Practical solutions to the invasion of lionfish in Utila, Honduras: science, education, food, and jewelry

Carolyn Corley
University of San Diego

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Practical solutions to the invasion of lionfish in Utila, Honduras: science, education, food, and jewelry

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Carolyn Corley
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Abstract

Lionfish (*Pterois* sp.) are invasive species capable of devastating coral reef ecosystems due to their lack of predators, large appetites, generalist diet, high fecundity, and rapid spawning rates. As lionfish have expanded their distribution across the Caribbean, many conservation groups have taken it upon themselves to systematically remove these predators from environments where they are threatening native species. However, few have involved the community the way I observed while interning with the Whale Shark and Oceanic Research Center in Utila, Honduras. Protecting coral reefs is extremely important, especially in small communities like Utila, where the majority of people’s livelihoods depend on diving tourism. In my project, I examined the different steps in the lionfish abatement efforts in Utila, how different community members are involved throughout this process, and what challenges they are facing. This process included educating the public on the negative impacts of these species, certifying divers to hunt them, hunting for the lionfish, and bringing them back to a lab for dissection and data collection. Hunting for conservation allows the community to use the collected fish to create economic opportunities while still helping preserve the reefs. By continuing to increase efforts to educate members of the community and allowing different groups to benefit from increasing lionfish removal efforts, Utila will be able to better control the threat they pose to reefs. Using Utila as a case study, it is my goal that this model of community involvement can be replicated in other tropical regions where lionfish are invasive.
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Introduction

The idea of having to kill an animal for conservation may sound counterintuitive, but in the case of invasive species removal, examples of this are happening in many different regions of the world. An invasive species is an organism introduced to an environment it is not native to that has the potential to cause harm to the environment, other organisms, the economy, or to human health. Due to this potential for harm, once a species has been introduced conservationists may try to remove it from an environment so it is not able to spread too quickly. One key example of this is the lionfish, a type of venomous scorpionfish that is native to the Indo-Pacific but now can be found throughout the Caribbean and Atlantic. These species are able to reproduce very quickly and will eat almost anything they can fit into their large gaping mouths, which make them a major threat to coral reef ecosystems because they will consume important native species, such as grazers that prevent algae from overgrowing and taking over the reefs. Past studies in Turks and Caicos and Curacao have suggested that regular lionfish removal efforts by divers lead to a reduction in lionfish abundance and an increase in both diversity and density of native fish species around reefs (Peiffer et al. 2017 and Henly 2017).

Other locations in the Caribbean also have been impacted by lionfish including the island of Utila, Honduras. Utila is one of the Bay Islands off the eastern coast of Honduras and it is one of many places currently taking part in lionfish removal efforts, led by an NGO called the Whale Shark and Oceanic Research Center (https://www.wsorc.org/). I have been fortunate enough to spend the last two summers living and working in Utila in a multitude of marine conservation projects including the invasive species removal of lionfish. Their approach to this project and how they are trying to educate and involve both dive tourists and locals in it from the early removal stages to cleaning up and using all parts of the fish after they have been killed is so
unique. This is why it is such a perfect place to do a case study on invasive species removal and involving community members in conservation.

It is also a great place for a case study on lionfish and their impacts on reefs because of how important the coral reefs are to nearly every person who lives in Utila. Almost all business on the island depends on the thousands of divers that visit annually to scuba dive on the pristine reefs surrounding the island, and without this tourism, the majority of the year-round residents would be out of a job. Other than economic dependence, it is important to protect coral reefs in Utila and all over the world because they are some of the most biodiverse ecosystems on the planet, are an important nursery habitat for juvenile fish, protect shorelines from damage from waves and storms, as well as many other benefits. The National Oceanic and Atmospheric Administration (NOAA) predicts that over 1 billion people around the world depend on coral reefs for food, income, or protection (NOAA Office for Coral Management 2023). While lionfish are far from the only thing impacting reefs in the Atlantic or Caribbean, they are one of many threats and removing them is one small action divers can take that may ultimately have a large impact.
1. What is a Lionfish?

Lionfish (*Pterois sp.*) are a species of carnivorous fish native to the Indo-Pacific. These fish are known for their beautiful red/maroon and white striped coloration and fan-like fins, making them very popular for aquariums, however they are top predators, wicked competitors with other species for space and food and have painful poisonous spines, causing them to be very difficult to manage. There are 12 known species of lionfish but the two most commonly encountered ones are the red lionfish (*Pterois volitans*) and the devil firefish or common lionfish (*Pterois miles*) (NOAA 2022).

**Biology/ Reproduction**

Scorpionfishes, or *Scorpaenidae*, are a family of mostly marine bony fish that contains most of the world’s venomous fish species, including the lionfish (Santhanam, 2019). Many people who have heard of lionfish, know them for their venomous spines. There is a common misconception that these spines are deadly to humans, and while this is not true, they can be quite painful and if they puncture deep enough, or the penetration occurs at a deep depth while scuba diving, it could lead to a hospital visit. There are a total of 18 venomous spines on each lionfish, 13 located on the dorsal fin, 3 in front of the anal fin, and 1 on each pectoral fin (Fig. 1) (Hatter et al. 2014).

One of the factors that make lionfish extremely successful invaders is their ability to reproduce quickly. They become sexually mature at just 1 year old and can breed all year round. Lionfish have an extremely high fecundity, laying anywhere from 1,800 to 41,945 eggs as often as every 2 to 4 days (Gardner et al. 2015). They have a unique way of reproducing in which the females release two gelatinous egg masses, containing thousands of eggs each that then float to
the surface where they are fertilized by male lionfish (Mostowy et al. 2020).

**Figure 1.** Lionfish anatomy and location of venomous spines (Hatter et al. 2014).

**Diet**

Lionfish are generalist and will eat almost any species of fish, crustacean, and invertebrates they find in their environment. The only limitation to what they eat is the gape width and height (NOAA 2016). A study in the Flower Garden Banks National Marine Sanctuary in the Gulf of Mexico found over 100 different prey species in the gut content of lionfish collected in just this region (Drinnen 2016). This includes commercially and
ecologically important species including species of shrimp, parrotfish and snappers. The wide range of prey species is another factor that makes them such effective invaders, as they are rarely limited by food source. They are capable of expanding their stomachs up to 30 times from their normal size to allow them to eat more (Drinnen 2016).

**Habitat/ Range**

Lionfish are mostly found in warm, tropical marine waters, however, previous studies have found that they have a wide thermal tolerance, and can withstand temperatures ranging from 13 to 32°C (Dabruzzi et al. 2017) and depths from 1 to 300 feet (NOAA 2022). This wide range of suitable environments gives them an ecological advantage to species that cannot withstand changes in ocean temperature or other conditions. This advantage has allowed them to successfully invade many regions across the world. While they were originally native only to the Indo-Pacific, lionfish can now be found throughout the Caribbean Sea, Gulf of Mexico, Atlantic, and Mediterranean Sea (Fig. 2). Their density varies greatly in these regions and they tend to have a high site fidelity meaning that if the environment they are born in is suitable, they rarely leave it (Andradi-Brown 2014).
**Figure 2.** Map of where lionfish can be found today. Red is the native region of *P. miles*, blue is the native region of *P. volitans*, and purple is the native region for both species. Green represents the regions where lionfish have invaded (Cayman Islands Department of Environment 2020).

**Invasion History**

Pamela J. Schofield, a scientist at the US Geological Survey and Florida Integrated Science Center, reported the extent and history of the lionfish invasion in a 2009 report (Schofield 2009). The first reported sighting of lionfish off the east coast of the United States was in October 1985 around Dania, Florida. Throughout the mid 1990s and early 2000s there were many reported sightings along the east coast, however there were not any reports in the Florida Keys until years later in January of 2009. The first lionfish were spotted in the Bahamas in Nassau and by 2005, they had spread to nearly every island and they are believed to have a
similar source to those found on the eastern coast of Florida. From 2005-2009 they continued to spread throughout the Caribbean and Gulf of Mexico, with reported sightings in Turk and Caicos, the Cayman Islands, Cuba, Jamaica, the Dominican Republic, Puerto Rico, Mexico, and Costa Rica. In May of 2009, the first known lionfish in Honduras was caught approximately 200 m from the Roatan shore in 7 m of water. By the end of that summer (August 2009), there were 17 additional reported sightings off the coast of Roatan and 4 off of Utila (Schofield 2009). Because lionfish are such a popular aquarium fish but so difficult to care for, the leading hypothesis on how lionfish were originally introduced to these non-native environments is that aquarium owners dumped their unwanted fish into the ocean.

**Containment/Removal**

Due to the dangerous impact of lionfish on reef communities, many conservation agencies and divers are working to remove them from ecosystems where they have invaded. Currently, the most effective and safest containment method is through hunting and spearing individual lionfish using a Hawaiian sling. Widespread containment efforts are currently being undertaken by many NGOs, most noticeably REEF in the Florida Keys ([https://www.reef.org/programs/invasive-species-program](https://www.reef.org/programs/invasive-species-program)). Due to this methodology of containment, it is unreasonable to think that lionfish can be completely removed, however the goal of containment efforts isn't to eradicate lionfish but rather to suppress the populations. Removal has proven to be successful in decreasing lionfish populations and increasing the abundance of native reef species. In Honduras, sites with regular removal 2-3 times a month have been found to have 30% higher densities and higher diversity of native prey-sized fishes.
and 20 times lower lionfish biomass than sites with no removal efforts (Peiffer et al. 2017 and Henly 2017).

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[https://doi.org/10.3391/ai.2009.4.3.5](https://doi.org/10.3391/ai.2009.4.3.5)


2. History and the Community of Utila, Honduras

Location and Geography

Utila is one of the Bay Islands along with Roatán and Guanaja and is located off the coast of Honduras at the southern end of the Mesoamerican Barrier Reef, the second largest reef system in the world (Fig. 3). These islands are each formed by above water peaks of the Bonacca Ridge, an underwater mountain range. The tropical climate causes it to be very humid, and very hot in the summers and rainy for much of the year but especially in October and November. The air temperature usually ranges from 25 °C to 29 °C, while the water temperature ranges from 26 °C to 30 °C in the summer, making it a great place for diving throughout the year (Wreck Hunters 2020).

Utila is the smallest of the three islands, with an area of only 17 square miles and it is most well known as one of the best and most affordable places in the world for diving. In the past, it was considered the “Whale Shark Capital of the Caribbean” as it was one of the few places where whale shark sightings were reported every month of the year, but in recent years sightings of these gentle giants have greatly decreased. The reefs surrounding the island are made up of two main types: barrier and fringing, meaning most of the popular dive sites are a wall of reefs slightly offshore, with some breaks and canals that boats are able to travel through. The variation of reef structures around the island are one of the attractions that make it so popular for tourists, especially along the southern shore where the walls are wide and sloping, making them a great place for beginner divers or professional training. In addition to the reefs, there are many bays and harbors located around the entire island, which provide areas for recreation and shallow vessels to anchor (Currin 2002).
Figure 3. Map of the Bay Islands off the coast of the mainland of Honduras. Utila is the smallest of the 3 islands, located closest to the mainland (Hillman 2017).

**History**

Over time, Utila has been home to 6 distinct groups: the Spaniards, buccaneers, English, English-descended Antilleans, African-descended Antilleans, and Native North Americans, leading to the diverse population and unique culture seen there today (Currin 2002). Christopher Columbus and the Spanish colonizers arrived in Utila in the early 1500s, but the earliest inhabitants were the Pre-Columbian Paya Indians who were believed to be there as early as 600 AD. They originally lived in the Utila Cays, a group of small islands off the southwest coast of Utila, and then moved to the main island. In the mid 1500s the English, French and Dutch realized that the Bay Islands were a strategic location for looting Spanish vessels which led to the growth of a pirate settlement of the islands and pirates remained present on the island for over a
century. Much of their influence can still be seen in the tourist culture on the island today, with a dive shop called Captain Morgan’s, and restaurants called Skid Row and Buccaneers. The Spanish and the British fought over the islands constantly from the 1630s till the mid 1800s, and in 1852 the Bay Islands were annexed to Great Britain. However in 1850, it was ceded to and officially became a part of Honduras at which point different socioeconomic and racial groups on the island began to separate. In the early 1900s, the main industries were agriculture, fishing, and coconuts, but by the 1940s the maritime and tourism industries began to grow and quickly became the main source of income for most of the island community (Currin 2002).

**Local Community**

The island is mostly uninhabited except for a small fishing village in the East Harbour and the tourist sector along the main road on the south side of the island. The population of Utila is only about 4,160 according to a census in 2015 (Census Bureau Data), however this only includes year-round residents and not the high number of tourists that visit throughout the year. The population is very diverse due to the wide range of people that have inhabited the island in the past. The locals are known for their openness and hospitality, and many visitors have reported feeling “at home there immediately”, a sentiment I can personally relate to, and many visitors end up staying for years to work at one of the many dive shops there. The main language spoken on the island is English, despite the main language on the mainland being Spanish, however many of the locals speak both languages. Most of the locals work in the tourism sector working at dive shops, restaurants, and stores.
Tourism and Diving

The largest industries on the island are tourism and diving. In a 2013 census approximately 183,000 international tourists were reported to have visited the island (Sustainable Travel International 2013). Utila has been a popular destination for backpackers, sailors, and fishermen and other adventure seekers since the 1940s-1950s, but increased dramatically with the growth of SCUBA diving in the 1970s. In the early 1980s the first three dive schools were established on the island, followed quickly by three new hotels (Currin 2002). Today there are 16 dive shops on the island specializing in everything from “fun” diving, teaching beginners, training instructors, and even technical diving. Most of these are linked to a hotel or resort and restaurant so vacationers are able to easily plan an all inclusive dive vacation (Utila Guide 2023).

Figure 4. A map of all the marked dive sites around Utila (Utila Cays Diving).
References


3. Intersections between NGOs and Diver Removal Efforts

*Hunting methodology*

Many of the dive shops on the island hunt for lionfish and most of them use a similar methodology to do so. For the sake of this report, I will be focusing on the Bay Islands College of Diving (BICD) because this is the dive shop where I studied. The first step for divers hoping to help control Utila’s lionfish populations is to learn how to effectively and safely search and hunt for them, which starts by getting certified by the Bay Islands Conservation Association (BICA). BICA is one of the NGOs on the island, whose mission is:

“To conserve in a participatory, transparent and sustainable way the coastal marine resources and the ecosystem services which they provide for the social and cultural well-being of present and future generations in the Bay Islands.” (BICA website)

Another NGO on the island is the Whale Shark and Oceanic Research Center (WSORC), who partners with BICA to train and certify their monthly marine conservation interns to hunt for lionfish. The certification tools are provided by BICA and the course is offered monthly and taught by WORC staff for their interns and any other divers that want to participate.

The certification process starts with a short presentation on what a lionfish is, why they are bad for reefs, and tips on how to properly hunt for them without causing damage to the reef or injuring yourself. Next students will practice loading and releasing the Hawaiian slings out of the water, trying to release it with enough strength and aim that it will stick into a wooden post. Once this has been mastered, it is time to practice in the water and with a moving target. For me
this meant trying to spear potatoes and onions thrown into the water by our instructor. Once each student has successfully speared a few of the suspended vegetables, they will be cleared by their instructor to receive the BICA certification and participate in their first removal dives.

Figure 5. A copy of my BICA lionfish hunting certification card front and back.
After receiving their certification, they receive a Hawaiian sling and certification card from BICA and they can participate in lionfish hunts. At BICD lionfish hunts happen approximately every other week, however only in good weather conditions. This is led by the WSORC staff, and the monthly marine conservation interns always participate as part of their internship experience, then any additional spots on the boats are available for other certified staff and guest divers at BICD. Lionfish removal dives typically take place at unmarked dive sites off the southside of the island referred to as the “sea mounds” because these sites have less diver traffic and typically more lionfish are found there than at frequently visited sites. During two morning dives, groups of 4-8 divers are dropped off at different spots around the sea mounds to complete a 45 minute drift dive, meaning the will not return to the drop off spot, but instead will deploy a surface marker buoy so the boat driver is able to spot and pick them up once their dive time has ended. While underwater, divers will typically descend anywhere from 15 to 30 m searching for lionfish. When a lionfish is spotted, the diver will alert the group by banging on their metal tank, then attempt to get a kill shot using their Hawaiian sling. If the lionfish is successfully killed, the spearing diver will signal to the diver carrying the Zookeeper, a plastic cylinder container used to hold the lionfish during the dive, and the fish will be transferred from the spear to the Zookeeper. Once returning to the boat, all fish are moved from the Zookeeper to an ice chest where they will be kept until the afternoon when the WSORC interns dissect and collect data on all the lionfish gathered that morning.
**Figure 6.** Collected lionfish are stored in an ice chest on the boat until returning to lab to be dissected. (Photo Credit: Carolyn Corley)

In the WSORC lab, each lionfish is labeled, weighed, and the standard length (mouth to start of caudal fin), and total length (mouth to tip of caudal fin) are measured. Each of these measurements are hand recorded by the Research Assistant for the month. After that the poisonous spines are removed and set aside for later use, and each fish is dissected to determine its sex and developmental stage. Finally the stomach is removed and the stomach contents are recorded to the lowest identifiable taxonomic classification. Once all of this data has been collected, the fish are fileted and distributed between the interns and the Utila Lodge to be used for food.
Figure 7. June 2022 marine conservation interns completing a lionfish dissection while I record the data for the WSORC lionfish database. (Photo Credit: Carolyn Corley)
Diver Survey Data

During my second summer in Honduras, I surveyed many of the divers on their knowledge of lionfish and involvement in the containment efforts. The majority of divers surveyed were divemaster trainees (DMTs) or higher, 24 of the 29 of survey participants were current or past marine conservation interns at WSORC, and 26 out of the 29 participants were certified by BICA to hunt lionfish. When asked to rank their knowledge of the lionfish invasion in Utila on a scale of 1 to 5, all participants answered with a 2 or higher, with the majority responding that their level or knowledge was a 4 (37.5%) or 5 (50%). When asked about their motivations for hunting lionfish 100% (n = 29) of participants reported conservation as a reason they are motivated, while only 13 participants said they were motivated by enjoyment/ fun of spearfishing, and only 12 said because lionfish were a food source for themselves or other.

Lionfish Derby

One fun way for the entire island community to get involved in lionfish removal is through Lionfish Derbies, which used to be an annual event, before COVID. Each year BICA hosts this event in partnership with many of the dive shops and restaurants around the island. Teams of 4 divers (3 hunters and 1 spotter) from many of the island’s dive shops compete with each other to catch the most lionfish, the smallest lionfish, and the largest one. Winning teams earn prizes and bragging rights which is a very coveted prize on a small island where practically everyone knows each other. After the morning dives, the caught lionfish are given to the participating restaurants who compete to make the best lionfish dish voted on by the public.
Figure 8. One of the BICA plaques given to the team that caught the most lionfish during the 2013 Utila Lionfish Derby. These plaques are displayed proudly in many of the dive shops on the island. (Photo Credit: Rebecca Sockwell)

References

https://bicainc.org/

https://rebeccaonthego.wordpress.com/2013/11/04/utilas-lion-fish-derby/

https://www.wsorc.org/
4. Using the Whole Fish: from ceviche to jewelry!

While removing this species must be done in order to protect the reef, discarding collected fish once the dissection data has been collected would be extremely wasteful. In efforts to be more sustainable, different groups on the island are using the meat of the fish as a food source and using the beautifully patterned fins to make jewelry adding an extra source of income for the women living in the Utila Cays.

*Lionfish on the menu*

One strategy to increase awareness and hunting efforts is to encourage people to include lionfish as part of their diet. The phrase “Save the Reef, Eat a Lionfish” has become so common in Utila, that it was even printed on shirts and posters (Fig. 9) for the “Save the Swampers Festival”, one of the largest events on the island, aimed at raising money to protect the islands endemic iguana species. One of the past WSORC marine conservation interns even made a lionfish cookbook for her personal internship project. When interning for WSORC, one of the first lectures is about lionfish and we were encouraged to try lionfish and ask restaurants owners for it, even if it did not appear on the menu, as it is the most sustainable option for consuming fish, which is a large part of the diet for most locals and tourist in the Bay Islands.
Figure 9. One of the posters for last year’s Save the Swampers festival, depicting an iguana eating a lionfish to help save the reef. (Artist: Michelle Cerrato)

Because lionfish are not fished the same way as most other fish species, there is often not a consistent supply so restaurants must be creative in how they use and market it. Some restaurants on the island only serve it on occasion including the Utila Lodge, which is partnered with BICD and WSORC. After their biweekly lionfish hunts, BICD and WSORC divers supply the Lodge with the lionfish for their “lionfish special”. This included everything from lionfish sandwiches and tacos to ceviche and is always a treat for interns and vacationers.

Only one restaurant on the island, Mister Buddha’s, has lionfish on its everyday menu in the form of a sushi roll they call the “Invasor Roll”, translating in English to the “Invader Roll” (Fig. 10). They are able to do this because they have a partnership with a diver who hunts for
lionfish each day and supplies everything he catches to the restaurant free of charge. Mister Buddha’s is one of the nicer and more expensive restaurants on the island, so they know the majority of their customers are foreign travelers. The majority of people visiting Utila are divers, who tend to be passionate about ocean conservation, which is why marketing lionfish this way is such an effective strategy.

Figure 10. Sign up in Mister Buddah’s restaurant advertising their “Invasor Roll” using the slogan, “Save the Reef, Eat a Lionfish!!” (Photo Credit: Carolyn Corley)

If serving lionfish at the island’s restaurants were to become a more common practice it could help the biodiversity of the reefs surrounding Utila in a number of ways, the first of which
is the direct impact of removing lionfish that I have described in previous chapters. Secondly, by choosing to eat lionfish in place of other popular seafood in Utila such as lobster, conch, snappers, and groups, the consumer is choosing a more sustainable option and decreasing the demand for these other ecologically important and threatened or endangered species, which are often overfished and fished illegally. Ideally lionfish would be a regular item in everyone's diet and included regularly on the menu at many of the island’s restaurants, however there are a number of challenges that make this difficult to accomplish which I will discuss in the next chapter.

_Fins to fashion_

Kanahau is the third NGO on the island, and they have recently joined forces with their fellow NGOs, WSORC and BICA, in helping with lionfish removal efforts. However, unlike the others, Kanahu’s contribution to this project comes after the fish have already been hunted and dissected. One of the distinguishing characteristics of lionfish are their beautifully colored and striped fins. In the past these fins have been discarded after the fish are fileted, but starting in early 2022, WSORC began donating fins to its partner NGO, who teach a lionfish-jewelry making course to woman in living in the Utila Cays on how to convert these beautiful fins into jewelry such as the necklace below (Fig. 11). This jewelry has been sold at the island’s annual Valentine’s Day Market, New Year’s Festival, and Save the Swamper Festival, along with many other events, providing the perfect opportunity to educate tourist about the impact of lionfish on the reef while providing them with a unique souvenir to bring home, and providing the locals and extra source of income.
Figure 11. One example of a necklace made using lionfish fins from fish collected by WSORC interns and then donated to Kanahua. (Photo Credit: WSORC Instagram page)

References


https://www.kanahau.org/
5. Challenges and Solutions

*Restaurants & Education*

As described in the last chapter, encouraging restaurants to serve lionfish could be a promising step towards increasing the awareness of the danger of lionfish and increasing the amount of effort put into removing them. However, a lack of communication between scientists/divers and restaurant owners has made it so many restaurants do not have the knowledge or ability to serve it to their customers.

During my second summer in Utila, the research assistant for WSORC, Michelle Cerrato, and I interviewed employees and managers of 30 different restaurants on the island to gauge their level of knowledge about lionfish and ask whether they served it. Of the people interviewed, 28 out of 30 claimed to be familiar with lionfish but only 21 knew why people were encouraged to eat them. Of these restaurants, only 4 serve lionfish at their restaurant, 3 (10% all interviewed restaurants) of which serve it weekly or biweekly, and 1 (3.3% of all restaurants) that has it on their menu daily. Almost all remaining restaurant representatives said they did not know where to get it from. Other problems that were reported as to why lionfish could not be served included that it is too expensive, the supply is too inconsistent, and that they think the meat of the fish was poisonous. This was a common misconception we encountered on the island, however only external spines are venomous. Venom glands are located on two grooves of the spine (NOAA 2016) and have no way of entering the lionfish internally, so once the spines have been removed there is no way for the meat of the fish to be contaminated by it.

In order to make lionfish meat more accessible to these restaurant owners, a similar model to that of the Utila Lodge (bi-weekly lionfish specials) or of Mister Buddha’s (consistent supply from a diver for daily menu) could be followed. If each dive shop on the island could
partner with one or more restaurants and give them their caught lionfish free of charge or at a lower price than commercial fish species, this could help to make consuming lionfish a more regular part of tourists and locals diets and increase the amount of efforts put into removing this species, leading to an overall healthier reef.

**Science**

Collecting data on the size, abundance, and distribution of lionfish is an important step to understanding how effective removal efforts are, which can lead to changes in how removal efforts are handled by scientists and governments in the future. For example, the government could fund projects to develop new ways of hunting lionfish that are more effective than individual divers or could provide incentives to fishermen to hunt for lionfish as opposed to other important species. In Utila there are 11 dive shops, of which at least 8 participate in lionfish removal dives, but currently BICD is the only one that performs dissections or collects any type of data on the fish they are removing.

Another issue within WSORC’s database that has been and is currently being improved is the standardization of data. The internship program at WSORC is 1 month and small island life isn’t the easiest and wages are low so their staff has a high turnover rate which means the data collection over the years has not always been consistent. Over the past couple of years the staff has worked on coming up with a standardized list of protocols for dissections and what to look for when determining the sex or developmental stage which has helped this process. Since there is only 2-3 years of usable data, there is not enough to determine if there are any yearly trends or changes.
The shark problem

One problem that has arisen between the two summers I spent in Utila studying lionfish is the growing aggression of the resident nurse shark population during lionfish hunts. Nurse sharks (Ginglymostoma cirratum) are a species of carpet shark known for their relatively docile nature when compared to other shark species (Smith et al. 2014). They are suction feeders whose diet consist of benthic invertebrates and small fish (Motta et al. 2008).

In many regions around the world including Utila, people have thought one solution to improving the lionfish problem is to train sharks to eat them by feeding them the lionfish they’ve caught. However, this has not had the intended effect, as the sharks have now learned to follow divers. During my first summer in Honduras in July of 2021, I participated in 3 lionfish removal dives and did not have a nurse shark encounter during any of them. In summer 2022, I participated in 4 lionfish removal dives, and we encountered anywhere from 1 to 3 nurse sharks during each dive, all of them coming within a few feet of divers within our group and 2 out of the 4 times taking lionfish directly from our Hawaiian slings or zookeeper. While many of the dive shops on the island have found this change exciting due to the increase in nurse shark sightings, it is in reading aggressive behavior in sharks that could lead to divers or sharks being injured. To help solve this problem, dive shops participating in lionfish removal dives must be educated on this danger and all efforts to feed lionfish to the resident nurse shark population must be immediately stopped.
**Figure 12.** In this image, a nurse shark is circling around my dive instructor, Gaby, during our safety stop, trying to score itself a free meal from the zookeeper in her hand while she gently pushes it away with her fins.

**Figure 13.** (left) Nurse sharks typically keep their distance away from divers, however this one came within inches of the diver taking the video in an effort to take a lionfish from the zookeeper seen on the left side of the photos.
References


Conclusion

Through my 2 years of working in Utila I grew a lot as a scientist and a diver. If someone had told me before then that I would be writing my honors thesis on hunting as a form of conservation, I would not have believed them. However, as I have learned, sometimes killing one species that is not supposed to be in a region is a necessary step to protect the native wildlife and prevent the ecosystem from collapsing. The lionfish is one example of this and by removing them from the reef we are giving native tropical fish species the chance to continue living there and the reefs a better chance of survival. Additionally, through the combined efforts of the NGOs on the island- WSORC, BICA, and Kanahu- the invasive species removal of lionfish on the island is not only an educational activity for tourists, but it is helping local business grow and develop. By giving many different groups in the community ownership in the removal efforts, it is my hope that everyone on the island will have the opportunity to be educated about the threat lionfish pose to reefs and what they can do to be a part of the solution.
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