Addressing Sea Turtle Bycatch in Developing Countries: A Global Challenge That Requires Adaptive Solutions for the 21st Century

Chapter · December 2020

DOI: 10.1016/B978-0-12-821029-1.00016-7

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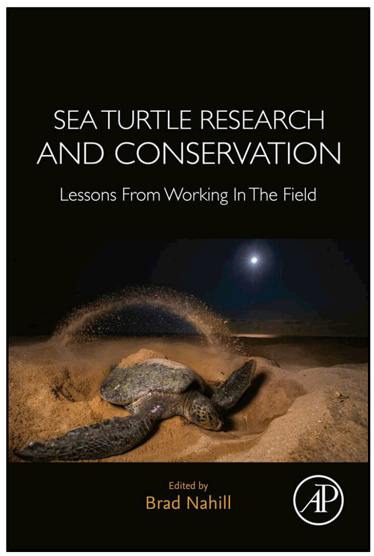

From J.F. Senko, M.A. Nalovic, Addressing Sea Turtle Bycatch in Developing Countries: A Global Challenge That Requires Adaptive Solutions for the 21st Century, In: B. Nahill (Ed.), Sea Turtle Research and Conservation: Lessons From Working In The Field, Elsevier, Academic Press, 2021, pp. 151–165.
ISBN: 9780128210291

Academic Press

Addressing Sea Turtle Bycatch in Developing Countries: A Global Challenge That Requires Adaptive Solutions for the 21st Century

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Introduction

Fishing effort in coastal regions has proliferated over the past few decades in the face of rapidly increasing demand for seafood [1]. Small-scale (hereafter termed coastal) fisheries are ubiquitous in coastal regions worldwide and comprise the vast majority of the world's fishers [2,3]. These fisheries provide a vital source of income and livelihood to coastal communities that often have few economic alternatives [4−6]. In addition to playing a major economic role in coastal communities, fisheries provide an important source of protein and essential nutrients in rural areas where nutritionally comparable food sources can be scarce.

Coastal fisheries also have intrinsic importance to the identity, values, and cultures in many of the communities they occur in. However, despite their` importance, incidental capture (i.e., bycatch) of nontarget species in these fisheries is notoriously difficult to assess and manage [7]. In particular, bycatch of sea turtles in coastal fisheries—primarily in gillnets, longlines, and trawls—has been linked to decline in populations worldwide [8,9]. Sea turtle bycatch is prevalent in coastal fisheries of developing nations, where fishing communities are generally marginalized with high rates of poverty, limited access to education, and few livelihood alternatives [4,6,10].

These important socioeconomic and institutional factors can limit the ability and willingness of fishers to reduce their sea turtle bycatch, especially if there are perceived economic costs such as increased fuel or operating costs, diminished operational efficiency, or reduced target catch [10−12]. As such, there has been growing recognition that, in developing nations, strategies to mitigate sea turtle bycatch must address the human dimensions of bycatch. Social networks as well as community-based fishing cooperatives or councils have shown promise by improving communication and knowledge transfer between managers, scientists, and fishers, but new solutions are needed [10,13,14].

Sea Turtle Research and Conservation. https://doi.org/10.1016/B978-0-12-821029-1.00016-7

We have developed a collaborative model for sea turtle bycatch reduction in the 21st century that leverages community-based conservation and innovation. Our approach incorporates the socioeconomic and ecological sustainability of fisheries, long-term conservation funding, market-based approaches to seafood supply chains, and community development and education. Our global model understands the social, economic, and ecological drivers behind sea turtle bycatch and uses this knowledge to develop real-world solutions. For example, when coastal fishers use high bycatch gear (e.g., gillnets), a more diverse catch can increase resilience through other species of fish that can be taken to market, or fish catches that can be consumed locally or used as bait in other fisheries. Thus, traditionally nonselective or high bycatch fisheries are, in many cases, important to maintaining resilience of coastal fisheries.

Sea turtle bycatch has traditionally been managed by reductions in fishing effort or bycatch caps, but these approaches can be costly for coastal communities because they usually close or restrict fishing effort [15]. For example, a recent fisheries closure in Mexico, established to reduce loggerhead turtle bycatch, eliminated the seasonal income of thousands of fishers and their families [16]. By contrast, solutions such as gear modifications may be more successful than closures or bycatch caps at managing bycatch of sea turtles and other marine megafauna, in part because they allow fishers to fish in their desired locations [15]. However, despite their promise, several bycatch reduction technologies (BRTs) that have demonstrated success in experimental trials have yet to be adequately implemented in active fisheries due to differences between controlled trials and real-world conditions, as well as operational challenges associated with their use [11].

A new global approach to sea turtle bycatch mitigation is needed that can work in diverse local contexts and simultaneously meet social, economic, and ecological needs. This approach can only come from integrating knowledge between local fishers and conservation scientists, practitioners, and managers. In the United States, the benefits of collaborative fisheries research have been clear with enhanced credibility and legitimacy of scientific findings in the minds of stakeholders, with potential to increase acceptability of management actions. Indeed, innovations that reduce bycatch can create greater mutual understanding and trust among partners, and opportunities to integrate diverse sources of knowledge about coastal and marine environments where fisheries and sea turtles intersect [17−22]. The collaborative research approach has been increasingly adopted by government, industry, and associations [21,23], as well as conservation organizations, such as the Nature Conservancy and WWF's Smart Gear program. Collaborative fisheries research is also emerging internationally, including in Central and South American fisheries.

In this chapter, we focus on small-scale or coastal fisheries, as opposed to industrial-scale fisheries, due to their importance in shaping coastal communities and propensity to incur high sea turtle bycatch. We explicitly focus on coastal fisheries due to their economic and cultural roles in coastal communities. Bycatch mitigation approaches employed for highly regulated industrial-scale fisheries, such as in the United States, are not typically applicable to coastal fisheries where top-down enforcement is limited or nonexistent [9,10,24].

Industrial-scale fisheries can be effectively managed differently, and management regimes generally consist of regulations, consumer demands, sustainability assessments (e.g., ecolabeling), and chain of custody from ocean to plate [10]. However, these approaches prove less effective for coastal fisheries in developing nations. For a comprehensive literature review on fisheries bycatch of marine megafauna that includes sea turtles, we recommend Komoroske and Lewison [10].

Here, we provide two case studies and key lessons learned from both, while highlighting priorities for future sea turtle conservation action and research. The first case study comes from French Guiana, which is considered to be the French department that has implemented the most measures to reduce sea turtle bycatch as part of an ongoing collaboration between fishers, biologists, and institutional actors [25,26]. The second case study highlights community-based conservation innovation in coastal gillnet fisheries in the Gulf of California, Baja California Sur, Mexico.

Case study 1: A collaborative fisheries research partnership between French Guiana's Regional Fisheries Committee and World Wildlife Fund (Michel A. Nalovic)

To reduce sea turtle bycatch in artisanal gillnet fisheries, fishers, through the Commitée Régional des Pêches Maritimes et Elevages Marins de Guyane (CRPM G), the local fisheries organization, had the opportunity to propose solutions to reduce fuel expenditures, eliminate polluting practices (e.g., emptying ballast water and oil at sea, keeping trash on board), and reduce overall bycatch. One of the options proposed over two decades was the adoption of the classic Turtle Excluder Device (TED) [27]. Indeed Gueguen [28] estimated that the French Guiana shrimp trawling fleet was responsible for the bycatch of 1000 olive ridley turtles per year.

An evaluation of the efficiency of existing TEDs and other grid style excluder devices under full commercial fishing conditions was proposed by the World Wildlife Fund (WWF) and performed by gear technicians from the French Institute for the Exploitation of the Sea (IFREMER). Results from these trials showed a 27% loss of shrimp production (Unpublished IFREMER data), which was deemed unacceptable by the fishing industry. Following these trials, WWF proposed to help train the CRPM G's technical staff on the use of TEDs by a gear specialist from NOAA Fisheries Harvesting Systems Branch office, located in Pascagoula, Mississippi, USA. This new capacity allowed the fishing industry in French Guiana to conduct its own experiments at sea including TED trials.

Tests conducted at sea revealed that standard TEDs were successful at maintaining target shrimp catch and eliminating bycatch of sea turtles as well as larger sharks and rays. However, the TED showed only small reductions in total bycatch [29], and was not efficient at reducing the massive amounts of finfish bycatch, which can regularly reach a ratio of 10 kg of bycatch for every 1 kg of shrimp in tropical shrimp trawl fisheries [30]. The industry in French Guiana therefore sought improvements in the TED performance [29].

The trials also led to fishers having a better first-hand understanding of the TED's effects on selectivity of the catch. This new knowledge inspired them to propose modifications to the existing TED models that could help them reduce finfish and thus overall bycatch. In particular, the fishers suggested reducing the spacing between the bars and the use of flat bars, rather than round bars. Flat bars were suggested because the reduced surface from bars that were less thick was expected to result in less hydrodynamic drag and turbulence ahead of the selective grid.

Following the acquisition of this gear, validation by at-sea trials, and experiments of different TED models using sampling protocols for comparison of towed gears [31], the fishing industry's perception of TEDs and BRTs began to change. The CRPM G, which was responsible for conducting the experiments, allowed for all of the fishing industry's members to access the results quickly and officially through a series of consultations. These regularly held meetings and exchanges acted as a steering committee and led the industry to call on the federal government to establish a new requirement for the use of the modified TEDs on all shrimp trawlers operating in French Guiana. The TTED law (Trash and Turtles Excluder Device) improved the selectivity of the original TED and was voluntarily adopted by the industry in March 2008, later becoming mandatory by government decree in January 2010 [29].

To facilitate the industry, WWF, in partnership with the CRPM G, requested a grant from the EU funds for fisheries for a project called "Toward the adoption of the selectivity system Trash and Turtle Excluder Device (TTED) by the shrimp trawlers of French Guiana." The objective of the program was to train captains, crews, and net menders on TED use and maintenance, order and acquire high quality TEDs and extra materials to fix damaged TEDs, and support the implementation and adoption of the new TEDs.

In the end, the development of a new TTED with two inches of spacing between flat bars resulted in a significant total bycatch reduction without target shrimp loss for the French Guiana shrimp trawl industry [31] and effectively eliminated sea turtle bycatch. The process changed the perception of the fishing industry toward conservation of sea turtles and working with environmental NGOs. The current perception among fishers is that the TED was tailored to the specific conditions of its fishery and was a product of their own innovation and stewardship.

French Guiana is considered the French overseas department to be the most proactive of the six total overseas departments working to reduce bycatch of sea turtles [25]. There were times when the industry could have backed out of the US TED certification program and stopped using TEDs altogether. However, fishers continued to use TEDs despite the government's refusal to inspect their use from 2014 to 2017. In 2017, the CRPM G even produced a report arguing that TEDs should be included in the EU rule books for use by all countries wishing to export wild caught shrimp to the EU [32].

In June of 2019, the CRPM Guyane, the French National Fisheries Committee, WWF, and the French Government advocated to include the new TEDs for the first time in the EU technical measures for fisheries. The addition of TEDs to the EU technical measures for fisheries and resulting regulations [33] set a precedence to make TEDs mandatory for all countries wishing to export wild caught tropical shrimp to the EU, much like the United States did 30 years earlier. Maritime affairs has since conducted 11 at-sea inspections of TED use and the results indicate 100% compliance [34].

The French Guiana TED project has drawn the attention of other French departments who are investigating the possibility of creating similar initiatives to address sea turtle bycatch in other fisheries [26]. Overall, the collaborative research approach in French Guiana produced concrete and enforceable conservation outcomes and benefits, gave fishers a voice and respect by integrating their knowledge to develop tailored, effective technological solutions to protect sea turtles, and developed an enhanced sense of ownership to the solution and stewardship among fishers. The TTED initially developed in French Guiana has since been evaluated successfully in the Suriname Seabob shrimp fishery through the Sustainable Management of Bycatch in Latin America and Caribbean Trawl Fisheries (REBYC-II LAC) FAO program and is slated to be evaluated by NOAA Fisheries for use in the Gulf of Mexico shrimp fishery.

French Guiana's artisanal gillnet fishery: different fishery, same approach

The collaborative approach we developed has continued to influence fisheries in French Guiana given that the trust established between industry, environmental NGOs, and scientists has spilled over into another fishery—the artisanal gillnet fleet. The French Guiana gillnet boats operate much like other gillnet vessels in the wider Guiana region, with the major difference being the amount of fishing effort of French Guiana's neighbors, which have many more boats and fish with longer nets.

In 2017, the PALICA Project (*Pêcheries Actives pour la Limitation des Interactions et des Captures Accidentelles* translation: "Fisheries working toward the Limitation of Bycatch")—a collaboration between the CRPM G and WWF, informed, evaluated, and helped articulate a plan by the artisanal gillnet fleet to comprehensively address bycatch of sea turtles, as well as other protected species [35]. This work was implemented with commercial fishers and their representatives from the inception of the development of ideas on potential solutions to reduce sea turtle bycatch in the region.

This project interviewed boat owners and fishers from different communities along the French Guiana coast in order to better understand the context, perception, complexities, and issues that could affect artisanal fisher's willingness to work toward addressing sea turtle bycatch. The fishers appeared to appreciate the consultative process, since they felt that their voice was being heard and taken into account. These consultations took almost 9 months, culminating in a report [35] that proposed two general approaches—one involved change of behavior, and the other was technological, or gear based (selectivity).

Two new projects arose from these approaches, the first one was based on negative experiences by fishers who recounted encountering large numbers of olive ridley turtles in their nets. Project staff explained to the fishers that olive ridley turtles exhibit a unique behavior where the turtles aggregate in front of nesting beaches to come ashore to lay eggs in events that can bring up to 500 individuals on the beaches of Cayenne in one night. Learning about this behavior, known as an "arribada" in Central America, brought about the reoccurring question from fishers as to whether or not it was possible to predict when these mass nesting events would occur. Thus, the French Guiana Project "Arriba" (Alerte aux Risques Relatifs aux Interactions Bloquant les Arribadas translation: "Warning of the risks associated to interactions preventing arribadas"), was established. The Arriba project seeks to create and develop a warning system for fishers to be informed when an arribada event is occurring so that fishers can voluntarily displace their fishing effort away from the area occupied by turtles, in real time.

In line with the collaborative approach, the fishers help define how the warning system will function. To inform the process, we are planning to solicit contributions from a variety of sources including scientists conducting telemetry studies on olive ridley turtles, NGOs responsible for patrolling the nesting beaches, and fishers. The National Center for Scientific Research of France (CNRS) will equip three turtles in the early part of the nesting season with fine-scale tracking devices and monitor their movements. The Kwata Association, which patrols the nesting beaches and monitors nesting activity, will help predict the first peaks that mark the cadence of the upcoming peaks. Finally, fishers will be asked to inform the CRPM G when and where they encounter olive ridley turtles at sea or in their nets.

By using this cross-disciplinary approach, entities that do not traditionally work together can share useful information and can jointly develop the warning strategy in real time. Secondly, fishers who receive the warning and choose to dismiss it will likely encounter a large number of turtles in their nets. This may seem counterintuitive, but we anticipate that fishers who have to deal with the consequences (damaged gear, lost time, and possibly embarrassment) may be more likely to participate and accept the information at a later date. To determine if our approach is successful, the warning system will operate for another 2 to 3 years and observations at sea will note the actual presence or absence of fishing vessels during the French Guiana arribada events.

The second project is slated to begin in July of 2020 and will focus primarily on technological components and mechanics of bycatch with gillnets. We will evaluate three gear modifications that aim to reduce sea turtle bycatch while maintaining target catch. These tests were chosen by the gillnet industries' fishers and prioritized by their willingness to actually implement potential gear modifications if deemed successful. The tests aim to evaluate strategies to mitigate bycatch of leatherback turtles in gillnet fisheries. Below, the tests are described in order from least to most complex.

The foraging behavior of leatherback turtles may lead to entanglement of their large front flippers in ropes and cables of fishing gear, and may be the result of turtles approaching buoys and biting them [36]. Bite marks were observed on floats entangled around leatherback necks in French Guiana. Leatherbacks will readily consume a variety of edible and inedible slow-moving and buoyant objects. Although this behavior is adaptive in exploiting large concentrations of medusae, these turtles regularly mistakenly ingest plastic bags and other floating marine debris (e.g., Refs. [36−40]. Gillnet floats in French Guiana tend to be made of Styrofoam or white plastic [41,42].

This material is used because it is readily available, cheap, and easy to manipulate. During at-sea observations conducted by the CRPM G in French Guiana, we found that at least 20% of leatherbacks were entangled in float lines of gillnets and not the actual mesh of the net [42]. However, this is believed to be an underestimate since entanglement was observed in the float lines and the mesh of the gillnet simultaneously without the possibility of knowing whether entanglement was initiated at the float line or in the mesh [42].

Leatherbacks are not able to see the color red [43]. This visual limitation may be the key to developing *a new* gear modification for the gillnet fleet of the Guianas, such as changing the color of a float involves minimal financial expenditures. As such, two boats using Styrofoam floats will be equipped with cameras that turn on only when an algorithm detects actual fishing is occurring so as to not impede on the fisher's privacy. In conjunction with these cameras, we will paint half of the floats (86) red to match the number of floats that will remain white. During retrieval of the gillnets, the cameras will record images that reveal if leatherbacks are bycaught in the segments of the gillnet that have the white or red floats.

The next two experiments will test whether bycatch of leatherbacks and other sea turtles can be reduced by allowing the top of the water column to be free from floats and gillnet gear. Recent findings indicate that green turtles rarely descend below 2 m in depth while swimming between nesting events [44], while observations at sea showed that 82% of leatherbacks were caught in the upper portion of gillnets [45]. To gather data at sea, the project will conduct experiments with observers on board to allow a direct comparison of bycatch and target catch of experimental and standard gillnets. As per other studies conducted to evaluate LED lights to reduce bycatch of sea turtles, the two boats that participated in these tests will operate in close proximity and with identical fishing effort (gear deployment time, soak time, and retrieval time) following other similar studies (see references on net illumination).

Test two will compare the bycatch of turtles and capture of target species of two gillnets, one with a vertical profile measuring 4 m in height (experimental gear) and the other measuring 6 m in height (control gear). Apart from this modification, all other gear including manufacturer and date of construction will be the same. The third test will compare nets of identical construction except for the floatation, with the control net having standard float lines widely used today and the experimental net having experimental floats included on the top line of the gillnet and, as such, completely submerged and out of sight of the leatherbacks apparent interest in floating objects.

According to the Proceedings of the Technical Workshop on Mitigating Sea Turtle Bycatch in Coastal Net Fisheries, this approach warrants investigation. This test is by far the most complex as it will be necessary to first determine the ideal amount of floatation to guarantee that the gillnet has an optimal opening configuration to catch fish and is not causing the gillnet to float above the sea floor. To do so we have initiated a partnership between the CRPMEM Guyane and NOAA Fisheries to use depth sensors to verify the actual position of the net and compare the control and experimental gillnets top and bottom-line positions during fishing activities.

In November of 2019, Jeff Gearhart from NOAA Harvesting Systems Branch in Pascagoula, Mississippi, USA, traveled to French Guiana for a 3-day at-sea expedition with the author of this case study. They conducted the first trials of experimental submerged floatation aboard a boat made available by the Abchee and Sons fishing company. The preliminary results were presented the next day to a room of boat owners and members of the French Guiana Marine Turtle Action Plan. NOAA Fisheries provided sensors and the software package and protocols to the CRPM G to be used to continue the sea turtle bycatch reduction work. Once the ideal floatation amount is determined, the CRPM G will organize a consultation among its fishers to determine the best shape and size of floats to be used, giving the industry a say in the way the experiment will be conducted.

Case study 2: A collaborative partnership between Arizona State University and the Grupo Tortuguero (Jesse Senko)

Sensory-based BRTs that use visual cues to alert or deter sea turtles to the presence of fishing gear can reduce their bycatch [46−50]. Recently, net illumination has emerged as a BRT with strong potential to reduce sea turtle bycatch in coastal gillnet fisheries at night while maintaining catch rates of some target fish species. Gillnet illumination has reduced sea turtle bycatch in paired trials by 40−74% in peer-reviewed published studies (i.e., [48−53]. Although the exact mechanisms behind net illumination remain unknown, it is believed to reduce sea turtle bycatch by providing a visual cue that alerts and deters turtles to the presence of gillnets [48].

While testing of gillnet illumination has expanded into coastal fisheries worldwide, a hurdle to broad-scale implementation is the need to address their energy use and design. Illuminating gillnets with nonrechargeable batteries presents challenges in terms of energy consumption and operational efficiency. Light levels in current LEDs begin to diminish after several weeks of use, which requires their batteries to be changed biweekly or monthly (depending on use) to maintain effectiveness.

In turn, frequent battery change-outs result in exorbitant additional costs for coastal fishers and concerns over environmentally safe disposal. For example, current LEDs use two AA batteries and have generally been placed every 10 m along the float line. Thus, one gillnet vessel fishing with 1 km of net would require 100 LEDs, resulting in 200 AA batteries for every change-out. Additionally, current LEDs were designed for longline fisheries, and they hang vertically from the net and weigh it down, while also snagging frequently and requiring a complex locking mechanism to replace batteries, all of which makes their design less optimized for gillnet fisheries.

To address the challenges associated with current gillnet illumination technology, we worked with fisher leaders in Baja California Sur, Mexico (BCS), and a team of engineers at Arizona State University to develop a more pragmatic and cost-effective method of illuminating gillnets. Our team has been partnering with local fishers at BCS over the past decade and have cultivated strong relationships with fishers in several coastal communities [54,14]. In January of 2018, we held our first of three fishery workshops with local fisher leaders from northwestern Mexico to discuss developing renewable-powered net illumination. Each of the three fishery workshops was coordinated in partnership with the Mexican NGO Grupo Tortuguero de las Californias. We held a subsequent fisheries workshop in Oaxaca, Mexico, following a mass fisheries bycatch mortality event in which over 300 olive ridley turtles were found dead in a single gillnet.

In all three fisher workshops, fishers suggested developing a lighted buoy that could be easily integrated into their existing gear. We thus chose to design the lights to effectively mimic a buoy that could be threaded onto the float line of a gillnet. The lighted buoys float just like a traditional buoy, and thus offset costs of actual buoys, which make up approximately 20% of the total cost to build a gillnet [24]. Notably, this design offered full integration into gillnets with little to no modification necessary. Through our fishery workshops, we also learned that different fishers prefer different size and types of buoys, highlighting the need to develop pragmatic but also flexible approaches that can be taken to scale.

Converting from AA-battery powered lights to solar power resulted in the entire unit becoming substantially lighter. It also eliminated the need for a sealed release mechanism, which was complex, difficult to maintain, and had a cumbersome waterproof seal that needed to be opened and resealed with each battery exchange. This approach allowed us to retain similar properties of proven LEDs employed in previously published studies. The use of solar power also allowed us to replace the AA batteries with rechargeable cells, since they provide a high recharge cycle count of several hundred cycles. Moreover, the solar cells are lightweight and provide a flat discharge characteristic, simplifying the circuit component count to maintain constant light output over time. Rechargeable cells are used in every cellphone and are the prevalent technology in portable electronics, which allowed us to rely on existing technology. Taken together, the latest rechargeable cells in the buoys can hold 500+ charge cycles, which substantially reduces costs over nonrechargeable cells, especially over an entire fishing season.

Discussion

Like bycatch of other vulnerable marine megafauna, sea turtle bycatch occurs in a dynamic marine and socioeconomic context. Sea turtles, their ecosystems, and people who depend on marine resources respond to rapidly changing conditions and multiple stressors [10]. As such, addressing sea turtle bycatch in the 21st century requires creative, highly integrated, and innovative approaches that are adaptable in a similar way to the complex human-natural systems in which bycatch occurs.

The ultimate success of sea turtle bycatch solutions is highly dependent on context due to a range of social-ecological factors such as fisheries dynamics; oceanographic and ecological conditions; political drivers; infrastructure; cultural, social, and economic conditions; or scale [10,13]. Nonetheless, the collaborative process, skills, and competencies are consistent and can produce effective solutions across a wide range of diverse contexts.

From our two cases studies, a clear theme that emerged is the inclusive approach to community-based sea turtle and fisheries conservation. In both case studies, scientists worked with local fishers as well as practitioners and/or engineers. This exchange of knowledge led to the development of emerging solutions and new insights that are likely to benefit both sea turtles and fisheries alike. These case studies developed conservation solutions that were tailored to their specific conservation and fisheries context, which helped contribute to their success.

Notably, the foundations for these case studies were built on long-standing relationships with local fishing communities. These relationships were cultivated over several years where researchers spent time on boats and in fishing ports with local fishers, learning their struggles, getting to know them on a personal level, and showing empathy for their situation. Below, we highlight actions that proved successful across both case studies, as well as general recommendations for engaging in participatory fisheries research.

Finally, both authors of this chapter acknowledge the benefits of having been influenced by previous work and the experience of collaborative fisheries researchers and practitioners. During the International Sea Turtles Symposium held in New Orleans in 2014, a special plenary session on bycatch was organized. At the time both authors were conducting graduate research on bycatch and had the opportunity to participate in the workshop and witness the presentation by Dr. Martin Hall entitled "Collaborating with fisheries to reduce bycatch: 30 years of education" [55]. We highly recommend this video to those interested in fisheries and bycatch, as it gives unique explanations to certain principles to addressing bycatch that are based on experience rather than built on empirical or published data.

Relationship building

It is clear from both case studies that building relationships among diverse stakeholders is paramount. This includes actively working to understand and appreciate each other's knowledge, build trust and respect, and emphasize a shared message of hope and resilience, as well as a shared sense of responsibility for marine resources. Below, we include key factors in building relationships with fishers and coastal communities for conservation scientists and practitioners interested in working on seas turtle bycatch.

- ***Empathy***—Empathy is perhaps the single most important trait to possess when working in participatory fisheries research. Notably, empathy moves beyond sympathy, which simply acknowledges what another human is going through. Having empathy toward fishers and their very real day-to-day struggles is a fundamental piece of the relationship building puzzle. Empathy shows them that you actually care about them and are not simply sympathetic to their situation. This distinction is crucially important, as we have found that many researchers are sympathetic to fishers, but not necessarily empathetic.
- ***Humility***—Recognize that you can learn from fishers in the same way that they can learn from you. Also, although they may not possess your vocabulary, many of them can teach you a lot to about sea turtles and marine ecosystems. In fact, both authors have learned more about sea turtle ecology from fishers than their graduate educations. Being humble will go a long way in the coastal fisheries and communities you seek to work in.

- ***Communication***—Effective communication does not simply include speaking the language of the country you are working in, although this is clearly important. Rather, effective communication requires understanding the cultural context of the stakeholders you are working with and their host country. Moreover, communication should be open, transparent, and inclusive. It is not necessarily a deal breaker if you do not speak the language, but if this is the case, you must find a trusted local partner who lives in the community that you can work with. Also, if you do not speak the language, try your best—you will be viewed as someone who is trying and cares, and forgiven for your lack of the language.
- ***Listening***—When working with fishers, it is important to listen carefully to what they are saying. We have found that good listening results in a more engaging dialogue, and that fishers are much more likely to be receptive to you when they feel like you are listening to them.
- ***Genuineness and a sense of humor***—People like being around others who are genuine and have a good sense of humor. Fishers are no different. Buy them lunch and have a beer (if you drink alcohol) with them.

Developing and planning a research project

Conducting fisheries research, and especially working with fishers and fishing communities, involves planning and foresight. Below, we include key factors in developing fisheries related research projects and partnerships.

- ***Empowering***—Where possible, empower fishers to tackle problems that are important to them, not just scientifically exciting. When we sought to build a solar-powered light, fishers suggested we develop a lighted buoy instead. This seemingly small suggestion resulted in a BRT that could more easily be integrated into their existing gillnet gear. Fishers also felt empowered that their design ideas were taken into account, resulting in more fishers who wanted to participate in the project.
- ***Generating hope and excitement for the future***—Fishing is extremely unstable, and the high variability associated with catches can be quite stressful for fishers and their families. Also, fishers' experiences with resource managers or conservation practitioners in the context of sea turtles tend to be negative, as they are often trying to either impose burdensome regulations or reduce their fishing effort, which in turn reduces their profits. Thus, we have found that it is vital to present a message of hope and resilience to fishers and their communities. It is important to remember that fishers and their communities will generally view their work with you as a source of pride, but do not take this for granted. Keep them excited and engaged!
- ***Extensive preplanning***—Fisheries workshops involve a lot of planning. It is imperative to provide food and coffee, and where possible, funding for participants to attend.
- ***Patience and long-term commitments***—Building relationships and research projects takes time. Be patient and show up frequently. It is critical that you continue to show up year after year, even if only once per year, as this demonstrates you are committed to them and the project.
- ***Developing clear, relevant, and agreed-upon objectives***— Having expectations is normal from both the conservation and fisheries standpoint, but making these expectations reflect objectives and realistic goals is vital to limiting feelings of frustration or disappointment.

Objectives are dependent on the maturity of the context, partnership, and even level of knowledge of the bycatch issue. It is probable that the bycatch issue will not be resolved immediately or by the end of the first project initiated, and that things may not work as planned because of unknown issues or variables that cannot be predicted. But you should build on this to move forward and improve upon the previous attempt. We have found that it is easier to build on successes than on failures; hence, it is important to think critically about the different potential outcomes and to agree on realistic objectives which will, inevitably, approach the conservation we are working toward.

- ***Careful consideration and attention to group dynamics***—Be cognizant of the fact that you may need to facilitate group dynamics.
- ***Being flexible***—When working in fisheries, it is important to be flexible and have an open mind. A willingness to compromise is especially important; remember, your research project is their livelihood, and compromising will likely pay dividends in the long term.

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