

***Nem tudo 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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INTRODUCTION

Marine turtles have been classified as endangered both federally in Brazil and at the international level.<sup>1</sup> 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 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 fishers 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.<sup>2</sup> Each year, Projeto

1. J. Baillie and B. Groombridge, *1996 IUCN Red List of Threatened Animals* (Gland: IUCN, 1996), pp. 62–4.

2. M. Â. Marcovaldi and G. G. Marcovaldi, "Marine Turtles of Brazil: The History and Structure of Projeto TAMAR-IBAMA," *Biological Conservation* 91 (1999): 35–41.

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.<sup>3</sup> 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.<sup>4</sup> After such a submersion, 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.<sup>5</sup> The estimates for the annual level of mortality associated with those captures range from 10,000 to 30,000 animals.<sup>6</sup> Since 1994, all US shrimping vessels have been required by federal law to use turtle excluder devices (TEDs),<sup>7</sup> 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<sup>8</sup> and it is thought that use of TEDs worldwide would help reduce the level of mortality of marine turtles at sea. Indeed, the Inter-American Convention for the Protection and Conservation of Sea Turtles, an international treaty that has not yet been fully ratified, promotes strict enforcement of the use of TEDs by 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; turtles are subject

3. National Research Council, *Decline of the Sea Turtles: Causes and Prevention* (Washington, D.C.: National Academy Press, 1990), pp. 82-107.

4. M. E. Lutcavage and P. L. Lutz, "Voluntary Diving Mechanism and Ventilation in the Loggerhead Sea Turtle," *Journal of Experimental Marine Biology and Ecology* 147 (1991): 287-96.

5. T. A. Henwood and W. E. Stuntz, "Analysis of Sea Turtle Captures and Mortalities during Commercial Shrimp Trawling," *Fisheries Bulletin* 85 (1987): 813-17.

6. *Ibid.*, National Research Council (n. 3 above).

7. M. E. Lutcavage, P. Plotkin, B. Witherington, and P. L. Lutz, "Human Impacts on Sea Turtle Survival," in *The Biology of Sea Turtles*, ed. J. A. Musick and P. L. Lutz (Boca Raton: CRC Press, 1997), p. 399.

8. L. B. Crowder, S. R. Hopkins-Murphy, and J. A. Royle, "Effect of Turtle Excluder Devices (TEDs) on Loggerhead Sea Turtle Strandings with Implications for Conservation." *Copeia* (1991): 773-9.

not only to injury during the explosions, but also attacks by Monk seals, whose food source has been largely depleted, causing them to prey on turtles as an alternative.<sup>9</sup> Driftnets can also entangle and kill sea turtles, and sea turtles are often caught by longline fisheries in the Atlantic and Pacific Oceans.<sup>10</sup> Clearly, different fisheries in various countries have particular impacts on sea turtles, and therefore different management strategies must be developed according to 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.<sup>11</sup> Schultz<sup>12</sup> and Pritchard<sup>13</sup> described a number of green and olive ridley turtles that were tagged while nesting on beaches in Suriname and 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.<sup>14</sup> 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 tag returns mentioned earlier were the direct result of incidental capture by fisheries.

The first objectives of Projeto TAMAR-IBAMA after its creation were to conduct a thorough survey of the Brazilian coastline to identify areas

9. D. A. Margaritoulis, D. Karavellas, and C. Irvine, "Predation of Adult Loggerheads by *Mediterranean Monk Seals*," in *Proceedings of the Fifteenth Annual Symposium on Sea Turtle Biology and Conservation*, ed. J. A. Keinath, D. E. Barnard, J. A. Musick, and B. A. Bell (NOAA Technical Memorandum NMFS-SEFSC-387, 1996), pp. 193-4.

10. P. Williams, P. Anninos, P. T. Plotkin, and K. L. Salvini, *Pelagic Longline Fishery-Sea Turtle Interaction: Proceedings of a Workshop* (NOAA Technical Memorandum NMFS-OPR, 1996).

11. B. W. Bowen and S. A. Karl, "Population Genetics, Phylogeography, and Molecular Evolution," in *The Biology of Sea Turtles*, ed. J. A. Musick and P. L. Lutz (Boca Raton: CRC Press, 1997), pp. 23-45; A. B. Bolen, K. A. Bjorndal, H. R. Martins, T. Dellinger, M. J. Biscoito, S. E. Encalada, and B. W. Bowen, "Transatlantic Developmental Migrations of Loggerhead Sea Turtles Demonstrated by mtDNA Sequence Analysis," *Ecological Applications* 8 (1998): 1-7.

12. J. P. Schulz, "Sea Turtles Nesting in Suriname," *Zoologische Verhandelingen* 143 (1975): 1-143.

13. P. C. H. Pritchard, "International Migrations of South American Sea Turtles (*Cheloniidae* and *Dermochelidae*)," *Animal Behavior* 21 (1973): 18-27.

14. M. A. Marcovaldi and A. Filippini, "Trans-Atlantic Movement by a Juvenile Hawksbill Turtle," *Marine Turtle Newsletter* 52 (1991): 3; L. L. Lum, E. M. Lima, and A. Santos, "Green Turtle Tagged in Brazil Recovered in Trinidad," *Marine Turtle Newsletter* 82 (1998): 11.

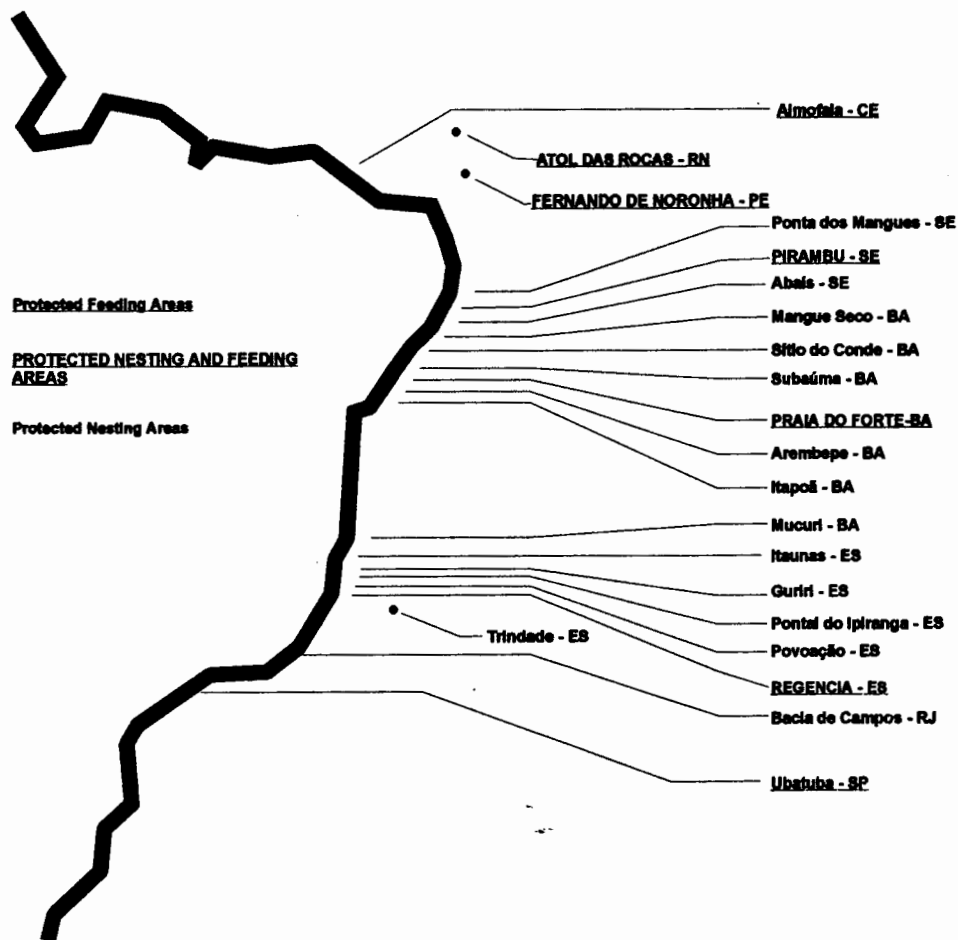


FIG. 1.—Map of the Brazilian coastline, with the locations of the 21 bases of Projeto TAMAR-IBAMA highlighted.

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,<sup>15</sup> congregate on seagrass pastures and areas with high levels of algae, such as in coastal waters of the

15. K. A. Bjorndal, "Nutritional Ecology of Sea Turtles," *Copeia* (1985): 736–51.

states of Ceará and São Paulo. Hawksbill turtles are mainly spongivorous<sup>16</sup> 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.<sup>17</sup>

On the other hand, there are large numbers of artisanal fishers 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* (traditional fishing weirs), 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 later.

#### 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 fishers were hesitant to cooperate, given that capture of sea turtles is forbidden by law in Brazil. It became clear that fishers, 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

16. A. Meylen, "Spongivory in Hawksbill Turtles: a Diet of Glass," *Science* 239 (1988): 393-5.

17. T. M. Sanches and C. F. Bellini, "Juvenile *Eretmochelys imbricata* and *Chelonia mydas* in the Archipelago of Fernando do Noronha, Brazil," *Chelonian Conservation and Biology* 3 (1999): 308-11.

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 visitors centers, or producing crafts and goods to be sold in the souvenir shops at the different bases.<sup>18</sup> 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 fishers. The solution was a simple idea; hire some of the fishers 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 fishers' 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 fishers who found a turtle in their nets that they had set for fish were not subject to punishment. Informing the fishers 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 by 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.<sup>19</sup>

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,

18. Marcovaldi and Marcovaldi (n. 2 above).

19. C. R. Shoop, C. A. Ruckdeschel, and R. E. Wolke, "The Myth of the Drowned Turtle," in *Proceedings of the Tenth Annual Workshop on Sea Turtle Biology and Conservation*, ed. T. H. Richardson, J. I. Richardson, and M. Donnelly (NOAA Technical Memorandum NMFS-SEFSC-278, 1990), pp. 85-7.

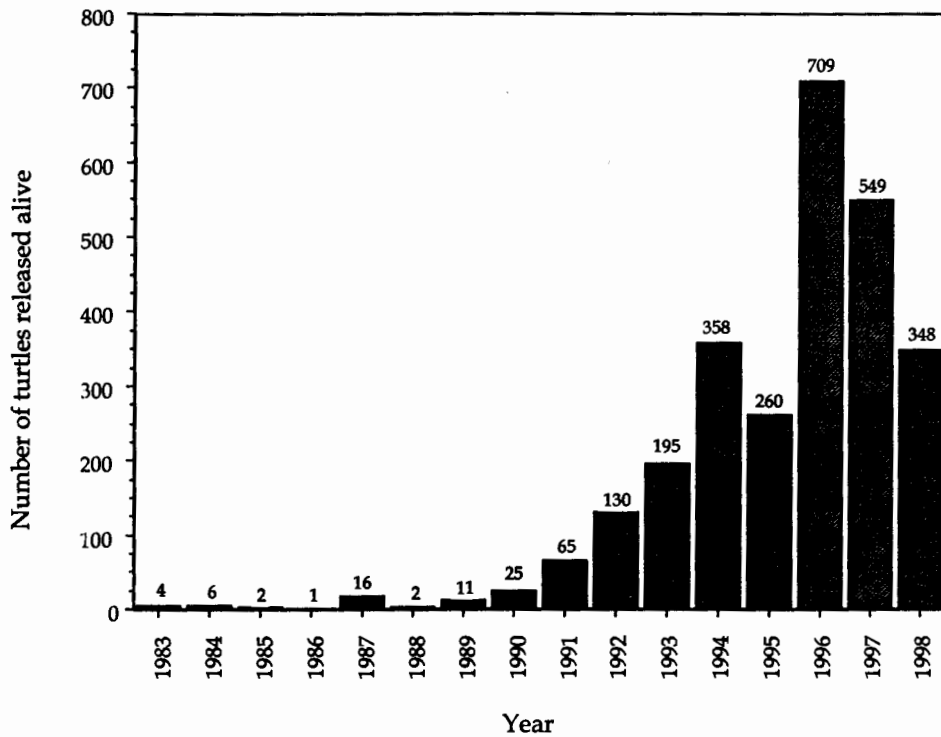


FIG. 2.—Annual numbers of turtles that are released alive, through the activities of Projeto TAMAR-IBAMA, after being captured accidentally in artisanal fishing nets.

and strengthened the connection between 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 figure 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

TABLE 1.—NUMBER OF CAPTURES OF SEA TURTLES BY FISHING NETS IN THE REGION OF UBATUBA, SÃO PAULO, BRAZIL, FROM 1991–98

Species	Released Alive	Dead
<i>Chelonia mydas</i> (green turtle)	2206	115
<i>Caretta caretta</i> (loggerhead)	43	6
<i>Eretmochelys imbricata</i> (hawksbill)	16	...
<i>Dermochelys coriacea</i> (leatherback)	10	2
Indeterminate	...	2
Total	2275	125

to the survival of sea turtle populations.<sup>20</sup> 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 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 focussed on catching shrimp and shark by 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 percent 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 eight areas with the highest occurrence of turtles.

20. D. T. Crouse, L. B. Crowder, and H. Caswell, "A Stage-Based Population Model for Loggerhead Sea Turtle and Implications for Conservation," *Ecology* 68 (1987): 1412–23.



TABLE 2.—NUMBER OF CAPTURES OF SEA TURTLES BY FISHING NETS IN THE REGION OF ALMOFALA, CEARÁ BRAZIL, FROM 1991–98

Species	Released Alive			Dead
	Male	Female	Indet.	Indet.
<i>Chelonia mydas</i> (green turtle)	24	29	124	14
<i>Caretta caretta</i> (loggerhead)	...	...	3	1
<i>Eretmochelys imbricata</i> (hawksbill)	...	...	4	...
<i>Dermochelys coriacea</i> (leatherback)	1	...	...	...
<i>Lepidochelys olivacea</i> (olive ridley)	...	...	3	...
Indeterminate	...	...	3	1
Total	25	29	137	16

Indet. = indeterminate.

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,<sup>21</sup> Projeto TAMAR-IBAMA introduced the double longline method of mussel culture, which so far has provided monetary returns in excess of six times the original investment in equipment. This has reduced the number of nets being used by local fishers, 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 descendants of the Tremembé tribe. The main source of income is derived from coconut plantations and artisanal fishing. Fishers 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 fishers 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 1993–98 was 36 (range: 5–82), of which more than 90 percent were released alive.

In terms of creating economic alternatives in Almofala, Projeto TAMAR-IBAMA has focussed on restoring the cultural traditions of embroidery and needlework by the wives of the fishers. The work produced is

21. S. Ostini and V. C. Gelli, *Manual Técnico de Mitilicultura* (São Paulo: Instituto de Pesca, Secretaria de Agricultura e Abastecimento do Estado de São Paulo, 1996), pp. 1–45.

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 *marambais*, which are traditional constructions used by fishers 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 *marambais*. To date, several fishers have begun to use the *marambais* 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 fishers, it is a logical step to recruit fishers to participate in research and data collection on sea turtles. Currently, fishers are hired only to patrol nets and to release turtles (indeed, many of the fishers also work as volunteers in the program), while members of Projeto TAMAR-IBAMA's teams do the actual tagging and measuring of animals. In the future, it is hoped that fishers 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 longline 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 nine longline trawl events.<sup>22</sup> 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 longline fisheries.

The study of sea turtles on their feeding grounds is an important source

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22. P. C. R. Barata, B. M. G. Gallo, S. Dos Santos, V. G. Azevedo, and J. E. Kotas, "Captura Acidental da Tartaruga Marinha *Caretta Caretta* (Linnaeus, 1758) na Pesca de Espinhel de Superfície na ZEE Brasileira e em Águas Internacionais," *Proceedings of XI Semana Nacional de Oceanografia* (Rio Grande, RS, Brasil, 1998), pp. 579-81.

of information on 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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