Forage Fish Research Program
Fellowship Update

<u>2024-2025 Fellows</u>

Mackenzie White
Fellowship funded through Fish Florida

Mackenzie "Mack" White is a PhD student at Florida International University under Dr. Jennifer Rehage. Mack's proposed research aims to explore the spatiotemporal dynamics of forage fish community biomass across seven major Florida estuaries (Apalachicola Bay, Cedar Key, Tampa Bay, Charlotte Harbor, Southern Indian River Lagoon, Northern Indian River Lagoon, Northeast Florida) in response to varying types of disturbance. This investigation proposes to address how community stability and its intrinsic properties, resilience and resistance, interact to influence responses to environmental stressors. By comparing estuaries across the state, the proposed research seeks to understand how differences in anthropogenic impacts, climatic conditions, and evolutionary histories across a latitudinal gradient affect the ecological stability and plasticity of these vital coastal systems. This understanding is important for maintaining biodiversity and supporting coastal fisheries in the face of increasing hydroclimatic variability as a result of climate change and water management decisions in the state of Florida.

Mack's proposed research seeks to address the following questions: (**1**) How temporally stable is community biomass, and are there differences across estuaries? (**2**) What aspects of community structure and diversity promote stability? (**3**) What are the intrinsic properties (i.e., resistant, resilient, or both) of communities which underpin responses to acute disturbances and are there breakpoints in time series to indicating state changes associated with chronic disturbances? Mack will test the following hypotheses: (**H1**) community biomass will be more stable in northern estuaries relative to their southern counterparts given differences in anthropogenic impacts and climatic differences; (**H2**) temporal stability of community biomass will be positively related to the trophic diversity and size-structure of communities characterized by intermediate generation times; (**H3a**) community biomass will be more resistant to acute perturbances in northern estuaries and resilient in southern estuaries resulting from differences in community asynchrony, leading to latitudinal patterns of tradeoffs in resistance and resilience; and (**H3b**) southern estuaries have experienced a larger number of significant breakpoints in their time series as a result of tradeoffs with resilience and more pronounced anthropogenic impacts.

To address the questions and hypotheses proposed, Mack will explore community biomass stability using generalized linear mixed models (GLMMs) to evaluate the effects of community structure and diversity on aggregate nitrogen supply rate stability. Independent variables in models will be averaged at the site level. Independent variables in models will included: ***species richness***, measured as the number of species within the community; ***species diversity***, measured as the inverse Simpson diversity index; ***trophic richness and diversity***, measured similar to above but using information about each species trophic ecology from literature; ***max size***, measured as the mean maximum size of each species in the community; and ***generation time***, measured as the mean generation of each species in the community using information from literature. All models will be fit with estuary as a random effect (i.e., random intercept) and evaluated using model information theory (Akaike information criterion; AICc).
Acute disturbance events will be defined as instances when environmental conditions (e.g., temperature, salinity) exceed two standard deviations from mean daily minimum or maximum observations from the longest and closest monitoring stations for each estuary and evaluated using the severity index. The severity index accounts for duration and amplitude, and the nonlinear effects of their. Prior to calculating severity, all data associated with acute disturbances will be log-transformed and z-scored for comparison across variable disturbance types. Resistance and resilience to each of the discrete events will be calculated and assessed for tradeoffs. A suite of GLMMs will be used to evaluate the effects of ***disturbance severity*** and ***type (e.g., cold snap, heat wave, drought)*** on observed resistance and resilience. Models will be evaluated similar to that described for temporal stability. The effects of chronic disturbance events will be evaluated using breakpoint time series analysis. The magnitude of identified breakpoints will be evaluated by calculating the magnitude of change in fish community biomass relative to time series averages and compared across sites and habitats using one-way analysis of variance.

Megan Siemann
Fellowship funded through Fish Florida
Megan Siemann is a PhD student at University of Florida studying under Dr. Dave Chagaris. The overarching goal of Megan's project is to develop directed, cost-effective sampling recommendations for trophic monitoring within the Nature Coast Aquatic Preserve (NCAP) and other APs. This will be achieved through two tractable objectives that will work on coupling ecological and trophic data to better incorporate temporal diet shifts into ecosystem models: *Objective 1)* Synthesize existing Stable Isotope Analysis (SIA) data from repositories with long-term Fisheries Independent Monitoring (FIM) Stomach Content Analysis (SCA) data to examine inter- and intra-annual diet variability, identify data gaps, and characterize the dominant prey items of key predators in the APs, *Objective 2)* Develop integrated SCA and SIA mixing models and provide recommendations for trophic data collection and incorporation into ecosystem models.
The approach Megan will take to achieve these objectives is as follows:

Objective 1) Data synthesis: Megan will summarize the FIM SCA data for key predators of prominent forage fish species in the eastern Gulf of Mexico region. From the SCA, the most important prey species will be identified. Next, stable isotope data for those prey will be obtained from Gulf Science Data Repository (GRIIDC), National Centers for Environmental Information (NCEI) repository, and other published values. By examining both the predator SCA and prey SI signatures, she will characterize data gaps with respect to predators and the baseline isotopic signatures of their prey. Megan will also quantify the spatio-temporal variability in predator diets reflected in SCA and SIA alongside the prey forage fish SI signatures. Variability estimates will provide guidance as to the frequency and spatial distribution of trophic data collection in the APs and provide probability distributions for a Bayesian mixing model in Objective 2. By examining both the prey diet and predator SI signatures, she will investigate whether changes in the SI signature of the predator are due to prey switching or changes in the prey SI signatures caused by changes in the environment (e.g. floods, droughts, upwelling). SI signatures do not provide specific prey information so while a shift in predator SI signature may suggest a shift in diet composition it could reflect a change in the SI signature of the prey items instead. If changes in prey SI signatures are detected, consideration of environmental data that has been collected as part of the water quality and habitat monitoring programs may inform drivers of the variation.
Objective 2) Isotope mixing models: With the synthesized SCA SI data, Megan will develop isotope mixing models that integrate the two methods. The mixing models will enable the reconstruction of predator diets from stable isotope ratios. To evaluate the cost and feasibility of each method (SCA and SI) she will conduct power analyses for the SCA and integrated models to determine how much sampling (sample number and frequency) would be required to accurately reconstruct the diet from the easier to obtain SI data. Cost comparison will also be completed based upon the sampling requirements suggested from the power analysis recommendations and summarized. The model development will prioritize identifying temporal diet switches for incorporation into ecosystem models. The functionality will be tested by incorporating the trends identified by the mixing model into the existing Suwannee River Estuary Model developed by a previous Florida Forage Fish Fellow Dylan Sinnickson (Sinnickson et al. 2021).

2023-2024 Fellows

Cristopher Crowder- University of Central Florida
Fellowship funded through Fish Florida

Christopher is a PhD student at the University of Central Florida under Dr. Geoff Cook. His project proposes the use of a habitat mosaic approach to better understand fish community dynamics in Tampa Bay. The project seeks to understand how shifting benthic habitats influence the abundance and structure of fish communities including both forage and associated predators.

The study aims to quantify how forage fish abundance and diversity dynamics shift across essential fish habitat, and in turn explore the influence of forage fish availability and habitat mosaic on the abundance of sportfish.

Specifically, this project will answer the following questions:
1) What habitat characteristics and environmental factors best predict changes in the forage fish community?
2) What habitat, environmental, and forage fish factors best predict changes in the sportfish community?
3) How can the knowledge regarding these predator-prey-habitat mosaic relationships be used to develop more effective management strategies for moving sportfish toward sustainability?

Chris will implement datasets from new FFRP partners Tampa Bay Estuary Program and Southwest Florida Water Management District as well as Florida Fish and Wildlife Conservation Commission (FWC) Fish and Wildlife Research Institute's (FWRI) Fisheries-Independent Monitoring (FIM) program data. To conduct the analyses necessary to answer the proposed questions, Chris will explore spatial patterns of abiotic metrics, including water temperature, velocity, depth, pH, as well as salinity and dissolved oxygen using GIS and statistical methods. He will then pull from FWRI's gut-content data to link sportfish and forage, looking at abundance in relation to habitat type, macroalgae by-catch, and potential effects levels ratios as habitat model layers. This study will utilize modern statistical methods and hierarchal models to analyze relationships among the habitat/environment, forage fish, and sportfish.

By using cutting edge statistical analyses to assess multiple pressures impacting fish communities simultaneously, this project will quantify changes in forage and sportfish populations in relation to habitat characteristics, environmental factors, and for sportfish, prey availability. The results from this study will yield a more predictive understanding of forage and sportfish dynamics; provide insight to better inform wildlife managers, habitat management, stock assessment, and restoration efforts; and guide regulators on the status and future of ecologically and economically important fish species on Florida's west coast. Ultimately, this will help local communities, the state of Florida, and the nation achieve the goal of healthier and more sustainable coastal ecosystems.

Hallie Repeta- University of South Florida
Fellowship funded through Fish Florida

Hallie is a PhD student at the University of South Florida under Dr. Cam Ainsworth continuing their ongoing work on the Gulf of Mexico Atlantis model which is a very complex 3-dimensional "end-to-end" ecosystem model capable of exploring predator-prey dynamics between forage fish and predators. The model can simulate fishery and population dynamics as well as the impacts of environmental perturbations.

Hallie's project proposes updating the GOM Atlantis model for forage species and their predators using surveys and monitoring data from the Florida Fish and Wildlife Conservation Commission (FWC) Fish and Wildlife Research Institute's (FWRI) Fisheries-Independent

Monitoring (FIM) program and data from Southeast Area Monitoring & Assessment Program (SEAMAP).
The study will address the following questions:
1) Does the health of forage fish impact the variability of reef-associated and pelagic predators under environmental stochasticity?
2) How does the biomass of forage fish affect ecosystem carrying capacity and safe harvest rates for reef associated and pelagic predator fish species?
3) How does seagrass restoration affect forage fish biomass and the delivery of these ecosystem services?

Hallie outlined three research objectives to answer the proposed questions:
Research Objective 1: Inshore-Offshore Connectivity Trophic Energy Transfer. Hallie will be the first FFRP fellow to implement offshore forage fish data and FWRI has indicated the benefits of this relatively underutilized dataset and their excitement for its implementation. To do this, Hallie will use diet data from FWRI to create a diet matrix to link forage species to their associated predators.

Research Objective 2: Inshore-Offshore Connectivity of Forage Fish Biomass. This objective will be achieved by updating the model's biomass information with FIM and SEAMAP data from 2019 to present along the west coast of Florida. This update will allow for the identification of spatio-temporal connectivity of focal forage fish between inshore and offshore habitats. Further, FIM's inshore sampling data will be used to confirm a reasonable age structure in Atlantis for forage fish groups. Since the baitfish trawl and beach seine sampling programs catch different ages of fish, it will be possible to validate the immature:mature ratio in the model.

Research Objective 3: Perturbance Impacts. The GOM Atlantis model will be applied to study the resilience of forage fish populations, and the subsequent effect on carrying capacity and resilience of predator populations. Resilience refers to the ability of the ecosystem to recover after disturbance and will be measured in this study by subjecting the model to environmental drivers. Habitat environmental drivers will be represented through harmful algal blooms (HAB), eutrophication, habitat loss, and habitat restoration. Habitat loss and restoration will be simulated through varying degrees in seagrass habitat availability. Eutrophication events will be simulated by driving primary production variability in estuarine Atlantis polygons. To represent anthropogenic pressure, fishing pressure will also be applied to forage fish populations at varying degrees. The model will then be run under various scenarios to test: a baseline with no environmental drivers, HAB pressure, and eutrophication pressure under differing fishing pressures.

This research will improve our understanding of forage fish intrinsic trophic linkages, population dynamics, and the ecosystem services provided by forage fish in estuarine and offshore ecosystems. Further, it will provide predictors of forage fish and ecosystem resilience thresholds under varying natural and anthropogenic pressures, which supports more effective and efficient holistic management.

2022-2023 Fellows

Dakota Lewis- University of Florida
Fellowship funded through Fish Florida

Dakota was one of our 2020-2021 fellows while working on her Masters degree at University of Central Florida and has been incredibly successful in her academic endeavors. Dakota is now working on her PhD at University of Florida. She has published her findings from her first fellowship and is currently awaiting the decision on her second manuscript based on the project. Dakota's current project will explore the forecasting of future estuarine fish communities in the Everglades using machine learning techniques. Her project sought to answer the question, "How will estuarine fish community structure respond to related changes in freshwater quantity, quality, and benthic habitat availability due to Everglades restoration?"

To answer this question Dakota constructed a combination of machine learning statistical models using FWRI Fishery Independent Monitoring (FIM) data on fish community, seagrass, and water quality. She then used environmental and habitat data to train the models and group communities into sub-basins within Florida Bay. She then validated with collected data from Summer 2022 and simulated future scenarios based on environmental changes due to Everglades restoration.

This study highlights the importance of FIM data in validating statistical model predictions and create a highly transferable framework for forecasting fish communities in a nonstationary environment. Applying this innovative quantitative approach to existing data identifies hidden patterns and relationships within community structure while simultaneously predicting fish communities under future restoration scenarios and environmental conditions, thereby serving as a blueprint for applying machine learning techniques to advance our fundamental understanding of coastal marine communities.

Dakota continues this work as of August 2023 as part of her PhD dissertation now at University of Florida. She has already published one paper from this work combined with her previous fellowship which can be found here: Freshwater discharge disrupts linkages between the environment and estuarine fish community

Barry Walton- Florida State University
Fellowship funded through Fish Florida

Barry is a former Marine and current PhD student at Florida State University. He is the first fellow from FSU, expanding the network of Universities within the Forage Fish Research Program. Barry's research explored the habitat and forage resources of redfish and spotted seatrout in the Apalachicola estuary using fatty acid profiles and stable isotope analysis.

Barry's project couples FWRI's (FIM) catch data with ecological and food chain data to examine prey/forage availability and presence in the diet of redfish and spotted seatrout as well as investigate predator-predator effects and competition using fatty acids and stable isotopes. The study uses fatty acid profiles to determine if forage fish species can be differentiated from one another. Characterizing fatty acid profiles of forage fish species provides fundamental information on their feeding ecology, biochemical composition, and the energy they provide to estuarine and offshore predators. Fatty Acid profiles of the predators will provide information on their diet and will be paired with catch data. Combined, this allowed Barry to address the hypothesis that redfish and spotted seatrout are partitioning habitat and food resources. The study had three main objections, 1. Characterize the fatty acid profiles of select forage fish species and evaluate the efficacy of using these profiles to differentiate species, 2. Estimate forage fish contribution to two predator diets using fatty acid profiles, 3. Use FIM catch data to investigate prey availability, forage fish and predator spatial distributions, and use fatty acid profiles and stable isotopes to examine predator-predator trophic interactions.

Barry's proposed analysis will allow him to determine which forage fish species have distinct dietary sources and pairing these data with stable isotope analysis will provide a more comprehensive view of food chain interactions between forage fish and predators. Spatial analysis of FIM catch data will provide information on how forage fish and predators are using areas within the Apalachicola system and when paired with the fatty acid and stable isotope analysis Barry will be able to determine how redfish and spotted seatrout are partitioning resources. Barry completed his fellowship in 2023 and continues to work on his analysis as part of his PhD dissertation with expectations of his first publication within the year.

2021-2022 Fellow
Kira Allen- University of Central Florida
Fellowship funded through Fish Florida

Kira is our current fellow, awarded the Forage Fish Research Program fellowship in 2021 while she undertakes her M.S.at the University of Central Florida. Kira has made good progress throughout her fellowship as she explores the effects of short-term and long-term drought events on Apalachicola Bay forage fish and their associated food web. Her research aims to address the effects of reduced freshwater input and sea level rise on forage fish species biomass and associated shifts in the food web dynamics of Apalachicola Bay. The study relies on the use of coupled hydrodynamic and food web models to evaluate changing hydrological, environmental, and biological characteristics.

Kira's research will contribute to the development of an adaptive modeling tool using FWRI's Fishery Independent Monitoring data to assess future drought impacts on Apalachicola Bay forage fish dynamics, an approach that has not been previously applied to this system. Once completed, the model will remain available for managers to use, as well as be modified to accommodate new data and/or scenarios. Study results will provide a better understanding of how future environmental changes may impact forage fish populations in Apalachicola Bay.

Study methods will highlight a versatile modeling approach that can be applied to address any number of future scenarios both within Apalachicola Bay and across other estuarine systems.

Kira is expected to complete her analyses by June 2022 as she continues to progress in her graduate studies at UCF.

2020-2021 Fellows

Dakota Lewis- University of Central Florida

Dakota Lewis was awarded the Forage Fish Research Program fellowship in 2020 while undertaking her M.S. degree at the University of Central Florida. Dakota's fellowship research examined algal blooms and fish kills in the Indian River Lagoon which stretches along 40% of Florida's East Coast. She used datasets from FWRI and a complex computer modeling framework to determine the relationship between environmental disturbance and forage and sport fish species as well as forage fish community dynamics. Examining a non-toxic brown algal bloom (*Aureoumbra lagunensis*) occurring from December 2015 through March 2016, she found that both sport fish and forage fish abundances decreased following the bloom, but the response of the forage fish community was more rapid. Forage fish community dynamics were more closely related to water quality metrics than sport fish communities during non-disturbed periods. However, during this algal bloom, sport fish community dynamics were more closely associated with water quality metrics than forage fish community dynamics. Furthermore, sport fish community dynamics were strongly related to bloom dynamics during the three months prior to the fish kill. In the three months following the kill, the forage and sport fish communities were less strongly linked than in non-disturbed years. These large shifts in community dynamics and relationships following a disturbance suggest both forage and sport fish communities, food webs, and trophic dynamics may be at increasing risk of crossing ecological thresholds as algal blooms become more common in coastal ecosystems.

"And so, there's a potential for a loss of that balance, due to that decoupling of those two communities that are so intertwined and, in the food web, related to one another," Lewis outlined. Lewis thinks shifts in community dynamics for forage fish and sport fish could have harmful effects on popular recreational fisheries, now and in the long term.

These findings were published in the journal *Ecological Indicators* here: Understanding shifts in estuarine fish communities following disturbances using an ensemble modeling framework

Dakota made tremendous progress over the course of her fellowship. She has published her first manuscript in *Ecological Indicators* and is actively working on submitting a second manuscript from her fellowship research modeling results. The second manuscript will include a comparison of fish community responses to algal blooms occurring on the east and west coasts of Florida. Shifts in forage fish-sport fish assemblage relationships in chronically disturbed versus acutely disturbed systems will be investigated in the paper as well. Dakota finished her proposed research early in her fellowship timeline and progressed well beyond what was proposed.

Dakota was accepted to undertake a doctoral degree at University of Florida where she will continue her quantitative analyses of fish communities in the face of disturbance and stressors.

Emily Farrell- University of Central Florida

Emily Farrell was awarded the FFRP fellowship in 2020 while undertaking her Ph.D. at University of Central Florida in Dr. Michelle Gaither's lab. Emily's project employed a relatively new field of study known as environmental DNA analysis, or eDNA, which can detect and characterize species composition from small volumes of collected water. "The dust in our houses is mostly shed skin cells; that would be environmental DNA," Farrell explained. "But in a fisheries context, it's mucus or scales, or other things that fish are releasing into the water by swimming through it." Farrell's method can account for even the smallest species, like forage fish, simply by collecting seawater samples along the lagoon. The eDNA analysis will help create a map of local biodiversity hotspots.

Although the Covid-19 pandemic had a major impact on Emily's ability to sample and analyze eDNA from the Indian River Lagoon, she made good progress once limitations eased. The research undertaken by Emily sought to address the following goals: (1) Optimize existing lab protocols for long-term eDNA monitoring to provide a cost-effective tool that will complement existing fisheries assessment methods. (2) Conduct eDNA field sampling alongside FWC scientists so that the two methods can be directly compared. (3) Use multivariate statistical techniques, to evaluate differences in species composition between FWC and eDNA datasets to identify the relative biases and strengths of each technique. (4) Integrate FWC FIM and eDNA datasets in a spatially explicit framework to serve as a baseline dataset for future efforts. (5) Develop species hotspot maps for forage fishes and their predators. (6) Work with FWC scientists to optimize protocols that combine traditional survey techniques with eDNA sampling that will reduce the time and money for monitoring efforts, and allow for the expansion of eDNA techniques to other Florida estuaries.

Emily was co-author on an article published in the journal *Environmental DNA* focused on the development of the methods used to collect and analyze eDNA samples. The link to this paper is here: [One size does not fit all: Tuning eDNA protocols for high- and low-turbidity water sampling]

Emily is also working on revisions for a second manuscript including the findings of her project and she continues to progress in her doctoral research.

2019-2020 Fellows

Michelle Shaffer- University of Central Florida

Michelle Shaffer was awarded the Forage Fish Research Program fellowship in 2019 while working on her M.S. at the University of Central Florida. Michelle's work focuses on the importance of understanding the effect of disappearing seagrass meadows in the Indian River Lagoon (IRL) in Florida due to Harmful Algal Blooms (HABs) on forage fish and their predators. The project includes collaboration with the FWRI using their Fisheries Independent Monitoring (FIM) datasets to conduct geospatial analyses and a diet study of economically important forage and predator species in the IRL.

The objective of Michelle's project was to evaluate spatial overlap of forage fish and their predators, investigating the influence of seagrass and environmental parameters on fish distribution and abundance pre (1998-2009) and post (2010-2018) seagrass die-off periods. This information is coupled with the diet composition study to test the geospatial hypothesis that seagrass die-off will have a significant effect on forage fish production when accounting for various other environmental parameters.

Michelle has transitioned to the Ph.D. program at University of Central Florida and successfully defended her Ph.D. proposal in December 2021 making her officially a Ph.D. Candidate. Working with her advisor, Dr. Kristy Lewis, Michelle is currently working to submit a manuscript for publication on her GIS analysis done for the FFRP fellowship. The FFRP fellowship research will be included in her dissertation's first two chapters. Michelle is also still running the gut lab at LLACE.

Dylan Sinnickson- University of Florida

Dylan Sinnickson was awarded the Forage Fish Research Program fellowship in 2019 as he works toward his Ph.D. in fisheries and aquatic sciences at the University of Florida. Dylan is focused on the dynamics of anchovies relative to environmental influence at Cedar Key along Florida's Nature Coast. Specifically, Dylan is looking at how nutrient flow and river discharge affect bay anchovies and their associated predators within an estuary.

Using data from FWRI, Dylan is employing complex modeling techniques to explore impacts of changing nutrient levels on abundance of anchovies which, in turn, affects the diets of predators such as seatrout and snook. He has found that as anchovy population increase, seatrout and snook see additional growth as well but snook benefitted more than seatrout. As abundance of snook and seatrout grew with additional forage of anchovy, snook began preying on seatrout. "Most predatory fish species benefit from abundant prey, but it's not a linear relationship," said Sinnickson, "The ecosystem is complex and acts in unpredictable ways."

The results of Dylan's work will provide much needed information on the effect of flooding, nutrient runoff, and droughts to both forage species and predators. This information can be used by fishery managers within these estuaries to better predict changes in fish dynamics as a result of ecosystem wide environmental changes.

An article from 3rd Year fellow Dylan Sinnickson at University of Florida was published in *Frontiers in Marine Science* in June 2021. In the article, Dylan's research group examines the effect of different levels of river discharge in the Suwannee River Estuary on forage fish and their predators.

Link: [Exploring Impacts of River Discharge on Forage Fish and Predators Using Ecopath with Ecosim].

Dylan is currently completing his doctoral degree at University of Florida.

2018-2019 Fellows

Brittany Troast- University of Central Florida

Brittany Troast was among two Forage Fish Research Program fellowship recipients in 2018, the second year of the fellowship program. While completing her master's degree in biology at University of Central Florida, Brittany researched the effect of changing populations of forage fish on the abundance and diversity of predators and predator-prey relationships in the Indian River Lagoon and St. John's River.

Troast hopes the information she gathered will help fishery leaders make big-picture decisions and manage ecosystems as a whole rather than focusing on only individual species. According to Troast, "We can manage the system from the bottom up instead of putting a Band-Aid on one species at a time, sometimes the solution is not just to limit the catch of a declining sport-fish population, but also improve the abundance of its prey."

During Troast's study, she analyzed over 20 years of fishery-independent monitoring data on forage fish such as pilchards, anchovies, and pinfish, which are important prey for larger sport fish such as red drum, tarpon, and snook. She also explored why forage fish are plentiful in some years and less so in others.

"A lot of people think humans have control over everything, but the oceans and our natural systems are bigger than us," says Troast, who also has a bachelor's degree in marine science from the University of Florida. "Everything we do has a ripple effect. It goes back to understanding that everything is connected. There is a way for people to respect the planet but also enjoy it, and we have to figure out how to do this sustainably."

Some of Brittany's research results have been published here: [Multidecadal shifts in fish community diversity across a dynamic biogeographic transition zone]

Following her graduate studies, Brittany transitioned her experience and into a career as an Ecosystem Assessment Scientist at the Cooperative Institute for Marine and Atmospheric Studies which is a collaboration between NOAA and the University of Miami.

Jonathan Peake- University of South Florida

Jonathan Peake was among the second-year awardees of the fellowship in 2018 while working as a doctoral student at the University of South Florida. Jon's work focused on ways to better understand the dynamics of prey species in Gulf Coast estuaries, specifically how they change in abundance, composition and by habitat relative to predators. Jon examined these dynamics by diving into decades of data on forage fish populations available in the FWRI database. Jon focused on the effect of major environmental events such as cold snaps, red tides, and changes to habitat on the local fish communities.

To explore the highly complex world of fish community relationships, Jon employed the use of complex statistical analysis methods in four Florida estuaries: Tampa Bay, Cedar Key, Charlotte Harbor, and Apalachicola Bay. In total, Jon analyzed 62 forage species and 75 predator species in these regions to determine a hierarchy within specific locations and how these may have shifted or changed due to environmental factors.

Jon is eager to shine a light on typically overlooked forage fish species and their highly complicated relationships to each other and predators in these estuaries. “They have tremendous value for the state of Florida and recreational and commercial fisheries,” Peake says. “They are the basis for the food web especially for fish we like to eat.”

In January 2022, Jon received notification that his manuscript on forage fish community dynamics had been accepted to the journal *Ecosphere*. This manuscript publication is expected later in 2022.

As Jon completes his doctoral degree, he has already accepted a job working for the Fisheries Independent Monitoring group at FWC. He will be working as a Research Associate serving as the lead data analyst for the FIM inshore program. Jon stated that it is his belief that the FFRP played a large role in him being offered the position.

2017-2018 Fellows

Ed Camp- University of Central Florida

Dr. Ed Camp was one of the first recipients awarded the Forage Fish Research Program fellowship in 2017 while working as a postdoctoral scholar at the University of Florida. Ed’s postdoctoral research shed light on the dynamics of predators such as redfish and their diets of forage fish by examining gut contents from the FWRI database. Ed also examined population records of identified forage fish to determine their abundance relative to predators over time, revealing trends in their predator-prey dynamics and shifts in prey preference.

A primary challenge in Ed’s work was determining the most preferred species the redfish chooses to eat, whether it be opportunistically available or sought out by the redfish. “If I ate a hamburger, was it because I wanted it or because it was the only thing available?” Camp explained. “If I had a refrigerator full of salads and I chose the hamburger, then we have a better idea.”

Ed published some of this work in a recent article here Identifying forage populations of concern: A new perspective based on predator recruitment considerations. The research found that forage fish consumed by recruiting predators has an effect on predator populations and that the diets of these recruiting predators can be different from overall predator diets. The work also found that many monitored forage species show declining trends in abundance even though most of these species are not commercially targeted.

Since completing his postdoctoral work, Dr. Camp has transitioned his experience to a career as an Assistant Professor at the University of Florida where he is an applied, interdisciplinary, and quantitative scientists working to promote desirable outcomes in fisheries and aquatic systems. His current research focuses on interconnected ecological, socioeconomic, and governance dynamics influencing markets and ecosystem function. Is interested in working with management organizations to develop new approaches to governing fisheries through development of quantitative techniques to better evaluate actions affecting marine systems.

Meaghan Faletti- University of South Florida
Meaghan was one of the first recipients awarded the Forage Fish Research Program (FFRP) fellowships in 2017 while completing her MS in marine science at University of South Florida. Her graduate research shed new light on the population dynamics of pinfish in the Gulf of Mexico by examining traces of carbon and nitrogen isotopes within their eyeballs. Pinfish are the most abundant forage fish species in the Gulf's seagrass beds where they represent a primary prey item for game fish such as tarpon, snook, snappers, and several grouper species. Pinfish are also a key contributor to healthy seagrass ecosystems through grazing and enrichment.

Meaghan's fellowship research focused on four Gulf estuaries: Charlotte Harbor, Big Bend, Tampa Bay, and Apalachicola Bay and she was able to document where pinfish spawn, their movements in and out of the estuary environments, and whether similarities between pinfish behavior in differing estuaries existed.

A publication of Meaghan's work can be found here Population dynamics of Pinfish in the eastern Gulf of Mexico (1998-2016)
This publication was requested by Dr. Matt Johnson, Chief, Fisheries Ecology Branch SEFSC of NOAA Fisheries to include in NOAA's Climate Vulnerability Analysis for Gulf of Mexico species. This was an important milestone for the FFRP's main goal – to have our fellow's peer-reviewed publications inform and improve understanding of forage fish and ecosystem-based fishery management.

Following her graduate studies, Meaghan transitioned here work into a career with the United States Geological Survey where she is an information specialist at the St. Petersburg Coastal and Marine Science Center. She now facilitates communication among partner organizations, stakeholders, and resource managers to encourage collaborative research and problem-solving.