

For over 10 years my livelihood has been based on the ocean. As a charter captain, scuba instructor, scientist, and commercial fisherman, I've developed a deep and complex relationship with marine life. I see the ocean as an awe-inspiring bioenergetic system, as a wilderness I hope to preserve for future generations, and as a resource – a means from which I and many others support our families. While these worldviews can contradict each other, they share the same long-term goal – a robust, sustainable ecosystem. My career aims to advance this common goal, using **research**, **mentorship** and **education** to guide science-based use and conservation of marine and coastal environments.

As an undergraduate at the University of Florida (UF) I studied Zoology and Environmental Science (BSc. *Cum Laude*, GPA = 3.96, graduated 2009). Concomitantly, I volunteered over 500 hours with the American Red Cross Volunteer Lifesaving Corps, from whom I was awarded the Gerry Wilson Scholarship (\$1,000) for academic achievement and the Oetgen First Aid Award after training over 100 lifeguards. I also served as President of UF's *OceanAware* student organization for two years, during which I organized four student research field trips and three fundraisers that cumulatively raised over \$5,000. In 2009, I was the UF nominee for the Morris K. Udall Scholarship for leadership in environmental conflict resolution. Concurrently, I worked in Dr. Brian Silliman's community ecology lab for the opportunity to conduct primary research. In my first project, I assisted a postdoctoral researcher, Dr. John Griffin, examine potential top-down control by white- and black-clawed mud crabs, two salt marsh predators. Our results showed that agonistic behavior reduces the predation efficiency of both species. Subsequently, I helped design a long-term study of how the loss of the marsh grass, *Spartina alterniflora*, affects the erosion rates in a salt marsh. The final results showed unequivocal evidence that the presence of wetland plants reduces shoreline erosion and land loss, and the manuscript is currently in preparation for the *Proc. Roy. Soc. B*.

After graduating I sought practical experience working in the marine environment. For the next two years I worked in the Florida Keys as a deck mate and ecotour guide for Fury Catamarans, as a marine science instructor for Newfound Harbor Marine Science Laboratory, and as a part-time commercial spearfisher. These jobs afforded me the sea-time (720 days-at-sea), experience, knowledge, and opportunity to earn a US Coast Guard 100-ton Master Captain's License, become a scuba instructor, and, eventually, a captain on the 34' dive/fishing vessel, the *F/V Native Diver II*. For the last five years, I have seasonally apprenticed on the *Native Diver* under Captain Stephen Park, who has taught me the knowledge, leadership and attention to detail necessary to bear the full responsibility of captaining dive and fishing operations up to 35 miles offshore. Wishing to document the mentorship and lessons I was taught by Captain Park and others, I wrote and published the book series, *Professional Diver: A Practical Guide to the Sport Diving Industry* ([ASIN: B01KQQ84B4](#)), which reached #5 on the bestselling book lists in "Scuba" on Amazon.com.

Having a diverse background working in research, diving, charter and commercial fishing, I wanted to one day make an impact in marine science and management. First, I knew I needed more education and experience. In 2012, I completed AAUS Science Diver training and began work as a Biological Scientist for the Florida Fish and Wildlife Conservation Commission (FWC). My research focused on the East Coast Red Snapper Cooperative Research Project (ECRCRP), where I conducted research aboard commercial fishing vessels on 1-to-10-day long offshore trips. These data were used to develop models for the 2014 *Benchmark Stock Assessment for Red Snapper*. After the ECRCRP ended, I moved to the Turks and Caicos Islands (TCI) to work as a Research and Teaching Assistant for the School for Field Studies' Center for Marine Resource Studies (CMRS).

My research interests at CMRS focused on lionfish, the only invasive marine fish to successfully establish populations in the Western Atlantic. In the preceding three years I had witnessed lionfish invade the reefs where I worked and fished. I remember finding reefs with more

than 70 lionfish on them and visually observing changes in reef community structure. Around the same time, a suite of studies quantified with what I suspected: lionfish were driving large-scale declines in the abundance and diversity of native fish and invertebrate communities. The research I conducted at CMRS sought to facilitate lionfish control with limited resources. We used detection probability and population density estimates from distance sampling as a proxy to estimate spatial variations in detectability of lionfish and prioritize removal efforts. The TCI's Department of Environmental and Maritime Affairs used the baseline data for lionfish abundances and our methods for distance sampling were published in *Aquatic Conservation: Marine and Freshwater Ecosystems*.

My path back to UF began when I was selected to participate in the 2015 Recruitment Training and Research (RTR) workshop hosted by UF and the National Marine Fisheries Service (NMFS). During the 15-day workshop, I collaborated with professors, NMFS scientists, and seven other early-career ecologists to model ecosystem impacts of lionfish in the Gulf of Mexico (GoM). Using 30-year dynamic simulations, we evaluated how reef fish populations would respond to different management strategies for lionfish control and reef fish harvest. Our results demonstrated non-intuitive outcomes for some species due to food web interactions and how a combination of removal efforts and reef fish harvest policies would have the highest potential to mitigate lionfish impacts on GoM food webs and fisheries. I presented our research to a large, public audience at the 2015 *REEF Open House* in Key Largo, FL, and to marine scientists at the 2016 *Fisheries and Aquatic Sciences Symposium* in Gainesville, FL. Our manuscript is currently in review in *Fisheries*.

After long conversations regarding my interests for using field experiments, qualitative research, and modeling to examine ecosystem impacts and management strategies of developing a market-based fishery for lionfish, the Director of the RTR Program, Dr. Micheal Allen, offered me an opportunity to begin a PhD in Interdisciplinary Ecology at UF. I believe UF is uniquely suited for the research I proposed. As the land and sea grant university for the state that has been most impacted by lionfish, UF is charged with finding solutions to mitigate the threat that lionfish pose to Florida's environment and economy. Moreover, the quality and diversity of research at UF make it possible to conduct a multidisciplinary project at a single institution, where my research will be overseen by faculty who are experts in resource economics (Dr. Sherry Larkin), quantitative fisheries assessment (Dr. Rob Ahrens), marine ecology (Dr. Tom Frazer), and reef fish management (Dr. Will Patterson). With their guidance, I am investigating socioeconomic mechanisms and management regimes that could support a viable fishery and function as a long-term control for lionfish. Establishing a commercial fishery for a marine stock we are trying to overfish has never been attempted before and will need to be developed in close cooperation with stakeholders and fishermen.

With this approach in mind, much of my research in the past year has focused on working with commercial fishermen (note that 'fishermen' is gender neutral) in Florida and the U.S. Virgin Islands (USVI). In Florida, I conducted in-depth interviews with commercial lionfish harvesters to understand the socioeconomic drivers and barriers for harvesters to enter and remain in the fishery. I found significant regional differences in buyer demand and price of lionfish, and that growth of the fishery is constrained by small profit margins and the dangers of harvest via SCUBA at the depths where high densities are found (30-60 m). I presented my preliminary findings at the 2016 *North Florida Marine Science Symposium*, which earned the Best Graduate Student Presentation Award. Subsequently, I conducted surveys and interviews with commercial fishermen in the USVI. More than any other stakeholder group with whom I have worked, the fishermen there felt marginalized as Afro-Caribbean and Hispanic minorities and had a strong distrust of scientists. To illustrate, a 2012 NOAA study using similar methods surveyed only 11 fishermen because most declined to cooperate. By building relationships with them, however, I was able to survey over 75% of the

registered commercial fishermen (n=152). In time, they invited me into their homes and brought me offshore to dive and fish with them to understand their operations. I found the fishermen have strong concerns about the impacts of lionfish on their reefs and livelihoods, but previously had been largely unaware that lionfish could be sold or even eaten. Moving forward, this research will identify opportunities and needed support to facilitate participatory development of a lionfish fishery.

This is the type of cooperative **research** I plan to continue throughout my dissertation and career: working with stakeholders, scientists and policy makers. I've been encouraged by the recent recognition of others on the importance and timeliness of this research and approach. This year, I was awarded the 2016 Guy Harvey Scholarship for achievement in marine science research and an Honorable Mention from my first NSF GRFP submission. Additionally, I worked with two professors to secure a \$149,000 FWC contract that will support my research on detection, removal efficacy and community impacts of lionfish removals. Following my PhD, I plan to continue research for developing and evaluating cooperative management strategies that will help moderate competing stakeholder interests in marine fisheries. Understanding the interdependence and tradeoffs between human and ecological systems is vital for finding solutions to the global-scale issues facing marine resource management: i.e. habitat degradation, climate change, overfishing and food security.

In my career, I plan to serve as a professor at an R-1 university or a scientist for the FAO Committee on Fisheries or NMFS Sustainable Fisheries Division. As an FAO or NMFS scientist, I would also serve as an adjunct professor so that I can continue to teach and **mentor** students. I have stayed in touch with many students and know how fulfilling it is to help them develop as scientists. Of the undergraduates I advised at CMRS, Anela Akiona is starting her Master's at Univ. of HI, Alyssa Thornton is interning for the Applied Wildlife Conservation Lab, and Emily Stokes is now the Lionfish Outreach Coordinator at REEF. In the last year, I've served as an Instructor for the 2016 RTR Program and mentored three students at UF. I helped a sophomore, Matt Shinego, secure a paid internship with FWC and assisted a mentee and master's student, Justin Procopio, via a \$20,000 grant I was awarded from the *Conservation Fund*. Finally, I've worked intensively with a Kenyan PhD student, Isigi Kadagi, to develop her research plans and grant applications. This year, Isigi was awarded the 2016 Schlumberger Fellowship for female leaders in STEM from developing nations.

Education will continue to be a mainstay in my career. Working as a teacher in a diversity of roles (Fig. 1) has honed my ability to communicate my passion for ecology and management to all ages and backgrounds. In particular, I plan to use the breadth of my experience to cultivate engagement and train future leaders from black and Hispanic communities where fishing is a major source of food and income, but who remain grossly underrepresented in fisheries science and management. Throughout my career I plan to educate via three primary mediums: (1) in the classroom, by teaching undergraduate and graduate courses – along with developing K-12 curriculum that integrates cross-disciplinary approaches to natural resource management; (2) mass media, via popular writing, presentations, and videos to tell the fascinating, multi-faceted stories surrounding marine resource conflicts; and (3) stakeholder extension, by facilitating reciprocal learning between fishermen, scientists and managers. I believe the scope of my background has prepared me to understand and balance the broad complexities of marine resource management. As an NSF GRF, I look forward to forging a career where I continue to teach, collaborate-with, and learn-from the extensive diversity of people who depend on healthy marine ecosystems.



Figure 1: Timeline of educator positions, including work in tourism, dive instruction, K-12 education, professional development, and academia. *Years between UF.

Introduction. Indo-Pacific lionfish (*Pterois volitans* and *P. Miles*) have invaded and are now well established in the western Atlantic Ocean, the Caribbean Sea, and Gulf of Mexico¹. Recently, lionfish have been documented off Brazil² and in the Mediterranean Sea³. Invasive lionfish have shown to destabilize marine food webs¹ and drive large-scale declines of native fishes⁴. The direct and indirect effects of lionfish are predicted to combine synergistically with other anthropogenic stressors, especially overfishing and climate change, to reduce biodiversity and weaken the resilience of hard-bottom and coral reef ecosystems⁵. Developing strategies to control lionfish abundances and mitigate their impacts is now a top priority for marine management agencies and NGOs¹. Although localized removal efforts have been shown to reduce lionfish numbers and improve native fish abundances⁶, population linkages and a lack of resources continues to limit management efforts^{1,7}.

Lionfish are an excellent food fish, thus developing a market and commercial fishery may be a feasible method to control their abundances in many locations. A market-based harvest system may help mitigate impacts of lionfish; however, establishing a commercial fishery with the goal of overfishing a marine stock has never been attempted. Broadly, my research is investigating (1) if, how, and where a socioeconomically incentivized system of harvest might serve as a viable mechanism of control, and, (2) what harvest systems and management regimes will maximize the social, economic, and ecological benefits from a commercial lionfish fishery.

Objectives and Methods. This research will be accomplished in four components to study (1) lionfish detection and removal efficiency, (2) lionfish recolonization and reef community impacts, (3) socioeconomic viability for a lionfish fishery, and (4) location-specific feasibility and ecosystem impacts for local lionfish fisheries. While these projects inform and build off one another, they are designed to be modular and allow for potential adaptation.

Project 1 is being conducted in partnership with REEF to examine how time-strategic harvest will effect detection and removal efficiency for lionfish. Preliminary data that I collected show estimates of mean lionfish densities are on average 2.6X greater during crepuscular periods than daytime periods (Fig. 1). The final results will examine (1) differences in detection based on time of harvest and (2) how time-of-day and depth can be used to optimize harvest efficiency.

Project 2 will assess the efficacy of lionfish removals on 27 refugia reefs (artificial reef structures with locations unreported to public) with high densities of lionfish in the northern Gulf of Mexico (GoM). Pre-removal surveys have been conducted in October 2016 with a VideoRay Pro4 ROV and analyzed to estimate lionfish density and reef fish community structure. Lionfish will subsequently be removed from 3 sites within 3 larger reef groups. All sites will be monitored for one year using ROVs for all reefs and divers for a subset of reefs. The results will examine (1) detection between ROVs and divers, (2) rate and spatial patterns for lionfish recolonization, and (3) reef fish community restructuring following lionfish removal and recolonization.

Project 3 is being conducted through a NOAA-funded cooperative study by UF and Emory University to assess the socioeconomic viability of a commercial lionfish fishery in the U.S. Virgin Islands (USVI). My role in this project has focused on working directly with commercial fishermen. Currently, I am analyzing data from 152 questionnaires and 13 extended interviews that were conducted summer of 2016. My analysis will identify factors that determine the likelihood that fishermen have caught and sold – and will catch and sell – lionfish, based on fishing gear, perceptions of lionfish and markets, and socioeconomic factors. These findings will be compared with responses

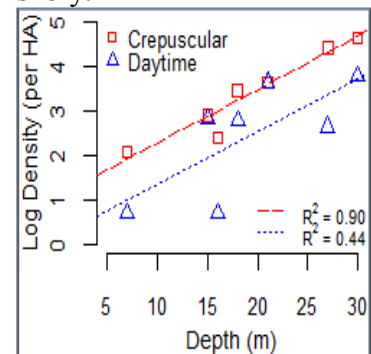


Figure 1: Densities for lionfish at 7 natural reef sites increase exponentially with depth. Detection differed significantly based on diel period (ANCOVA, $p = 0.03$, $F = 6.70$).

from Florida commercial lionfish harvesters to examine willingness for commercial fishermen to enter the fishery based on location, fishing gears, perceived abundance, and market price for lionfish.

Finally, project 4 will synthesize the data collected in the first three field projects to develop an integrative framework for assessing economic thresholds and ecosystem impacts of a market-based lionfish fishery. The analysis will incorporate information for removal efficiency, reef community response, market price, and willingness to fish to update Ecopath with Ecosim (EwE) models used to monitor and manage GoM fish stocks⁸. Using new parameters for lionfish densities, recolonization dynamics, and market/logistical feasibility the EwE model will be used to identify and evaluate possible locations, incentive systems, and management strategies based on the potential to maximize economically viability, control of lionfish abundances, and ecosystem benefits.

Intellectual Merit. Although marine invasive species can have profound ecological and economic impacts, understanding the patterns of invasion in marine systems has lagged far behind terrestrial and freshwater systems. Upper trophic level, vertebrate invasive species are rare in marine systems and lionfish research presents opportunities to better describe the mechanisms underlying invasion ecology and assess how a mesopredator release restructures marine food webs. Specifically, this research will describe and evaluate detection, harvest efficiency, and recolonization patterns for lionfish – along with reef community restructuring and resilience – to help inform reef fish ecology and management. Moreover, the incorporation of social and economic systems into ecosystem modeling offers opportunities to discover and evaluate innovative solutions for natural resource management. Through a cross-disciplinary application of systems ecology, fisheries anthropology, and resource economics, this research is examining socioeconomic mechanisms, policy scenarios and reef community impacts for novel strategies of invasive species control and cooperative fisheries management. The analyses, results and models from this research will be presented via peer-reviewed journals (e.g. *Ecol. Appl.*, *Fisheries*), fisheries advisories councils (GoM, South Atlantic, and Caribbean), regional conferences (*Amer. Fisheries Soc.*), and international conferences (*GCFI*).

Broader Impacts. Because of high larval connectivity and the range of the lionfish invasion, international cooperation will be necessary to suppress lionfish densities^{1,7}. This research facilitates collaboration among scientists working in in the Caribbean, South, and Central America – many of whom are underfunded with respect to research. For marine resource managers, our outcomes offer wide-scale applications for increasing the efficiency of lionfish control efforts, particularly in data-poor regions. The results will assist financially-strapped resource managers with information on how to optimize removal efforts, identify economic opportunities, and assist the development for a cooperatively managed commercial fishery. Specifically, this research actively engages commercial fishermen – many from black and Hispanic communities who often feel ignored by scientists and managers – to **directly participate** in the research and management for a commercial lionfish fishery.

Ultimately, this research seeks to better equip managers, non-profits, stakeholders, activist groups, and commercial fishermen with practical information to facilitate long-term control of lionfish densities and mitigate their effects on commercially and ecologically important reef species. To disseminate key findings, I will develop **workshops, seminars, and videos** for managers and commercial fishers. To produce, implement, and share these educational products, I intend to leverage my connections with the Sea Grant extension network, research intuitions abroad (e.g. CMRS, Univ. of Virgin Islands), resource management agencies (NOAA, DEMA, FWC), the seafood industry (Wild Fish Direct, Lionfish Atlantic), and NGOs (REEF, SEALEG, Reef Savers, and CORE).

Works Cited. 1. Morris, J.A. *GCFI: Spec. Pub.* (2012). 2. Ferreira C. et al. *PLoS One* (2015). 3. Bariche M. et al. *Medet. Mar. Sci.* (2013). 4. Green, S. et al. *PLoS One* (2012). 5. Albins M. & Hixon M. *Environ. Biol. Fishes* (2013). 6. Green, S. et al. *Ecol. Appl.* (2014). 7. Johnston M. & Purkis S. *MEPS*. (2015). 8. Chagaris D. et al. *Mar. Coast. Fish.* (2015).

Intellectual Merit Criterion

Overall Assessment of Intellectual Merit

Excellent

Explanation to Applicant

The proposed work was well thought out and is interesting. The intellectual merit ties well to the broader impacts. well done. The research is interesting.

Broader Impacts Criterion

Overall Assessment of Broader Impacts

Excellent

Explanation to Applicant

The proposed work will likely have high impact. The applicant has critical thought about the problem and created a plan that will likely result in change.

Summary Comments

The applicant has a good GPA (above 3.5). The broader impacts and intellectual merit of this study warrant funding.

Intellectual Merit Criterion

Overall Assessment of Intellectual Merit

Excellent

Explanation to Applicant

Candidate has unique background and perspective. The socio-ecological approach will allow for a broader understanding of the issues driving lion fish distribution and persistence and will have broad applications as this species continues to spread. The personal statement and project statement are well integrated. The note regarding the integration but independence of the components is interesting and illustrates an understanding that success of one does not hinge on the other, but rather broadens impacts

Broader Impacts Criterion

Overall Assessment of Broader Impacts

Excellent

Explanation to Applicant

As is indicated by his letters of support he is self driven and passionate about sharing his knowledge with the scientific community, stakeholders in the field, and the community as a whole. It is surprising that the outreach efforts are not more well developed within the project description.

Summary Comments

Strong candidate and project with likelihood of successful outcome and broad impacts. The broader impacts application lacked detail.

Intellectual Merit Criterion

Overall Assessment of Intellectual Merit

Excellent

Explanation to Applicant

The applicant has a history of research studying lionfish. He has been involved with state and federal agencies, private organizations, and academic institutions. He has received several grants to fund research related to his GRFP and has made several presentations and has several papers in the works on the research topic. He has developed population modeling skills. The specific research focuses on working with local fisheries to develop a lionfish market to reduce the numbers of the invasive species. By incorporating economic drivers and working with commercial fisheries, the applicant hopes to control this mesopredator.

Broader Impacts Criterion

Overall Assessment of Broader Impacts

Excellent

Explanation to Applicant

His extensive background working in marine systems in a variety of roles lends itself to outreach. The goal is to work with Caribbean islanders and Central Americans who are involved in the fishing industry to help address the issue of the invasive lionfish. Workshops, seminars, and videos will be provided to these stakeholders through Sea Grant extension network.

Summary Comments

The applicant has an interdisciplinary blend of ecology, economics, and marine/fisheries science to address a specific problem, i.e., controlling lionfish invasion. The project involves a diverse group of stakeholders and a variety of socio-economic/ecological models to understand the system. There are several diverse questions which represent a significant body of work.