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Migration and Movement of Olive Ridleys along the East Coast of India

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Current knowledge of sea turtle life history suggests that individual turtles occupy a series of different habitats during the course of their life cycles. Satellite telemetry and other modern techniques have made it possible to monitor the movements of free-ranging sea turtles in the open ocean.

It is well established that the breeding grounds and foraging areas of sea turtles are often widely separated, sea turtles undertake long-distance migrations between these areas on an annual or multi-annual basis. These migrations range from a few hundred kilometres to several thousand kilometres and have been well documented in various species of sea turtles (Balazs 1976, Pritchard 1976, Parmenter 1983, Mendonca and Pritchard 1986, Mortimer and Carr 1987, Limpus et al 1992, Plotkin et al 1996, Miller et al 1998, Nichols et al 2000).

Olive ridleys nest in low densities all along the Indian coast (Kar and Bhaskar 1982); however, the most important nesting beaches are found in Orissa where these turtles are known to nest *en masse* at Rushikulya, Devi river mouth and Gahirmatha (Pandav et al 1994). The turtles nest through the year in Orissa (Dash and Kar 1990), although the majority of the nesting occurs in winter and early summer, between the months of December and April.

Olive ridleys arrive in the coastal waters of Orissa by early November and are thought to spend nearly six months there before leaving, evidently returning to their feeding areas. There is little information about the foraging habitats of this population, much less the migratory routes used by the turtles to travel to and from the nesting beaches. Numerous anecdotal accounts (Oliver 1946, Deraniyagala 1953, Whitaker and Kar 1984)

describe the offshore migrations of large numbers of turtles between Sri Lanka and Orissa. Migrating turtles have been sighted prior to (October–November) and after (April–May) the nesting season in Orissa. Although olive ridley turtles have been studied along the east coast of India for more than two and a half decades, very little is known about their migration and movement along the east coast of India. Recent tagging studies on olive ridleys along the coast of Orissa, followed by a satellite telemetry study in the same area, have revealed many interesting aspects of these migrations and intra-nesting movements. Here, we briefly review recent studies based on conventional tagging and satellite telemetry.

Methods

The study was conducted along the coast of Orissa,[1] principally at the mass-nesting beaches of Gahirmatha, Devi river mouth and Rushikulya, and at Chinchiri and Chilika lagoon.

TAGGING

Conventional metal tagging was carried out at all three principal mass-nesting sites (Gahirmatha, Devi river mouth and Rushikulya) and two other sites (Chinchiri and the mouth of Chilika lagoon) between 1997–99. Both male and female turtles were tagged using monel flipper tags on their fore-flippers. Nesting females were tagged during both sporadic nesting and arribadas. Mating turtles were captured and tagged in Gahirmatha using a mechanised boat and a locally designed triangular trap. The nesting beaches were regularly patrolled during the nesting season to monitor tag recoveries.

SATELLITE TELEMETRY

Four Kiwisat 101 transmitters (Sirtracks Ltd., New Zealand) were employed for this study. The specifications selected were: 1 Watt transmissions, 30 second repetition rates, 2 lithium D cells, 8-bit temperature sensor, two 8-bit 'surface-time' counters, 'surface-time' data to be reported in four 6-hour categories, duty cycle to be 24 hours on for the first two weeks, followed by a 72-hour cycle of 24-hours on/48-hours-off until the end of the transmission. The transmitters were attached at the end of April to minimise the chance of turtle mortality due to trawling. Between 18–21 April 2001, four satellite transmitters were attached to four post-nesting female olive ridley turtles, on the nesting beach south of Devi river mouth. The transmitters were attached to the carapace of the turtles using Epoxy, an adhesive (Frazier et al 2003).

Results

MIGRATION IN OLIVE RIDLEYS: EVIDENCE FROM TAG RETURNS

Tagging has been widely used in sea turtle research to obtain information on reproductive biology and movements. Apart from long-distance movements, tagging provides information on site fidelity and movement between breeding sites. Prior to this tagging study, nearly 15,000 olive ridleys were tagged at Gahirmatha rookery between 1978–85.

[1] The study area is described in detail in Chapter 7, while nesting populations are discussed in Chapter 29.

However, the scope of that tagging study had been restricted only to the Gahirmatha population—it had not revealed any information on turtles using other beaches in Orissa for nesting. Apart from studying the biology of male and female ridleys in the coastal waters, the new tagging programme investigated long-distance movements of olive ridleys from the nesting beaches in Orissa as well as their movement between nesting beaches within Orissa.

During our offshore tagging study, we captured 1,767 mating pairs of olive ridleys in the coastal waters of Gahirmatha and tagged 1,657 males and 1,616 females. On the beach, 10,327 nesting females were tagged at five tagging sites in Orissa. Both males and females tagged during the study showed fidelity to a breeding ground. While tagged females were recorded to re-lay their nests within 100 to 300 m of their previous nests (Pandav 2001), both males and females showed annual re-migration to the same courtship areas every year (Pandav et al 2000). Females tagged at different nesting beaches in Orissa exhibited movement between these nesting beaches, both within a breeding season as well as between seasons. The range of inter-rookery movement varied from 35–220 km (Pandav 2001).

Prior to their arrival along the Orissa coast in early November, olive ridleys are believed to follow a course along the east coast, i.e. through the coastal waters of Tamil Nadu and Andhra Pradesh (Dash and Kar 1990). Long distance tag recapture data from our study

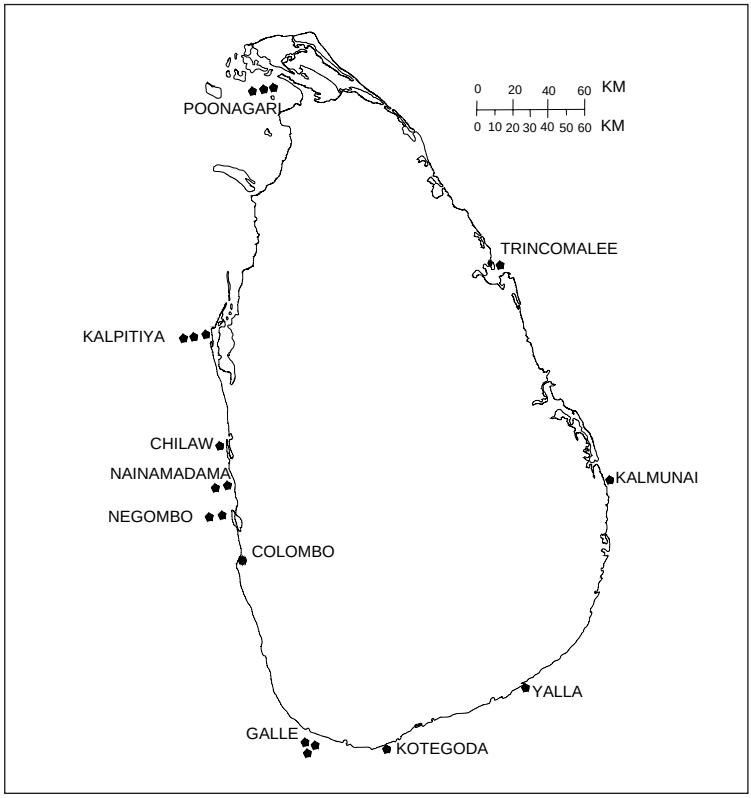

Figure 1: **Long distance recaptures of olive ridley turtles tagged in Orissa, India.**

suggests that female turtles move southward along the coast after completing nesting. One of the turtles tagged on 13 March 1997 during the arribada near Devi river mouth (Tag No.WG22081 / WG22082) was subsequently recovered 324 degrees off the Kalmunai coast and about 22 nautical miles from Kalmunai, eastern Sri Lanka on 27 April 1997. The straight-line distance between Devi river mouth and Kalmunai is roughly around 1,900 km.

So far, there have been 24 long distance recoveries of the ridleys tagged in Orissa (see Appendix 1), of which five are from the Gulf of Mannar, south Tamil Nadu and the remaining are from Sri Lanka (Figure 1). Ridleys tagged at all the three mass-nesting beaches as well as in the coastal waters of Gahirmatha have been recaptured from Sri Lanka. Of the 24 long-distance recaptures, only three recaptures occurred during the non-breeding season of ridleys in Orissa; the remaining 21 occurred during their breeding season in Orissa. Of the other three, two ridley females were recaptured off Galle, Sri Lanka while the arribada was in progress at Gahirmatha in March 2000; the third was captured at Poonagari, Sri Lanka a few days after the completion of the March 2000 arribada at Gahirmatha. The recovery of these ridleys from the coastal waters of Sri Lanka during their breeding season in Orissa is interesting and suggests either that a part of the olive ridley population does not breed annually or that some Orissa turtles nest along the Sri Lankan or southern coast of India (Shanker and Pandav 2001)

MIGRATION IN OLIVE RIDLEYS: INFERENCES FROM SATELLITE TELEMETRY

Four sea turtles were fitted with satellite transmitters in April 2001. A total 48 to 114 days of data was received on the four turtles, with 25–88 high-quality location points (Shanker et al 2002). Initially, the turtles moved into offshore waters and seemed to be moving randomly. It then became clear that three of the turtles were moving in large circles off the coast of Orissa and northern Andhra Pradesh. After that, one of the turtles began to move south towards Sri Lanka. This turtle then swam 1,000 km in 18 days to reach the coast of Sri Lanka (see Plate 13). The turtles swam a total of 1,300–2,900 km, but they all averaged about 25–30 km per day despite differences in daily and monthly travel rates. The turtle that swam to Sri Lanka achieved rates of about 150 km per day during her migration south (Shanker et al 2002). In July and August, the transmissions ceased suddenly for each of the 4 transmitters. Though there are several possible causes—failure of transmitter, failure of battery, method of attachment, and damage to antenna—it seems likely that the high fishery-related mortality of turtles on the coast of Orissa may be the cause.

MOVEMENT BETWEEN NESTING BEACHES

Recent genetic studies have demonstrated that sea turtles return to their region of birth to breed (Bowen and Karl 1997). After returning to their natal regions and selecting a nesting beach, sea turtles tend to re-nest in relatively close proximity. During multiple nesting attempts within the same nesting season, a small percentage of sea turtles utilise more distant nesting sites in the general area or within a few hundred kilometres (Bjorndal et al 1985, Limpus et al 1984, Hays and Sutherland 1991, Limpus et al 1992).

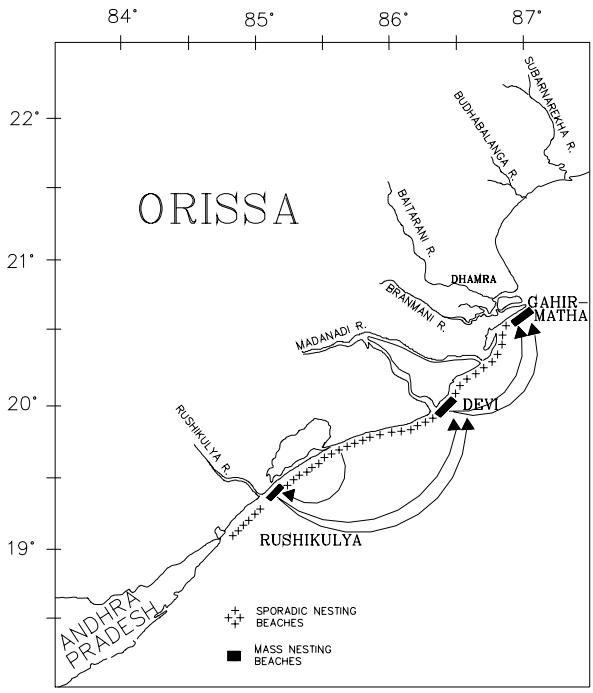

Figure 2. Inter-rookery movement of olive ridley turtles in Orissa.

Ridleys tagged at nesting beaches in Orissa also exhibited movement between nesting beaches in the same breeding season as well as during subsequent breeding seasons (Figure 2).

Two of the turtles tagged during the arribada at Rushikulya rookery on 2 and 3 February 1997 (Tag Nos WR25417 / WR25418 and WR25793 / WR25794) were recaptured while nesting in another arribada at Robert Island near Devi river mouth on 17 March 1997. One of the turtles tagged during the arribada at Robert Island on 14 March 1997 (WG23444 / WG23445) was subsequently recaptured while nesting at Nasi rookery on 16 April 1997. An estimated 300 turtles had nested at Nasi rookery on the same night.

Besides these intra-seasonal movements between the rookeries, ridleys in Orissa also exhibited inter-seasonal shift in nesting beaches. Two of the turtles tagged at Nasi rookery on 2 April 1997 (WG01484 / WG01485) and 14 April 1997 (WG01912 / WG01913) were recaptured while nesting on the beach near the mouth of River Baunsagarha on 22 April 1998 (35 km away from Nasi). Similarly, one of the turtles tagged near the Chilika mouth (WG20020 / WG20021) on 30 March 1997, was recaptured while nesting at Rushikulya rookery during the arribada on 23 March 1998. The range of these inter-rookery movements of ridleys in Orissa varied from 35 to 320 km (n=10, Appendix 2).

Earlier tagging studies on olive ridleys have also recorded movements between nesting beaches with a range of 85 km (Schulz 1971, n=3) to 160 km (Meylan 1982, n=1). Compared to these studies, the movement of olive ridleys between nesting beaches in Orissa seems to be the longest for the species recorded so far. Eckert et al (1989) recorded

similar movements between nesting beaches for leatherback turtles with a range of 30–110 km. Bjorndal et al (1983) reported that the distance between intra-seasonal re-nesting attempts of 38 loggerheads ranged up to 290 km. Other records of intra-seasonal nesting movements suggest that loggerhead turtles are capable of moving long distances, but the proportion of individuals doing so is low (Limpus 1985).

The movement of olive ridleys between nesting beaches has also been observed between the two mass-nesting sites in Costa Rica—Nancite and Ostional. Between 1980–84, a total of 29 Ostional olive ridleys were observed at Nancite and 35 Nancite turtles were recorded at Ostional (Cornelius and Robinson, unpubl. report, c.f. Valverde et al 1998). This dynamic movement between beaches is remarkable and may suggest that natal homing does not restrict turtles to particular nesting beaches. It is possible that beach exchange is part of a complex phenomenon that olive ridleys use to colonise, or even to move to, another beach altogether. Since olive ridleys seem to prefer dynamic beaches such as spits and sand bars at river mouths, this may be essential to their survival. Continuous monitoring at these nesting beaches in Orissa is essential to determine the degree of movement between nesting beaches.

Further, some of the turtles that were tagged while nesting at Devi river mouth were recaptured mating at Gahirmatha. The turtles that mate at Gahirmatha have also been recorded to nest as far south as Chinchiri (25 km) and some have been recovered 100 km south. Monitoring the coastal waters off the nesting beaches can thus provide substantial information on the movement of olive ridleys between sites in Orissa.

Studies on the Offshore Biology of Olive Ridleys in Orissa

Whereas the biology of ridleys on nesting beaches in Orissa has been studied to some extent, little effort has gone into understanding their biology in offshore waters. Preliminary offshore studies in Orissa have revealed some interesting facts about the offshore biology of olive ridleys (Ram 2000, Pandav 2001). Olive ridleys arrive in the coastal waters off Orissa by early November and mating pairs become visible in the coastal waters immediately after their arrival. Peak mating in Orissa is observed between mid-December to mid-January (Pandav 2001). Monitoring in the coastal waters has revealed that, like the females, male ridleys also show fidelity to a breeding ground (Pandav et al 2000). An analysis of within-season recaptures of breeding males and females revealed that males remained sexually active for a longer period (up to 50 days) compared to females (7–10 days, Pandav 2001). Both Ram (2000) and Pandav (2001) studied the reproductive aggregations of olive ridleys in the coastal waters of Gahrimatha rookery and found that a reproductive patch (a region of high density of mating pairs) is spread over an area of 32 and 52 sq km respectively. The location of these reproductive patches in the coastal waters of Orissa is of considerable importance. By locating such patches and by providing adequate protection in these areas, fishing-related mortality of sea turtles in coastal waters can be drastically reduced.

Discussion

The results of recent tagging and telemetry studies indicate that at least some of the ridleys nesting in Orissa migrate to and from the coastal waters of Sri Lanka. Recovery

of turtles tagged in Orissa from Sri Lanka and the Gulf of Mannar indicate that these could be feeding areas for the ridleys that migrate to the Orissa coast every winter. However, it is also noteworthy that tag returns from Sri Lanka are mostly during the breeding season. It has been suggested that a proportion of these turtles could be nesting elsewhere along the coast (Shanker and Pandav 2001), though this needs to be confirmed. Although the tagged turtles have been recovered all around Sri Lanka, most of the recoveries are made from the south of the Gulf of Mannar and the west coast of Sri Lanka. Further surveys are needed to identify potential threats to ridleys in these areas.

The tag returns at different nesting beaches in Orissa clearly show that ridleys move between nesting beaches as well as in coastal waters. Olive ridleys in Orissa use more than one beach for nesting during the same, as well as subsequent, breeding seasons. Therefore, the sea turtle nesting beaches in Orissa as well as their coastal waters need to be treated as a single conservation unit. Protection of the three mass-nesting beaches and their coastal waters is extremely crucial for the survival of olive ridleys in Orissa, which could well be a single population, as also suggested by molecular genetic studies (Shanker et al 2000). Of the three mass-nesting beaches in Orissa, only the Gahirmatha rookery and its coastal waters are protected by law. Nesting beaches near Devi river mouth and Rushikulya lack legal status, making them vulnerable to anthropogenic disturbances, particularly development.

The tagging data demonstrates that ridleys that nest in Orissa migrate to southern Tamil Nadu and Sri Lanka during the non-breeding season. The occurrence of tagged turtles in these waters during the breeding season and the absence of population genetic structure raises questions about the precision of natal homing in these turtles. However, it is the satellite telemetry study that provides evidence about the exact migratory route taken by turtles, including important data such as travel rates and offshore distance from the coast. Another important finding is that ridley turtles remain in the waters off Orissa and northern Andhra Pradesh during the post-nesting period. During their post-nesting movement, they may come into nearshore waters (within 30 km) and are thus vulnerable to fishery-related mortality. Considering that all four turtles might have fallen prey to fishery-related mortality, the results also highlight the threats to this population. Over 100,000 turtles have been counted dead in the last eight years on the Orissa coast (Shanker et al 2004), and this situation needs to be remedied at the earliest.

Ideally, a combination of methods helps to answer questions about the biology and conservation of sea turtles. However, an additional factor that needs to be considered is the conservation importance of scientific studies. Apart from providing information critical to framing conservation strategies, many scientific projects can be used to generate public interest and spread awareness. In this study, much was gained from the awareness and training programmes associated with the telemetry exercise (Shanker et al 2002). Local communities, local government agencies and biologists were addressed during the course of the exercise. In addition, a lot of publicity and awareness was generated through coverage in national newspapers and TV channels. TV channels carried updates on the telemetry programme over a few months. A website (www.wii.gov.in/webs/satindex.html) was set up to illustrate the movements of the turtles and the site was

frequently hit. A positive outcome of the publicity is that anecdotal reports become available from various sectors including fisher folk, the coast guard and navy, and the public, who may provide useful information about the distribution and movements of turtles. Hence, a multi-pronged strategy serves best to understand their biology and to conserve these animals and their habitats.

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Appendix 1

Long distance recaptures of olive ridley turtles tagged in the coastal waters as well as on the nesting beaches of Orissa between 1996–99. A total of 24 recaptures have been made outside Orissa till February 2002.

Tag No. left	Tag No. right	Recapt. date	Place of recapture	Tagged on	Place of tagging	Remarks
WG22081	WG22082	27.04.97	Kalmunai, Sri Lanka	13.03.97	Robert Island, near Devi river mouth	Tagged while nesting during the 1997 arribada at Robert Island and recovered 22 nautical miles off the coast of Kalmunai, eastern Sri Lanka. Reported by B H Jayaratna, Kottegoda, Sri Lanka.
WG03019		15.12.98	Poonagari, Sri Lanka	13.11.97	Gahirmatha	This female was tagged while mating in coastal waters off Gahirmatha. Reported by Pallikkuda Fishermen's Co-op Soc., Poonagari, Sri Lanka.
WR26559		Dec. '98	Ruwanthika, Nainamadama Sri Lanka	22.03.98	Rushikulya	Tagged while nestingduring the 1998 arribada. Reported by WSC Thamel, Nainamadama, Sri Lanka.
WR27619	WR27620	Jan. '99	Trincomalee: east coast of Sri Lanka	23.03.98	Rushikulya	Tagged while nesting during the 1998 arribada. Reported by P D Amarasooryia, NARA, Sri Lanka.
# 855		Jan. '99	Chilaw, northwest Sri Lanka	–	Gahirmatha	Tagged by Orissa forest department. Reported to us by PD Amarasooryia, NARA, Sri Lanka.
WR25087		15.12.99	Keelamanakudi, Thoothikudi, Kanniyakumari district, Tamil Nadu	02.02.97	Rushikulya	This female was found dead and washed ashore. Reported by Hans Raj Verma, Director of Fisheries, Tamil Nadu.

Tag No. left	Tag No. right	Recapt. date	Place of recapture	Tagged on	Place of tagging	Remarks
WR30084	WR30085	31.08.99	18 km east of Manapad, Tirunelveli district, Tamil Nadu in the Gulf of Mannar	23.03.98	Rushikulya	Tagged while nesting during the 1998 arribada, Reported by CMFRI, Tuticorin.
WG09385	WG09386	22.09.99	Kanegodalla, Kottegoda, 7°43' N 83°35' E Sri Lanka	29.03.99	Gahirmatha	Tagged while nestingduring 1999 arribada. Reported by HR Abedeera, Kottegoda, Sri Lanka and S Tripathi, High Commission of India, Colombo.
WR26203	WR26204	12.01.00	Galle, Sri Lanka	22.03.98	Rushikulya	Tagged while nesting during the 1998 arribada. Reported by TCP, Sri Lanka.
WG13247	WG13248	Jan. 2000	Nainamadama, Sri Lanka	23.12.98	Gahirmatha	This male was tagged while mating in the coastal waters off Gahirmatha. Reported byNainamadama, Sri Lanka.
WG17375	WG17376	10.01.00	Uvari, Tirunelveli dist. Tamil Nadu, 52 km NE of Kanniyakumari, Gulf of Mannar	25.03.99	Gahirmatha	This female was caught and was subsequently drowned in a multi-filament fishing net, Reported by CMFRI, Tuticorin.
WR29834		01.02.00	Negambo, Sri Lanka	23.03.98	Rushikulya	Tagged while nesting during the 1998 arribada. Reported by TCP, Sri Lanka.

Tag No. left	Tag No. right	Recapt. date	Place of recapture	Tagged on	Place of tagging	Remarks
WG01891	WG01892	07.02.00	Negambo, Sri Lanka	14.04.97	Gahirmatha	Tagged while nesting at Nasirookery, Gahirmatha. Reported by TCP, SL.
WR28131		15.01.00	Poonagari, Sri Lanka	23.03.98	Rushikulya	Tagged while nesting during 1998 arribada. Reported by Pallikuda Fishermen's Co-operative Society, Poonagari, Sri Lanka.
WG17563	WG17564	01.04.00	Poonagari, Sri Lanka	25.03.99	Gahirmatha	Tagged while nesting during 1999 arribada. Reported by Pallikuda Fishermen's Co-op Soc., Poonagari, Sri Lanka.
WG17805		15.03.00	Galle, Sri Lanka	25.03.99	Gahirmatha	Tagged while nesting during 1999 arribada, Reported by TCP, Sri Lanka.
WR30398	WR30399	18.03.00	Galle, Sri Lanka	12.03.99	Rushikulya	Tagged while nesting in a minor arribada. Reported by TCP, Sri Lanka.
WR27677	WR27678	Jan. 2001	Kandakkuliya, near Kalpitiya, Sri Lanka	23.03.98	Rushikulya	Tagged while nesting during 1998 arribada at Rushikulya. Reported by TCP, Sri Lanka.
WG15045		Jan. 2001	Kandakkuliya, near Kalpitiya, Sri Lanka	08.01.99	Gahirmatha	Female tagged while mating in the coastal waters off Gahirmatha. Reported by TCP, Sri Lanka.
WR26135		Jan 2001	Kanniyakumari, Tamil Nadu	22.03.98	Rushikulya	Tagged while nesting during the 1998 arribada at Rushikulya. Reported by S Bhupathy, SACON vide letter No. STP/55/SB dated 08.02.2001.
WG14805		Jan 2001	Kudankulam, Tamil Nadu	06.01.99	Gahirmatha	Female tagged while mating in the coastal waters off Gahirmatha. Reported by S Bhupathy, SACON vide letter No. STP/55/SB dated 08.02.2001.

Tag No. left	Tag No. right	Recapt. date	Place of recapture	Tagged on	Place of tagging	Remarks
WG24885	WG24886	June 2001	Kandakkuliya, near Kalpitiya, Sri Lanka	31.03.99	Gahirmatha	Female tagged while nesting in March 1999 arribada at Nasi rookery, Gahirmatha. Reported by Thushan Kapurusinghe of TCP, Sri Lanka. The turtle was found dead after getting entangled in a fishing net at the time of recovery.
WG15423	WG15424		4° 23' N, 77° 55' E, Sri Lanka	22.01.99	Gahirmatha	Female tagged while mating in the coastal waters off Gahirmatha. Caught in a gill net in Sri Lanka and was subsequently released by fishermen. Informed about the recovery by D Amarasooriya vide his e-mail to Kartik Shanker dated 3 January 2002.
WG12927	WG12928	12.02.02	Gurugoda pokuna on the western boundary of Nimalawa sanctuary, close to Yala National Park, 81° 21' 7" E and 6° 14' N	07.04.99	Barunei, Gahirmatha	Female tagged while nesting during an arribada at Barunei, along the southern end of Gahiramatha coast. Highly decomposed carcass was found washed ashore near Yala.

Appendix 2

Details of beach exchange by olive ridleys between the three sea turtle rookeries and sporadic nesting beaches in Orissa. A total of 10 turtles were recorded straying between nesting beaches in Orissa and the distance of this movement varied from 35 –320 km. (AA = Arribada-Arribada, SA = Solitary-Arribada, SS = Solitary-Solitary)

Date of tagging	Place of tagging	Turtle No.	Date of recapture	Place of recapture	Distance between the sites	Nesting type	Remarks
02.02.1997	Rushikulya	WR25417	17.03.1997	Robert Island	220 km	AA	Within season
03.02.1997	Rushikulya	WR25793	17.03.1997	Robert Island	220 km	AA	Within season
14.03.1997	Robert Island	WG23444	16.04.1997	Nasi	100 km	AA	Within season
30.03.1997	Chilika mouth	WG20020	23.04.1998	Rushikulya	60 km	SA	Between seasons
02.04.1997	Nasi	WG01484	22.04.1998	Chinchiri	35 km	SS	Between seasons
14.04.1997	Nasi	WG01912	22.04.1998	Chinchiri	35 km	SS	Between seasons
23.03.1998	Rushikulya	WR28045	14.03.2000	Nasi	320 km	AA	Between seasons
17.03.1997	Robert Island	WG06264	14.03.2000	Nasi	100 km	AA	Between seasons
07.04.1999	Barunei	WG12891	18.03.2000	Nasi	40 km	AA	Between seasons
25.02.1999	Agar Nasi	WG21853	19.03.2000	Nasi	40 km	SA	Between seasons