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Marine Turtle Nesting Activity at Playa Naranjo, Santa Rosa National Park, Costa Rica, for the 1998–1999 Season

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The leatherback turtle (*Dermochelys coriacea*) is listed by the World Conservation Union (IUCN) as a Critically Endangered species (Hilton-Taylor, 2000) and populations are experiencing global declines (Spotila et al., 1996, 2000). Population declines have been documented at a major nesting colony at Playa Grande in Las Baulas National Park, Guanacaste Province, Costa Rica, with numbers of nesting females plummeting from approximately 1400 in 1988–89 to 117 in 1998–99 (Steyermark et al., 1996; Spotila et al., 2000). In order to improve our understanding of the cause of the decline of this species, we need to improve data on the population, begin to test hypotheses on possible causes of the population decline, and address those which appear to be critical. One possible cause of the decline of turtles nesting at Playa Grande may be their emigration to other nearby, or even distant, beaches. One means of assessing this is to individually mark and monitor nesting females on all leatherback nesting beaches.

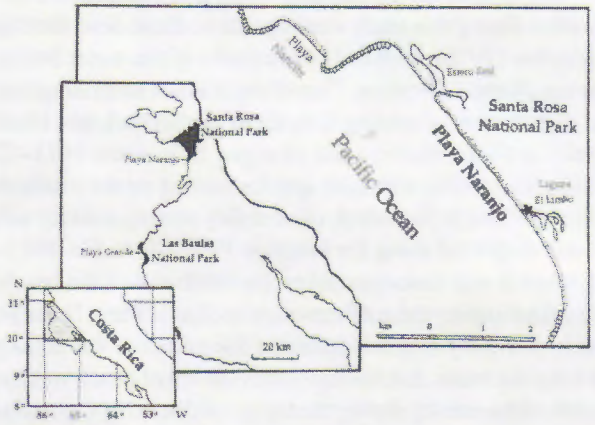

Figure 1. Map of study site, Playa Naranjo, Santa Rosa National Park, Guanacaste Province, Costa Rica. The beach was surveyed from the southern side of the mouth of Estero Real to the rocks at the southern end of the beach. Figures redrawn from Cornelius (1976), Chaves et al. (1996), and Hughes and Richard (1974).

Playa Naranjo, also in Guanacaste Province, Costa Rica, is a nesting site for three species of sea turtles, the olive ridley (*Lepidochelys olivacea*), the black turtle (*Chelonia mydas agassizii*), and the leatherback turtle. Playa Naranjo is located approximately 45 km north of Playa Grande, and immediately southeast of Playa Nancite, an important mass-nesting beach for olive ridleys. Marine turtle nesting activity has been monitored intermittently on Playa Naranjo since the 1970s (Cornelius, 1976, 1986; Cornelius and Robinson, 1985; Arauz-Almengor and Morera-Avila, 1994). It is important to monitor the marine turtle nesting activity at Playa Naranjo due to its proximity to two principal marine turtle nesting beaches on the northern Pacific coast of Costa Rica and its potential importance as an alternate nesting beach for leatherbacks from Playa Grande.

Methods. — We collected nesting data on 3 species of marine turtles between 11 October 1998 and 28 February 1999 on the 4.5 km of beach south of Estero Naranjo on Playa Naranjo (10°47'N, 85°40'W) in Santa Rosa National Park, Area de Conservacion Guanacaste, on the Pacific coast of Costa Rica (Fig. 1). The beach morphology and vegetation at Playa Naranjo have been described by Cornelius (1976), and were very similar to his description during this study. The northern end of the beach, beginning south of the estuary, is wide with low sand dunes, while the middle of the beach is still wide, but steeper, with more and taller vegetation. The mouth of Laguna El Limbo was near the middle of the survey area; it only opened to the sea once during the survey. The south end of the beach is narrow and rockier, with denser vegetation that reaches down the high tide line.

For this study, we recorded crawls and the number, location, and depredation of olive ridley, leatherback, and black turtle nests via nocturnal surveys and early morning nest counts. We also examined, measured, and PIT (Passive Integrated Transponder)-tagged adult nesting female leatherbacks during our nocturnal surveys according to the protocol established and utilized at Playa Grande in Las Baulas National Park (Steyermark et al., 1996).

Results. — We recorded a total of 292 olive ridley, 24 black turtle, and 48 leatherback crawls on Playa Naranjo south of Estero Naranjo. These resulted in 215 olive ridley, 11 black turtle, and 25 leatherback nests. Coyotes were the only observed marine turtle nest predator during this study. Nests laid in October that were not depredated by coyotes were lost to extremely high and strong tides and torrential rains which accompanied Hurricane Mitch at the end of that month (Table 1). The olive ridley nests were relatively equally distributed along the beach, while black and leatherback turtles nested mostly at the south end (Fig. 2).

We observed and PIT-tagged 7 individual adult female leatherbacks on Playa Naranjo during our beach surveys. Of these 7, we encountered 2 only once, 1 female twice, 2 females three times, and 2 females five times. None of these turtles were encountered nesting at Las Baulas National Park that season (R. Reina, unpubl. data) and no turtles PIT-tagged at Las Baulas were encountered nesting at Playa Naranjo during this season.

In addition to the above nests, coyotes depredated 66% (n = 166) of the nests (n = 251) we encountered during this study. We recorded predation of 74% of the olive ridley nests (159 of 215), 64% of the black turtle nests (7 of 11), and only one of the leatherback nests (Table 1), with the percentage of olive ridley and black turtle nests depredated by coyotes being higher during the dry season (January–February) than during the wet season (October–December).

We encountered 20 dead adult olive ridleys on the beach over the course of the study, but none of the other species. Sixteen of the 20 dead turtles were killed by coyotes; the other 4 apparently drowned (Drake et al., 2001).

Discussion. — During the 1998–99 nesting season at Playa Naranjo, we encountered far fewer marine turtle crawls and nests than were reported in studies conducted in the 1970s, 1980s, and early 1990s (Table 2). The frequency of leatherback and black turtle nesting activity at Playa Naranjo decreased greatly after 1990–91. We recorded 48 leatherback, 24 black turtle, and 292 olive ridley crawls during this study. Cornelius and Robinson (1985) reported 312 leatherback and 63 black turtle crawls between December 1983 and March 1984. Arauz-Almengor and Morera-Avila (1994) reported 466 leatherback, 431 black turtle, and 308 olive ridley crawls between October 1989 and February 1990. The crawls we recorded included 25 leatherback, 11 black turtle, and 215 olive ridley nests, while Mayor and Spotila (1998) reported 56 leatherback, and approximately 75 black turtle and 100 olive ridley nests on Playa Naranjo in 1997–98.

Although the number of leatherbacks encountered nesting at Playa Naranjo during the 1998–99 season may seem small (n = 7), representing approximately 6% of the number of leatherbacks encountered nesting at Las Baulas National Park in 1998–99 (n = 117), Playa Naranjo is still the second most important leatherback nesting beach on the Pacific coast of Costa Rica (Reina and Spotila, 1999). Playa Grande has seen an exponential decline in numbers of nesting turtles (Spotila et al., 2000). Playa Naranjo also appears to have experienced a decline in nesting activity for all three species which nest there.

Table 1. Marine turtle activity on Playa Naranjo, Santa Rosa National Park, Costa Rica, October 1998 – February 1999. Numbers were obtained during diurnal and nocturnal beach surveys. Coyotes were the only observed predators of marine turtle nests during this study. October nests not subject to coyote predation were lost to high tides from Hurricane Mitch.

Month	Total # Crawls	Total # Nests	Depredated Nests
Lepidochelys olivacea			
October	41	36	27
November	64	47	28
December	67	35	25
January	59	58	48
February	61	34	31
Total	292	215	159
Dermochelys coriacea			
October	0	0	0
November	4	4	0
December	17	5	0
January	21	13	1
February	6	3	0
Total	48	25	1
Chelonia mydas agassizii			
October	13	8	5
November	6	2	1
December	0	0	0
January	5	1	1
February	0	0	0
Total	24	11	7

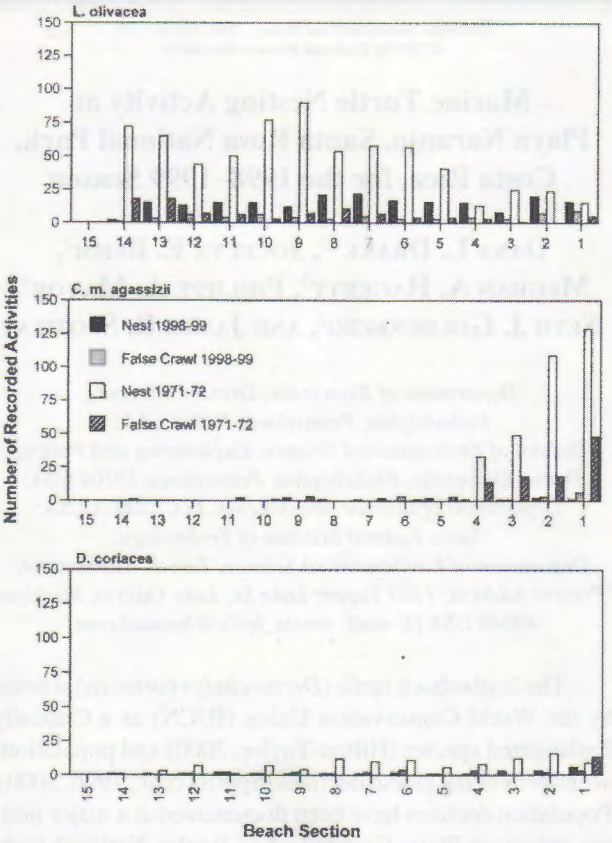

Figure 2. Distribution of *L. olivacea*, *C. m. agassizii*, and *D. coriacea* nesting activity at Playa Naranjo, Santa Rosa National Park, Costa Rica, in 1971–72 (Cornelius, 1976) and 1998–99 (present study). Section 1 is at the south end of the beach. Section 15 was not monitored during the 1998–99 season. The beach morphology and vegetation has changed little from the description by Cornelius (1976).

The overall beach characteristics and vegetation composition during this study were similar to those described by Cornelius (1976), with only the mouths of the water bodies having changed location. Therefore, it is not surprising that the distribution of nesting activity of leatherback and black turtles at Playa Naranjo has changed little since 1971–72 (Cornelius, 1976), with both species nesting on the southern end of the beach. However, olive ridley nesting activity was evenly dispersed along the beach in 1998–99, unlike 1971–72, when it was concentrated on the north end of the beach. We did not survey the northern-most section of Playa Naranjo, due to difficulty in safely crossing the mouth of the estuary on a regular basis. Additionally, this stretch of beach was the mouth of the estuary during the study conducted by Cornelius (1976). The introduction of the minimally-developed campsite behind section 7 after Cornelius' studies did not seem to affect the distribution of marine turtle activity of any of the three species of turtle (Fig. 2).

Coyotes were the only predators of marine turtle nests encountered during this study, although raccoons, known turtle nest predators, were present in the camping area and adjacent forest, but never encountered on the beach. Coatis, also known turtle nest predators, were not present at Playa Naranjo during this study, but are common at nearby Playa Nancite.

During this study, coyotes were responsible for the predation of both turtle eggs and adult nesting turtles. The majority of depredated nests were olive ridley nests, followed by black turtle nests. Two reasons for this may be: 1) olive ridley nests are laid at the shallowest depths in the sand of the three species (olive ridleys lay their nests at approximately 35 cm depth, while black turtle nests are laid at approximately 55 cm, and leatherbacks lay their nests at approximately 80 cm depth, making it a formidable task for digging predators to reach them), and 2) black turtles laid more nests in the vegetation than in the open beach, as the olive ridleys did, making olive ridley nests easier to locate and excavate.

Sixteen of the 20 dead adult *L. olivacea* we encountered on the beach during the study were attacked and killed by coyotes in mid-crawl, either prior to or after completing the nesting process. The other 4 adult turtles apparently drowned, as they bore no external wounds which were consistent with coyote attack (Drake et al., 2001), and their appearance coincided with illegal offshore fishing activity in front of Playa Naranjo. We did not encounter any dead individuals of other marine turtle species during our study; however, dead black turtles have occasionally been encountered (Oscar Hernandez, *pers. comm.*).

The loss of reproductive adult females from a population is much more detrimental than the loss of nests (Congdon et al., 1993, 1994). It is clear that if conservation efforts on behalf of sea turtles at Playa Naranjo are to be initiated, the first step may need to be some form of predation mitigation, although Costa Rican laws preclude the killing of coyotes in National Parks.

Nesting activity at Playa Naranjo has declined since the 1970s, although quantitative trend analysis could not be done due to differences in the collection and reporting of the data by various investigators. Regardless, the numbers clearly indicate a dramatic decline in the nesting activity of all three endangered species of marine turtle at Playa Naranjo over the past 3 decades. A standard protocol to monitor marine turtle activity on the beach should be established and utilized. A full year's survey should be conducted to provide baseline data as well as determine the frequency of out-of-season (prior to October and after February) leatherback nesting. Annual monitoring of Playa Naranjo should be undertaken to understand its role in the overall nesting patterns of leatherbacks on the Pacific coast of Costa Rica.

The predation rate at Playa Naranjo was very high for olive ridley and black turtle nests. Additionally, the number of adult female olive ridleys depredated by coyotes was surprising, given that no adult predation by coyotes had been previously reported. Both the high percentage of nest loss and the loss of reproductive adults has serious conservation implications, and should be addressed.

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Table 2. Summary of reported marine turtle nesting activity on Playa Naranjo, Santa Rosa National Park, Costa Rica. Cr = crawls, any emergence of a turtle onto the beach, regardless of outcome; N = nests, a crawl which resulted in deposition of eggs; P = number of depredated nests; and (*) = no data available. Calculations of data in terms of observations/unit effort were not possible due to variability in reporting.

	Dermochelys			*Lepidochelys*			*Chelonia*							
Season	Cr	N	P	Cr	N	P	Cr	N	P	Season Span	# of Days	Activity Counted	Count Frequency	Source
1971-72	119	106	*	811	710	*	437	326	*	11/9/71-3/3/72	202	Cr	Appears daily	Cornelius, 1976
1983-84	312	*	*	40	*	*	63	*	*	12/13/83-3/3/84	80	Cr	5-7 times/wk	Cornelius and Robinson, 1985
1989-90	466	*	*	304	*	*	431	*	*	10/1/89-2/28/90	151	Cr	Unknown	Arauz-Almengor and
1990-91	1212	*	*	447	*	*	364	*	*	10/10/90-2/28/91	151	Cr	Unknown	Morera-Avila, 1994
1996-97	76	76	22	452	439	396	110	102	54	11/1/96-2/15/97	107	Cr,N,P	1-2 times/wk	Mayor and Spotila, 1998
1997-98	50	*	*	*	*	*	*	*	*	11/1/97-2/15/98	107	Cr	1-2 times/wk	Mayor and Spotila, 1998
1998-99	48	25	1	292	215	159	24	11	7	10/11/98-2/28/99	140	Cr,N,P	Daily	Present Study

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Ecology and Conservation Status of the Arakan Forest Turtle, *Heosemys depressa*, in Western Myanmar

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The Arakan forest turtle (*Heosemys depressa*) is endemic to Myanmar and is regarded as one of the world's least known chelonians (Ernst and Barbour, 1989; van Dijk, 1993). From 1875, when the species was first described, to 1908 only 5 *H. depressa* were collected, all from Rakhine (formerly known as "Arakan") State, Myanmar (Iverson and McCord, 1997). These presumably originated from the Arakan Yoma Hills, although specific locality data are lacking (Iverson and McCord, 1997). More recently, at least 18 additional *H. depressa* were obtained from turtle markets in Yunnan Province, China (Iverson and McCord, 1997; P.C.H. Pritchard, *in litt.*). Given the extensive trans-border turtle trade in this region (Kuchling, 1995; Platt et al., 2000), these specimens were most likely imported from Myanmar rather than collected locally (Iverson and McCord, 1997; P.C.H. Pritchard, *in litt.*).

Heosemys depressa is classified as Critically Endangered (facing an extremely high risk of extinction in the near future; IUCN, 1994) by the IUCN due to continuing exploitation and limited distribution, and since 2003 also receives Appendix II protection under CITES (IUCN/SSC Tortoise and Freshwater Turtle Specialist Group and Asian Turtle Trade Working Group, 2000; IUCN, 2002; CITES, 2003). Nothing is known concerning habitat preference, ecology, or population status of *H. depressa*, and consequently, surveys have been accorded high priority (van Dijk, 1993, 1997; Platt et al., 2000). We herein report the results of a recent survey to assess the conservation status and gather ecological data on *H. depressa* in central Rakhine State, Myanmar. Conservation recommendations based on this survey are also provided.

Study Area. — Rakhine State encompasses much of the Arakan Yoma Hill range, one of the most rugged and sparsely inhabited regions in mainland Southeast Asia (Salter, 1983). The Arakan Yoma Hills extend for 500 km along the western coast of Myanmar, and represent a southern extension of the Himalayas (Henderson et al., 1971; Salter, 1983). These hills consist of parallel north-south ridges separated by streams flowing within restricted valleys (Stamp, 1930; Henderson et al., 1971). Maximum elevation ranges from 915 to 1150 m, while valley bottoms are often less than 100 m above sea level; thus a wide range of slope, aspect, and elevational conditions often exist within a small area (Salter, 1983). A narrow alluvial belt occurs along the coast (Henderson et al., 1971). Mean annual precipitation ranges from 4500 to 5300 mm with a pronounced wet season extending from early June to late October (Smythies, 1953; Henderson et al., 1971).

The evergreen forests of the Arakan Yoma Hills have been variously described as rainforest (de Terra, 1944), semi-evergreen rainforest (Salter, 1983), tropical semi-evergreen forest (Champion, 1936), and evergreen tropical forest (Stamp, 1924, 1930); even so, their floristic composition remains poorly documented (Salter, 1983). Extensive tracts of bamboo (*Melocanna bambusoides*) occur throughout the region, developing in response to human disturbances such as shifting cultivation, fire, or both (Stamp, 1924, 1930; de Terra, 1944). Small tracts of deciduous forest are restricted to porous soils in the foothills of the coastal