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Assessment of Sea Turtle Mortality Rates in the Bahía Magdalena Region, Baja California Sur, México

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In Mexico, declines in sea turtle populations in the Gulf of Mexico and Caribbean Sea have been well documented and primarily attributed to pressures from marine pollution and harvest (Márquez-Millan and Villanueva, 1988). Much less information is available for the northwest coast of Mexico and the Baja California Peninsula. This region is considered the largest reservoir of commercially important marine organisms in the country and coastal lagoons, such as Bahía Magdalena, provide important feeding and developmental grounds for sea turtles (Alvarado and Figueroa, 1990; Nichols and Seminoff, 1994; Nichols et al., 1998; Nichols et al., 2000). Five different sea turtle species are known to occur in this region: the East Pacific green turtle (*Chelonia mydas*), locally known as the black turtle (*C. m. agassizii*) (see Karl and Bowen, 1999 and Pritchard, 1999, for reviews on taxonomy), the Pacific loggerhead (*Caretta caretta*), the olive ridley (*Lepidochelys olivacea*), the hawksbill (*Eretmochelys imbricata*), and the leatherback (*Dermochelys coriacea*).

In 1972 the Mexican government began to regulate the capture of sea turtles (Secretaria de Pesca, 1990). Although regulations now exist that forbid the capture or consumption of turtles, they are often difficult to enforce. Along the Baja California Peninsula there are numerous natural resource-dependent communities. In many of these towns, such as those in the Bahía Magdalena region, the majority of the inhabitants are employed as fishermen who have limited economic alternatives. In towns such as these, sea turtles have been historically considered a delicacy to be served on special occasions (Caldwell, 1963; Felger and Moser, 1987). In addition to being a food source, sea turtles were used by coastal communities for various purposes including games and decorations, and gained traditional, even spiritual, importance. Despite the fact that it is illegal to deliberately take a turtle anywhere in Mexico, it has proven to be very difficult to control the use of this resource which is so engrained as part of this region's cultural heritage (Cliffton et al., 1982; Figueroa et al., 1992; Nichols et al., in press a).

Our study was conducted to assess the mortality of sea turtle populations in the region of Bahía Magdalena. The specific objectives were to identify which species are experiencing the highest mortality levels in this region; to determine the size classes that are most commonly vulnerable, and to estimate the magnitude of mortality of sea turtles in this region.

Methodology. — Bahía Magdalena is located on the Pacific coast of the Baja California Peninsula between 24°15'N and 25°20'N, and 111°30'W and 112°15'W (Fig. 1). As a result of seasonal marine upwelling, it is a highly productive lagoon that is sheltered from Pacific waters by two barrier islands, Isla Magdalena and Isla Margarita. Because of a high evaporation rate and the lack of fresh water inflow, Bahía Magdalena is considered a reverse estuarine environment with normal marine salinity levels at the mouth of the bay and higher values near shore.

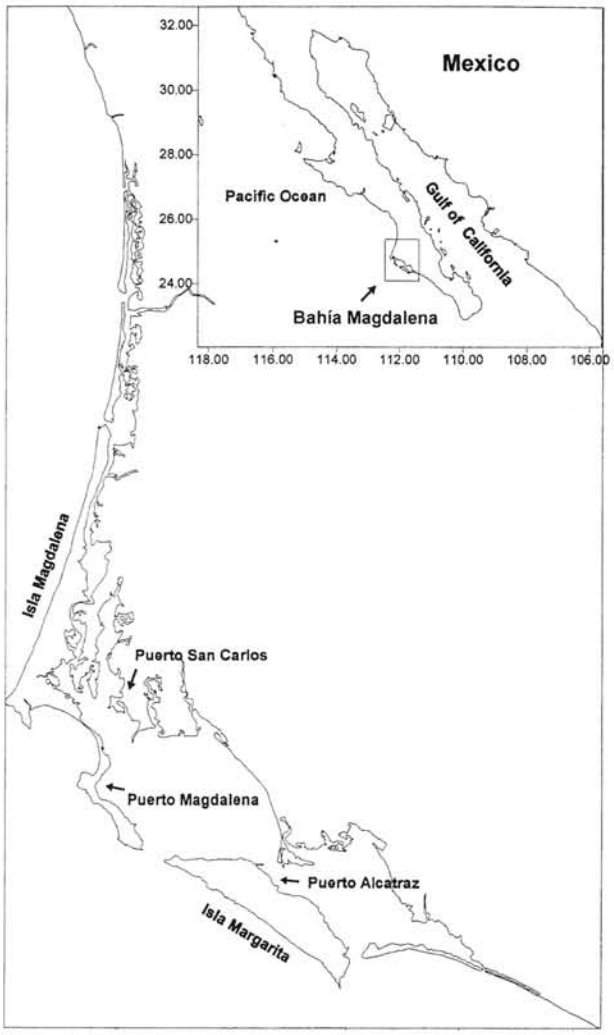

Figure 1. Map of the Bahía Magdalena region, Baja California Sur, México, where surveys where conducted for sea turtle carcasses during the summer and fall, 1999.

A search for sea turtle carcasses was conducted throughout the Bahía Magdalena region from June to December 1999. This search included the towns and dumps of Puerto San Carlos, Puerto Magdalena, and Puerto Alcatraz (Fig. 1). Also surveyed were the Pacific coastal beaches of Isla Magdalena and Isla Margarita. The species was identified and the location of each turtle carcass was determined using a handheld Garmin 12 Global Positioning System (GPS).

The straight carapace length (SCL) of each turtle was recorded using calipers, taken from the anterior nuchal notch to the longest posterior point of the carapace. After each carcass was measured, it was marked with neon spray paint or collected to avoid duplicate counting.

Initial surveys were conducted in June to identify and mark all turtle carcasses, and then the surveys were repeated throughout the 6-month study period in order to estimate a rate of mortality based on the new turtles found over time. The estimated mortality rate for the Bahía Magdalena region was the number of new carcasses found for each survey area divided by the amount of time elapsed between surveys.

Results. — Over the 6-month study period, carcasses of 4 out of the 5 species known to occur along the peninsula were found. No leatherback turtles were encountered. A total of 514 turtle carcasses were recorded (Table 1). Green turtles were the most frequently observed ($n = 267$, 52%), with loggerheads ranking second ($n = 180$, 35%). Olive ridleys ($n = 12$, 2%) and hawksbills ($n = 6$, 1%) were less frequently encountered. The species identity of approximately 10% of the carcasses found could not be determined due to their state of fragmentation.

Table 1. The location of sea turtle carcasses during surveys conducted in the Bahía Magdalena region, Baja California Sur, México, region during the summer and fall, 1999.

a) Surveys conducted in communities

Species	Puerto Magdalena	Puerto San Carlos	Puerto Alcatraz	Total
C. mydas	119	123	12	254
C. caretta	80	18	3	101
E. imbricata	4	1	0	5
L. olivacea	5	2	0	7
Unidentified	30	1	2	33
Total	238	145	17	400

b) Surveys conducted on uninhabited beaches

Species	Isla Magdalena	Isla Margarita	Unidentified	Total
C. mydas	11	0	2	13
C. caretta	78	1	0	79
E. imbricata	0	0	1	1
L. olivacea	5	0	0	5
Unidentified	12	0	4	16
Total	106	1	7	114

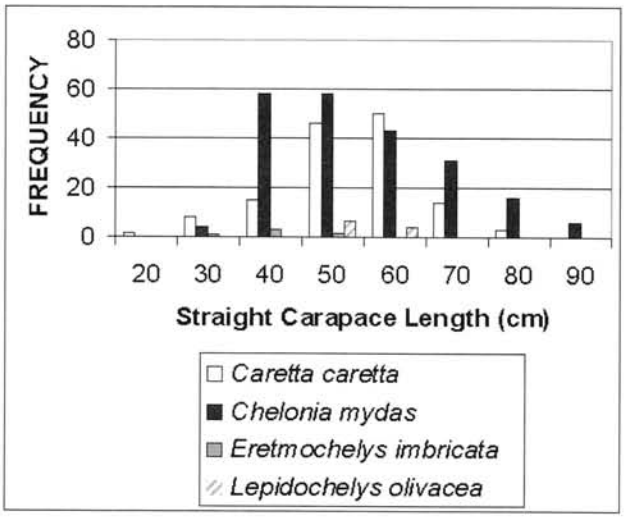

Figure 2. Frequency distribution of the straight carapace length of sea turtle carcasses measured in the Bahía Magdalena region during the summer and fall, 1999.

The size distribution of each of the 4 species is shown in Fig. 2 (a standard error of ± 0.5 cm was calculated for all SCL measurements). The mean SCL of loggerhead turtles was 58.5 cm ($n = 180$, S.D. = 11.1, range = 26.6–83.4). The green turtle mean SCL was 59.8 ($n = 267$, S.D. = 13.7, range = 35.6–94.2).

The majority (78%) of the turtle carcasses were encountered in the towns and dump sites of the region (Table 1). Turtle carcasses in the town of Puerto Magdalena made up 46% of all findings, in Puerto San Carlos, 28% of the carcasses were observed, and in Puerto Alcatraz they made up only 3%. Only 22% of the carcasses were found in the uninhabited areas of the region. The minimum sea turtle mortality rate for this region was estimated to be 47 turtles per month, or 564 turtles per year.

Discussion. — The minimum sea turtle mortality rate calculated for this region (564 turtles per year) establishes an initial indication of the level of threats occurring. This minimum estimate is most likely conservative as some turtles were likely overlooked or remains disposed of at sea and some areas were only surveyed a single time.

Turtle carcasses were 3.5 times more numerous in the towns and dump sites of the region than on the uninhabited beaches and there were 2.5 times as many green turtles as loggerheads found in the towns. This suggests that the mortality of green turtles measured in this region may be primarily related to domestic consumption, which impacts both juvenile and adult animals. For carcasses measured, the green turtle mean SCL (59.8 cm) was smaller than the mean lengths reported for this species in the Gulf of California (Nichols et al., in press a) and over 87% of the green turtle carcasses found in the Bahía Magdalena region were smaller than the average size of adults reported on Mexican nesting grounds (SCL = 77 cm; Figueroa et al., 1992).

A stranded turtle found on one of the uninhabitated beaches was 6 times more likely to be a loggerhead than a green turtle. Most loggerhead turtle mortality in this region impacts juvenile animals that have not yet reached reproductive maturity. All of the loggerhead turtles measured had a smaller SCL (range 26–83 cm) than the average size of adults reported on nesting grounds (SCL = 87 cm; Miller, 1997). This is likely a reflection of the constitution of the local population, rather than selective mortality (Nichols et al., in press a).

A hindrance to this study was that some regions were located in such isolation that they were difficult to access and could not be surveyed more than once. For instance, during the fall surveys (September to November), 92 of the 255 new turtles found were located along the northern beaches of Isla Magdalena. This region contained approximately 1.5 turtles/km but was surveyed only in September. Since these areas were not surveyed again, they could not be included in the mortality rate estimates. The western beach of Isla Margarita and the town of Puerto Alcatraz were also surveyed only once. Only 17 turtles were found in this town and only one carcass was found along the 20 km beach of this island. This contrasts greatly with the high numbers of turtles found on the surveyed beaches of Isla Magdalena. Two hypotheses could explain this difference: the directions of coastal currents, or less fishing off the coast of Isla Margarita. Two of the surveyed beaches of Isla Magdalena (where the highest number of stranded turtles were found) face northwest, while the beach on Isla Margarita faces westsouthwest. Furthermore, fishermen report higher fishing effort in waters offshore Isla Magdalena, in Bahía Santa Maria, than in waters off Isla Margarita. Additional research is needed to support or refute either hypothesis.

It was difficult to ascertain whether consumed turtles were incidentally or purposefully captured. However, local informants suggested that it is a combination of both as well as an incomplete understanding of the Mexican regulations prohibiting turtle use (Nichols et al., in press b). Sea turtles originating on beaches as far away as Japan and southern Mexico contribute to the populations found in the regional waters of the Baja California Peninsula. Continuation of the rate of mortality recorded in this study, particularly if Bahía Magdalena is representative of the entire region, will drastically impede and confound long-term recovery efforts for these sea turtle populations.

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