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Marine turtles of Brazil: the history and structure of Projeto TAMAR-IBAMA

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Abstract

Projeto TAMAR-IBAMA, jointly administered by the Government of Brazil and the non-governmental organization Fundação Pró-TAMAR, has established 18 conservation stations which cover 1100 km of the Brazilian mainland coast (in the states of São Paulo, Rio de Janeiro, Espírito Santo, Bahia, Sergipe, and Ceará). In the oceanic islands of Fernando de Noronha, Atol das Rocas, and Trindade, only the first has a permanently staffed station. The program was initiated in 1980 to investigate and implement a program for the conservation of sea turtles. As a direct result of TAMAR's efforts, the harvest of gravid females and of eggs has ceased in all major nesting areas. The success of the program is based on local participation of the fishing villages, including the employment of former egg poachers to patrol the beaches and protect the nests, education programs, and ecotourism. The majority of stations are staffed year round and not only promote the conservation of endangered sea turtles, but also organize community festivals, support local schools and health care facilities, and assist in developing alternative sources of income for residents who once relied on the exploitation of sea turtles. A similar effort to protect coastal feeding areas where incidental capture is high was initiated in 1991.

Keywords: Sea turtle; Community based conservation; Community participation; Environmental education; Brazil

1. Introduction

Legislation partially protecting sea turtles was passed in Brazil in 1967 and a moratorium on the capture of leatherback (*Dermochelys coriacea*) and hawksbill (*Eretmochelys imbricata*) turtles was approved in 1968. In 1976, the moratorium was extended to the olive ridley (*Lepidochelys olivacea*) and the harvest of loggerhead (*Caretta caretta*) and green (*Chelonia mydas*) turtles was restricted to individuals larger than 70 and 80 cm, respectively, during an annual open season (1 May through 30 November). Full protection for all species occurring in Brazil was enacted in 1986. Despite advances in the regulatory framework, Brazil came under increasing international pressure to promulgate more comprehensive conservation legislation and to implement sea turtle conservation programs. Advocates argued that since sea turtles are migratory and routinely feed in the waters of one country and then lay eggs on the beaches of another, all nations must work together to achieve the sustained recovery of regionally depleted stocks. In response, the Brazilian government established the National Marine Turtle Conservation Program in Brazil (Projeto TAMAR) in 1980, affiliated with the Brazilian Institute for the Environment (IBAMA).

The initial objectives of TAMAR were to quantify the number of species, distribution and abundance of sea turtles, the seasonality and geographic range of egg-laying, and the primary threats to turtle survival. A comprehensive two-year survey of the coastline was carried out between 1980 and 1981. Although virtually nothing had been published about sea turtles in Brazil, information gleaned from an international literature review suggested that the survey should be divided into two regions. South of Rio de Janeiro, climatic conditions were not expected to be conducive to sea turtle nesting, and questionnaires were sent to all government agencies, universities, and other institutions that had marine programs in this region. North of Rio de Janeiro, a field survey, to include interviews with coastal residents, was planned. At that time, most urban agencies and universities in the northern region had no

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information about sea turtles; indeed official sources assumed there were no sea turtles at all in Brazil.

The purpose of this paper is to provide an explanation of the activities of Projeto TAMAR. A description of the stations, the study areas, and selected details of program administration, and community outreach are included. This paper is not intended to present a thorough literature review of sea turtle conservation techniques, but rather illustrate what we have established by way of a national conservation program in one of the largest developing countries in the world. We hope that this will give conservationists elsewhere a working experimental model from which to design their own national recovery programs for endangered species.

2. Initial survey

Sandy beaches, many of which are difficult to reach, span ca. 6000 km of coastline from Rio de Janeiro to the French Guiana border. Beach surveys, both continental and insular, made use of boats, foot-patrol, and horses. Interviews with fishermen were arranged and conducted cautiously, with simple questions designed not to prompt biased answers. Questions asked included: "Have you ever seen a sea turtle?", "If so, how many?", "When do the turtles come to the beaches?", and "How many different kinds of turtles have you seen?" Other sources of information, such as decorative displays of turtle shell in houses, were used to confirm and augment the interview data. From all the sources of information, it became clear that (1) there were three main nesting areas on the mainland: Praia de Comboios, Espírito Santo; Praia do Forte, Bahia; and Pirambu, Sergipe, (2) the loggerhead turtle was the most abundant nester on the mainland, (3) only the green turtle nested on the islands, (4) the mainland nesting season spanned September through March (and sometimes April), (5) the island nesting season spanned December through May, and (6) the main threat was the harvest of eggs and to nesting females.

Despite the fact that exploitation had occurred at a subsistence level (we found no formal markets for turtle products), the survey revealed that a substantial annual harvest had taken place for generations with little regard for population size or rates of recruitment. Many interviewees confided that populations had been considerably larger in the past. The primary commodities were eggs, meat and shell, but there was no evidence of the use of oil or skins. Patterns of harvest and use differed only slightly among villages. Generally, feeding or nesting turtles were captured opportunistically. In the states of Alagoas and Pernambuco, a few artisans earned income from the sale of hawksbill shell jewellery to urban retail buyers. There was a small and informal market in some cities for whole turtle shells displayed for decoration. Egg poaching was widespread all along the coast, often approaching 100% of all eggs laid. In no case did turtles provide a primary source of either income or protein.

As a direct result of the initial surveys, in 1982 TAMAR established stations at the three primary nesting sites it had encountered. Study area boundaries were based on anecdotal data pertaining to the relative number of nests and consideration of natural rookery boundaries, especially for the rarer species. TAMAR has since expanded, and today a network of stations and associated conservation and monitoring activities provide for the protection of all sea turtles and their eggs on ca. 1100 km of coastline and oceanic islands. In addition, coastal fishing villages are fully integrated into the program. Fishermen and local villagers comprise the majority of paid personnel (85%) who work in the program.

3. Stations and study areas

At the current time, Projeto TAMAR operates 21 research and conservation bases in Brazil (Table 1, Fig. 1). The majority of the bases on the mainland are staffed year round, and in the archipelago of Fernando do Noronha. The islands of Atol das Rocas and Trindade are visited sporadically by TAMAR personnel, as it is difficult logistically to transport people and supplies back and forth. The Biological Reserve of Atol das Rocas is located 267 km off the coast of the state of Rio Grande do Norte, and comprises two small islands (Bellini et al., 1996). These two island groups are also feeding grounds for green and hawksbill turtles. Trindade Island (state of Espírito Santo) is located 926 km from coast of Espírito Santo, is administered by the Brazilian Navy, and has the only nesting population of sea turtles in Brazil that apparently has not suffered a decline caused by human activities.

4. Methods

4.1. Nesting areas

Despite almost two decades of conservation work, it has not been possible to extend equal effort to all areas of the Brazilian coastline, even within TAMAR stations. Therefore, an intensive study area (ISA) and a conservation area (CA) are associated with each of the continental stations that have nesting populations. Each ISA is coincident with a major concentration of nesting. A research team consisting of the station manager and a variable number of interns, generally biology students, patrol the ISA each night during the nesting season. An ISA can extend from 5–50 km; vehicles are used to

Table 1
Conservation and research stations operated by TAMAR

Station name	State	Station type	Founded	Area covered	Species
Ubatuba	SP	Feeding grounds	1991	100 km	*Cm, Cc, Ei, Dc*[a,b]
Bacia de Campos	RJ	Nesting areas	1993	60 km	Cc
Comboios	ES	Nesting areas	1982	40 km	Cc, Cm, Dc
Povoação	ES	Nesting areas	1987	60 km	Cc, Ei, Dc
Pontal do Ipiranga	ES	Nesting areas	1987	70 km	Cc, Ei, Dc
Guriri	ES	Nesting areas	1988	55 km	Cc, Ei, Lo
Trindade	ES	Nesting areas	1986	2 km	Cm
Itaunas	ES	Nesting areas	1991	30 km	Cc, Ei, Lo
Mucuri	BA	Nesting areas	1994	57 km	Cc, Ei, Lo
Itapoã	BA	Nesting areas	1993	20 km	Cc, Ei, Lo, Cm
Arembepe	BA	Nesting areas	1983	65 km	Cc, Ei, Lo, Cm
Praia do Forte	BA	Nesting areas/ feeding grounds	1982	50 km	Cc, Ei. Lo, Cm, *Cm*[a]
Subauma	BA	Nesting areas	1988	43 km	Cc, Ei, Lo, Cm
Sitio de Conde	BA	Nesting areas	1991	50 km	Cc, Ei, Lo, Cm
Mangue Seco	BA	Nesting areas	1991	32 km	Cc, Ei, Lo, Cm
Abaís	SE	Nesting areas	1987	35 km	Lo, Cc, Ei, Cm
Pirambu	SE	Nesting areas	1982	55 km	Lo, Cc, Ei. Cm
Ponta do Mangues	SE	Nesting areas	1990	80 km	Lo, Cc, Ei, Cm
Fernando do Noronha	PE	Nesting areas/ feeding grounds	1984		Cm, *Cm, Ei*
Atol das Rocas	RN	Nesting areas/ feeding grounds	1982	4 km	Cm, *Cm, Ei*
Almofala	CE	Feeding grounds	1992	65 km	*Cm, Ei, Cc*

[a] Marine turtle species given in italics are species protected at sea, on their feeding grounds.
[b] NOTE: State abbreviations are as follows: SP = São Paulo, RJ = Rio de Janeiro, ES = Espirito Santo, BA = Bahia, SE = Sergipe, PE = Pernambuco, RN = Rio Grande do Norte, and CE = Ceará. Species abbreviations are as follows: Cm = *Chelonia mydas*, Cc = *Caretta caretta*, Dc = *Dermochelys coriacea*, Ei = *Eretmochelys imbricata*, and Lo = *Lepidochelys olivacea*.

patrol larger areas. Nesting turtles encountered during patrols are measured [curved carapace length (CCL) and width], and flipper-tagged with monel or inconel tags (#681, National Band Company, Kentucky, U.S.A.; cf. Pritchard et al., 1983; Limpus, 1992) [for loggerheads, straight carapace length (SCL) can be estimated from: SCL = 0.98 CCL–5.14; Frazer and Ehrhart, 1983]. All nests left in situ are marked with a unique number. In areas where predators are a serious threat, nests are protected with a plastic or wire mesh buried just below the surface of the sand, above the eggs. The mesh size is large enough ($\geq$7 cm square) to allow hatchlings to escape from the nest. Each TAMAR station has an open-air hatchery that normally receives eggs from the surrounding beaches in the CAs. The ISA, where nests are always monitored in situ, serves as a control against which to evaluate the success of the eggs and the incubation conditions in the hatchery.

Unlike the ISAs, the CAs are monitored and protected by the local fishermen. These are the same fishermen who in the past were the main turtle hunters and egg collectors, and are now hired by TAMAR to patrol sections of beaches. Each fisherman is responsible for patrolling ca. 5 km of beach each morning. When he encounters a nest the fisherman carefully transfers it to a Styrofoam box, using sand to pack the eggs together. The fishermen deliver the boxes to TAMAR station staff at collection points. The eggs are then moved to hatcheries that are centrally located in natural nesting habitat, which normally reduces transport time to less than 12 h between laying and reburial. This strategy reduces the potential negative consequences for developing embryos associated with transport (Limpus et al., 1979, 1980; Parmenter, 1980; Blanck and Sawyer, 1981; Chan et al., 1985). Hatchery nests are maintained as closely as possible to natural conditions (D'Amato and Marczwski, 1993; Marcovaldi and Laurent, 1996).

While some authors have highlighted the potential biological impacts of hatcheries (e.g. Vogt, 1994), our experience has been that properly constructed and maintained enclosures provide comparable hatch success to in situ nests (Bapistotte, 1995; Marcovaldi and Laurent, 1996). In addition, we carefully monitor a variety of incubation variables (incubation period, temperature, etc.) in order to keep the incubation conditions similar between the natural nests and those in the hatchery. Hatcheries are a necessary interim step; for now, nests that cannot otherwise be protected from poachers, predators, heavy beach traffic, or erosion, are moved to hatcheries for safe incubation. Where TAMAR has been working for several years, the level of involvement and pride in the project on the part of the villagers is very high, and more nests are being left in situ over ever-expanding areas. The main goal of TAMAR in the near

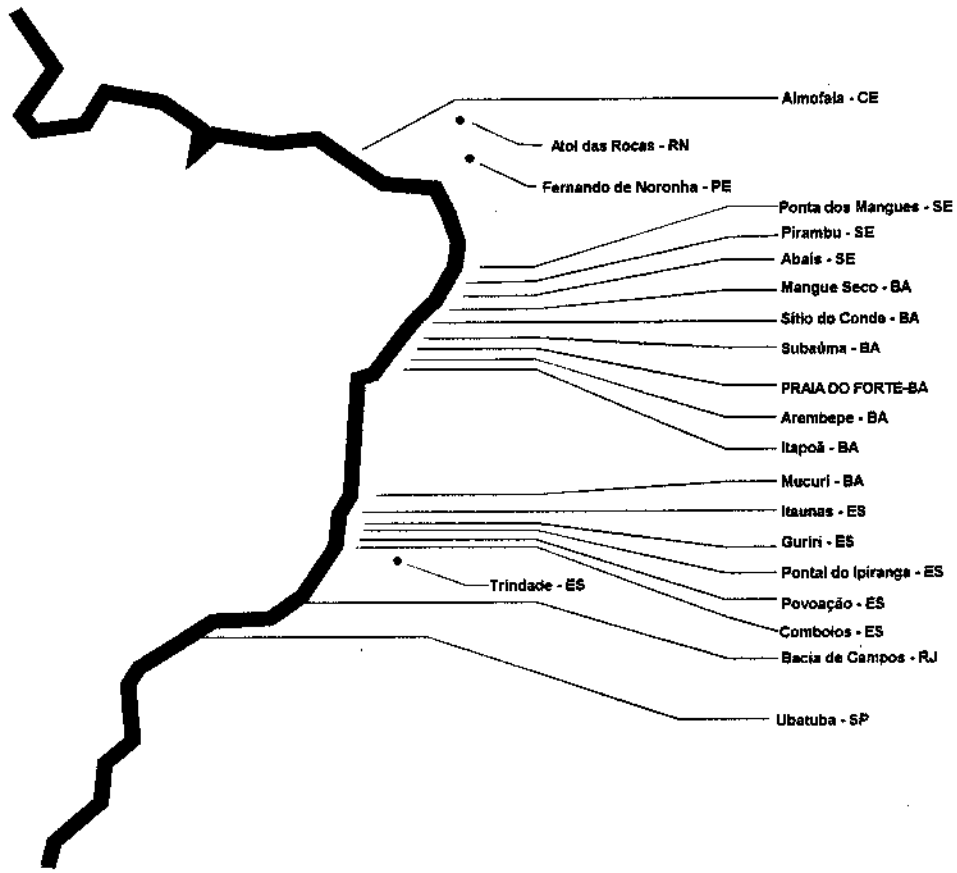

Fig. 1. Projeto TAMAR administers 21 sea turtle conservation stations along 1100 km of Brazil's coast, both on the mainland and on oceanic islands. The headquarters is located in Praia do Forte, Bahia. There are no permanent stations at Atol das Rocas or Trindade island. State abbreviations are given in Table 1.

future is to keep as many nests as possible in situ. Nowadays, nearly 70% of all nests are left in their original places. For the time being, the beach hatcheries are a necessary component of our national strategy.

Conservation on the islands is more expensive and logistically challenging than on the mainland. TAMAR has established one permanent island station, located on the Marine National Park of Fernando de Noronha. There are several beaches on the main island of this archipelago which are patrolled nightly, from December through May, to tag and measure nesting females and to mark and monitor nests. All nests are protected in situ; after hatching, nests are exhumed and the contents recorded. In the Biological Reserve of Atol das Rocas, which receives ca. 500 occurrences of nesting females per nesting season, field teams are transported to the atoll by boat and remain there for 1 month periods. Until recently, there was complete coverage of the 1 km nesting beach from December through July, to tag and measure nesting females, and mark and monitor nests (Bellini et al., 1996). Currently, visits are made opportunistically, and a sample of nests is exhumed post-hatching and analyzed each year. There has also been tagging of gravid females on Trindade Island, but no conservation efforts have been necessary (Moreira et al., 1995). Trindade supports the largest nesting colony of green turtles in Brazil, with ca. 5000 occurrences of female turtles on its nesting beaches per season, and offers a potentially excellent research opportunity because the nesting population has been undisturbed, largely due to the presence of a Brazilian Naval facility, which restricts public access to the island.

4.2. Feeding areas

The stations dedicated to protecting turtles on their feeding grounds were set up in areas where it was believed that large numbers of turtles were being accidentally caught and subsequently drowned in various forms of artisanal fishing nets and wooden currais (Marcovaldi, 1993). Building on the positive experience at the other stations, research and monitoring of turtles in the water have been designed to incorporate participation of the coastal residents. The objectives include (1) educating fishermen and coastal residents about the natural history of sea turtles, and their role in the ecosystem, and (2) to develop strategies to reduce the numbers of turtles drowned through incidental capture.

Results so far include the introduction of alternative fishing methods, such as the 3 Fish Aggregating Device (Bergstrom, 1983), or, more recently (and more successfully), oyster and mussel culture. Several families that once relied on fishing nets for their livelihoods now work with shellfish culture (Giffoni et al., 1998). Another positive outcome has been the recruitment of the fishermen in actively resuscitating "stunned" turtles. Frequently, after being caught in a net, a sea turtle becomes comatose and appears dead (Shoop et al., 1990). In the past, stunned turtles accidentally caught by the fishermen were quickly thrown back in the water, causing them to die. These actions were based on the fishermen's fear of punishment, because turtles in Brazil are protected by law and their intentional capture is banned. In response to this situation, TAMAR began distributing pamphlets and posters explaining how the fishermen can save turtles that are accidentally caught. The fishermen are encouraged to check their nets often for sea turtles, and are instructed how to revive an unconscious animal. After resuscitation, the turtles are released in the ocean by the fishermen, usually with tags. This educational initiative, entitled "Not everything caught in a net is fish," exemplifies the kind of innovative approach needed to successfully protect and monitor turtles in Brazil. In addition, the tagging program at the feeding ground stations has provided information about the migratory routes of these turtles (e.g. Lum et al., 1998).

5. Institutional structure

Projeto TAMAR is a federal governmental program created in 1980, by IBAMA, (Brazilian Institute for the Environment), with the mandate to protect sea turtles in Brazil. In the beginning, the program was also affiliated with and assisted by several national non-governmental organizations (NGOs). However, as the program matured in scope and personnel, and the budget expanded at a quickening pace, the alliance became unmanageable for a number of reasons. In response, in 1988, Fundação Pró-TAMAR was legally created to support, raise funds, and co-administer Projeto TAMAR with the government. Fundação Pró-TAMAR, a Brazilian NGO, is comprised of a president, a board of counselors, five regional coordinators, and five technical coordinators. Each regional coordinator position is usually held by a former TAMAR station manager, and is responsible for the functioning of the bases within his or her specific region. At the present time, TAMAR is funded by the government (~40%) and Fundação Pró-TAMAR (~60%). The non-governmental monies comes from the manufacture and sale of TAMAR products (T-shirts, embroidery, etc.) as well as from Brazilian private and public organizations, and two international financial agencies: the European Economic Union and the Interamerican Bank for Development.

6. Community participation

Of the 400 people working in the 21 TAMAR stations, 85% are presently salaried by Fundação Pró-TAMAR, and most of the employees are fishermen and other local villagers. In most beaches where TAMAR is present, the program is the primary source of income, both directly and indirectly, to the local village. Most of the funds raised by Fundação Pró-TAMAR are invested in the communities where TAMAR develops its activities, helping to solidify the bond between TAMAR and the coastal communities. Regular meetings with fishermen provide a forum to discuss problems, air complaints, and highlight successes.

The primary community benefit has been the direct hire of ex-poachers to patrol the beaches. This has given these fishermen status within their communities, a greater knowledge of sea turtles (which they then share with others), and an enhanced conservation ethic. The decision to spend virtually all the project budget within the fishing communities was based on the simple reality that the sea turtles of Brazil were disappearing. When beginning a program with endangered species, there is not always the luxury of conceiving long-term goals and elaborate educational strategies. At that time, the only way to immediately halt the ongoing harvest of turtles and eggs was to hire key fishermen. They receive a salary for patrolling the nesting beach in their regular fishing areas. Each man comes from a different community, and this is a practical way to disseminate the sea turtle conservation message. The fishermen are seen as TAMAR representatives in the outlying villages. They are proud of and respected for the work that they do toward the preservation of the species.

7. Educational programs

TAMAR staff live at the majority of stations yearround, and their constant presence reflects their status as integral members of the village communities. This integration is the heart of the TAMAR project, and central to the success of its efforts to provide for the sustained conservation of sea turtles and a corresponding benefit to the lives of coastal residents. One of the most important aspects of the project is community outreach and education within the coastal villages, including school presentations of videos and slides, hatchling release ceremonies, and festivals. The goal is to increase local awareness of the importance of a healthy marine ecosystem, which includes turtles.

Tourists are also targeted in the education campaigns. At least one station in each state is equipped with a visitor's center, where a small number of turtles (15–30) at various stages of maturity, are maintained in healthy condition for public education purposes. These facilities are open to the public free of charge, except for the center in Praia do Forte, which collects a token entrance fee. Visitors learn about Brazil's endangered sea turtles by observing live turtles in the tanks, inspecting the hatchery, watching videos, and interacting with station staff. At some visitor's centers, tourists have the opportunity to participate in a hatchling-release program with biologists as guides (Vieitas and Marcovaldi, 1997). In Praia do Forte, TAMAR has established a "Mini-Guide" program, whose aim is to provide environmental education and experience for the young people of the village (Vieitas et al., in press).

TAMAR also has an intern-training program, which involves ca. 50 university students or recent graduates each year. The interns receive room and board during their stay of six months (the majority of the nesting season) at an assigned base. In return for their daily work at TAMAR, the interns gain valuable experience in the management of endangered species, which allows them to integrate their academic background with the practical realities of conservation.

8. Accomplishments and future plans

We count among our most visible achievements the following: the declaration of two Federal Biological Reserves, which were created to protect sea turtles and are currently administered by TAMAR; the creation of a Marine National Park; a nationwide prohibition of the capture of sea turtles or their eggs; and total control of the beaches which fall within the boundaries of the stations of TAMAR. As a result of our work, the killing of females and collection of eggs has been drastically reduced, turtles that are accidentally captured in nets are being revived and returned to the sea alive, and there has been an increasing trend in the total number of turtle nests protected on all the mainland beaches patrolled by TAMAR (Fig. 2).

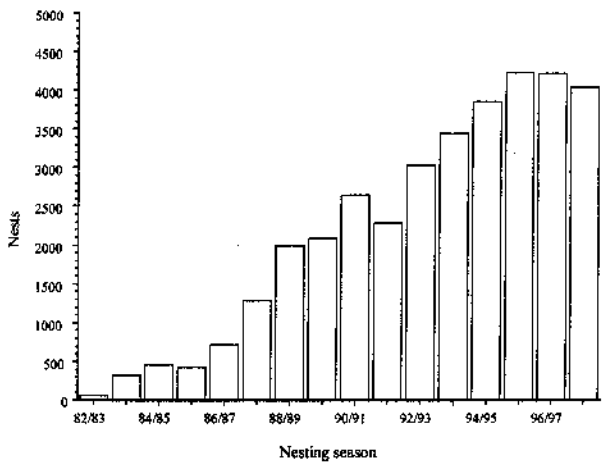

Fig. 2. Number of sea turtle nests protected by research stations of Projeto TAMAR, on the mainland coast of Brazil. In addition, the islands of Atol das Rocas and Trindade receive approximately 500 and 5000 occurrences per season, respectively.

We hope to increase our level of self-sustainability to a level that will guarantee that Projeto TAMAR continues on long into the future. We also hope to keep up the process of self-evaluation and assessment. Finally, we continue to strive for cooperation with other marine turtle conservation programs elsewhere in the world, as we believe that by exchanging experiences, different programs can generate new ideas that will help achieve better conservation programs for marine turtles.

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