

**Hawksbill sea turtle, Eretmochelys imbricata, and green
sea turtle, Chelonia mydas, nesting census with
management recommendations. Culebra, Puerto Rico.
August 1993 to February 1994.**

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ABSTRACT

Beaches in the Culebra, Puerto Rico archipelago were surveyed from August 1993 to February 1994 three times per week on non-consecutive days to document hawksbill, Eretmochelys imbricata and green sea turtle, Chelonia mydas, nesting activity. No green turtle nests were encountered. Sixty hawksbill activities were recorded, 68% of which occurred on beaches included in the Culebra National Wildlife Refuge.

Peak nesting activity occurred between 17 October 1993 and 12 December 1993. Nest contents and hatching success were analyzed for 23 nests. Mean clutch size was 142.92 eggs, and mean hatching success was 89.34%.

Various entities, both private and governmental, are striving to augment opportunities for the public to utilize and enjoy Culebra's coastal resources. Unmanaged public use of nesting and foraging areas poses major threats to nesting and foraging habitat integrity in the Culebra archipelago. Recreational boat use on holiday weekends and activities of off-island fishermen have caused degradation of habitat and sea turtle mortality.

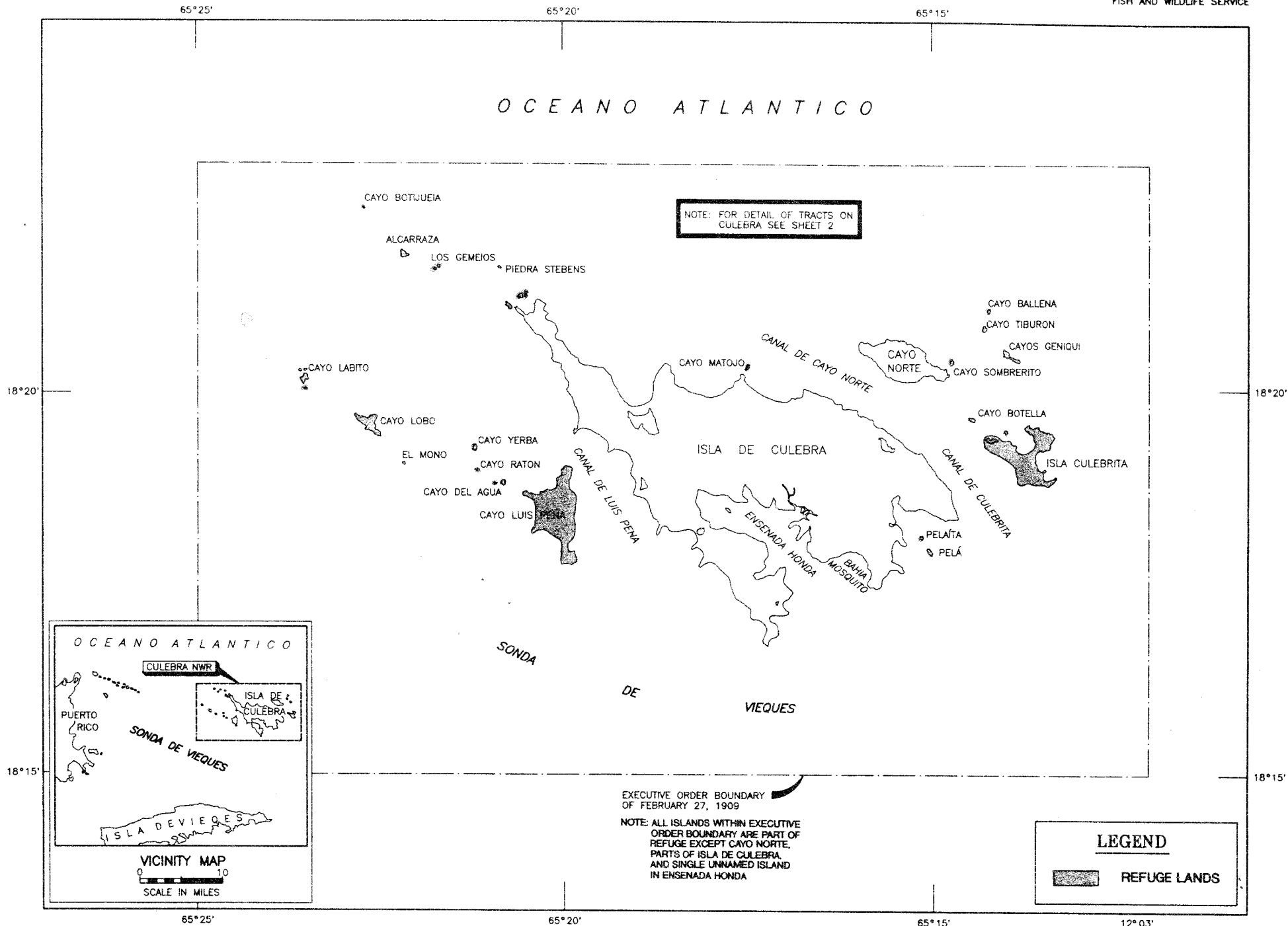
Communication and cooperation among P.R. Planning Board, U.S. Army Corps of Engineers, P.R. Department of Natural and Environmental Resources, The Municipality of Culebra, P.R. Regulations and Permits Authority, Fish and Wildlife Service, National Marine Fisheries Service, and the public is mandatory to prevent irreversable damages to Culebra's resources. Until such an effort is realized, attempts to manage public use in the archipelago will be ineffective.

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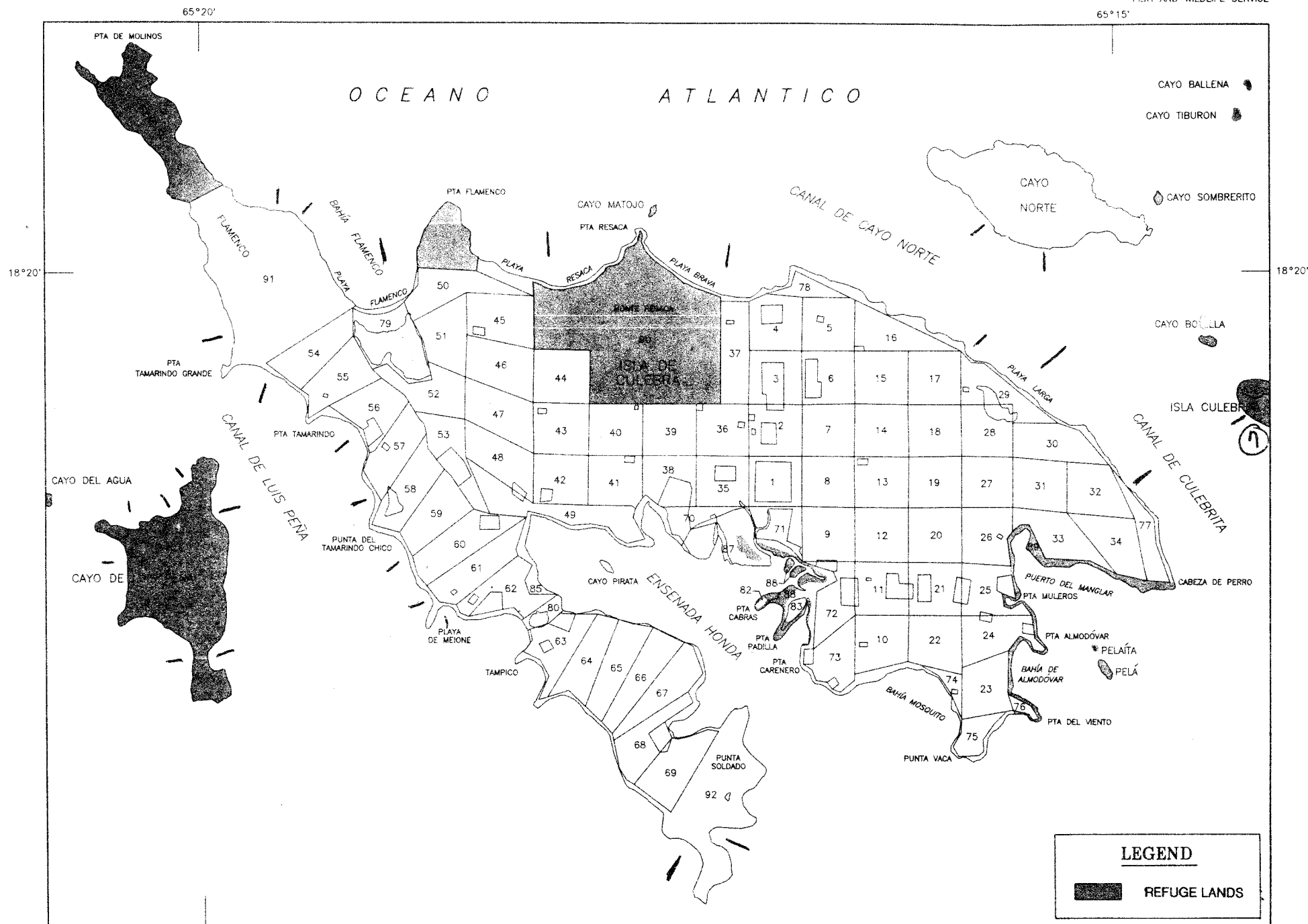
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INTRODUCTION

The Culebra archipelago (18° 19' N , 65° 20' W) is located approximately midway between the main island of Puerto Rico and St. Thomas, U. S. Virgin Islands (Figure 1). Total area is 3080 hectares, one quarter of which is contained within the Culebra National Wildlife Refuge. Non-refuge lands are either privately owned or are under the jurisdiction of the Puerto Rico Commonwealth or Municipal government. The entire shoreline of the main island, other than that included in refuge units, is afforded protection by Commonwealth and Federal laws through the P.R. Department of Natural and Environmental Resources (DNER), and the U.S. Army Corps of Engineers (ACE).

The archipelago is composed of 25 islands and rocky projections, the largest of which (Culebra) is centrally located and inhabited with a population of approximately 1600 people (Census, 1990). Smaller unpopulated cayos encircle the main island and range in size from that of small rocky prominences to more than 150 hectares.

The shoreline of the largest island is characterized by sandy and/or coral/cobble beaches from 50 to 150 m in length on the north and east portions interrupted by rocky points and stretches of eroding cliff faces of volcanic origin or descalabrado series soil. The west and southern shore features sand/coral/ cobble beaches and bays fringed by coral reefs. Seagrasses dominated by Thalassia testudinum, Syringodium filiforme, and Halodule wrightii, are grazed by green sea turtles, Chelonia mydas. A fragmented coral reef system, recovering from impacts sustained during Hurricane Hugo in 1989, virtually surrounds the island, providing resting habitat for green sea turtles, and both resting and foraging sites for hawksbills, Eretmochelys imbricata. North and northeast shore sandy beaches are utilized as nesting habitat by leatherback sea turtles, Dermochelys coriacea, with a recorded 12 to 40 turtles nesting per year since 1984.

Preliminary surveys of sea turtle nesting and foraging habitat in the late 1970's (Carr 1977) indicated the significance of Culebra sea turtle habitat. Subsequent on-going studies initiated and sponsored by Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS) have documented leatherback sea turtle nesting biology and trends, and green sea turtle utilization of the archipelago as developmental habitat during juvenile and sub-adult

life stages. Seagrass beds have been designated FWS Resource Category 1 (1993) and NMFS is currently proposing Critical Habitat designation for all waters extending from mean high water out to 3 miles from shore throughout the archipelago.

The Culebra sea turtle species on which the smallest amount of information has accumulated is the hawksbill. Anecdotal information provided by local fishermen and more recently available technical data indicated that nesting was occurring, but documentation on frequency and locality was lacking. Hawksbill sea turtles nest throughout the Culebra archipelago on small, widely distributed pocket sand and/or coral/cobble beaches on remote cayos and Flamenco Peninsula, or on longer sand beaches contiguous with the shoreline of the island of Culebra. Until the implementation of this study, the maximum extent of hawksbill nesting surveys consisted of a weekly census on beaches included in the Culebra National Wildlife Refuge and certain off-refuge beaches where nests had been reported in the past. This information, combined with that provided by daily census of north shore beaches during the leatherback nesting study conducted on an annual basis February through August, provided sketchy records not indicative of true nesting chronology and location.

Very few green sea turtle nesting records have accumulated since commencement of turtle activity monitoring efforts in 1984. Local residents claim that nesting once did occur here; however, identification of the turtles might have been confused with that of loggerheads, Caretta caretta, which are known to have nested in the archipelago up to the year 1972. Preserved specimens of loggerheads, including the carapace and head of a female turtle killed while nesting on Isla Culebrita in 1972, are owned by various local citizens.

The objective of this pilot study is to provide baseline data on the number and location of hawksbill and green turtle nesting activities throughout the archipelago during months thought to encompass peak nesting frequency. The information is considered preliminary to be followed by subsequent surveys for determination of interseasonal trends.

METHODS and MATERIALS

A. Beach surveys

Diurnal surveys commenced on 1 August 1993 and continued through 15 February 1994. Study sites were selected due to appearance as suitable nesting habitat combined with susceptibility to illegal take and, therefore, in need of priority protection. All beaches able to be censused within a 60 hour total man hour week were included, and stations were divided among personnel according to location or method of approach. Beaches accessible only by boat were surveyed by contracted personnel who provided their own boat, and those accessible by car or on foot were covered by a resident FWS Ecological Services technician.

Refuge beaches surveyed were 7 beaches on Culebrita, 7 beaches on Cayo Luis Peña, and Playa Cascajo on Peninsula Flamenco. Non-refuge beaches were Brava, Resaca, Zoni, Larga, Blanca, Tamarindo, Carlos Rosario, Melones, Punta Soldado, Malena, and Cayo Norte (Figure 2.).

Each site was surveyed by foot at least 3 times per week on non-consecutive days as early in the day as practical. For each nesting activity the location, track diagram, and weather variables were recorded. Tracks were camouflaged to minimize the possibility of poaching.

B. Nest excavation

Possible nest sites were carefully examined after sixty days for signs of hatching activity. Confirmed nests were excavated as early in the day as practical, and contents were analyzed. Live hatchlings remaining in the nest were released.

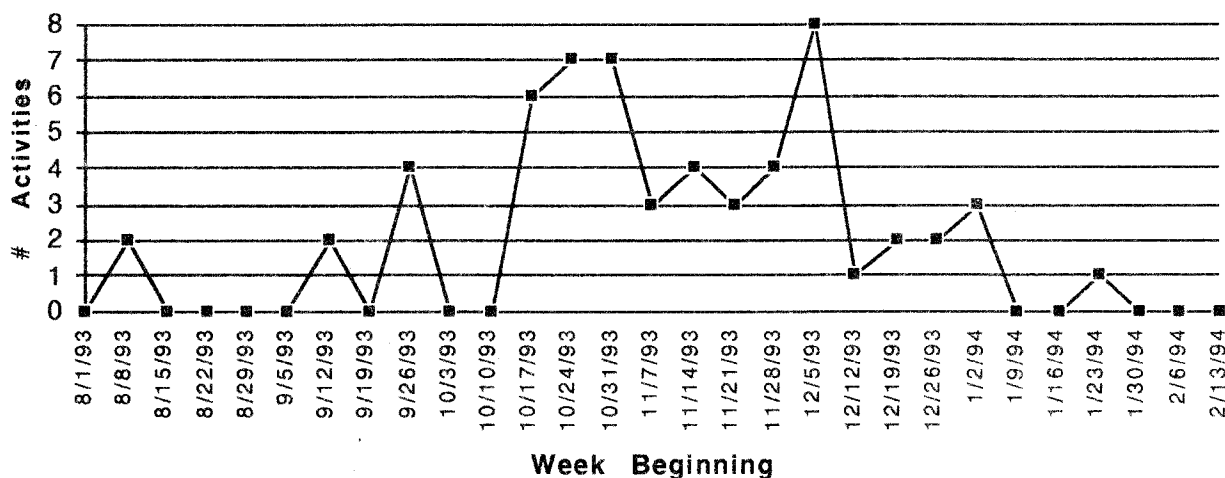
RESULTS

A. Nesting activities

No green sea turtle nests were encountered. A total of 60 hawksbill nesting activities were recorded. The first activity was noted on 10 August 1993 and the last on 28 January 1994. Peak nesting activity occurred between 17 October and 12 December 1993 (Figure 3.).

Figure 3. Hawksbill Nesting Activity Chronology.

August 1993 - February 1994. Culebra, P.R.



Nesting activity distribution is indicated in Table 1. The majority of nesting activity (69.9%) occurred in the eastern portion of the archipelago.

Table 1. Hawksbill nesting activity distribution. Culebra, Puerto Rico
August 1993 to February 1994.

LOCATION	#ACTIVITIES	% TOTAL
Culebrita	28	46.6%
Luis Peña	6	10.0%
Playa Blanca	1	1.7%
Playa Cascajo	6	10.0%
Cayo Lobito	1	1.7%
Playa Zoni	11	18.3%
Playa Larga	3	5.0%
Carlos Rosario	3	5.0%
Tamarindo Grande	1	1.7%
TOTAL	60	100.0%

Of all recorded nesting activities, 68.3% occurred on Culebra NWR beaches, the majority on Isla Culebrita. All other activities occurred on P.R. DNER beaches, 1 of which (Playa Zoni) is managed

cooperatively by FWS and P.R. DNER. Cayo Lobito was not surveyed routinely, but 1 crawl was reported by a local fisherman.

B. Nest contents and hatching success

Hatching activity was noted for 25 out of 60 activities. By the project's completion date, 10 activities were still within incubation period range but were not monitored to determine hatching success.

Hatching success was determined for 23 out of 25 documented nests. Mean success was 89.34 %; N=23, range= 77.24 % to 98.10 %. Mean clutch size was 142.92 eggs; N= 23, range = 95 to 198. Out of a total of 3396 eggs, 195 (5.7%) were infertile. Of 3201 viable eggs (total number eggs - infertile eggs) 3.4% exhibited partial development ranging from embryonic eyespot to pipped hatchlings.

For 6 nests for which incubation time could be calculated, mean incubation was 65 days, range = 60 to 69 days.

DISCUSSION

A. Project design and results

Hawksbills nesting in Culebra do so on widely distributed beaches making nighttime monitoring extremely difficult without large numbers of personnel. Diurnal surveys are providing baseline information from which future census techniques can develop.

Results of this study should be considered as a preliminary indication of hawksbill and green sea turtle nesting activity in the Culebra archipelago. Thorough coverage of all archipelago beaches was impossible within the limitations of available funding for personnel and environmental conditions. Hazardous sea conditions during winter months make approach to the more remote cayos Lobito and Lobo very difficult. Also, unexploded ordnance remain from past U.S. Navy bombing exercises on some Flamenco Peninsula beaches which, although appearing to be good candidates for nesting activity, were not surveyed due to danger imposed by the ordnance as cited by U.S. Army Corps of Engineer (ACE) personnel during ordnance surveys (Wayne Galloway, ACE, personal communication).

A total of 60 man hours per week were provided by the 2 employed personnel. The wide distribution of beaches and large number of potential nesting sites require a greater expenditure of man hours to cover all areas than that possible under this project format. The technician responsible for surveying beaches on off-shore cayos was assisted throughout the duration of the census by a volunteer who helped tremendously with logistics in boat anchoring and actual beach coverage. Monitoring off-shore cayos within a 20 hour week would have been impossible without his additional 20 hour per week assistance.

The shallow, sloping nature of some pocket beaches on Culebrita and Flamenco Peninsula yields them more susceptible to overwash by tidal flux and, therefore, makes detection of tracks more difficult. This characteristic has been questioned in past years in analyzing effectiveness of "every other day" beach census methodology in Culebra. It is possible that unsuccessful nesting attempts went unrecorded. However, because of the lack of hatching activity other than that noted for nests recorded during surveys conducted 3 times per week, combined with the tendency for hawksbills to nest in or under vegetation, and close monitoring of vegetation disturbance by personnel, we believe that documentation of actual nests on these beaches was complete during this study. Beach coverage 3 times per week might be sufficient under labor or financial restraints, but results should be closely monitored in subsequent years and notation of hatching activity from undocumented nests reviewed to effectively evaluate this method.

The number of accountable nests (25 out of 60 activities) might be explained by several factors. The exact locations of unwitnessed hawksbill nest events can be difficult to identify. Due to the superficial sand disturbance caused by hawksbill hatchlings on their way to the sea, evidence of hatching is difficult to detect when nests are not monitored daily and are subjected to wind, rain, and tidal activity. Also, in Culebra, the possibility of poaching is very high due to the remoteness of beaches and lack of nocturnal vigilance. Monitoring consists solely of that diurnally conducted by refuge personnel on an opportunistic basis and technician presence.

The ratio of crawls to actual nesting events documented from nocturnal surveys and witnessed nesting events in other areas of the Caribbean has varied from 1:1 to 4:1 in Buck Island, St. Croix, USVI based on beach platform conditions (Zandy Hillis, National Park

Service, personal communication) and 2.22:1 to 2.32:1 in Mona Island, P.R. (Paréz et. al , 1991, 1992) which suggests that our ratio of 2.4:1 for total crawls vs. confirmed nests might reflect the actual crawl vs. nesting ratio. Without conducting nocturnal surveys it is impossible to ascertain.

B. Public Use impacts on sea turtles and their habitat

1. Recreational beach use and land development

Nesting occurring on non-refuge beaches is subjected to more human disturbance than that on refuge beaches because of camping, campfires, and off-road vehicular activity. Livestock animals have been a problem, as well, on non-refuge beaches Playas Resaca, Zoni, and Tortolo. Leatherback hatchlings died due to dessication on Playa Tortolo in 1994 due to entrapment in cattle hoof prints. A hawksbill hatchling died due to dessication on Playa Zoni in 1994 when entrapped in jeep tire tracks on its way to the sea. It is also possible that some nests might have been compacted by vehicular traffic and cattle.

Refuge areas were closely monitored during periods of heavy public use to document impacts on nests. The greatest public use threat to nest integrity on Isla Culebrita and Cayo Luis Peña was from boat stern anchors placed high up the beach platform, and nest compaction from visitors and trespass animals sitting or walking on top of nest sites. White-tail Deer activity, obvious from tracks seen around nests on Culebrita, is not thought to have affected hatching success this year but should be monitored in the future. The deer swim from the island of Culebra to Culebrita and Cayo Norte.

Coastal development is increasing in Culebra and protective regulations, if applied, are rarely enforced on the ground. Sand extraction occurs on Playa Tamarindo, Punta Soldado, and Playa Zoni, and beach erosion due to upland clearing on highly erodable soils is a constant threat. Erosion of Playa Zoni and Tamarindo have already occurred from water being funnelled to the beach by existing roads and sand extraction. Bulldozer activity behind Tamarindo in 1991 associated with Culebra landfill work and in privately owned lands above Playa Tortolo in 1990 produced the same effect and yielded sedimentation over bordering coral reefs. Even permitted activities with the best intentions can be poorly designed. A newly

permitted road constructed uphill of Playa Melones and Sardinias will channel rainwater through Playa Sardinias to bordering seagrass beds and coral reefs. Turbidity as a by-product of development activities can severely degrade water clarity necessary for seagrass growth, and, once damaged, seagrasses are slow to recover (Vicente 1993).

Mercury vapor and high pressure sodium lamps are used at businesses and private homes near nesting areas at Tamarindo and Flamenco, and development is planned bordering Playa Zoni and Bahia Mosquito where nesting has occurred in the past. Because of the lack of regulation on artificial lighting bordering nesting habitat, compliance with efforts to minimize disorientation potential is totally voluntary.

2. Fishing and recreational boat use

Off-island fishermen have been encountered in the archipelago on numerous occasions setting legal mesh size nets in hawksbill and green turtle foraging and resting areas. A dead hawksbill turtle was found by FWS personnel and P.R. DNER vigilantes in October 1992 in a net placed in Puerto del Manglar. Restrictions on netting methods or areas is non-existent. Our approach in addressing this problem has been to go directly to fishermen during netting activity and explain the concerns while asking them to move their operation to a different location.

Spear fishing is not regulated and has been responsible for the death of at least 2 sea turtles in Culebra since 1987. Also, off-island fishermen bringing "Hooka" rigs or SCUBA tanks overfish already depleted fish stocks, and are rumoured to take turtles, as well. Documented sea turtle mortality has been the result of impact with speeding recreational boats (1990 and 1994) or entanglement in floating monofilament line, fishing trot lines, and discarded personal floatation devices (1987, 1988, 1993, 1994).

Recreational boat use in green turtle and hawksbill foraging and resting areas is heavy during holiday weekends. Over 500 boats measuring up to 60 feet in length are commonly encountered in the archipelago on a given long weekend, and over 100 boats crowd into Bahia Tortuga at Isla Culebrita and anchor for daytime use during this time. Consequences of the lack of limits on boat density and a mooring plan, combined with lack of enforcement of P.R. Law 48

which limits boat velocity to 5 MPH or less within 150 feet from shore, are now being realized.

Past studies of juvenile and sub-adult green turtle population characteristics and habitat use documented up to 40 green turtles utilizing Bahia Tortuga, Culebrita during sampling efforts for the period 1987 to 1989 (Collazo et al., 1992). During that period Thalassia testudinum, Syringodium filiforme, and Halodule wrightii, with Syringodium dominating, formed a fringe of forage material in the bay from the beach to 10 meters of water depth. All grass is now gone other than Thalassia, Syringodium, and Halodule located adjacent to and among coral reef at the northeast side of the bay which is not used for anchoring, and sparsely distributed Syringodium and Halodule in formerly vegetated areas. Presently only 1 to 2 green turtles are now seen in the bay on a given occasion.

Noise associated with speeding boats and jet-skis could be a factor in this decline of habitat quality, as well. Preliminary telemetry studies on green turtles indicated that they are interrupted from foraging activity and leave the site when subjected to boat motor noise (Tallevast 1989).

RECOMMENDATIONS

Clearly the most formidable threat to sea turtle nesting and foraging in Culebra is human induced impact. Without inter-agency communication and cooperation combined with enforcement of existing laws, most protective measures will continue to be difficult, if not impossible, to sustain. A comprehensive conservation plan for the archipelago incorporating recommendations from appropriate agencies, the Municipality of Culebra, and the public, should be established and enforced at the earliest possible opportunity.

The following addresses specific problem areas in the archipelago and potential solutions.

DNER/FWS COOPERATIVELY MANAGED BEACHES AND QUITCLAIM DEED LANDS

Playas Zoni and Tortolo:

Place sunken telephone pole sections at entrance paths to effectively block vehicular traffic. Funding could be provided by FWS Caribbean Field Office.

Maintain fencing along other areas to prevent passage of livestock or insure that cattle owners keep their animals contained. Provide water flow control mechanisms at roads to divert rainfall away from the beach. These projects could be financed through a "Partners in Wildlife" program established among FWS, PRDNER, the Municipality of Culebra, and private landowners.

Incorporate lighting plans into the "Partners in Wildlife" program to minimize disorientation.

Increase vigilance by law enforcement personnel.

Playas Brava and Resaca: Post signs advising of regulations and concerns. Maintain fencing to exclude livestock from the beach. Increase vigilance by law enforcement personnel.

Punta Soldado: Post regulatory signs and increase vigilance by law enforcement personnel.

CULEBRA NWR BEACHES

Culebrita and Luis Peña : Removal of any trespass animals. Increase vigilance by law enforcement personnel. Cooperate with DNER and Municipality of Culebra in comprehensive management plan in DNER marine areas incorporating mooring, boat density limit, and speed limit regulations.

Flamenco Peninsula and remote offshore cayos: Removal of any trespass animals. Increase law enforcement.

DNER BEACHES

Tamarindo and Carlos Rosario: Discuss with DNER possible methods of controlling impacts caused by campers, such as roping off nest areas or informative signs, etc. plus increased law enforcement.

Playas Mosquito, Manzanilla, Larga: Enlist support of landowners through "Partners in Wildlife" or other cooperative program to minimize erosion potential from upland areas and reduce potential disorientation due to lighting. Increase law enforcement.

Marine areas:

Establishment of a comprehensive management plan for all marine areas is mandatory. Communication among the Municipality of Culebra, FWS, DNER, NMFS, ACE, and the public via inter-agency meetings and Public Hearings can insure development of a plan that will be most easily and effectively implemented.

A DNER Reserve would help in protection and restoration of seagrass beds and coral reefs if it addresses boat density and speed limits as well as mooring and anchorage areas (reserves already established on the main island of P.R. have no limit on numbers of boats per given area). Also, maritime law enforcement has to be established to insure compliance by recreational boaters and off-island fishermen.

Education

Much more effort in educational outreach programs is urgently needed in Culebra to inform the public on conservation concerns and create active support from the community. Cooperative associations among FWS, NMFS, DNER, the municipal government, and private groups or individuals can alleviate financial and jurisdictional constraints, and would greatly enhance realization of goals through better communication. Continued employment of local citizens in this and other FWS projects is the best form of possible involvement.

Finally, continued FWS funding of annual hawksbill beach surveys will provide a more accurate synopsis of nesting trends. Culebra is receiving attention from a variety of sources due to its relatively pristine state when compared to surrounding areas, and tourism is being aggressively promoted. Thorough longer-term documentation of nesting and foraging habitat characteristics and cumulative impacts will be necessary to implement public use and development plans designed to circumvent destruction of this irreplaceable resource.

ACKNOWLEDGMENTS

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