PROCEEDINGS

Opening Remarks

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Session 1 – Aquatic Habitat Research

Marine Debris and Other Anthropogenic Effects on the Endangered Smalltooth Sawfish

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The population of endangered smalltooth sawfish (*Pristis pectinata*) in the United States declined throughout the twentieth century due mainly to bycatch mortality from net fisheries. While conservation, management, and outreach efforts have reduced these threats, the species is still at risk from other direct anthropogenic effects such as entanglement in recreational and commercial fishing gear and various forms of marine debris. The impact of marine pollution has increased since research began on the species in the early 2000s. From 2017 to 2021, data from research and the U.S. Sawfish Recovery Hotline (1-844-4-SAWFISH; sawfish@MyFWC.com) documented 176 reports of individuals that were entangled, injured, or died from debris

interactions. While recreational and commercial fishery gears (e.g., trawls, gill nets, cast nets, fishing tackle) remain the most frequent entanglement issues for sawfish, other household and miscellaneous items are increasingly present. A concerning number (at least 30) sawfish with encircling debris (e.g., monofilament loops, rubber bands, hair ties, ball-bungee cords) around anterior parts of their bodies have been encountered in southwest Florida. The ball bungee cord issue has emerged in recent years and is likely related to increased numbers of covers on boat lifts; this issue is expected to intensify in the coming years due to the destruction from Hurricane Ian and installation of more boat lift covers. Collectively, these encircling items have caused severe injuries (e.g., interfered with spiracle, gill, and mouth function) and led to the death of at least one individual. Clearly, outreach will need to be an ongoing priority to help address these marine pollutants, their sources, and the impacts they can have on recovery of this endangered species.

Ontogenetic Shifts in Habitat Use by Endangered Smalltooth Sawfish in Southwest Florida Nurseries

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In southwest Florida, endangered smalltooth sawfish (*Pristis pectinata*) use nursery habitats for at least their first 2 or 3 years. Past studies have analyzed fine-scale movements and habitat use of small juveniles within the two riverine nurseries of Charlotte Harbor, as well as state-wide migrations of large juveniles and adults. Building on past studies, we aim to better understand the way juveniles use and occupy space within the nurseries as they grow. From 2017 through 2021, gill nets and hook gear (i.e., drumlines and rod and reel) were used to catch and tag juveniles in the Charlotte Harbor estuary, including 180 that were implanted with 5- or 10-year acoustic transmitters. This study will analyze catch and acoustic telemetry data to visualize movements, characterize residency, and compare home range across size classes. We hypothesize that juveniles use deeper water and expand their home range as they grow. Understanding ontogenetic shifts in habitat use will inform management decisions, such as designating large juvenile and adult critical habitat.

Shifting Baselines: Effects of Seagrass Loss on Nekton Communities in Southwest Florida Tidal Creeks

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Phase shifts can occur in marine ecosystems because of external stressors. Such shifts from one steady state (e.g., clear water, vast seagrass) to another (e.g., phytoplankton blooms, bare substrate) are being documented worldwide. In coastal environments, the external stressors that cause phase shifts are numerous and frequently interact, yet case studies often implicate altered hydrology and increased nutrient input. Tidal creeks may be especially prone to phase shifts because of their position in the landscape, which exposes them to the brunt of deleterious effects caused by coastal development. We analyzed an eight-year dataset (2014-2022) acquired by

fisheries-independent monitoring using 21.3-m seines in tidal creeks on the Cape Haze peninsula of the Charlotte Harbor estuary, Florida. Multivariate analyses identified a change in fish assemblages that coincided with algal blooms and seagrass loss in a tidal creek downstream of development; these changes did not occur in creeks downstream of more natural habitat. Reductions in benthic species, such as rainwater killifish *Lucania parva*, were offset by increases in the planktivorous bay anchovy *Anchoa mitchilli*. The phase shift observed in a tidal creek in need of hydrologic restoration may be a harbinger for seagrass losses that are starting to occur in the open estuary. Inter-agency coordination will be needed to implement estuary-wide strategies for conservation, mitigation, and restoration.

Navigating the Gauntlet – Juvenile Tarpon Emigration from Coastal Ponds in Southwest Florida

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Coastal wetlands worldwide are threatened by disrupted hydrology, urbanization, and sea-level rise. In southwest Florida, coastal wetlands include tidal creeks, many of which terminate into a series of coastal ponds that are the primary habitat used by juvenile tarpon, an important sport fish. Such coastal ponds occur at the interface with uplands and are ephemerally connected to the open estuary creating conditions of variable dissolved oxygen (0.5–7 mg/L) and salinity (0–40 psu). Tarpon can tolerate these conditions, but little is known about how they leave the remote nursery habitats, which often requires them to cross ~1 km mangrove forest to reach the open estuary. An acoustic telemetry study (n=56 juvenile tarpon tagged; ~ 360–660 mm TL) accompanied with the use of water-level loggers was conducted on the Cape Haze peninsula of Charlotte Harbor, Florida to track juvenile tarpon emigration from coastal ponds to open estuarine waters. A generalized-linear model found that low barometric pressure, high water level, and fish size were important factors allowing for tarpon emigration. Tarpon left during summer king tides in ponds close to tidal creeks, while tropical storm conditions were needed to allow for emigration from ponds farther in the landscape. After leaving coastal ponds, tarpon were detected in arrays located at the mouths of large rivers 30 km up-estuary. The characterizations of water levels and event criteria needed for successful tarpon nurseries make it possible to incorporate coastal ponds in restoration designs and potentially through modification of stormwater ponds in urbanized settings.

Session 2 – Water Quality

The Hangover Effect: Coupling Seagrass Loss, Macroalgal Growth, & Water Quality in Charlotte Harbor

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Charlotte Harbor, in southwest Florida, is the second largest open water estuary in Florida with a surface area of approximately 700 square kilometers. From 1988 to 2018, seagrass coverage remained relatively stable between roughly 17,000 and 20,000 acres. In 2020, seagrass coverage reached its lowest level in 32 years, since the Southwest Florida Water Management District began mapping seagrass. Between 2018 and 2020, the Harbor lost an unprecedented 4,442 acres of seagrass. Most notably, the east side of Charlotte Harbor, known as "the east wall," lost half (1,760 acres) of its seagrass. Concurrent with seagrass loss was an explosion of drift and attached benthic macroalgae. This relatively sudden shift from seagrass to macroalgae occurred in the wake of a protracted regional red tide event that lasted approximately 15 months from October 2017 to January 2019. While red tide was extreme in many coastal areas along southwest Florida, the east wall was largely spared direct impact. We hypothesize that seagrass loss and macroalgal proliferation along the east wall was not a direct result of red tide, rather it was a function of its aftermath, a phenomenon we term "the hangover effect." During and after the major red tide event, massive amounts of nutrients from dead and decaying organisms were likely released into the water column. Many of these nutrients likely re-mineralized, became bioavailable in the water column, and were rapidly assimilated by benthic macroalgae. We utilize seagrass maps, aerial imagery, water quality data, and hydrodynamic modeling to support the idea that "the hangover effect" at least in part led to the greatest loss of seagrass in Charlotte Harbor in over 30 years. As a post-script to this story, we will also examine the most recent 2022 (pre-Hurricane Ian) seagrass mapping results to see if "the hangover" persists, or if there are some signs of recovery.

Water Quality Trends in the Peace River Basin & Estuary

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The University of Florida Center for Coastal Solutions recently completed an interdisciplinary research project to understand water quality and hydrodynamics in the Peace River basin and estuary, relationships between water quality and the regional economy, and stakeholders' impressions of water quality issues and their effects. This presentation describes empirical work on water quality dynamics in the Peace River basin and estuary, between approximately 2000 and 2021. Nitrogen concentrations in the estuary's water column have been elevated and trending upward over the past 10 years, and nitrogen hot spots span the full basin, from the headwaters to the estuary. Phosphorus concentrations in the estuary have been below the numerical criterion for over 10 years, but phosphorus hot spots span the middle to upper basin. In addition, preliminary causal results reveal a potential link between Charlotte Harbor red tide blooms and nitrogen loads from the Peace River basin, suggesting that nutrient loads from the Peace River have broad systematic effects throughout Charlotte Harbor. This research is ongoing and will be expanded to a provide a 20-year history of water quality for the full CCHMN area (Coastal Charlotte Harbor Monitoring Network) as well as a causal analysis of Peace River nutrient loading and its effects on Charlotte Harbor, to complement earlier work linking Charlotte Harbor red tides to Lake Okeechobee discharges and nitrogen loads.

Synthesizing Monitoring Data with a 1D Model for the Assessment of Water Quality Conditions in the Caloosahatchee River Estuary, Florida

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Assessment of changing water quality conditions in an estuary that is susceptible to significant algal bloom risk is a challenging task for water managers. Monitoring data including regular periodic sampling and episodic event-based sampling are used to provide important information for the condition of the estuary that may be used to develop predictive tools to understand how future conditions may evolve. A one-dimensional (1D) mathematical model was developed for the analysis and synthesis of the monitoring data. The model is a modified version of a previously developed analytical solution for a riverine estuary (Sun et al., 2022). It solves a cross-sectionally and tidally averaged 1D advection-dispersion-reaction equation with first order kinetic assumptions for water quality constituents including nutrients and chlorophyll a. Net primary production for algae was computed based on an empirical primary production model in coastal waters (Mathew et al., 2015; Sun et al, 2021). The 1D equation was solved semi-analytically using the salt-balance approach (Rattray and Officer, 1979) with a realistic configuration for the Caloosahatchee River Estuary and observed or modeled salinity from a hydrodynamic model (Sun et al., 2016). The model was applied to survey events of monthly water quality monitoring performed by the South Florida Water Management District. Results demonstrated good model performance with R2 between modeled and observed better than 60% and 50% for nutrients and chlorophyll a, respectively and was able to reproduce the observed longitudinal profiles for nutrients and chlorophyll a. The model suggests that the observed chlorophyll a profile could be a good indicator of strength of algal growth, making it a promising synthesizing tool for the assessment of the water quality conditions in the estuary.

Water Quality Trends and Responses to Specific Events in Estero Bay Aquatic Preserve [2005-2022]

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Water quality influences the health and productivity of estuarine habitats as well as human health, recreation, and economic opportunity. Over fifty years ago, Estero Bay was designated as Florida's first aquatic preserve, to be maintained in its essentially natural condition for the benefit of future generations. It is also designated as Outstanding Florida Waters, along with its tributaries, and water quality is therefore protected by the Florida Department of Environmental Protection. Estero Bay is a shallow estuarine system with saltwater in-flows from the Gulf of Mexico and freshwater inputs from five tributaries—Hendry Creek, Mullock Creek, Estero River, Spring Creek, and Imperial River. Many activities within the watershed have the potential to impact water quality within the bay, such as point- and non-point sources of pollution, hydrological modifications, increased development and associated impervious surface area, and loss of wetlands. Since mid-to-late 2004, Estero Bay Aquatic Preserve staff have maintained a network of continuously deployed multiparameter water quality instruments (data sondes) at three sites located in northern, central, and southern reaches of Estero Bay. A fourth station was added in 2021 near the confluence of Hendry and Mullock Creeks. The data sondes measure

temperature, specific conductivity, salinity, pH, dissolved oxygen, turbidity, and depth at fifteen-minute intervals. The data undergo a quality assurance check utilizing the procedures of the National Estuarine Research Reserves' Centralized Data Management Office during which readings are rejected or marked as suspect if appropriate. The purpose of this network is to establish baseline water quality for Estero Bay and evaluate daily, seasonal, and long-term trends in water quality. The frequency of data points provides DEP and other local water quality managers the ability to assess short-term impacts of specific events, such as hurricanes, and long-term trends across the span of years. Using the eighteen full years of data recorded, we conducted some of these long-term analyses using seasonal Mann-Kendall tests and report on changes in the parameters over time. We also looked at the data surrounding Hurricanes Irma (2017) and Ian (2022) to compare their impacts. Long-term datasets, such as those from Estero Bay Aquatic Preserve's continuous water quality monitoring program, are invaluable as a resource to assist in advancing our understanding of how human activities and natural disasters within our watersheds may potentially impact downstream, estuarine water quality as well as the habitats and organisms that these waters support.

Session 3 – Public Engagement

Citizen Science: A Two-Prong Approach to Addressing Florida's Seagrass Loss

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Seagrasses offer a variety of ecosystem services including shoreline stabilization, nutrient cycling, nursery habitat, and blue carbon storage. Regular monitoring is necessary to quantify the value of seagrass, particularly in the face of global seagrass loss and local restoration efforts. However, high costs of long-term monitoring regularly prevent seagrass conservation projects from reaching their full potential. Eyes on Seagrass proposes a solution using citizen scientists that would close data gaps, increase capacity, and foster a sense of stewardship in participants. Methods executed by volunteers were designed with state agency collection in mind, allowing integration with regulatory datasets. Since the implementation in 2019, more than 70 sites have been surveyed annually in Southwest Florida and the Panhandle outside of state agency monitoring, a service valued nearly $52,000. In addition, every participant gained knowledge of seagrass ecology and threats, with an additional 91% implementing behavior to protect it. Citizen science represents an untapped resource in the fight against habitat degradation. Established programs like Eyes on Seagrass provide a chance to discuss barriers, expansion opportunities and the potential for similar programs to study other valuable habitats.

Manatee County Environmental Lands Program and Candidate Property Dashboard Enable Prioritizing Land for Conservation Acquisition

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A grassroots effort, led by individuals and organizations throughout the region, resulted in a successful 2020 Referendum to finance the purchase, improvement, and management of conservation lands in Manatee County. The Conservation and Parks Projects Referendum calls for a 0.15 mill ad valorem tax and up to $50,000,000 in general obligation bonds to finances the acquisition, improvement, and management of land to protect water resources, preserve fish and wildlife habitat, and provide parks.

The Referendum is being implemented through the Environmental Lands Program and the Environmental Lands Management and Acquisition Committee (ELMAC), an Advisory Board to the Board of County Commissioners, who decide which properties are purchased. The program provides for both fee simple and conservation easement acquisition. Anyone can nominate a property for conservation acquisition using an online form.

Four main criteria are used to assess Natural Resource Value in screening and prioritizing land for conservation acquisition:

1) Ecological Quality – quality of species or habitat, degree of alteration or degradation, level of restoration required; 2) Rarity of Species or Habitat – uniqueness, number of threatened, endangered or species of special concern supported; 3) Importance to Water Resources – protection of or degradation to portable water supply or aquatic environment; and 4) Connectivity – proximity to existing conservation lands or planned corridor, size of connection.

While the Natural Resource Value criteria above address the purpose of the Referendum, these specific elements are evaluated to determine how well sites meet the purpose of the Referendum: 1) Drinking Water Protection; 2) Water Quality Protection; Prevention of Stormwater Runoff Pollution; 3) Preservation of Fish Habitat; Preservation of Wildlife Habitat; and 4) Provision of Parks.

Conservation priorities of other organizations are also considered in the review and selection process. Partnerships with other organizations result in additional funds and resources that support the success of the program.

The use of limited referendum funds for acquisition, restoration, capital improvements for passive recreational use, and long-term management are important decisions that require transparency and accountability. A Candidate Property Dashboard was created to allow staff, stakeholders, partners, public, ELMAC members, and the BCC to investigate candidate properties for conservation acquisition prior to making recommendations or decisions for acquisition. The dashboard characterizes the natural resources of the properties, how well they meet the intent of the Conservation and Parks Projects Referendum, and provides other key information needed to prioritize land for conservation acquisition. Dashboard indicators for candidate properties can be readily compared, and properties can be interactively explored with relevant maps at an individual's convenience and interest level.

With each new property, an automated GIS analysis feeds results into to the dashboard, avoiding the need for time consuming analyses and ongoing reporting. Only properties with willing sellers are considered for conservation acquisition and included in the dashboard. An online Hub for community engagement is anticipated in the future, as well as StoryMaps for acquired properties. An annual report will provide for accountability and oversight measures using performance measures and financial reporting. The web page will include periodic updates with news and dashboard indicators.

Engaging K-12 Audiences in Their Watershed Through Use of Geospatial Technologies

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The Center for Environment and Society, within FGCU's the Water School, has partnered with Southwest Florida school districts to develop a GIS enhanced curriculum to get students into the schoolyard and thinking critically about their watershed. The TREES (Teaching Resiliency through Environmental Education in Schoolyards) curriculum, is based on Florida math and science standards, integrates targeted schoolyard learning time with data collection and analysis. All topics within TREES are based on current research, teaching, and techniques used at the Water School's departments of ecology & environmental studies and marine & earth sciences. By using GIS, students and teachers must go into their schoolyard to collect geospatial and environmental data during the school day. By leveraging this technology, schools are able to easily meet the needs of their students and community through standards based long-term inquiries into their local watershed. Training teachers in the use of GIS, piloting curriculum in classrooms, and developing engaging SWFL focused inquiries based on the work of the Water School, brings environmental and watershed literacy to communities throughout a student's lifetime.

GIS is a powerful tool underutilized in the K-12 educational setting. By leveraging the easy-to-use interfaces within Survey 123, Web Mapping Applications, and Dashboard, K-12 teachers in partnership with FGCU faculty, staff, and students, can use their schoolyards as living laboratories sharing their data across the school district and southwest Florida community. Others will learn how to implement a sustainable program that can be adopted within a school district connecting teachers, classrooms, and local watershed data through ArcGIS online applications that was piloted in middle and elementary school science classrooms in southwest Florida.

Connecting Concepts: Local Youth Relate Water Quality and Macroinvertebrate Biodiversity in a Hands-On LIFE Lab

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Today, young people are increasingly isolated from the natural world, highlighting the need to provide opportunities for youth to explore their environment in ways that are engaging, interactive, and thought-provoking while modeling future career opportunities in the sciences. To this end, a Water Quality and Biodiversity Lab was developed and delivered as part of *Learning in Florida's Environment* (LIFE), an environmental education program coordinated by UF/IFAS Extension Sarasota County in partnership with Florida State Parks, Sarasota County Parks, and Sarasota County Schools. Our objective was to introduce students to the concept of water quality and the use of scientific equipment by measuring several parameters and relating measured

values to macroinvertebrate biodiversity observed in real-time at Lake Osprey in Oscar Scherer State Park.

An initial lesson was held in the classroom where children were introduced to concepts including biodiversity, water quality, and the types of equipment that they will be using in the field. The field lesson took place at Lake Osprey in Oscar Scherer State Park and began with exploring water quality by measuring the pH, temperature, and Dissolved Oxygen (mg/L) of a sample collected from the lake. Students were split into three groups, one for each parameter, and each group was given a data sheet. Each group would participate in a facilitated discussion about the importance of their water quality parameter, then was given the opportunity to analyze the water using handheld field instruments.

After each parameter was measured, students were asked to use what they learned about water quality to develop a hypothesis about the level of biodiversity they might observe in Lake Osprey. All student groups demonstrated the ability to develop a logical hypothesis using what they learned about pH, temperature, and dissolved oxygen. Upon completion of the water quality analysis, each group was presented with a plastic bin containing live macroinvertebrates that were collected by dipnet from the lake prior to the lesson. Students carefully examined the contents of the bins, counting the different types of macroinvertebrates and marking their findings on their data sheet. After examining their bins all student groups asserted that their hypotheses were correct, demonstrating that the students were able to use critical thinking to connect the concepts of water quality and biodiversity. Upon completion of the program in March, knowledge gain will be calculated by comparing pre- and post-tests.

Applying a Terrestrial Conservation Approach to Better Engage Recreational Fishers in Fish and Habitat Conservation Strategy

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Anthropogenic habitat alteration is a threat to biodiversity globally. Mangroves and other threatened coastal habitats that serve as the transition between terrestrial and estuarine/marine systems are especially vulnerable to the impacts of coastal development and have already suffered significant degradation and loss. Mangrove habitats continue to be lost despite application of an ecosystem services approach to guide mangrove conservation that has been only partly successful. Challenges to conservation are often related to lack of data and public awareness of conservation importance. In terrestrial conservation, these challenges have often been addressed using surrogate species. This includes umbrella species, whose ecological needs are known and encompass the needs of many other species that depend on the same habitats. Lack of public support for conservation has been addressed using flagship species, which are selected based on non-biological characteristics to promote public awareness of conservation needs and increase support for habitat conservation. In this presentation we show that the fish Common Snook (*Centropomus undecimalis*), an obligate user of mangrove creeks and other transitional coastal habitats as juveniles, is an appropriate umbrella species for habitat conservation. Data spanning 16 years across 27 mangrove creeks shows that protecting habitat use by juvenile snook protects an ecologically important fish assemblage of more than 55 native species, further adding value to mangrove habitats. Because snook support an economically

important recreational fishery with a high public profile comprised of fishers with increasing interests in conservation, snook is also an appropriate flagship species that will help leverage collaboration between stakeholders and the fishery management agency. Although the species of focus here is common snook, this approach is applicable in other regions. The concurrence of threatened coastal habitats and economically important recreational fisheries creates an opportunity for collaborative integration of fisheries management and habitat conservation.

Coastal Acidification Network Stakeholder Feedback Project

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The Southeast Ocean and Coastal Acidification Network (SOCAN) and the Gulf of Mexico Coastal Acidification Network (GCAN) have been collecting information on social and environmental vulnerabilities in the US Southeast (SE) and Gulf of Mexico (GoM) in response to the Intergovernmental Working Group on Ocean Acidification's (IWGOA) request for CAN engagement in identifying Ocean Acidification (OA) vulnerabilities and research and monitoring priorities along coastal and estuarine regions. Together, SOCAN and GCAN created a question-and-answer survey to engage SE and GoM stakeholders and presented it as an in-person software application survey as well as a virtual google form survey. This survey asked stakeholders to prioritize research and monitoring needs across both regions based on identified gaps in the draft IWGOA SE and GoM Coastal Communities Vulnerability Assessment. Results of the survey have been synthesized for contribution to development of the IWGOA Research and Monitoring Priorities Reports for the SE and GoM, who will also integrate this feedback in their future working plans. The results of this survey are presented here and will also serve as information for SOCAN/GCAN research, educational, and outreach priorities.

Session 4 – Hydrology

Climate Change Impact on Freshwater Inflows to Estuaries: A Case Study in South Florida Coastal Watersheds

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Climate change can have a significant impact on freshwater inflow to estuaries. Changes in precipitation patterns can affect location, quantity, and timing of watershed runoff, potentially causing flooding and increasing freshwater flow into estuaries bringing high nutrient loads and decreasing salinity. Similarly, droughts can decrease the amount of freshwater flowing into estuaries, harming the estuarine ecosystem, and causing damage to aquatic habitats with elevated salinity.

Significant uncertainties are associated with forecasting future change and variability in places like South Florida; however, temperatures and evapotranspiration are predicted to increase. Assessing the impact of climate change on freshwater inflow, groundwater, and other hydrologic

parameters involves taking projections of climatic variables (e.g., precipitation, temperature) at a global scale, downscaling them to a local scale, then computing hydrologic components for variability and risk of hydrologic extremes in the future.

We investigated how changes in daily temperature and precipitation might translate into changes in freshwater inflows and other hydrologic components. This study aims to assess the potential impact of climate change on freshwater inflows from the south Florida coastal watersheds. Using the watershed water quality model (WaSh), a hydrologic, hydrodynamic, and water quality model initially developed for the unique hydrologic conditions in south Florida, we evaluated potential climate change impacts on freshwater flows to St. Lucie and Caloosahatchee River estuaries. The WaSh model is physically based and developed using long-time series rainfall (NexRad and GRIDIO rainfall data), temperature, evapotranspiration, basin boundary, hydrography including streams and canals features, soil, land use, and land surface elevations. The developed calibrated WaSh model was used to quantify freshwater inflow and evaluate the impact of climate change on freshwater inflow to Estuaries in coastal watersheds. These models will help the South Florida Water Management District better assess total freshwater availability and inflow to the estuaries to manage these systems in an ecologically sound way.

Alligator Creek Stream Restoration – A Pioneer Project in Fish-Friendly Design

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Alligator Creek is an important tidal creek located in southern Sarasota County that flows to Lemon Bay, one of Florida's 41 Aquatic Preserves and an Outstanding Florida Water. The Alligator Creek Basin is approximately 11 square miles in size and is an urbanized drainage basin that comprises approximately 20% of the Lemon Bay Watershed. Historically, Alligator Creek was connected to wetlands but by the 1940s, hydrologic alterations had reduced connections to the historic floodplain and adjacent wetlands. The creek was deeply excavated and channelized to improve drainage. The steep-sided banks are prone to erosion, causing sedimentation of the creek channel, which degrades important benthic and fish habitats. It is currently an impaired waterbody for nitrogen, dissolved oxygen, bacteria, and chlorophyll.

A conceptual plan for the restoration of approximately 3.4 miles, or 42 sq. acres of Alligator Creek and riparian buffer was previously developed by Sarasota County. The project is currently in the design phase with anticipated construction to begin in 2024. The County hired WSP, formerly Wood Environment and Infrastructure, to design the project and they have included Mote Marine Laboratory and Aquarium (Mote) as a subconsultant. Objectives for the proposed stream restoration and enhancement portion of the project include water quality improvements realized from reducing downstream flow volume, improving denitrification, and stabilization and naturalization (via natural channel design) of the existing creek banks to prevent erosion. In addition, the project will reduce future maintenance costs, provide hydrologic restoration of historic floodplain areas adjacent to the creek, natural systems conservation and restoration, enhanced recreational utilization, and increased wildlife utilization by important recreational fisheries species such as red drum (*Sciaenops ocellatus*), striped mullet (*Mugil cephalus*) and snook (*Centropomus undecimalis*). Most notably, what makes this project unique is that it's the

first comprehensive natural stream restoration project in the area that incorporates fish-friendly design elements from scientists at Mote.

This project directly implements both the Sarasota County Parks, Recreation Strategic Master Plan as well as the Coastal and Heartland National Estuary Partnership Comprehensive Conservation and Management Plan. Improvements to water quality and coastal resiliency through stream restoration is a relatively new technique in Florida and Sarasota County is excited to be one of the pioneers in this innovative Best Management Practice technique. This presentation will outline Sarasota County's design plans for the construction of this remarkable restoration project.

Modeling to Assess Influence of Water Withdrawals on Spatial Distributions and Population Abundance of Estuarine Species in Charlotte Harbor, Florida

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Spatial distributions and population numbers of estuarine species due to changes in freshwater inflows were predicted using habitat suitability modeling (HSM) in the Lower Peace River, Lower Shell Creek and Charlotte Harbor, Florida. Water-column (salinity, temperature, dissolved oxygen) and benthic habitats (depth, bottom type) were mapped using GIS. Catch-Per-Unit Effort were computed from Fisheries-Independent-Monitoring data collected from 1996-2013. HSMs were applied to 8 fish and macroinvertebrate species life-stages (32 life-stages by 4 seasons) with affinities for low to moderate salinities. Seasonal HSM maps were created for early-juvenile, juvenile and adult life-stages. Seasonal salinity and temperature grids derived from hydrodynamic modeling from 2007-2014 differed between Baseline conditions (i.e., flows not affected by water withdrawals) and reduced flow conditions that could occur in association with currently recommended Minimum Flows for the Lower Peace River/Shell Creek. Dissolved oxygen, depth, and bottom type were held constant, which allowed for the assessment of seasonal impacts of water withdrawals on species life-stages using HSM. Salinity was the most significant factor in models for most species' life-stages. The seasonal HSM maps produced were very similar between the Baseline and Minimum Flows scenarios for each species life-stage. Most seasonal estimates of population numbers under Minimum Flows were less than the estimates for Baseline conditions.

Watershed Resiliency Through One Water Planning

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The City of Winter Haven, also known as the Chain of Lakes City, is in the final phases of a One Water Master Planning effort. This plan is the blueprint of how a community can continue to grow, develop and prosper while creating a sustainable and resilient future for generations to come. Winter Haven sits at the headwaters of the Peace River Watershed, and we take our

location within the watershed seriously. Managing water resources collectively in our community will ultimately create positive impacts for downstream communities.

One of the signature projects the plan has generated is the Sapphire Necklace. This concept includes restoring 5000 acres of historic wetlands, recharging the aquifer, upgrading operations to generate more reclaimed water, and helping to balance the regional water cycle to reuse water most efficiently. Merging all aspects of water resource management will bolster the water supply for the region, minimize future flood situations, treat stormwater effectively, and restore hydrologically impaired waterbodies within the region, and encourage a more resilient community as we grow and develop.

The City is working with a willing landowner to create the first project within the overall Sapphire Necklace. This gem will showcase all aspects of the plan and will serve as an educational tool for future growth in Winter Haven, Florida and beyond. This presentation will highlight the multiple benefits each component of the One Water Master Plan provides as well as the role the Sapphire Necklace plays in the community and how the city plans to execute its first project.

Session 5 – Aquatic Habitat Restoration

Evaluation of Optical Water Quality, Light Attenuation, and Freshwater Discharges in the Caloosahatchee River Estuary

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Seagrass communities are vitally important ecosystems that support estuarine ecosystems across trophic levels. Therefore, understanding the drivers of seagrass distribution and extent in estuary systems is valuable for conservation and restoration efforts. A critical driver of seagrass distribution is how light moves through the water column (i.e. light attenuation) and the availability of light to reach the estuary bottom. Light attenuation combined with the depth of seagrass colonization is used to estimate the percent surface irradiance and an indicator of seagrass light requirements The objective of this study was to evaluate optical water quality parameters within the Caloosahatchee River Estuary (CRE) relative to changes in freshwater discharge conditions. During the study period, freshwater discharge significantly increased resulting in an increase of stressful and damaging discharge events to estuarine indicator species. Concurrent with changes in freshwater discharge conditions, changes to optical water quality parameters including color, chlorophyll-a, total suspended solids, and light attenuation were detected along the estuary. Using photo-interpreted seagrass coverage data combined with bathymetric data, the depth of colonization was estimated for three survey years (2008, 2014, and 2020). To provide spatially explicit light attenuation estimates a spatiotemporal generalized additive model (GAM) was fit to light attenuation values observed during the study period resulting in a relative model fit (R2) of 0.70. Percent surface irradiance (%SI) was then estimated across the estuary for the three survey years. Over the study period, %SI significantly increased across the lower CRE concurrent with high freshwater discharges. For the past decade (2009 – 2020) the occurrence of stressful and damaging discharge events has significantly increased, concurrent with this increase light attenuation has significantly decided resulting in an increase

in %SI across the lower CRE impacting seagrass communities. However, changes to water management are expected with the implementation of the Lake Okeechobee System Operating Manual that will improve freshwater discharge conditions to the CRE.

Working with Charlotte County Planning to Protect Sportfish Nursery Habitat

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Coastal habitats are in decline due to development, altered water flows, excess nutrients and contaminants. Because coastal habitats are essential to the juvenile life stage of sportfish species, sportfish populations are in decline. However, current fisheries regulations rely entirely on stock assessments, with standard regulations like seasonal closures, slot sizes and bag limits, and don't include habitat in fisheries management plans.

By using anglers as citizen scientists, Bonefish & Tarpon Trust (BTT) has identified sportfish nursery habitat and habitat condition (natural or degraded) for two economically, ecologically and culturally valuable species in our area – Atlantic tarpon (*Megalops atlanticus*) and common snook (*Centropomus undecimalis*). Natural habitats are recommended for protection through local and state land managers. Degraded nursery habitats are prioritized for habitat restoration using a ranking system developed by BTT which includes data layers that account for feasibility, biology and connectivity. One potential way to circumvent the lack of habitat in fisheries management is to work directly with county land use planning agencies to guide land use near nursery habitats.

In 2022, Florida Fish and Wildlife Conservation Commission (FWC) hosted a series of workshops to create a juvenile sportfish management plan for Charlotte County. During those workshops, BTT proposed the creation of a Vulnerability Index (VI – also known as a 'District Overlay') that would be implemented by Charlotte County in their permitting software. The VI would overlay juvenile sportfish natural and restorable nursery habitats with current and potential land use to determine which locations are most at risk. For example, a natural or highly feasible restoration site that is at imminent risk for development would rank high on the VI. This parcel would be flagged in the county land use planning software. Potential actionable steps could be to send the parcel to review by FWC or DEP, reallocating density units or recommending a development design that is less likely to alter nursery habitat quality.

Conversely, a site that is already developed or has low feasibility for habitat restoration would provide a good opportunity to shift density units from a more sensitive area. In short, the VI will guide development in a way that reduces impacts to nursery habitats.

The Vulnerability Index is currently in review for NOAA's Actionable Science grant as part of a larger grant collaboration with FWC, CHNEP, Charlotte County, University of Florida, and the Florida Fish & Wildlife Foundation focusing on juvenile sportfish nursery habitat. This is a first step at revolutionizing the way fisheries and habitats are managed. Ultimately, without healthy coastal habitats, we don't have healthy fisheries.

A Snapshot of Changes in Seagrass Habitat Along the West Coast and the Caloosahatchee River Estuary, Florida

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Seagrass habitats are vital to the health and function of an estuary; however, seagrasses are declining throughout Florida due to decreased water quality and frequent disturbances. The Comprehensive Everglades Restoration Plan (CERP) aims to improve the quantity, quality, timing, and distribution of freshwater inflows from Lake Okeechobee to the Northern Estuaries of the Everglades. It is anticipated that CERP will improve the hydrology to more natural conditions which will enhance the spatial and structural characteristics of the biological communities, such as seagrasses. To determine the success of restoration, pre-CERP conditions of seagrass habitat in the Caloosahatchee River Estuary have been monitored since 2008. The monitoring program was expanded in 2018 to assess seagrasses at three different spatial scales: landscape, community, and population levels Estuary. The three-tiered approach enables a broader assessment of the ecosystem. At the landscape level, seagrass distribution is assessed from aerial imagery, ground truthing and photointerpretation every 5-6 years from southern Charlotte Harbor to Estero Bay. Seagrass communities and populations are evaluated at the patch level using randomized sampling and fixed transects throughout the Caloosahatchee River Estuary. Since 2018, seagrass percent cover ranged between 18 – 45% on average, with a shift in dominant species from *Halodule wrightii* (2018 and 2019) to *Thalassia testudinum* (starting in 2020). Mapping results from 2021 show an almost 10% loss in coverage from 2014 with the greatest loss in the Tidal Caloosahatchee segment at the mouth of the river. A 7% loss was documented in Tidal Caloosahatchee segment between 2020 and 2021 through the in-situ monitoring, supporting the results from the aerial mapping efforts. Seagrass cover declined another 5-10% between 2021 and 2022. The decline in seagrass cover may be attributed to reduced water quality, including light availability due to increased turbidity or color. The relationship between water quality and seagrass cover will continue to be evaluated as CERP projects are completed.

Progress of Oyster Restoration Project on Cormorant Key in Charlotte Harbor

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Since Hurricane Charley in 2004, Cormorant Key in Gasparilla Sound-Charlotte Harbor Aquatic Preserve has experienced significant loss of mangroves and oysters along with severe erosion leading to complete loss of the island over time. Staff at Charlotte Harbor Aquatic Preserves teamed up with Sanibel-Captiva Conservation Foundation (SCCF), Friends of Charlotte Harbor Aquatic Preserves, and 55 local volunteers, from eleven different organizations, for an oyster restoration project on Cormorant Key. On May 17-18, 2022, volunteers shoveled, transported, and placed over 800 buckets of loose oyster shell (~12 tons) on Cormorant Key; accumulating 168 volunteer hours. Cormorant Key was surveyed for oyster density and shell height after 6-months and compared to a nearby reference reef to determine if the restoration was successful. After 6-months, with spat included, Cormorant Key had nearly triple the oyster density than the reference reef but when spat are removed (oysters <25 mm) the reference reef had almost double

the oyster density than Cormorant Key. Cormorant Key also had a smaller average shell height than the reference reef. This data indicates there was an initial settlement event at Cormorant Key with a large abundance of spat, but if the reef follows patterns of other oyster restoration projects in this area, then oyster density will drop after 2-3 years, and shell heights will resemble those of the reference reef. The one-year restoration monitoring will occur in May of 2023 and Cormorant Key will then be monitored annually, thereafter.

Session 6 – Hurricane Ian Impacts

Interagency Water Quality Response and Observed Data Post Hurricane Ian

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In the aftermath of Hurricane Ian, multiple agencies and organizations coordinated to collect water quality samples throughout Sarasota Bay, Lemon Bay, Charlotte Harbor, the Peace and Myakka river basins, and the Caloosahatchee Estuary. This presentation will provide an initial examination of Charlotte Harbor and Lemon Bay, illustrating the impact of Hurricane Ian to the water quality of these systems in the weeks following its landfall. In addition, an overview of the logistics behind this effort will be explored, discussing successes, challenges, and lessons learned for future storm response events.

Water Quality in the Charlotte Harbor Watershed After the Passage of Hurricane Ian – Dissolved Oxygen and Nutrient Impacts and Recovery

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On September 28th, 2022, Hurricane Ian made landfall in southwest Florida as a category 4 storm producing catastrophic storm surge, damaging winds, and historic freshwater flooding. The Peace and Myakka River Basin experienced unprecedented flooding with rainfall totals in some areas exceeding 20 inches over a three-day period. For example, median discharge at the Peace River at Arcadia gage is less than 2,000 $ft^3\ s^{-1}$. Three days after Ian's passage, discharge at this location rose to a record 50,800 $ft^3\ s^{-1}$. With massive amounts of water moving through the watershed, long-term water quality impacts including bacterial contamination, unprecedented nutrient inputs, harmful algal blooms, and hypoxia were of great concern. In response to these concerns, a coordinated multi-stakeholder team including the Southwest Florida Water Management District (SWFWMD) quickly mobilized deploying crews to collect water quality data as soon as three days after the storm's passage. Data were collected for several months to evaluate the severity of water quality impacts and determine when pre-storm conditions might return. Here we focus primarily on hypoxia defined as dissolved oxygen (DO) concentrations below 2.0 mg L^{-1}. Hypoxia is a major concern for fish and other important species in Florida that generally require DO concentrations of at least 5 mg L^{-1} or greater. Prolonged hypoxia can result

in fish kills exacerbating impacts. As expected, hypoxia was widespread throughout the watershed, but conditions in the Peace and Myakka Rivers improved after only a few weeks. Despite the passage of Hurricane Nicole in November 2022, DO levels returned to pre-storm conditions within 2-3 months. This was consistent with what was reported in 2004 after Hurricanes Charley, Frances, and Jeanne. We also present nutrient concentration data and loading estimates from the gaged portions of the Peace and Myakka Rivers before and after Hurricane Ian.

Continuous Water Quality Data in Charlotte Harbor and Matlacha Pass Pre, Mid, & Post Hurricane Ian

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The Florida Department of Environmental Protection (FDEP), Charlotte Harbor Aquatic Preserves' (CHAP) continuously deployed data sondes captured water quality data before, during, and after Hurricane Ian which hit the Charlotte Harbor region as a Category 4 storm on September 28th, 2022. These data sondes collect 7 water quality parameters: temperature (C), specific conductivity (mS/cm), salinity (psu), dissolved oxygen (% and mg/L), pH, depth (m), and turbidity (FNU) every 15 minutes. Only 2 of CHAP's 4 deployed data sonde stations were located and retrieved after the storm, one along the West Wall of Charlotte Harbor (CHWW1) and one near the Matlacha bridge (MP3C). The piling at MP3C remained stable throughout the storm and the data was able to be downloaded afterwards. The piling at CHWW1 was knocked over during the storm, but the data sonde continued to log data and was found by FDEP scuba divers on November 30, 2022. Data from MP3C during the hurricane showed a dramatic increase in salinity and depth from the storm surge which then dropped in the days following the storm. Alternatively, at CHWW1 salinity and depth decreased during the storm until the piling fell. Post-hurricane water quality parameters at MP3C began to resemble pre-hurricane conditions after 3 weeks. Comparing pre- and post-storm data and data between the two stations provides greater insight into the impact the hurricane had on water quality in the Charlotte Harbor region. Currently, the MP3C location is the only site collecting continuous data and CHAP is currently working to reestablish the other 3 stations. Data from this program is managed in-house and by the Centralized Data Management Office and is available on the AP Data Portal (https://floridaapdata.org/index.php).

Phytoplankton and Harmful Algal Bloom Dynamics in the Caloosahatchee Estuary and Nearshore Gulf of Mexico

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Harmful Algal Blooms (HABs) in Florida have negative effects on the fish and wildlife that depend on healthy coastal ecosystems. The effects are wide ranging from direct effects of the toxins that HABs produce on fish and wildlife to causing indirect effects such as hypoxia to large areas. People are also affected by HABs, through exposure to the toxins in the water and in the

air and by impacting our quality of life and tourism-based economy. Events starting after Hurricane Irma in 2017 prompted a research study on phytoplankton and HAB communities from the upper Caloosahatchee estuary to the Gulf of Mexico. Samples were collected starting in 2018 and showed several bloom events including a bloom of *Akashiwo sanguinea* in the middle estuary and *Karenia brevis* in the nearshore Gulf of Mexico. Monthly sampling starting in November 2021 to present to analyze nutrients, chlorophyll, stable isotopes and phytoplankton communities was conducted across the salinity gradient and into the nearshore. The results highlight the seasonal and salinity dynamics that drive phytoplankton community composition. The landfall of Hurricane Ian in September 2022 also occurred during the sampling and the results show immediate increases in total and inorganic nitrogen that persist for several months. A *Karenia brevis* bloom also initiated near Venice Inlet and expanded into the study area in October 2022. The results from this study better explain the occurrence and dynamics of phytoplankton and HABs in the Caloosahatchee and are being used in modeling efforts.

FWC's Fisheries Independent Monitoring Program: An Approach to Understanding Environmental Disturbance Impacts on Florida's Fisheries

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The Fisheries-Independent Monitoring (FIM) program was established to survey fishery resources and provide information on annual fish population trends throughout Florida. Sampling by the FIM program first began in the Tampa Bay and Charlotte Harbor estuaries in 1989 and has since expanded statewide. Monthly sampling is conducted using a stratified-random sampling (SRS) design to distribute effort spatially and across a range of habitats. A variety of techniques and sampling gears are used by the FIM program to provide data on the wide range of species, sizes, and ages necessary for the assessment and management of Florida's fisheries. Data from the FIM program, especially data on annual abundance trends, are critical to effective management; however, data can also be used to define essential fish habitat, describe life-history parameters, and assess impacts of environmental disturbances such as red tides and abnormal weather events. In recent years, multiple hurricanes have directly impacted the Charlotte Harbor Estuary watershed, altering both environmental conditions and short-term FIM priorities. Most recently, Hurricane Ian passed through the Charlotte Harbor estuary on September 28, 2022. Following this storm, FWC played a variety of roles assisting with emergency response efforts in the impacted community and for Florida's fish and wildlife. After ensuring the safety and well-being of staff affected by the storm, FIM biologists resumed sampling efforts as safe access points to the estuary were restored. Despite challenging field conditions, all sampling in October, 2022 and beyond was completed. Preliminary analyses of those data indicate that disturbances associated with the passage of hurricane Ian were similar to those observed during previous storms. Overall, while dramatic localized shifts occurred, fish communities stabilized quickly, and estuary-wide impacts were minimal. These results highlight how the historical context provided by the FIM program is essential to understanding the full system-wide effects of natural and anthropogenic disturbances to Florida's estuarine systems.

Long Term Trends and Hurricane Impacts on Colonial Wading and Diving Bird Nesting Effort and Islands in Estero Bay

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Estero Bay Aquatic Preserve (EBAP) is the state's first aquatic preserve, designated in 1966. It is managed by the Florida Department of Environmental Protection- Office of Resilience and Coastal Protection and includes habitats such as mangroves, intertidal flats, seagrass meadows, and salt marshes. These habitats are utilized by multiple wading and diving bird species for roosting, feeding and breeding. From 1977-2008 bird rookery monitoring was conducted sporadically within the bay utilizing a variety of survey methods. In 2008 EBAP established a colonial nesting wading and diving bird monitoring program which included 15 islands that has since expanded to 36 islands. This program provides peak estimates of nesting effort for each species of wading and diving bird, monitors population trends, maintains a current atlas of historic and active colonies, documents human disturbance, and records the number of fishing line entanglements and fatalities.

Monthly nest counts of active and historically active nesting islands are conducted throughout the breeding season using a direct count method. Since 2012, surveys have been conducted year-round due to the extended period of nesting. Direct count surveys are conducted by slowly circling each island at a safe distance so that nesting birds will not be disturbed, and two observers count the number of nests and nesting stage. Data are analyzed annually to determine long-term trends, with peak nest counts from the current year being compared with mean peak nest counts since 2008. This monthly monitoring also allows for assessment of short-term impacts from specific events on rookery islands and nesting effort.

Historically, the highest concentration of wading and diving bird nesting activity in Estero Bay has been observed on three islands: Matanzas Pass, Coconut Point East, and Big Carlos West of M-52. These islands are designated as Critical Wildlife Areas (CWA) and were marked in February of 2018. Data from these islands has been assessed for changes in nesting effort over time as well as impacts from recent events including Hurricane Ian. The information gathered from this ongoing program aids in the effective management of wading and diving birds in Estero Bay.

Summit Host:

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