MARINE TURTLES

OF THE INDIAN SUBCONTINENT

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Fishery-Related Mortality of Sea Turtles in India: An Overview

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Coastal communities have exploited sea turtles for centuries. In the 1950s, organised fisheries were developed to capture turtles in many parts of the world; sea turtles were considered an important exploitable fishery resource due to their high commercial value. Turtle meat and eggs were seen as a basic protein source for coastal populations. In India, Jacob (1973) highlighted the potential of sea turtle resources. Organised trade in turtle products existed prior to the eighties (Dattatri 1984, Rajagopalan 1984, 2000). It is estimated that 50,000–80,000 adult olive ridleys were captured off the Gahirmatha coast every nesting season up to 1981–82 (Das 1985).

In September 1977, the five species of sea turtles that occur in Indian waters were included in Schedule I of the Indian Wildlife (Protection) Act, 1972. As a consequence of the implementation of regulatory measures, organised capture and trade decreased, though illegal trade persisted till the mid-1980s. While the threat from targeted capture and trade decreased, incidental capture of sea turtles in gear operated for other species of fish and shellfish has become more significant over the years. The interaction of sea turtles with fisheries has become an area of critical importance in many parts of the world (Gerosa and Casale 1999, Vivekanandan 2002). In India too, incidental capture in gill nets and trawls has become a serious threat to sea turtle populations (Rajagopalan et al 1996, 2001, Pandav and Choudhury 1999, Wright and Mohanty 2002). Due to an increase in the number of fishing units, and also improvement in technology, incidental bycatch has increased in recent years to the extent that it is the most significant cause of sea turtle mortality in Indian waters.

Considering the magnitude and gravity of the threat, it is imperative to plan and implement measures that will reduce fishery-related incidental mortality of sea turtles.

The complex linkage of fishing activities with the objectives of different sectors and interests of multiple stakeholders makes it difficult to plan and execute conservation measures in isolation. To initiate feasible measures, the causative factors and ramifications of conservation action have to be clearly understood. In this paper, we have traced the development of the marine fisheries sector, which has culminated in excessive fishery-related mortality of sea turtles. We have also provided a framework to evolve possible approaches to achieve the objectives of conservation.

Status of Marine Fisheries in India

Fish is an important source of protein for coastal communities and prior to Independence, traditional fishing craft and gear characterised the marine fisheries sector in India. The trade was entirely domestic except for the limited export of dried/cured products. The latter half of the last century witnessed tremendous structural transformations in the marine fishing sector. The most important change was the introduction of mechanised fishing craft[1] and modern fishing techniques such as trawling, purse seining and long-lining. In addition, motorisation of traditional craft[2] was promoted in a big way to enable fisher folk to reach distant fishing grounds and save cruising time. These and other developments have facilitated overall growth and expansion in production and trade, elevating marine fisheries as an economically important sector.

The population of fisher folk in the country is estimated to be five million, of which about one million are actively engaged in marine fishing. They currently operate 47,000 mechanised boats, 36,500 traditional motorised boats and 150,000 traditional non-motorised craft from six major fishing harbours, 27 minor fishing harbours and 2,271 traditional fish-landing centres along the coast. The traditional and mechanised fishing units spend about 72 million fishing hours annually for the capture of fishery resources from coastal waters. The gross investment in fishing equipment and processing plants at current price is estimated to be Rs 180 billion. The value of annual production at landing centres, and at consumer levels, is estimated to be Rs 100 billion and Rs 200 billion respectively (Vivekanandan 2002).

India's fish production rose from a mere 0.75 million tonnes in 1950–51 to 5.6 million tonnes in 1999–00. The marine fish production during this period increased from 0.54 m t to 2.8 m t. The growth in marine products exports was dramatic, beginning with a meagre 19,700 t valued at Rs 24.6 million in 1950–51, and increasing to 0.38 m t valued at Rs 41.2 billion during 1996–97. Though the quantity has fluctuated slightly during subsequent years, the export earnings increased to peak at Rs 50.95 billion during 1999–2000. The growth in production and exports was not uniform during this period. In general, the growth was slow during the '50s, but gathered momentum during the '60s and '70s and again started slowing down during the late-'80s (Table 1).

[1] Most designs in mechanised craft and gear were initially promoted by various international agencies and projects. Mechanised vessels use power from inboard engines for propulsion as well as operation of gear. Larger vessels even use engine power for refrigeration onboard.

[2] Motorised craft are traditional fishing craft modified to use power from the engine (mostly outboard) for propulsion only, though recently some traditional motorised craft have started using engine power to operate small dragged nets.

Table 1. Fish production and exports at selected periods during the period 1950–2000.

Year	Marine ($t \times 10^5$)	Total ($t \times 10^5$)	Exports ($t \times 10^3$)	Value ($Rs \times 10^7$)
1950–51	5.34	7.52	19.7	2.46
1960–61	8.8	11.6	15.7	3.92
1970–71	10.86	17.56	35.9	35.07
1980–81	15.55	24.42	75.6	234.84
1981–82	14.45	24.44	70.1	286.01
1982–83	14.27	23.67	78.2	361.36
1983–84	15.19	25.06	92.7	373.02
1984–85	16.18	28.01	86.2	384.29
1985–86	17.16	28.76	83.7	398
1986–87	17.13	29.42	85.8	460.67
1987–88	16.58	29.59	97.2	531.2
1988–89	18.17	31.52	99.8	597.85
1989–90	22.75	36.77	110.2	635
1990–91	23	38.36	139.4	893.37
1991–92	24.47	41.57	171.8	1,375.89
1992–93	25.76	43.65	208.6	1,767.43
1993–94	26.49	46.44	244	2,503.62
1994–95	26.92	47.86	305.1	3,553.08
1995–96	28.25	49.5	296.3	3,501.11
1996–97	28.57	51.4	378.2	4,121.36
1997–98	29.5	53.88	383.8	4,697.48
1998–99	26.96	52.62	302.9	4,626.87
1999–2000	28.34	56.05	340	5,095.73

(Source: Department of Animal Husbandry and Dairying, Ministry of Agriculture, Govt. of India.)

The structural changes that took place in marine fishing during the latter half of the past century was catalysed by the expanding export markets for commodities like shrimp. The shrimp market has had a significant impact on sea turtles in India (Vijayakumaran 1996, Rajagopalan and Vijayakumaran 2001); in the absence of such a market, significant progress in mechanisation would not have happened. This mechanisation and expansion of fisheries has had a detrimental effect on sea turtles in Indian waters. Examining the magnitude of the changes in some key components of the fisheries sector at select points of time may give an indication of the nature and degree of their effect on sea turtle populations.

CHANGES IN KEY COMPONENTS

The active population of fisher folk involved in marine fishing in the country was a mere 0.23 million during the early '60s, which grew to one million by 1999. The number of traditional boats increased from 90,000 in the early '60s to 150,000 in 1999.

The fleet of mechanised vessels, non-existent during the early '60s, rose to 47,000 by 1999. Fishing villages and fisher folk showed remarkable growth during this period (Table 2).

Table 2. The changing numbers of marine fishing villages, fisher folk and number of craft in India over different periods.

Period	1961–62*	1973–77*	1980*	1999**
Fishing villages	1,797	1,913	2,408	3,651
Fisher folk	959,937	1,435,158	2,096,314	5,000,000
Active fisher folk	229,345	322,532	474,731	1,000,000
Traditional boats	90,424	106,480	140,833	150,000#
Mechanised boats	0	8,086	19,013	47,000

(Source: * James 1989, ** Devaraj and Vivekanandan 1999)

Does not include 36,500 motorised boats

From 1980–98, there was a phenomenal increase in the number of craft and gear all along the coast, though some types of craft and gear (like *catamarans*) showed a reduction in number (Table 3). While the number of mechanised boats increased by 428 per cent, the traditional craft showed an overall decline of 5 per cent. It must be noted that significant numbers of traditional craft were motorised, resulting in expanded areas of operation and reduced cruise time to and from grounds. Modern gear such as trawl nets, purse seines and gill nets were responsible for a 235 per cent increase in gear, while major traditional gear such as traps, shore seines and boat seines declined significantly.

Table 3. Increase in number of fishing craft and gear from 1980–98.

Particulars	1980	1998	Change (per cent)
Fishing craft			
a) Mechanised			
Trawlers	6,288	30,979	393
Gill netter	2,362	9,968	322
Doll netter	241	5,538	2,198
Purse seiners	221	1,006	355
Others	177	1,579	792
Total	**9,289**	**49,070**	**428**
b) Traditional			
Plank-built boats	37,904	39,951 (43)*	5
Dug-out canoes	21,684	17,297 (38)*	-20
Catamarans	73,431	58,921 (29)*	-20
Others	1,722	11,349 (89)*	559
Total	**134,741**	**127,518 (40)***	-5
Fishing gear			
Trawl nets	14,165	151,466	969
Purse seines	238	1,216	411
Drift / set gill nets	216,037	1,534,555	610
Boat seines	29,976	8,166	-73

Table 3 (contd.)

Particulars	1980	1998	Change (per cent)
Fixed bag nets	48,817	77,582	59
Hooks and lines	56,676	89,261	57
Rampans	187	257	37
Shore seines	18,841	4,481	-76
Traps	98,825	4,068	-96
Scoop nets	6,080	3,719	-39
Others	95,804	86,527	-10
Total	**585,646**	**1,961,298**	**235**

* motorised vessels (percentage in parentheses) included.

(Source: CMFRI census 1980 (Anon 1981) and Rapid Census 1998.)

The current strength of the fleet per unit length of coastline in different maritime states gives an indication of fishing traffic (Table 4). In India, on an average, there are more than six mechanised vessels, nearly 16 traditional vessels and about 183 gill nets for every kilometre of the coastline.

These figures must be viewed cautiously since the spatial distribution of fishing effort is not uniform, especially in the case of mechanised fishing vessels. There is also a great degree of overlap of operational boundaries, of both mechanised as well as traditional vessels, from adjacent states.

Table 4. Number of boats and gear per kilometre of coastline in different maritime states as per the 1998 rapid survey.

States	Mechanised boats	Traditional craft	Gill nets
West Bengal	26.68	24.45	47.89
Orissa	4.17	16.4	42.77
Andhra Pradesh	2.18	29.09	63.61
Tamil Nadu	7.37	37.29	145.06
Pondicherry	10.27	60.76	214.07
Kerala	8.62	43.02	72.11
Karnataka	10.81	26.93	38.94
Goa	9.39	12.86	19.98
Maharashtra	18.66	8.96	231.23
Gujarat	6.36	3.88	628.9
All India	**6.1**	**15.86**	**183.28**

(Source: Vijayakumaran 2004)

The growth in the fisher folk population and their dependence on a fixed resource base has reduced the per capita availability of resources. Along the Indian coast, the number of active fishermen per sq km of inshore area increased from 1.3 in 1961–62 to 4.4 in 1996–97. The annual catch per active fisher, on the other hand, decreased from 3.5 tonnes to 1.9 tonnes during the same period. These changes vary widely in different maritime states (Table 5).

Table 5. Changes in the estimated number of fisher folk / sq km of inshore area (<50 m depth) and production per fisher from two points of time.

State	Active fisher folk per sq km			Annual Production (t) per fisher		
	1961–62	1996–97	Change per cent	1961–62	1996–97	Change per cent
West Bengal	0.3	2.2	633	2.1	1.9	-10
Orissa	0.3	2.4	700	0.5	0.5	20
Andhra Pradesh	2.9	7.6	162	1.3	0.7	-46
Tamil Nadu	2.4	5.2	117	2	1.8	-10
Pondicherry	9.6	38.6	302	1.8	0.6	-67
Kerala	5.9	16.5	180	2.5	1.7	-32
Karnataka	1.1	9.7	782	5.3	1.3	-75
Goa	2.4	4.3	79	2.9	2.9	0
Maharashtra	0.8	3.2	300	6.1	3.5	-43
Gujarat	0.2	1	400	8.4	6	-29
All India	**1.3**	**4.4**	**238**	**3.5**	**1.9**	**-46**

(Source: adapted from Devaraj and Vivekanandan 1999.)

While the number of active fisher folk increased by 238 per cent, the catch per fisher declined by 46 per cent. This is because, in an underexploited or moderately exploited fishery, yield would increase as fishing pressure is increased up to a certain level, commonly known as the biologically sustainable level of stock. Further increase of effort will result in reduced yield per unit of effort, though there may still be an increase in aggregate production. However, there are qualitative changes in output—such as reduced size of the fish, dominance of less valuable species, etc—which are concealed in the aggregate figures. Added to that, the cost of fishing—in terms of search and fishing time and other operational inputs—is likely to go up, affecting the operational viability of fishing. Reduction in resources available per fisher would result in exhaustion and degradation of common property resources (Vijayakumaran 1999). This is a matter of serious concern to be addressed by coastal management initiatives and appropriate fisheries agencies.

Fishery-related Mortality of Turtles

The incidental capture of turtles in fishing gear and the resultant mortality has been widely reported, especially from Orissa (Silas et al 1983, Dash and Kar 1990, James et al 1989, Pandav et al 1994). The number of olive ridleys stranded along the Gahirmatha coast during 1983–92 ranged between 360–7,500 with the peak in December–February (James et al 1989, Rajagopalan et al 1996). The number of ridleys counted dead along the Orissa coast increased from a few thousand in the early 1990s to 15,000 turtles per year by 1998 (Pandav and Choudhury 1999, Pandav 2000). For the rest of the coast, there is insufficient data on the incidental mortality of sea turtles. Hence, CMFRI carried out a project from 1997–99 to quantify the incidental mortality of sea turtles along the Indian coast (Rajagopalan et al 2001).

SAMPLING DESIGN

The coast of each maritime state was divided into zones of contiguous fish-landing centres. From each zone, nine landing centres were selected at random. Each centre was observed on two consecutive days; 1200–1800 hrs on Day I and 0600–1200 hrs on Day II. Three clusters of two days were selected from three 10-day periods within a month and the centres were randomly allotted to these selected cluster days. On each observation, the number of live turtles landed/trapped by fishing gear, and dead turtles stranded in the landing centres were recorded. Further, inquiries on the number of turtles landed/trapped and stranded were made from the fisher folk for the period between two observation days at each landing centre. This data was processed and the number of turtles landed/trapped and stranded was estimated for each zone and subsequently for each state.

RESULTS

An estimated 3,190, 2,605 and 1,927 adult turtles were incidentally caught (landed/trapped or stranded) respectively during 1997, 1998 and 1999 along the Indian coast barring the Gahirmatha coast of Orissa. Of this, 4,142 (54 per cent) turtles were landed/trapped alive and the remaining 3,580 were caught in fishing operations, discarded as dead and stranded ashore (Table 6). The east coast accounted for the bulk (90–93 per cent) of the incidental capture of sea turtles. Along the west coast, the incidental mortality of turtles was negligible to the north of Karnataka. A significant proportion of mortality would be of olive ridleys, barring Gujarat and Tamil Nadu. One caveat is that the data on strandings is subject to the accuracy of information provided by fisher folk. The data clearly underestimates turtle mortality in Orissa, especially in trawls, which result in a large number of strandings (see Pandav and Choudhury 1999, Pandav 2001).

Table 6. Sea turtle mortality during the years 1997, 1998 and 1999, barring mortality along the Gahirmatha coast.

	Landed/trapped			Stranded			Total		
State	**1997**	**1998**	**1999**	**1997**	**1998**	**1999**	**1997**	**1998**	**1999**
West Bengal	0	28	0	96	97	60	96	125	60
Orissa	199	305	130	129	201	378	328	506	508
Andhra Pradesh	175	159	114	209	276	587	384	435	701
Tamil Nadu	1,518	900	69	538	457	510	2,056	1,357	579
Kerala	270	182	69	4	0	0	274	182	69
Karnataka	0	0	0	10	0	0	10	0	0
Goa	24	0	0	0	0	10	24	-	10
Maharashtra	0	0	0	18	0	0	18	0	0
Gujarat	0	0	0	0	0	0	0	0	0
Total	**2,186**	**1,574**	**382**	**1,004**	**1,031**	**1,545**	**3,190**	**2,605**	**1,927**

(Source: Rajagopalan et al 2001)

From data collected opportunistically between 1985–95, it is estimated that gill nets accounted for 76.8 per cent of turtles landed or trapped along the Indian coast, while trawl nets accounted for 17.8 per cent and other gear for about 5 per cent (Rajagopalan

et al 1996). During 1997–98, gill nets operated by traditional and mechanised vessels accounted for 60 per cent of the 3,760 turtles landed or trapped, while trawl nets accounted for 13.1 per cent, seine nets for 4.2 per cent and other gear such as bag nets, stake nets and hook-and-line for 22.6 per cent (Rajagopalan et al 2001). The gear responsible for the dead stranded turtles was not known. The seasonal distribution of incidental catch along the different maritime states during 1997–98 showed that about 65.7 per cent of the deaths occurred during the first quarter (January–March) all along the east coast and Kerala (Table 7). This is understandable since this is the peak nesting season along the east coast (Kar and Bhaskar 1982).

Table 7. Month-wise incidental catch of sea turtles from different maritime states during 1997–98.

State	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
West Bengal	74	103	16	0	0	0	0	0	0	0	9	19
Orissa	241	318	68	0	4	5	0	7	0	13	34	144
Andhra Pradesh	282	229	92	24	17	0	0	5	7	9	38	66
Tamil Nadu	356	943	691	772	163	75	30	29	15	66	41	132
Kerala	90	89	79	28	23	36	8	12	10	24	12	46
Karnataka	10	0	0	0	0	0	0	0	0	0	0	0
Goa	0	0	12	0	0	0	0	0	0	12	0	0
Maharashtra	0	0	0	0	0	0	0	0	0	18	0	0
Gujarat	0	0	0	0	0	0	0	0	0	0	0	0
Total	**1,053**	**1,732**	**958**	**824**	**207**	**116**	**38**	**53**	**32**	**142**	**134**	**407**
Percentage	18.5	30.4	16.8	14.5	3.6	2	0.7	0.9	0.6	2.5	2.4	7.1

(Source: Rajagopalan et al 2001)

TOWARDS REDUCING INCIDENTAL MORTALITY

Ever since incidental catch of sea turtles in shrimp trawling came to be taken as a serious issue, followed by the US embargo on shrimp imports,[3] the use of the turtle excluder device (TED), to allow turtles a passage to escape from inside nets, has become the focus of conservation efforts. This has eclipsed the fact that trawls accounted for less than 20 per cent, while gill nets accounted for more than 60 per cent of incidental mortality along much of the Indian coast. Even in Orissa, the extent of damage done to turtles by gill nets is likely to have been underestimated (see Wright and Mohanty 2002).

The fact that gill nets cause most of the fishery-related mortality is not surprising because they are the most abundant type of gear, accounting for about 78 per cent of the total gear (Table 8). There are 183 gill nets per km of coastline for the entire country (Table 4). Leaving aside the large, meshed gill nets which would allow passage of young turtles, all gill nets are capable of entangling adult turtles. Assuming a minimum average length of 200 m per net, the total length of gill nets available in the country would be sufficient to erect nearly 36 consecutive net walls all along the coastline. Therefore, while it is necessary to continue with the popularisation of TEDs, appropriate regulatory measures need to be evolved to lessen the impact of gill net fishery.

[3]See Chapter 25 for a report on the shrimp–turtle dispute.

Table 8. Operational details of gill nets at selected centres along the Indian coast.

Landing centre	Operating distance (km)	Length of craft (m)	Maximum length of net (m)	Height of net (m)	Mesh size (mm)
Veraval (Gujarat)	20–45	7–13	2,310	7	65–215
Ratnagiri (Maharashtra)	15–30	5–9	1,000	9–11	50–130
Mangalore (Karnataka)	10	10	700	7	65–135
Kozhikode (Kerala)	5–10	9	600	10	100–150
Kochi (Kerala)	20–50	7–9	1,000	4–8	70–130
Chennai (TN)	8–20	10	700	4–7	10–150
Kakinada (AP)	2–10	5–10	1,600	4–8	18–100
Visakhapatnam (AP)	2–8	5–10	660	3–6	15–90

(Source: adapted from Vivekanandan 2002)

Gill net fishery is the mainstay of the traditional sector along the Indian coast. Therefore, the crucial factor to be considered in planning conservation measures is the livelihood of coastal fisher folk. Technological intervention (like the TED for trawls) is not possible in the case of gill nets. It is quite unlikely that a material or net that could exclude or repel turtles would be efficient in capturing fish. Therefore, a spatial and/or temporal restriction seems to the best alternative since turtles show preference to specified areas and seasons for nesting. For instance, from the information available, the period November–March could be the control season for West Bengal, Orissa and Andhra Pradesh, whereas Tamil Nadu and Kerala may need a more prolonged period. In Orissa, the main reproductive aggregations may be restricted to small areas off the mass-nesting beaches (Pandav 2000). Once vulnerable areas and seasons are identified, it should be possible to evolve and adopt suitable measures with the active participation of fisher folk. A strong database generated from continuous monitoring and evaluation of incidental mortality is necessary for the adoption of spatial and temporal restrictions.

Apart from gill nets, traditional fisher folk use a multitude of gear for capturing fish and shellfish. As a primary step, fisher folk should be encouraged to use gear which cause least mortality to turtles during the nesting season. Further research is required to estimate turtle mortality in relation to the type of gill nets, depth of operation and time of operation. Use of gill nets with less height, hauling of nets every 45 minutes and releasing of entangled turtles can be attempted where total restriction is not feasible. But all these measures seldom work unless suitable alternatives or adequate compensation is given to the fisher folk. When the welfare of coastal communities is linked to the conservation objective, the relevant socio-economic costs have to be assessed carefully.

A Framework to Develop Conservation Measures

A framework for planning conservation measures can be evolved in the context of development in the marine fisheries sector and fishery-related threats to turtle populations. Considerable research still needs to be done to understand the biology, migration and population dynamics of turtles in Indian waters. In the absence of information on the stock size of turtle populations, the extent of fishery-induced damages

to stock cannot be assessed properly (Rajagopalan et al 2001). Until such information becomes available, a precautionary approach must be adopted.

The process must start with identifying different activities causing threats to turtle populations and prioritising them in the order of importance. Understanding the linkages of these activities to the objectives of the sector and interests of the stakeholders is the next step. Identification of alternatives becomes possible only if the strength and direction of linkages are clear. The cost of imposing a conservation measure has to be considered if the targeted activity is linked to livelihood issues. This implies providing compensation for those affected in return for compliance to regulations. Thus, channeling resources for effective conservation in areas identified as 'hotspots', and times referred to as 'critical periods', would be desirable. Through a dynamic and flexible process, it should be possible to facilitate optimum use of resources alongside successful conservation of sea turtles.

For conservation to succeed, a participatory approach with coastal communities is essential, which requires educating and empowering these communities. Long-term strategies to enhance the resource base of the communities is an essential part of the process (Vijayakumaran 1999). Unfortunately, current coastal management initiatives are focuss overly on carrying capacity assessment and health of the ecosystem, while issues facing coastal communities are peripheral. Therefore, the focus must shift to the community, their livelihood and their interactions with natural resources. Coastal communities can also be encouraged to exploit emerging opportunities such as coastal tourism and other such income-generating activities. With continued research inputs and initiatives for integrated approaches to coastal area management, the conservation of turtles has to become an issue addressed by the coastal communities for their benefit and for the sustainability of the system.

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