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Conservation and Biology of the Leatherback Turtle in the Mexican Pacific

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ABSTRACT. – Proyecto Laúd coordinates the conservation activities for the leatherback turtle on 4 index beaches of the Mexican Pacific, combining efforts of different government and nongovernment institutions. With more than 20 years of tagging and conservation data, this project represents the most solid source of knowledge about the biology and ecology of the leatherback turtle in Mexico. Daily nesting track counts done from 1982 to 2004 showed a declining trend for the number of leatherback nests on the 4 index beaches of the Mexican Pacific (Mexiquillo, Tierra Colorada, Cahuitán, and Barra de la Cruz). The worst nesting season was 2002–2003, in which only 120 leatherback nests were recorded on the index beaches combined. The decline is attributed to a combination of extensive egg harvest on all Mexican Pacific beaches before conservation activities and high mortality of large adults in pelagic fisheries. A total of 5314 females were individually identified since 1982; the average remigration interval is 3 years, and there is evidence of interchange of females between some beaches. The female population has an average curved carapace length of 143.8 cm and an average clutch size of 62 eggs. The average estimated clutch frequency is 5.5 ± 1.9, with an average clutch interval of 9.7 ± 1.2 days. From 1982 to 2004 a total of 270,129 leatherback hatchlings were released to the wild population. This comparatively small number was not enough to offset the mortality of juveniles and adults offshore. This may explain the continuing population decline in spite of 20 years of protection activities. Currently, hope for the future of the population relies on the protection of at least 80% of the clutches laid on the priority beaches, the participation of local communities in conservation activities, and increased awareness of the leatherback's status among Mexican society.

KEY WORDS. – Reptilia; Testudines; Dermochelyidae; *Dermochelys coriacea*; marine turtle; Pacific Ocean; population; conservation; management; decline; Mexico

The leatherback turtle (*Dermochelys coriacea*) is a unique sea turtle with a unique history. In the early 1950s, when many important nesting sites for most sea turtle species were characterized, Archie Carr considered that the leatherback did not appear to nest anywhere in important numbers (Carr 1952). As late as 1971, Pritchard wrote that no areas of high nesting concentrations were known for the eastern Pacific (Pritchard 1971). But soon it became evident that the eastern Pacific hosted an important population.

René Márquez wrote the first report of leatherbacks nesting in the Mexican Pacific in 1976 and mentioned that the beach of San Juan Chacahua in Oaxaca (15°57′N, 97°41′W – 15°56′N, 97°33′W) was the most important nesting site in Mexico, with 2000 females nesting each season. In 1981, Márquez referred to Tierra Colorada (Guerrero) and Mexiquillo (Michoacán) as major nesting sites for this species, calculating around 3000 to 5000 females nesting per season in each of these beaches (Márquez et al. 1981). Fritts et al. (1982) reported leatherbacks nesting in a beach 15 km south of Punta Marqués, Baja California (22°48′N, 111°53′W); this was the northernmost report of nesting for this species in Mexico.

Pritchard conducted the first aerial survey along the Pacific coast of Mexico in 1981, which allowed him to estimate the size of the leatherback nesting population in the region (Pritchard 1982). As he noted, it was impossible to directly count the nests because of the high density; nevertheless, estimations suggested that the area between Maruata (18°15′30"N, 103°05′23"W) and the Tehuantepec Isthmus (16°10′N, 95°00′W) hosted a nesting population of 75,000 females. He concluded that this was the largest leatherback nesting population in the world, which represented 65.2% of the global estimate of 115,000 females. Pritchard also observed remains of dead females on some beaches, which indicated that illegal slaughtering was common.

Pritchard's aerial survey and population estimate for the Mexican Pacific leatherbacks was the only study of its kind up to 1995. For more than a decade, the only information available were local unpublished data for certain areas and certain years, gathered by independent

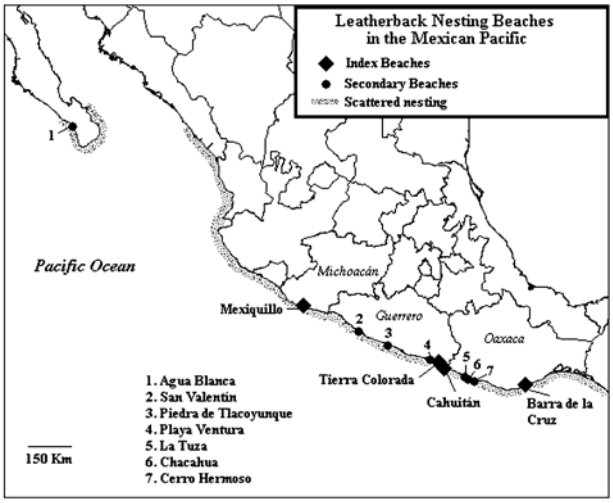

Figure 1. Distribution of leatherback nestings in the Mexican Pacific and location of the priority nesting beaches.

working groups from Mexiquillo, Tierra Colorada, Barra de la Cruz, and San Juan Chacahua.

The beach of Mexiquillo has the oldest uninterrupted conservation program for the leatherback in Mexico, which was generated over 2 decades of biological information for this species. During this period our research group, working for the National University of Mexico (UNAM), documented annual fluctuations in the number of leatherback nests, recording from 3000 to 5000 nests per year from 1982 to 1989. In the 1993–1994 nesting season, the first sharp decline in the number of nests recorded in Mexiquillo caused great concern. Although conservation projects in other Pacific beaches like Tierra Colorada, Chacahua, and Barra de la Cruz were either younger or not continuous, the same sharp decline in nesting numbers was noticed in the 1993–1994 season. Sarti et al. (1994) suggested that this decline in the nesting numbers could be attributed to:

1. a true decrease in the number of leatherbacks in the Mexican population, because of intensive egg harvest and killing of adult females both on beaches and in open waters,
2. natural fluctuations of the reproductive biology of this species, or
3. movement of the females to other nesting areas.

The concern caused by the low leatherback nesting numbers in 1993–1994 motivated several researchers from different institutions to join forces, and, in 1995, a new coordinated conservation effort took shape as the "Proyecto Laúd" (Leatherback Project). Proyecto Laúd identified the major nesting sites as index beaches used for evaluating the population size: Mexiquillo, Tierra Colorada, Cahuitán, and Barra de la Cruz (Fig. 1). Other beaches with lower nesting densities but among priority areas for conservation (named secondary beaches) are Agua Blanca (Baja California), Playa Ventura, Playa San Valentín, Piedra de Tlacoyunque (Guerrero), La Tuza, and Chacahua (Oaxaca). The main objectives of this ongoing project are to evaluate the nesting population size of the leatherback in the Mexican Pacific and to protect the reproductive effort of this population through a coordinated research and management plan.

Proyecto Laúd, currently under the auspice of the Mexican Comission for Natural Protected Areas (CONANP), a decentralized agency from SEMARNAT (Mexican Ministry of Environment), compiles the data generated by government and nongovernment institutions working at important leatherback beaches in a single database. The project also standardizes the field methods throughout the nesting range and monitors the fluctuations of the leatherback nesting numbers in the Mexican Pacific. This paper presents the results of 20 years of data gathered by this project regarding distribution, nesting numbers, conservation activities, and biological characteristics of the leatherback turtle in the Pacific coast of Mexico.

METHODS

To accomplish the project's objectives, teams of field technicians worked at the index beaches for the full nesting season (October to May). The protection activities started at different years on different beaches (Fig. 2), but, by 1997, all index beaches had standardized methods for population evaluation. The teams patrolled the beaches each night from 2000 to 0500 hours, looking for nesting females. All females were checked for old tags or tag scars, which indicated a remigrant. Previously untagged females were equipped with 2 kinds of tags: 1 metal (Monel or Inconel) placed in the right hind flipper and 1 PIT (passive integrated transponder, AVID brand) injected in the right shoulder, by using standard procedures (Dutton and McDonald 1994). Notes were made on the presence of epifauna and general body condition. We obtained, for each female, the standard curved carapace length (CCL) and width (CCW; Bolten 1999) during the motionless phase of the nesting process, with a plastic measuring tape and averaged those values for the season. We considered only females with complete caudal tip and with no carapace deformities for measurement analysis.

If the female built a nest and did not lay eggs, that was a "failed oviposition"; the presence of a clutch was verified by direct observation of the laying process or direct evidence (e.g., eggs, egg shells, hatchling tracks in case of in situ nests). Tagging the females allowed estimating reproductive parameters, such as average estimated clutch frequency (ECF) and average clutch interval (CI). We defined CI as the number of days between consecutive successful ovipositions per female and averaged for the season. We used CI to calculate ECF per female (Tucker and Frazer 1991), with the following assumptions: 1) the first recorded clutch for a female was its first for the season, 2) the last recorded clutch for a female was its last for the season, 3) there is no emigration or immigration for the Mexican Pacific during the

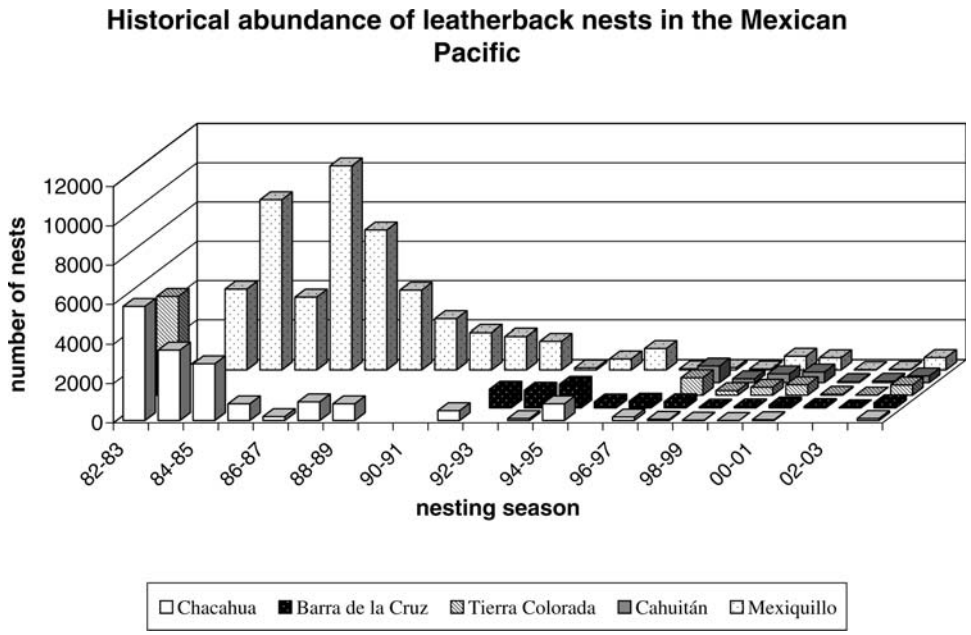

Figure 2. Historical information of leatherback abundance on the Mexican index beaches. Chacahua is no longer considered an index beach but is among the priority areas because of its historical importance.

reproductive season, although movements between beaches do occur (Sarti and Barragán 2004), 4) only successful ovipositions are considered, 5) no more than 2 consecutive successful ovipositions are estimated for any female when using its average CI. Females with only 1 recorded clutch in the season or that did not meet the last assumption were not considered for analysis. We defined fecundity as the total number of eggs laid by a female in a season, calculated from the average clutch size and the ECF.

We verified the number of nesting emergences per night with an early morning track count over the whole length of each beach, in case some emergences were not encountered during the night. A distinction was made between nests (tracks with a body pit) and non-nesting emergences (tracks without a body pit). In 1996, Proyecto Laúd started aerial surveys to describe the distribution and abundance of leatherback nests along the Mexican Pacific. These surveys occurred once a year, close to the peak nesting period (January) and were backed up with ground truthing on all the index beaches. We located the coordinates of each nest or group of nests in high density areas with a global positioning system and marked them on 1:250,000 topographical maps. By combining the daily track counts, the ground truthing, and the aerial surveys, we could correct the nest count for 3 errors, by using a model (Sarti 2000b) that is currently being improved.

Because poaching and predation on all the index beaches make in situ incubation unsafe, clutches were collected as they were laid and relocated to protected fenced areas as soon as possible, usually within 1–2 hours. We counted the eggs as they were reburied, and the clutch size was averaged for each season. We released the hatchlings upon emergence, in different areas of the beach each time, to avoid predator concentrations. After hatchling emergence, the nests were opened and the contents excavated to evaluate hatching success as defined by Miller 1999. We defined recruitment as the total number of released hatchlings/number of eggs, averaged for all clutches in a season.

RESULTS

Population Trend and Spatial Distribution of Nesting. — Current conservation activities for the leatherback turtle in the 4 index beaches of the Mexican Pacific comprise 64 km of coast (Table 1). If we consider the secondary beaches, in which such activities have not been continuous, the protection efforts for the leatherback in Mexico span 214 km. The daily track counts done from 1982 to 2004 showed a declining trend for the number of leatherback nests in the Mexican Pacific (Fig. 2). The best nesting season was 1985–1986 with 5000 nests recorded in the southeast portion of Mexiquillo (4 km); by adjusting for the proportion of nests that occur each season on the rest of the beach, we estimated as many as 10,000 nests on the whole beach in that season. Population size reached the lowest level in the 2002–2003 season, when we recorded only 120 leatherback nests on the index beaches combined with a maximum nesting density of 12 nests/km. In later seasons, the nesting numbers fluctuated but did not recover in spite of more than 2 decades of protection activities.

Leatherback nesting, although occurring along the whole Pacific coast of Mexico, was not homogeneous but concentrated in rather defined areas. Sarti et al. (1998) estimated that the 4 index beaches hosted about 42% of the total number of nests in the Mexican Pacific. If

Table 1. Index and secondary nesting beaches for the leatherback turtle in the Mexican Pacific.

Beach	State	Coordinates (beginning/end)	Length (km)
Index beaches			
Mexiquillo	Michoacán	18°10′25″N 102°58′25″W / 18°05′34″N 102°48′31″W	18
Tierra Colorada	Guerrero	16°30′03″N 98°43′40″W / 16°19′36″N 98°34′05″W	26
Cahuitán	Oaxaca	16°18′42″N 98°32′26″W / 16°16′47″N 98°26′59″W	12
Barra de la Cruz	Oaxaca	15°49′19″N 95°57′59″W / 15°50′36″N 95°53′28″W	8
Km of index beaches			64
Secondary beaches			
Agua Blanca	Baja California	23°29′34″N 110°16′27″W / 23°42′01″N 110°35′31″W	40
San Valentín	Guerrero	17°28′42″N 101°20′23″W / 17°26′17″N 101°14′09″W	21
Piedra de Tlacoyunque	Guerrero	17°15′59″N 101°03′0″W / 17°08′15″N 100°39′43″W	44
Playa Ventura	Guerrero	16°33′32″N 98°58′12″W / 16°32′25″N 98°55′14″W	6
La Tuza	Oaxaca	16°03′57″N 97°54′34″W / 15°59′12″N 97°47′20″W	16
Chacahua	Oaxaca	15°58′45″N 97°46′41″W / 15°57′50″N 97°40′41″W	11
Cerro Hermoso	Oaxaca	15°57′52″N 97°40′37″W / 15°57′55″N 97°34′05″W	12
Km of secondary beaches			150
Total km of protected beaches			214

conservation projects for the secondary beaches were permanent, as much as 73% of the total nesting of leatherbacks in the Mexican Pacific would be protected in an average season. Nevertheless, in later seasons, we recorded changes in the pattern of the nesting distribution (Fig. 3), with a lower concentration of nests in the index beaches and more scattering toward unprotected areas. It is possible that some females from the major nesting beaches are moving to areas without protection activities, and this effect is more evident with an extremely depleted population.

We found a relatively high interchange of females between some beaches when we combined the tagging data from all index beaches. Individuals may switch nesting beaches both within and between seasons; the degree of interchange depends on geographic proximity of the beaches. Tierra Colorada and Cahuitán are 25 km apart and can share up to 18.7% of the females that nest in both beaches in a season (9% on average), functioning as a single unit for those females. Mexiquillo is about 475 km from the closest index beach (Tierra Colorada), and we did not find any female interchange within seasons, although a

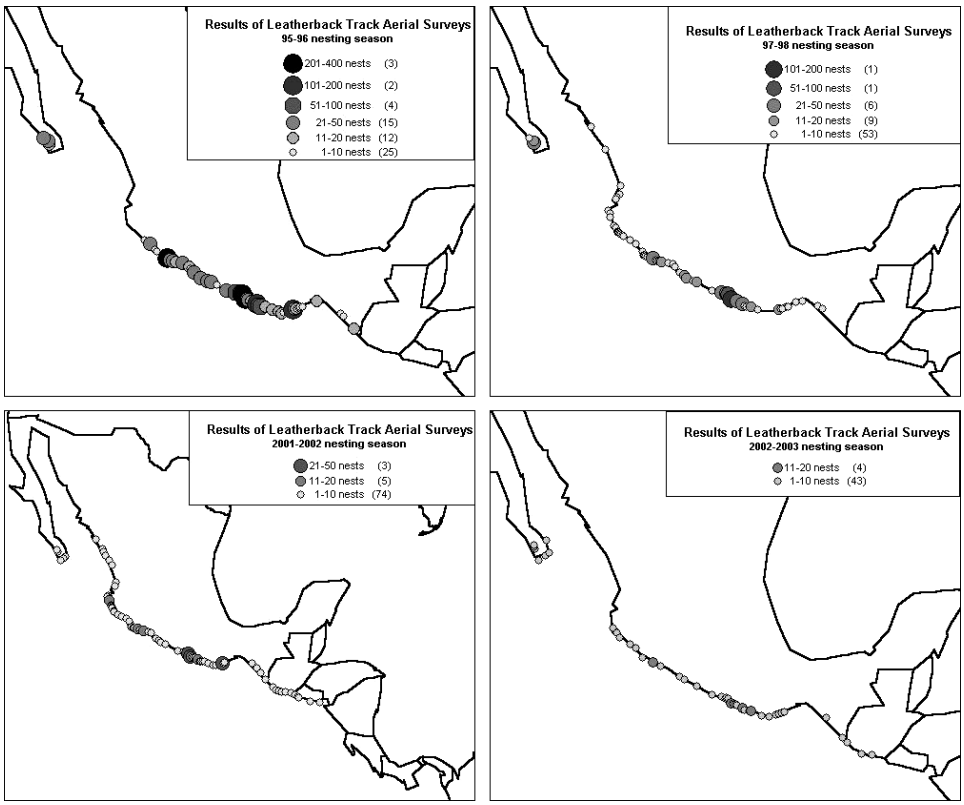

Figure 3. Changes in the nest distribution and abundance from 1995 to 2003, as documented during aerial surveys.

female tagged in Mexiquillo in 1999–2000 was recaptured nesting in Tierra Colorada in 2001–2002 and a female originally tagged in Tierra Colorada was recaptured in Mexiquillo in 2003–2004. The movement of females between index beaches is a strong reason for a coordinated and standardized long-term conservation project in these nesting sites, because relevant reproductive data would be lost otherwise.

Tagging Program and Nesting Biology. — To date, the teams working on the index beaches tagged 5314 leatherback females (Table 2). Most were not recaptured in later seasons, especially in the early days of the project when only flipper tags were used. However, we recognized many females as remigrants because of the scars in their flippers caused by a lost tag. The use of PIT tags on Mexican leatherbacks started in 1996, and this is a successful method for identifying individuals on the long term (McDonald and Dutton 1996).

Mexiquillo is the beach with the longest record of leatherback tagging in Mexico and can be used as a model for the remigration behavior of the Mexican leatherback population (Fig. 4). The average remigration interval recorded in this beach is 3 years, with the largest interval (9 years) found for a female tagged in the 1981–1982 season (García-Muñoz 2000). Given the presence of scattered nesting along the entire Pacific coast of Mexico, it is probable that she nested on beaches with no surveillance during that period. We observed a decline in the proportion of remigrants found in Mexiquillo from 1995 to 1999 (Fig. 4), which coincided with low nesting numbers in all the index beaches. From 1999 to 2004, the proportion of remigrants rose again, coming closer to pre-1995 levels. The average percentage of remigrants for all index beaches was 22.4% from 1996 to 2004.

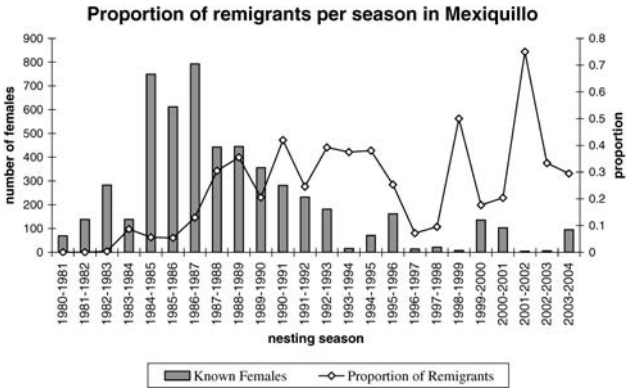

Figure 4. Proportion of remigrant leatherback nesting females per season in Mexiquillo.

The Mexican Pacific leatherback females ranged in CCL from 120.0 to 168.0 cm, with a mean of 143.8 cm (Table 3). This population had an average ECF of 5.5 (1.9 SD; range = 3–12), with an average CI of 9.7 days (1.2 SD; range = 8–14 days). We estimated that the average total fecundity per female was 341 eggs, with a maximum of 744 eggs in a season.

Conservation. — From the beginning, protecting most of the eggs, females, and hatchlings was a priority among the conservation activities of all the institutions working with the leatherback in Mexico. Since the early 1980s, at

Table 2. Results of the tagging program on the index beaches of the Mexican Pacific.[a]

Nesting season	New females	Tags from unknown beaches	**Individual females identified**	Remigrants	Number observation of tag scars	**Total females per season**
1980–1981	68	1	**69**	0	0	**69**
1981–1982	138	0	**138**	0	0	**138**
1982–1983	271	11	**282**	1	0	**283**
1983–1984	126	0	**126**	12	0	**138**
1984–1985	679	28	**707**	42	0	**749**
1985–1986	567	12	**579**	33	0	**612**
1986–1987	680	10	**690**	103	0	**793**
1987–1988	302	6	**308**	135	0	**443**
1988–1989	271	16	**287**	158	0	**445**
1989–1990	277	6	**283**	73	0	**356**
1990–1991	162	1	**163**	118	0	**281**
1991–1992	174	1	**175**	57	0	**232**
1992–1993	109	1	**110**	71	0	**181**
1993–1994	10	0	**10**	6	0	**16**
1994–1995	43	1	**44**	27	0	**71**
1995–1996[b]	258	3	**261**	64	0	**325**
1996–1997	47	0	**47**	1	0	**48**
1997–1998	100	0	**100**	13	0	**113**
1998–1999	58	0	**58**	13	0	**71**
1999–2000	258	0	**258**	61	35	**354**
2000–2001	308	1	**309**	56	13	**378**
2001–2002	20	0	**20**	15	0	**35**
2002–2003	19	0	**19**	8	0	**27**
2003–2004	271	0	**271**	73	2	**346**
TOTAL	**5216**	**98**	**5314**	**1140**	**50**	**6504**

[a] From 1980 to 1995 females were tagged only in Mexiquillo.
[b] From 1996 to 2004, results on 4 index beaches (Mexiquillo, Tierra Colorada, Chacahua, and Barra de la Cruz).

Table 3. Statistical parameters of curved carapace length, curved carapace width, and clutch size for nesting leatherbacks on the Mexican index beaches.[a]

	CCL (cm)	CCW (cm)	Clutch size
Average	143.8	102.8	62
Standard deviation	6.88	5.03	17.9
Variance	47.41	25.31	323
Minimum	120	83	1
Maximum	168	121	121
N	6466	5829	1098

[a] CCL = curved carapace length; CCW = curved carapace width.

least 639,270 eggs were protected and a minimum of 270,129 leatherback hatchlings were released to the wild population at the priority beaches. Projects that focus on other species (e.g., olive ridley and black turtle) on beaches where leatherback nesting is scarce usually protect the leatherback clutches they find and release an unknown number of hatchlings; this number is low but important, because it occurs all along the entire distribution range of the leatherback in the Mexican Pacific.

For the last 20 years, the average hatch success fluctuated between 35% and 52%, with minimum values between 0% and 30% and maximum values between 58% and 78%, with a few clutches reaching 100% hatch success. The number of hatchlings released is proportionately small compared with the original reproductive potential of the population: an estimated 4,184,938 eggs, considering the total number of nests on index beaches, 92% oviposition success, and an average of 62 eggs per clutch. In the 1980s, only Mexiquillo produced leatherback hatchlings every season, and even there the protection effort comprised only less than half (30%–45%) of the total number of clutches, the rest were lost to poaching.

DISCUSSION

Population Trend and Spatial Distribution of Nesting. — As a conservation program, Proyecto Laúd represents the most solid source of knowledge about the biology and the ecology of the leatherback turtle in Mexico. The project showed that the population trend of the leatherback in the Mexican Pacific has had a drastic decline for several years. This situation greatly supported the listing of the leatherback turtle as critically endangered by the World Conservation Union (IUCN) in 2000 (Sarti 2000a). Such a decline is comparable with the one recorded for the Playa Grande leatherback population, in Costa Rica, the last remaining large nesting colony in the Eastern Pacific (Steyermark et al. 1996).

The aerial surveys conducted since 1996 refuted the hypothesis of the possible movement of females to unknown areas as a cause of the decline in the nesting numbers on index beaches. Cahuitán was "discovered" as an important nesting area in 1996 during the first aerial survey, but interviews with local residents confirmed that the leatherbacks had nested there as far as the oldest persons could remember and that the nesting numbers had declined as on other beaches. Therefore, no new nesting areas were documented in the Mexican Pacific from 1996 to 2004.

Tagging Program and Nesting Biology. — The tagging program suffered several modifications for the past 20 years. In the 1980s and mid-1990s, only females at Mexiquillo were consistently tagged by using flipper tags (Table 2), mostly Monel and sometimes plastic. If any females were tagged on other Mexican beaches, the information is not available, although the high number of tags of unknown origin recaptured in Mexiquillo indicates that this is the case. In those days, the tagging program was far from achieving saturation. We estimated that an average of 65% of the females that nested in Mexiquillo between 1983 and 1989 received a tag. Conducting a saturation tagging program in the Mexican Pacific is not an easy task because of the length of the beaches and the dispersion of the nesting events; during the latest nesting seasons, more than 95% of the females on the index beaches were tagged each year with Monel and PIT tags.

The long-term tag-recapture program and the use of better technologies for identifying individuals gave us a better understanding of the situation of the leatherback population in Mexico; we have just begun to elucidate the dynamics of the declining process. The decline in numbers of tagged females seen in Table 2 is a direct reflection of the decline in the nesting population, because actually more kilometers of beach are covered for the full season each year and is not an artifact from a differential tagging effort among beaches.

The proportion of remigrants seen on the Mexican index beaches during the late 1990s was similar to the one reported for Playa Grande, Costa Rica, from 1996 to 1999 (24.8% on average; Spotila et al. 2000) but lower than the one reported for St. Croix, U.S. Virgin Islands, during the same period (52.5%; Dutton et al. 2005). The low proportion of remigrants observed in the Eastern Pacific could indicate a high mortality of larger adults in the pelagic environment. Few turtles were arriving at the nesting beaches and most of them were new ones (apparent neophytes, unless they nested before on a beach with no tagging program). In contrast, the St. Croix population has a high estimated annual survival probability for adult females (Dutton et al. 2005).

The severe population decline for the Mexican leatherback population was attributed to an increase in adult mortality from the fishing effort of South American swordfish fisheries occurring around the same time, which captured Mexican leatherbacks in the past (Frazier and Brito-Montero 1990; Eckert and Sarti 1997). The impact of the high-seas industrial fisheries on the eastern Pacific leatherback population is discussed elsewhere (Spotila et al. 1996, 2000); nevertheless, the interaction of local artisanal fisheries with leatherbacks close to shore is

poorly documented. Dead leatherbacks wash ashore sometimes at the index beaches, but we need a systematic evaluation of the impact of near-shore artisanal gill nets and longlines in Mexico.

The results of carapace measurements are in concordance with the differences between the Pacific and Atlantic leatherback populations reported by other authors (Pritchard 1971; Fretey 1978; Eckert and Eckert 1985; Boulon et al. 1996). The leatherbacks in the eastern Pacific are indeed smaller and lay fewer eggs than the ones in the Atlantic; the information presented here is the most thorough and accurate compiled for the Mexican Pacific leatherback population, standardized for its complete distribution range and for several nesting seasons.

The estimation of the number of nesting females each season is based on the total number of clutches and the average ECF per season on the index beaches. The average ECF obtained for the Mexican population is similar to the average ECF reported from 1993 to 2000 in Playa Grande, Costa Rica, (5.6 $\pm$ 0.2 SE; Reina et al. 2002) but lower than the average ECF reported for Culebra, Puerto Rico (6.7 $\pm$ 2.7 SD; Tucker and Frazer 1991). However, caution must be taken while comparing these values, because the methods used for calculating ECF in the 3 cases use different assumptions.

The maximum clutch frequency observed in the Mexican population was 12 clutches per female per season (Sarti et al. 2004). Considering that not all of the nesting events are observed along the distribution range and that females may move between beaches, the actual average clutch frequency could be closer to the maximum value reported for the population. Higher values of average clutch frequency mean lower numbers of estimated females, so the Mexican Pacific leatherback population could actually be smaller than estimated.

Conservation. — Early accounts (Márquez et al. 1981) and anecdotal information suggest that 25 years ago the harvest of eggs on most of the important nesting beaches of the Mexican Pacific could reach 100%, causing very limited recruitment. This situation combined with the high incidental capture of adults in pelagic fisheries for an unknown period might be the cause of the dramatic crash in the nesting numbers of the leatherback all over the Pacific coast of Mexico, and the reason the population is not yet responding to more than 2 decades of protection efforts.

The hatchlings released by the early protection program in Mexiquillo appear to be the major source of the young nesting females seen on the index beaches in recent seasons. However, time and increased efforts are still needed to see a change in the population trend. Most importantly, current efforts must not be abandoned. Today, the protection activities on all index beaches relocate at least 80% of the clutches to hatcheries, and care is taken to avoid any management problems that can harm the population. We recognize the proven fact that in situ leatherback nests have a better hatch success than relocated nests (Sarti et al. 1987, Boulon et al. 1996); nevertheless, the condition of most of the nesting beaches with regard to poaching and predation by introduced mammals, turn beach hatcheries into the only currently viable conservation option. Studies done in Mexiquillo show that in a properly managed hatchery, the sex of the hatchlings is skewed toward females, in a proportion similar to in situ nests sampled in the same season (Benabib 1984; Ordoñez 1998). The status of the Mexican leatherbacks is dire but not hopeless. The protection results presented above give hope for the future of this important population and are essential for other conservation measures to operate.

One of the major achievements of Proyecto Laúd is the involvement of local community members in conservation activities. After years of reluctance and animosity toward the protection efforts, some people who live in villages close to the index beaches agreed to participate side by side with biologists in patrolling the beaches and relocating the clutches to protected areas. Most of these persons receive remuneration for their work, and some communities organized into protection committees that began to show a true interest in the recovery of the leatherback population, turning their protection efforts into a matter of pride for the community.

Government authorities showed an increased interest in the fate of the leatherback turtle. In September 2003, the governors of Michoacán, Guerrero, and Oaxaca joined federal authorities in the signature of the Tri-State Agreement for the Recovery of the Leatherback Turtle in the Mexican Pacific, in which the parties committed to support all the necessary activities for the conservation of this species along the coast of those states. This was the first high-level government agreement centered on the recovery of a single sea turtle species and included the protection of leatherback individuals, as well as their habitat. As part of the agreement, the technical committee established the Community Network for the Recovery and Protection of the Leatherback Turtle. This network includes several communities located close to the priority beaches and serves as a communication bridge between the communities and the authorities. The network also promotes awareness of the status of the leatherback among the local population and increased training of conservation workers in standard management methods, supported by the best available knowledge of leatherback biology.

In recent years, CONANP promoted the protection of nesting habitat, with 2 of the index beaches (Mexiquillo and Tierra Colorada) designated as natural protected areas (turtle sanctuaries) in 2002, and 3 of them (Mexiquillo, Tierra Colorada, and Cahuitán) were listed as Ramsar Sites in 2003.

The threats faced by the Mexican leatherbacks are no different from the ones faced by the rest of the eastern Pacific population. We know that in most of Central America the harvest of leatherback eggs is more intense than in Mexico, and few protection programs in the area

are older than 10 years. This has contributed to the decline of the nesting population throughout the eastern Pacific.

It is very important to establish recovery programs on a regional level, with international cooperation, focused on increasing the production of healthy hatchlings and the survival of juveniles and adults in the pelagic environment. It is worthwhile to note that the number of hatchlings released so far on the Mexican index beaches is similar to the number of hatchlings released to date in the St. Croix conservation program (estimated in ca. 260,000; Dutton et al. 2005) but that population is increasing and the Mexican one is not. Clearly, there are more factors involved, particularly regarding survival probabilities, which need to be assessed.

The resolution for the protection of the leatherback passed at the COP 2 (Venezuela, 2004) of the Inter American Convention for the Conservation of Sea Turtles is a relevant step toward a regional conservation approach. The sum of the actions of all stakeholders as protection of eggs on nesting beaches, reduction of incidental capture on the high seas, along with awareness programs and education of wide audiences in general, will contribute greatly to the recovery of the population of the eastern Pacific leatherback. With these efforts, we would expect to witness positive results and an increment in the nesting numbers in Mexico by 2010 to 2015, given the increase in the production of hatchlings on all the beaches for the past 10 years and by assuming 13–14 years for the leatherback's average sexual maturity but 9 years as a minimum age of maturity (Zug and Parham 1996).

In Mexico, there is an increased concern for the fate of the Pacific leatherback. Proyecto Laúd will continue with the long-term monitoring of the population trend, including possible changes in biological parameters, such as clutch frequency, hatch success, clutch size, body size, and other parameters of the nesting biology, and the health condition of reproductive adults. We will continue producing hatchlings and give this population time for the other conservation measures to yield results.

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