Fisheries and Aquatic Sciences
Graduate Student Symposium
February 28, 2020
Austin Cary Forest, Florida

PROGRAM
GRADUATE STUDENT SYMPOSIUM
ORGANIZING COMMITTEE

Scott Borsum, Derek Chamberlin, Lisa Chong, Allison Durland Donahou, Michael Espriella, Nick Fisch, Justin Lewis, Amy Oxton, Diana Perry, Aaron Pilnick

Faculty Coordinators
Dr. Rob Ahrens, Dr. Ed Camp, Dr. Kai Lorenzen
Feb 28, 2020 Fisheries and Aquatic Sciences Graduate Student Symposium Agenda

8:00-9:00 Registration

Session I Moderator: Daniel Vilas Gonzalez

9:00-9:10 Welcome and Announcements

9:10-9:45 Keynote Speaker: Fisheries as Ecosystem Experiments: Meta-analysis of a Global Marine Fisheries Database
Olaf Jensen, Associate Professor, Rutgers University

9:45-10:00 Lone Cabbage oyster reef restoration: effects of oyster restoration on nekton assemblages in the Big Bend region of Florida
Chelsea Conley (Mike Allen)

10:00-10:05 Hogfish Recruit and Adult Comparative Analysis (Lachnolaimus maximus) in Big Bend, Florida
Johnny Polasik (Mike Allen)

10:05-10:20 Exploring Alternatives to the Multinomial for Fitting Composition Data within a Stock Assessment Simulation
Nicholas Fisch (Rob Ahrens)

10:20-10:25 Examining Aging Error in Northern Gulf of Mexico Gray Triggerfish (Balistes capriscus) via Multiple Hard Part Age Estimates (recorded talk)
Derek Chamberlin (Will Patterson & Rob Ahrens)

10:25-10:40 Coffee Break

Session II Moderator: Chelsea Conley

10:40-10:45 Evaluating environmental drivers that influence recruitment of Spotted Seatrout in Cedar Key, FL (recorded talk)
Samara Nehemiah (Mike Allen)
10:45-11:00 Assessing Habitat Influences on Oyster Mortality by Predation
Gabrielle Love (Ed Camp & Shirley Baker)

11:00-11:15 Relational data call into question the role of *Diadema antillarum* is shaping benthic algal assemblages
Lindsay Spiers (Tom Frazer)

11:15-11:20 Tracing carbon flow through reef food webs in the northeastern Gulf of Mexico using amino acid-specific δ13C signatures
Justin Lewis (Will Patterson)

11:20-11:35 Variation in fish community stability in relation to salinity across the Suwannee Sound Estuary
Scott Alford (Charles Martin)

11:35-11:50 Gag Spatial Ecology on the West Florida Shelf
Rachel Germeroth (Will Patterson & Susan Lowerre-Barbieri)

11:50-11:55 Effects of River Discharge on Seagrass and Fish Communities in the Steinhatchee and Ecofina Estuaries, Florida
Stephanie Winn (Mike Allen)

11:55-12:10 The Relationship Between Freshwater Discharge and Fish Communities in a Gulf of Mexico Estuary
Dylan Sinnickson (Dave Chagaris & Mike Allen)

12:10-12:25 Inferring life history of northern Gulf of Mexico Warsaw grouper, *Hyporthodus nigritus*, based on otolith radiocarbon analysis
Beverly Barnett (Will Patterson)

12:25-1:15 Lunch

Session III Moderator: Beverly Barnett

1:15-1:30 Understanding spatio-temporal patterns and drivers of fish biomass on the West Florida Shelf
Daniel Vilas Gonzalez (Dave Chagaris)
1:30-1:45 **Spatial considerations can determine net socioecological effects of artificial reefs on recreational fisheries and their management**
Lisa Chong (Ed Camp)

1:45-1:50 **A range-wide assessment of Gulf Sturgeon stock status and trends**
Stephen Parker (Rob Ahrens & Bill Pine)

1:50-2:05 **Automating the delineation of intertidal habitats from unoccupied aircraft imagery**
Michael Espriella (Vince Lecours)

2:05-2:20 **Identification of Potential Cold-Water Coral and Sponge Conservation Sites with Respect to Oil & Gas Infrastructures in the Northern Gulf of Mexico**
Amy Oxton (Don Behringer)

2:20-2:25 **Diversity and disease of mobile benthic fauna in Florida Bay after cyanobacteria blooms degrade hard-bottom habitat**
Elizabeth Duermitt Moreau (Don Behringer)

2:25-2:40 **Ecological and environmental determinants for the pathobiome of bay scallops Argopecten irradians in the northern Gulf of Mexico**
Abigail Scro (Don Behringer)

2:40-2:55 **Can intraspecific variation in crayfish behavior impact ecosystem functions?**
Bana Kabalan (Lindsey Reisinger)

2:55-3:10 **Coffee Break**

**Session IV Moderator:** Esteban Rodofili

3:10-3:15 **The impact of hard clam aquaculture on sediment denitrifying gene densities at Cedar Key, FL (recorded talk)**
Kenneth Black (Shirley Baker)
3:15-3:30 Effects of microalgae and prey density on survival and feeding incidence for Pacific Blue Tang (*Paracanthrus hepatus*) and Melanurus Wrasse (*Halichoeres melanurus*)
Grace Sowaske (Matt DiMaggio)

3:30-3:35 Establishment of Immunological Assays of Hemocytes in the Hard Clam *Mercenaria mercenaria* to Evaluate Environmental Stresses by use of Flow Cytometry
Yangqing Zeng (Huiping Yang)

3:35-3:50 Characterizing the digestive enzyme ontogeny and larval gastrointestinal morphology of *Halichoeres melanurus*
Casey Murray (Matt DiMaggio)

3:50-3:55 Optimizing nutritional profiles and capture success of copepods for marine finfish larviculture
Sarah Hutchins (Matt DiMaggio)

3:55-4:10 Effects of Domestication on Life History Traits in the Trinidadian Guppy *Poecilia reticulata*
Allison Durland Donahou (Jeff Hill)

4:10-4:15 Regulatory Cost Assessment of the Ornamental Aquaculture Industry in Florida
Noah Boldt (Matt DiMaggio & Frank Asche)

4:15-4:30 Can native pathogens mitigate the impacts of invasive crayfish?
Cheyenne Stratton (Lindsey Reisinger)

4:30-4:35 Hatch Rates and Survival to First Feed of Hogfish (*Lachnolaimus maximus*): Refining Protocols for Larval Production
Fred Shopnitz (Cortney Ohs)

4:35-4:40 Hatchery Management: Allocating Resources to Maximize Stocking Success
Diana Perry (Ed Camp)

4:40-4:50 Break
4:50-5:45 Poster Session

5:45-6:00 Poster and Presentation Awards

6:00 Cleanup, Appetizers, and Beverages
Poster Session:

Preliminary data for sea turtle behavior around vessels off the Northwest coast of Florida
Trenton Aguilar (Mike Allen)

Evaluation of the Lake Chubsucker (Erimyzon sucketta) for High Density Aquaculture and Biological Control of Filamentous Algae
Tyler Ferguson (Cortney Ohs)

Investigation of Temporal Patterns in Fish Communities in Clearwater Bay
Savannah Gandee (Savanna Barry)

Preliminary results investigating intra-specific differences of nursery-grown Acropora cervicornis metabolite profiles
Joseph Henry (Josh Patterson)

Measurement of Total Lipid in Commonly Used Microalgae for Hard Clam Aquaculture
Marlyn Kallau (Huiping Yang)

Maximizing fish habitat through SAV restoration
Audrey Looby (Charles Martin)

Investigating Diet and Husbandry Preferences for Marine Ornamental Fish Larvae
Kathryn McCord (Cortney Ohs)

Distribution of North Florida Cyanobacterial Toxins and the Corresponding Human Routes of Exposure
Chris McTurnan (Ed Phlips)

Developing Intensive Aquaculture of the Long-Spined Sea Urchin Diadema antillarum As a Tool for Coral Reef Restoration
Aaron Pilnick (Josh Patterson)

Predicting Patagonian Toothfish (Dissostichus eleginoides) Distribution to Inform Management and Conservation in the Southern Ocean
Esteban Rodofili (Vincent Lecours)
Habitat restoration and stock enhancement of seagrass and scallops in Florida’s Central Gulf Coast
Shelby Thomas (Josh Patterson)

Do crayfish metabolic rates and ecological impacts shift along a climate gradient?
Nicole Tripp (Lindsey Reisinger)

Oyster Restoration and Coastal Protection: A Coastal Vulnerability Analysis of Lone Cabbage Reef, Levy Co., FL
Charles Wallace (Ed Camp)
KEYNOTE SPEAKER - Dr. Olaf Jensen

Dr. Jensen is originally from Callicoon, NY on the Upper Delaware River. He attended Cornell University for a BA in Biology & Society and then the University of Maryland Chesapeake Biological Lab for an MS in Marine Science. He completed his Ph.D. research at the University of Wisconsin Center for Limnology, followed by a postdoc (Smith Fellowship) at the University of Washington. Dr. Jensen joined the Department of Marine & Coastal Sciences at Rutgers as an Assistant Professor in 2010 and will join the faculty of the University of Wisconsin Center for Limnology as an Associate Professor in the summer of 2020.

Dr. Jensen’s lab is focused on fisheries and aquatic ecosystems - including marine, estuarine, and freshwater environments. The word fishery refers to an entire social-ecological system including a wild fish or invertebrate population, as well as the fishermen and processors who harvest and sell the fish (in a commercial fishery), and the managers who regulate the fishery to prevent overharvest. His lab’s research topics range from field studies of endangered salmonids in Mongolia to meta-analysis of stock assessment data to better understand fish population dynamics. Specific focus areas include: (1) the impacts of climate change on rivers, lakes, and their fish communities, (2) use of chemical biomarkers (stable isotopes and fatty acids) to understand aquatic food webs, and (3) stock assessment and management of fisheries.
Variation in fish community stability in relation to salinity across the Suwannee Sound Estuary

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Changes in salinity due to climatic (e.g., large rain events, droughts) and anthropogenic (e.g., river diversions, water management) alterations to riverine inflow leads to changes in environmental conditions across estuaries. Spatial variability in estuarine fish and crustacean (nekton) communities result due to differences in physiological tolerance to environmental factors, such as salinity, and species interactions across the salinity gradient. Nekton community stability in relation to fluctuating salinity was compared across 3 estuarine salinity zones (oligohaline, mesohaline, polyhaline) in the Suwanee Sound, FL using a 20-year (1996 to 2006) dataset collected by the Florida Fish and Wildlife Conservation Commission’s (FWC) fisheries independent monitoring (FIM) program. A multivariate autoregressional model (MAR) was used to track variation in estuarine nekton community stability with changes in salinity (i.e., resiliency of nekton communities to changes in salinity). Comparison of three stability metrics (variation in community distribution from stationary distribution, return rate to stationary distribution, reactivity) indicate that there is variation in community stability among estuarine zones, that may be independent of variation in salinity. Higher community stability was associated with polyhaline and mesohaline communities, with oligohaline communities, comprised of higher proportions of stenohaline freshwater species, being more susceptible to salinity changes. Examination of species contributions to stability indicates that abundance of euryhaline species determines stability in all communities. Our results indicate that changes in salinity derived from alterations to freshwater inflow in the Suwannee Sound affects species distributions differently depending on location within the estuary.

Inferring life history of northern Gulf of Mexico Warsaw grouper, Hyporthodus nigritus, based on otolith radiocarbon analysis

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Warsaw grouper, Hyporthodus nigritus, is a western Atlantic Ocean species that is listed as a
species of concern by the National Marine Fisheries Service and near threatened by the International Union for the Conservation of Nature. Little information exists on the species’ life history in the northern Gulf of Mexico (GOM) and its stock status in that region is currently unknown. Age of nGOM Warsaw grouper was investigated via counts of opaque zones in otolith thin sections, and the accuracy of age estimates validated using the bomb $^{14}$C chronometer. Otoliths cores ($n = 14$) were analyzed with accelerator mass spectrometry and resulting $\Delta^{14}$C values overlain on a loess regression computed for a regional coral-otolith $\Delta^{14}$C time series. Residual analysis between Warsaw grouper otolith core $\Delta^{14}$C values and predicted $\Delta^{14}$C values from the loess regression indicated no difference in the two data series, therefore validating the accuracy of otolith-based aging and enabling growth and longevity estimates to be made for nGOM Warsaw grouper. Dissolved inorganic carbon $\Delta^{14}$C values collected from the nGOM support the inference that juvenile Warsaw grouper occur in shelf waters < 200m. A Bayesian model fit to age composition data produced von Bertalanffy growth parameters of $L_\infty = 1,533$ mm, $k = 0.14$ y$^{-1}$, and $t_0 = 1.82$ y, and a fishing to natural mortality ratio of 5.1:1. Overall, study results indicate Warsaw grouper is a long-lived species (max age = 61 y) that is estimated to have experienced significant overfishing in the nGOM.

**Spatial considerations can determine net socioecological effects of artificial reefs on recreational fisheries and their management**

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Artificial reefs are increasingly deployed in marine waters to enhance recreational fisheries and provide economic benefits to surrounding communities. Reefs can alter vital rates affecting fish populations, but they may also influence angler fishing behaviors such as site choice, total effort, and catchability. This means that artificial reefs can not only increase fish populations and bolster economies, but also can increase fishing mortality that could eventually trigger stricter regulations. These effects may depend on the spatial placement of these reefs, though this has not been well evaluated. To better understand the possible outcomes of artificial reef implementation and spatial disposition, we developed a spatial integrated socioecological model representing a red snapper population and simulated how effects of artificial reefs and their placement affect the fishery. Our results demonstrate that simultaneously increasing socioeconomic fishery objectives (greater catch rates, more fishing effort) and conservation objectives (greater spawning biomass) would be very difficult to achieve—and are only possible if the placement of artificial reefs allow biological benefits to greatly outstrip augmented fishing opportunities. Under most placement scenarios, artificial reefs would often lead to more depleted fish populations and more restrictive regulations that could have undesired effects on nearby coastal communities. How many artificial reefs and where they are deployed relative to the coast and natural reefs are essential to balance the socioeconomic and conservation objectives of the overall fishery. These results highlight the need to consider fisheries management in the siting and decision-making of the implementation of artificial reefs.
Lone Cabbage oyster reef restoration: effects of oyster restoration on nekton assemblages in the Big Bend region of Florida

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Oyster reefs provide a suite of ecosystem services including enhanced nekton productivity through increased recruitment or enhanced growth and survival by providing refuge and foraging grounds during various life stages. Despite their ecological importance, they are also one of the most threatened marine ecosystems in the world, with an estimated 85% global loss over the last several decades. Oyster reefs along Florida’s Big Bend coast have suffered similar decline, and in 2018 the University of Florida received funding for a large-scale project to restore Lone Cabbage Reef (LCR), located in Suwannee Sound, FL. From July 2018 through October 2018, 22 reef elements were constructed from limestone boulders and shell to provide a permanent substrate for oyster spat to settle and grow, restoring LCR to its historic length (5km) and elevation. Rebuilding oyster reef substrate will likely enhance freshwater retention in the estuary and may also restore the functional role of increased nekton productivity. The objectives of this study were 1) to characterize historic nekton assemblages along LCR using over 20 years of fisheries independent monitoring (FIM) data and 2) to evaluate short-term effects of oyster restoration on nekton assemblages through directed sampling along LCR. Directed sampling was conducted monthly from October 2017 through October 2019 using a 21.3m seine. Relative abundance and species richness were used to evaluate changes in nekton assemblages along LCR. Preliminary results indicate changes in species composition, increased forage fish abundances, and increased sport-fish presence on the restored reef habitat.

Effects of Domestication on Life History Traits in the Trinidadian Guppy *Poecilia reticulata*

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Florida is a hotspot for non-native species; however, not all non-natives that are introduced become established. Many introduced fish species come from the production environment. Domestication may alter life history traits due to changes in selection pressures, such as decreased predation pressure and controlled feeding, potentially altering an organism’s ability to survive in the wild. While many factors affect establishment success, traits that increase propagule pressure and success following introduction, such as earlier age at maturity and higher reproductive output, are characteristic of a population that can establish based on life history traits alone. Using a popular
ornamental fish that has undergone decades of domestication, the Guppy *Poecilia reticulata*, we analyzed differences between domesticated and wild populations in life history traits that may affect invasiveness. Using eight unique populations of guppies (four wild and four domesticated), reproductive output and age and growth were assessed. While there was not a clear influence of domestication across all life history traits, domestication significantly affected age at maturity, number of offspring, and growth rate of offspring. The feeder Guppy population, which is most similar in morphology to the wild populations, was more similar in life history traits to the wild populations than to the domesticated populations. The two fancy Guppy populations (directly selected for large fins and bright coloration) had lower reproductive output and slower growth, thus did not exhibit life history traits that are hypothesized to increase population success if introduced. This indicates that the degree of domestication may affect the invasiveness of introduced Guppy populations with the wild populations having the highest potential invasiveness. Future research will analyze the effects of other traits that could alter survival, such as behavior and recruitment in the presence of a native predator, in order to determine the potential success of these populations in a Florida environment.

Automating the delineation of intertidal habitats from unoccupied aircraft imagery

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Intertidal habitats like oyster reefs and salt marshes provide vital ecosystem services, such as shoreline erosion control, habitat provision, and water filtration. Globally, these systems face significant changes as a result of a combination of anthropogenic stressors (e.g., coastal development and overharvest) and environmental stressors (e.g., sea-level rise and disease). Traditional intertidal habitat monitoring techniques are often cost- and time-intensive, limiting how frequently these resources are mapped. These limitations can hinder effective management. Unoccupied aircraft systems (UAS) have demonstrated the potential to mitigate these costs as they provide a platform to rapidly, safely, and inexpensively collect data in coastal areas. In this study, a UAS was used to survey intertidal habitats near Cedar Key, FL. RGB (i.e., regular red, green and blue) images captured by the UAS were stitched together to generate an orthomosaic and a digital terrain model (DTM) depicting elevation across the scene. These products were used in a Geographic Object-Based Image Analysis (GEOBIA) workflow to classify mudflat, salt marsh, and oyster reef habitats. GEOBIA segments pixels into meaningful objects across the scene using textural and geometric characteristics, allowing for a more informed classification than traditional, individual pixel-based techniques. The developed ruleset allows for a repeatable workflow that enables reliable temporal monitoring using a UAS. The classification produced an overall accuracy of 80% in classifying habitats in a coastal environment with little spectral and textural separability, demonstrating that automated delineation of intertidal habitat from UAS imagery using GEOBIA can become a cost- and time-effective monitoring approach.
Exploring Alternatives to the Multinomial for Fitting Composition Data within a Stock Assessment Simulation

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Fisheries stock assessments have traditionally represented age and size composition data using the multinomial likelihood, however the multinomial cannot account for the correlations and overdispersion that exist in the data. Not accounting for these phenomena can affect assessment performance. Methods to remedy this have included down-weighting composition data within assessment and using alternative likelihoods to the multinomial. Down-weighting composition data in stock assessment is laborious and does not ultimately account for the correlation in the residuals, and alternative likelihoods for composition data have not all been evaluated using stock assessment simulation. To evaluate the performance of alternative likelihoods in fitting composition data, we developed a spatially-explicit age-structured simulation model that mimics correlation structure observed in composition data. We fit assessment models to simulated data and assessed the performance of various composition likelihoods in estimating stock dynamics and quantities of management interest. We expect to present preliminary results regarding model performance with regards to likelihood choice and the degree of spatial clustering of data. This study may have important implications for the determination of which likelihood is appropriate conditional on how data were sampled, and could provide information on how one might sample data to more appropriately match a likelihood.

Gag Spatial Ecology on the West Florida Shelf

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The ontogenetic migration of Gulf of Mexico Gag on the West Florida Shelf takes them as larvae from their shelf spawning grounds to estuarine nurseries, then to mid-shelf reefs as adults. After maturity, most female Gag undertake a migration to shelf-edge reefs during the spawning period and return to shallower waters afterward. However, the topic of how female Gag spend the rest of the year and how fisheries interact with them during this time period is relatively unstudied. It is theorized that some mature females head to inshore waters in the fall before beginning their spawning ground migrations in late January, and anecdotal evidence from fishermen corroborates this. With the use of fishery-dependent data collected from recreational private and for-hire fisheries, this study will examine seasonal patterns in the Gag spatial ecology paradigm.
Can intraspecific variation in crayfish behavior impact ecosystem functions?

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Little is known about the ecological significance of intraspecific variation and whether among-population variation in behavior is important for ecosystem functions. Crayfish are fundamental consumers in freshwater ecosystems worldwide because of their high biomass, omnivorous feeding habits, and ability to alter nutrient cycling. Crayfish could influence stream metabolism by consuming benthic resources such as periphyton and leaf litter, and excreting nutrients into the water column. This study focused on 19 populations of two widely distributed crayfish species in North America, Faxonius rusticus and F. virilis, across a latitudinal gradient ranging from northern Wisconsin to southern Illinois. We tested the extent to which populations within each species varied in ecologically important behaviors including boldness, activity, and feeding rate and whether crayfish behavior was related to stream metabolism measured as benthic, water column and whole-stream gross primary production and ecosystem respiration. We predicted that bold, actively feeding crayfish would reduce benthic metabolism and increase water column metabolism in streams. Here we present significant results from laboratory behavioral assays showing evidence of substantial intraspecific behavioral variation in boldness, activity and feeding rate, as well as how crayfish behavior related to stream metabolism in the field. Future research will test the impacts of populations with different behaviors on ecosystem functions in controlled mesocosm experiments.

Assessing Habitat Influences on Oyster Mortality by Predation

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Eastern oysters (Crassostrea virginica) and the reefs they create provide numerous ecosystem services, such as nutrient cycling, habitat construction, and shoreline buffering, and they are a significant economic resource for many coastal communities. Recent collapses of oyster populations and fisheries have drawn much attention and investigation into management strategies and have prompted heightened restoration efforts. There are, however, gaps in our understanding of factors that influence oyster population dynamics which would provide key information for decision-makers of restoration projects and fisheries managers. Influences on the foraging behavior of invertebrate oyster-predators have been well-documented in controlled laboratory settings, but the impacts of oyster habitat on mortality from predation have not been well-documented in situ. Here we describe the proposed methods for a field study in the Northeast Gulf of Mexico that assesses predation on oysters across environmental gradients, such as structural habitat, oyster density, and reef height.
Comparing different mortality rates will demonstrate preferential habitat conditions for predators as well as relative risk of predation mortality by oysters in the estuary. This work will improve understanding of predator foraging preferences in a dynamic environment and will be useful in oyster reef management and restoration planning to protect natural resources from additional mortality.

Characterizing the digestive enzyme ontogeny and larval gastrointestinal morphology of *Halichoeres melanurus*

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Marine ornamental aquaculture often relies on the production of live feeds including microalgae, copepods, rotifers, and *Artemia* to support the rapid growth and major morphological changes that occur during larval development. Considerable costs associated with live feed production may constrain the growth of the marine ornamental aquaculture industry. Introducing inert microdiets during larval development may help reduce the amount of live feeds needed and therefore greatly reduce the cost and labor involved. Many marine fish larvae are considerably underdeveloped at hatching, often lacking functional eyes, mouths, and digestive tracts, which makes the digestion of inert microdiets difficult. Characterizing the digestive enzyme ontogeny and changes in gastrointestinal (GI) morphology throughout larval development will provide insight into developing effective nutritional protocols. Newly hatched *H. melanurus* larvae were raised exclusively on live feeds for 25 days. Larvae were sampled throughout the experiment to analyze growth, digestive enzyme activity, and GI development. The activities of lipase, trypsin, and pepsin were analyzed using standard microplate spectrometric assays. GI morphology and development was characterized using histological and histochemical techniques. Lipase and trypsin activities were detectable from 3 days post-hatch (dph) and continued to increase until 25dph. Pepsin activity was undetectable until 15dph and remained low until 25dph. The GI tract remained agastric and was characterized by an oesogaster located posterior to the esophagus and anterior to the intestine. Although *H. melanurus* is agastric, the detection of pepsin activity and increase in lipase and trypsin activities will help guide future nutritional protocols.

Identification of Potential Cold-Water Coral and Sponge Conservation Sites with Respect to Oil & Gas Infrastructures in the Northern Gulf of Mexico

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The northern Gulf of Mexico hosts several orders of cold-water corals and sponges that form three-dimensional benthic habitats. The complex biogenic structures provide a variety of ecosystem
services, such as protection from predators as well as nursery and spawning sites for various species. The Flower Garden Banks National Marine Sanctuary, which supports pristine coral reef systems, is currently the only marine protected area in the northern Gulf of Mexico. Extensive networks of oil and gas infrastructure, such as platforms and pipelines, surround the sanctuary. Since implementation, activities in these areas have impacted benthic environments via drilling, bottom trawling, pipe laying, and sediment disruption. The pressures that corals and sponges face highlight the need to identify hotspots as potential conservation sites. Our purpose was to identify relatively undisturbed areas with high probabilities to find corals and sponges for the establishment of potential marine sanctuaries. We created species distribution models of cold-water corals and sponges in the northern Gulf of Mexico and paralleled hotspot locations with existing oil and gas infrastructure. Bathymetry and bathymetric derivatives such as slope and rugosity were used with presence-only cold-water coral and sponge data classified into two phylums and nine orders to produce 12 distribution models using a maximum entropy approach. Oil and gas infrastructure layers with buffer zones were imposed over models to identify undisturbed biodiversity hotspots as potential conservation sites. Distinguishing additional hotspots in reference to relative locations of preexisting oil and gas infrastructure bolster the connectivity of designated conservation sites, ensuring larval recruitment to these communities is preserved.

Ecological and environmental determinants for the pathobiome of bay scallops *Argopecten irradians* in the northern Gulf of Mexico

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The bay scallop *Argopecten irradians* once supported a commercial fishery in Florida but their populations declined and the fishery was closed in 1994. However, a recreational fishery remains along the Florida gulf coast from Gulf to Pasco County despite evidence of further population decline. Therefore, characterizing potential threats beyond fishing is important to ensure fishery sustainability and the success of ongoing restoration efforts. Environmental change is one well-known threat, especially to coastal fisheries, but now disease is increasingly recognized as a prominent threat. To understand the impacts of environmental drivers and disease on the population ecology of the bay scallop we are examining their pathobiome across their fished range. The `pathobiome` refers to an organism’s pathogenic microbes, which cause disease. Three study sites were chosen within Florida’s recreational scallop fishery: St. Joseph’s Bay in the northern Gulf of Mexico, offshore of the Steinhatchee River in the Florida Big Bend, and offshore of Hernando County, Florida at the southern end of the fishery. Each site was visited prior to the opening of the fishery to survey the abundance and distribution of scallops, and to collect samples (n=50) for the creation of parasite profiles. At each location, water quality parameters were measured, and benthic type was recorded. Using a combination of traditional histological methods and molecular diagnostics we have so far identified 10
putative parasites from which to describe the geospatial distribution of their pathobiome. Screening will continue through the 2020 pre-fishery season (season typically opens July 1).

The Relationship Between Freshwater Discharge and Fish Communities in a Gulf of Mexico Estuary

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The Suwannee River Estuary of Florida’s Big Bend Coastline has historically been a productive and diverse estuarine ecosystem supported by significant freshwater inputs from the Suwannee River. In recent years, significant changes in land use and climatic conditions have resulted in lower discharges from the Suwannee. Since 2003, the river has experienced four of its six most extreme low flow events in the past 100 years. This study attempts to understand the impact of freshwater inputs from the Suwannee River on the estuarine fish communities downstream. This was done by utilizing Ecopath with Ecosim to simulate changes in salinity and nutrient concentrations as well as the respective effects on the estuarine ecosystem. First, a mass-balanced Ecopath model was created by assigning dominant taxa to functional biomass pools. In Ecopath, fifty-nine functional groups have been created that capture the dominant fish species along with benthic invertebrate groups and primary producers. Model inputs were obtained from a long-term fisheries independent monitoring survey. Following the completion of a balanced Ecopath model, we calibrated the time dynamic Ecosim model to biomass densities from 1997 to 2018. The calibrated model was used to project future flow scenarios on the ecosystem. This model demonstrates changes in populations affected by nutrient pulses as well as ecosystem wide effects resulting from food web dynamics. The model has applications for management of freshwater flow and fisheries resources.

Effects of microalgae density, prey density, and potential feed attractants on survival and feeding incidence for Pacific Blue Tang (Paracanthurus hepatus) and Melanurus Wrasse (Halichoeres melanurus).

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Although most of the marine ornamental fish market is satisfied through the sale of wild caught individuals, ornamental aquarium consumer’s preference is shifting to include more aquacultured fish. Melanurus Wrasse (Halichoeres melanurus) and Pacific Blue Tang (Paracanthurus hepatus) are of interest to aquaculture due to their popularity in the trade and lack of established rearing methods.
Pelagic spawning species produce underdeveloped larvae that rely on a diet of copepod nauplii and other small zooplankton. Challenges associated with these characteristics need to be addressed for production of pelagic species to reach commercialization.

Algal and prey densities were evaluated to determine a suitable environment during the transition from endogenous nutrition to exogenous feeding. For evaluation of algal density, a control treatment with no algae and three treatments containing *Tisochrysis lutea* were examined at 100,000, 300,000, or 500,000 cells/ml. To investigate live feed density, *Parvocalanus crassirostris* nauplii were stocked at densities of 2.5, 5, or 10 nauplii/ml. Potential feed attractants were also evaluated, comparing a control to the addition of taurine, tryptophan, or betaine at $10^{-5}$ M. Results suggest a *T. lutea* density of 300,000 cells/ml is optimal for both survival ($P < 0.0001$) and feeding ($P = 0.02$) for Melanurus Wrasse and for survival of the Pacific Blue Tang ($P < 0.0001$). Prey density experiments resulted in no difference in feeding incidence. Inclusion of feed attractants decreased survival ($P < 0.0001$) for Melanurus Wrasse. These results will help shape commercial production protocols and inform decisions about feasibility of production for these species.

**Relational data call into question the role of *Diadema antillarum* is shaping benthic algal assemblages**

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Degradation of coral reefs is a global issue and can be attributed directly or indirectly to a broad suite of factors, both anthropogenic and natural. Loss of herbivorous fishes and *D. antillarum* in the latter part of the 20th century, due to overfishing and disease respectively, seemingly led to increases in algal cover and declines in coral cover on coral reefs throughout the Caribbean. In recent years, recovery of herbivorous fishes and *D. antillarum* has been observed in some Caribbean locations with corresponding decreases in algal cover and documented increases in coral recruitment. In these cases, the improved condition of reefs has been attributed largely to the recovery of *D. antillarum* and not fishes. To explore in greater detail the potential influence of *D. antillarum* on algal cover and species composition on coral reefs, I completed a series of benthic surveys on reefs near Carrie Bow Cay, Belize. These surveys provided an opportunity to relate herbivore density, primarily *D. antillarum* density, to the composition of benthic communities. In contrast to expectations, results indicated that areas with greater densities of *D. antillarum* had more algae and fewer sponges. Furthermore, these areas had higher cover of chemically rich and structurally defended species compared to reefs without *D. antillarum*. These findings suggest that a simple top-down influence, i.e. increased abundance of *D. antillarum*, is unlikely to account for observed changes in benthic structure on Caribbean coral reefs and that a more complex dynamic is at play.
Can native pathogens mitigate the impacts of invasive crayfish?

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Invasive species cause ecological and economic harm globally. Specifically, invasive crayfishes cause ecological harm through competition and habitat alteration. However, it is unclear whether these effects persist over long timescales as natural enemies such as pathogens accumulate in invasive species. If pathogens are species-specific and can mitigate crayfish impacts via changes in behavior or population size, they may provide an effective method for controlling invasive crayfish. Our study focused on pathogens in northern Wisconsin, a region where the invasive rusty crayfish (Faxonius rusticus) replaces resident congeners. Our goals were to 1) determine whether pathogen prevalence and composition differ among lakes that vary in rusty crayfish density and impacts, and 2) evaluate crayfish pathogens to determine if they are good candidates for biocontrol. We collected over 700 crayfish from 18 lakes and are currently using histology and molecular tools to evaluate disease prevalence and composition. We also used behavioral assays to assess crayfish anti-predator behavior and fitness prior to dissection. So far, we have identified pathogens from 10 taxonomic groups. The most promising of these pathogens for biocontrol is a microsporidian which decreased fitness and altered anti-predator behavior of rusty crayfish. In addition, our preliminary results suggest that rusty crayfish behavior differs across lakes with high and low rusty crayfish densities. Further screening of crayfish using histology will elucidate whether differences in behavior are due to differences in pathogen prevalence. Future work will focus on experimentally infecting native and invasive crayfish with candidate pathogens and monitoring their behavior, growth, and survival.

Understanding spatio-temporal patterns and drivers of fish biomass on the West Florida Shelf

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The West Florida Shelf (WFS) fosters diverse fish communities and supports valuable commercial and recreational fisheries. But it is exposed to multiple anthropogenic and environmental stressors such as overexploitation and red tide events. Therefore, it is important to understand how marine species distribute over a space and time and identify plausible drivers of change. To do so, a multispecies vector autoregressive spatio-temporal (VAST) model was developed using the Southeast Area Monitoring and Assessment Program (SEAMAP) trawling data for the WFS. The VAST model implements a delta-generalized linear mixed model and predicts variation in density across multiple locations, time intervals and species. It also approximates the covariance between these multiple factors using a factor-model decomposition by assuming across the contribution of multiple random effects. Spatio-temporal patterns and center of gravity showed positive correlations among several
species. Unobserved factor explained high percent of spatial and spatiotemporal variability of these species and highlighted associations among these. This spatio-temporal analysis represents a methodology to calibrate spatio-temporal ecosystem models using Ecopath and Ecosim that are going to be developed for Ecosystem-based fisheries management (EBFM) in the WFS.
SPEED TALK ABSTRACTS

The impact of hard clam aquaculture on sediment denitrifying gene densities at Cedar Key, FL.

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The Dog Island High Density Lease Area (DLA, Cedar Key SHA #30 – 3012 Zone A) consists of 57 two-hectare (100 m x 200 m) plots of underwater mud and sandflat immediately adjacent to Dog Island, Levy County, FL. These underwater lease plots are used for the extensive culture of hard clams (Mercenaria mercenaria), and the DLA as a whole contains in excess of 100 million clams at any given time. Our project was designed to assess the impact, if any, that this high-density culture has on the denitrifying capacity of the benthic microbial community. Sediment physical and chemical characteristics were assessed, and qPCR was performed to quantify the abundance of nirS gene fragments associated with the nitrite reductase step in the denitrification pathway. Sediment nirS densities varied with the depth of the lease site, as did sediment OM, %N, %C, bulk density, and 16S gene density. In shallow leases, (0 m mean elevation NAD88), there were no statistically significant differences for those same parameters between farmed and unfarmed sites. In the deeper sites (1.0 m NAD88), statistically significant differences in all of those parameters were observed between farmed and unfarmed sites. In all sites, principle component analysis suggests that nirS gene density is most strongly associated with sediment organic load, and that the deeper sites within the DLA were more likely to accumulate organic material.

Regulatory Cost Assessment of the Ornamental Aquaculture Industry in Florida

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The ornamental aquaculture industry is the largest aquaculture sector in the state of Florida accounting for 40 percent of total aquaculture sales in 2012. While many regulations, like those protecting environmental interests and worker safety, are critical for a sustainable industry, some redundancies may exist in the regulatory framework. This study aims to assess the total regulatory cost of local, state, and federal statutes which effect ornamental growers in Florida. This data will be collected via in-person or telephone interviews administered to producers across the state as a census of the entire industry. Previous research on the sportfish/baitfish, salmonid, and west coast shellfish industries have yielded results suggesting a high regulatory cost relative to other on-farm production
costs. Preliminary data suggests that farmers in Florida do not consider regulations to be a major cost or impediment to their business when compared with labor costs and disease management. However, a common regulatory issue that has emerged during stakeholder surveys has been the restriction of drugs (e.g. methyl testosterone) and pesticides (e.g. Dylox and Baytex) which are restricted for use in the ornamental aquaculture industry. Overseas competitors generally operate in less stringent regulatory climates resulting in decreased production costs and thus increased competition for domestic producers. Future work assessing the value of the ornamental aquaculture industry via economic impact reports and economic efficiency studies may help to better describe the breadth of the ornamental industry and identify opportunities for producers to improve upon current production practices.

Examining Aging Error in Northern Gulf of Mexico Gray Triggerfish (Balistes capriscus) via Multiple Hard Part Age Estimates

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Ageing error can be propagated in stock assessments, which in turn can result in erroneous estimates of stock status and productivity and contribute to depleted stocks not recovering according to projected timelines. The Gulf of Mexico (GOM) gray triggerfish (Balistes capriscus) stock is one such stock that has failed to rebuild at projected rates. Dorsal spines have been the preferred ageing structure for gray triggerfish, but the lack of precision in age estimates derived from dorsal spines is well-documented and recent evidence exists that spines may produce biased age estimates as well. Unlike many marine fishes, gray triggerfish have not been routinely aged with otoliths due to their small size thus difficult extraction and preparation. We assessed ageing error (both imprecision and bias) in gray triggerfish by comparing age estimates between dorsal spine translucent zone counts and sagittal otolith opaque zone counts. Age estimates were validated by analyzing radiocarbon (\(\Delta^{14}C\)) from eye lens cores and fitting radiocarbon signatures to the regional coral bomb radiocarbon chronometer. Bias was assessed by fitting a linear regression to the regional coral data and computing the sum of squared residuals for ages ± 1-4 years. Results indicate otoliths are the more accurate and precise ageing structure. Improved age estimates will allow for the more accurate modeling of current gray triggerfish stock dynamics and projections of future rebuilding scenarios.
Diversity and disease of mobile benthic fauna in Florida Bay after cyanobacteria blooms degrade hard-bottom habitat

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Shallow, hard-bottom habitat covers ~30% of Florida Bay and is designated as an Essential Fish Habitat for commercially fished teleosts and invertebrates. It is dominated by a diversity of sponges, which give structural complexity to the otherwise low-relief habitat. This habitat and its many ecosystem functions can become severely impaired after periodic cyanobacterial blooms. The direct and indirect effects of these blooms on the commercially important Florida stone crab *Menippe mercenaria* and Caribbean spiny lobster *Panulirus argus*, and their diseases, remain broadly unknown. These species are affected directly by habitat loss (sponge die-off), but indirect effects due to potential lack of prey and upon their local epidemiology remain understudied. In the summer of 2019, we surveyed three healthy sites and three degraded sites (sites hit by blooms) in Florida Bay. We used transects to quantify the structural differences across the habitats and collected benthic fauna by suction sampling to explore changes in biodiversity. Up to 30 *M. mercenaria* and *P. argus* were hand collected from each site and submitted for disease screening to discern their individual pathogen profiles. The results include the detection of *Panulirus argus Mininucleovirus* in *P. argus* and a trophically transmitted gregarine in *M. mercenaria* that may use local fauna to transmit. This study increases our understanding of the ongoing changes in Florida Bay from epidemiological and biodiversity perspectives in response to cyanobacterial blooms.

Optimizing nutritional profiles and capture success of copepods for marine finfish larviculture

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One of the most difficult bottlenecks to overcome when culturing marine larval finfish is first feeding. Identifying and culturing small, nutritious zooplankton that elicit larval feeding responses can be challenging. Rotifers (*Brachionus* spp.) and *Artemia* are the most commonly used larval feeds because they are easy and inexpensive to produce but may not adequately meet dietary requirements of larval fish. Copepods are an important food source for larvae of many marine finfish species, especially altricial larvae with small mouth gapes. Newly hatched copepod nauplii can be very small (~45 µm), have a quick escape response thought to elicit predatory feeding behavior, and are the natural prey for many fish larvae in the wild. However, it is unclear if copepod nutritional composition can be manipulated through shifts in dietary microalgae.
Proposed experiments aim to optimize copepod nutritional profiles and increase capture success for larval fish. Characterization of fatty acid and free amino acid profiles for algae, copepods, and larvae of select species in production at the UF/IFAS Tropical Aquaculture Lab will be pursued. Next, copepod nutritional profiles will be manipulated through dietary modifications. Protocols to reduce the escape response of copepod nauplii and increase larval feeding success will also be evaluated. Determining the most efficient ways to deliver highly nutritious and easily captured live feeds is the overarching goal of these investigations. Results of these experiments are expected to advance larviculture practices in the marine ornamental aquaculture industry.

Tracing carbon flow through reef food webs in the northeastern Gulf of Mexico using amino acid-specific $\delta^{13}$C signatures

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The demersal food webs of continental shelf ecosystems integrate carbon from multiple resource pools and elucidating patterns of energy flow can provide useful insights into ecosystem dynamics. The role of recycled material, which is primarily integrated through benthic trophic channels, is of particular interest because it can serve as a source of sustenance between seasonal pulses of primary production. However, in systems where the detrital pool is dominated by phytoplankton, limitations associated with traditional bulk stable isotope analyses (SIA) hinder our ability to assess the significance of detritus as an energy source. $\delta^{13}$C of essential amino acids ($\delta^{13}$C$_{EAA}$) provides a novel alternative because of distinct differences in $\delta^{13}$C$_{EAA}$ between bacteria and microalgae that arise during amino acid biosynthesis. More importantly, temporal, spatial, or within group factors have little effect on one’s ability to differentiate carbon sources. Here, we present an approach that couples bulk and amino acid-specific SIA to trace the flow of new and recycled material to reef fish consumers in the northeastern Gulf of Mexico (neGOM). The specific objectives are to 1) validate the use of consumer proxies to characterize basal end member signatures 2) compare patterns of resource utilization within and among eight previously identified trophic guilds and 3) evaluate how patterns vary with depth.

Evaluating environmental drivers that influence recruitment of Spotted Seatrout in Cedar Key, FL

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Spotted Seatrout, *Cynoscion nebulosus*, support a popular recreational fishery in Florida. Various environmental pressures, including severe weather events like droughts, can influence recruitment of Spotted Seatrout by impacting the growth and survival of juveniles. Therefore, understanding variation
in year class strength is an important tool for assessing stock health and implementing management decisions for this species. The Florida Fish and Wildlife Conservation Commission’s Fisheries-Independent Monitoring Program generates Indices of Abundance (IOAs) for young-of-the-year Spotted Seatrout to evaluate trends in recruitment within six estuaries across Florida. In this study we assess the ability of IOAs to track year class strength and determine what environmental factors influence the observed variation in year class strength. IOAs were validated using catch curve residuals, which take the natural log of the catch at age data and create a regression against age which can be used to indicate year class strength. Once validated, IOA anomalies were used to determine relationships between environmental factors, such as water temperature and salinity, and year class strength. Early results suggest increases in water temperature, specifically between February and April, drive strong years of recruitment. Increases in salinity negatively impact recruitment. Other environmental factors explored (ex. dissolved oxygen, vegetation) appear to have little influence on recruitment individually.

A range-wide assessment of Gulf Sturgeon stock status and trends.

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Gulf of Mexico Sturgeon Acipenser oxyrinchus desotoi ("Gulf sturgeon") are large, long-lived, anadromous fish. Overexploitation, loss of spawning habitat, and alteration of riverine habitat are among identified factors that contributed to declines in Gulf sturgeon populations, leading to their designation as a threatened species under the Endangered Species Act in 1991. Recent episodic mortality events including major hurricanes, red tide, and the 2010 Deepwater Horizon oil spill have also occurred. Current management units for Gulf sturgeon include seven river systems and adjacent estuarine and marine habitats across the northern Gulf of Mexico from Louisiana to Florida. To address core needs identified by NOAA and USFWS, a comprehensive data management system for Gulf Sturgeon Working Group (GSWG) research activities is being developed. Specifically, the Gulf Sturgeon Encounter History Database has resulted in the accumulation of capture-recapture data for over 18,000 Gulf Sturgeon with the oldest tagging data dating back to 1976. Using these data, I will assess current stock status for Gulf sturgeon from all seven management units, develop an individual-based population viability analysis model to assess threats to populations from episodic mortality events, and implement an electronic logbook program to update data collection efforts to increase efficiency and assist in screening and prioritizing recovery actions. Limited work has been done to integrate range-wide information to develop models to forecast Gulf sturgeon populations in the future and assess basic concerns related to risk of extinction for each population to inform decision making related to restoration actions. This integration of information will be imperative to assess stock status, trends, and tradeoffs in different management actions designed for species recovery over the next 14 years with funding support from the Natural Resource Damage Assessment.
Hatchery Management: Allocating Resources to Maximize Stocking Success

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Management of freshwater recreational fisheries has long used stock enhancement—the addition to wild populations of hatchery raised fish. Effective stocking requires many things, including the efficient allocation of hatchery space. The challenge is that hatchery space is often limited in a specific season, and managers seek to raise as many fish as possible of different species, sizes, and even condition. Hatchery space typically includes ponds and raceways that can be filled with a number of different species at various life stages. Each species and life stages require a certain amount of space for optimal rearing in the hatchery and most species are exclusively reared in ponds. Efficiently delegating space in the hatchery can be optimized by addressing it as a knapsack problem—a combinatorial optimization problem typically addressed via dynamic programming. By understanding the cost for each species in terms of space and other resources, the knapsack-problem-program can deliver the solution that will result in the highest hatchery success given the parameters laid out by the state. In Florida, we collaborated with state hatchery and stocking managers and researchers to develop a tool to understand and suggest use of hatchery space to accomplish defined stocking goals each year. This tool illustrates the resource cost of rearing each species requested and could prove useful as it can be adapted to other regions’ or states’ parameters for use in their stocking programs.

Hogfish Recruit and Adult Comparative Analysis (*Lachnolaimus maximus*) in Big Bend, Florida

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Estuarine seagrass beds are known as essential habitat for ontogenetic species during critically important juvenile stages. The Big Bend region of Florida contains one of the largest contiguous examples of seagrass habitats in the Gulf of Mexico. Physical and biotic factors such as seagrass species and coverage, river discharge, pH, and temperature can influence species spatial and temporal preferences within these areas. This project will utilize long-term (2008-2018) trawl data to characterize year class strength and the spatial and temporal patterns of habitat selection of juvenile Hogfish (*Lachnolaimus maximus*) in three eastern Gulf of Mexico river-influenced open estuary systems in Florida: St. Mark’s, Econfina, and Steinhatchee. Data will be analyzed for each system to determine trends in year class strength, relative abundance, and spatial and temporal variability in relation to
several biotic and abiotic factors. A comparative analysis will be conducted to assess if the same factors influence hogfish recruitment and preferences in the same manner across study locations. Juvenile year class trends will be compared to adult abundances obtained from SEAMAP data.

**Hatch Rates and Survival to First Feed of Hogfish (Lachnolaimus maximus): Refining Protocols for Larval Production**

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Hogfish (Lachnolaimus maximus) is a large warmwater marine fish from the family Labridae that is targeted by both recreational and commercial fishers along the Atlantic Coast of the Americas. Currently there are no comprehensive data on aquaculture methods for this highly desired foodfish. The University of Florida has collected Hogfish to develop broodstock and aquaculture protocols for this species, with groups kept in recirculating systems that are temperature controlled and set up as harems (1M:>3F). Establishment of proper egg incubation and larval rearing protocols are essential to combat naturally low survival rates of larval fish and to ensure high quality larvae are used for grow-out. Over the duration of the project, 30+ spawns of fertilized eggs have been collected from broodstock harems with a portion of these used for experiments. Stocking rates of 100, 200, 400, 800, and 1600 fertilized eggs/750mL were tested in either static or mesh-bottom cups to determine hatch rate. Separately, hatched larvae (1DPH) were stocked at a standard 50 larvae/750mL in the same cup system described until first feed (3DPH) to determine survival. Preliminary results from hatch rate trials are presented herein.

**Effects of River Discharge on Seagrass and Fish Communities in the Steinhatchee and Ecofina Estuaries, Florida**

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Seagrass communities provide essential habitat for commercially and recreationally important fish and invertebrate species. Approximately 85% of the recreational and commercial fish species in Florida spend a portion of their life in estuarine and nearshore seagrass habitats, and the Big Bend region of Florida contains one of the largest expanses of continuous seagrass habitats in the eastern Gulf of Mexico. Riverine input influences estuarine community structure in these areas, including
seagrass and nekton productivity, coverage, and abundance. Substantial reductions in the freshwater discharge of coastal rivers, which have been documented in this region, can have long-term negative effects on estuary ecosystems and seagrass community composition. Both natural and anthropogenic factors such as drought, drawdown, or damming can alter the quantity of freshwater reaching these coastal areas. This project will utilize 11 years of existing trawl data collected by the Florida Fish and Wildlife Conservation Commissions (FWC), Fisheries Independent Monitoring Program (FIM). In addition to FIM trawl data, this project will also utilize river discharge data from the United States Geological Survey (USGS). Data will be analyzed for each system to evaluate trends in fish assemblages and relative abundance in relation to river discharge. The influence of changes in river discharge and associated environmental conditions have on fish communities in seagrass beds will be assessed for the Steinhatchee and Econfina estuaries. A comparative analysis will be conducted to assess if river discharge has similar effects on these two systems.

Establishment of Immunological Assays of Hemocytes in the Hard Clam Mercenaria mercenaria to Evaluate Environmental Stresses by use of Flow Cytometry

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Aquaculture of the hard clam, Mercenaria mercenaria is a $65 million industry in the U. S. Often, environmental stresses, such as such as the hot summers in Florida and harmful algal bloom, affects this industry greatly. Molluscan bivalves are poikilothermic with open circulatory system and hemocytes can function as multiple-purpose defense system through inmate immune responses to protect host against natural environmental stresses, diseases, and toxins. The goal of this study was to establish immunological assays of hemocytes in the hard clam by use of flow cytometry for evaluation of environmental and disease stresses. The objectives are: 1) develop a non-lethal method for hemocyte sampling from the hard clams and determine the pH and osmolality of hemolymph. 2) measure the hemocyte size and classify cell types through microscopic observation after making slides and staining with Wright – Giemsa (Camco Quik Stain™ II); 3) evaluate hemocyte viability and concentration with fluorescent stains of SYBR Green and propidium iodide and compared with that recorded through microscope observation, 4) develop assay of hemocyte phagocytosis with artificial 2-um fluorescent beads, and 4) develop assays of hemocyte ROS (Reactive Oxygen Species) with specific staining of cell permeant reagent 2’,7’-dichlorofluorescin diacetate (DCFDA), a fluorogenic dye that measures hydroxyl, peroxyl and other reactive oxygen species (ROS) activity within the cell. It is expected that the assays to be established in current study will be applied to further investigation of hard clam immunological responses to environmental and disease stresses.
Type I: Eosinophil
Type II: Basophile
Type III: Lymph-like
Type IV: Mix-phil
Preliminary data for sea turtle behavior around vessels off the Northwest coast of Florida

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Globally, all species of sea turtles are considered endangered or threatened, largely due to anthropogenic threats. An often-overlooked hazard is vessel strikes, which result in live and dead strandings of many, if not all, sea turtle species. In the US Virgin Islands during 1982-1997, it is estimated that vessel strikes caused 34% of all reported strandings. In Hawaii, regardless of their low frequency of occurrence, vessel strikes have the highest mortality per-event of the threats observed in the region. Florida waters contain five of the seven sea turtle species (Green turtles - *Chelonia mydas*, Loggerhead turtles - *Caretta caretta*, Leatherback turtles - *Dermochelys coriacea*, Hawksbill turtles - *Eretmochelys imbricata*, and Kemp’s Ridley turtles - *Lepidochelys kempii*), including three species that have extensive nesting beaches along Florida’s coasts (Greens, Loggerheads, and Leatherbacks). Florida stranding records have associated a third of these nesting species’ strandings in the state to vessel strike injuries. With Florida’s large recreational and commercial boating presence along its coasts, which coincide with many of the present species migratory, foraging, and nesting areas, a study describing sea turtle avoidance behavior and flight initiation distance to vessels is a necessary step in lowering anthropogenic mortality rates. I will present preliminary data obtained during a region wide survey along the Northwest Coast of Florida.

Investigating Drivers of Seasonal Change in Fish Abundance in the Homosassa River System

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The 2013 Springs Coast Fish Community Assessment project conducted by the Florida Fish and Wildlife Conservation Commission documented significant seasonal differences in four spring-fed systems. Rivers with direct connection with the Gulf of Mexico exhibited a seasonal shift in fish species composition, depicting an increase in marine species and a decrease in freshwater fish species relative abundance during winter months. Of these systems, the increase was most evident in the Homosassa River system. Following completion of the Springs Coast project we chose to further investigate the drivers of the seasonal shift using the Homosassa River as a pilot study. We aim to determine the effects of seasonal abundance shifts on freshwater fish species dependent upon the Homosassa River for forage, refuge, and reproduction through examination of fish movement, water quality parameters, and habitat associations of targeted fishes in river mainstem and tributary habitats.
This project uses acoustic telemetry, electrofishing, mark-recapture, habitat assessment and abiotic measurements to investigate the impacts of Gray Snapper and Common Snook seasonal migrations and their effects on freshwater fish. Data collected during this study will assist in determining the mechanisms driving seasonal change in fish abundance in coastal spring-fed river systems. Understanding these mechanisms will assist resource managers in implementing management strategies that can protect and/or enhance critical aquatic freshwater habitat. Management implications brought forth by data collected in this study may be adapted to benefit other coastal spring-fed rivers similar in ecological nature.

Evaluation of the Lake Chubsucker (Erimyzon Sucetta) for High Density Aquaculture and Biological Control of Filamentous Algae

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Degradation of natural springs and other water bodies has been observed throughout Florida, and the increase of algae (Stevenson et al., 2004). Contributing factors to increased algae are nutrient inputs of nitrates, phosphorus and anthropogenic redistribution of algae species. Filamentous algae of particular concern are the cyanobacteria in the genus Lyngbya and the green algae genus Spirogyra. Currently, only sterile triploid Asian Grass Carp (Ctenopharyngodon idella) are used to control aquatic vegetation in these nutrient enriched water bodies. However, Grass Carp do not prefer to consume filamentous algae. Presently, algaecides like copper sulfate and peroxyhydrate are used to control algae. Unfortunately, when algaecide is used in hot summer months problems may arise, because decreased oxygen production and the inhibition of the growth of zooplankton (Taub, 1989). Massive die offs of algae in ponds can result in depletion of dissolved oxygen, increased levels of CO₂ and ammonia causing a decline in pH (Boyd, 1975). While Lake Chubsuckers have been shown to have a 100% occurrence of filamentous algae in their stomachs, this does not directly indicate the fish may be used to control algae in any capacity. Therefore, this study will investigate the Lake Chubsucker’s effectiveness at controlling and reducing filamentous algae. In order to produce a sufficient number of Chubsuckers for this study, research to define spawning and culture methods will be investigated. Spawning techniques will be evaluated in natural pond conditions, volitional spawning in raceway tanks, and hormonal injections in raceway tanks. Hormonal chemicals investigated will include Carp Pituitary Extract (CPE), human chorionic gonadotropin (Chorulon R), and sGnRha + domperidone (Ovaprim). Additionally, techniques to help overcome initial handling stress from pond collection to hatchery acclimation will be evaluated. Three different levels of formalin (50, 100, and 150 ppm) and two different levels of peroxide (25 and 50 ppm) will be administered to newly collected fish to determine which, if any, is most effective and has the lowest mortality.
Investigation of Temporal Patterns in Fish Communities in Clearwater Bay

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Clearwater Bay is an estuarine system that is tidally connected to the Gulf of Mexico and is characterized by a mix of seagrass and open mud and sand flats. Despite being located in a densely populated area, the Bay’s wildlife populations have not been extensively studied. To gain a better understanding of the temporal patterns in abundance, Clearwater Marine Aquarium has been sampling local fish and invertebrate populations through otter trawl net pulls since 2009. For this project, trawls were typically conducted multiple times each day, year-round, and rotated through 53 unique locations throughout the Bay. Samples largely included a mix of juvenile fish and invertebrate species. Species in each sample were identified and tallied in conjunction with a suite of environmental variables. Using 11 years of data, comprising of 10,566 trawl samples and a total of 409,276 collected organisms, this study has a broad goal to develop a novel, long-term perspective look of the Bay’s nekton communities. One objective is to formulate a baseline understanding of the ecosystem’s species diversity, richness, and habitat use. A second objective will focus on potential tropicalization occurring in the Bay; determining if species that predominately inhabit more southern, warmer water systems are becoming more abundant and common in the area. The final objective will compare and contrast species’ responses to major weather events including hurricanes, tropical storms, and cold events. Preliminary results from each objective will be addressed.

Preliminary results investigating intra-specific differences of nursery-grown Acropora cervicornis metabolite profiles.

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In the last 30 years, a multitude of anthropogenic and environmental forces has reduced hard coral cover in the western Atlantic by 80%. Restoration practitioners have responded by exploring methodologies that select coral species and genotypes most suitable for restoration efforts. Natural variation in growth and disease resilience between different genotypes of the same coral species is
well documented within coral populations. Thus, understanding intraspecific variation in regard to phenotypes of interest could substantially improve the long-term success of coral restoration efforts. In the last three years, metabolomics has emerged as a new tool in coral restoration science to identify the underlying physiologic state of these phenotypes of interest. To perform this study, we applied proton nuclear magnetic resonance (H-NMR) and liquid chromatography–mass spectrometry (LC-MS) to identify and compare metabolomic profiles for seven unique genotypes of the threatened coral Acropora cervicornis in a common garden coral nursery. In contrast with previous findings, preliminary results suggest no significant differences in hydrophilic metabolite profiles found between known A. cervicornis genotypes from a common garden. Interestingly, the lipidome appears to vary between known genotypes and furthermore, reflect known genetic A. cervicornis lineage. Ultimately, further work will be necessary to refine sample acquisition and processing in order to replicate unique metabolite signatures in corals.

**Measurement of Total Lipid in Commonly Used Microalgae for Hard Clam Aquaculture**

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Molluscan shellfish aquaculture in the U.S. is a $442 million industry with filter-feeding molluscan bivalves (e.g., oysters, clams, scallops, and mussels) as major cultured species. To sustain this large-scale industry, commercial seed production (in term of quality and quantity) is always the number one priority. For hatchery seed production, microalgae are essential because they are the food for broodstock and larvae. To provide the optimum nutritional needs for larval growth and survival and broodstock sex maturity for hatchery seed production, microalgae need to have required biochemical compositions, mainly known as macro nutrients (lipid, protein, and carbohydrate), suitable cell size and density, and easy culture. The goal of this study is to evaluate total lipid accumulation in the commonly used microalgae by use of a flow cytometry method with a newly developed cytoplasmic fluorescent lipid probe, BODIPY 505/515. The objectives are to: 1) determine the effective staining concentration, time, and temperature of BODIPY 505/515 for different algal species; 2) estimate total lipid accumulation during algal growth period, and 3) establish total lipid protocols for fast and accurate measurement and evaluate total lipid of several microalgal species. It is expected that this study will provide a better understanding of total lipid composition of the microalgae. The flow cytometry method with fluorescence dyes will provide a fast, accurate, and cost-effective method for immediate assessment of lipid content in microalgae. This study will lay foundation on shellfish nutrient management for broodstock and larvae for seed production.

Maximizing fish habitat through SAV restoration
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Submerged aquatic vegetation (SAV) provides many ecosystem functions, including habitat for recreationally and commercially important fishes. Reestablishing SAV as a foundation species in degraded lakes has the potential to increase ecosystem function including fish habitat. In this study, we used an ongoing SAV restoration in Lake Apopka, FL as well as mesocosm experiments to determine how different SAV characteristics impact fish use of SAV. We conducted field sampling using fyke nets and trotlines of areas with varying SAV species, patch size, and origin (e.g. natural or restored) in Lake Apopka to examine changes in fish communities. Our results indicate that fish communities changed with an increase in SAV patch size, regardless of SAV composition and origin. Threadfin shad (Dorosoma petenense) decreased, while all other fish species like warmouth (Lepomis gulosus) increased with an increase in SAV patch size. Fish diversity also increased with an increase in SAV patch size. In mesocosms, we created habitats with differing SAV species, morphology, genetic diversity, and species diversity and monitored juvenile largemouth bass preferences of the habitats presented. Fish clearly preferred SAV over the sand control treatment for every choice experiment, and demonstrated specific preferences for different SAV types, such as thicker, taller, and more genetically diverse eelgrass (Vallisneria americana). The information from our study will help inform future SAV plantings aimed at maximizing fish use and restoring recreational fisheries.

\textbf{Investigating Diet and Husbandry Preferences for Marine Ornamental Fish Larvae}

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My research will focus on marine ornamental fish production through aquaculture. Marine ornamental fish larvae will be raised under different conditions in order to determine optimal survival conditions for each species studied. Variables will include tank size, feed type, feed density, stocking density, algae density, and aeration. Feed types will include Brachionus rotifers and Parvocalanus copepods and may include Apocyclops panamensis. Water parameters will be maintained at reef aquarium levels, with nitrogenous wastes monitored most closely. Each experiment will run for the first ten days of larval life. Success will be measured by the larval growth, survival rates, presence or absence of stomach contents, and behavior on day 10. This experiment may be applied to many species of larvae. My research will be focusing on both preceded and unprecedented
Distribution of North Florida Cyanobacterial Toxins and the Corresponding Human Routes of Exposure

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In recent decades, the occurrences of toxin producing algal blooms has increased significantly within the United States and around the world. Public anxiety has escalated since this increase however, there has been few scientific studies linking algal toxins with potentially related human health problems. This study, which is funded by the Florida Department of Health, will attempt to identify a correlation between human health problems and algal toxins. The three specific algal toxins that are to be isolated are the hepatotoxin microcystin produced by Microcystis aeruginosa, the neurotoxin saxitoxin produced by Anabaena circinalis, and the lesser known toxin BMAA. Geographic distribution and toxin profile data will be utilized to develop a HotSpot analysis via ArcGIS and ELISA (enzyme-linked immunosorbent assay) respectively. Correlation data will be produced by a geographically weighted regression model with inputs from the OneFlorida clinical research consortium, Florida LAKEWATCH data, and algal data provided by personnel from the Philips Lab.

Developing Intensive Aquaculture of the Long-Spined Sea Urchin Diadema Antillarum As A Tool For Coral Reef Restoration

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The long-spined sea urchin Diadema antillarum was once an abundant reef grazing herbivore throughout the Caribbean. Benthic surveys conducted in the Florida Keys during the 1960s-70s revealed average densities of 5-10 individuals/m². During the early 1980s, 98-99% of Diadema populations on Caribbean coral reefs disappeared due to an undescribed disease. To date, these populations have not recovered naturally and it is understood that the loss of associated herbivory has contributed to ongoing coral reef decline as hard coral dominated reef systems shift towards macroalgae dominated reef systems. Outplanting corals alone does not address the stressors causing reef decline, thus there is great interest in reviving functional herbivory via a multi-niche ecological approach. Intensive aquaculture and restocking of Diadema is a potentially viable method for coral reef restoration. The development of Diadema aquaculture has been met with limited success due to larval culture difficulty and the lack of existing literature. The purpose of this study is to refine methodologies for reliable ex situ reproduction and larval rearing of Diadema in a closed recirculating aquaculture
system (RAS). The intention of this work is to improve the viability of Diadema aquaculture at restoration relevant scales. This presentation outlines the research methods and experimental design conducted in a novel RAS at The Florida Conservation and Technology Center, alongside the Florida Aquarium in Apollo Beach, Florida.

**Predicting Patagonian Toothfish (Dissostichus eleginoides) Distribution to Inform Management and Conservation in the Southern Ocean**

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The Patagonian toothfish (Dissostichus eleginoides) fishery is one of the most valuable in the southern hemisphere, yet it is subject to illegal, unreported, and unregulated fishing. From an international management perspective, there is a need to identify the different stakeholders and their relative importance. Our goal was thus to predict the species' distribution and to compare it to different jurisdictions. We developed a map of potential habitats based on physical characteristics of the seafloor (e.g., slope, rugosity) and compared it with presence records below the 28° parallel. Then, we used these data to develop a species distribution model based on maximum entropy. Our potential habitats were defined mainly by depth, but also by slope and relative topographic position. The predicted distribution of toothfish was also mostly driven by depth, with a preference for relatively shallower waters and higher slopes. These results suggest that toothfish prefer to inhabit continental shelves, continental slopes, and seamounts. Areas of high probability of occurrence (≥65%) were mostly found in international waters (46.61%), with 10.36% in unprotected waters and 36.25% managed by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR). Areas of high probabilities were also found within the Exclusive Economic Zones (EEZs) of New Zealand, Argentina, the United Kingdom, South Africa, Australia, Chile and France, among other countries. Our results emphasize the need to strengthen the management efforts of the CCAMLR and the countries that host significant portions of the resource, and the need for a new agreement for unprotected international waters.

**Habitat restoration and stock enhancement of seagrass and scallops in Florida’s Central Gulf Coast**

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Seagrasses provide food and critical habitat for a variety of marine species. They are a vital part
of the marine ecosystem and help maintain water quality, stabilize the sea bottom, and support local economies. Bay scallops are obligate residents of seagrass beds and an indicator species of coastal water quality. In addition to their economic importance derived from recreational fisheries, scalloping and the scallops themselves are a beloved symbol of summertime leisure for many Floridians. Unfortunately, various anthropogenic factors have resulted in progressive declines in water quality and seagrass beds. Rural communities along central Florida's Gulf Coast are dependent on healthy coastal resources, like seagrasses, for activities such as fishing, scalloping, and wildlife viewing. Unfortunately, these activities can also damage these resources. Careless or improper boating can cause propeller scarring, which damages seagrass habitat. We will study seagrass propeller scar and bay scallop restoration efforts in Citrus County and Tampa Bay, respectively. The aim is to generate information that will dovetail to create a framework for improving these two restoration practices, which have important ecological linkages. Seagrass restoration studies will employ robust monitoring of restored scars with environmental metagenomics to improve understanding of the biological transition from dry, "sterile" encapsulated sediment to marine benthos permeated with rhizomes. Density-dependence in bay scallop larvae released for restoration will be tested experimentally. Further, previously developed microsatellite markers will be used across four hatchery spawns to measure genetic diversity of released animals and potentially identify scallops found post-restoration. The project goal is a holistic approach to restoration, providing a unique opportunity to improve outcomes for one of Florida’s most iconic ecosystems.

Do crayfish metabolic rates and ecological impacts shift along a climate gradient?

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Due to climate change and biological invasions, species are being exposed to novel thermal regimes. Temperature can alter the metabolic rates of ectotherms, which can affect their energy requirements, and thus their behavior and ecological impacts. We examined metabolic rates and feeding behavior across populations of a widely distributed crayfish species, the virile crayfish (\textit{Faxonius virilis}). Virile crayfish inhabit a large native range and have also established nonnative populations in 34 states. Thus, the extent to which the thermal regime affects virile crayfish metabolic rates and impacts could have substantial ecological consequences. We hypothesized that crayfish metabolic rates would shift along a latitudinal gradient and that populations with higher metabolic rates would also have higher feeding rates. We hand collected virile crayfish from eight populations along a latitudinal gradient from Northern Wisconsin to Southern Illinois and used intermittent respirometry to measure crayfish metabolic rates at two temperatures (23°C and 28°C). These temperatures represent mean summer water temperatures across this range. We also conducted a laboratory feeding behavior experiment at the same two temperatures. Preliminary results suggest that variation in metabolic rates and feeding behavior existed among populations, but that this was not related to latitude. Through understanding how virile crayfish acclimate to local thermal regimes and
how metabolic rates are related to their impacts, we may be able to better predict their potential to
invasive and affect new ecosystems.

Oyster Restoration and Coastal Protection: A Coastal Vulnerability Analysis of Lone Cabbage Reef,
Levy Co., FL

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Oysters are one of the most important managed estuarine natural resources in North America. In addition to supporting commercial fisheries, oysters provide ecosystem services such as filtering water, creating habitats used by animals important to humans, carbon sequestration, pest control, erosion prevention. There has been a decline of oyster populations in America extending from New England in the 17th century to the Gulf of Mexico region at the start of the 1860’s. Restoration is necessary to sustain and recover the ecosystem services provided by oysters. Previous studies have not examined the effect oyster restoration has on coastal protection over sea level rise trends. There is a need to investigate the usage of oysters as a candidate for both restoration and green infrastructure to protect against sea level rise impacts due to oyster’s ability to provide vertical relief against sea level rise and prevent erosion. Impacts of oyster restoration can be evaluated by using the Coastal Vulnerability model from the Integrated Valuation of Environmental Services and Tradeoffs (InVest) software suite to measure exposure and coastal protection. The objective of this research is to measure the difference oyster restoration has on coastal vulnerability exposure in Lone Cabbage Reef, Cedar Key, Florida across current (Baseline), moderate, and high sea level rise trends. The explicit assessment of likely ecosystem service benefits provided by Lone Cabbage Reef restoration across current and future sea-level rise trends should augment more transparent decisions making regarding oyster restoration in the Gulf of Mexico.