Greetings, Friends!

This edition of WaterWorks continues the theme of graduate students, past, present and future. Last January we featured the successes of just a few of our past graduates. Here we highlight the research of four current and recent graduate students, whose work is directly relevant to Florida, yet has national and international utility.

The adage of "think globally, act locally" might not strictly apply to our programs. Our students and faculty are acting both locally and globally and not just thinking about the bigger picture.

Kristen Dahl’s doctoral dissertation and Tim Lyons’ master’s thesis address different aspects of the invasive lionfish problem plaguing Florida waters, the entire Gulf of Mexico, the Caribbean, and Atlantic waters of the Eastern U.S. Yet these fishes originate in reef systems on the other side of the world, where explosive population growth and massive range expansions are not part of their ecology.

Katie Lohr’s doctoral dissertation addresses the opposite kind of problem. What can be done to restore declining coral reefs in Florida, regionally and globally? Katie’s work has ranged from the reef tract of the Florida Keys to Australia’s Great Barrier Reef and has garnered national recognition.

Kate Harriger Holcomb’s master’s thesis addresses the scientific information needed to manage small, cryptic freshwater fishes that are often among the species listed as endangered, threatened, or of special concern. While Kate’s work on the Harlequin Darter is specific to rivers in the Florida Panhandle, her methodology has relevance throughout the nation and abroad.

The section featuring Global Gators might give you some idea of the geographic reach of our faculty, which inspires students to delve into Florida problems with a national and international context. But, you might ask, “What about students not yet in graduate school?” The many accolades on pages 8 through 10 should reassure you that quality education and student projects will continue long into the future...as well as some quality fishing!

Please enjoy this edition of WaterWorks and feel free to give us your feedback.

All the Best,

Bill
Ecology and Mitigation of Invasion Lionfish in the Northern Gulf of Mexico

Kristen Dahl (Graduate Advisor: Will Patterson)

Non-native plants and animals introduced to areas outside of their historic natural ranges may become biological invaders. Invasive species, which are defined as non-native species that adversely affect occupied habitats, have become an emerging environmental issue in recent decades, not only in Florida, but globally, where they threaten biodiversity, economies, and human health. Florida is home to an unusually high number of invasive species, with notable examples including hydrilla (Hydrilla verticillata), island apple snail (Pomacea maculata), Cuban treefrog (Osteopilus septentrionalis), Burmese python (Python molurus bivittatus), and Indo-Pacific red lionfish (Pterois volitans).

Invasive Indo-Pacific red lionfish were first observed off the east coast of Florida three decades ago and have since spread throughout the temperate and tropical western Atlantic, arriving in the northern Gulf of Mexico (nGOM) in 2010. Lionfish are believed to be the most successful invasive marine fish on record, due in part to their biology (e.g., venomous spines, fast growth, early maturity), feeding ecology (e.g., generalists, novel behaviors), and a lack of biotic resistance from native communities (e.g., no effective native predators, few competitors). Furthermore, their broad environmental tolerances to extremes of temperature, salinity, and depth are reflected in the variety of habitats they inhabit. I began studying nGOM lionfish populations off the Florida Panhandle in 2013, research I conduct as a part of the UF FAS Marine Fisheries Laboratory. My dissertation research seeks to understand the ecological implications of lionfish on native nGOM reef fish communities, as well as examine potential means to mitigate negative impacts.

A long-term monitoring project of reef fish communities among natural and artificial reefs across the nGOM shelf has allowed tracking of the lionfish invasion progression through time and monitoring of changes in native communities (Fig. 1). Unchecked population growth has led to lionfish densities that can be more than an order of magnitude higher than in their native range, especially on artificial reefs where densities are currently 8x to >10x higher than mean densities reported from across the Caribbean. Community structure analysis on nGOM artificial reefs has shown substantial declines in reef fishes, especially small demersal reef fishes (e.g., damselfishes, cardinalfishes, blennies, gobies), as well as species richness since lionfish have become established.

Traditional diet analysis and DNA barcoding, which is used to identify species based on a section of a mitochondrial gene, confirmed that nGOM lionfish are generalists and consume an impressive diversity of native fishes and invertebrates. Overall, DNA barcoding proved to be an approach to identify partially digested fish prey, resolving 83% of unidentified prey fish and adding a substantial amount of new information to our understanding of lionfish diet. DNA barcoding results also indicated potential cannibalism among lionfish, which was confirmed via follow-up genotyping of individual fish and prey items that barcoded as lionfish juveniles.

Lastly, I have been conducting research to determine the efficacy and frequency of lionfish removals necessary to mitigate negative impacts. In a targeted lionfish removal experiment over a two-year period, divers removed 1,575 individual lionfish from 17 reefs off Pensacola, including over 500 adults and juveniles that recruited to previously cleared reefs. Sustained removals limited lionfish densities temporarily but were too infrequent to keep numbers below thresholds predicted to mitigate negative effects. Results of the removal experiment and diet analyses suggest there may be considerable adult movement to colonize new habitats. Overall, my dissertation research has added to our knowledge of lionfish population dynamics and feeding ecology, as well as informed managers as to best practices for lionfish mitigation.
Research to benefit the conservation of Harlequin Darters in northwest Florida

Kate Harriger Holcomb (Graduate Advisor: Mike Allen)

The Harlequin Darter *Etheostoma histrio* is a small, cryptic freshwater fish found only in the Escambia River watershed in Florida. They rely heavily on in-stream wood for food, cover, and probably spawning (Figure 1). The species’ biology makes it well-adapted to woody habitat; it is perfectly camouflaged and its over-sized pectoral fins allow it to move around woody structure like a squirrel (Figure 2). The Harlequin Darter has been listed as either threatened or a species of special concern in Florida since 1977 due to its restricted range and infrequent historical collections. In 2013 The Florida Fish and Wildlife Conservation Commission (FWC) developed a Species Action Plan (http://myfwc.com/media/2738831/Harlequin-Darter-Species-Action-Plan-Final-Draft.pdf) for this species with the main goal to determine its population status in Florida. However, large-scale population estimates can be costly and time-consuming endeavors, and it is difficult to sample small, cryptic Harlequin Darters in complex woody habitat using traditional sampling gear like seins and backpack electrofishing.

FWC biologists realized that a unique methodology would be necessary to estimate the population size of Harlequin Darters over a large scale, so I designed a thesis project to address this need. Specifically, my objectives were to (1) determine how darter abundance and in-stream wood were related at sampled sites, and (2) to use this relationship to extrapolate darter abundance stream-wide. I felt there was as a strong positive relationship between the amount of wood and Harlequin Darter abundance, so I thought this relationship would allow me to predict darter abundance at an unsampled site if I knew how much wood was there. I estimated abundance of darters via visual snorkel surveys in two creeks (Figure 3; Figure 4) and quantified wood throughout both creeks using side scan sonar technology and a Geographic Information System. I then used a statistical model to determine the relationship between the number of wood pieces and darter abundance at sampled sites. Finally, I used the empirical wood-darter relationship to predict darter abundance at unsampled sites to achieve stream-wide Harlequin Darter abundance estimates.

In the end, I found that there was indeed a positive relationship between wood and darter abundance in the two creeks (Figure 5), and Harlequin Darters were more abundant than previously thought. The estimated stream-wide abundance of Harlequin Darters was 7,238 individuals (95% credible interval = 5,746-9,220 individuals) in Big Escambia Creek and was 8,804 individuals (95% credible interval = 7,684-10,116 individuals) in Pine Barren Creek. These abundance estimates will provide biologists with a better idea of the status of Harlequin Darters in Florida.

This study also brings to light the importance of maintaining wood in the Escambia River for Harlequin Darters. Because more wood means more darters, removal of wood from the Escambia River watershed could potentially have negative effects on Harlequin Darter populations. This finding has implications for deadhead logging in northwest Florida rivers. However, it is still unclear which types of woody habitat (large vs. small wood or overlapping wood vs. single logs) are most important to Harlequin Darters. Further research to identify specific habitat needs for this species will help biologists identify potential threats and properly protect habitat to ensure persistence of Harlequin Darters in Florida.
Trait-Based Selection of Corals for Use in Reef Restoration

Katie Lohr (Graduate Advisor: Josh Patterson)

Coral reefs have declined globally over recent decades due to factors ranging from poor water quality to disease outbreaks and climate change. This threatens the key ecosystem services provided by coral reefs, including shoreline protection, habitat provision, and revenue from fishing and tourism. In response to coral reef decline, active coral restoration strategies have been developed. These strategies often involve collecting donor branches from healthy wild colonies and propagating them in ocean-based nurseries. Nursery-reared corals can then be outplanted to restore degraded reefs.

Although reef-scale improvements have been observed following active coral restoration, restored sites can also be characterized by high rates of outplant mortality due to factors like coral bleaching (a stress response to thermal extremes), storm damage, and algal competition. One strategy to improve success of restored populations is the selective use of coral genotypes known to possess stress-resistant traits. These traits might include high thermotolerance to avoid bleaching, high skeletal density to resist breakage, or fast growth rate to outcompete algae for limited space on reefs.

My research characterized phenotypes, including linear growth, branch formation, buoyant weight, and bleaching prevalence, among ten unique genotypes of the staghorn coral, Acropora cervicornis, in a nursery. Phenotypes were measured by divers underwater during eight study intervals spanning 13 months. Differences among genotypes were found for each of the traits assessed (Fig. 1). Furthermore, bleaching was found to significantly stunt colony growth.

Although it is critical to maintain high levels of genetic diversity in restored populations, even a slight increase in the number of robust genotypes used in restoration could enhance the ability of restored populations to withstand stressors and survive longer. However, the methods used to identify phenotype might not be easily applied by time- and resource-limited restoration practitioners and NGOs. To address this concern, I sought a more rapid method for reliably differentiating phenotype among corals. Metabolomic profiling is a molecular method that identifies the small chemical compounds (metabolites) used in metabolism and cell signaling. The makeup of metabolites within an organism (metabolome) is governed by both genetic and environmental effects, and has therefore been closely linked to phenotype in non-coral species. I aimed to determine whether the metabolite profiles of phenotypically different corals were also distinct. If these metabolite “fingerprints” vary predictably among corals of interest, they could someday be used to rapidly differentiate among corals with desirable phenotypes without sustained underwater measurements.

To assess variation in metabolite profiles, I selected three genotypes with unique traits: U25 (high bleaching, slow growth), U41 (moderate bleaching, fast growth), and U44 (low bleaching, moderate growth). Samples were clipped from colonies of each genotype, processed, and subjected to two metabolomic techniques. Both techniques revealed distinct metabolite profiles for the three genotypes examined (Fig. 2). These results support the idea that metabolomic profiling can become a key tool for studying phenotypic variation in corals. Improving our ability to identify coral genotypes with desirable traits can aid ongoing nursery and outplanting work, as well as new selective breeding and genetic banking efforts for threatened corals.

Partial least square discriminant analysis (PLS-DA) model comparing metabolomic profiles among three unique genotypes of A. cervicornis: U25 (red), U41 (green), and U44 (blue). The PLS-DA model revealed distinct clustering of metabolite profiles among genotypes. The amount of variance explained is shown in parentheses on each axis.
Invasion Risk Assessment of Lionfishes Imported into the US in the Aquarium Trade

Tim Lyon (Graduate Advisor: Jeff Hill)

My graduate research is focused on risk assessment of lionfishes, which are popular aquarium fish imported from the Indo-Pacific. The global trade in marine ornamental fishes supplies a broad diversity of species to hobbyists, and with it the potential that some of these fishes will be released into the environment. While few species associated with this pathway have established and spread, the lionfishes *Pterois volitans* and *P. miles* are notable exceptions. These successful marine invaders have spread throughout the western Atlantic and Gulf of Mexico in recent decades. Despite documented evidence of lionfish impacts on the species diversity, species abundance, and recruitment success of native fishes, little effort has been made to identify other lionfishes in the ornamental pathway that may present a similar invasion risk. Therefore, the scorpionfish subfamily Pteroinae, which contains the lionfishes, is an ideal group for proactive risk assessment because it meets the criteria of a documented pathway and shares common characteristics with the invasive lionfish complex.

Prior to identifying risk, my first research objective identified the availability and quality of literature in the context of invasion ecology, how our understanding of an invader changes temporally across the invasion process, and its implications for proactive management. Overall, lionfishes that do not exhibit invasion history are poorly understood. This is a trend that is characteristic of species invasions and demonstrated in the invasive lionfish complex, where research effort is not expended until an invader has already become widespread with perceived negative impacts.

Given the importance of propagule pressure (the size, number, and timing of discreet introduction events) in predicting invasion success, my second objective characterized the US trade of ornamental lionfishes by identifying the volume and diversity of lionfishes in trade, the spatial distribution of lionfish availability during import, and further along the supply chain at the retail level. My results suggest a lower diversity of lionfishes available to the public than previously thought, with just two species, *P. volitans* and *Dendrochirus zebra*, common in the trade (Fig. 2). The trade of lionfishes is low when compared to many other popular aquarium fishes. Despite very high trade volumes of these popular species, none have established outside of their native range. Conversely, lionfish have managed to establish with potentially limited propagule pressure, further highlighting the importance of invasive characteristics and invasion history as a predictor of success.

Once the diversity of trades species was identified, we used a semi-quantitative risk screening tool, the Aquatic Species Invasiveness Screening Kit (AS-ISK) to score the relative invasion risk of the other lionfishes in the pathway. Overall, we found just three species, *P. russelli*, *P. lunulata*, and *D. brachypterus*, that present moderate invasion risk. Given reduced trade and low invasion risk for most lionfishes, my research suggests a low overall risk associated with the trade of lionfishes. Future research should seek to address the diet, reproductive characteristics, and habitat use of these moderate risk species to improve the accuracy and scope of proactive risk management. Some studies suggest polyphyly in *Pterois* and potential hybridization among its largest-bodied members, which needs future clarification.

Eight species of *Pterois* (top) and *Dendrochirus* (bottom) lionfishes potentially imported into the US via the aquarium trade. Images collated with the permission of J. Randall.

Invasion risk assessment (AS-ISK) scoring for 14 species of lionfishes potentially imported into the US via the aquarium trade.
GLOBAL GATORS
Fisheries & Aquatic Sciences faculty are making waves across the world!

From Spain, to Mexico....

Dr. Don Behringer led international research and teaching trips to Trinidad, Grenada, Mexico, Cuba, Dominican Republic, and Spain this past spring and fall. Don earned the IFAS Mid-Career Travel award and an IFAS Global Fellows Award.

..to Kenya...

Dr. Rob Ahrens and Dr. Mike Allen led a UF/IFAS Fisheries Assessment workshop at Pwani University in Kalifi, Kenya in late July 2018. The workshop was organized by Rob and Mike along with Rob’s Ph.D. student, Isigi Kadagi. The workshop was funded by UF/IFAS, Pwani University, World Wildlife Fund-Kenya, the African Billfish Foundation, Guy Harvey, and the Scientific Committee on Oceanic Research. The 57 workshop participants come from 14 African Nations to learning quantitative methods in fisheries assessment.
...to Australia

Dr. Roy Yanong of the Tropical Aquaculture Laboratory was the invited keynote speaker at the Aquatic Animal Health Chapter of the Australian and New Zealand College of Veterinary Scientist conference in Gold Coast, Australia. Dr. Yanong gave three keynote lectures: CIA: Crime Investigation – Aquaculture; A matter of aquaculture security; and The Strain (and other diseases that just won’t die).

...to the Caribbean.

Dr. Joshua Patterson attended the Trinational Initiative for Marine Science and Conservation in the Gulf of Mexico and Western Caribbean. This workshop was created in 2007 to advance collaborative work on the marine resources shared by the US, Mexico, and Cuba in the Gulf of Mexico and Western Caribbean.

Dr. Kai Lorenzen, Charles Sidman (Florida Sea Grant) and Nancy Montes have been conducting studies on the socio-economic impacts and governance arrangements of pelagic fish aggregating devices in the Caribbean, funded by the Japan International Cooperation Agency (JICA).
Scout Felipe Quintana installs new dock at Millhopper

This April, Scout Felipe Quintana of Troop 454 completed his Eagle Scout project by completely renovating the handicap dock at the Millhopper ponds. Many special needs groups rely heavily on a handicap-accessible dock to fish. The project called for over 208 boards and $2236 in materials.

“I caught my first fish at Family Fishing days when I was 4 and plan to be a Marine Biologist when I am older,” said Felipe. “This combines both my interests and will provide a place where others can learn about aquatic life and have fun fishing.”

Veterans explore aquaculture careers at the Tropical Aquaculture Lab

Eric Cassiano at the Tropical Aquaculture Laboratory (TAL) in Ruskin, FL created a pilot program to connect Florida veterans with the aquaculture industry as a potential career after leaving the military. The vets visited two local fish farms, Golden Pond Tropicals and Norton’s Tampa Bay Fisheries (a part of Segret Farms). Faculty and staff at TAL plan to partner with the Hillsborough County Department of Economic Development to offer internship programs for veterans.
Awards

Faculty & Staff

Congratulations to Craig Watson, who was inducted into the Florida Tropical Fish Farms Association Hall of Fame.

Chuck Cichra received the Rich Cailteux Award from the Florida Chapter of the American Fisheries Society.

Shirley Baker won the Undergraduate Faculty Adviser/Mentor of the Year Award for CALS and all of UF.

Vince Lecours and Don Behringer both received the IFAS Global Fellows Award.

Congratulations to Josh Patterson SFRC’s FAS Faculty Member of the Year!

Carrie Schuman (Advisor: Shirley Baker) received a UF Graduate School Dissertation award which provides funding for Summer and Fall 2018.

Beverly Barnett (Advisor: Will Patterson) was awarded funding through the National Ocean Sciences Accelerator Mass Spectrometry (NOSAMS) graduate internship program.

Elizabeth Groover (Advisor: Matt DiMaggio) was awarded the 2017-2018 Outstanding Master’s Student of the Year award for FAS, along with student travel awards from UF Grad Student Council and the US Aquaculture Society.

Elizabeth Moreau (Advisor: Don Behringer) received funding from FILAMO to attend a workshop on Movement Ecology of Marine Organisms in South Africa.

Kathryn Lohr (Advisor: Josh Patterson) and Kristen Dahl (Advisor: Will Patterson), were co-winners of the FAS 2017-2018 Outstanding PhD student award.

Kristen Dahl (Advisor: Will Patterson), won a Best Student Paper award at the International Otolith Symposium in Keelung, Taiwan.

Students

Fall Seminar Series

The FAS Fall Seminar Series is officially underway! Seminars are Fridays, 3:30-4:30 in the Millhopper facility conference room, followed by a social.

Seminar coordinators: Ed Camp (edvcamp@ufl.edu) & Vince Lecours (vlecours@ufl.edu).

To view the full line-up, visit: bit.ly/2NmqzT
The 22nd Annual UF Fisheries and Aquatic Sciences/FWC Fishing Tournament at Cedar Key is in the books! We had a great event this year. We had a total of 12 boats participating.

Largest Redfish – Tim Jaskiewicz, 24.7 inches, out of Tim’s kayak! Tim is an undergraduate student in the Geomatics program, and this was his first year to join the tournament.

Largest Spotted Seatrout – Tucker Woodward, 20.2 inches with his father Larry and Andrew Gude on board M. Allen’s boat

Largest Mackerel – Dan Willis and Michael Morris, 25 inches.

Most Impressive Cooler – This prize is awarded to the boat with the most impressive total catch of qualifying game fish in this event (trout, Spanish mackerel, redfish, and cobia).

the Tanner brothers. These guys brought in six legal Spotted Seatrout and a limit of 45 Spanish Mackerel. Might be the most weight of sport fish ever brought in in 22 years.
Recent Publications By Our Faculty


