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Population Status and Internesting Movement of Leatherback Turtles, *Dermochelys coriacea,* Nesting on the Northwest Coast of Papua, Indonesia

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ABSTRACT. – **The northwest coast of the province of Papua in Indonesia is thought to host the largest remaining leatherback nesting population in the Pacific Ocean. We conducted a census of nesting activity at Jamursba-Medi from 2001 through 2004 and of Wermon from 2002 to 2004, and tracked internesting movements of female leatherbacks by using satellite telemetry during the nesting season in 2003. We recorded 1865–3601 nests each season at Jamursba-Medi and 1788–2881 nests at Wermon. Nesting occurred year-round, with a peak in activity between May and September at Jamursba-Medi, and between October and March at Wermon. Comparing these data with previous records of nesting activity from 1981 to 2001 indicates that, although there are indications of a long-term decline, this population has not been depleted to the extent found at other major rookeries in the Pacific. Satellite telemetry indicates that nesters frequent waters around the Raja Ampat Islands and coastal waters to the west of Jamursba-Medi, and may also nest outside the monitored area. We recommend establishing a marine protected area to ensure protection of this population in these critical nearshore marine habitats and implementation of conservation measures in partnership with local communities at these nesting beaches before this population becomes depleted.**

KEY WORDS. – **Reptilia; Testudines; Dermochelyidae; *Dermochelys coriacea*; sea turtle; nesting trends; threats; conservation; internesting movement; Jamursba-Medi; Wermon; Papua; Indonesia**

There has been an alarming decline in leatherback nesting populations throughout the Pacific Ocean (Spotila et al. 1996). The Malaysian population appears to be almost extinct (Chan and Liew 1996), and, more recently, eastern Pacific populations have collapsed (Sarti Martínez et al. 1996; Spotila et al. 2000). Because of their remoteness and lack of consistent monitoring, the status of the other western Pacific nesting populations is unclear. There appear to be more leatherbacks nesting throughout the Solomon Islands, Vanuatu, and Papua New Guinea, than previously thought (Dutton et al. 2007). In addition, large numbers of leatherbacks are known to nest along the northwest coast of Papua on the island of New Guinea (Hitipeuw and Maturbongs 2002). An aerial survey conducted in 1981 identified this region as the site of the largest Pacific leatherback population in Asia (Salm 1982). An intensive survey conducted by the World Wildlife Fund along the 17.8 km of coast extending eastward from Jamursba-Medi revealed an estimate of at least 13,000 leatherback nests (Bhaskar 1985). Since then, there have been sporadic surveys conducted over the last 2 decades; however, the methodologies have been inconsistent, thus, precluding reliable estimates of abundance and trends during this period (Suarez et al. 2000). Despite indications of a long-term decline over the last 20 years, this nesting population is still the largest remaining in the Pacific (Hitipeuw and Maturbongs 2002). As a result of renewed conservation efforts on behalf of leatherbacks in the Pacific, consistent surveys were initiated in Papua, Indonesia, in recent years. This paper presents the results of monitoring and research along the northwest coast of Papua. We identify the main nesting beaches, report results of population surveys, and compile and reanalyze data from the previous years to assess the current status and trend of leatherbacks in this region. We also assess current threats and examine internesting movement to evaluate and develop new conservation measures. Satellite telemetry has been used to study long-range postnesting movement and foraging behavior in leatherbacks (Hays et al. 2004; James et al. 2005; Eckert 2006; Benson et al. 2007). We use satellite telemetry to provide information on movement by nesters within the nesting season to identify other potential nesting sites used by nesters outside the monitored areas on Jamursba-Medi and also to identify the extent of the coastal area frequented by breeding females from this population.

METHODS

Study Site. — Jamursba-Medi (0°20'–0°22′S and 132°25'–132°39′E) is the principal known nesting site

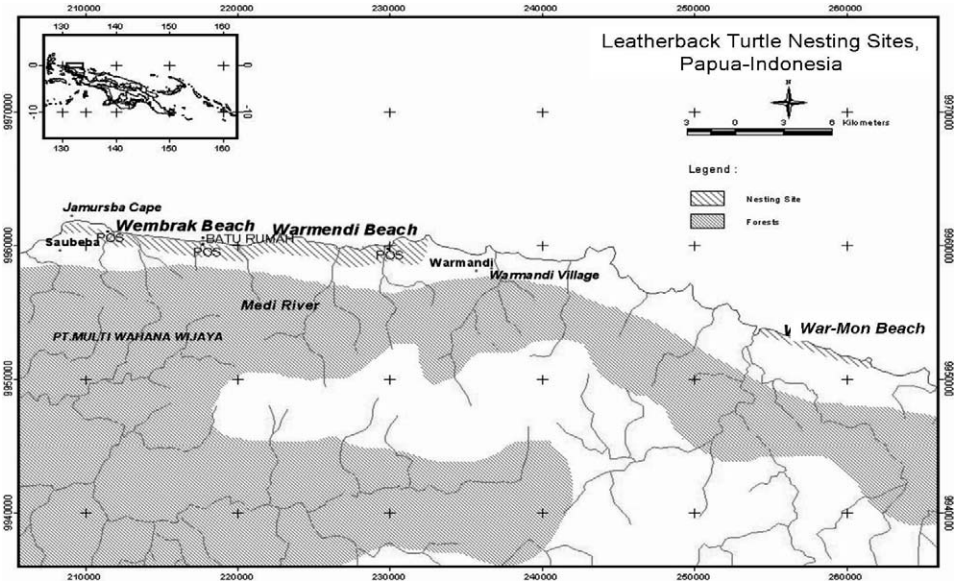

Figure 1. Northwest coast of Papua, Indonesia, indicating leatherback nesting beaches at Jamursba-Medi (Wembrack, Warmamedi, and Batu Rumah), and Wermon.

for leatherbacks on Papua, and comprises 3 black sand beaches (Wembrak, Warmamedi, and Batu Rumah; Fig. 1) that together span 18 km of coastline. A second nesting site is located at Wermon (0°41′–0°43′S and 132°80′–132°86′E), which consists of a 6-km beach ca. 30 km east of Jamursba-Medi and halfway between Welos Cape and Wau Village (Fig. 1). Green turtles (*Chelonia mydas)*, olive ridley turtles (*Lepidochelys olivacea)*, and hawksbill turtles (*Eretmochelys imbricata)* are also known to nest at these same beaches (Hitipeuw and Maturbongs 2002). The coastal lowlands stretch approximately 21 km inland and are bordered by the Tamarau Mountain, which is fringed by beach forest and lowland rain forest (0–100 m above sea level).

The beaches of Jamursba-Medi and Wermon are divided by cliffs, rocky outcrops, perennial rivers, and estuaries. The Jamursba-Medi beaches are subject to seasonal patterns of erosion and accretion. Changes in the currents brought on by the monsoons that begin in late August cause beach erosion that often removes the entire beach until accretion begins again in early February.

Nesting Activity Census. — We assessed leatherback nesting activity by using daily beach patrols from 2002–2004 at the 3 beaches on Jamursba-Medi and also on Wermon. All 3 Jamursba-Medi beaches were monitored from March to August in 2002, March through November in 2003, and from January through August in 2004. At Wermon, the beach was monitored from November 2002 through June 2003 and from November 2003 through September 2004. At both study sites, the beaches were patrolled every morning, and the number of crawls and apparent nests were recorded. In addition, the number of nests newly disturbed by predators was recorded at Wermon from November 2003 to September 2004.

Population and Trend Estimation. — We compiled data on leatherback nesting activity at Jamursba-Medi from previous unpublished reports from 1984 through 1985 (Bhaskar 1987) and data collected from 1993 to 2001. Because the time frame of the surveys were not consistent across years, we estimated the number of nests laid for the entire nesting season to compare with Bhaskar's original surveys conducted from April to October in 1984 and 1985. We did this by estimating the number of nests that were laid before and after the time frame the beaches were monitored and by adding this to the observed nest counts to estimate nesting for a standard period consisting of the 6 months between April 1 and September 30. We determined the average proportion (of the total for the season) of nests laid for each month based on the data available for multiple years (Fig. 2), and applied a correction factor as follows:

$$Ni/Pi = N \quad \begin{pmatrix}\text{estimated number of nests}\\ \text{laid for whole season}\end{pmatrix}$$

Where *Ni* is the observed number of nests and *Pi* is the proportion of the season. *Pi* was estimated from mean nesting distributions calculated from data in Bhaskar (1987) and nest counts during this study (Figs. 2 and 3).

To further compare nest counts at Jamursba-Medi from 1993–2004, we only took into account nest counts for the period from the beginning of June through the end of September. Because this covered the height of the season and eliminated many of the gaps in information for the tail end of the season in different years, we felt this approach would allow us to determine a meaningful trend for this time series. In years where counts were not available for all these months (e.g., September of 1997, 2002, and 2004), numbers were estimated by using the same approach outlined above, so that *N* in these cases is

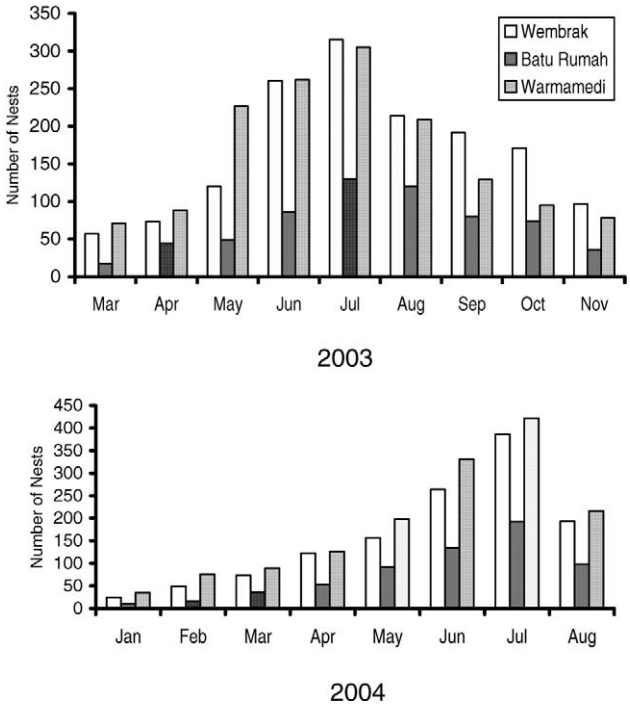

Figure 2. Seasonal distribution of nests at Jamursba-Medi.

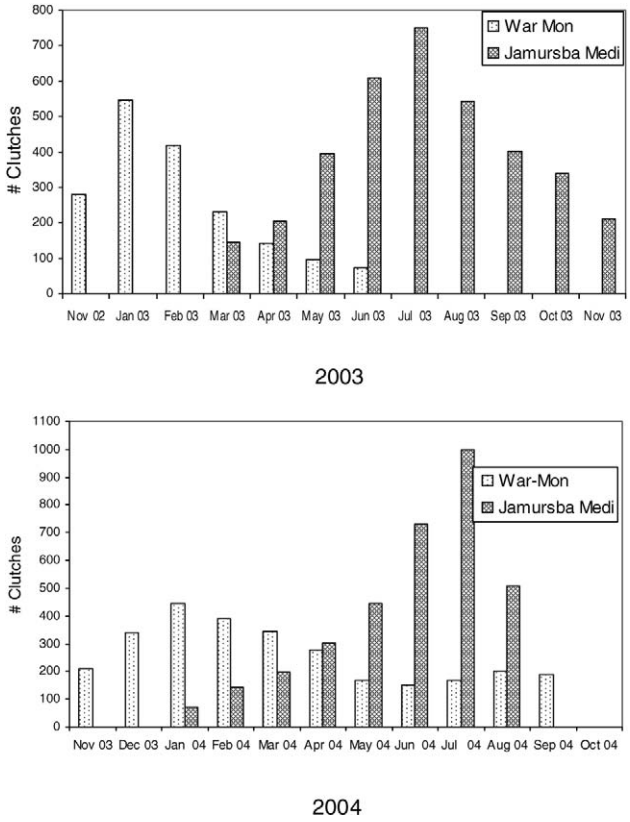

Figure 3. Total number of nests observed at Jamursba-Medi and Wermon from November 2002 through August 2004.

the estimated number of nests between June 1 and September 30.

To estimate the number of females potentially nesting at Jamursba-Medi, we divided the number of nests by the average numbers of nests per female that were reported for various nesting populations in the Atlantic and eastern Pacific. These range from 4.4 nests per female (Sarti et al. 2000) to 5.8 nests per female (Boulon et al. 1996). No data on average number of nests per female are available for western Pacific leatherbacks.

Internesting Movement. — Satellite telemetry was used as part of a broad study to determine postnesting migration and habitat use by female leatherbacks at Jamursba-Medi (Benson et al. 2007). Satellite transmitters were attached with harness backpacks to a total of 10 female leatherbacks at Warmamedi Beach by using methods described in Eckert and Eckert (1986). The harness design incorporated a corrodible release link and elements intended to minimize encumbrance to the turtle (Eckert and Eckert 1986; Troëng et al. 2006). To minimize disturbance, harnesses were attached to nesting females after egg laying, during the 20 minutes that the turtles were relatively immobile. We deployed Sirtrack Kiwisat 101 transmitters programmed to transmit with a duty cycle of 6 hours on and 19 hours off. Position data were obtained via ARGOS-linked orbiting satellites. Locations were plotted to determine fine scale local movements for up to 60 days after nesting, to determine interesting movements and to identify the nearshore areas used by leatherbacks, including potential nesting sites outside of the monitored areas. Poor quality location data (LC < 0) were not included.

RESULTS

Population Assessment and Nesting Ecology. — We recorded 1865–3601 nests each season at Jamursba-Medi, and 1788–2881 nests at Wermon (Table 1; Fig. 3). Nesting occurred year-round, with a peak in activity at Jamursba-Medi between May and September, and at Wermon between October and March (Fig. 3). Nesting activity was ca. 2 times greater on Wembrak and Warmamedi than on Batu Rumah (Fig. 4). A steep erosion cliff persisted at Batu Rumah, preventing many leatherbacks from nesting there, whereas Wembrak and Warmamedi had large sections of flat open sand areas.

Predation and Nest Loss. — At Wermon, 10.7% of all nests observed in 2003–2004 were laid below the high water mark (HWM; demarcated by the most recent spring high tides) and were washed away by high tides (Table 2). At Warmamedi, 80% of nests marked randomly during July were washed away before they hatched. Predation by feral pigs and dogs was observed for Wermon and accounted for a loss of 17.5% of all nests observed during 2003–04 (Table 2). Most of this predation came from pigs digging up nests at night and, to a lesser extent, from domestic dogs during daytime. Predation by pigs appeared to be extensive at the Jamursba-Medi beaches, particularly at Warmamedi but was not quantified in this study.

Internesting Movement and Habitat Use. — Seven of the satellite transmitters deployed on leatherbacks in 2003

Table 1. Number of nests recorded at Jamursba-Medi by different surveys from 1981–2004. For comparison purposes, nest counts were adjusted to reflect nests observed or estimated for main nesting season from beginning of April through October (see methods).

Survey Period	Nests no.	Adjusted no. nests	No. estimated females[a]	Reference
Sept 1981	4000+	7143	1232–1623	Salm 1982
Apr-Oct 1984	13,360	13,360	2303–3036	Bhaskar 1985
Apr-Oct 1985	3000	3000	517–682	Bhaskar 1987
June-Sept 1993	3247	4091	705–930	J. Bakarbessy unpubl. data
June-Sept 1994	3298	4155	716–944	J. Bakarbessy unpubl. data
June-Sept 1995	3382	4228	729–961	J. Bakarbessy unpubl. data
Jun-Sept 1996	5058	6373	1099–1448	J. Bakarbessy unpubl. data
May-Aug 1997	4001	4481	773–1018	Lamuasa unpubl. data
May-Sept 1999	2983	3251	560–739	Teguh unpubl. data
Apr-Dec 2000	2264	2194	378–499	KSDA-YAL, unpubl. data
Apr-Oct 2001	3056	3056	527–695	Wamafma unpubl. data
Mar-Aug 2002	1865	1921	331–437	World Wildlife Fund 2003
Mar-Nov 2003	3601	2904	501–660	World Wildlife Fund 2003
Mar-Aug 2004	3183	3871	667–879	World Wildlife Fund 2003

[a] Number of females were estimated by dividing number of estimated nests by average number of nests/female reported by Dutton et al. (2000) (5.8 nests/female) and Sarti et al. (2000) (4.4 nests/female).

provided information on internesting movement (Fig. 5). Most turtles returned at least once to Jamursba-Medi or adjacent beaches, and 2 may have renested at nearby Raja Ampat Islands. In general, turtles moved within an area that extended up to ca. 180 km north of Jamursba-Medi and ca. 250 km west to waters around the Raja Ampat Islands (Fig. 5). After nesting on 23 July, 1 turtle (ID no. 27959) traveled in a loop ca. 80 km offshore and returned near the beach, apparently nesting again 9 days later, on 1 August (Fig. 5). This turtle then moved north ca. 120 km before turning west and occupying waters just north of the Raja Ampat Islands for 35 days before traveling north (Fig. 5). Another turtle (ID no. 27957) looped ca. 60 km north after nesting and went ca. 80 km west of Jamursba-Medi, swimming within 10 km of shore, where it traveled eastward along the coast, within 20 km of shore before returning to nest on August 3 where she was observed on Wembrak Beach. This turtle then traveled ca. 100 km north before heading west and occupying waters around the Raja Ampat Islands for 60 days. It is unclear whether this turtle nested during this time, although there were a number of good quality (LC2) transmissions from land as late as October 9 that may indicate nesting. Another leatherback (ID no. 27960) traveled ca. 180 km offshore, meandering in a loop near Jamursba-Medi and perhaps returning to nest on 2 occasions, around 1 and 14 August.

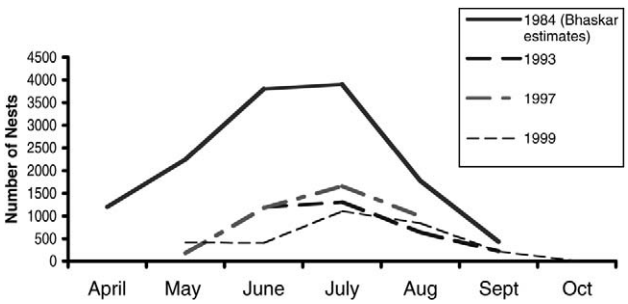

Figure 4. Nesting activity (number of nests laid) observed at the 3 beaches at Jamursba-Medi during 2003 and 2004.

This turtle then moved north and departed Indonesian waters for a long-distance migration (Benson et al. 2007). Similarly, the other turtles (ID nos. 5396, 5397, and 5398) may have renested unobserved at Jamursba-Medi, with no. 5396 perhaps continuing to nest through September (Fig. 5).

DISCUSSION

Population Status and Trend. — The nesting activity recorded in 1984 (Bhaskar 1987) was over 4 times greater than most subsequent years (Table 1). There was a sharp decline in 1985, and numbers have been below 6500 nests ever since. However, there are no data available from 1986 to 1992, and it is not clear how extensive surveys were in different years. Although there appears to be a slight declining trend since 1993 for the Jamursba-Medi nesting population (Fig. 6), there were similar numbers of nests estimated in 2004, as there were in the early 1990s (Table 1). We estimate broadly between 300–900 females nesting annually (FNA) during the peak portion of the season at Jamursba-Medi in recent years (Table 1) compared with ca. 1000–3000 FNA before 1985. These estimates do not

Table 2. Number of nests laid, depredated, and washed away by tides at Wermon between November 2003 and September 2004.

Month	Nest counts	Depredated nests		Inundated nests
		Pigs	Dogs	
November 2003	208	12	11	62
December 2003	338	19	21	56
January 2004	445	31	15	75
February 2004	389	24	11	62
March 2004	343	0	0	23
April 2004	278	19	26	4
May 2004	167	15	18	14
June 2004	152	—	—	—
July 2004	170	64	0	0
August 2004	202	168	12	0
September 2004	189	17	22	4
Total	2881	369	136	310

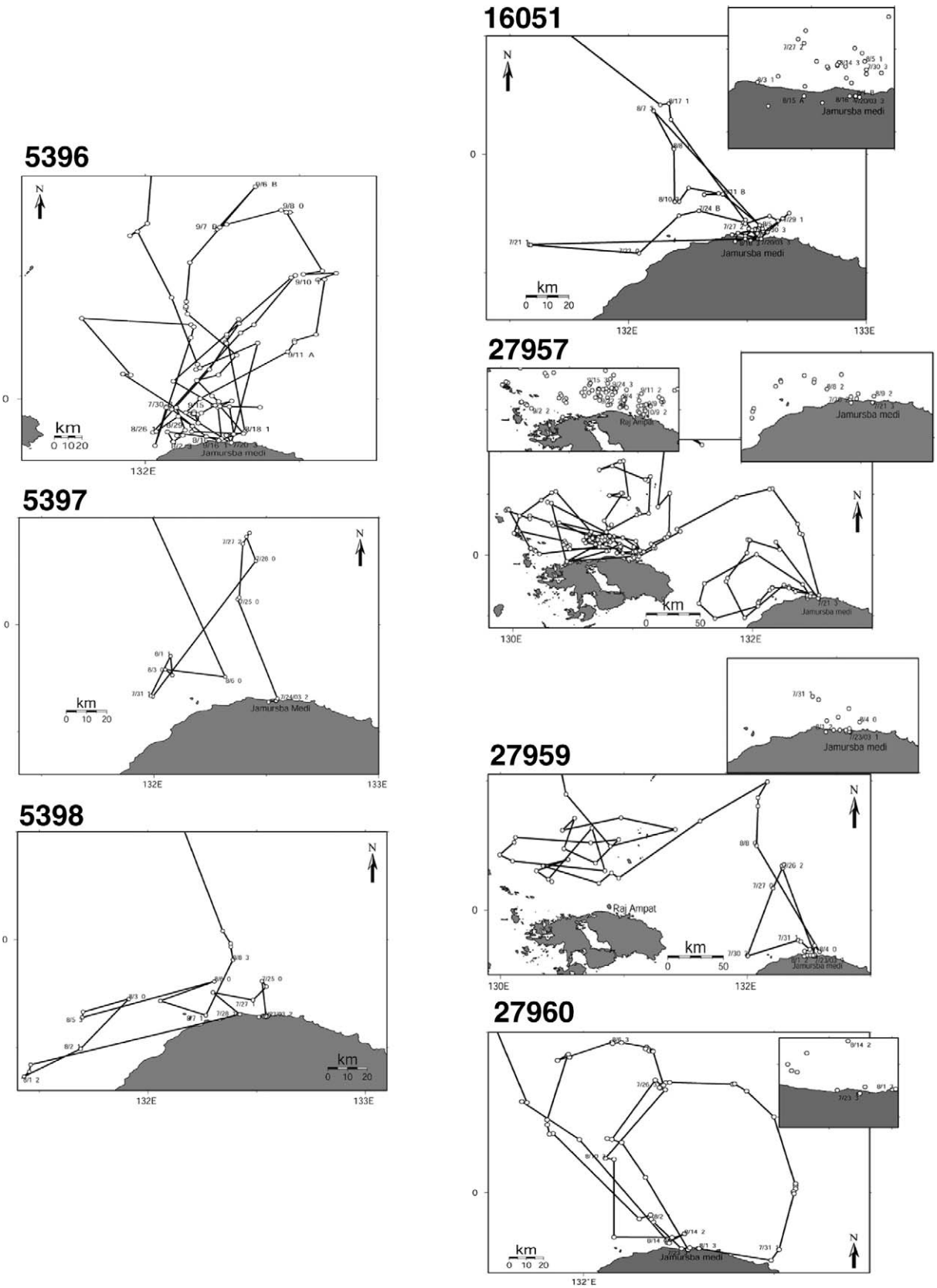

Figure 5. Satellite-tracked movements of 7 leatherbacks tagged after nesting at Jamursba-Medi in July 2003.

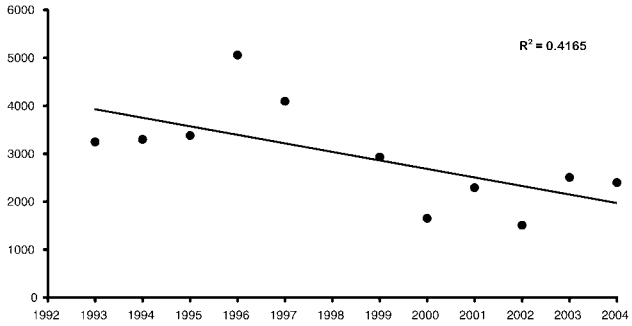

Figure 6. Trend of leatherback nesting abundance (number nests) on Jamursba-Medi from 1993–2004. Nest counts are for a portion of the nesting season from beginning of June through end of September and do not represent total nests for the year. Beaches were not monitored in 1998.

include data from Wermon. Our recent surveys from 2002 to 2004 provided the first complete census of Wermon, and numbers of nests recorded were similar to those in Jamursba-Medi (Fig. 3). Although it is not possible to derive reliable population estimates before 1994, Bhaskar's early studies (1987) suggest there were considerably more turtles nesting at Jamursba-Medi before the mid-1980s than in recent years when compared with the results of our study. This is consistent with information from local people who say that fewer turtles nest now than in the 1980s. There is even a prevalent belief among local people that the metal flipper tags used in studies reported by Bhaskar (1987) caused the turtles to leave Jamursba-Medi. Because of this, the local tribal council will not permit flipper tagging. The kinds of numbers reported by Bhaskar (1987; Table 1) have not been seen since, suggesting a sharp decline occurred in the 1980s. Betz and Welch (1992) reported large-scale egg harvest during the 1980s as the main reason for this decline. Commercial exploitation of eggs at Jamursba-Medi Beach was relatively intense for many years, harvested largely by fishermen from adjacent districts (Sorong, Manokwari, Biak, North Maluku). For example, in 1984 and 1985, 4 to 5 boats were observed visiting the beach weekly and returning with 10,000–15,000 eggs per boat (Betz and Welch 1992). During the peak nesting season, the beaches would become crowded with temporary dwellings that housed egg collectors and traders. Commercial egg harvest has been effectively eliminated since beach monitoring was established in 1993. There has not been a harvest of adult females on the beach, because the leatherbacks are not considered palatable and are revered as a sacred species by the local people. Although nesting activity has apparently declined over the last decade, there are still relatively large numbers of turtles, and the nesting population in Papua has not collapsed to the extent seen at the Malaysian and eastern Pacific rookeries.

Previous population estimates should be interpreted with caution, because it is clear from our recent surveys that Wermon is a sizable rookery that has been overlooked in the past. The first complete censuses carried out as part of our study at Wermon in 2003–2004 found almost as many nests laid on Wermon as on Jamursba-Medi (Fig. 2). It is unclear whether this represents a recent demographic shift or if there has always been this level of nesting on Wermon. Further work is ongoing to determine whether the Papuan leatherbacks consist of 2 demographically distinct nesting populations: one that nests primarily between October and March at Wermon, and another that nests at Jamursba-Medi between April and October.

An alternative scenario is that nesting occurs year-round along the northwest coast of Papua and that seasonal changes in nesting habitat determine where the turtles concentrate. The northwest monsoon occurs in the winter months and is associated with dramatic erosion of the beaches at Jamursba-Medi beginning in August, so that by October there are no suitable nesting beaches there, and the turtles instead nest on the stable beach at Wermon. Late in January, the pattern reverses, with the northeast monsoons, leading to erosion of beaches at Wermon and accretion of beaches at Jamursba-Medi. Future population assessment carried out simultaneously at all key beaches, along with passive integrated transponder tagging (McDonald and Dutton 1996), satellite telemetry, and molecular studies will determine the level of demographic independence between these rookeries, and help to better define the units appropriate for management of the Papuan leatherback population (see Dutton et al. 2007).

Internesting Movement and Habitat Use. — The satellite tracking results show that the area north of Jamursba-Medi and west around the Raja Ampat Islands is important habitat for the Papuan leatherbacks and is consistent with anecdotal evidence provided by local communities who report that leatherback turtles (locally called *tabob* or *kumep*) have been sighted around the larger straits of the Raja Ampat Islands. This species was reported in interviews as migrating across the islands, often in groups, from north to south around September (Hitipeuw 2003). The appearance of leatherbacks following the prevailing southward current is common along Sagawin Strait (between south Batanta and Salawati), Sele Strait (between Papua mainland and Salawati), and Dampier Strait (between north Batanta and Weigeo). The prevailing southward current suggests the Raja Ampat archipelago is an important migratory corridor and/or internesting habitat for Papuan leatherback breeding populations. Leatherbacks are frequently sighted off the north and northwest of Raja Ampat, and local people have said that leatherbacks occasionally nest at those small islands. Our telemetry results support these reports of sporadic nesting. The presence of leatherbacks off Raja Ampat seems to be seasonal; however, further work should be done to determine whether males or juveniles are also present to determine whether this is also a foraging and developmental habitat, and potentially a mating area.

The telemetry results also reveal that nesters frequently swim into areas within 20 km of the shore and travel

along the shore, particularly to the west of Jamursba-Medi. This should be taken into account during future marine protected area planning. Local reports of illegal fishing in this region are of concern, particularly because these activities will impact the population by removing potential breeders.

Threats

Predation. — Our results show that predation still is significant at Jamursba-Medi. The numbers we report are similar to those reported by Stark (1993) who reported that 181 of 1300 nests (14%) were destroyed by pigs from July to September 1993. Bhaskar (1985) estimated that up to 93% of the nests surviving inundation were destroyed by pigs. A survey done on Warmamedi in May 1992 found 387 leatherback nests destroyed by feral pigs (Stark 1993); this represented almost all the nests laid on this beach during that period. Starbird and Suarez (1994) reported that egg predation by pigs at Wermon exceeded 40% of nests laid. This is higher than the level we observed, suggesting that the increased presence of people working as monitors on the beach at night during our surveys may have reduced feral pig activity. Anecdotal information also suggests that harvest of pigs by the local people at Wermon has reduced the number of pigs near the beach; this has likely occurred as a result of a growing local human population.

Further work is needed to better quantify impacts of predation; however, it is clear that pig predation needs to be reduced to improve hatchling output at Jamursba-Medi and Wermon (Tapilatu and Tiwari 2007). Several approaches have been tried with limited success, including planting thorny bushes and cacti to create living fences along the edge of the forest, relocating the vulnerable nests located near the beach vegetation to protected enclosures, use of traps, and electric fences (Suganuma 2005). The effectiveness of these methods should be further assessed and improved.

Beach Erosion. — The Jamursba-Medi beaches are subject to seasonal or storm-related erosion and accretion, which can lead to nest loss when sections of beach are washed away. The northwest monsoon currents and rough seas prevalent from August through October cause erosion that washes away large numbers of unhatched nests. During this period, it is common to find only 5–10 m of beach left between the HWM and the forest, and the entire beach may be eroded along other stretches. The pattern reverses around April each year as nesting increases at Jamursba-Medi, and sand accretion results in beaches that are up to 65-m wide by late August. We estimate that relocating eggs prone to destruction by erosion could save ca. 45% of nests at Jamursba-Medi.

The best management option is to protect eggs in situ. However, at sites with excessive seasonal beach erosion and tidal inundation, eggs could be relocated to prevent destruction (Dutton et al. 2005). Research is ongoing into feasibility of nest relocation and factors affecting hatch success at Jamursba-Medi and Wermon (Tapilatu and Tiwari 2007; R. Tapilatu unpubl. data).

Logging. — In additional to natural beach erosion and accretion processes, there is a potential threat from erosion as a consequence of logging activity. Currently, logging concessions are found extending beyond the southern boundary of the nesting beach, beyond the limit of the area designated as limited production forest. Current and potential logging activities include lumber harvest and transportation, and the construction of a log pond and base camps. Logging and log transportation will likely cause upstream erosion of rivers and lead to degradation of nesting habitat (Putrawijaya 2000; World Wildlife Fund 2001a; World Wildlife Fund 2001b). The use of the beach as an access for harvested lumber to the log pond also has a direct impact on leatherbacks, because logs washed up on the beach present a barrier to both adult turtles attempting to nest and to hatchlings seeking the ocean (World Wildlife Fund 2003).

Fishing Activities. — The waters off the north coast of Papua are being increasingly targeted by both national and foreign fishing fleets. The types of fisheries include tuna longline, gill net, trammel net, and traditional fisheries (trap nets, floating cages with submerged lights). In addition, illegal fishing activities occur in the vicinity of nesting area. Fishing activities occur during the eastern monsoon, which coincides with the nesting season at Jamursba-Medi. Although fisheries-related mortality of turtles has not been quantified, communities along the north coast and north islands of Papua reported dead leatherbacks entangled in fishing nets and marine debris. Impacts of coastal fisheries remain unknown, and there have been global calls to assess the magnitude of these impacts on sea turtles (Bellagio Conference on Sea Turtle Steering Committee 2004; FAO 2004).

Legislative Status

In the Indonesian province of Papua, a coastal wildlife sanctuary that included a 10,000-ha turtle sanctuary was created in 1994 to protect Jamursba-Medi and adjacent sites by local district decree (No. 2599/II-SBKSDA IRJA/93). Although this has granted protection of nesting areas at the regional level, such decrees can potentially be overturned or superseded by national decrees, and, to date, the region has not yet received protected area status at a national level (World Wildlife Fund 2000).

A recent proposal to designate the coastal protected area as a national park originally received strong support in the form of recommendation letters from the district head of Sorong (no. 503/546 May 2000) and the governor of Papua (no. 522.5/1676/SET June 2000). Ordinarily, the next step would have been to legalize the park through a ministerial decree from the ministry of forestry in Jakarta, but adverse reactions from communities that had not been

involved in the process delayed the establishment of a national park and required a change of approach from World Wildlife Fund and other stakeholders who were supporting the proposal (World Wildlife Fund 2000). The recent development toward regional autonomy and the decentralization of political power now leads to new opportunities and responsibilities, as well as new challenges for regional and local authorities. There is potential for more local control of natural resources, including a stronger voice and a role for local communities and the ability of local governments to issue regulations.

Conclusions and Management Recommendations

Although there is evidence of an apparent long-term decline in the Papuan leatherback nesting populations, it is clear that nesting activity has been underestimated and that the rookery at Wermon is, in fact, a major nesting area. Although there are still relatively large numbers of leatherbacks nesting on the north coast of Papua, this population is in danger of becoming further depleted if the threats on the nesting beaches are not immediately addressed to increase hatchling production.

The management issues described in the previous sections indicate a need for intensive interventions that include 1) protecting nests from depredation, 2) relocating nests vulnerable to tidal destruction, 3) beach patrols to prevent illegal egg harvest, and 4) protecting adult leatherbacks in nesting and internesting habitats. Indirect interventions are also necessary, such as maintaining the quality of nesting habitats through protection of adjacent forest area. However, forest protection will require a set of different strategies, because there are obvious financial incentives for pursuing nonconservation options, such as developing forest concessions and, thus, a strong likelihood of conflict with individual interests within the community (such as landowners). Up to now the focus has been on immediate issues, such as enabling community-based patrols and nesting beach monitoring, but there is also a need to develop approaches to ensure sustainability of long-term conservation activities.

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