Traditional Fishing Folk's Knowledge on Costa Rica's Southern Caribbean Coast: A Critical Component in a Formula for Lionfish Reducction

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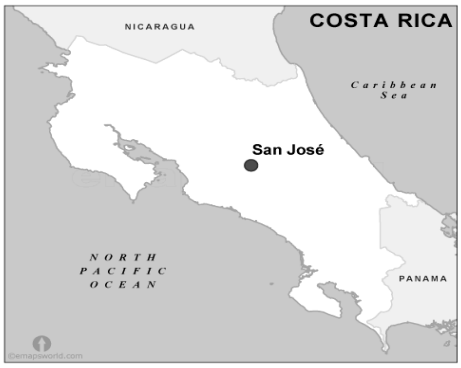
Introduction

The artisanal fishing community on Costa Rica's Southern Caribbean coastline has learned to protect its marine ecosystems while developing an artisanal fishing livelihood based on the traditional knowledge that has characterized the area historically. This has been the case since 1750, when the first non-indigenous fishing folk arrived there from Panama's Caribbean coast, from small Caribbean islands and from the Nicaraguan Atlantic coast.

Initially they would create temporary settlements during the fishing months from March to September, but in 1828 the first permanent settlers established themselves in the region. These settlers were



Afro-Caribbean fishermen who came mostly from Panamá and Jamaica, some with their families, while others partnered with Bribri and Cabécar indigenous women who lived in the Talamanca highlands. Fishing turtle to sell in Bocas del Toro in Panamá was their main livelihood while they also developed subsistence agriculture and fishing for their food ("Fishers of Turtle", n.d.). The coastal marine ecosystems of the Southern Caribbean where they fish include coral reefs, tidal flats, coastal lagoons, mangroves, and sea grass communities that contain a vast diversity of marine life, in an area of some 12,800 km of ocean.

At the end of the 1970s, two Protected Marine Areas were declared in the region by the government as part of its conservation policy: Cahuita and Gandoca Manzanillo (Hoyt, 2005). Artisanal fishing has continued in the region with strong restrictions being imposed in the protected areas and weaker restrictions being imposed in non-protected

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areas. The region's fishing communities have been organized under the auspices of the *Association de Pescadores Artesanales Caribe Sur* (ASOpacs - Association of Artisanal fishing folk of the Southern Caribbean Coast – hereafter referred to as the "Association") since 2011 to "protect local artisanal fisheries, improve local living conditions and livelihoods, and establish collective decision-making in the fishing community.

The Lionfish (*Pterois volitans*, and *Pterois miles)* is a small predatory reef fish, with bold red, white, creamy or black bands, pectoral fins and spiky venomous spines (Pterois, n.d.). It was originally was restricted in its distribution to Indo-Pacific waters, but was discovered in the Southern Caribbean region in 2009 by fishermen in the area, who immediately reported it to local and national authorities. In the face a potentially devastating invasion of its marine ecosystems by this dangerous predator, the Association has adopted a holistic approach for reducing its numbers.

The effects of Lionfish on the marine ecosystems of the Southern Caribbean are currently being studied by the Association, principally by tapping into the traditional knowledge of local fishing folk with the goals of collecting data on the Lionfish for scientific studies, gathering the stories of the fishing folk, proposing relevant policy changes to deal with the damage inflicted by this invasive species, and mobilizing the fishing folk to take steps to control the predator themselves. After all, they are the population that is on the frontlines of the invasion. Local natural resource agencies have had to rely primarily on local knowledge, thus reinforcing the importance of local communities and their traditional knowledge in conservation. The fishing folk's organization is showcasing how traditional knowledge is relevant to the protection of marine life, to the maintenance of the livelihood of the community, to the promotion of ethical and sustainable science and to the formulation of renewed policy making about the protection of marine ecosystems.

Traditional knowledge is defined in this study as the knowledge that is constructed by human beings in "interactive observation" with other forms of life in their day to day lived experiences in their quest to live life to its fullest. The phrase coined to describe this in the Southern Caribbean has become a motto: *pura vida* (pure life). *Pura vida*, however, is more than just a motto. It is an active concept, not just the descriptive noun that many newcomers to the area might think it is. In this case study, "traditional knowledge" relates to the knowledge that has emerged historically in a community that has had fishing as one of its main livelihood strategies. Fishing folk's interactive observation with the rest of nature has provided a wealth of knowledge that has been critical historically and is critical today in the interaction between protection of the environment and protection of people´s livelihoods, showing that it is possible to achieve an equilibrium among all forms of life.

This case study documents how the Association is tapping into its members' traditional knowledges and practices to reduce the population of lionfish and

simultaneously establish a local lionfish export fishery to complement more traditional revenues generated through lobster and red snapper sales, while protecting native fish stocks and influencing policy making regarding invasive species in protected areas.

New emerging issue faced by the fishing community

Fishing on the Caribbean Coast of Costa Rica has been largely based on "sustainable fishing", which to the Association means protecting the coastal marine environment that provides their livelihoods, while at the same time creating better social conditions for their communities. These communities traditionally use many fishing methods including, but not restricted to, spears, hooks, loglines, diving, traps and gillnets. This is contrary to what has happened on the Pacific Coast of the country, for example, where industrial commercial boats and methods, such as bottom trawling, have emerged, almost extinguishing artisanal fishing and definitely impacting marine life in destructive ways. Bottom trawling does not discriminate in its catch and it kills marine life at a rate that does not allow for it to reproduce according to its own natural cycles.

Sustainable fishing has not been easy to maintain in the Southern Caribbean. Conflicts regarding policy have emerged. One example is turtle fishing, a main source of income for fishing folk, which has been banned since 1977 when the laws that created National Parks came into effect with provisions for the protection of endangered species and more recently, Law No.8325 enacted in 2002 for the Protection, Conservation and Recovery of Populations of Marine Turtles. Resistance to those measures did not last long, however, probably because fishing folk had always developed diverse ways of fishing for a diversity of species. During the times of the year when they cannot fish due to weather conditions or the "*vedas*" (fishing bans) for the protection of the reproduction of lobster, they combine fishing with growing crops, construction and more recently conducting eco-tourism boat trips. Another conflict has arisen because the government has not provided a subsidy to the fishing folk of the Caribbean in the same way that is has for fishing folk on the Pacific coast. This is something that the Association is trying to change by demanding equal treatment.

The most recent challenge, however, comes from the Lionfish which is spreading massively on the Caribbean and Atlantic coasts of Central America because it has no predator in this region. According to marine biologists (Hixon, 2011), there is now a higher larger density of Lionfish in the Atlantic Ocean than there is in its place of origin in the Indo Pacific region. A study by Arrieta (2013) in Puerto Viejo and Punta Mona in 2010 examined the Lionfish as part of the structure of the community of fish in the coral reefs. In the findings, the Lionfish appears as one of the 10 most common species. Another survey conducted by Sandel (2011) of the catch of Lionfish in the Cahuita National Park and the Gandoca Manzanillo Natural Reserve found that there were an average of 92 Lionfish fish per hectare, with

Manzanillo having the highest density of Lionfish at 161,5 ± 217,6.

Rafael Hernández, a local fisherman in Punta Uva explained how he was first to report the invasion to national authorities and scientists in June 2009 (Personal interview, 2015). Although fishing folk did not have Internet access at that time to learn more about the Lionfish, they realized early on that this was a foreign species, because they knew their ecosystems from first-hand lifelong experience. Hernández is in his forties and has fished almost every coral reef in the area since he was a child. The strange animal (Lionfish), which looks like seaweed when its camouflage blends into the coral reef, did not fool him when he saw it.

Another experience was related by his younger brother Andres Hernández who, upon realizing that he was looking at one of the fish his brother had reported seeing, went ahead to catch it with his spear and then used both hands to bring it to shore. The stings from the venomous spikes of the Lionfish were so bad that he had to take an ambulance to the local clinic to treat the resulting respiratory problems and swelling which lasted for days. This story sounded the alert for the entire fishing community who in turn began doing their own research and calling attention to the problems posed by the new invader for their ecosystem, their livelihoods and their health.

An early example of the link between traditional knowledge and "good science"

That same year, a fisherman by the name of Jose Ugalde Sr. asked me to show him a weathercast on the computer. He wanted to see if computer technology could help him to figure how weather changes might be having an impact on his fishing and his livelihood (J. Ugalde, personal interview, 2012). I showed him and he was in awe at what he saw on the screen. The weather forecast for the day was correct. "How does it (the computer) know?" Don Jose asked. I explained that there were people placing the information on the computer, people like him who learn through their interaction with the rest of nature, but also people who learn about the weather by studying the issue scientifically in laboratories and through mathematical projections.

"Are they fishermen?" Don Jose asked me**.** He wanted to know how those people behind the computers knew about the weather. I explained to him that there are many ways of knowing about the weather. "Some have learned it through the study of the weather and climate of the planet and others from practical experience as you learned from your parents and grandparents, which is the oldest way of producing knowledge."

Almost immediately we engaged in a conversation about climate change, concluding that nowadays it is almost impossible to predict the weather, which is one of the reasons why the fishermen wanted access to computers to try to figure out what is going on. With climate change, the weather has changed so much that as a fisherman he felt he could no longer figure out for sure whether to go out in his boat on a given clear day or not. More than once had Don Jose and I gone fishing only to be caught in strong winds and high waves in his small boat.

Local fishing folk rely on "signs" from the sky when looking south to tell them if the day is going to be clear or rainy. They also 'read' the winds which, when they shift to come form the Talamanca mountains instead from the ocean as they usually do, indicate that bad winds are soon to come. They interpret shifts in the rocking of their boats as well, so that when they rock sideways instead of front to back and back to front, they know that high waves are soon to come. All of these signs have been passed from one generation to the next through years of interactive observation. But today, a red sky at night is not necessarily a sailor's delight as the saying goes. The atmosphere is warmer and it can cause a red glow under new conditions that are not necessarily linked to good weather the next day. Changes in climate – whatever their origins - are bringing about weather patterns that are hard to predict, even with traditional interactive knowledge.

The main thing I learned from this interaction is not to underestimate fishing folk's ways of knowing, because although they might need adjustment in new emerging situations, their traditional science has much to teach academic science in creating a "good science", that is a more sustainable and equitable science, to confront crises such as climate change and the invasion of Lionfish in the Caribbean (Suárez Toro, 2008). The respect for nature is something deeply ingrained in elder fishing folk in particular, who have historically made their livelihood off fishing. Since that experience, Don Jose and I have become members of ASOpacs – the Association of Artisanal fishing folk of the Southern Caribbean Coast, which is combining sources of knowledge to face the new challenges.

Another person who understands a deep connection and respect for nature is Doña Grace Jiménez, a member of the board of the Association. Together with her husband Don Jose Ugalde Sr., she has raised six children by combining fishing with agriculture and construction labor. Doña Grace believes that the rest of nature has to be respected, not only biologically but in its "secrets", something that too often academic scientists overlook, thinking that humankind can control everything. "Nature cannot be fully comprehended, it has its secrets, pretty much like the secrets we keep to protect ourselves and our knowledge from being abused. We can know nature, but with respect", she said (Grace Jiménez, personal interview, 2013). The way that nature responds to changes through adaption and adjustment is a process that "hard" academic science has not yet figured out. For example, biologists today know that biodiversity helps nature protect itself from the impact of climate change, but they do not know exactly how that happens (Brigitte Baptiste in Viera, 2011). This is one of nature's secrets that science has not been able to unravel.

Organized fishing folk's knowledge: a critical component in strategies for coastal conservation

The presence of an organized fishing community on the Southern Caribbean of Costa Rica has been a critical component for success in tackling new challenges that have emerged due to the Lionfish invasion. As

part of a campaign initiated in 2012, the Association has embarked on two projects that have already shown the effectiveness of its strategies based on traditional knowledge in joint initiatives with government, academic bodies, social organizations and other institutions. One project was begun in 2013 under the title "Control of the Lionfish and Conservation of Marine Life in Costa Rica's Southern Caribbean" sponsored by the Small Donations Fund of the United Nations Development Program (UNDP), and the other project was begun in 2014 under the title "Improving the Quality of Life of fishing folk in the Southern Caribbean" sponsored by the Inter American Foundation (IAF).

These two projects share four objectives: 1) to contribute to the reduction of the invasive population by implementing diverse methods of catching Lionfish; 2) to promote the creation of an inter-institutional network of collaborators in limiting the threat from the Lionfish; 3) to generate a scientific data base about the Lionfish; and 4) to conduct a campaign in the local communities about the threat of the Lionfish and, since Lionfish is good to eat, the need to become 'Lionfish predators' that is, to consume and market Lionfish as a strategy to reduce its numbers.

To date the Association has been the only social organization to mobilize communities on the Southern Caribbean coast of Costa Rica to face this challenge. The context for this mobilization is well described in a recent community initiative ("Why a special law…", 2014):

> The Southern Caribbean is comprised of an historical experience that extends back more than 100 years when the first immigrants to the area arrived from Jamaica and other countries north and south of Costa Rica along the Atlantic Coast. They were fishermen who built their homes along the beach for convenience, as fishing was their main source of livelihood. In the surrounding forests, they cultivated crops of food for their livelihood and to sell, as in the case of cacao and coconut production. They developed a sustainable family-based economy that recognized from the beginning the importance of living in harmony with the environment. This vision, based on a balanced relationship or co-existence with nature, was a primary resource of all social, economic and human development. The people themselves with little government intervention have used this development model for decades in the region, which is still characterized largely by a family-based economy with micro-tourism enterprises combined in many cases with sustainable agriculture and/or fishing or artisanry. The model is designed to protect and balance the rights of the people and the environment, which in the past led to creation of a number of special environmental reserves that today require a policy where co-management can contribute to co-existence between peoples and environment in unprecedented ways.

The necessity to further develop co-management strategies for the protection of the seas has been made even more evident by the fishing folk's proposals to reduce the Lionfish population, which takes into account the fact that the invasive species does not respect borderlines and frontiers between protected areas of ocean and places where fishing folk can catch Lionfish with no restrictions.

The Association claims that in order to be successful in eradicating the Lionfish, they have to be able to seek them out, even in restricted areas where some kinds of fishing are prohibited by law. Contradictory conditions often emerge in the zones between areas under special protection and unprotected areas. Sandoval Hernandez and Castillo Chinchilla (2011) believe that "the presence of large unprotected areas and the distance that surround protected areas and the distance between one protected area to the next can reduce the exchange between species…" (p. 25). For this and other reasons, it has long been recognized that the protection of the seas is generally weak. "The administration of marine coastal area in Costa Rica has been a conflictive area throughout the last decade, particularly the complaints by the environmental sector about overexploitation of fisheries, the lack of environmental policies and policies about the use of marine resources." (State of the Nation Report, 2013)

Created in 1982, Cahuita National Park hosts a 600-acre (242-hectare) that is known to have at least 35 species of coral, 140 species of mollusks, 44 species of crustaceans, and 123 species of fish ("Cahuita National Park," n.d.). The land areas of the park are home to many types of animals, including the northern tamandua (anteater), pacas, white-nosed coatis, raccoon, sloth, agoutis, mantled howler monkey, and the white-faced monkey. It has a variety of birds as well, including the green ibis, green-and-rufous kingfisher and keel-billed toucan. The Gandoca Manzanillo Wildlife Refuge (REGAMA) includes 10,900 marine acres (4,436 hectares) in which there are five types of coral reefs (The Green Iguana Foundation, n.d.). These formations contain a wide variety of plant and animal species not found elsewhere, including 11 types of sea sponges**,** 27 species of algae**,** and 34 species of mollusks, which have been identified so far. The beaches from Monkey Point in Manzanillo south to the mouth of the Sixaola River are sites for four types of sea turtles, all of which are endangered, including the leatherback and green hawksbill**.**
All protected areas are mainly legislated by the Law of Biodiversity and the Environmental Law and administered by the National System of Conservation Areas or SINAC (*Sistema Nacional de Areas de Conservacion*--SINAC), created in 1994 as part of the Ministry of Environment and Energy (MINAE, n.d.) This Agency administers national parks, conservation areas, and other protected natural areas. Most fishing is banned in the protected areas except for purposes of research, training and ecotourism).

Non-protected areas of ocean are regulated by the Instituto Costarricense de Pesca y Acuicultura (INCOPESCA), under Law no. 7384 of 16/1994 which allows for

artisan (small scale coastal), commercial, sports, touristic, scientific and promotional fishing. Its few protective measures cannot be adequately supervised, opening way for over-exploitation by commercial fishing. A large proportion of the fishing in the Southern Caribbean seas, however, is "responsible fishing," meaning on a small-scale and does not involve the use of large-scale *pesca de arrastre* (trawling) nor the use of *trasmayo* (gillnet) fishing (in contrast to large-scale commercial fishing in the Pacific). (MINAE, n.d.)

The presence of Lionfish and methodologies for its removal require a holistic approach where fishing needs to occur in both protected and non-protected areas of the ocean in the specific case of invasive species. The Association has made put forward this argument precisely because while the protected areas often include special coral reefs, these same coral reefs are also the preferred habitat of the Lionfish. Héctor MacDonald Sr., a fisherman, member of the Association and coordinator of one of the projects for Lionfish removal said that "one of the problems we face in our efforts to reduce the species is the lack of adequate regulation about Lionfish removal in the protected areas in the Southern Caribbean" (H. MacDonald, personal interview, 2013.) A 2013 study by graduate students at the University of Costa Rica, entitled "Analysis of environmental and fishing norms in Costa Rica and recommendations about the control of Lionfish" (Calderón & Morales, 2013) presented evidence to support this argument.

The Association has been devising, advocating and implementing multiple strategies for the control of the Lionfish. A multi-strategy approach is fundamental to their vision, because their practice as fishing folk has always been based on multiple approaches instead of single interventions. Their results thus far indicate the crucial importance of the active participation of the local population, along with their traditional knowledges and practices.

Drawing from traditional knowledge: multiple methodologies to catch the Lionfish

The Association has put into place a holistic campaign to roll back the Lionfish invasion on the Caribbean coast, demonstrating that a plan with multiple strategies works better as a whole, than does any one single method alone. They are therefore implementing a battery of strategies which range from fishing Lionfish one by one with hooks and spears, to organizing community Lionfish fishing contests involving many fishing folk working together, to the use of "*nasas*" (traps) and more recently, to training youth in scuba diving with tanks in order to spear Lionfish in deeper waters than snorkeling allows.

Furthermore, involving all sectors of the community has enhanced the success of the venture. Traditionally these fishing folk have seen themselves as part of whole communities, therefore, when they design actions to face challenges, they always do so alongside the rest of their communities. Because the Association is comprised of people who are members of the coastal communities themselves, and because the Association's policy and practice have been

in the hands of these same fishing folk, it has been "natural" for the rest of their communities to get involved. "Organic" community actions have brought together fishing folk, their families, local restaurants, male and female vendors, chefs, traditional cooks, schools and government institutions in concerted efforts to face the new challenge. These efforts have contributed to "build community" around the emerging threat of the Lionfish and have contributed to the development of a new consciousness about the links between environmental protection and livelihoods.

Traditional lobster traps to catch Lionfish: bettering lives, bettering the catch

Among the strategies for catching Lionfish advocated by the Association is the use of a lobster trap. In this way, the Association has successfully revitalized a traditional fishing method, which has proven to be one of the most effective methods to capture the Lionfish. This is due to the fact that the traps can be placed in deeper waters than those reached by diving, the fact that many fish can be caught in one trap, and the fact that traps can be left at the bottom of the sea without the need for human presence as the fish are attracted and captured. Also, the fish remain alive until removed from the trap, either to throw back (those that are not Lionfish) or to take back fresh, be it for eating or selling.

Early in the debates by members of the Association as to the best methods to catch the Lionfish, many proposed the use of their traditional traps. But the rising cost of the materials needed to make these devices (chicken wire, wood sticks and tying cord) had diminished their use. On the basis of this local knowledge and experience, one of the first tasks that the Association took on was to locate sources of funding to be able to provide fishing folk with the materials to make the traps. The Association was able to garner enough resources to develop a pilot project involving 19 members of the organization, each of whom received the necessary materials to make the traps to catch both Lionfish and lobster. Each participant signed a written agreement which allowed them to keep the lobster and other fish caught in these traps, but to give the Lionfish to the organization. This agreement allowed the Association to accumulate enough Lionfish to develop a marketing campaign for the fish to consumers, which in turn would motivate fishing folk to continue catching the invasive species.

This arrangement is a good example of the potential success of cooperation when livelihood and conservancy go hand in hand, because the methodology is a "win-win" situation for all, as both research and marketing for consumption further enhance the livelihood of the families while contributing to conservation efforts. "Pun", an elder who has been a fisherman since he was 12 years old, and one of the experts in building the traps said that this traditional form of fishing had become scarce in the area until the Association provided support to build them once again (Pun, personal interview, 2014). "Material for the traps has become really expensive and here in the Caribbean, we do not have the incentives and

support that fishermen get on the Pacific Coast by way of gasoline and a stipend during the times of fishing bans. The support for us to be able to make them again has improved our capacity to catch the Lionfish while improving our livelihoods with whatever else we catch, such as lobster and red snapper, etc."

Fishing Tournaments: building community through Lionfish hunting

Another successful strategy organized by the Association since 2012 is the annual Lionfish fishing tournament, where community members compete in catching, cooking, learning about and consuming Lionfish. Held for one day every September, fishing folk gather at a particular beach site, organize themselves in teams of three, get in their boats and go out for five hours for an organized Lionfish catch. Meanwhile on shore, government institutions, scientists, women vendors, chefs, families and children develop awareness activities such as showcasing live Lionfish, distributing information, cooking Lionfish to eat and other related activities such as music. At the end of the five-hour saga, the team that catches the largest Lionfish gets an award, as does the team that catches the smallest fish, along with the team that catches the largest amount of Lionfish. All of the catch is counted and examined by students and professors of biology from participating universities to be integrated into a database being developed by the Association for research.

The annual Lionfish event is an opportunity for everyone to get a taste of the fish and also get information about the need to participate in community actions to eradicate it. Lucia Hernández, a young fisherwomen and a member of the Association, was the certified captain of her boat in the tournament on September 27, 2014. Lucia talked about the experience, saying: "It is very important for us to take part in this because although the day looks like the everyday diving that we do to catch fish and lobster. The feeling of a collective effort where all the boats go out at the same time, filled with teams of fishing folk with the one common aim of contributing to reduce the Lionfish, reminds us that we are a community. That is why I love this place. It has provided me and my family with abundant food throughout my whole life!" (Personal interview, 2014).

As part of the preparations for the Tournament, the Association visits each elementary school in the Southern Caribbean region. Young local marine biologists from the area participate with the Association in providing information to students about the Lionfish. The students, mostly grandchildren and children of fishing folk, are asked to talk about what they have learned from their elders about the species but they are also asked to take what they learned from the Association that day back to their homes. Motivation for the students to undertake scientific experiments while at school also forms part of these community outreach efforts.

One such case is the scientific experiment undertaken by Romi Hernandez, a 6th grader, daughter of Andres Hernández of the Association. With his help she

designed and built protected "houses" at the bottom of the ocean where lobster can lay their eggs away from the Lionfish. In the process she learned that the traditional knowledge that her father brought to her research was just as relevant as other scientific information. After all, her father was the one who showed her how to dive, who knew every corner of the reef and who knew the lobsters' hiding places (R. Hernández, personal interview, 2014). Because fishing folk often construct equipment and tools for their work, he is the one who taught Romi how to build the cement "houses" for the lobsters.

Combining the scientific method with the traditional knowledge that these children learn from their parents is a good way to keep the young connected to fishing, the ocean, their families and their communities. These youth are also the generation that has been the first to break the 6th grade glass ceiling in education in the Southern Caribbean region. For her scientific experiment, Romi received an award and a scholarship to attend high school.

Media, including most every newspaper and radio station in Costa Rica, have covered the tournament, providing a broader audience with information about the campaign to curb the Lionfish population. One headline in Costa Rica´s major mainstream newspaper *La Nación* declared: "fishing folk are a key element in the control of Lionfish" (Soto, 2014). Another newspaper proclaimed:

> In Costa Rica, it is local fishermen – not the government – battling on the front lines of the Lionfish war. Spurred by a desire to protect both their businesses and their coasts, fishermen have convinced restaurants throughout the Southern Caribbean to serve the fish and are now developing a strategy to fill the growing demand with a steady stream of dead invasive lionfish (Fendt, 2014).

International media have also hailed the contributions of the fishing community to the campaign.

Scuba diving for a deeper catch: involving youth on their own terms

In the process of exploring ways to connect to youth, three young Afro-Costa Ricans from the area were invited to participate in the 2nd Lion Fish Tournament organized by the Association in September 2012. They were the only young people who participated in the activity and garnered media attention. In pictures of the event, the three youth stood tall with their fishing spears like warriors and the media named them the "Lionfish Warriors". They were later asked what it would take to get them committed to working on Lionfish control with the Association, and they said that they had been longing to learn to scuba dive for years. The three youth noted that although they thought that catching Lionfish by snorkeling is very effective and they do it all the time on their own, scuba diving with tanks would allow them to develop new skills in order to go into deeper water and stay longer in places where they had seen many Lionfish in the past but could not reach them.

Therefore, the most recent strategy devised to tackle the Lionfish problem is the

creation of a community-oriented scuba diving community center named, "Ambassadors of the Seas". It was launched in late 2014 with the aid of professional scuba diving trainers who form part of the membership of the Association. The scuba diving center is designed mainly, but not exclusively, to engage youth in learning both to dive with a snorkel and to scuba dive with oxygen tanks so as to participate actively in the protection of the ocean by catching Lionfish at depths not reached by snorkel divers or with the use of traps as well as by conducting periodic clean-ups where foreign debris is collected from the reefs. Their motto is "Scuba diving with a purpose: Preserving the marine ecosystems in interaction with the culture and livelihood of the fishing communities in Costa Rica's Southern Caribbean" (*Escuela de buceo Caribe Sur*, n.d.). This project was developed to engage the younger generation in the Association's endeavors, because the relationship of the youth to fishing is not as intense as it was for their parents.

The youth make a commitment to undertake voluntary work hours at home, in the community and with the Association in consideration of the fact that they are trained free of charge, and recognizing that there is a cost for their families, community and the organization in providing this opportunity. The Association is fostering youth involvement in the protection of their marine ecosystems, especially considering that this generation will face the enormous challenges due to climate change and other factors affecting their coastal ecosystems. On May 1, 2015 during the second Lionfish sweep by the Association with the Scuba Center, Rocio León, the mother of Romi, and some of the children who came to the activity suggested that children be educated at an early age not to fear the ocean. She suggested they be trained in snorkeling, identification of reef fish and other activities such as cleaning the shore while the older kids and adults cleaned the ocean floor. On the basis of this suggestion, Lucia Hernández, Rocío Aguilar, Blanca Espinoza and Lariza Brenes Bermúdez have organized the first pilot class with a group of 23 children ranging from ages 2 to 13.

Developing a taste and market for Lionfish consumption: everyone can become a predator

The Association also realized that because the Lionfish is a new species in the Caribbean, developing "a taste" for it in the community was to become as important as devising diverse ways to catch it. Building a market for its consumption would further develop an approach that would link conservation with livelihood, a key to success of any conservation strategy that requires participation of all sectors of society. The Association has therefore developed a campaign to eat Lionfish and because it collects the catch of all fishing folk, it has become a reliable distributor to local restaurants. Cooks and chefs at the local, national and international levels have been contacted to compile recipes, and cooks are taught how to clean it and cook it safely.

One Lionfish chef is Doña Elena Spencer, an Afro-Costa Rican who was born and has lived in Puerto Viejo her entire life.

She teaches a Caribbean Gastronomy class to youth every Saturday and on special occasions, she makes *rondon* with Lionfish. *Rondon* is a traditional Caribbean coconut stew with fish. "Lionfish is an easy meat to cook because it is strong and sturdy, therefore hard to 'disappear' in the coconut soup and it absorbs the taste of the spices very well", explained Doña Elena. Chef Rauch from Colombia who now lives in San José, the capital of Costa Rica, has made contact with the Association in order to form an alliance regarding Lionfish consumption. He has a restaurant in this country and a chain of restaurants in Colombia and elsewhere where he has specialized in Lionfish with great success. He told the Association that the fishing folk-chef alliance is critical to expanding the struggle against the presence of the invasive fish in the Caribbean. He pledged to buy the fish from the Association for his restaurant in the city. Leo Guerrero is another Colombian chef living in Costa Rica. He learned about the Lionfish from the Association and took part in one of its Tournaments, preparing a Lionfish dish with his own recipe. He told the Association that Lionfish has particular gastronomical features that are very important because "it eats other fish species that have a high protein value like lobster and shrimp among others. And as if this were not enough, by eating it we are contributing to clean the environment, the reefs and the lives of fishing folk."

A priority of the Association has been contacting restaurants in the area and encouraging tourists and locals to talk about their experience in eating the fish in order to "get the fish into the culture". One such effort last year was to get the President of Costa Rica to try Lionfish when he came to listen to the community on August 30, 2014. Along with 20 of his cabinet members, he sat in a local restaurant "La Esquina", overlooking the shoreline where local people keep their fishing boats. All of these officials recognized the good taste of the fish and called on the Costa Rican community to support the Association in its campaign. The country's largest mainstream newspaper, *La Nación* reported that the President declared his support for consumption of Lionfish after having tasted it. The headline stated: "Luis Guillermo Solís supports more consumption of Lionfish, a fish that threatens other marine species in Puerto Viejo." (Murillo, 2014)

Sharing recipes and information about how to handle the Lionfish in preparation for cooking has recently been addressed by the Asociation. Because people know that the fish has a toxin, they are afraid to eat it. "They have to learn that the toxin dies with the fish", says Héctor Mac Donald Jr., President of the Association (Personal interview, 2014). At the end of the day, every effort in this campaign is dependent upon the consistent and reliable supply of Lionfish to the market, which is in turn directly dependent on the way that the Association upgrades its fishing and data collection methods. This is so because as a non-profit organization, the Association is depending on the commercialization of Lionfish as a way to improve its efforts and make them sustainable in the longer term.

Conclusion

The Lionfish is not the only recent problem that threatens destruction of coastal ecosystems, but in Costa Rica it seems to have emerged as an emblematic metaphor for what is happening along the Caribbean coast and elsewhere in the country. Foreign invasive "phenomena" have disturbed traditional integrated approaches to living which in the past guaranteed the health and wellbeing of local communities. Government actions regarding Lionfish removal as well as concerted efforts among all stakeholders is crucial, but understanding and supporting fishing communities and their traditional knowledge and practice is the foundation upon which any effort in this direction must be built, if it is to have any hope for success. This means that policy decisions must be informed by the historical and empirical knowledge of fishing folk.

Through its programming and practice, the Association has opened a space where fishing folk have been able to organize themselves in ways that have enhanced the connection between conservation and the livelihoods of coastal communities. These efforts are providing innovative approaches to conservation of coastal ecosystems, as well as the conservation of the culture and the wellbeing of their inhabitants by tapping into traditional knowledge alongside scientific knowledge. Working to strengthen livelihoods by developing sustainable fishing which has no negative impact on the environment is proving to be a necessary component in viable strategies for the elimination of the Lionfish. The protection of the livelihoods of coastal peoples and the protection of the environment cannot be separated. One cannot succeed without the other.

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