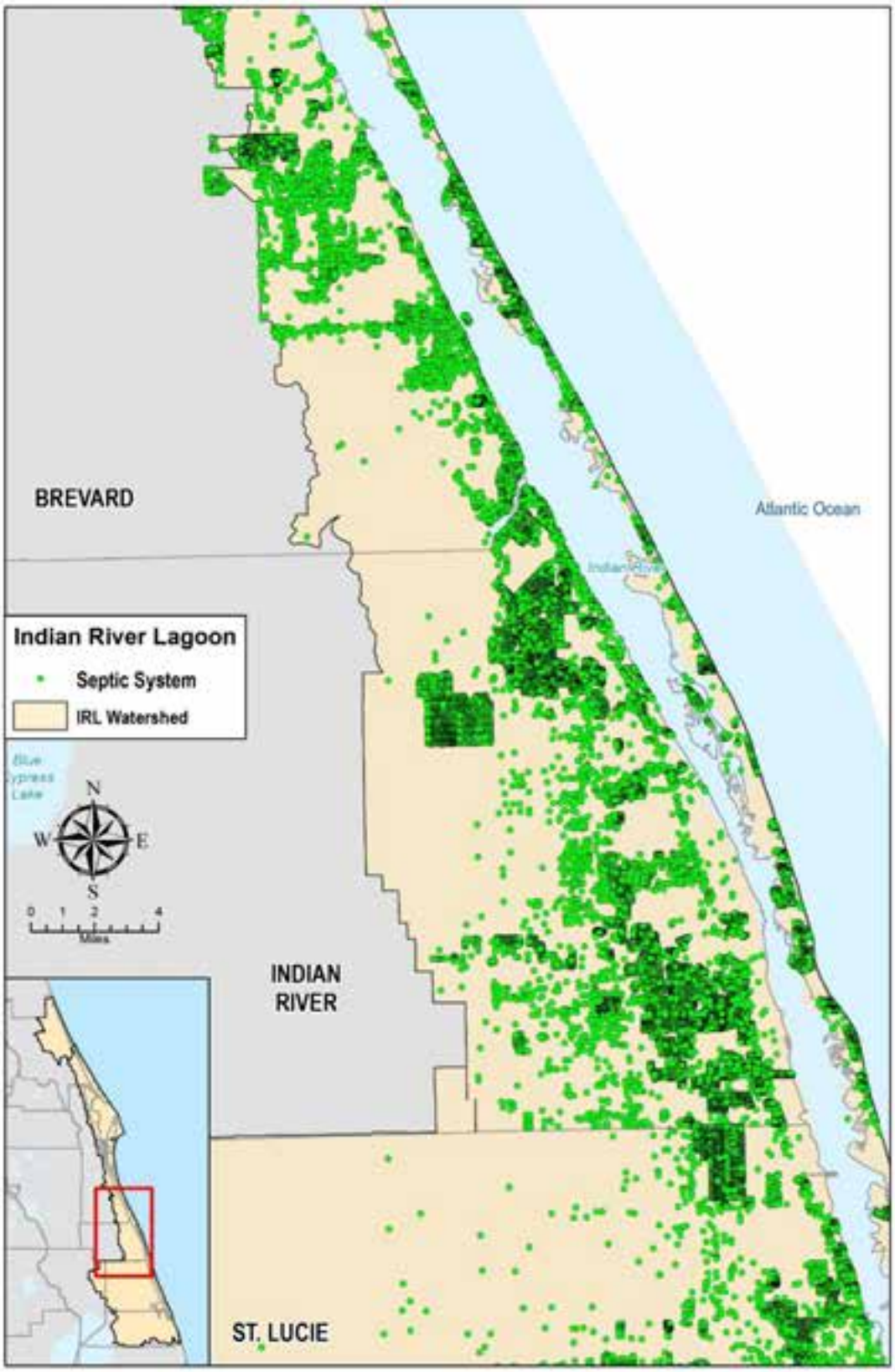


**Figure B-12: Septic systems in southern Brevard, Indian River, and northern St. Lucie Counties in the IRLNEP area**

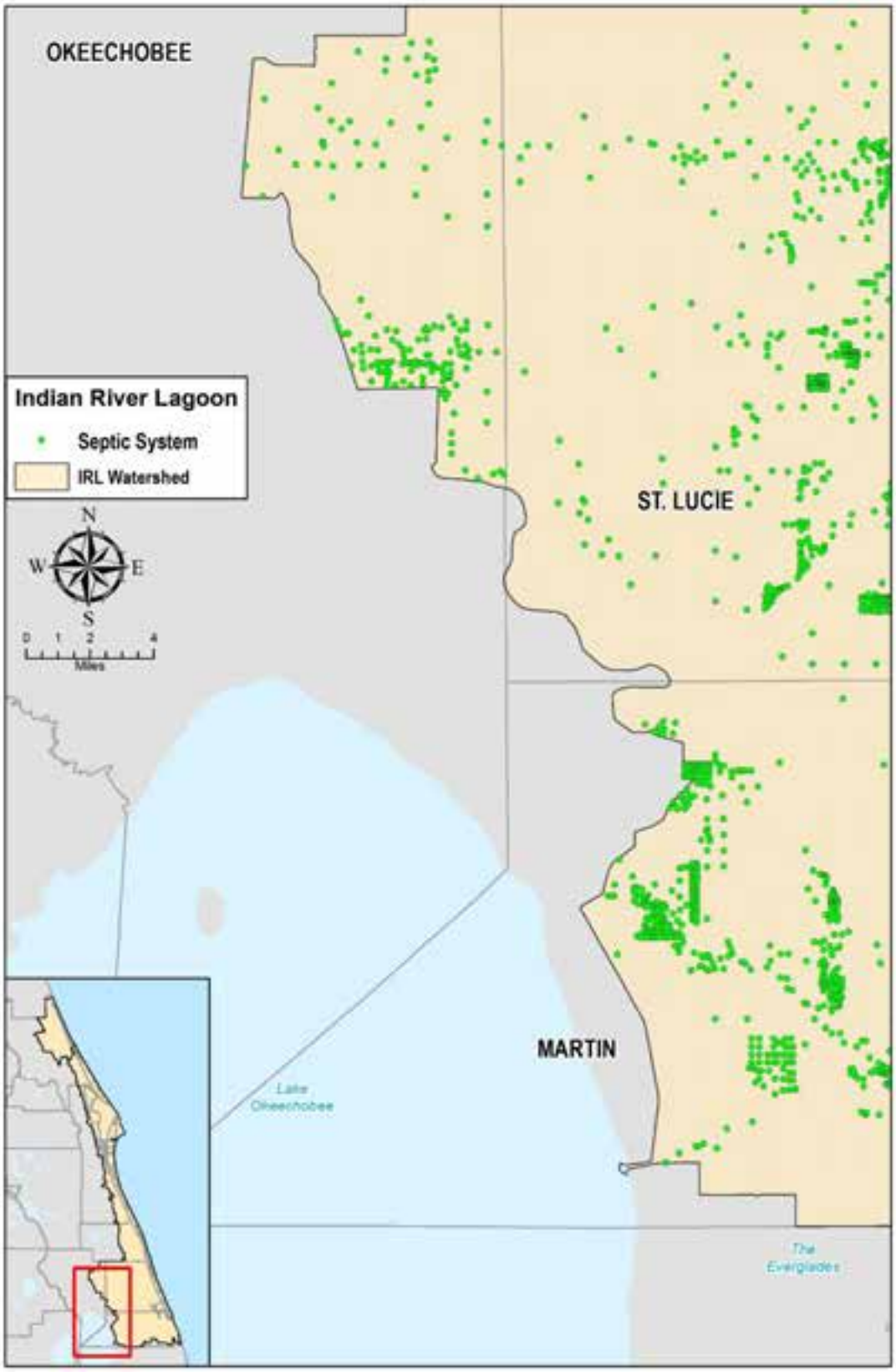


**Figure B-13: Septic systems in western St. Lucie, western Martin, and Okeechobee Counties in the IRLNEP area**

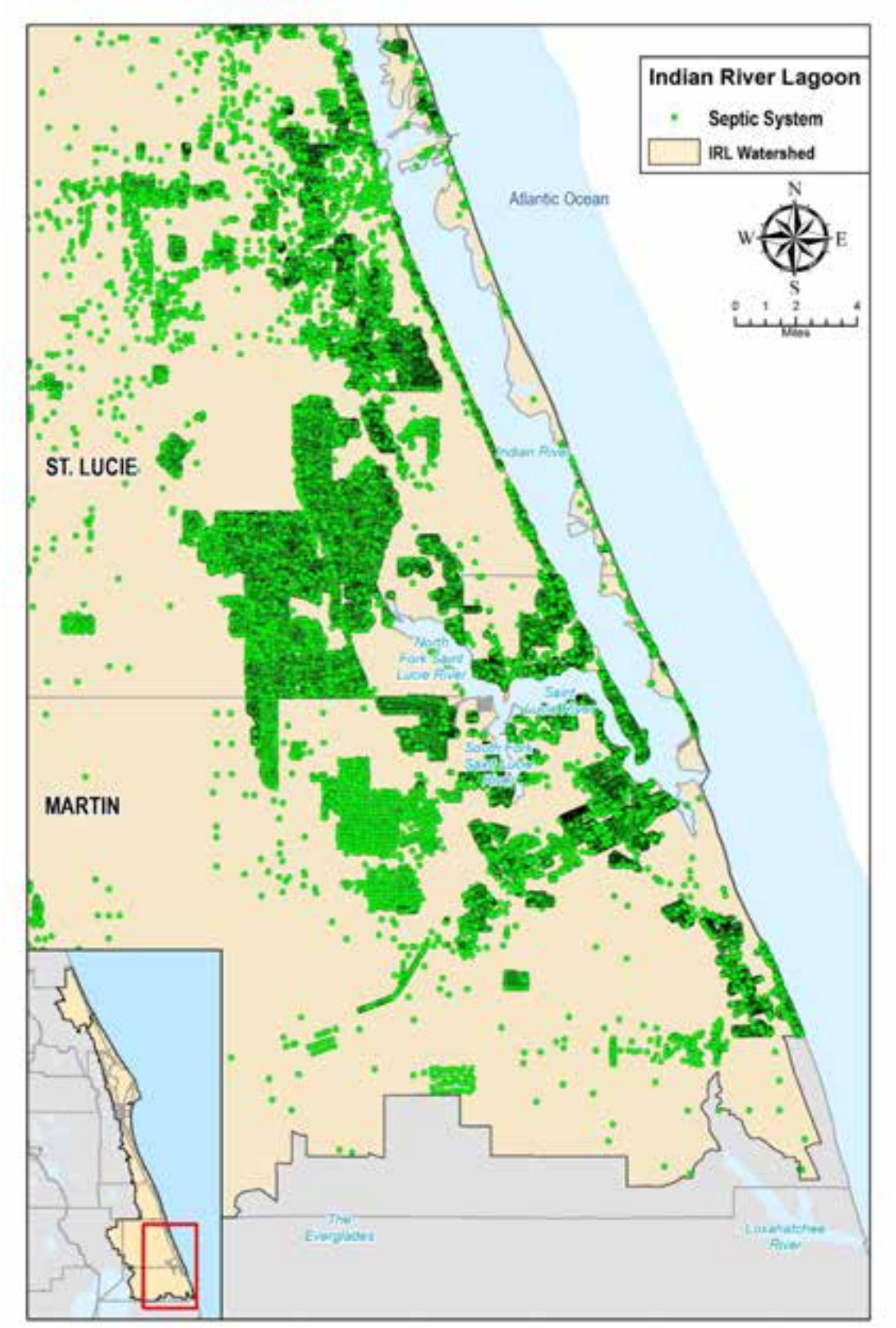


**Figure B-14: Septic systems in eastern St. Lucie and eastern Martin Counties in the IRLNEP area**

# APPENDIX C. AGRICULTURAL BMP ENROLLMENT

**Implementation of Agricultural Best Management Practices**

The Florida Watershed Restoration Act of 1999 directed DEP, FDACS, and WMDs to work together to reduce pollution in Florida's waters, citing BMPs as the best way to accomplish this task. BMPs are the future of agriculture in Florida, and are guidelines advising producers how to manage the water, nutrients, pesticides, herbicides, and other potential pollutants that agriculture uses to minimize impacts on the state's natural resources. Through the Office of Agricultural Water Policy (OAWP), Florida Forest Service, and Division of Aquaculture, FDACS develops, adopts, and assists producers in implementing agricultural BMPs to improve water quality and conservation. Adopted BMPs are initially verified by DEP as reducing nutrient loss to the environment. OAWP BMPs are published in commodity-specific manuals that cover key aspects of water quality and water conservation. The BMP categories include:

- Nutrient management practices that help determine appropriate source, rate, timing, and placement of nutrients (both organic and inorganic) to minimize impacts to water resources.
- Irrigation and water table management practices that address methods for irrigating to reduce water and nutrient losses to the environment and maximize the efficient use and distribution of water.
- Water resource protection practices, such as buffers, setbacks, and swales to reduce or prevent the transport of nutrients and sediments from production areas to water resources.

The Notice of Intent to implement BMPs and BMP checklist are incorporated into each manual. Information on the BMP manuals and field staff contact information can be obtained at: http://www.freshfromflorida.com/Divisions-Offices/Agricultural-Water-Policy. Printed BMP manuals can be obtained by contacting OAWP field staff.

OAWP outreach to solicit enrollment extends to all types of agricultural operations but is more intensive in BMAP areas because of the relationship of BMPs to the presumption of compliance with water quality standards in a BMAP area. FDACS field staff work with producers to enroll them in the BMP program by signing a Notice of Intent. Enrollment is based on the expectation that producers recognize and address the water quality and conservation issues associated with their operations. Upon completion of all information in the BMP checklist, a Notice of Intent must be signed by the landowner or the landowner's authorized agent (who may be the producer if the producer is not the landowner). **Table C-1** summarizes FDACS BMP Program enrollment within the IRLENP area. **Figure C-1** shows the agricultural acres enrolled in the FDACS BMP Program in the IRLNEP area as of July 31, 2018.

**Table C-1. FDACS BMP enrollment in the IRLNEP area**

| BMP Manual | Acres Enrolled |
|---|---|
| Citrus | 81,505 |
| Conservation Plan Rule | 1,316 |
| Cow/Calf | 133,448 |
| Dairy | 5,757 |
| Equine | 704 |
| Fruit/Nut | 11 |
| Lake Okeechobee Protection Plan | 13,154 |
| Multiple Commodities | 25,156 |
| Nursery | 1,758 |
| Row/Field Crops | 38,813 |
| Sod | 1,275 |
| **Total** | **302,897** |

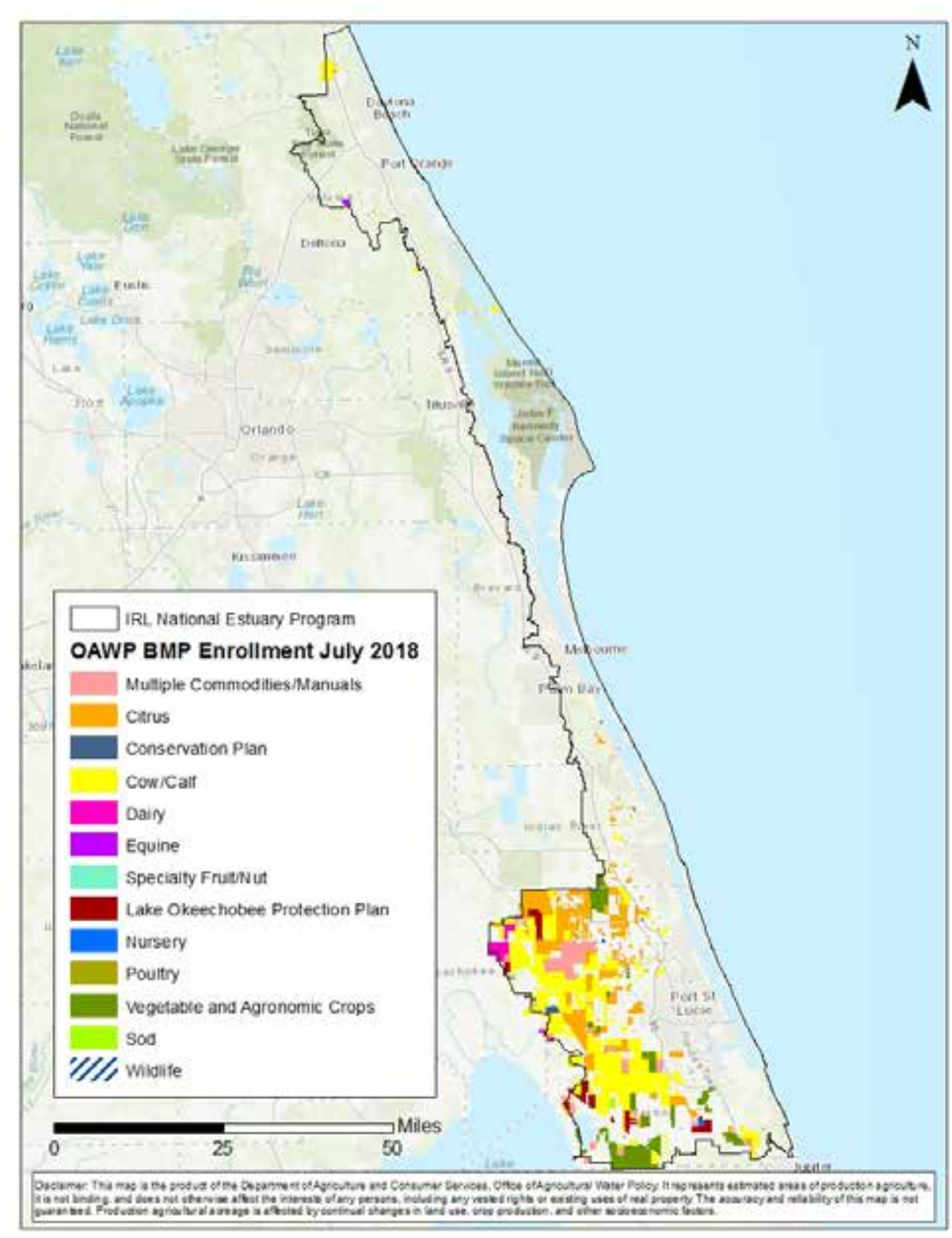


**Figure C-1. BMP enrollment in the IRLNEP area as of July 31, 2018**

**FDACS OAWP Role in BMP Implementation and Follow-Up**

OAWP works with producers to submit Notices of Intent to implement the BMPs applicable to their operations, provides technical assistance to growers, and distributes cost-share funding, as available, to eligible producers for selected practices. OAWP follows up with growers through site visits to evaluate the level of BMP implementation and record keeping, identify areas for improvement, if needed, and discuss cost-share opportunities.

When DEP adopts a BMAP that includes agriculture, it is the agricultural producer's responsibility to implement BMPs adopted by FDACS to help achieve load reductions. If land use acreage corrections and BMP implementations do not meet the current agricultural load reduction allocation, it may be necessary to develop and implement additional projects and practices that reduce nutrients from agricultural nonpoint sources and will require additional funding sources and producer participation. In that case, FDACS will work with DEP and water management districts to identify appropriate options for achieving further agricultural load reductions.

Section 403.067, Florida Statutes, requires that, where water quality problems are demonstrated despite the proper implementation of adopted agricultural BMPs, FDACS must reevaluate the practices, in consultation with DEP and stakeholders, and modify them if necessary. Continuing water quality problems will be detected through the BMAP monitoring component and other DEP and water management district activities. If a reevaluation of the BMPs is needed, FDACS will also include water management districts and other partners in the process.

**OAWP Implementation Verification Program**

OAWP established an Implementation Assurance Program in 2005 in the Suwannee River Basin as part of the multi-agency/local stakeholder Suwannee River Partnership. In early 2014, OAWP began to streamline the Implementation Assurance Program to ensure consistency statewide and across commodities and BMP manuals. The Implementation Assurance Program was based on interactions with producers during site visits by OAWP staff and technicians as workload allowed. For the visits, field staff and technicians used a standard form (not BMP specific) developed in 2014, that focused on nutrient management, irrigation management, and water resource protection BMPs common to all BMPs that were adopted by rule. Once completed, these paper forms were submitted to OAWP staff and compiled into a spreadsheet, and the data were reported annually.

On November 1, 2017, the OAWP's Implementation Verification rule (Chapter 5M-1, Florida Administrative Code) became effective. The Implementation Verification Program provides the basis for assessing the level of BMP implementation and for identifying enrolled producers who require assistance with BMP implementation. The components of the Implementation Verification Program are (1) site visits, (2) implementation status reporting on common practices that apply across all BMP manuals, (3) technical assistance, and (4) external reporting. Implementation verification is confirmed by field staff through site visits and by producers through annual self-verification of the common practices.

Site visits to agricultural operations by OAWP field staff and contract technicians are the most effective means to determine the level of BMP implementation. These visits also provide an opportunity to identify needs for assistance with implementation and explore potential improvements. Resource limitations prevent site visits from occurring on all enrolled operations every year, and for that reason, site visits are prioritized. The program objective is for field staff to conduct site visits for 5–10% of active Notices of Intent each year, with approximately 10% of the site visit locations selected randomly.

Per the Implementation Verification rule, each year producers participating in the BMP program will be requested to report on the implementation of common practices for their operations. Lack of response from enrollees with parcels in a BMAP area raises the priority of the operation for a site visit from field

staff. Where a need is identified, OAWP may facilitate technical assistance for the producer from UF-IFAS or other resources, including third-party vendors. In some cases, cost-share support may be available. Data from producers and site visits will be used to complete the OAWP's annual report on the status of BMP implementation as required by Section 403.0675(2), Florida Statutes.

**BMP Enrollment Data and Manuals**

OAWP maintains a database on the implementation of BMPs for producers enrolled in BMP programs and creates spatial data that show agricultural BMP enrollment by manual statewide.

FDACS OAWP has adopted BMPs for commodities shown in **Table C-2**. The BMPs are designed to improve water quality while maintaining agricultural production. Each BMP manual covers key aspects of water quality and water conservation. These manuals are located at https://www.freshfromflorida.com/Business-Services/Water/Agricultural-Best-Management-Practices.

**Table C-2. FDACS BMP manuals**

| Manual | Adoption Date | Rule Reference | Next Review |
|---|---|---|---|
| Cow/Calf | 2009 | 5M-11 | Under Review |
| Sod | 2008 | 5M-9 | Under Review |
| Specialty Fruit and Nut | 2011 | 5M-13 | Under Review |
| Equine | 2012 | 5M-14 | Under Review |
| Citrus | 2013 | 5M-16 | Under Review |
| Nursery | 2014 | 5M-6 | 2019 |
| Vegetable and Agronomic Crops | 2015 | 5M-8 | 2018 |
| Dairy | 2016 | 5M-17 | 2021 |
| Poultry | 2016 | 5M-19 | 2021 |
| Small Farms | Pending | Pending | Pending |