Charlotte Harbor
National Estuary Program
presents the
2017 Charlotte Harbor Watershed Summit: Showcasing Our Accomplishments
March 28-30, 2017

Charlotte Harbor Event & Conference Center
Punta Gorda, Florida

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Charlotte Harbor National Estuary Program
2017 Charlotte Harbor Watershed Summit: Showcasing Our Accomplishments
AGENDA

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8:45 Welcome & Announcements – Jaime Boswell, CHNEP Environmental Scientist

8:50 Opening Remarks – Jennifer Hecker, CHNEP Executive Director

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9:10 Moving Toward Ecosystem Restoration on Cecil Webb WMA - Roger Copp, Water Sciences Associates, and Andrew Cason Pope, Florida Fish and Wildlife Conservation Commission (p7)

9:30 Online Water Quality Trend Analysis: Improving Accessibility of a Robust Statistical Analysis Technique - Jason Scolaro, Water Institute, University of South Florida (p7)

9:50 Aspects of Development of a Comprehensive Nutrient Management Plan for Sanibel, Florida - Mark Thompson, Sanibel-Captiva Conservation Foundation (p8)

10:10 – 10:30 Break

10:30 Three-dimensional Model Evaluation of the Impact on Salt Transport by Physical Alterations to the Caloosahatchee River and Estuary - Detong Sun, South Florida Water Management District (p9)

10:50 Developing a Nutrient Framework for Managing and Restoring Biological Integrity of Southwest Florida Tidal Creeks - Jay Leverone, Sarasota Bay Estuary Program (p10)

11:10 Nitrate plus Nitrite Loads into the Tidal Caloosahatchee River, 2015-2016 - Amanda Booth, USGS (p11)

11:20 Water Quality and Effects of Water Release from Lake Okeechobee to Caloosahatchee River and Estuary - Michael Celebrado, St. Michael Lutheran School (p11)

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WQQ3 Shifting Chlorophyll *a* Baselines: Changes in Phytoplankton Abundance in Response to Physical Variability and River Discharge in Charlotte Harbor National Estuary – Michael Sauer, Sanibel-Captiva Conservation Foundation (p14)

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1:30	Engaging the Community in the Alligator Creek TMDL Watershed - John Ryan, Sarasota County (p30)
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3:20	Swamp Walks: Connecting People to the Landscape of Southwest Florida - Brenda L. Thomas, Florida Gulf Coast University (p34)
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Day 3: Thursday, March 30, 2017

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8:50 Opening Remarks – Jennifer Hecker, CHNEP Executive Director

9:05 Session 5 - Habitat and Living Resources: Fish – Courtney Saari, FWC – Fish and Wildlife Research Institute

9:10 Modeling to Assess the Influence of Water Withdrawals on Spatial Distributions and Abundance of Estuarine Species in Charlotte Harbor, Florida - Peter J. Rubec, Florida Fish and Wildlife Conservation Commission (p35)

9:30 Impacts of Coastal Development and Altered Watersheds on Juvenile Fish Nursery Habitats - JoEllen Wilson, Bonefish & Tarpon Trust (p36)

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1:20 Collecting Ultra Fine-scale Movement Data on Sawfish in the Peace River using Traditional Acoustic Monitoring Techniques - Rebecca K. May, Florida Gulf Coast University (p44)

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2:10 Oyster (*Crassostrea virginica*) Larval Transport Modeling for the Caloosahatchee River/Estuary - Joëlle Richard, Florida Gulf Coast University (p47)

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2:50 The Effects of the 2015-2016 El Nino on the Coastal Ecosystem around Sanibel Island, FL - Eric Milbrandt, Sanibel-Captiva Conservation Foundation (p48)

3:10 Measuring the Fate and Non-target Impacts of Dibrom using Aerial Ultra-low Volume (ULV) Spray Technology in Mangrove and Open Marsh Wetlands - Edwin M. Everham III, Florida Gulf Coast University (p49)

3:30 Sixteen Years of the Southwest Florida Frog Monitoring Network - John Herman, Florida Gulf Coast University (p50)

Tuesday, March 28, 2017
Session 1 - Water Quality and Quantity: New Tools

Moving Toward Ecosystem Restoration on Cecil Webb WMA

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The Charlotte Harbor Flatwoods Initiative has been working to restore the southwestern portion of Cecil Webb Wildlife Management Area. The CHFI is composed of a coalition of public and private organizations including Florida Fish and Wildlife Conservation Commission, FDEP, FDOT, SFWMD, SWFWMD, Charlotte County, Lee County, and the Trust for Public Lands. The goals of the CHFI are to remove flow obstructions for Cecil Webb Wildlife Management Area, partially restore the flow pathways to Yucca Pens, create storage for wet season runoff from Cecil Webb WMA on the Bond Farm for subsequent discharge to Yucca Pens during off-peak periods, lengthen hydroperiods of historic wetland areas within Yucca Pens, reduce peak discharges from man-made canals from west of I-75 to tidal waters in Matlacha Pass, and increase base flows and reduce pollutant loads to tidal waters, which will improve habitat for estuarine biota. The first step has already completed, which was to purchase a 600+ acre farm (the Bond Farm) that is the first flow obstruction. That farm will be converted to a water storage facility that will store water and then deliver the water to extend the hydroperiod in wetlands in the Yucca Pens Unit. A flow-way from the Bond Farm to Yucca Pens needs to be secured, and planning efforts are underway to accomplish that objective. This presentation will discuss the work completed by the CHFI and describe the current activities including the design of the conversion of the Bond Farm to a water storage facility.

Online Water Quality Trend Analysis: Improving Accessibility of a Robust Statistical Analysis Technique

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Protection and restoration of water resources requires a detailed understanding of changes and trends in surface water quality over time. Unfortunately, scientifically defensible temporal water quality trend analysis has historically required substantial effort and the expertise of consultants and researchers. Trend analysis has been an expensive process requiring time-

consuming data acquisition and preparation, and a high level of statistical expertise and analysis. This has made it difficult for management organizations to track these changes on a regular basis. In order to address this problem, the USF Water Institute, funded by the Charlotte Harbor National Estuary Program, developed an automated statistical method that uses existing multi-agency data stored in the Water Atlas (wateratlas.org). The water quality trends tool was implemented on the Charlotte Harbor Water Atlas (chnep.wateratlas.org) in such a way that agencies would be able to run the analysis on a routine annual or more frequent basis. The trend analysis tool leveraged prior approaches developed by USGS and used by Janicki Environmental, which used a seasonal Kendall Tau test for determining trend. USF developed an updated scripting process using the R open-source statistical software. The primary statistical component of the updated process is the Environmental Stats R package ("EnvStats"). Included in this core testing procedure were techniques to first apply quality assurance filters to the raw data, account for seasonality, temporal autocorrelation and multiple comparisons in an effort to ensure that the reported statistical outcomes were valid, reliable and robust. Results were validated against published results that used tried and true techniques initially developed by USGS. Online web tools were developed to present the trend data on an interactive map that includes 251 sampling location sites. Each site included both 10-year and period-of-record trend tests for three water quality parameters: dissolved oxygen concentration, total nitrogen, and chlorophyll a. The water quality trends website was developed to include the statistical trend result, source of data, graph of parameter values, and downloadable version of all analysis scripts and data. The ability to visualize changes in water quality trends on a routine basis is pivotal to water resource management. Since the creation of the tool in 2015, a second analysis has been performed, providing an opportunity to compare the two result sets. For instance, using the online mapping tool, it is possible to see an improving trend in total nitrogen within the Caloosahatchee River. Similar comparisons can be made for other parameters and time frames, including the entire period of record. The Water Quality Trends tool continues to grow into other areas of the state. Additional parameters will be added to test for significant trends, which will assist organizations with better and more timely information as they attempt to manage their water resources. This presentation will discuss the development and implementation of the tool, including an overview of the statistical analysis processes, validation of results, web interface development and lessons learned.

Aspects of Development of a Comprehensive Nutrient Management Plan for Sanibel, Florida

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This is the fourth year of a multi-year effort to provide information needed to develop a nutrient runoff/discharge management plan for the City of Sanibel. The first year was dedicated

to analyzing existing surface water data, and developing estimates of nutrient loadings to Sanibel surface waters based upon concentrations and flows taken from best available literature data. In the second year, Sanibel specific stormwater runoff coefficients were developed using GIS-based tools and field sampling of stormwater from Sanibel. These Sanibel-specific coefficients and concentrations were then used to more precisely estimate nutrient loadings from Sanibel's stormwater and surface waters. The third year (2014-2015) of work consisted of groundwater nutrient concentration and flow monitoring. From this information, nutrient loadings attributable to Sanibel's groundwater could be accurately estimated. In addition, discharge flow monitoring instrumentation and software were installed on the Sanibel Slough for calculation of seasonal and storm-driven nutrient loading to the nearshore waters based on previously collected nutrient concentration data. In the fourth year, nutrient loading data acquired in the previous years was integrated into a comprehensive evaluation of areas of concern. The major sources of elevated nutrient loads were identified and a list of specific best management practices and projects aimed at reducing loads was developed. Nutrient loading models were used to evaluate the potential impacts of specific BMP projects to help prioritize project implementation. This will allow the City to consider basic design and a cost benefit analysis of the prioritized projects.

Three-dimensional Model Evaluation of the Impact on Salt Transport by Physical Alterations to the Caloosahatchee River and Estuary

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Hydrodynamic modeling of estuaries provides a platform to assess the effects of physical alterations on hydrodynamics, transport, and mixing. This study component utilized a three dimensional hydrodynamic model, CH3D (curvilinear hydrodynamic three dimensional) of the Caloosahatchee River and Estuary to compare simulated salinities of the existing condition with the reversal of five historical physical alterations to the estuary. Alterations included: (1) removal of the S-79 water control structure; (2) removal of the downstream causeway (Sanibel); (3) backfill of the oyster bar near the estuary mouth; (4) backfill of the navigation channel; and (5) the reestablishment of predevelopment bathymetry. Model results indicated that refilling the navigation channel had profound effects resulting in a five-fold reduction in dry season salinity distribution. The reduced salt transport was more pronounced with the predevelopment bathymetry because the estuary was much shallower. Increased estuary depth and cross-sectional area significantly enhance salt transport into the upper estuary. Increased salt transport can push biologically relevant isohalines further upstream depending upon freshwater inflow conditions.

Developing a Nutrient Framework for Managing and Restoring Biological Integrity of Southwest Florida Tidal Creeks

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Tidal creeks are integral to the ecological function of their larger coastal estuaries. They serve as filters for watershed inputs, sites of high nutrient cycling, and critical nursery areas for many fish species of recreational and commercial importance. However, these transitional water bodies are often underrepresented in routine water quality and fisheries monitoring programs, at least within southwest Florida. Furthermore, many have come to understand that tidal creeks provide productive nursery habitat because of their less than optimal water quality conditions. This presentation describes how linking source water sampling with intensive water quality sampling in the tidal portion of southwest Florida tidal creeks was used to develop quantitative management level nutrient targets and thresholds derived specifically for the protection of the tidal portion of these creeks. We describe how these derived targets and thresholds protect the biological integrity of these systems. This study involved bimonthly sampling for one year in sixteen of the more than 300 tidal creeks from southwest Florida. Biological endpoints, or response variables, included water column and sediment chlorophyll as well as several fisheries metrics. These data were combined with existing remote sensing and in situ water quality data that described landscape-level effects at varying spatial scales. Various aspects of conceptual models developed during the project planning phase were analyzed along several independent lines of evidence to generate inferences on protective water quality (particularly nutrients) standards for tidal creeks. This presentation details how these results were used to recommend quantitative management-level nutrient targets and thresholds from which to evaluate tidal creek biological integrity over time. Recommendations for additional data needs, which will be investigated through a new wetland grant, are also presented. Finally, results will be discussed with respect to how they can provide guidance for habitat restoration opportunities within tidal creeks, particularly living shoreline projects along riparian edges to control anthropogenic nutrient inputs.

Nitrate plus Nitrite Loads into the Tidal Caloosahatchee River, 2015-2016

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Eutrophication is a concern for many coastal ecosystems, because excess nutrients can degrade water-quality and increase the frequency and severity of algal blooms. The tidal Caloosahatchee River and downstream estuaries are typically nitrogen limited; however, during the last decade numerous algal blooms have raised concern about nitrogen loads to the system. Continuous nitrate plus nitrite records have been computed by the U.S. Geological Survey (USGS) upstream of the W.P. Franklin Lock and Dam (S-79) since 2015. In-situ data are collected at 15-minute intervals using an optical sensor, but sensor data are affected by interference from the highly colored water of the Caloosahatchee. Monthly water samples are collected and sent to the USGS National Water Quality Lab for nutrient analysis, and these water sample data allow corrections to be applied to the sensor data. Preliminary results indicate that monthly nitrate plus nitrite loads ranged from 7.4 tons in June 2015 to 173.0 tons in February 2016. Continuous nitrate plus nitrite data at S-79 will provide access to the water quality conditions of the tidal Caloosahatchee River on a real-time basis for use by water resource managers and others.

Water Quality and Effects of Water Release from Lake Okeechobee to Caloosahatchee River and Estuary

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The purpose of this study are: (1) is there a difference in acidity, alkalinity, dissolved oxygen, nitrate, phosphates and pH content of the waters in Lake Okeechobee, Caloosahatchee River and Caloosahatchee Estuary, and; (2) is there an effect in water quality with release of Lake Okeechobee into Caloosahatchee River and Estuary. The hypotheses are: (1) the lake will have poorer water quality, and; (2) water quality will be worse (more acidic or alkaline, lower dissolved oxygen, higher nitrate and phosphate and pH change) with release of water from Lake to River. Water samples were collected and tested at Lake Okeechobee, the Caloosahatchee River in Labelle, and Caloosahatchee Estuary in Fort Myers over five weeks. Water characteristics were compared against water release from Lake Okeechobee into Caloosahatchee. Independent variables: amount of water tested, location and depth of water sample taken, water release from Lake Okeechobee. Dependent variables: acidity, alkalinity, dissolved oxygen, nitrate, phosphate and pH of water samples. Lake Okeechobee had the most acidic, alkaline and nitrate content and the least phosphates and dissolved oxygen. Water release from the lake caused decrease in dissolved oxygen and pH and rise in acidity and

phosphates, but had no effect on alkalinity and nitrate. Both hypotheses were proven true. Water at Lake Okeechobee had the worst water quality and water release from Lake Okeechobee to Caloosahatchee River worsened the river and estuary's acidity, dissolved oxygen, phosphates and pH. Thus, water release from the lake to the river is detrimental to marine life.

Water quality Trends in Estero Bay (2005-2016)

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Water quality greatly influences the health and productivity of estuarine habitats as well as to the maintenance of aesthetic and social values placed upon a given area. It is also a topic that has been receiving great interest and discussion in recent years. Fifty years ago, Estero Bay was designated as Florida's first aquatic preserve to maintain it in its essentially natural condition for future generations to enjoy. The bay and its tributaries are also designated as Outstanding Florida Waters, meaning that ambient water quality is protected. Estero Bay is influenced by saltwater that enters from the Gulf of Mexico through six passes and by freshwater from five major tributaries. Many activities within the watershed potentially impact the bay, including both point- and non-point sources of pollution and modified flow patterns. Since the end of 2004, Estero Bay Aquatic Preserve has continuously deployed datasondes at three sites spanning the northern, middle, and southern reaches of Estero Bay. These datasondes measure temperature, salinity, specific conductivity, 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. Analyses of these data will include examinations of trends in each parameter over the length of the program as well as a specific look at the seasonality of those parameters.

Tuesday, March 28, 2017
Poster Session - Water Quality and Quantity

Innovation for Restoration: the C-43 Water Quality Treatment and Testing Project

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The Caloosahatchee River Estuary Total Maximum Daily Load, adopted by the State of Florida in 2009, requires a 23% reduction in total nitrogen (TN) loads. To date, there have been limited efforts to design treatment wetlands to optimize nitrogen removal from non-point runoff and surface waters to the low concentrations that may be needed to achieve a 23% reduction. This is especially true for dissolved organic nitrogen (DON), which accounts for approximately 80% of the TN present throughout the Caloosahatchee River and Estuarine system (Wetland Solutions, Inc., 2012). Through over a decade of successful operation of Stormwater Treatment Areas (STAs), the South Florida Water Management District (SFWMD) has attained extensive expertise in total phosphorus removal from non-point runoff using constructed wetland treatment systems. However, the mechanisms for TN removal via wetland treatment systems have not been demonstrated or optimized to the same extent. The SFWMD, in partnership with Lee County, is investigating optimization of wetland-based strategies for removal of TN from Caloosahatchee River surface water through the C-43 Water Quality Treatment and Testing Project (C-43 WQTTP) demonstrations. In this study, special attention will be given to the net removal of DON, which is possibly the most recalcitrant form of nitrogen in the Caloosahatchee River. As a multiphase study, the first phase of demonstrations is twofold. Biologically available DON (BDON) was quantified through bioassays using laboratory incubations under different physical/chemical conditions of surface water collected along the river from December 2014 to October 2015 across seasons, and mesocosms will be employed to assess potential surface water nitrogen removal rates using different plant communities and hydrologic loading rates. Using the results of the Phase I demonstrations, a mass balance model of nitrogen processes will be developed to inform how nitrogen is stored in (both temporarily and permanently) and removed from the treatment systems. Collectively, this information will inform the Phase II demonstrations focused on scaling up the most effective mesocosm treatments. The objective of the overall project is to demonstrate and implement cost-effective, wetland-based strategies for reducing loads of TN and other constituents, including phosphorus, to the Caloosahatchee River and its downstream estuary. Nutrient reduction strategies identified and tested through this project may be applicable to other South Florida river and estuarine systems.

Sediment Iron Flux along the Caloosahatchee River

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Iron concentrations along the sediment-water interphase were examined for the Caloosahatchee River. Little is known about the dependence of organic-Fe (III) flux on high frequency estuarine physical and chemical variations or the potential for this flux to contribute to phytoplankton blooms on the West Florida Shelf. In sediments of organic- and iron-rich "blackwater" (high CDOM) rivers, soluble organically-complexed Fe (III) is formed from the remobilization of flocculated dissolved Fe (III) and can contribute to the total portion of dissolved Fe at the mouth of the estuary. This soluble organic-iron (III) is bioavailable and can be exported to coastal waters. Sediment samples were analyzed to locate regions along the Caloosahatchee River with high concentrations of solid phase reactive Fe (ascorbate extractable), the precursor to soluble organic-Fe (III). In addition, core samples were analyzed both colormetrically and electrochemically to obtain a vertical profile of iron species presence.

Shifting Chlorophyll *a* Baselines: Changes in Phytoplankton Abundance in Response to Physical Variability and River Discharge in Charlotte Harbor National Estuary

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The intensity and duration of wet/dry seasons and freshwater input from local and regionally sourced river discharge supplies nutrients to the coastal zone strongly influence light and nutrient availability and the productivity of southwest Florida estuaries. Chlorophyll a (Chl *a*), as a proxy for phytoplankton abundance, is an indicator of nutrient loading and estuarine health (Valiela et al. 1998, Boyer et al. 2009). A roughly 10-year time-series of Chl *a* and salinity with which to track both short and long-term phytoplankton community responses to changes in physical conditions is analyzed from the Sanibel-Captiva Conservation Foundation's (SCCF) RECON sites, an array of bio-optical instrumentation that broadly covers the Charlotte Harbor National Estuary. Not surprisingly, the annual cycle of phytoplankton abundance at many locations showed a strong response to regional changes in wet/dry season and river discharge.

However, baseline concentrations of Chl *a* have also increased considerably in relation to rises in river discharge over the past 10 years. This rise in Chl *a* baseline concentration also lasted for a much longer extent than did the seasonal river discharge signal. Our analysis indicates that large scale weather or climate events as well as discharge scheduling can induce long-term effects on phytoplankton abundance and/or community structure that can have lasting consequences on the structure of the nearshore or estuarine food web.

Tuesday, March 28, 2017
Session 2 - Water Quality and Quantity: Monitoring and Assessment

Charlotte Harbor Aquatic Preserves' Long-term Water Quality Monitoring within Matlacha Pass Aquatic Preserve

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Charlotte Harbor Aquatic Preserves (CHAP) collects water quality data within the Matlacha Pass Aquatic Preserve through two monitoring programs. Charlotte Harbor Estuaries Volunteer Water Quality Monitoring Network's (CHEVWQMN) four sites within Matlacha Pass Aquatic Preserve were established in 1998. These sites are sampled monthly, at sunrise, to capture a snapshot of the surface water quality with the collection of 19 parameters. The continuous water quality monitoring program has three in-situ YSI 6600 datasondes deployed in stations located in north and south Matlacha Pass (both established in 2005) and middle Matlacha Pass (south of the draw bridge, established in 2009). The sondes collect data for seven parameters every 15 minutes, 0.5m off the bottom. With a total of seven site locations throughout Matlacha Pass Aquatic Preserve, the collection methods of the two programs vary by frequency and location in the water column. Monthly direct grab samples for total phosphorus, nitrate/nitrite and chlorophyll a are collected at each the sites as well. By taking the monthly average of the continuous field parameter data and comparing with the monthly CHEVWQMN data, we can determine general water quality characteristics within Matlacha Pass Aquatic Preserve. The data highlight how the two programs complement each other in assisting CHAP with resource management within the Matlacha Pass Aquatic Preserve.

Scratching the SERFIS: Surveying Estuarine Response to Freshwater Inflows in the Caloosahatchee

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The majority of freshwater entering the Caloosahatchee River Estuary (CRE) comes through the Franklin Lock and Dam structure (S-79). Flow rate is controlled and varies with season, Lake Okeechobee levels, and rainfall. The quantity and duration of freshwater inflow can impact downstream water column conditions and estuarine functions such as primary and secondary production. The SERFIS project uses a shipboard flow-through data sonde system to measure surface water quality parameters including salinity, turbidity, color, and chlorophyll concentrations. Zooplankton are collected concurrently. This provides a "snapshot" in time and space of system-wide estuarine conditions and the location of the zones of maximum production, where turbidity, chlorophyll, and zooplankton peak concentrations can overlap. These "snapshots" are then compared to freshwater inflow rates of different timescales (1-day flow, 7-day average flow, 14-day average flow, etc). Assessing the existence and location of the zones of maximum primary and secondary production in relation to freshwater inflow will help water managers determine estuarine functional response to water release schedules and guide operational decision making.

Caloosahatchee Regional Water Management Issues – Short and Long-term Solutions for Storage and Treatment (a white paper)

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The coastal communities of Lee County are routinely impacted by freshwater discharges from Lake Okeechobee and excessive stormwater runoff from the Caloosahatchee watershed. The latest event occurred during the winter and spring of 2015/16, at the peak of Southwest Florida's tourism season. A strong El Niño that developed in 2015 and extended into 2016 resulted in rainfall throughout south Florida greatly exceeding the historic average. This resulted in water managers releasing billions of gallons of freshwater to the Caloosahatchee and St. Lucie estuaries. During the peak of the freshwater flows (late January–early February), the Caloosahatchee estuary received daily average flows exceeding 14,000 cubic feet per second (cfs) measured at the Franklin Lock (S-79). The Caloosahatchee continued to receive flows exceeding the high-flow harm threshold (2,800 cfs) through the middle of April 2016. These damaging flows were the result of runoff from the Caloosahatchee watershed and the regulatory discharges from Lake Okeechobee. As with past high-volume Lake releases in 2005-

2006 and again in 2013, the excessive freshwater discharges impacted the ecology of the Caloosahatchee estuary and coastal waters of Lee County. This in turn impacted the quality of life of our residents, regional property values, revenue of area businesses, and it continues to have a lasting effect on our local economy. This problem persists because of inadequate water storage within the Kissimmee, Lake Okeechobee, and Caloosahatchee watersheds and our inability to treat and convey more water south into Everglades National Park and Florida Bay where it is desperately needed. Flood control projects, channelization, and other land use changes that have occurred throughout Central and Southern Florida during the past century have resulted in a water management system that is very different from its original state. The highly-engineered, man-made system that exists today delivers water to the coast very quickly, with little to no treatment. This has resulted in the Caloosahatchee estuary receiving too much water during the wet season and not enough during the dry season. The water that is delivered is often laden with excessive nutrients that can stimulate harmful algal blooms. These blooms can degrade aquatic habitats and the quality of local beaches. The purpose of Caloosahatchee Regional Water Management Issues white paper is to summarize and place into context the projects and policies needed to restore freshwater flows to the Caloosahatchee River and estuary. It outlines a number of the challenges we must overcome in order to be successful in restoring the Everglades and Northern Estuaries.

Early Detection of Stress and Preemptive Rehabilitation for Successful Mangrove Forest Management

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We contend that mangrove forest rehabilitation should begin much sooner than at the point of catastrophic loss (referred to here as “preemptive rehabilitation”) as perhaps the only mechanism to preempt large scale losses of mangroves and the resulting loss of ecological services and carbon storage. We describe the need for “mangrove forest heart attack prevention” as part of that process, and how that might be accomplished in a general sense by embedding plot and remote sensing monitoring within sentinel sites as part of strategic coastal management plans. The major cause of mangrove stress at many sites globally, based upon our decades of international experience, relates to modified (most often reduced) tidal water flows and exchanges, which are essentially analogous to blocked blood flows in human veins and arteries. The medical parallels are clear; long-term degradation of function leads to acute mortality prompted by acute events, but created by a systematic propensity for long-term neglect of many mangrove ecosystems. Often, mangroves are abruptly lost within just a few years; however, the vulnerability of many mangrove forests is often re-set decades earlier when seemingly innocuous hydrological modifications are made (e.g., road construction, tidal channel modifications, port dredging and disposal, etc.), but which remain undetected without

reasonable large-scale monitoring. With so much development occurring around mangroves globally, simply protecting forest patches from direct physical destruction is not enough unless provisions are made for detecting and ameliorating impacts that drive mangroves to unhealthy states, which we term "preemptive rehabilitation." Whether mangroves are degraded immediately or in degrees over decades, their eco-physiological requirements for long-term persistence are sensitive enough to affect a loss either way, but "preemptive rehabilitation" can preserve many of the essential functions and allow for rapid recovery back to reference conditions.

Evaluating the Benefits of Hydrologic Restoration of Shakett Creek and Dona Bay - Phase II Efforts

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In the late 1960s, the Cow Pen Canal was constructed. This large regional drainage feature redirected a portion of the lower Myakka River watershed to the west, toward the coastal estuary of Dona Bay. The change in regional drainage increased the Dona Bay watershed from 15 to 75 square miles, and also removed 60 square miles of the Myakka River watershed from its historical alignment. As a result, Dona Bay has been adversely impacted by significantly increased freshwater inflows, which have reduced salinities to levels incompatible with native flora and fauna, along with increased nutrient loads to Dona Bay. These impacts have occurred concurrently with the reduction in freshwater inflows to their original destination, the lower Myakka River and Charlotte Harbor. This presentation summarizes findings conducted to determine the expected benefits and/or impacts, if any, of diverting 3 mgd of water out of the Cow Pen Slough watershed and redirecting those flows back into the Myakka River watershed. Based on measured flows and water quality data, it was determined that diverting up to 3 mgd of water from the Cow Pen Slough system back into the Myakka River, would not cause or contribute to an existing water quality concern in the Myakka River. The increased load to the Myakka River was estimated to be equal to approximately one percent of the measured nutrient loads at a location that gages approximately half of the Myakka River's watershed. After being processed through an extensive wetland system, nitrogen concentrations of additional loads are expected to be lower than concentrations in the river itself. In the Dona Bay system, a 3 mgd diversion would be expected to benefit the artificially depressed wet season salinities along a stretch of Shakett Creek greater than 7,000 feet, over an area in excess of 70 acres. A smaller benefit would occur for the cool dry season as well, along a length of shoreline greater than 4,000 feet, and benefiting an area in excess of 60 acres. For the year as a

whole, salinities would be expected to increase with a 3 mgd diversion along more than 4,000 feet of the creek's shoreline, benefiting an area in excess of 50 acres.

Shell and Prairie Creek RA Plan – Management Actions to Address Mineralized Impairment of Surface Waters

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The Shell Creek in-stream reservoir, located in the southern region of the Peace River Basin, provides potable water to the City of Punta Gorda, Florida. The reservoir is sustained by two Class I water bodies, Shell Creek and Prairie Creek. Between 1999 and 2002, drinking water standards for chloride were exceeded in the reservoir. Subsequently, the Florida Department of Environmental Protection (FDEP) proposed to place these waters on the verified list of impaired waters. As a result, a stakeholder group led by the Southwest Florida Water Management District (District) and consisting of federal, state, local, commodity, and public entities, was formed to address the surface water impairments. The stakeholders group developed a Reasonable Assurance Plan (RAP) that identified various resource management actions to address the mineralized impacts to these surface waters through a comprehensive approach, to subsequently remove these water bodies from a verified impaired status. These actions included existing regulatory and non-regulatory tools, research, education and outreach programs, and cost-share reimbursement Best Management Practice (BMP) incentives. The RAP, approved by FDEP in 2005, included the following goals, with a time frame of ten years to achieve success toward reducing mineralized input to the surface waters within the impaired Shell and Prairie Creek watersheds - Improve water quality to consistently meet Class I standards, and maintain:

- specific conductance values below 1275 uS/cm within Prairie and Shell Creeks
- chlorides values below 250 mg/L within Shell Creek
- total dissolved solids (TDS) values below 1000 mg/L at all times, and 500 mg/L as a monthly average within Prairie and Shell Creeks

The fifth RAP progress report was submitted to the FDEP in April 2016 and summarizes that significant success has been achieved since 2005 in reducing the concentrations, as well as number of occurrences, for the mineralized parameters listed above. The commitment of the stakeholders along with implementation of the resource management actions were

instrumental in addressing the water quality impairments. Over $47 million (not including cost-share funding from private agricultural landowners) supported the successes, and also allowed performance monitoring efforts to occur throughout the ten year time frame of the RAP. Based on results provided in the fifth monitoring report, and further supported by the FDEPs Group 3/Cycle 3 Verified Assessment Period Report Card, the stakeholder group has requested the FDEP consider delisting TDS and specific conductance for both Prairie Creek segments that were identified as impaired. Analysis of historical surface and groundwater quality conditions in the Shell Creek watershed, along with implementation of numerous BMPs, suggest that the surface waters within Shell Creek naturally exceed FDEP Class I drinking water standards. Although BMP and other resource management actions will continue to be implemented in the Shell Creek watershed, additional water quality improvements are expected to be minimal due to the ambient nature of water quality conditions in this region.

Wednesday, March 29, 2017
Session 3 - Habitat and Living Resources: Plants

Ecological Enhancements of the Charlotte Harbor Spectral Optical Model for Interpretation of Inter-annual Seagrass Performance

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A spectral optical model was recently completed to estimate light availability to seagrass in the 14 estuarine segments of Charlotte Harbor. The model uses routinely collected discrete water quality monitoring data (color, chlorophyll, and turbidity) as inputs, rather than depending on difficult and sometimes biased field measures of light attenuation. This model is now being employed to report on spectral diffuse attenuation coefficients (Kdλ) and spectral irradiance values at depth which is are integrated to provide modeled values of the overall attenuation of photosynthetically active radiation (PAR), or KdPAR. Particularly in highly colored systems, model results are depth dependent and so modeling is performed using segment-specific seagrass target depths established based on 1999-2005 transect data. Desired water clarity necessary for seagrass success was identified as the distribution of modeled KdPAR at target depths during a reference period of 2003-2007 when seagrass cover was generally acceptable. A “Water Clarity Reporting Tool” is used to monitor annual distributions of water clarity (1998-2015) and to test for temporal trends with respect to target clarity distributions. In addition to computing KdPAR, % PAR can be evaluated at target depths. Unlike the often-used 25% PAR for

seagrass light requirements, medians of individual segments ranged from 10-34% PAR at the target depth for seagrasses during the reference water clarity period, with an overall median of near 19%. We have now updated this model to permit spectral irradiance at depth to be weighted for the usefulness of the individual wavelengths for photosynthesis, which can then be integrated to compute the more ecologically relevant photosynthetically useful radiation or % PUR reaching target depths. Variation among segments was reduced for % PUR relative to % PAR and ranged from 8-24% PUR with an overall median of 13%PUR. Using annual seagrass transect monitoring data, conducted at 50 fixed locations since 1999 and including maximum depths, densities, and qualitative epiphytic coverage, various measures of annual, seasonal, and shorter term light history as % PUR can be linked to annual observations of seagrass maximum depths. Variations in depth:light relationships among segments can be qualitatively linked to additional influences such as epiphytic attenuation, salinity, site energy, sediment characteristics, and abrupt bathymetric controls. This presentation will report on updates of this model to allow for more ecologically relevant estimates of the usable light reaching seagrasses and the relationship between variations in the amount of usable light and attributes describing seagrass success.

Comparison of Two Seagrass Programs within the Charlotte Harbor Estuaries

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Seagrasses are an important indicator species and provide many benefits to the estuaries and fisheries within southwest Florida. The seagrass beds within the Charlotte Harbor estuary have been mapped bi-annually since 1988 by the Southwest Florida Water Management District (SWFWMD), and monitored through fixed transects by the Charlotte Harbor Aquatic Preserves (CHAP) since 1999. Together, these two programs have been able to characterize the overall extent and health of seagrass beds over time. The potential contrasting differences stem from the design of each of the programs. The WMD aerials may not accurately capture the entire extent of seagrasses due to poor visibility in the darker colored freshwater rivers or due to aerial imagery being flown during the non-seagrass growing season. On the same note, the CHAP fixed transect program cannot provide overall acreages and extent as the transects were setup to monitor specific information, representing each of the estuary segments. The CHAP deep edge of seagrass growth at each of the transects will be compared to the 2014 SWFWMD seagrass map, as well as the CHAP seagrass abundance data to the SWFWMD patchy vs. continuous categories. The overall trends between programs will be compared over time as

well. Both seagrass programs are effective in characterizing seagrasses in different ways, and when combined, provide a powerful tool for resource managers.

Integrated Management Practices Controlling Submerged Vegetation in the Canals of Cape Coral, Florida

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Cape Coral is an urban metropolis constructed in the 1950s with a network of canals built to provide residential parcel next to navigable canals. These waterways have additional functions controlling flood, navigation and irrigation. The canals extend over 400 linear miles averaging 10 feet in depth by 50 feet wide, some holding freshwater and others saltwater connected directly to the tidal influences of the Caloosahatchee River. The Lee County Hyacinth Control District is authorized by the City to manage the aquatic vegetation in the system. Areas stocked with triploid grass carps within the Cape's urbanized interior freshwater systems are routinely monitored with hydro acoustic technology (Biosonic DT-X Echosounder) to determine the presence of underwater submerge vegetation. The District incorporates various methods of control (chemical, biological and mechanical) each or all have been implemented with evidence of a balanced system to maintain water navigation, fisheries, wildlife and aesthetics. Historical data will be presented as an example of a protocol for integrated management of this unique system in South West Florida.

Vallisneria americana (Tape Grass) as an Indicator of Freshwater Inflow to a Sub-tropical Estuary

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Vallisneria americana (tape grass) is a freshwater macrophyte which provides essential habitat in the Caloosahatchee River Estuary (CRE) in southwest Florida. Low freshwater inflow to the CRE in the dry season (Nov-Apr) can promote upstream salt intrusions which elevate salinity (S) too high for tape grass survival (S > 10). This study contrasted observed patterns of S and tape grass density between two time periods (5/1/1993 to 10/31/1999 and 5/1/2007 to 10/31/2013, developed a simulation model for tape grass, and evaluated the inflows associated with viable habitat. The salinities that were potentially detrimental to tape grass were related to the rate of freshwater inflow through a water control structure at the estuary head (S-79). Salinity at Ft. Myers in the first period (5.4 + 5.4) when tape grass was abundant were significantly less than

in the second period (10.0 + 8.0) when it was largely absent. *Vallisneria* shoot density ranged from 0-370 shoots m-2 with greatest abundance in 1998-1999, sporadic shoots in 2001-2003, increased distribution and density in 2005-2006, and widespread loss in 2007-2008. The calibrated model (1998-2014) provided estimates of 85.4% and 86.7% shoot disappearance in 2001 and 2007 as S was >10 for 145 and 174 consecutive days, respectively. Salinity values greater than 12 led to net mortality with inflow rates less than 9.7+5.1 m3 s-1 in model simulations. The acute sensitivity of *Vallisneria americana* to salinity makes it an ideal indicator of freshwater inflow to sub-tropical estuaries such as the CRE.

Identifying and Diagnosing Locations of Ongoing and Future Saltwater Wetland Loss: Mangrove Heart Attack

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The Charlotte Harbor National Estuary Program (CHNEP) partnered with the Southwest Florida Regional Planning Council (SWFRPC), Coastal Resource Group Inc., University of Massachusetts and Sanibel-Captiva Conservation Foundation Marine Laboratory to characterize Charlotte Harbor mangroves, evaluate mangrove condition trends and recommend restoration opportunities. EPA funded this work through a Wetland Program Development Grant during fiscal years 2015 and 2016. Florida Department of Environmental Protection also supported the work by providing boat access to mangrove sites and funding a portion of the mapping analysis. Since the 1970s, mangrove forests have been characterized by six geomorphic types: Overwash Island, Fringe, Riverine, Basin, Hammock and Scrub. Southwest Florida includes four mangrove species: red mangrove, black mangrove, white mangrove and buttonwood. Classic mangrove zonation suggests that mangrove species are found with red mangrove most waterward, followed by black mangrove, then white mangrove and then buttonwood most landward. Mangrove forest data were collected at 56 sites. Mangrove species mixes were far more common than classic mangrove zonation would suggest. Buttonwoods were found on the mangrove shoreline and red mangroves were found in the high scrub. Conceptual diagrams were prepared representing actual Charlotte Harbor mangrove forests by geomorphic type.

CHNEP staff mapped mangroves by geomorphology and species/species mixes for Charlotte Harbor proper (including the tidal Peace and Myakka Rivers). Mapped information and site data were used in combination with Landsat multispectral data to develop mangrove geomorphic and species interpretations for the entire CHNEP area. The results offer an astonishingly sensitive and detailed interpretation suggesting underlying hydrology, difficult to map from aerial photography and Lidar digital elevation models alone. The highlight of the project is the use of the "Green Normalized Difference Vegetation Index." Pastor-Guzman et al (2015) found this index describes mangrove canopy chlorophyll at the landscape scale received by Landsat sensors. Known areas of poor mangrove condition and excellent mangrove condition corresponded to the results of the index using 2015 Landsat data. The 2015 index was coupled with 1985 Landsat data to develop a mangrove condition trend. The project team assembled to identify restoration opportunities included four mangrove biologists and a regional planner, all with on-site experience in the Charlotte Harbor area. The 2015 mangrove condition and 1985 to 2015 mangrove condition change maps were used to identify 90 potential restoration opportunities throughout the study area. In addition, sites with poor or declining condition due to natural causes, where there was no remedy or where restoration was in progress were identified. The mangrove condition and change tool has many potential uses. Mangrove quality can now be measured and targets set, pursuant to CHNEP policy. Changes of mangrove vigor as a result of restoration can be measured, even after the restoration has taken place. This tool needs no pre-restoration monitoring because of the ongoing collection and archiving of Landsat data. Restoration opportunities can be identified easily in other areas now that the tool has been vetted.

Habitat Restoration in Charlotte Harbor

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The Southwest Florida Water Management District (District) Surface Water Improvement and Management (SWIM) Program is partnering with the Florida Department of Environmental Protection (FDEP) Parks Service and the Lemon Bay Conservancy to implement three new habitat restoration projects for Charlotte Harbor. The Alligator Creek Habitat Restoration Project is located on a 1,600 acre site that is owned by FDEP and is located south of Punta Gorda abutting Charlotte Harbor. Five project areas are included in the Phase III plan. Project goals for this phase consist of restoring the historic hydroperiod to approximately 120 acres of wetland and salttern area, which has been severely impacted by anthropogenic activities. The project will commence construction in October 2016. The Coral Creek Ecosystem Restoration Project is located on 2,600 acres of FDEP and District co-owned land. This project consists of hydrologic and habitat restoration of degraded and impacted wetlands on the Cape Haze peninsula. The current phase includes restoration of a series of remnant finger canals. The restoration design incorporates three research treatments to better understand juvenile tarpon

habitat requirements. Construction of Phase II will begin in early 2017. The Lemon Bay Habitat Restoration Project is located on an 80 acre parcel that is owned by the Lemon Bay Conservancy. Project goals include creating and enhancing estuarine and freshwater wetland communities and their associated uplands. Exotic removal has recently been completed on approximately 45 acres of the site. Construction of wetland features and re-planting of the uplands with native species is expected to commence in spring 2017. Including the above mentioned projects, the SWIM Program has partially or fully funded over 40 research and restoration projects in the Charlotte Harbor watershed, leading to nearly 4,500 restored acres, providing significant benefits to wildlife and fisheries.

Wildflower Preserve Habitat Restoration Project

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Near Cape Haze, Florida, a site known as the "Wildflower Preserve," (an 80-acre tract of land located in southwest Charlotte County) was purchased by the Lemon Bay Conservancy (LBC) in 2006 for preservation purposes. This abandoned golf course is hydrologically connected to Lemon Bay though a series of culverts and man-made ponds (golf course water features). These waterways have been documented by the Florida Fish & Wildlife Conservation Commission (FWC) as one of the most productive juvenile tarpon spawning areas in the region. In the past ten years the site has been overgrown with exotic vegetation, primarily Brazilian pepper, Australian pine, and punk trees. The LBC solicited grant funding from the Southwest Florida Water Management District (SWFWMD) and NOAA to achieve the following objectives: Removal of all exotic vegetation;

1. Enhance and expand the tarpon fisheries productivity;
2. Expansion of estuarine and freshwater wetlands;
3. Improve water quality that enters Lemon Bay; and,
4. To provide a nature preserve sitting with trails and educational signage.

In 2014, the SWFWMD approved up to $750K in funds for the restoration of this tract. Also 2015, NOAA committed funding ($422K) through their Coastal Ecosystem Resiliency Grants Program; this very competitive program only awarded six grants nationally, and this grant was the only Florida awarded project. The SWFWMD engaged Scheda Ecological Associates as the lead contractor for the project design and permitting activities. Thomas Ries, executive vice president and principal scientist, heads the Scheda team. Tom and Scheda have completed more than 97 similar habitat restoration and stormwater retrofit projects, restoring over 2,500 acres to date. For this restoration plan, the design team consulted with tarpon experts, (Dr. Aaron Adams & JoEllen Wilson) from the Bone Fish Tarpon Trust on the specific habitat requirements for juvenile tarpon. The design features recommended were incorporated into

the overall estuarine areas. The final approved ecosystem restoration design includes sub-tidal, intertidal, transitional, and freshwater wetlands as well as coastal upland habitats. Restoration of these communities will help offset habitat impacts and losses suffered throughout the Charlotte Harbor ecosystem. Further, treatment of stormwater entering the site will improve water quality in Lemon Bay and ultimately in Charlotte Harbor. Restoration of the site will meet management goals of the Surface Water Improvement Management (SWIM) Program, the Charlotte Harbor National Estuary Program, and the LBC. Finally, this project will also increase resilience of neighboring communities to the potential impacts of climate change (flooding and storm protection), enhance recreationally important fisheries, and improve overall ecosystem function within the Charlotte Harbor watershed. This presentation will highlight the design consideration and illustrate the final design elements for this important tarpon nursery restoration effort. Currently this project has received authorization from Charlotte County and the Florida Department of Environmental Protection (FDEP) and is awaiting the final permit from the US Army Corps of Engineers. Once this permit is secured, the SWFWMD will solicit bids from qualified contractors to begin construction; which is anticipated to commence in 2017.

Wednesday, March 29, 2017
Poster Session – Habitat and Living Resources

The Impact of Removal of *Melaleuca quinquenervia* on the Growth of Native Trees: Slash Pine (*Pinus elliotii*) and Pond Cypress (*Taxodium ascendens*)

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In 1997 a 1-Ha Forest Plot was established as a long-term study site on the Florida Gulf Coast University campus. Data were collected on tree (>10 cm dbh) species, location and diameter. The plot was remeasured before and after management activities to removal the invasion exotic tree *Melaleuca quinquenervia*. We report on the long-term population dynamics and growth of native and exotic tree species, *Melaleuca quinquenervia*, *Pinus elliotii*, *Taxodium distichum*, and *Sabal palmetto*, in particular in response to various approaches to managing exotics. The results of this study can help guide management decisions.

Factors Affecting the Restoration of *Vallisneria americana* in the Caloosahatchee River

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Development and hydrologic alteration in the Caloosahatchee watershed have drastically altered the ecology of the river and estuary. This has led to loss of submerged aquatic vegetation (SAV), which serves as an indicator of the overall health of the system. The aim of this project was to examine factors affecting the growth of restoration plantings of the freshwater SAV *Vallisneria americana* in the Caloosahatchee River. Factors examined included sediment characteristics, planting densities, herbivore exclosure size, and geographic strain of donor plants. Differences between exclosure sizes were observed when examining transportation and deployment, planting and sampling effort, wave action, and herbivory. When examining planting density the results indicate the initial planting density had no effect on the growth of *V. americana*. Although planting density lacks a vital role in the growth and establishment of *V. americana*, genetic variation may account for observed differences. Preparation for a SAV restoration that includes an investigation of the donor plants genetic makeup should be standard practice. Restoration of any species to an extirpated site will involve attempting to find appropriate genetic material often from geographically separated populations. Site selection is another critical factor when considering a SAV restoration attempt.

Peace and Withlacoochee River Threats Assessment

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Habitat degradation is the primary factor causing the decline of biodiversity in aquatic ecosystems of the southeastern United States. Sedimentation is one of the main contributors causing degradation, loss of habitat complexity and impairment of river habitat and biological communities. The Peace and Withlacoochee river watersheds have experienced varying levels of habitat degradation due to urbanization, agriculture, and mining. An initial step in conserving and restoring natural function and biodiversity of rivers affected by habitat degradation is identifying those areas contributing to habitat degradation throughout the system. Currently,

Florida Fish and Wildlife Conservation Commission (FWC) is conducting a habitat assessment on the Peace and Withlacoochee Rivers and their major tributaries. FWC staff are following methodologies developed by the United States Fish and Wildlife Service (USFWS) and David Rosgen's Watershed Assessment of River Stability and Sediment Supply (WARSSS). The objectives of this project are to: (1) identify and inventory the location and magnitude of habitat degradation within the Peace and Withlacoochee rivers, including their navigable tributaries; (2) identify and inventory fish passage impacts at road crossings; (3) identify, inventory and score unpaved road crossings; (4) develop restoration recommendations at each impacted location; and (5) develop a prioritized Basin Restoration Plan for state, federal, and local agencies and private land owners to implement conservation and restoration efforts.

Wednesday, March 29, 2017
Session 4 - Habitat and Living Resources: Stewardship

Caloosahatchee Freshwater Flows and Submersed Angiosperms

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Anthropogenic changes in freshwater flow and salinities in the Caloosahatchee Estuary have caused drastic changes in submersed angiosperm coverage and density. Tape grass has been recovering from several years of high salinities but no plants were found in the downstream portion of it's former range. Widgeon grass was also found in low density and biomass in recent years until 2015 when significant meadows were noted. Tape grass and widgeon grass were propagated in outdoor tanks and ponds on Sanibel and transplanted into the Caloosahatchee to increase the coverage and density of plants. Clumps of plants were either enclosed by fencing or planted with no exclosures. Both methods were successful in increasing shoot density, but the enclosed transplants increased in density and biomass more quickly.

Using Web-based GIS Software to Survey the Mangroves of Sarasota County's Shoreline

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Mangrove swamps are highly productive, ecologically significant ecosystems found in saline environments. Mangroves provide a variety of benefits to coastal communities and offshore marine communities. They filter stormwater runoff, capturing pollution and sediment before it can reach the marine ecosystem. Healthy seagrass communities and coral reefs rely on mangrove shorelines for water clarity and quality. The State of Florida regulates the trimming and alteration of mangroves through the 1996 Mangrove Trimming & Preservation Act (Act), and mangrove trimming occurs by these rules. Recognizing the role of mangroves, the Sarasota County Commission in the early 2000s sought to evaluate mangrove trimming occurring in the county. In 2004, Sarasota County undertook a study to the status of the mangrove shorelines in Sarasota County, including distribution of mangroves, their height, and whether or not they are trimmed. A shoreline was considered to have mangroves if the shoreline contained greater than 30% mangrove coverage. County staff also documented shoreline hardening, the presence of invasive plant species, opportunities for native plantings, and alleged violations of the Act. County staff undertook subsequent studies in 2005, 2011 and 2016. The 2011 and 2016 studies introduced new data recording methodologies, though base information taken remained consistent. Staff collected additional points of data as data collection tools improved. The 2016 data was entered using a mobile device and the GIS applet ArcCollector. This applet allowed data entry directly into a web-based GIS portal, creating maps concurrent with data collection. Data has consistently confirmed that most property owners chose to trim their mangrove shorelines. Of the shorelines surveyed, 45% have mangroves and of that, 54% are trimmed. Staff determined that over 90% of mangrove trimmings documented in the study for 2004, 2005, 2007, 2011 and 2016 were consistent with state rules concerning mangrove trimming. The data collected will continue to inform local policy regarding mangrove protection and potentially allow for future analysis of carbon sequestration, storm protection, fishery productivity and other mangrove ecosystem services.

Challenges of Competing Interests, Logistics, and Payoffs in Two Different Restoration Projects in Southwest Florida

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Southwest Florida has been experiencing rapid population growth for several decades. Along with that development come intense habitat alterations including hydrological modifications

and suppression of fire. I am working on two habitat restoration projects, with the help of Service-learning students from Florida Gulf Coast University (FGCU). Similar challenges exist with both projects, including: balancing competing interests, funding, need for education of humans, and logistics of working in a highly altered habitats surrounded by residences.

Engaging the Community in the Alligator Creek TMDL Watershed

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Sarasota County is focusing on getting the residents of the Alligator Creek watershed to recognize, value and contribute to the protection and enhancement of the creek and contributing areas. The focus is on Alligator Creek in the community of Venice Florida because there is an EPA TMDL calling for a 28% reduction in nitrogen pollution. The County already had an innovative nitrogen removal facility there and a community led waterway restoration project. County staff have been working with community leaders to support and encourage their participation and leadership. We have learned a lot together about waterway restoration, being a cheerleader, adding technical details about water quality and working collaboratively with our regulators - the FDEP. This is a story about a work in progress and the collaboration, challenges, and successes that got us where we are today.

Water Management - Making Tangible Improvements in the Health of the Caloosahatchee River and Estuary through Innovation, Planning and Relationship Building

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The Southwest Lehigh Weirs project, otherwise known as the Aquifer Benefit and Storage for the Orange River Basin (A.B.S.O.R.B) project, provides construction of 25 weirs in Lehigh Acres through a strategic, multi-agency partnership between, the State of Florida the Florida, the Department of Transportation (FDOT), South Florida Water Management District (SFWMD), the Florida Department of Environmental Protection (FDEP) and the Lehigh Acres Municipal Services Improvement District (Lehigh Acres MSID). It is a crucial step to making tangible improvements in the health of the Caloosahatchee River and Estuary (Tidal and Estuarial Basins) through improved water quality and aquifer recharge and increased storage for the Orange River Basin. The Southwest Lehigh Weirs project is funded in part through a $1.22 million grant through the FDEP TMDL Water Quality Restoration Grant program. Annually, the state legislature provides funding for the implementation of best management practices, such as regional stormwater treatment facilities, designed to reduce pollutant loads to impaired waters

from urban stormwater discharges. This funding is administered by FDEP as the TMDL Water Quality Restoration Grant. The Southwest Lehigh Weirs project will increase canal control elevations and local groundwater levels by constructing 25 weirs within an approximately ten square mile area in southwest Lehigh Acres. Lehigh Acres MSID will improve stormwater storage for at least 800 acre-feet of storage depending on the severity of the storm event. The additional water stored and its nutrients/pollution will be removed from the Orange River and the Caloosahatchee River of an estimated 888 kg/yr of Nitrogen and 87 kg/yr of phosphorus, etc. Lehigh Acres MSID provided $80,250 in matching funds for a State of Florida CIBR Grant in the amount of $160,500 and SFWMD provided $57,590 to fund preliminary study. An additional $1.9 million in funding was secured through an agreement between Lehigh Acres MSID and FDOT in which FDOT will purchase the ability to discharge into Lehigh Acres MSID's stormwater system and receive fill dirt for road beds in their State Road 82 (SR82) widening project; this mutually-beneficial agreement has helped speed up the timeframe for road construction as well as for Lehigh Acres MSID's capital projects; has eliminated the need for roadside retention ponds along SR82; and has allowed Lehigh Acres MSID to be proactive in solving infrastructure needs and provided the ability to construct crucial stormwater projects without imposing an assessment increase on ratepayers.

Cross-curricular Integration of the Florida Gulf Coast University Campus as a Living Laboratory

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Since its opening in 1997, Florida Gulf Coast University's campus, incorporating preserved uplands as well as created and restored wetlands surrounded by a rapidly developing landscape, has served as a living laboratory and vital component of the curriculum. In 1998, a National Science Foundation funded project to integrate the curriculum with campus, watershed, and regional research needs resulted in the Campus Ecosystem Model (CEM). CEM is a framework for guiding field-based course projects and faculty, undergraduate, and graduate student research. This campus model allows for experiential learning and place-based

education, not only within our FGCU curricula, but also in community outreach programs pre-K to adult education. We report on 20 years of using the campus for natural sciences and engineering education and on the expansion of this interdisciplinary integration across the curriculum. The campus habitats, developed environments, and university operations continue to provide opportunities for undergraduate and graduate learning, research and scholarship (more broadly defined), development of student ecological literacy and sense of place, and service learning projects. This 'place-based education' is both efficient, in the use of the campus, and effective in reconnecting the students to their environment, providing real world case studies that can effectively explore issues in conservation, restoration, green design, efficient use of resources, and the impact of the built environment on the ecosystem. Examples of the integration of our campus into the curriculum can be extended to a variety of K-adult educational settings.

WET PLAN - Collaboration to Improve Stormwater Quality in Neighborhood Ponds

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WETPLAN - Watershed Education Training - Ponds, Lakes & Neighborhoods - is an education program and resource for anyone interested in improving and caring for their neighborhood lakes and ponds. The program provides workshops several times a year with a panel of experts providing assistance for home/condo owners associations and individuals. WETPLAN is a partnership of water quality and lake management experts including members from the Charlotte Harbor National Estuary Program, the City of Bonita Springs, Lee County Natural Resources, Lee County Hyacinth Control District, Florida Gulf Coast University, Lee County Extension Services, the Florida Native Plant Society, and private partners including GHD, Johnson Engineering, Hans Wilson & Associates, All Native Garden Center and many others. This talk will present WET PLAN to the scientific community. The presenter will provide background including why and how WET PLAN was developed, who are the participating partners, and what WET PLAN is designed to achieve – assisting Lee County and stakeholders in meeting goals to reduce nutrient loads to our waters using Florida Friendly Landscaping, while improving the aesthetics of neighborhood stormwater ponds. Metrics from the past 3 years of workshops will be presented. WET PLAN addresses citizen concerns about their neighborhood stormwater ponds including: Bank Erosion, Fluctuating Water Levels, Choosing Appropriate Littorals, Weeds & Overgrown Plants in Pond, Fish & Wildlife, Water Quality, Algae Blooms, and Community Board Involvement.

Detention Ponds for Stormwater Treatment: Evaluation of Compliance and Effectiveness in Lee Co., FL

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The overall objective of the research is to investigate ways in which deviation from geometric design criteria impacts the water quality of stormwater ponds in the Southwest Florida environment, evidenced by a sample of residential community stormwater ponds in Lee County Florida. The findings will act as an assessment of differing ways in which the regulations might be modified to improve conformance to guidelines, and or ways in which guidelines might be modified to improve the capability of removing nutrients. The research developed to following questions in an effort to address the overall objective: Is there demonstrated, documented, rigorous compliance of stormwater ponds in our sample with regulatory requirements including permitting, design requirements, and condition of the pond after it has been in operation since construction? Is there a significant relationship between water quality and geometric characteristics of ponds as they currently exist? Do stormwater ponds that diverge further from regulatory requirements regarding geometric design criteria have greater concentrations of nutrients, indicating that they may be less successful at pollutant removal, than stormwater ponds that nearly conform? An initial sample selection process was undertaken to acquire residential community stormwater ponds with water quality data. A sample of ponds were selected from the LCHCD Pondwatch program based upon two main concepts; ponds with relatively lengthy history and the most consistent through time. Following these two main concepts, fourteen ponds were selected with water quality data ranging from 2007-2014. The next step was the acquisition and assessment of individual community Environmental Resource Permits (ERP) for the analysis of conformity to required maps and pertinent documents by the SFWMD. This trying step was followed by a field study to quantify the bathymetry of the selected stormwater ponds as they currently exist, in an effort to assess conformity to design criteria. Finally, a comparison of trends in water quality to trends in conformity to regulations was undertaken, both respect to the ERPs and respect to the pond bathymetry.

Swamp Walks: Connecting People to the Landscape of Southwest Florida

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Personal connection to natural systems is a critical component of moving society and individual actions to more sustainable practices that preserve native biodiversity and maintain critical ecosystem functions. The immersion swamp walk experience appears particularly powerful as a learning experience. We are developing a research program to explore the variations in learning objectives and delivery of swamp walks; and to investigate the effectiveness of these experiences in creating a personal connection to swamp ecosystems for participants and increasing their ecological literacy.

Limnological Assessment of the Ponds of Burnt Store Lakes POA (Charlotte County, FL)

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Like most parts of Florida, the timing, quality and amount of freshwater deliveries to the coasts has been altered subsequent to anthropization. As part of a palliative remedy, impoundments from reservoirs, constructed wetlands or stormwater ponds have been constructed. In southwest Florida, there is an estimated 10,000 urban ponds between 1-40 ha in size (2m mean depth) located near the coasts. Although most were dug for flood mitigation or inexpensive fill, since the early 1980ies, following the chapter 62-40 of the Florida Administrative Code, ponds were mandated to additionally i) prevent land erosion, ii) provide pollution runoff control via filtration and decantation and iii) attempt to reestablish the natural hydropatterns in the region thus allowing aquifer recharge and adequate freshwater deliveries to the coastal systems. Research conducted on ponds of the region show that, because of questionable aesthetic values, these ponds become eutrophic. The growth suppression algae and plants by xenobiotics further render the ponds inefficient in treating polluted runoffs which, along with nutrients, reach the coasts thus potentially obviating restoration efforts made more inland. In 2016, a research was conducted on ponds characterized by a relatively underused watershed. The study conducted between March and June 2016 focused on 11 ponds located within Burnt Store Lakes POA (southern Charlotte County) which ~450 ha watershed abutting Charlotte Harbor is currently 25% developed. The use of sonar allowed to map pond bathymetry, submerged aquatic vegetation and bottom hardness. Ponds encompassed a total surface area of 50ha (min. 0.35ha, max. 16.1ha, average 6.1ha) for a total volume of 1.1 million m^3 (1.6m mean depth) and an average shoreline development index of 1.6. Vertical profiles of temperature, dissolved oxygen (DO), pH, specific conductivity and oxidation reduction potential

were made at 16 stations. An integrated water column was sampled for nutrients, chlorophyll_*a* and total alkalinity. Additionally, a Secchi disk depth coupled with a light profile were made. Six ponds out of eleven were freshwater while the rest were brackish and ponds also had decreasing gradient of total alkalinity along a northeast-southwest axis. This complicated the limnological interpretation of the results. Water quality unexpectedly ranged from mesotrophic to eutrophic on the Carlson trophic status index scale (TSI, min. 45, max. 67., average 53). The two largest ponds had the lowest TSI, while the rest was nutrients rich. Despite the use of aeration, six ponds had inadequate levels of DO (i.e. <5mg/l) while two others were clearly supersaturated in DO linked to phytoplankton photosynthesis and could have lower DO at night. Because most of the ponds had limited amount of sediment, nutrient loading sources to the ponds are unknown for most although it is hypothesized that one pond received nutrients via perched bird droppings, while another received nutrient from a polishing lagoon of nearby wastewater treatment plant. Research on other ponds point out that groundwater loading could be the additional source of nutrients loading. Overall, it does not appear that Burnt Store Lakes POA ponds act as a buffer zone to the Charlotte Harbor.

Thursday, March 30, 2017
Session 5 - Habitat and Living Resources: Fish

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

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To help set minimum flows and levels associated with planned water withdrawals from the Lower Peace River, the Southwest Florida Water Management District (SWFWMD) is sponsoring research to assess the influence of changes in salinity and temperature patterns on selected fish and invertebrate species in Charlotte Harbor, Florida. In order to create an ecological baseline, habitat mapping has been conducted using environmental data (temperature, salinity, dissolved oxygen, depth, and bottom type). Catch rates (CPUEs) have been computed using Fisheries-Independent Monitoring (FIM) data collected from 1996-2013 by the Florida Fish and Wildlife Conservation Commission (FWC). A statistically rigorous habitat suitability model (HSM) was developed by FWC, using generalized additive models (GAMs), and applied to seasonally assess the spatial distributions and relative abundances of eight fish and invertebrate species (32 species life-stages). All species chosen have affinities for low salinities

found in the Lower Peace River. Using geographic information systems, predicted HSM maps were created from the FIM data depicting the spatial distributions and relative abundances of juvenile and adult life-stages. These represent long-term HSM conditions by species across years. The predicted CPUE grids produced have been used to estimate seasonal population numbers for each species life-stage. The next phase of the study involves running "what-if" scenarios. Circulation modeling is being conducted by SWFWMD to predict seasonal temperature and seasonal salinity patterns associated with: a) baseline flow conditions, and b) water withdrawal conditions. Habitat grids created from the temperature and salinity data are being used with HSM to assess the potential impacts of water withdrawals on each species life-stage by season. Rainfall is generally low during the winter (January-March) and spring (April-June) and higher in the summer (July-September) and fall (October-November). Using the HSM analyses, the influence of water withdrawals during each season will be determined. The HSM analyses can help SWFWMD managers make decisions concerning minimum flows and levels that conserve the estuarine ecosystem.

Impacts of Coastal Development and Altered Watersheds on Juvenile Fish Nursery Habitats

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Coastal habitat loss and degradation is a global issue, but is especially pertinent in Florida due to our massive amount of coastline and the human desire to live near the water. Many of these coastal lands serve as nursery habitats for important juvenile fishes. Habitat loss through building, excess nutrient run off from nearby housing and roads, and alterations of freshwater flows to these nursery habitats can have major implications on juveniles in the estuaries and will ultimately affect the overall fisheries. Juvenile snook and tarpon in particular rely on these estuarine nursery habitats. My research focuses on the ecological requirements for snook and tarpon nursery habitats and how these fishes are impacted by changes in the habitat. A statewide mapping project of current juvenile snook and tarpon locations allows us to determine what essential features these locations have in common. With the help of FWC habitat specialists, I have generated a list of characteristics that are pertinent to a successful nursery habitat, including quantity and quality of freshwater flows entering the estuary. This list will be used to protect natural nursery habitats and enhance altered nursery habitats. Habitat restoration has the potential to combat habitat loss and degradation by improving habitats that have been altered and returning them to a more natural condition that is ideal for juvenile fishes. We will use the list of essential characteristics from the habitat mapping project as the blueprint for habitat restoration. I will also discuss the Coral Creek Preserve habitat restoration design project (funded by CHNEP) that includes multiple nursery habitat restoration designs. This allows us to use a side-by-side comparison to determine which aspects of habitat

restoration are more desirable to juvenile snook and tarpon and what features should be included in future habitat restoration designs.

Environmental Drivers Affecting River Use by Large Predatory Fishes in Southwest Florida

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Large floodplain rivers of the Charlotte Harbor estuary have been shown to provide important habitat for a variety of euryhaline and freshwater predatory fishes. Several of these species are iconic sportfish that are highly sought after by anglers, and help support the local economy. A major challenge for resource managers is to gain a functional understanding of how variation in hydrology, geomorphology, and vegetation type that occurs along the rivers affects fish populations, and expectations of fishing quality, at varying spatiotemporal scales. We examined abundance and distribution of predatory fishes (Common Snook, Florida Gar, and Largemouth Bass) in relation to habitat and environmental conditions in the Peace and Myakka rivers for four years using electrofishing. In addition to variables known from previous studies to influence the abundance of predators (e.g., depth, snag cover), dissolved oxygen (DO) was found to be a major driver contributing to lower bass abundance in the Myakka (DO < 3 mg/l). In contrast, the abundance of snook and gar in the Myakka was comparable to the Peace. Gar are obligate air breathers that thrive in shallow marshes and rivers that experience anoxia (i.e., the Everglades), and snook are euryhaline and appear to push upstream until they reach areas that test their oxygen limits (~<2 mg/l). Hydrogeomorphic differences are likely causing the disparity in DO between the two river systems. In the Myakka River, the lowest DO occurred just downstream of a large, emergent marsh. The marsh is prone to large-scale die-offs, which may contribute to the anoxic water conditions as the vegetation decays. These conditions appear to be natural and are similar to those found in tropical rivers around the world; however, more investigation is needed to determine if any anthropogenic effects exasperate the low DO. Understanding the ecology of the river and the factors contributing to low bass abundance will determine if any interventions by managers to improve fishing quality (e.g., stocking fish) can be successful, or if expectations simply need to be reset.

Fish Communities and Diet of a Juvenile Sportfish in the Seagrass-associated Tidal Creeks of Charlotte Harbor's Cape Haze Peninsula

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Evaluating the status of coastal wetlands and tidal creeks can provide an important management tool because these habitats lie at the margin between land and open estuary, and are generally close to the sources of any upstream impacts and water quality degradations. The objective of this study was to determine habitat use of fishes in tidal creeks dominated by seagrasses on Charlotte Harbor's Cape Haze peninsula in Southwest Florida, and to compare them with nearby unvegetated creeks (no seagrasses) more typical of the Florida Gulf coast. A stratified-random sampling design was used to sample the creeks monthly for a period of one year using a 21-m seine. The density of fish in the Cape Haze creeks was four times higher and differed in species composition (analysis of similarity R=0.71, p=0.001) compared to unvegetated creeks in upper Charlotte Harbor. Of the top 12 distinguishing species (e.g., Rainwater Killifish, Pink Shrimp, two mojarra species, silversides, Pinfish) all were more abundant in the Cape Haze creeks, with the exception of Striped Mojarra and Bay Anchovy. The diet of a representative predator was used as an additional sampling tool because prey assemblages are often reflective of those species abundant in the environment and can include species not represented well in traditional fishing gear (e.g., grass shrimp, snapping shrimp, mud crabs). The prey assemblages of Common Snook (100–400 mm SL), a sport fish that uses tidal creeks as a juvenile habitat, differed between tidal creeks of Cape Haze and upper Charlotte Harbor. Snook collected in Cape Haze creeks fed heavily on Rainwater Killifish and Pink Shrimp (seagrass associated species), and were found to have consumed more diet items in general than snook collected in creeks of upper Charlotte Harbor. The seagrasses in the tidal creeks of Cape Haze represent an additional habitat type that supports greater numbers of fish, and potential prey for juvenile sport fish, than unvegetated tidal creeks more typical of the Florida Gulf coast. Conservation and restoration targets that maintain the diversity of Cape Haze would further the National Estuary Program's Comprehensive Conservation Management Plan.

Indicators of Wetland Restoration Success in South Florida: Two Case Studies

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Aquatic macroinvertebrates are a diverse group of organisms that form important trophic linkages to higher level consumers like fish, amphibians, reptiles, birds and small mammals including many listed species. In a typical Florida wetland you may find several Classes of aquatic animals including bivalves, crustaceans, insects, gastropods, worms and even sponges. Aquatic invertebrates have a long history as indicators of stream condition and water quality. More recently they have been used as performance measures for restoration success in Everglades restoration projects because of their sensitivity to changes in hydrology habitat quality. Several indicator species have been identified for assessing hydrologic restoration in the Picayune Strand Restoration Project (PSRP) in Collier County and at Babcock Ranch in Lee and Charlotte Counties. A rapid field assessment technique was specifically developed for evaluating wetland condition and for tracking restoration success in response to management actions that restore hydroperiods and native plant communities. This method was accepted by the Project Delivery Team (PDT) for PSRP in 2005 and has proven to be cost-effective, simple & repeatable method when conducted by trained and experienced aquatic ecologists. These same methods were applied at Babcock Ranch to assess baseline and post-restoration conditions. Rare and cryptic fauna were collected and identified in both cases and found be important indicators of restoration success. Rare and cryptic species of macroinvertebrates were significant contributors to community structure and often absent from disturbed systems.

Differences in Large-scale Habitat Use Patterns between Two Smalltooth Sawfish, *Pristis pectinata*, Nursery Areas

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Endangered Smalltooth Sawfish (*Pristis pectinata*) are known to use multiple southwest Florida estuaries during their first 2–3 years of life and understanding region-specific habitat use patterns has become important for effective management. Our research in the Charlotte Harbor estuarine system, was initially focused in the Caloosahatchee River, a highly human-altered river system, and we have now expanded sampling into a more natural area, the Peace River. A total of 238 juveniles ranging from 708 to 2,640 mm stretch total length were captured, tagged, and released between 2010 and 2015. Electivity analyses showed that sawfish in both

rivers had affinities for water <1 m deep, water >24°C, moderate to high dissolved oxygen levels (>4 mg l-1), and salinities between 12 and 27. Movements were monitored in main-stem river habitats and non-main-stem habitats (i.e., natural mangrove-lined creeks, semi-natural creeks, seawall-lined canals) using acoustic listening stations. Sawfish used all of the habitats available to them in both rivers, but tended to reside in specific regions of the nurseries. In the Caloosahatchee River, sawfish were usually associated with five hotspots along a 25 river kilometer (rkm) stretch of the river. They moved upriver during dry, low freshwater inflow conditions and downriver during wet, high inflow conditions. In contrast sawfish tended to remain in only a six rkm portion of the Peace River during all freshwater inflow conditions. Possible reasons for these observations relate to differences in geomorphology and freshwater inflow regimes between the rivers.

Diel Movements of Juvenile Smalltooth Sawfish (*Pristis pectinata*): Implications for Defining the Size of a Nursery Hotspot

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Movements and habitat use of endangered juvenile (<3 yr old) Smalltooth Sawfish (*Pristis pectinata*) were studied in the Peace River, Florida during 2014 using active manual tracking and passive acoustic monitoring to (1) document fine-scale habitat associations and (2) estimate the boundaries of the only known nursery hotspot in the river. A total of 23 sawfish were acoustically tagged on the north side of the river during the peak recruitment period in April and May. Subsequently, rather than following individuals for long periods of time, manual tracking was conducted during June and July using kayaks (day) and small boats (night) to determine position estimates of individuals relative to the shoreline and major habitat types (e.g., red mangroves, oyster reefs, canals) throughout the study area. During the day, juveniles remained along the northern shoreline and tended to be close (< 25 m) to red mangrove-dominated shorelines. At night, juveniles moved away from the northern shore, and made excursions to the south side of the river. These data suggest that the boundaries of the hotspot include both shorelines of a six river kilometer portion of the Peace River between the US 41 and I-75 bridges.

Thursday, March 30, 2017
Poster Session - Habitat and Living Resources

The Gopher 300: a Metadata Analysis of Gopher Tortoise (*Gopherus polyphemus*) Burrow Commensals

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The number of organisms that utilize gopher tortoise burrows is typically reported as "300-400". This number is based on a comprehensive review of the available literature in 1989 by Jackson and Milstrey. Their database did not include regional variation, only partly explored the varying uses by commensals (e.g. parasitic, co-habitant, or colonizer following abandonment), and can benefit from an update with the 25 years of data since that review. We report on a metadata analysis that attempts to update our understanding of the role of gopher tortoises as a keystone species.

Habitat Use of Florida Box Turtle (*Terrapene carolina bauri*) on a Barrier Island: Sanibel, Florida

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Florida box turtles (*Terrapene carolina bauri*) are potentially important indicators of environmental disturbances in southwest Florida. This research focused on habitat use and home ranges of box turtles in a golf course on Sanibel Island, FL. Little literature has presented home range size for box turtles in Florida and none have been published for South Florida. We installed transmitters and tracked four box turtles (one female, two males, and one juvenile), from a larger database of marked turtles at The Sanctuary Golf Course from August to October in 2015. We report on home range sizes, habitat use within the home ranges, and movement patterns. These data are used to explore impacts of human land use and possible wildlife habitat on golf courses.

Range of the Zebratail Blenny, *Hypleurochilus caudovittatus* Bath, 1994, with Comments on Identification of the *Hypleurochilus* complex in the Gulf of Mexico

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Range-restricted marine species present a compelling case study for latitudinal shifts due to climate change. We examined the distribution of the recently described Zebratail Blenny, *Hypleurochilus caudovittatus*, which was thought to occur only in the northeastern Gulf of Mexico. Because of its recent description, it was necessary to search collections for three sympatric *Hypleurochilus* species to identify all available specimens. We found that cephalic pore branching complexity was the most reliable way to distinguish between *H. caudovittatus* and its congeners. Using multi-decadal fisheries-independent and museum data, we determined that *H. caudovittatus* ranges from Perdido Key, Florida in the northeastern Gulf of Mexico to at least southern Pine Island Sound, Florida in the southeastern Gulf of Mexico, where it reaches at least 64 mm standard length and occurs in estuaries and open waters from 0.5 m to at least 30 m deep. We propose *H. caudovittatus* as a candidate species to study the future effects of climate change because of its restricted range and existing barriers that may prevent range adjustments.

SCIENCE FAIR: Using *Brassica juncea* to Phytomine Copper from Low Grade Ores using Chelating Agents

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A high concentration of copper can be found as a toxin in soils. This project uses phytomining which is a new environmentally friendly technology that can decontaminate soil by extracting toxic metals through the roots of plants, which can be extracted from the plant without pollution. Not all metal ions are available to the plant, and to fix this, chelates can be added to soils to facilitate the process. The chelates used in this experiment are citric acid and disodium ethylenediaminetetraacetic acid or EDTA. *Brassica juncea* (Indian mustard) plants were exposed to high amounts of copper, and in some cases, chelates, for two weeks and then the plants were trimmed and burned in an oven to be reduced to ash. Sulfuric acid (H_2SO_4) was then added to the ash (that contains copper) to yield copper sulfate ($CuSO_4$), as seen in the following reaction: Cu(s)+ H2SO4(aq)→ CuSO4(aq)+ H2(g). The copper sulfate ($CuSO_4$) from this

reaction had zinc (Zn) added to it to displace the copper (Cu), as seen in the following equation: $CuSO4(aq)+ Zn(s) \rightarrow ZnSO4 (aq) + Cu(s)$. This formed a copper precipitate. It was found that the most copper produced came from plants whose soil had been applied with citric acid, which produced 9.36% copper from its ore, which is a 94.6% greater yield than plants that did not have a chelate applied to their soil. Phytomining is a valuable technique to decontaminate soil with a high copper concentration and also supports mining copper in an environmentally sustainable way.

Thursday, March 30, 2017
Session 6 - Habitat and living resources: Reptiles, Invertebrates and Shellfish

Where and How Do Sawfish Spend Time in Nurseries? Insights from Acoustic and Accelerometer Data

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In recent decades, use of telemetry to determine general locations of many fish species has improved our understanding of broad habitat use patterns. However, these studies are limited in their ability to provide insights into specific behaviors or reasons for using specific habitats. Recently, acceleration data loggers (ADLs) have been developed to quantify behavioral parameters (e.g., % time active, resting, feeding, mating) based on the animal's movements. Although ADLs provide data on behavior and physiology they do not provide information on animal location. For this reason, we used acoustic and ADL tags concurrently to improve our understanding of endangered smalltooth sawfish (*Pristis pectinata*) ecology in the Peace River, Florida. In 2014 and 2015, seven juveniles (0.8–1.8 m stretch total length; <2 yr old) received both tags and one received both tags twice. Preliminary ADL data analyses have indicated a diel pattern of hourly activity with juveniles more active at night (mean = 77.5% ± 26.5 SE) than during the day (mean = 63.1% ± 31.3 SE). Acoustic data showed that juveniles resided in a protected cove near red mangrove shorelines during the day and moved into open water habitats away from shore at night. Brief events of high acceleration amplitude and frequency, which may be indicative of foraging, occurred during day and night. This suggests that the diel patterns of activity and location within the nursery were not solely related to foraging. Water temperature, depth, and tide will be examined to determine how they may have influenced habitat use.

Collecting Ultra Fine-scale Movement Data on Sawfish in the Peace River using Traditional Acoustic Monitoring Techniques

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Fine-scale movements of endangered juvenile (<3 yr old) Smalltooth Sawfish (*Pristis pectinata*) were studied in the Peace River during 2016 using passive acoustic monitoring. A total of 24 sawfish were acoustically tagged in the river primarily during the peak recruitment period of April and May. Subsequently, rather than following individuals for long periods of time, a time-synchronized, optimized array of nine acoustic receivers was used to determine highly-accurate (within 1–3 m) position estimates of individuals near the Trabue Harborwalk oyster restoration project. To date, 11 sawfish have entered the array and four spent significant time there, primarily at night. Associations of sawfish with critical habitat features (e.g., red mangrove shorelines, water depths < 1 m) and the restored oyster reef will be investigated to determine the validity of previously documented habitat use patterns and the extent to which sawfish interact with the restoration area.

Utilizing Citizen Scientists for Long-term Oyster Habitat Restoration Monitoring

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One of the commonly recognized needs in habitat restoration science is long-term monitoring data. The data is critical to evaluating the effectiveness of restoration techniques, and to valuing cumulative ecosystem benefits gained by restoration projects. Funding for habitat restoration projects rarely includes money to support monitoring for more than one year after the project begins, leaving the long-term fate of most projects unknown. The CHNEP Oyster Habitat Restoration Plan identified the need to develop a consistent long-term monitoring plan to help guide effective future restoration and the value of involving the community in oyster

restoration projects. To address these two needs the CHNEP developed a pilot Volunteer Oyster Habitat Monitoring (VOHM) project, which was funded in part from the Florida Department of Environmental Protection's Florida Coastal Management Program, through a grant provided by the NOAA Office of Ocean and Coastal Resource Management. This type of Citizen Scientist program is growing in popularity to fill gaps in monitoring while engaging the public.

Volunteer and scientific steering groups were established to assist in the development of a monitoring program that was scientifically credible while also feasible for volunteers. The identification of metrics for inclusion in the monitoring program was based on the "Oyster Habitat Restoration Monitoring and Assessment Handbook" and The Nature Conservancy's (TNC) monitoring plan for the Trabue Harborwalk Oyster Habitat Creation Project. The metrics ultimately included in the program are reef area, reef height, live oyster density, live oyster size frequency, shell volume of sample, salinity, water temperature, crown conch abundance, and waterbird utilization. Data collected on each of these metrics will help to answer specific scientific questions. Ensuring that the data being collected will be used to quantitatively assess project performance and to answer scientific questions are crucial components of a sustainable volunteer, or Citizen Scientist, program. CHNEP staff worked in partnership with TNC and a group of volunteers to test the implementation of the monitoring plan during the first year, post-deployment, of the Trabue Harborwalk Oyster Habitat Creation Project.

Volunteer participation, in both the six-month and one-year post-deployment monitoring events, greatly reduced the project staff time requirements to complete the tasks. The volunteers were quick to learn how to identify and accurately measure live oysters, and their enthusiasm about the project makes them great advocates for community restoration. Volunteers are regularly monitoring waterbird utilization bimonthly, measuring water quality weekly, and crown conch abundance quarterly. Volunteers conduct the monitoring on these metrics without any project staff on site, data collected is then entered into an online data entry form that can be accessed via the CHNEP Water Atlas site. The result of this project is a monitoring handbook for volunteers including monitoring protocols and a handbook for volunteer coordinators. The intent of the project is to provide a consistent long-term monitoring program that can be implemented by CHNEP partners, with limited staff time needed, so that over time the results of projects throughout the CHNEP study area can be evaluated collectively to inform the effective restoration of oyster habitat.

Restoring Oyster Reefs in Charlotte Harbor – Trabue Harborwalk Pilot Oyster Reef Creation Project Early Results

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The Nature Conservancy (TNC), in collaboration with the City of Punta Gorda, Charlotte Harbor National Estuary Program (CHNEP) and Florida Department of Environmental Protection's Charlotte Harbor Aquatic Preserves, installed nine reefs as part of a pilot oyster reef restoration project in the northern portion of Charlotte Harbor. The reefs were installed along the southern shore of the Lower Peace River off the City of Punta Gorda to test whether oyster reef restoration could be successful in this area and which if any of the three tested materials performed best. Site selection was based on highly suitable areas identified by the Restoration Suitability Model (RSM) in the CHNEP Oyster Habitat Restoration Plan (Boswell et al. 2012) and other factors including presence of an oyster larvae source, accessibility for volunteers and adjacency to publicly-owned property. Community volunteers formed the backbone of the workforce used to construct and deploy reef materials and also assisted in monitoring efforts before and after reef installation. A volunteer coordinator was hired during the materials construction phase of the project, which included bagging fossil shell and attaching recycled shell to 16 inch square mats. The third material to be used for the reefs, loose fossil shell, needed no preparation. Just prior to reef installation and following acquisition and preparation of materials, permitting and logistics planning, sparse seagrass was discovered at the site delaying reef construction until a mitigation plan could be developed. Following an approximately 1-year delay, pre-restoration monitoring was conducted in August 2015 and the reefs were installed thereafter. The monitoring plan implemented by TNC, agency and organization staff as well as volunteers closely followed recommendations provided in the "Oyster Habitat Restoration Monitoring and Assessment Handbook" (Baggett et al. 2014). Project and partner staff as well as community volunteers participating in the CHNEP's Volunteer Oyster Habitat Monitoring program conducted the 6-months post-installation monitoring to assess reef condition. Highlights of the monitoring results include the following: density of live oyster recruits (>10 mm shell length) were greatest on the bagged shell reefs with 1,328 recruits/m2 followed by loose shell reefs with 585 recruits/m2, and mat reefs with 330 recruits/m2. Over 270,000 oysters were estimated to be growing on the nine approximately 12 foot by 36 foot experimental reefs with recruits as large as 3 inches in length.

More than 1,286 volunteers from area schools, fishing clubs, agencies and other community-based organizations contributed approximately 2,800 hours to the project as of the 6-months post installation monitoring. Concurrent with implementation of the Trabue Harborwalk reefs, the Southwest Florida Oyster Working Group who had developed the Restoration Plan identified potential restoration sites throughout Charlotte Harbor. A total of 53 potential sites estimated at 28 acres within 11 of the harbor's estuary segments were selected using the Restoration Plan's RSM as a guide followed up by field visits. Partners are now working to identify a permitting mechanism that will recognize the regional nature of Charlotte Harbor oyster reef restoration efforts while allowing for multiple entities to work on individual projects.

Oyster (*Crassostrea virginica*) Larval Transport Modeling for the Caloosahatchee River/Estuary

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Because of their wide distribution, historical context, and essential habitat value, the Eastern oyster (*Crassostrea virginica*) is one of the primarily target species designated in the Monitoring Assessment Plan (MAP) which has been developed to assess the system-wide performance of the Comprehensive Everglades Restoration Plan (CERP). In the Restoration, Coordination and VERification (RECOVER) program, the monitoring of oyster response to varying hydrological conditions in the Caloosahatchee Estuary has been continued since 2000. A previous study emphasized the fact that the effects of various salinity and inflow patterns on the early life stages of oysters (e.g., veliger, umbo and pediveliger) are insufficient and should be investigated further. Different larval and water sources controlled by unstable flow patterns may be responsible for different peaks in larval supply, thus resulting in spatially variable settlement intensity. To investigate the spatial and temporal variability in the oyster larval recruitment within the estuary, we proposed an approach similar to the oyster larval transport and settlement study conducted in Mobile Bay and surrounding estuaries along coastal Alabama. We propose to initiate a field and modeling study to investigate the larval transport, supply, and settlement of *C. virginica* in the Caloosahatchee River Estuary and numerically evaluate the effect of freshwater release on the recruitment of the oyster. A data mining has been initiated to collect all environmental data sets already available for this estuary (e.g., tidal currents, freshwater discharge, rainfall, salinity, temperature, O2, pH, chlorophyll *a*,

phytoplankton species, primary production). The following specific questions will be addressed in our comprehensive research:

- Are there seasonal variations in larval transport and retention?
- How the freshwater release from the lock influence the larval transport and retention in the lower reaches of the river and the San Carlos Bay?
- How does biological movement of oyster larvae influence their transport within the estuary? Which are viable locations to implement reef restoration project?

We will develop a coupled hydrodynamic-larval transport model for the Caloosahatchee-Charlotte Harbor estuary system using MIKE 3Model suite. An Agent Based Model will be used for simulating the transport of the larvae, under the forcing of tide, wind, freshwater discharge, salinity-temperature variability of the estuary etc. Model can also accommodate behavioral tendencies of larvae, viz., diurnal vertical migration, flood–tide transport (FTT). Model will be calibrated by collecting larvae samples from multiple transects during the spawning season.

The Effects of the 2015-2016 El Nino on the Coastal Ecosystem around Sanibel Island, FL

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The frequency of extreme events is expected to increase with increased global ocean temperatures. The 2015-2016 El Nino affected southwest Florida by having an extended warm and record rainfall during the dry period (Nov. through June). Record rainfall produced high flows, and low salinities throughout the region. We examined the response of restored and reference oyster reefs, water quality, and seagrasses to the 2015-2016 El Nino. Large pulses from storm and release events caused chlorophyll blooms and low salinities throughout San Carlos Bay and "Ding" Darling National Wildlife Refuge. Oyster (*Crassostrea virginica*) spat settlement rates were significantly lower than the previous year caused either by decreased spawning or increased larval mortality due to low salinities. There were significant changes in the seagrass community due to high flows based on a BACI analysis. The long-term viability of the ecosystem is threatened by higher frequency of extreme events and the current flood control policies for Lake Okeechobee and the Caloosahatchee Estuary.

Measuring the Fate and Non-target Impacts of Dibrom using Aerial Ultra-low Volume (ULV) Spray Technology in Mangrove and Open Marsh Wetlands

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Florida's most prolific mosquito breeding habitat is its highly biologically productive coastal mangrove and marsh habitats. We established a treatment site and a control site for examining the impact of aerial adulticide (Dibrom®) treatment for mosquito control on potential non-target arthropods in coastal ecosystems of Lee County, Florida. We explored the fate of the pesticide and impacts on: the European honey bee (*Apis mellifera*), a native coastal butterfly species -the white peacock (*Anartia jatrophae*) - and the entire arthropod community using CDC light traps, drop traps, malaise traps, and with sweep net sampling. Our results on fate showed a delayed (one hour) deposition, canopy interception, and suggest possible longer term persistence in aquatic environments. Butterfly mortalities were high (~70%) in both habitats at both sites within 24 hours, and were not significantly different between control and treatment sites. Bee and arthropod communities showed immediate impacts, but the bee mortality was not significantly different than baseline. Drop trap mortality was significantly different through time and habitat, but not between sites. These impacts did not appear to persist, with both survival of hives and recovery of arthropod community structure within a month. These results from this study on Dibrom® fate and non-target impacts can be used to address concerns of effects on endangered species, mangrove and open marsh wetlands, and may help redefine mosquito adulticide exposure levels. These findings may also influence management decisions regarding mosquito control, particularly in wetlands of public lands.

Sixteen Years of the Southwest Florida Frog Monitoring Network

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Amphibians can provide insight into long-term changes in our landscape, particularly changes in hydrology. The Southwest Florida Frog Monitoring Network was established in 2000 to collect long-term data on frog communities within the watersheds of Southwest Florida. Routes of 12 stops each are monitored monthly during the rainy season (June – September). Environmental data on wind, temperature, humidity, and sky conditions are collected at each stop, as is information on habitat changes. Data on all frogs heard calling during a three minute period are recorded using a three-level intensity code. We report on the data from the first sixteen years of monitoring, examining changes in populations of individual species across the region, interactions among species, and site-specific changes that might be driven by landscape alteration. We calculated measures of biological diversity, community classification, and community ordination, as techniques for exploring the factors that explain the differences in frog communities among sites and over time. Changes in frog communities may provide opportunities to detect the environmental implications of altered hydroperiods and landscape changes in our watershed, and possibly the positive responses to restoration efforts.

Charlotte Harbor National Estuary Program

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Thank you for participating in the CHNEP Charlotte Harbor Watershed Summit. Please visit our website at www.CHNEP.org to find materials created as part of the Watershed Summit, including the abstracts, all the presentations as PDF files, links to the WebEx recordings (audio and PowerPoint) and links to videos on YouTube.

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Working together to protect the natural environment from Venice to Bonita Springs to Winter Haven