Nem tudo o que cai na rede é peixe: An environmental education initiative to reduce mortality of marine turtles caught in artisanal fishing nets in Brazil.

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ABSTRACT

Conservation initiatives for marine turtles generally focus on nesting beaches, with the aim of protecting nesting females and their developing eggs. These efforts are largely successful at increasing the numbers of hatchlings produced and released to the ocean. However, mortality at sea resulting from incidental capture by fisheries is a serious threat to the survival of marine turtle populations. Recognizing the importance of protecting turtles in the water, Projeto TAMAR-IBAMA, the National Sea Turtle Conservation Program of Brazil, has expanded its activities to include protection of turtles in their feeding areas, especially where turtles are likely to become entangled in local artisanal fishing nets. Towards this end, Projeto TAMAR-IBAMA instituted an education campaign to teach fishermen the importance of conserving marine turtles, and how they can participate in the conservation process. The program has been successful, with an increasing trend in the annual number of turtles that are released safely after being accidentally caught. Projeto TAMAR-IBAMA is also involved with creating ecologically sound alternative sources of income, to reduce the need for predatory fishing. As with their achievements in protecting nests and nesting turtles, Projeto TAMAR-IBAMA's accomplishments in protecting sea turtles on these feeding grounds are dependent on the cooperation and participation of local coastal communities and fishermen.

INTRODUCTION

Marine turtles have been classified as endangered both federally in Brazil and at the international level [1]. Five species of marine turtle occur in Brazil: the loggerhead (*Caretta caretta*) hawksbill (*Eretmochelys imbricata*) olive ridley (*Lepidochelys olivacea*), leatherback (*Dermochelys coriacea*), and the green turtle (*Chelonia mydas*). Since 1980, Projeto TAMAR-IBAMA, which is affiliated with the Ministry of the Environment of the federal government of Brazil, has been responsible for managing and conserving the marine turtles found along the Brazilian coast. Projeto TAMAR-IBAMA operates 21 stations that dot the coastline, most of which focus on protecting nearby nesting populations of marine turtles. Largely through the recruitment of local fishermen to monitor the nesting beaches of Brazil, Projeto TAMAR-IBAMA has been successful in eradicating almost all-local consumption of sea turtles and their eggs in areas where Projeto TAMAR-IBAMA operates [2]. Each year, Projeto TAMAR-IBAMA helps liberate over 350,000 hatchlings from nests that are either protected in their natural sites, or have been relocated (due to threats such as erosion, predation, or heavy foot-traffic) to open-air hatcheries, located in natural nesting areas.

Threats to marine turtle populations in Brazil and elsewhere are not restricted to harvesting or disrupting nesting females or their eggs on sandy beaches. Indeed, accidental capture by fisheries has been recognized as being perhaps the greatest threat to marine turtle populations worldwide [3]. For sea turtles accidentally caught in nets or traps, the primary cause of death is asphyxiation. Sea turtles

are air-breathing reptiles, and if they are forcibly submerged for long periods, they suffer oxygen depletion and acidosis [4]. Following this, they become exhausted and comatose, and will eventually die without intervention. In the case of the shrimping industry off the Atlantic coast of the United States, prior to implementation of protective measures, it had been estimated that as many as 50,000 turtles were being accidentally caught each year in trawl nets [5]. The estimates for the annual level of mortality associated with those captures range from 10,000 - 30,000 animals [6 7]. Since 1994, all US shrimping vessels have been required by federal law to use Turtle Excluder Devices (TEDs), which function as trap doors through which turtles can escape. The implementation of TEDs is considered to be an example of the successful application of technology to help conserve marine turtles [9], and it is thought that the use of TEDs worldwide would help reduce the level of mortality of marine turtles at sea. Indeed, the Convention for the Protection and Conservation of Sea Turtles in the Western Hemisphere, an international treaty that has not yet been fully ratified, promotes the strict enforcement of the use of TEDs by the fishing fleets of all signatory countries.

Despite the apparent success of TEDs, sea turtles remain subject to other perils associated with fisheries. In the Mediterranean, the use of explosives has direct and indirect impacts on local sea turtles: the turtles are subject not only to injury during the explosions, but also attacks by Monk seals, whose food source has been largely depleted and thus have begun to prey on turtles [10]. Driftnets can also entangle and kill sea turtles, and sea turtles are often caught by long-line fisheries in the Atlantic and Pacific oceans [11]. Clearly, different fisheries in different countries have particular impacts on sea turtles, and therefore different management strategies must be developed according the specifics of each situation.

Incidental capture of marine turtles in Brazil

Largely migratory, marine turtles can travel great distances between their developmental, reproductive, and feeding habitats [12 13]. Schultz [14] and Pritchard [15] described a number of green and olive ridley turtles that were tagged while nesting on beaches in Suriname, which were later, found in Brazilian waters. Turtles tagged in Brazil have been recovered as far away as Senegal and the Azores in the eastern Atlantic, and Nicaragua and Trinidad in the Caribbean [16 17]. The international movements of these species not only underscores the importance for international cooperation in sea turtle conservation, but also highlights the extent of the impact that fisheries have on marine turtles: all the tag returns mentioned above were the direct result of incidental capture by fisheries.

The first objectives of Projeto TAMAR-IBAMA following its creation were to conduct a thorough survey of the coastline of Brazil, in order to identify areas where the various species of sea turtle occur, to define the major threats to their survival, and to develop potential solutions for conservation problems involving turtles. The survey revealed that although turtles may be encountered in the waters all along the coast of Brazil, there are concentrations of feeding populations in key areas (Fig. 1). Green turtles, which are largely herbivorous and feed on turtle grass and algae [18], congregate on sea grass pastures and areas with high levels of algae, such as in coastal waters of the states of Ceará and São Paulo. Hawksbill turtles are mainly spongiverous [19], and tend to feed in areas with coral reefs; such as the waters around the oceanic islands of Atol das Rocas and Fernando do Noronha. In addition, there are some areas, for instance Itacimirim, Bahia, where turtles occur in large numbers both on nesting beaches and on nearby feeding grounds.

As one of the primary goals of Projeto TAMAR-IBAMA is to reduce the impact of human activities on sea turtles in Brazil, most of its efforts have been concentrated in those areas where there is interaction between people and turtles, including on the feeding grounds. For instance, there are large populations of feeding turtles in the waters of the island groups of Atol das Rocas and Fernando do Noronha, but as both are protected areas (as a Biological Reserve and as a National Marine Park,

respectively), fishing is not allowed. Nevertheless, TAMAR-IBAMA has been conducting an ongoing mark recapture study of hawksbill and green turtles in the waters of Fernando do Noronha, which has revealed details about growth and behavioral patterns [20].

On the other hand, there are large numbers of artisanal fishermen in Ceará and São Paulo, where there are also aggregations of turtles feeding in the water, and thus higher levels of accidental capture. TAMAR-IBAMA focuses its efforts on reducing the impacts of fisheries on turtles in these areas. In São Paulo, the primary fishing technique employed is a floating weir, while in Ceará most fish are caught using wooden *currais,* each of which span several kilometers and fence in fish (and turtles). The Projeto TAMAR-IBAMA bases of Ubatuba, in the state of São Paulo, and Amolfala, in the state of Ceará, were established specifically to work on the problem of accidental capture. More detailed descriptions of the problems and solutions for these areas are described below.

Education campaign

Prior to the establishment of the bases in areas with high levels of incidental capture of marine turtles, little was known about the status of marine turtles in their feeding grounds. The main difficulty early on was that the fishermen were hesitant to cooperate, given that capture of sea turtles is forbidden by law in Brazil. It became clear that the fishermen, fearing punitive legal retributions for revealing that they had accidentally captured sea turtles, were immediately throwing overboard all sea turtles found in their nets or traps. However, as most of these turtles were comatose, they probably were not able to recover and eventually died of asphyxiation. Projeto TAMAR-IBAMA realized that the law, although designed to protect sea turtles, was not enough to reduce the impact of incidental capture on marine turtles, and that a more creative solution was needed.

A founding principle for Projeto TAMAR-IBAMA was to establish a conservation program for marine turtles that would not be damaging economically to coastal communities that in the past had relied in part on the consumptive use of sea turtles or their products. The solution was to involve members of the local community in the machinery of the conservation program, such as helping patrol the nesting beaches, interacting with tourists in the visitor centers, or producing crafts and goods to be sold in the souvenir shops at the different bases [21]. In the case of incidental capture, Projeto TAMAR-IBAMA needed to find a way to reduce the level of mortality while at the same time not jeopardize the economic livelihoods of the local fishermen. The solution was a simple idea: to hire some of the fishermen who use nets to help patrol for turtles that had been accidentally captured, and to revive any comatose turtles so they were not likely to die once returned to the ocean.

Initially, Projeto TAMAR-IBAMA had to overcome the fishermen's fear of admitting they had accidentally caught turtles in their traps. It was established that the law was enacted strictly to halt the intentional capture of marine turtles; therefore, local fishermen who found a turtle in their nets that they had set for fish were not subject to punishment. Informing the fishermen of this paved the way for greater cooperation. The next hurdle to overcome was the problem of reviving the comatose turtles. For this, an education campaign was mounted to show the simple process of reviving turtles caught in nets. Using the slogan "Nem tudo que cai na rede é peixe" ("Nets catch more than just fish"), Projeto TAMAR-IBAMA distributed the information using posters, pamphlets, and even T-shirts. Simple graphics were designed and printed as posters to show the process of laying a comatose turtle on its back, and allowing it to recuperate until it begins beating its flippers against its plastron (in attempts to right itself), indicating recovery. Revived turtles returned to the water are thought to be more likely to survive than comatose turtles [22].

The education campaign also included information on the natural history of marine turtles, and their importance in the ecosystem. This imparted a greater understanding of the role that marine turtles play in the ocean, and strengthened the connection between the

coastal communities and these animals. A wider aim was to reinforce the feelings of respect and regard for the marine ecosystem as a whole. This in turn would help shape the way local communities interacted with the marine ecosystem; particularly in the way they envisioned how their actions, such as helping to revive comatose sea turtles, impacted the ecosystem upon which their livelihoods are dependent.

The benefits of the education program are represented by the number of turtles that have been released alive from the nets (see Tables 1 and 2). Although few data exist for the period prior to the establishment of monitoring by Projeto TAMAR-IBAMA, it has been inferred that more than half of all marine turtles accidentally captured in nets before 1990 probably did not survive (M.Â. Marcovaldi, personal observation). Life history analyses of marine turtles suggest that juvenile and adult mortality is a serious threat to the survival of sea turtle populations [23]. Therefore, the reduction of the level of mortality of turtles on feeding grounds in Brazil is a necessary component to the conservation and management of sea turtle populations in Brazil. However, long-term success of these conservation initiatives requires the integration of coastal communities who were previously dependent on turtles or their products. In this spirit, Projeto TAMAR-IBAMA has been trying to find ways to initiate alternative sources of income for coastal communities, as a way to reduce pressure on sea turtles from fishing techniques.

Creating alternative sources of income in Ubatuba and Almofala

Ubatuba is located on the north coast of the state of São Paulo. It is surrounded by small traditional communities whose primary earnings come from fishing, although increasing levels of tourism are creating alternative sources of income. Fishing efforts in and around Ubatuba are largely focused on catching shrimp and shark, using floating nets. It is in these nets that marine turtles are accidentally caught, primarily juvenile green turtles, although other species are also occasionally encountered. Between 1991, when the base of Ubatuba first started operating, and the end of 1998, about 2400 turtles were recorded as being incidentally captured, of which more than 90% were released alive (Table 1). The average number of captured turtles per year during this time was 275 (range: 44-675). Projeto TAMAR-IBAMA works year round in monitoring the fishing areas for incidental captures, with most of the focus being in 8 areas with the highest occurrence of turtles.

In addition to monitoring accidental capture in the nets, the Ubatuba station is also involved in developing alternative sustainable methods of using ocean resources for their economic livelihoods. One example is shellfish culture. Following the model of Ostini and Gelli [24], Projeto TAMAR-IBAMA introduced the Double Long Line method of mussel culture, which so far has provided monetary returns in excess of 6 times the original investment in equipment. This has reduced the number of nets being used by local fishermen, which in turn has reduced the number of incidental captures, all without jeopardizing the income of local residents.

Created in 1992, the Projeto TAMAR-IBAMA station in Almofala is located about 240 km to the west of Fortaleza, the capital of the state of Ceará. Almofala is a small indigenous community comprised primarily of descendents of the Tremembé tribe. The main source of income is derived from coconut plantations and artisanal fishing. Fishermen in Almofala use long wooden structures, called *currais,* to corral fish into a small area where they can be easily retrieved. Using simple boats without motors, the fishermen regularly check the *currais,* in which sea turtles are also trapped. The waters around Almofala are rich with benthic algae, upon which green turtles feed, and correspondingly, the primary species of turtle captured in Almofala is the green turtle, although

other species are also encountered (Table 2). The average number of captures each year from 1993 through 1998 was 36 (range: 5-82), of which more than 90% were released alive.

In terms of creating economic alternatives in Almofala, Projeto TAMAR-IBAMA has focused on restoring the cultural traditions of embroidery and needlework by the wives of the fishermen. The work produced is sold in shops at different Projeto TAMAR-IBAMA bases in Brazil, and profits are redistributed to the different bases. Projeto TAMAR-IBAMA has helped create community gardens, to supplement the diet of the local community. In terms of alternative methods of fishing in Almofala, predominant winds from the northwest during July and December make it challenging to implement any kind of fishing activity; even the *currais* are destroyed during this period of heavy sea-swells. Projeto TAMAR-IBAMA has been working to reintroduce *marambaias,* which are traditional constructions used by fishermen to attract fish so they can be captured easily. An important contribution from Projeto TAMAR-IBAMA has been the transition from the previous use of mangrove wood for construction, to the current use of recyclable materials (such as old tires, plastic bottles, etc.) for making the *marambaias.* To date, several fishermen have begun to use the *marambaias* instead of *currais,* which should help to reduce the occurrence of the accidental capture of marine turtles.

Future aims

Given that the foci of interaction between people and turtles on the feeding grounds are fishermen, it is a logical step to recruit fishermen to participate in research and data collection on sea turtles. Currently, fishermen are hired only to patrol nets and to release the turtles (indeed, many of the fishermen also work as volunteers in the program), while members of Projeto TAMAR-IBAMA teams do the actual tagging and measuring of the animals. In the future, it is hoped that fishermen will also be hired to collect morphological data and to tag the sea turtles they encounter.

Projeto TAMAR-IBAMA is also initiating a new program of monitoring incidental capture by industrial fishing ventures, in particular the long line fisheries in the southern waters of Brazil, which may represent an important source of sea turtle mortality at sea. An initial study aboard a single commercial fishing vessel in March/April 1998 revealed that more than 100 juvenile loggerhead sea turtles were captured during 9 long-line trawl events [25]. Of these, 83 were successfully released alive, suggesting that there is a good potential for success in reducing levels of mortality associated with this fishery, given an active collaboration between Projeto TAMAR-IBAMA and the long line fisheries.

The study of sea turtles on their feeding grounds is an important source information of the natural history of these endangered species. Such studies can reveal information on growth, behavior, and migration, which will enhance the understanding of the impacts of different forces, both natural and anthropogenic, on sea turtle populations. This in turn will benefit Projeto TAMAR-IBAMA, and perhaps other marine turtle conservation programs in other countries, in securing the long-term survival of marine turtles.

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