MARINE TURTLE NESTING IN WESTERN PUERTO RICO, 1993

Final Report for the Cooperative Agreement

between

the U.S. Fish and Wildlife Service

and

the Sea Grant College Program
University of Puerto Rico, Mayagüez Campus

Cooperative Agreement No. 1448-0004-93-929

Submitted by: Kathleen V. Hall
May 1994

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Submitted to:

Dr. Manuel Hernández-Avila

by:

Kathleen V. Hall

12 May 1994

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INTRODUCTION

This is the final report for the 1993 sea turtle nesting monitoring project under the Cooperative Agreement between the U.S. Fish and Wildlife Service (USFWS) and the Sea Grant College Program, University of Puerto Rico, Mayagüez Campus. Endangered species permit number EPE 93-45 was granted for the study by the Department of Natural Resources (DNR). Collaborators included the DNR departments in Mayagüez and Arecibo. The main species of nesting sea turtles in the Northwest are the leatherback (*Dermochelys coriacea*) and the hawksbill (*Eretmochelys imbricata*).

The project was initiated in 1992, partly because of a concern that development could harm one of the few areas where sea turtles still nest on mainland Puerto Rico, and that more knowledge was needed of existing populations in the Northwest. Also because DNR personnel and concerned citizens had found that egg poaching was prevalent and nesting females were also being poached occasionally. A major goal of the project was to camouflage nests and to educate the public about the plight of sea turtles.

The study area continued to include Añasco Beach, with approximately 5 km of shoreline from the border of Rincón/Añasco to the north, to the Río Grande de Añasco (Añasco River) to the south (Figs. 1 & 2); and Playa Grande (Los Negritos), Bo. Islote, Arecibo (1.4 km) (Fig. 1). Last year only 2 km of El Maní Beach, Mayagüez were patrolled systematically, from the Río Grande de Añasco to the Río Boquilla, or North El Maní. It was believed that South El Maní was too heavily developed for much turtle nesting, but this proved untrue. Once nesting was discovered, another 2.75 km of beach was covered from the Boquilla to Punta Algarrobo, which is the southern limit of this beach (Fig. 1). Therefore a total of 9.75 km of beach was covered in the Añasco/El Maní area. Other beaches covered sporadically are listed inside the map of Northwestern, PR (Fig. 1).

The predominant vegetation at Añasco and El Maní Beaches consisted of vines such as *Canavalia maritima*, *Ipomoea pes-caprae*, and *I. stolonifera*; grasses such as *Sporobolus virginicus* and *Cenchrus*; low plants and bushes such as *Sansiveria trifasciata*, *Chrysobalanus icaco*, *Dalbergia ecastaphyllum*, and trees such as *Cocos nucifera*, *Terminalia cattapa*, *Thespesia populnea*, and *Cassia*.

Añasco Beach usually consisted of one continuous stretch of sand with numerous *quebradas* — streams that reach the beach but not the sea. However, during the rainy season these would often swell enough to pass to the ocean, causing difficulties in crossing during beach patrols. This was particularly the case with Caño la Puente, which was opened by the

municipality to reduce flooding, and was for all purposes impassable at night, until it closed up once again by sand building up at the mouth. There are quite a few homes on the beach at the Rancho Grande sector, some with bright white lights, and car headlights can be seen from some points.

There are few homes on the beach at North Maní, most of them being vacation homes; however, South Maní has virtually a continuous row of homes. There is also a large baseball field very close to the beach, with luminaires that are taller than nearby trees and shine on the beach. Unfortunately these extremely bright lights are used during public meetings at the field, such as religious gatherings.

Playa Grande of Arecibo is a fairly undeveloped beach that stretches between two rocky promontories. There is a large well lit restaurant on the eastern end, overlooking part of the beach. Near the center of the beach, a "Teen Challenge" home for wayward youth can be found right on the beach, as well as a few houses with bright lights. The dunes have been stripped from the west end of the beach, and have been replaced by a string of boulders, which permits photocontamination of the beach.

METHODS

This report will cover the calendar year of 1993 from January to December, although the main study period was from March to August. In January and February daytime patrols were made three times a week from the extreme north end of Añasco Beach to the fisherman's pier (markers 1-157) to check for possible hawksbill nests. The south end of Añasco Beach to the Añasco River (markers 157-250) and the north end of El Maní Beach, Mayagüez (Añasco River to Boquilla River) were surveyed approximately once a week. Other beaches that were surveyed sporadically for hawksbill nesting included Surfer's Beach and Survival Beach in Aguadilla, Sandy Beach from Río Grande to Punta Gorda in Rincón, and Jobos to El Bajo de Los Cedros in Isabela.

In March, at the beginning of the leatherback nesting season, morning coverage of the south end of Añasco Beach increased to at least five times a week, and also began at Playa Grande, Arecibo. Nocturnal patrols were carried out from March to June at Añasco and from April to June at El Maní (North and South) and Arecibo, whenever a turtle was expected. Night patrols were also conducted at Pta. Borinquen Beach, Aguadilla in June, and in search of a nesting hawksbill at El Bajo Beach, Isabela in August. From August to December, hawksbill nesting beaches such as those mentioned above were surveyed once again.

A sea turtle nesting was confirmed when the eggs or hatchlings were seen, otherwise it was listed as an activity. A false crawl was noted when a turtle obviously returned to the water without nesting. Nests thought to be in danger from poaching or the elements were translocated. Nest sites could not be marked with a flag or other identifying marker immediately after laying due to the threat of poaching. Therefore, a system of triangulation from known markers was used to locate nests at a later date. Last year's markers were repainted with green florescent paint or taped with reflective tape, and a 3 cm numbered aluminum tag was attached either by nailing or wiring to a tree, fence post or other solid object. Markers were placed on Añasco Beach every 20 m, numbering 1-250 from north to south. For a description of landmarks and numbered sectors, see Appendix 1. Each nest was triangulated to the two nearest markers by measuring with a fiberglass tape and taking a compass reading. On beaches without markers, the two nearest trees were temporarily marked for triangulation.

Field volunteers were procured through public education which included lectures, slide shows and exhibitions sponsored by Proyecto Tortugas Marinas, a local nonprofit group founded by the author to work in conjunction with the government. Department of Natural Resources personnel Milagros Justiniano

and Yadira Feliciano also provided public education. Target groups included primary and secondary schools, universities, environmental groups, civic organizations, scouting groups, and fishing associations. Over 300 volunteers participated in 1993. Four student assistants were provided by the UPR-Mayagüez Biology Department. They were taught field methods and wrote a report for an independent study course.

When turtle tracks were located, they were concealed by using driftwood to flatten the sand and by throwing dry sand and seaweed on top of the area. Then the internesting interval was calculated depending on the species, and nighttime patrols were set up. For the leatherback, patrols were usually initiated on the 8th night and continued until the 10th night; and for hawksbills, they were carried out on the 13th and 14th night. Volunteers were oriented in proper field techniques, such as when and how they could use flashlights and cameras, and how to take data. Bilingual books and pamphlets were made available for browsing between patrols.

Data taken included time, location, species, number and size of eggs, turtle size and diagnostic markings (Appendix 2). Both yolked and yolkless eggs were counted as they fell, and up to ten yolked eggs were measured with Vernier calipers to the nearest 0.1 mm. Only curved turtle measurements were taken, and this was done with a fiberglass tape measure to the nearest 0.1 cm. Standard length was taken from the central base of the neck to the posterior projection of the carapace (notch to tip), with the tape measure laid adjacent to the median dorsal ridge. A longer length measurement was taken for leatherbacks, from the right anterior point of the carapacial ridge over the shoulder to the posterior projection of the carapace (tip to tip). Carapace width was taken at the widest point.

Following oviposition, leatherbacks were tagged in the right and left inguinal folds (between rear flipper and tail). The surplus tags from last year were self-piercing No. 49 Monels, 40 x 10 mm, inscribed: "Pls. Inform P.R. DNR Reserves & Refuges, San Juan, PR. 00906." The No. 49 tag is the weaker "tamper-proof" design with an internal bridge locking mechanism that can break off (Balazs 1982). The No. 19 is a better tag of the same size, but has a through-the-hole locking mechanism. I found that No. 49's could be "converted" to No. 19's by breaking off the bridge and drilling a hole in the little cup at the end of the tag. After a tag was applied to the turtle, the tip was examined to make sure it had gone through the hole and clasped, and then the last third of the tag near the folded end was slightly compressed with pliers to relieve spring-action in the tag (Balazs 1982). The one hawksbill was tagged on the right front flipper with a No. 681, 25 x 8 mm tag inscribed NMFS Lab Vir. Key,

Miami, FL. 33149. The tagging pliers were lost temporarily in the sand before a second tag could be attached.

About a week before a clutch was due to hatch, the nest was roped-off with flagged stakes, to help protect it from traffic. The path from the nest to the water was cleared of vines and debris, and vehicle and human tracks were smoothed over to permit a quicker and safer entry to the water. If a nest was in the vicinity of a planned summertime activity such as a music festival, it was surrounded with cyclone fencing to keep people from disturbing it.

Turtle "activities" that had not hatched, and were well past the expected hatching date were often probed with a rod to try and find a nest pit. Activities where hatching occurred were excavated the same day or the next morning to prevent unnecessary mortality of any live hatchlings that might have remained in the nest. The live hatchlings were weighed with a 50 or 100 g spring scale, their carapaces were measured with Vernier calipers, and they were allowed to crawl to the ocean from near the nest site (Appendix 3). These stragglers were considered doomed in emergence success calculations. Hatchlings that were unable to crawl or swim strongly were kept a day before being released. Near term embryos were also kept to see if they hatched.

Nest excavations permitted more accurate egg counts than when the turtle was laying; however, the number of yolked eggs are typically underestimated because of shell fragmentation from hatchling activity (Whitmore and Dutton 1985, Hall and Tucker 1986). Yolkless, rotten and infertile eggs usually remain intact and can be counted easily. All egg counts in the results represent excavation counts. Fertility was determined by opening and examining all unhatched eggs for the presence of embryos. Eggs were considered infertile if there was no sign of blood or an embryo upon gross inspection, although this method does include embryos arrested at very early stages of development. Eggs with embryos were classified as early, midterm, fullterm unpipped, or fullterm pipped.

Three measures of reproductive success were tabulated to best estimation (Hall 1990): (1) nesting success = number of nests that produced some hatchlings that emerged from the sand ÷ total number of nests, (2) hatching success = number of hatchlings (ie. empty egg shells) ÷ total number of yolked eggs, and (3) emergence success = number of hatchlings emerging the nest (unaided by humans) ÷ total number of yolked eggs.

RESULTS AND DISCUSSION

Leatherback Nesting

The leatherback nesting season extended from 5/6 March to 26/27 June of 1993. There was a shift in beach use from Añasco toward North and South El Maní. Twenty activities were seen on Añasco Beach last year, and eight were seen in 1993. On the other hand, no leatherback nesting was seen at El Maní last year, and ten activities were found this year. The Añasco River Mouth was a formidable barrier to night and daytime crossing due to its depth (1.25 m), swift currents, and large floating debris. The closest bridge was several miles upstream. Unfortunately, because the turtles kept switching beaches, we were not able to actually see and tag a turtle in this area until 18/19 May. Many nights were spent patrolling one or the other beach, only to find the turtle had come to the unattended beach that night. To patrol both beaches at the same time would have required many volunteers and radio contact, and this was only accomplished once. A future possibility would be to boat or raft across the river, but this could be dangerous at night.

Six of the activities at Añasco were seen in the Caño la Puente area, between markers 196 and 208, a span of only 240 m (Table 1). The other two were at Rancho Grande and South End, both adjoining Caño la Puente. Use of El Maní consisted of three nests in the North, which were probably made by one of the same turtles that was nesting in Añasco; and seven activities in the South, which were probably made by one turtle.

Since the turtles were not seen every time they laid, internesting intervals and track size aided in assumptions of which turtle laid which nests. From these assumptions, the most likely scenario is that turtle #615 laid nine times — using both Añasco and North El Maní — from 5/6 March to 18/19 May. There was a 17 day gap between the nestings of 21/22 April and 8/9 May (Table 1). A local resident, Juan Cebollero, mentioned that a turtle tried to nest during that time period, but was frightened back into the water by dogs. It is believed that the 9/10 May and 26/27 June nestings were made by two other turtles that each laid one nest. The S. Maní turtle #613 may have laid eight times, assuming that it too completed a nest that was not detected or was laid elsewhere during its 22 day internesting interval.

Leatherback nesting was first reported at S. Maní by Milagros Guzmán the day after a turtle nested in Guzmán's backyard on 3/4 May. This turtle was tagged the night of 13/14 May, as it nested several feet from a large trash heap in Manuel Arcelay's backyard. Approximately 20 people came out of their homes to watch the process after Manuel realized why we were trespassing.

This was the beginning of a love affair for turtles by this small beach community. Milagros Guzmán's house became "Grand Central Station" for all S. Maní turtle patrols, and the bulk of volunteers came from the neighborhood. One very old woman had wanted to see a nesting turtle all her life, and when she finally did she fell to her knees shouting with joy. These concerned citizens jealously guarded all turtle nests on their beach. Soon some fishermen let us know that two other nests had been laid earlier in the season, and that nesting had occurred there in other recent years. Two nests laid at S. Maní were 45 m and 50 m respectively from Pta. Algarrobo, where there was a proposal to build a coal-fired electric plant.

At Playa Grande, Arecibo, turtle #1851 probably laid eight times and false crawled five times, either the night before or the same night, before actually laying (Table 1). Although two different turtles may have been present all along, the nest on 19/20 June was more likely to have been made by a second turtle, but there is slight chance it was #1851's eleventh nest after a being gone for 26 days.

The Arecibo turtle emerged on nearly the same nights as the Añasco turtles, therefore I could not go as often to Arecibo this year. The Arecibo turtle was first seen the night of 13/14 April, and her nest was immediately translocated by DNR personnel from Arecibo. They thought it was too close to the recent high water mark, and in an area where off-road vehicles traversed. The night of 22/23 April, DNR tagged this individual with a 25 x 8 mm tag (#1851) on the right rear flipper. When I saw the turtle on 8/9 May, I removed the tag because it was too tight and small for a leatherback, and did not allow room for growth. It was replaced by two 40 x 10 mm tags, which were placed in each inguinal fold.

The 19/20 June leatherback track at the eastern end of Playa Grande was highly visible from buildings and the road. We decided to move the nest; however, since no one was there when the turtle nested, we had to probe for it with metal rods. Four of us spent two hours each poking holes in the ground, and digging trial holes with no luck. The stakes were high because a small group of men, including suspected poachers, was watching us closely. No hatch was found from this activity (nor from any other at Playa Grande this year).

A single leatherback may have nested three times at Rincón, with one missed nesting. The leatherback that supposedly laid at Borinquen Beach, Aguadilla never returned to nest again there, and no evidence was found of a hatch. Summarizing the most valid assumptions of how many turtles we had nesting, a pattern emerged much like last year's. In 1992 it was estimated that there were two full-time nesters at Añasco with two possible stragglers, and one full-time nester at Arecibo. This year there were probably two full-time nesters

at Añasco/El Maní with two possible stragglers, and one full-time nester at Arecibo with one possible straggler.

The turtles' standard curved length ranged from 152.4 - 166.2 cm (Table 2). Using a length (x) versus weight (y) regression formula of y = -468.84 + 5.2076x, provided by Ralf Boulon of the Division of Fish and Wildlife in St. Thomas, this year's turtles estimated weight ranged from 324.8 - 396.7 kg. This regression was derived from five years of data from nesting females in St. Croix.

S. Maní was a narrow beach averaging 13 m, Añasco/El Maní was approximately 20 m, and Arecibo was the widest beach at 45 m (Table 2). Beach widths were very similar to last year's, as was the spatial use of the beach platform for nesting. Nests were not generally in danger of saltwater inundation, with the possible exception of one nest in Rincón that was on both a narrow and high energy beach. Looking at the distance from nest to vegetation, it is interesting to note that leatherbacks seem to show a preference for nesting near the vegetation (or structure) on the upper beach platform (Table 2). However, at the very wide beach of Playa Grande in Arecibo, they averaged a distance of 12.6 m from the vegetation. Perhaps it is more important to the turtle to crawl a safe distance from the water's edge, than to nest close to the vegetation. The Borinquen Beach turtle nested on an ephemeral spit of sand that only exists during the summer months.

The average internesting interval was 8.3 days for the turtle at Arecibo, approximately 9.2 days for the turtle at Añasco/N. Maní, and 10.3 days for the turtle at S. Maní. Clutch sizes were more consistently determined at hatching and will be discussed in the next section. Nine eggs were measured from #1851's sixth known clutch for a mean egg size of 53.7 mm, seven eggs were measured from #613's estimated fifth clutch for a mean egg size of 55.0 mm, and four eggs were measured from #615's estimated ninth clutch for a mean egg size of 52.2 mm. A comparison of egg size to turtle size was not made in this case, because sample sizes were too small, and each sample was from only one clutch.

Encountering a turtle at night fostered a greater appreciation for sea turtles by the local population. Families that lived on the beach often came to orientation sessions, then went home and asked to be awakened when a turtle arrived. One woman wanted to see a turtle so badly, her husband carried her down the beach, because she had a cast on her leg. Hopefully, as the sentiment changes from exploitation to protection, the turtles will come out ahead.

Leatherback Hatching

Hatching information was obtained for six out of nine assumed nests in the Añasco/N. Maní area. For the sake of summarizing hatching results (Tables 3 & 4) , five of the hatches that were probably from turtle #615 were grouped together. The nest laid on 9/10 May was from a different turtle, because it was laid the day after a definite nest of normal clutch size (Table 1). Furthermore, the crawl from 8/9 May was 213 cm wide and the crawl from 9/10 May was only 140 cm wide. The tracks from the previous nestings were large, and one was also measured at approximately 200 cm. The results of the hatch of 9/10 May showed a very low hatching success, so for this reason also, it was kept separate from the other Añasco/N. Maní results in Tables 3 & 4. The hatching results for turtle #613 of S. Maní were also averaged separately and were compared to those of #615 from Añasco/N. Maní in Table 4.

Hatching success (% hatch) in general was high for Añasco and El Maní this year as it was last year; with only roots, bacteria and fungi possibly affecting the eggs. Embryonic mortality was highest for early embryos (Table 3). A live egg was found in one of #615's nests at excavation, and was kept to see if it would hatch. It died the next day, so I brought it on a local TV show, where I was to speak about sea turtles. I opened the egg on the show, not expecting to see a semi-headless deformed, part albino turtle! I think this impressed upon viewers to protect our turtles and their environment even more.

Table 4 shows differences between the two turtles that nested consistently at Añasco and El Maní, however it was not known if these differences were due to the use of different beaches. Hatching success was somewhat lower at S. Maní. The sand at S. Maní had a higher organic content, because of people and fishermen living in close proximity to the beach. One of the nests was laid approximately 1 m from a trash dump, and another nesting area had a high content of *Donax* shells buried in the sand strata.

A "t" test showed that turtle #615's hatchlings weighed much less than #613's ($p < 0.001$); however, #615's hatchlings were just significantly larger than those from #613 ($p < 0.05$). Turtle #615's hatchlings averaged 39.4 g, which was lower than hatchling weights from this beach last year, including from a clutch with similar-sized hatchlings averaging 60.95 mm, that weighed 41.6 g (Hall 1993). The mean hatchling length in Culebra was 61.9 mm and the median weight was 46.0 g (Hall and Tucker 1986). Therefore, #615's hatchlings appear to be proportionately underweight; perhaps due to less rainfall, although this was not measured.

More dead and live-trapped hatchlings were found in #615's nests at Añasco/N. Maní. In one nest, vines impeded four hatchlings from leaving and

they were killed by ants. Somewhat fewer dead hatchlings were found on the beach at S. Maní. The beach at S. Maní was relatively narrow (Table 2), and local volunteers often monitored hatches, making sure all the hatchlings reached the water. Hatchling mortality at N. Maní was caused by entangling in beach vines and driftwood. After entangling occurred, the hatchling was usually attacked by red ants — a problem which may have been aggravated by food sources in the form of trash washing up on the beach. Birds and crabs were also likely hatchling predators. It is estimated that approximately 680 leatherback hatchlings made it to the ocean this season from nests known to hatch (other hatches may have been missed).

Nesting success was 0% in Arecibo this year with nine possible nests failing to hatch and emerge (Tables 1 & 3). A clue to this strange situation lay in the excavation of a nest of known location, which was laid on 8/9 May. Arecibo volunteers unearthed this nest 79 days after it was laid. They found 13 broken yolked eggs and 11 broken yolkless eggs. All the eggs in the clutch appeared to have thin shells. They opened approximately seven more yolked eggs for inspection. None of the broken or opened yolked eggs were fertile, and the unopened eggs did not appear to have embryos either. Very thin shells were found earlier this year in a green turtle (*Chelonia mydas*) clutch which will be discussed in the section on green turtles. Broken egg samples were sent for evaluation to Dr. Gloria Seabourn at the National Marine Fisheries Service (NMFS) Laboratory at Charleston, South Carolina and to the USFWS National Wildlife Health Lab., in Madison, Wisconsin.

In early December I found out there was locality data for another nest laid on 13/14 April in Arecibo that did not hatch. This nest had been translocated the same night it was laid and we were able to find and excavate it. Originally 94 yolked and 29 yolkless eggs were buried. We found 86 eggs, none of which had hatched, and 25 yolkless eggs. Five of the eggs had possible embryos, but it was hard to tell because the eggs were so decayed. The eggshells were thin, but it was hard to tell if they had been thin from when they were laid or had become that way after 7.5 months degrading in the sand.

Hawksbill Nesting

A hawksbill activity was reported to us the first week of April by a third party who saw it at Caracoles Beach in Arecibo (Figure 1). Pedro Reyes informed us of several activities at Barceloneta from mid April, mid May and the end of May (Table 1). Two tracks were reported by Richard Smith after mid April from the Spanish Wall area of Rincón, near Punta Gorda. Upon examination, one

appeared to have been made by a leatherback, and the other by a hawksbill. The sand in that area was very coarse and dry, and each track had several trial nest pits. It is not known if the turtles laid. On 27 June a track was found at Survival Beach, below the US Coast Guard Base at Aguadilla. The hawksbill travelled 46.5 m up the beach and under a rock overhang, but a nest could not be found.

A fresh hawksbill track was found the morning of 27 July, several kilometers east of Survival Beach, at El Bajo Beach (the Shacks), Isabela. The nest was 10.5 m from the high tide mark, 11.5 m from the water's edge, and was just within the vegetation. Because the nest was found in front of an unbroken series of exposed reef and caves, it was moved that same morning to Jobos Beach, approximately 1 km to the east, where there are no exposed reefs. The area chosen was in front of a volunteer's house, where the nest could be monitored daily. A random sample of ten eggs averaged 39.4 mm in diameter and weighed 34.7 g. There were some green spots on several of the first laid eggs.

Two weeks later, at 21:06 on the night of 9/10 August, we encountered the turtle during night patrols at El Bajo. She was just inside the vegetation, 23 m from the high tide mark and 30 m from the water's edge. When a group of fishermen arrived in the area, we pretended we were watching a meteor shower, and they did not see the turtle. The turtle measured 84.2 cm over the curve standard length and 79.0 cm greatest width. After the eggs were laid, ten were measured from near the top of the nest. They averaged 39.1 mm in diameter and 34.1 g weight. Some of the eggs were turgid and others were soft. Tag #PPY301 was applied to the right front flipper, before the pliers were lost by a young volunteer (they were found at hatching time), preventing a second tag application. Interestingly, a scuba diver told me several weeks later that she had seen a turtle with one tag during a dive at the Shacks (El Bajo) on 10 August. However, she thought the tag was on the left front flipper. She was diving the outer part of the reef at 09:30 in 14.5 m of water. We did not encounter the turtle again two weeks later. Nevertheless, a resident that was present at the nest excavation showed us where another hawksbill nest had been laid at El Bajo during mid August. We do not know if this was from the same or a different turtle.

One other hawksbill track was reported from the small beach in front of the Horned Dorset Primavera Hotel in Rincón. This beach is approximately 4 m wide and has a wall running most of its length, instead of vegetation. The turtle emerged around 19:30 at the dark end of the beach, and crawled along the wall toward the row of dimly lit lamp posts at the other end of the beach. There was no evidence of nesting.

Hawksbill Hatching

Close monitoring of the 9/10 August El Bajo nest allowed for a group of people to be present during the actual hatch at 20:42 on 15 October. Only flashlights with red lenses were allowed on the beach, and none of the hatchlings were disoriented. A random sample of ten hatchlings were weighed and measured (Table 3). Also, 2nd graders from the Children's Alliance for Protection of the Environment (C.A.P.E.) were able to see a hatchling during the day, and have their pictures taken with it. They framed the photos, brought them home to their families, and had one published in their international newspaper.

This nest and the two other hawksbill nests at El Bajo were excavated after hatching. Two of the nests had a hatching success near 65%, while the third nest had 100% (Table 3). Perhaps the nest from mid Aug. had a higher success because it was not handled or because it may have been laid by a different turtle. Compared to the 100% hatch nest, the nest from 9/10 Aug. was laid in a similar environment, around the same time, and only ten eggs were handled, so one would not expect such a large difference in hatching success from environmental factors alone.

Green Turtle Nesting

The night of 28 March, a turtle activity from 27/28 March was reported by a resident of Jobos Beach, Isabela. The nest area was examined the morning of the 29th, and was found to be large, like that of a leatherback. The nest pit was 17.8 m from the vegetation and 10.0 m from the water's edge; however, it was 2.7 m below the recent high water mark. Therefore, the nest was moved 14 m higher up the beach, away from dune crossovers and other traffic.

The nest was located by probing with a 0.65 cm diameter steel rod, until the sand was felt to give way. Although I have never broken an egg using this method, some broken eggs were found in the nest. However, as the nest continued to be unearthed, many more broken eggs were found. The holes in these eggs were sometimes found in the sides or bottoms of the eggs, and could not have been caused by the probing rod. Out of 189 eggs, 17 were broken, one had a large weak spot, and another had an irregular shape. All eggs had thin spots in the shell, that appeared to have less calcification. The

usual white spots (drying of the eggshell) had started forming on some of the eggs, and were approximately 1.5 cm in diameter.

The eggs were carefully moved without rotation to a man-made nest of nearly equal dimensions as the original, because the nest was over a day old. A sample of ten eggs had a mean size of 45.1 mm. Due to the lack of yolkless eggs, small egg size, and large number of eggs, the nest was determined not to be that of a leatherback. Although the clutch size was closer to that of a hawksbill, it fit into the range of the green turtle. The eggs were also of green turtle size, so it was most likely that this was a green turtle nest. Samples of eggs were sent to the USFWS and NMFS for testing.

Green Turtle Hatching

No hatchling tracks were found for the green turtle nest at Jobos, probably due to heavy rains at the end of May. The nest was opened after 82 days of incubation, and a live hatchling was found about 15 cm under the sand, even though it was several weeks after the projected hatching date. The characteristics of the hatchling confirmed that this was a green turtle nest, and the hatchling's length and weight are listed in Table 3. It appeared to be in fairly good health, but was missing a small patch of scales on the dorsal part of each of the front flippers and on the left rear flipper. This may have been caused by chafing against sand while trying to escape the nest. Also, the ventral part of the throat and axillae were pinkish, possibly from fungal growth.

The hatchling was kept in seawater overnight and released the next morning. Its traversal of the beach and surfzone was filmed with an underwater video camera. When the turtle crawled down the beach, the left front flipper did not have the full range of motion or as much strength as the right front flipper. However, the hatchling swam powerfully, and made a series of seemingly effortless dives near the bottom, while heading out to sea. The turtle dove in water that was approximately 1.5 m deep, with a coral reef substrate. The nest contained 79 hatched shells. There were also 79 rotten eggs, two with possible fullterm dead embryos, and one that might have had a very small embryo. The remnants of a dead hatchling were found in a late stage of decomposition.

THREATS TO TURTLES AND NESTS

Last year's report offered a fairly comprehensive coverage of threats in the study area, and should be referred to if the reader prefers greater detail. This year a N. Maní nest was probed with a stick and two people tried to dig up a S. Maní nest, but fortunately both nests were not discovered and hatched. Attempted egg poaching has been a problem not only at El Maní, but also at Rincón and Playa Grande, Arecibo. Nesting at Playa Grande occurs very close to the Teen Challenge home and these youth have been seen probing nests. Another time three men in Arecibo were seen digging for a nest with shovels.

One nest and three possible nests at Añasco never hatched as far as we know, as well as two possible nests at S. Maní. All of these were early or late season nests, which for various reasons were harder to keep track of as far as hatching was concerned; however, the possibility remains that some of them may have been poached. On 22 March a dried leatherback turtle egg with a hole in it was found in the wrack line at the Balneario Tres Hermanos. There was a report of a leatherback slaughtered around mid-April at Espinar Beach in Aguada.

Vehicles driven over nests can compact sand making it harder for hatchlings to escape and can crush hatchlings just under the sand's surface. Hatchlings *en route* to the ocean may fall into deep tire tracks and continue crawling long distances in the tracks, which can increase mortality from dessication and predation. Vehicles driven on the beach, especially on the upper beach platform, continue to be a problem at almost all beaches in the Northwest. At least one nest at N. Maní was passed over by a jeep, and there were close calls at Añasco. Fortunately, the N. Maní nest had a high hatching success.

Fishermen tramping over nests as they haul in beach seines may also compact sand. Nets left on the beach to dry overnight could get caught on nesting turtles, and could impede hatchlings from reaching the sea. Fishermen cooperated by putting their nets away at night, after notices were posted at Añasco Beach. There was no need this year to install cyclone fencing around nests to protect them from summertime activities held at Rancho Grande, because none of the nests were in the impacted area. High seas almost touched a nest laid on 14/15 March at Caño la Puente, and no nests were washed over to our knowledge.

The lights at the new Centro Vacacional at N. Añasco did not excessively shine on the beach this year. Most of them are low pressure sodium (LPS) vapor and many are low to the ground. There were some fairly high non-LPS lights at the basketball court, but these were rarely used and trees helped block

their light. There were very few access points to the beach from the fence that surrounds the Vacacional, so little damage has occurred to beach vegetation. Buoy lines were used to demarcate a large swimming area, as is done in front of the public bathing beach (Balneario Tres Hermanos). Experience has shown that leatherbacks generally do not nest within these areas, and the lines could cause entanglement. Some prime areas of nesting beach are now not as accessible to the leatherbacks.

Stray dogs continue to be a problem at Añasco and El Maní Beaches. They have not caused any known predation yet, but their barking when females emerge to nest alerts the locals to the presence of a turtle, which could contribute to poaching. Also they are known to frighten turtles back into the water.

Litter in the Añasco/El Maní area usually consisted of river-derived organic materials such as tree branches and trunks, but also included plastics such as used transfusion bags that continue to wash up. The majority of debris from the Añasco River appears to be carried to the south by the currents. Litter may obstruct, entrap or injure nesting turtles and hatchlings. If hatchlings are delayed, predation can increase, especially from fire ants that feed in the debris. It was disheartening to see a hatchling killed by ants in the wrack line, only inches from the water's edge.

Small scale illegal sand extraction of actual beach sand occurred at most beach access points in the Añasco/El Maní area. Large scale "legal" extractions are wiping out all sand storage areas in the secondary dunes of Isabela, and in Aguadilla to the west of El Bajo Beach. When we experience a "100" year storm, we may lose these beaches completely. Fighting against the extensive permitting of sand extraction at these beaches and in Arecibo has been an ongoing battle.

CONCLUSIONS AND RECOMMENDATIONS

Leatherback activities have remained about the same in the last two years at Añasco/El Maní with 20 activities in 1992 and 18 in 1993; however, there was shift toward use of El Maní in 1993. There were approximately eight leatherback nests in Arecibo last year and nine nests this year. A pattern seems to be emerging of two types of individuals, those that nest many times at one beach, and those that visit the beach once or perhaps twice. This year there were probably two full-time nesters at Añasco/El Maní with two possible stragglers, and one full-time nester at Arecibo with one possible straggler. They used both developed and undeveloped sections of beach. The main study beaches have not changed appreciably in width since last year. Leatherbacks sporadically use other northwestern beaches for nesting.

Hawksbill activities were found at several different beaches, especially at Barceloneta, and El Bajo, Isabela, where one turtle nested at least two times. Successful hawksbill nesting occurred in undeveloped sections of beach. Although green turtle nesting is rare in Puerto Rico, a nest was found at Jobos Beach this year. The eggs of this nest had thin spots in their shells and some were broken, although fifty percent of the eggs hatched. Oddly, a leatherback nest in Arecibo also had thin-shelled eggs, with some yolked and yolkless eggs broken, but none of the eggs hatched. Another nest that did not hatch from the same turtle was located months after the hatching date, and those eggs also seemed to be thin-shelled.

In my personal experience and from a cursory review of the literature, this is not a common problem. Hendrickson (1958) mentions the existence of abnormal shells in the clutches of some green turtles in Malaya and Sarawak — "They seem to lack the normal content of calcium and they feel soft to the touch." He thought that if the whole clutch was composed of abnormal eggs it was due to a "general malfunction of the female genital tract." He said it was very rare for more than one of a female's clutches to be abnormal. Perhaps laboratory results of the egg samples will shed some light upon the problem.

Leatherback hatching success was generally in the 70th and 80th percentiles at Añasco/El Maní, which is very good. An estimated 680 hatchlings made it to the sea, from the nests that were known to hatch. Sadly for the residents of Arecibo, none of the clutches they monitored all season emerged. Since all the clutches were probably laid by the same turtle, and two of her clutches were known to be defective, we assume that all the clutches had the same problem. Hawksbill hatching success averaged out to be about the same as for leatherbacks, with approximately 330 hatchlings reaching the sea. If we include the green turtle hatchlings, there were approximately 1090 hatchlings of

all three species. Hopefully at least one of these will reach maturity to reproduce.

Attempted egg poaching is still occurring at El Maní and Arecibo beaches, but there were no known attempts at Añasco. To our knowledge no nesting turtles were poached at the study beaches, but a leatherback may have been taken at Espinar Beach in Aguada. As the residents learn more about the plight of turtles from informative talks and by actually watching us in the field, their attitudes are changing. Many have helped by providing information on nests and by protecting them. Fishermen have cooperated by not leaving their nets out to dry overnight. College students enjoy participating on patrols with their professors and friends, and are coming up with research ideas.

Specific recommendations remain much the same as last year. Camouflaging tracks, and roping or fencing off near term nests should continue, as well as public education. More stringent enforcement of laws governing vehicles on the beach, sand extraction, campfires, and dumping of trash is needed. Illegal sand extraction and dumping can often be thwarted by placing barriers at secondary beach entry points. DNR beach cleaners should remove debris from the beach, and not just bury it. They should also sponsor several major cleanups a year, where large tree trunks and driftwood are removed (without driving their trucks on beach vegetation or nests).

A beach lighting ordinance should be established for Puerto Rico. In the mean time light owners must be approached and asked courteously to shield their lights or turn them off after a certain hour at night. The opening of *quebradas* and the Caño la Puente should be limited because of the inconvenience it causes to patrollers, and the threat of washing away nests. More DNR personnel, or other enforcement agents should be present during summertime beach activities, even though they usually occur on weekends. Lastly, there should be a systematic reduction of stray dogs, and other animals should be kept off the beach.

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Each beach had its special guardians. At S. El Maní, special thanks go to Milagros Guzmán and her family for putting up with people tracking sand into their home day and night, and to Pepe Rodriguez and the rest of the locals who tirelessly walked the beach. Angel and Sylvia Hernández, owners of the Rancho Grande Seafood Restaurant of Añasco, where we usually camped out at night, were very hospitable as usual. Sandy and Joe Chatt also allowed us to stay at their beach house several times. Sandy Rios and Farideh Ridao tirelessly covered the northern section of Añasco three mornings a week, and Juan Cebollero kept an eye out in the southern section. In Arecibo, patrols were usually led by Osvaldo de Jesús, and a boy scout named José Carlos Rojas who was working on his honorday project. Peggy Toth allowed us to rest in her home between patrols at Jobos Beach.

As usual it would be impossible to list all the volunteers that participated, but I am especially thankful to Professors Tony Ortiz (UPR, Ponce), Robin Walker (Inter American, San German), and Nelson and Candida Peña (UPR, Arecibo) for bringing carloads of students to the beaches. Other important beach walkers and nest monitors included Mildred Abadías, Héctor Ayala, Denise Cabrero, Ramón (Pito) Calero, Walter Ceballos, Pat Easton, Jo Hollingsworth, Dianne Lewis, Ricky Lopez, Joselito Muñiz, Enrique Ortiz, Craig Reithmeyer, Pedro Reyes, Rosa Shirley, Richard Smith, the Arecibo Rotaract Club and the Arecibo Dive Shop. Walter Ceballos also provided a valuable service by video documenting many events.

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Figure 1. Map of northwestern PR taken from "Estudio de Accesos a Playas de Puerto Rico" published by DNR in 1978. The highlighted coastline represents beaches. The names of specific beaches included in this study were added to the interior of this map.

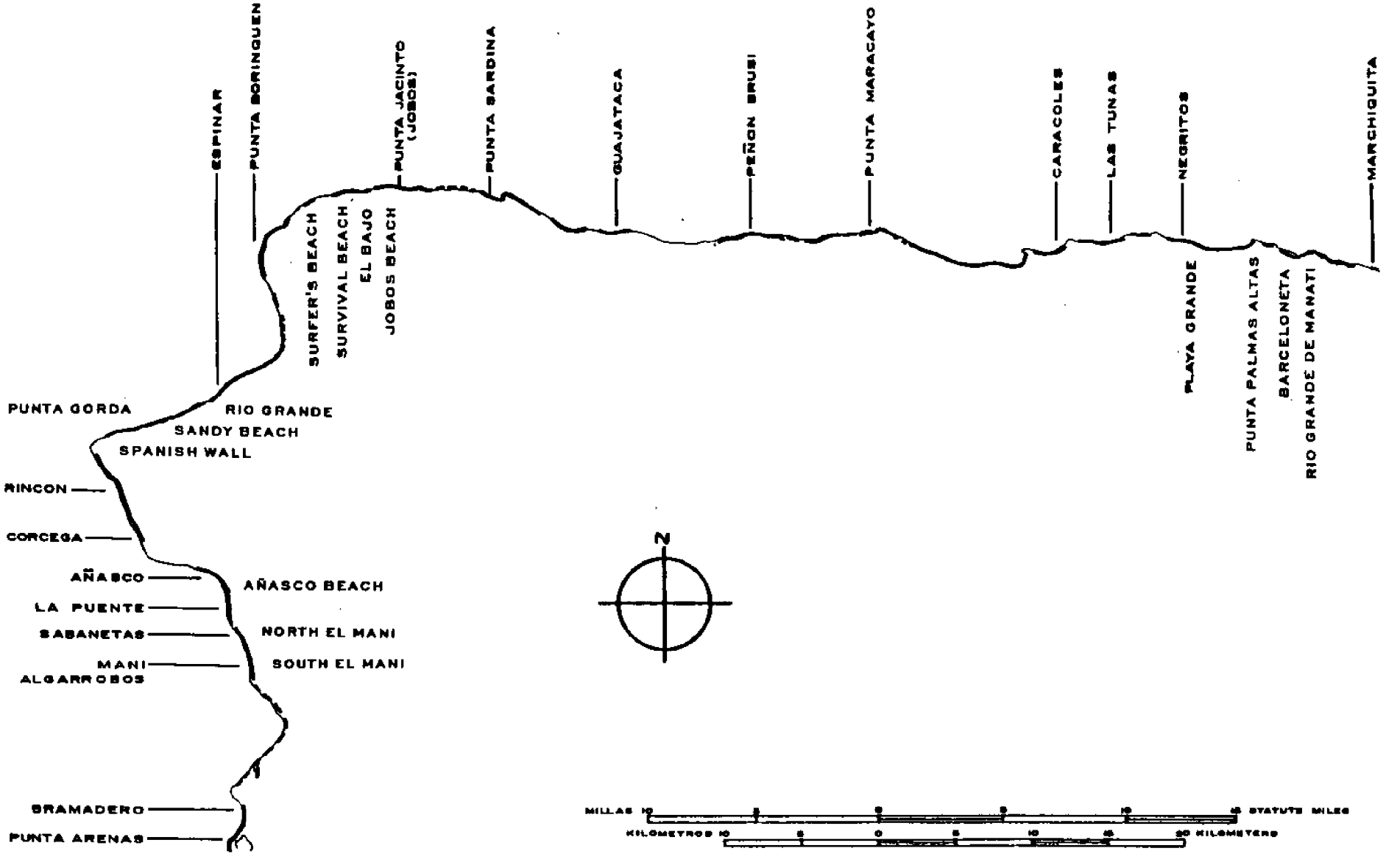

Figure 2. Beaches of Añasco and El Maní, Puerto Rico.

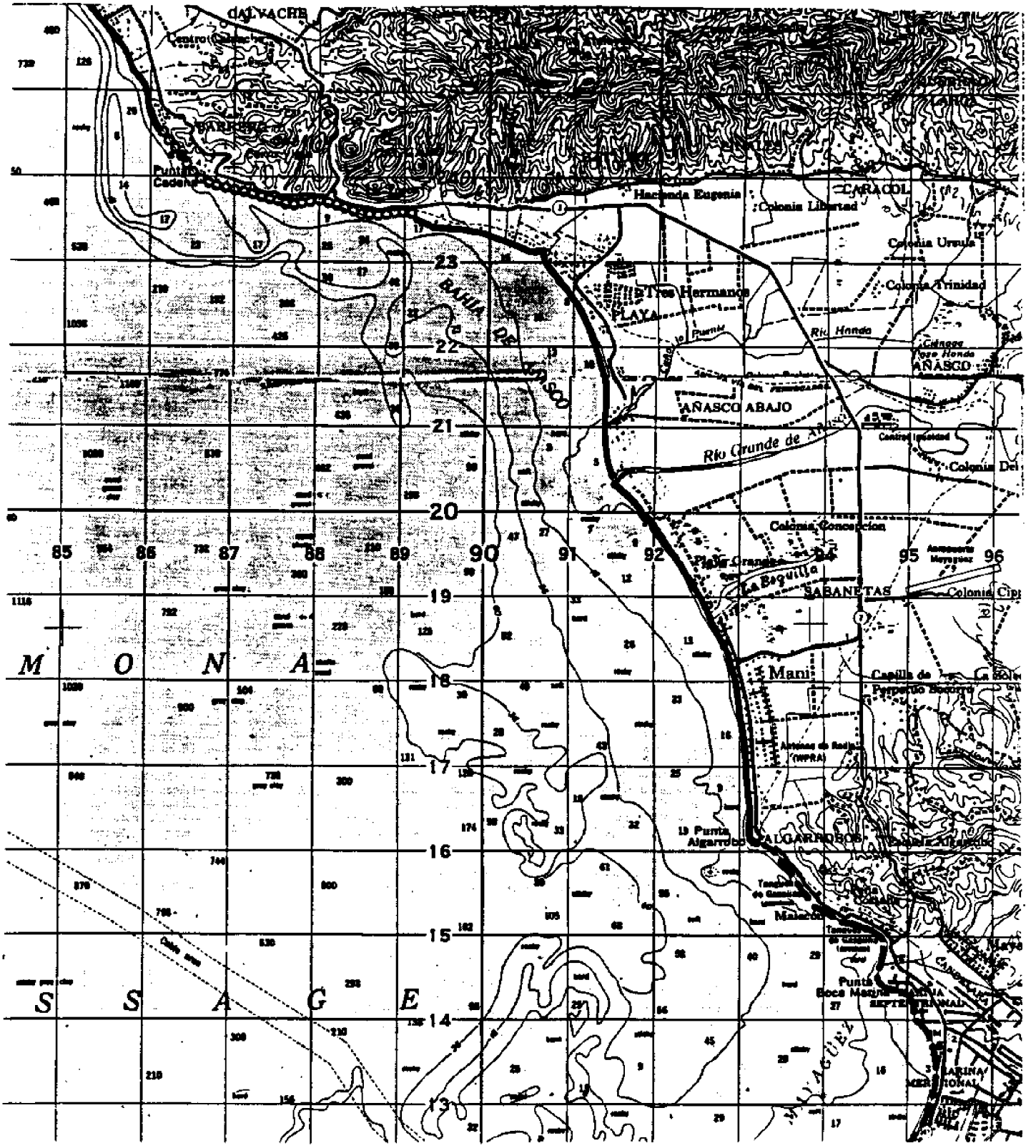

Table 1. Sea turtle nesting summary for western PR in 1993

Species	Tag Number	Date Laid	Beach	Marker Nos.	Activity
Dc		3-5/6-93	Añasco, Caño Puente	196 & 197	probable lay
Dc		3-14/15-93?	Añasco, Caño Puente	205 & 206	probable lay
Dc		3-27/28-93?	North Maní		lay
Dc		4-5/6-93	Añasco, Rancho Grande	167 & 168	false crawl?
Dc		4-5/6-93	Añasco, Caño Puente	207 & 208	lay
Dc		4-13/14-93?	North Maní		lay
Dc		4-21/22-93	North Maní		lay
Dc	(big track)	5-8/9-93	Añasco, Caño Puente	207	lay
Dc	(small track)	5-9/10-93	Añasco, Caño Puente	200	lay
Dc	615 & 616	5-18/19-93	Añasco, Caño Puente	200 & 201	lay
Dc		6-26/27-93	Añasco, South End		probable lay
Dc		3-27/28-93	Arecibo, Playa Grande		probable lay
Dc		4-4/5-93	Arecibo, Playa Grande		probable lay
Dc	1851	4-13/14-93	Arecibo, Playa Grande		lay, relocated
Dc?		4-20/21-93	Barceloneta, Palmas Altas		false crawl?
Dc		4-21/22-93	Arecibo, Playa Grande		false crawl
Dc	1851	4-22/23-93	Arecibo, Playa Grande		lay
Dc		4-30/5-1-93	Arecibo, Playa Grande		probable lay
Dc		5-8/9-93	Arecibo, Playa Grande		false crawl
Dc	1851; 605 & 612	5-8/9-93	Arecibo, Playa Grande		lay
Dc		5-15/16-93	Arecibo, Playa Grande		false crawl
Dc		5-16/17-93	Arecibo, Playa Grande		probable lay
Dc		5-23/24-93	Arecibo, Playa Grande		false crawl?
Dc		5-24/25-93	Arecibo, Playa Grande		probable lay
Dc		6-19/20-93	Arecibo, Playa Grande		false crawl?
Dc		4-2/3-93	South Maní		lay
Dc		4-24/25-93	South Maní		lay
Dc		5-3/4-93	South Maní		lay
Dc	613 & 614	5-13/14-93	South Maní		lay
Dc	613 & 614	5-23/24-93	South Maní		lay
Dc		6-3/4-93	South Maní		probable lay
Dc		6-mid-93	South Maní		probable lay
Dc		4-27/28-93	Rincón, Pta. Gorda		probable lay
Dc		5-15/16-93	Rincón, Pta. Gorda		probable lay
Dc		5-30/6-1/93	Aguadilla, Pta. Borinquen		probable lay
Eí		4-early-93	Arecibo, Caracoles		probable lay
Eí		4-mid-93	Rincón, Pta. Gorda		probable lay
Eí?		5-mid-93	Barceloneta, La Boca		probable lay
Eí?		5-end-93	Barceloneta, La Boca		probable lay
Eí		6-26/27-93	Aguadilla, Survival		false crawl?
Eí		7-26/27-93	Isabela, El Bajo		lay, relocated
Eí		8-9/10-93	Isabela, El Bajo		lay
Eí		8-mid-93	Isabela, El Bajo		lay
Eí		9-24/25-93	Horned Dorset Hotel, Rincón		false crawl
Cm		3-27/28-93	Isabela, Jobos		lay, relocated

Table 2. Leatherback morphometrics and spatial use of beaches for western PR in 1993.

Beach and Turtle Tag No.	Length[1] in cm	Length[2] in cm	Width in cm	Egg Width in mm	N-HWM in m	N-water in m	N-veg in m	Beach Width in m
Añasco/N. Maní	166.2	174.2	121.1	52.2	12.4	18.8	1.2	20.3
615, 616	(n=1)	(n=1)	(n=1)	(n=4)	(n=5)	(n=8)	(n=7)	(n=7)
S. Maní	157.8	166.8	117.1	55.0	9.9	12.1	0.9	13.0
613, 614	(n=1)	(n=1)	(n=1)	(n=7)	(n=2)	(n=3)	(n=3)	(n=3)
Arecibo	152.4	160.3	110.9	53.7	22.5	31.5	12.6	45.0
1851, 605, 612	(n=1)	(n=1)	(n=1)	(n=9)	(n=2)	(n=6)	(n=5)	(n=5)
Rincón	____	____	____	____	7.0	16.3	2.4	18.7
untagged					(n=1)	(n=2)	(n=2)	(n=2)

Length[1] = curved length notch to tip

Length[2] = curved length tip to tip

Width = greatest curved width

N-HWM = mean distance of nest to recent high water mark

N-water = mean distance of nest to water's edge

N-veg = mean distance of nest to vegetation (or structure)

Beach width = mean width where turtles were nesting

Table 3. Sea turtle hatching summary for western PR in 1993

Sp.	#Nest	Date laid	Beach	Incu. days	#Yolk eggs	#Yless eggs	% Hatch	% Emerg	H'ling length	H'ling wt.	#H'ling meas.	Rotten eggs	Early embryos	Midterm embryos	Fullterm embryos	Live + dead h'lings/nest	Dead h'lings on beach
Same turtle? (# 615):																	
Dc	3	3-27/28-93?	N. Mani	?	81	38	79.0	76.5	62.2	43.2	n = 2	10	5	2	0	2	0
Dc	4	4-5/6-93	Añasco	64?	81	40	85.2	82.7	64.8	45.5	n = 2	5	6	0	1	2	0
Dc	5	4-13/14-93?	N. Mani	64?	98	40	85.7	81.6	60.4	37.6	n = 6	10	1	3	0	4	2
Dc	6	4-21/22-93	N. Mani	65	72	41	84.7	84.7	59.4	36.5	n = 5	3	4	4	0	0	5
Dc	8	5-8/9-93	Añasco	63	75	37	86.7	84.0	61.1	42.0	n = 2	7	2	1	0	2	0
Different turtle, untagged:																	
Dc	1	5-9/10-93	Añasco	65	81	28	44.4	43.2				41	0	4	0	1	0
#1851, 605:																	
Dc	3	4-13/14-93	P Grande	DNH	86	25	0.0	0.0				81	0	3?	2?	0?	0
Dc	6	5-8/9-93	P Grande	DNH	81	36	0.0	0.0				81	0	0	0	0	0
Same turtle? (#613):																	
Dc	1	4-2/3-93?	S. Mani	72?	83	35	77.1	77.1				19	0	0	0	0	0
Dc	3	4-24/25-93	S. Mani	64	83	31	85.5	85.5				11	0	1	0	0	0
Dc	4	5-3/4-93	S. Mani	62	78	31	76.9	75.6				10	4	0	4	1	0
Dc	5	5-13/14-93	S. Mani	67	82	37	80.5	79.3	61.6	48.0	n = 1	15	1	0	0	1	0
Dc	6	5-23/24-93	S. Mani	64	85	29	69.4	69.4	59.0	45.2	n = 10	26	0	0	0	0	0
#PPY301:																	
El	1	7-26/27-93	El Bajo	?	151	0	64.9	64.9				44	0	0	9	0	?
El	2	8-9/10-93	El Bajo	67	121	0	66.1	65.3	45.0	19.8	10	35	2	4	4	1	0
Different turtle?:																	
El	?	8-mid-93	El Bajo	?	154	0	100.0	98.7	40.6	14.5	1	0	0	0	0	2	?
Untagged:																	
Cm	1	3-27/28-93	Jobos	?	158**	0	50.0	48.7	53.5	22.0	n = 1	79	1?	0	2?	2	?

Dc = Dermochelys coriacea; El = Eretmochelys imbricata; Cm = Chelonia mydas

#Nest = Estimated number of nests for each individual during season; #Yolk eggs = Excavation counts

DNH = Eggs did not hatch

Table 4. A comparison of hatching results between nests thought to be from two different leatherback turtles that nested on different beaches.

Mean	# 615 ? Añasco/N. Maní	# 613 ? S. Maní
Days incubation:	64.0 (n = 4)	64.2 (n = 4)
#Yolked eggs (excavation count):	81.4 (n = 5)	82.2 (n = 5)
#Yolkless eggs (excavation count):	39.2 (n = 5)	32.6 (n = 5)
% Hatch (hatchlings out of eggs):	84.3 (n = 5)	77.9 (n = 5)
% Emergence (hatchlings out of nest):	81.8 (n = 5)	77.4 (n = 5)
Hatchling length (cm):	60.9 (n = 17)	59.2 (n = 11)
Hatchling weight (g):	39.4 (n = 17)	45.5 (n = 11)
Live + dead hatchlings/nest:	2.0 (n = 5)	0.4 (n = 5)
Dead hatchlings on beach/nest:	1.4 (n = 5)	0.0 (n = 5)

APPENDIX 1

For convenience, Añasco Beach was divided into sections, which were named for a prominent landmark as follows:

Marker	Landmark
1	North end of beach (last house on sw border of Rincón)
64	Quebrada at beginning of Centro Vacacional
97	"Casa blanca" — vacant cement house
157	Fisherman's pier
190	Rancho Grande Seafood Restaurant
215	Caño la Puente
250	Rio Añasco

Using these markers, the sectors were named:

1-64	North End (NE)
64-97	Centro Vacacional (CV)
97-157	Balneario Tres Hermanos (BA)
157-190	Rancho Grande (RG)
190-215	Caño la Puente (CP)
215-250	South End (SE)

Original Tag #_____ Crawl #_____ Page #_____

1992 PROYECTO TORTUGAS MARINAS DE ANASCO

DATE _____ TIME _____ ACTION _____

NEW TAG NOS. (____)_____ / (____)_____

OLD TAG NOS. (____)_____ / (____)_____

REMOVED TAG (____)_____ POSSIBLE TAG SCARS: LF RF LR RR

SPECIES: DC EI CM OUTCOME: LAY PROBABLE LAY FALSE CRAWL

ORIG. NEST #_____ _____M _____DEG / #_____ _____M _____DEG

REBURIED #_____ _____M _____DEG / #_____ _____M _____DEG

#YOLKED EGGS_____/REBURIED_____ #YOLKLESS EGGS_____/REBURIED_____

EGG SZ mm:_____/_____/_____/_____/_____/_____/_____/_____/_____/_____

TIME LAID _____ TIME REMOVED _____ TIME REBURIED _____

NEST TO VEGETATION/FENCE _____M NEST TO RECENT HWM _____M

NEST TO WATER'S EDGE _____M CRAWL WIDTH _____M

BUILDINGS/LIGHTS NEARBY _____

TURTLE SIZE / TAPE MEASURE	TURTLE SIZE / CALIPERS
LENGTH (notch-tip) _____CM	LENGTH (notch-tip) _____CM
LENGTH (rt.tip-tip) _____CM	LENGTH (rt.tip-tip) _____CM
WIDTH (greatest) _____CM	WIDTH (greatest) _____CM
WEIGHT _____KG	HEAD WIDTH _____CM

COMMENTS: _____

DIAGNOSTIC MARKINGS/ECTOBIOTA

LF: _____ RF: _____

LR: _____ RR: _____

HEAD: _____ CARAPACE: _____

SKY _____ WIND VELOCITY/DIRECTION _____/_____

TEMP._____ RAIN _____ MOON PHASE O ◐ ● / VISIBLE: YES NO

OBSERVERS: _____

HATCHING DATA

6. Females' original tag _____ Date laid _____

Nest type: IN SITU RELOCATED Location _____

Yolked eggs buried _____ Yolkless eggs buried _____

7. Weather at emergence:

Sky _____ Wind direction _____ Wind velocity _____

Air Temperature _____ Precipitation _____ Seas _____

Previous weather: _____

8. Nesting results: Date emerged _____ Incubation _____ days

Time(s) emerged _____ Date cleaned _____

Hatchlings released _____ Nesting success _____ %

9. Nest contents:

Total Eggs _____

live hatchlings _____ embryos (tiny) _____

dead hatchlings _____ embryos (midterm) _____

hatched deformed _____ embryos (fullterm pipped) _____

unhatched deformed _____ (fullterm unpipped) _____

rotten/undeveloped _____ hatched shells _____

yolkess recovered _____

0. Predation: eggs _____

hatchlings _____

1. Comments/causes for poor hatch: _____

2. Hatchling measurements:

Notch/tip (mm)	____	____	____	____	____	____	____	____	____
width (mm)	____	____	____	____	____	____	____	____	____
weight (g)	____	____	____	____	____	____	____	____	____
crawl rate (m/min)	____	____	____	____	____	____	____	____	____

3. Notes and observations:

no. full yolkless:

no. semi collapsed:

no. full collapsed: