FLORIDA POWER & LIGHT COMPANY

ST. LUCIE UNIT 2

ANNUAL ENVIRONMENTAL OPERATING REPORT

1998

FLORIDA POWER & LIGHT COMPANY

JUNO BEACH, FLORIDA

QUANTUM RESOURCES, INC.

PALM BEACH GARDENS, FLORIDA

ENVIRONMENTAL OPERATING REPORT

TABLE OF CONTENTS

PART I

PART II

1.0 EXECUTIVE SUMMARY

1.1 INTRODUCTION

The St. Lucie Plant is an electric generating station on Hutchinson Island in St. Lucie County, Florida. The plant consists of two nuclear-fueled 850 net MWe units; Unit 1 was placed on-line in March 1976 and Unit 2 in April 1983. This document has been prepared to satisfy the requirements contained in Appendix B, Environmental Protection Plan (EPP), to St. Lucie Unit 2 Facility Operating License No. NPF-16. This report primarily discusses environmental protection activities related to sea turtles as required by Subsection 4.2 of the EPP. Other routine annual reporting requirements are addressed in Volume 2.

1.2 TURTLE NESTING SURVEY

Since monitoring began in 1971, there have been considerable year-to-year fluctuations in sea turtle nesting activity on Hutchinson Island. However, data collected through 1998 have shown no long-term reductions in nesting on the island. Relatively high nesting during recent years may actually reflect an increase in the number of nesting females in the study area. On a smaller scale, power plant operation has had no significant effect on nesting near the plant. Low nesting activity in 1975 and again in 1981-1983 in the vicinity of the plant was attributed to nighttime construction activities associated with installation of plant intake and discharge structures. Nesting returned to normal or above normal levels following both periods of construction. During 1991, daytime construction activities associated with velocity cap repairs had no apparent effect on nesting. Formal requirements to conduct nesting surveys expired in 1986, but this program has been continued through 1998 with agreement from federal and state agencies. In 1998, the continuation of the nesting survey program was mandated as part of the biological opinion and incidental take statement issued by the National Marine Fisheries Service.

1.3 INTAKE CANAL MONITORING

Since plant operation began in 1976, 6086 sea turtles (including recaptures) representing five different species have been removed from the intake canal. The majority of the turtles captured (59 percent) were loggerheads. Differences in the numbers of turtles found during different months and years, including dramatic increases in green turtle captures in recent years, have been attributed primarily to natural variation in the occurrences of turtles in the vicinity of the plant, rather than to operational influences of the plant itself. The majority of turtles removed from the intake canal (about 97 percent) were captured alive and released back into the ocean. Ongoing evaluations and improvements to the canal capture program have substantially reduced mortalities of entrapped sea turtles during recent years. Turtles confined between the barrier net and intake headwalls typically reside in the canal for a relatively short period prior to capture, and most are in good to excellent condition when caught. An improved design barrier net completed in January 1996 is expected to further reduce the residence times and potential for mortalities to sea turtles in the intake canal system.

2.0 INTRODUCTION

2.1 BACKGROUND

This document has been prepared to satisfy the requirements contained in Appendix B, Environmental Protection Plan, to St. Lucie Unit 2 Facility Operating License NPF-16.

St. Lucie Units 1 and 2 use the Atlantic Ocean as a source of water for once-through condenser cooling. Since 1971, the potential environmental effects resulting from the intake and discharge of this water have been the subject of FPL sponsored biotic studies at the site. Jurisdiction for sea turtle studies is with the NRC, which is considered to be the lead federal agency relative to consultation under the Endangered Species Act. Previous results dealing with sea turtle studies are contained in fourteen annual environmental operating reports covering the period from 1983 through 1997. This report describes the 1998 environmental protection activities related to sea turtles, as required by Subsection 4.2 of the St. Lucie Unit 2 Environmental Protection Plan.

2.2 AREA DESCRIPTION

The St. Lucie Plant is located on a 457-hectare site on Hutchinson Island on Florida's East Coast (Figures 1 and 2). The plant is approximately midway between the Ft. Pierce and St. Lucie Inlets. It is bounded on the East Side by the Atlantic Ocean and on the West Side by the Indian River Lagoon. Hutchinson Island is a barrier island that extends 36 km between inlets and attains its maximum width of 2 km at the plant site. Elevations approach 5 m atop dunes bordering the beach and decrease to sea level in the mangrove swamps that are common on much of the western side. The Atlantic shoreline of Hutchinson Island is composed of sand and shell hash with intermittent rocky promontories protruding through the beach face along the southern end of the island. Submerged coquinoid rock formations parallel much of the island off the ocean beaches. The ocean bottom immediately offshore from the plant site consists primarily of sand and shell sediments. The Florida Current, which flows parallel to the continental shelf margin, begins to diverge from the coastline at West Palm Beach. At Hutchinson Island, the current is approximately 33 km offshore. Oceanic water associated with the western boundary of the current periodically meanders over the inner shelf, especially during summer months.

2.3 PLANT DESCRIPTION

The St. Lucie Plant consists of two 850 net MWe nuclear-fueled electric generating units that use near shore ocean waters for the plant's once-through condenser cooling water system. Water for the plant enters through three submerged intake structures located about 365 m offshore (Figure 2). Each of the intake structures is equipped with a velocity cap to minimize fish entrainment. From the intake structures, the water passes through submerged pipes (two 3.7 m and one 4.9 m in diameter) under the beach and dunes that lead to a 1,500 meter long intake canal, which transports water to the plant. After passing through the plant, the heated water is discharged into a 670 meter long canal that leads to two buried discharge pipelines. These pass underneath the dunes and beach and along the ocean floor to the submerged discharges, the first of which is approximately 365 m offshore and 730 m north of the intake.

3.0 TURTLES

3.1 INTRODUCTION

Hutchinson Island, Florida, is an important rookery for the loggerhead turtle, Caretta caretta, and also supports some nesting of the green turtle, Chelonia mydas, and the leatherback turtle, Dermochelys coriacea. State and federal statutes protect all three species. The federal government has classified the loggerhead turtle as a threatened species. The federal government endangered species lists include the leatherback turtle and the Florida nesting population of the green turtle. It has been an FPL goal that the St. Lucie Plant would not adversely affect the Hutchinson Island rookery. Because of this concern, FPL has sponsored monitoring of marine turtle nesting activity on the island since 1971.

Daytime surveys to quantify nesting, as well as nighttime turtle tagging programs, were conducted in odd numbered years from 1971 through 1979. During daytime nesting surveys, nine 1.25 km-long survey areas were monitored five days per week (Figure 3). The St. Lucie Plant began operation in 1976; therefore, the first three survey years (1971, 1973, and 1975) were pre-operational. Though the power plant was not operating during 1975, St. Lucie Plant Unit 1 ocean intake and discharge structures were installed during that year. Installation of these structures included nighttime construction activities conducted offshore from and perpendicular to the beach. Construction had been completed and the plant was in full operation during the 1977 and 1979 surveys.

A modified daytime nesting survey was conducted in 1980 during the preliminary construction of the ocean discharge structure for St. Lucie Unit 2. During this study, four of the previously established 1.25 km-long survey areas were monitored. Additionally, eggs from turtle nests potentially endangered by construction activities were relocated.

Every year from 1981 through 1998, 36 one-km-long survey areas comprising the entire island were monitored seven days a week during the nesting season (Figure 3). Beginning in 1994, the southern half of the island has been surveyed by Ecological Associates of Jensen Beach, Florida, and their data is included in this report. The St. Lucie Unit 2 discharge structure was installed during the 1981 nesting season. Offshore and beach construction of the Unit 2 intake structure proceeded throughout the 1982 nesting season and was completed near the end the 1983 nesting season. Construction activities associated with installation of both structures were similar to those conducted when Unit 1 intake and discharge structures were installed. Eggs from turtle nests potentially threatened by construction activities were relocated.

During 1991, another major offshore construction project was undertaken to replace damaged velocity caps on the three intake structures. A large elevated platform, from which repair activities were conducted, was erected around the three structures. Construction occurred throughout the nesting season. However, in contrast to previous offshore projects, work was restricted almost entirely to daylight hours, nighttime lighting of the work area was minimal, and no equipment or materials were used on the beach. A sea turtle protection plan implemented in support of the project included caging of nests along a 1,500 meter section of beach west of the platform and release of hatchlings to unaffected areas to the north and south. This plan was

intended to mitigate any negative effects potentially resulting from required safety and navigational lighting on and near the platform.

Requirement 4.2.1 of the St. Lucie Unit 2 Appendix B Environmental Protection Plan was complete with submission of the 1986 nesting survey data (ABI, 1987). The nesting survey was continued voluntarily through 1998 with agreement from federal and state agencies. Results are presented in this report and discussed in relation to previous findings.

In addition to monitoring sea turtle nesting activities and relocating nests away from plant construction areas, removal of turtles from the intake canal has been an integral part of the St. Lucie Plant environmental monitoring program. Turtles entering the ocean intake structures are entrained with cooling water and rapidly transported through the intake pipes into an enclosed canal system where they must be manually captured and returned to the ocean. Since the plant became operational in 1976, turtles entrapped in the intake canal have been systematically captured, measured, weighed, tagged, and released.

Previous publications and technical reports have presented findings of the nesting surveys, nest relocation activities and canal capture program (ABI, 1994) (Quantum, 1995, 1996, 1997, 1998). Results of studies to assess the effects of thermal discharges on hatchling swimming speed have also been reported (ABI, 1978). In July 1994, responsibility for sea turtle research and conservation activities was transferred from Ecological Associates, Inc. (formerly Applied Biology, Inc.) to Quantum Resources, Inc. Methodologies employed in both the nesting surveys and canal capture operations remained essentially unchanged so that data collected in 1994 through the present are directly comparable to previous year's data. The purpose of this report is to: 1) present 1998 sea turtle nesting survey data and summarize observed spatial and temporal nesting patterns since 1971, 2) document and summarize predation on turtle nests since 1971, and 3) present 1998 canal capture data and summarize comparable data collected since 1976.

3.2 MATERIALS AND METHODS

3.2.1 Nesting Survey

Methodologies used during previous turtle nesting surveys on Hutchinson Island were described in earlier reports (ABI 1994). Methods used during the 1998 survey were designed to allow comparisons with these previous studies.

In 1998, only areas A-S were surveyed by Quantum Resources biologists (Figure 3). Data supplied by Ecological Associates, Inc. are used to provide whole island nesting totals in Figures 6, 8, and 9.

From March 24, 1998 through April 14, 1998, several preliminary nest surveys were conducted along Hutchinson Island in areas A-S. No nesting was recorded in areas A-S prior to the beginning of formal nesting surveys on April 15, 1998. From April 15, 1998 through September 8, 1998, nest surveys were conducted on a daily basis. The last nest recorded in area A-S was on September 7, 1998. Biologists used small off-road motorcycles to survey the island each morning. New nests, non-nesting emergences (false crawls), and nests destroyed by

predators were recorded for each of the 1-km-long survey areas A - S (Figure 3). The 1.25-km-long survey areas that were established in earlier studies also were monitored so comparisons could be made with previous studies.

Data collected from beach nesting surveys were reported to the Florida Department of Environmental Protection (FDEP) as part of the FDEP Index Nesting Beach Survey. In a cooperative effort, data from stranded turtles found during beach surveys were routinely provided to the Florida Department of Environmental Protection and the National Marine Fisheries Service (NMFS) through the Sea Turtle Stranding and Salvage Network.

3.2.2 Intake Canal Monitoring

Most turtles entrapped in the St. Lucie Plant intake canal were removed by means of large-mesh tangle nets fished near the intake canal headwalls at the extreme eastern end of the intake canal (Figure 2). Nets used during 1998 were from 30 to 40 m in length, 3 to 4 m deep and composed of 40 cm stretch mesh multifilament nylon. Large floats were attached to the surface, and unweighted lines used along the bottom. Turtles entangled in the nets generally remained at the water's surface until removed. Since its inception in 1976, the canal capture program has been under continual review and refinement in an attempt to minimize both entrapment time and injuries/mortalities to entrapped sea turtles. Prior to April 1990, turtle nets were usually deployed on Monday morning and retrieved on Friday afternoon. During periods of deployment, the nets were inspected for captures at least twice each day (mornings and afternoons). Additionally, St. Lucie Plant personnel checked the nets periodically, and biologists were notified immediately when a capture was observed. Sea turtle specialists, that retrieve captured turtles from the plant intake canal system, were on call 24 hours a day.

Beginning April 1990, after consultation with NMFS, net deployment was scaled back to daylight hours only. Concurrently, surveillance of the intake canal was increased and biologists remained on site for the duration of each day's netting activities. This measure decreased response time for removal of entangled turtles from nets and provided an opportunity to improve daily assessments of turtle levels within the canal. Records of daily canal observations were compared with capture data to assess capture efficiencies.

In 1978, a barrier net at the A1A Bridge was constructed to confine turtles to the easternmost section of the intake canal, where capture techniques have been most effective. This net is constructed of large diameter polypropylene rope and has a mesh size of 20.3 cm x 20.3 cm. A cable and series of large floats are used to keep the top of the net above the water's surface, and the bottom is anchored by a series of concrete blocks. The net is inclined at a slope of 1:1, with the bottom positioned upstream of the surface cable. This reduces bowing in the center and minimizes the risk of a weak or injured turtle being pinned underwater by strong currents.

In the past, the integrity of the barrier net was occasionally compromised, and turtles were able to move west of A1A. These turtles were further constrained downstream by an underwater intrusion detection system (UIDS) consisting, in part, of a large barrier positioned perpendicular to the north-south arm of the canal (Figure 2). The UIDS security barrier has a mesh size of 22.9 cm x 22.9 cm. Prior to completion of the UIDS in December 1986, turtles unconfined by the

A1A barrier net were usually removed from the canal at the intake wells of Units 1 and 2 (Figure 2). There they were retrieved by means of large mechanical rakes or specially designed nets. Following construction of the UIDS barrier, all but the smallest individuals were unable to reach the intake wells. Improvements made to the A1A barrier net during 1990 have effectively confined all turtles larger than 32.5-cm carapace length (28.7-cm carapace width) to the eastern end of the canal. In response to the large numbers of small turtles encountered in the intake canal in recent years, an improved design, small mesh barrier net was erected east of the A1A barrier net. Construction was complete in January 1996. This improved barrier net is designed to confine all turtles with a carapace width greater than 18 cm to the extreme eastern portion of the intake canal.

Formal daily inspections of the intake canal were made to determine the numbers, locations, and species of turtles present. Surface observations were augmented with periodic underwater inspections, particularly in and around the barrier nets.

In addition to the use of tangle nets, dip nets and hand captures using snorkel and SCUBA were also employed. Long handled dip nets, employed from small boats, the canal banks and headwall structures were moderately effective in capturing turtles with carapace lengths of about 30 cm or less. Divers were employed to hand capture turtles whenever underwater visibility permits, and this technique has proven highly effective in the capture of turtles of all sizes, particularly less active individuals often found partially buried in the sediment in the vicinity of the barrier nets. Hand capture efforts have had a significant impact in reducing entrapment times for turtles in the intake canal.

Regardless of capture method, all turtles removed from the canal were identified to species, measured, weighed, tagged and examined for overall condition (wounds, abnormalities, parasites, etc.). Beginning in July 1994, all turtles captured have been photographed dorsally and ventrally prior to release, and the photographs retained for future reference. Healthy turtles were released into the ocean the same day of capture. Sick or injured turtles were treated and occasionally held for observation prior to release. When treatment was warranted, turtles were transported to an approved rehabilitation facility.

Resuscitation techniques were used if a turtle was found that appeared to have died recently. Beginning in 1982, necropsies were conducted on dead turtles found in fresh condition.

Florida Power & Light Company and Quantum Resources, Inc. continued to assist other sea turtle researchers in 1998. Since the program began, data, specimens and/or assistance have been given to the Florida Department of Environmental Protection, National Marine Fisheries Service, US Fish and Wildlife Service, US Army Corps of Engineers, Smithsonian Institution, South Carolina Wildlife and Marine Resources Division, Center for Sea Turtle Research (University of Florida), Florida Atlantic University, University of Central Florida, Texas A & M University, University of Rhode Island, University of South Carolina, University of Illinois, University of Georgia, Virginia Institute of Marine Science, Western Atlantic Turtle Symposium, South Atlantic Fishery Management Council, Florida Marine Fisheries Commission, Harbor and Branch Oceanographic Institution and the National Research Council.

3.3 RESULTS AND DISCUSSION

3.3.1 Nesting Survey

3.3.1.1 1998 Loggerhead Nesting Summary

In 1998, 7962 loggerhead turtle nests were recorded in the 36 one-kilometer segments comprising Hutchinson Island. This figure is in accordance with a general increase in loggerhead turtle nesting on Hutchinson Island since surveys began in 1971, although significant year to year fluctuations are evident. loggerhead nests and emergences for survey areas A-S is presented in Figure 4.

3.3.1.2 Spatial Distribution of Loggerhead Turtle Nests

From 1981 through 1998, 36 one-km-long segments comprising the island's coastline have been surveyed. The distribution of nests among these 36 survey areas has shown an increase in nesting from north to south along the northern half of the island (ABI, 1987, 1994). Along the southern half of the island there has been either no gradient or a gradient of decreasing nesting from north to south. Though beach dynamics may sometimes affect the selection of nesting sites by loggerhead turtles, relationships between spatial nesting patterns and specific environmental conditions are often difficult to establish because of the interrelationship of the factors involved.

Not all ventures onto the beach by a female turtle culminate in successful nests. These "false crawls" (non-nesting emergences) may occur for many reasons and are commonly encountered at other rookeries. Davis and Whiting (1977) suggested that relatively high percentages of false crawls might reflect disturbances or unsatisfactory nesting beach characteristics. Therefore, certain factors may affect a turtle's preference to emerge on a beach, while other factors may affect a turtle's tendency to nest after it has emerged. An index, which relates the number of nests to the number of false crawls in an area, is useful in estimating the post-emergence suitability of a beach for nesting. In the present study this index is termed "nesting success" and is defined as the percentage of total emergences that result in nests. loggerhead nesting success for areas A - S in 1998 is presented in Figure 5.

Historically, the pattern of loggerhead emergences on the island has generally paralleled the distribution of nests (ABI, 1987, 1994). In contrast, nesting success by loggerheads along the island has typically lacked gradients (ABI, 1987, 1994). Thus, the relatively high numbers of loggerhead nests observed in certain areas are usually a result of more turtles coming ashore in those areas rather than of more preferable nesting conditions being encountered by the turtles after they emerged. A variety of environmental factors (i.e., offshore bottom contours, distribution of reefs, type and extent of dune vegetation, and human activity on the beach at night) may effect loggerhead turtle emergence patterns and several have been reported to affect emergence patterns on Hutchinson Island (ABI, 1988, 1989). Undoubtedly, a combination of factors accounts for the overall distribution of emergences and therefore the overall nesting pattern on the island.

Nesting surveys on Hutchinson Island were initiated in response to concerns that the operation of the St. Lucie Plant might negatively impact the local sea turtle rookery. Previous

analysis, using log-likelihood tests of independence (G-test; Sokal and Rohlf, 1981) demonstrated that the construction of the plant's offshore intake and discharge structures significantly reduced nesting at the plant site during construction years -- 1975, 1981, 1982, 1983 (ABI, 1987). However, nesting at the plant consistently returned to levels similar to or greater than those at a control site in years following construction. During 1991 when offshore construction was restricted almost entirely to daylight hours, nests were more abundant at the plant site than at the control site. Data collected through 1998 have shown that power plant operation exclusive of nighttime intake/discharge construction has had no apparent effect on nesting.

3.3.1. 3 Long-Term Trends in Loggerhead Turtle Nesting

Various methods were used during surveys prior to 1981 to estimate the total number of loggerhead nests on Hutchinson Island based on the number of nests found in the nine 1.25 km-long survey areas (ABI, 1980a). Each of these methods was subsequently found to consistently overestimate island totals (ABI, 1987). Since whole-island surveys began in 1981, it has been possible to determine the actual proportion of total nests deposited in the nine areas. This has allowed extrapolation from the nine survey areas to the entire island for years prior to 1981.

From 1981 through 1993 the total number of nests in the nine areas varied from 32.5 to 35.6 percent of the total number of nests on the island. This is slightly higher than the 31.3 percent, which would be expected, based strictly on the proportion of linear coastline comprised by the nine areas. Using the thirteen-year mean of 33.81 percent, estimates of the total number of nests on Hutchinson Island can be calculated by multiplying the number of nests in the nine areas by 2.958. This technique, when applied to the nine survey areas during the thirteen years in which the entire island was surveyed, produced whole-island estimates within 5.3 percent of the actual number of nests counted. Because the proportion of nests recorded in the nine survey areas remained relatively constant over the last thirteen years, this extrapolation procedure provides a fairly accurate estimate of total loggerhead nesting for years prior to 1981, and is used to generate data points for 1971 through 1979 in Figure 6.

It is clear that loggerhead-nesting activity on Hutchinson Island fluctuates considerably from year to year (Figure 6). Annual variations in nest densities also are common at other rookeries, and may result from non-annual reproductive behavior. Despite high variability, data collected through 1998 suggest an overall increase in nesting on Hutchinson Island since surveys began in 1971. Total nesting activity was greatest during 1995 when 8184 loggerhead nests were recorded. No relationships between total nesting activity and power plant operation or intake/discharge construction were indicated by year-to-year variations in total nesting on Hutchinson Island.

3.3.1.4 Seasonal Patterns of Loggerhead Turtle Nesting

The loggerhead turtle nesting season usually begins between mid-April and early May, attains a maximum during June or July, and ends by mid-September (ABI, 1987). Nesting activity during 1998 followed this same pattern.

Cool water intrusions frequently occur over the continental shelf of southeast Florida

during the summer (Smith, 1982). These intrusions may have been responsible for the temporary declines in loggerhead turtle nesting activity previously observed on Hutchinson Island (ABI, 1994). Though natural fluctuations in temperature have been shown to affect temporal nesting patterns on Hutchinson Island, there has been no indication that power plant operation has affected these temporal patterns (ABI, 1988).

3.3.1.5 Predation on Loggerhead Turtle Nests

Since nest surveys began in 1971, raccoon predation has been a major cause of turtle nest destruction on Hutchinson Island. Researchers at other locations have reported raccoon predation levels as high as 70 to nearly 100 percent (Hopkins et al., 1979). Raccoon predation of loggerhead turtle nests on Hutchinson Island has not approached this level during any study year, though levels for individual 1.25 km-long areas have been as high as 80 percent. Overall predation rates for survey years 1971 through 1977 were between 21 and 44 percent, with a high of 44 percent recorded in 1973. A pronounced decrease in raccoon predation occurred after 1977 and overall predation rates for the nine areas have not exceeded 10 percent since 1979. A decline in predation rates on Hutchinson Island may be attributable to trapping programs, construction activities, habitat loss, and disease.

During 1998, raccoon predation levels were extremely low, with only one loggerhead nest in areas A-S depredated by raccoons (Figure 7). In previous years (ABI, 1994), predation of turtle nests was primarily restricted to the more undeveloped portions of the island.

Ghost crabs have been reported by numerous researchers as important predators of sea turtle nests (Hopkins etal, 1979; Stancyk, 1982). Though turtle nests on Hutchinson Island probably have been depredated by ghost crabs since nesting surveys began in 1971, quantification of ghost crab predation did not begin until 1983.

Overall predation rates by ghost crabs have varied from 0.1 to 2.1 percent from 1983-1998. During 1998, three loggerhead nest in areas A-S were depredated by ghost crabs (Figure 7). Nests destroyed by a combination of raccoon and ghost crab predation have been included as raccoon predations in previous discussions. When these combination predations are included as crab predations, the overall predation rates by ghost crabs range from 0.1 to 4.7 percent. During 1998, no such combination predations were recorded.

3.3.1.6 1998 Green and Leatherback Nesting Summary

In 1998, 258 green turtle and 77 leatherback turtle nests were recorded in the 36 one-km segments comprising Hutchinson Island. The green turtle total represents a new record for Hutchinson Island green turtle nesting and a substantial increase from last year's totals. 1998 was also a record year for leatherback turtle nesting on Hutchinson Island (Figures 8 and 9). Although strong year to year fluctuations are common, the general trend since 1971 may reflect an increase in the numbers of nesting females in the Hutchinson Island area.

3.3.1.7 Trends in Green and Leatherback Turtle Nesting

Green and leatherback turtles nest on Hutchinson Island, but in fewer numbers than loggerhead turtles. Prior to 1981, both survey (nine 1.25 km-long sections) and inter-survey areas were monitored for the presence of green and leatherback nests. Thirty-one kilometers of beach from Area 1 south to the St. Lucie Inlet were included in that effort. During whole-island surveys from 1981 through 1993, only 2.6 percent (7) of the leatherback nests (n=266) and only 1.4 percent (12) of the green turtle nests (n=831) were recorded on the five kilometers of beach north of Area 1. Therefore, previous counts of green and leatherback nests within the 31 kilometers surveyed probably were not appreciably different from total densities for the entire island. Based on this assumption, green and leatherback nest densities may be compared among all survey years, except 1980, when less than 15 kilometers of beach were surveyed.

Since surveys began in 1971, the number of nests observed on the island ranged from 5 to 258 for green turtles and from 1 to 77 for leatherbacks (Figures 8 and 9). Temporal nesting patterns for these species differ from the pattern for loggerhead turtles. Green turtles typically nest on Hutchinson Island from mid-June through the first or second week of September. Leatherback turtles usually begin nesting in March or April and continue to nest through early to mid-July. Considerable fluctuations in green turtle nesting on the island have occurred among survey years (Figure 8). This is not unusual since there are drastic year-to-year fluctuations in the numbers of green turtles nesting at other breeding grounds (Carr et al., 1982). Despite these fluctuations, data collected through 1998 suggest an overall increase in nesting since 1971 and may reflect an increase in the number of nesting females in the Hutchinson Island area. During 1998, green turtles nested most frequently along the southern half of the island. This is consistent with results of previous surveys.

Leatherback turtle nest densities have remained low on Hutchinson Island, however, increased nesting during recent years (Figure 9) may reflect an overall increase in the number of nesting females in the Hutchinson Island area.

3.3.2 INTAKE CANAL MONITORING

Entrainment of sea turtles at the St. Lucie Plant has been attributed to the presumed physical attractiveness of the offshore structures housing the intake pipes rather than to plant operating characteristics (ABI, 1980b and 1986). The velocity caps, which are supported above the openings to each intake pipe, eliminate vertical water entrainment and substantially reduce current velocities near the structures by spreading horizontal draw over a wider area. Even when both units are operating at full capacity, turtles must actively swim into the mouth of one of the pipes before they encounter current velocities sufficiently strong to effect entrainment. Consequently, a turtle's entrapment relates primarily to the probability that it will detect and subsequently enter one of the intake structures.

3.3.2.1 1998 Canal Capture Summary

In 1998, 666 sea turtles were captured in the intake canal of the St. Lucie Plant. Captures included 393 loggerheads, 268 green turtles, 1 leatherback, 2 hawksbill, and 2 Kemp's ridley turtles (Table 1).

3.3.2.2 Relative Abundance and Temporal Distribution

Since intake canal monitoring began in May 1976, 3578 loggerhead (including 222 recaptures), 2432 green (including 478 recaptures), 21 leatherback, 33 Kemp's ridleys, and 21 hawksbill capture have taken place at the St. Lucie Plant. Annual catches for all species combined ranged from a low of 33 in 1976 (partial year of plant operation and monitoring) to 933 in 1995.

Except for 1993 through 1997, when the green turtle was the most abundant species in the canal, loggerheads have dominated annual captures. Since 1977, the first full year of plant operation, the number of loggerheads captured each year ranged from 62 in 1981 to 393 in 1998 (Figure 10). Numbers have exhibited considerable year-to-year fluctuations with no persistent trends evident, although recent year's data are suggestive of a possible increasing trend.

The number of green turtles captured each year since 1977 have ranged from 3 in 1979 to a record high of 673 in 1995 (Figure 10). Increasing numbers of captures over recent years may reflect an increase in the number of turtles inhabiting the nearshore coastal area near the plant or may simply represent statistical variation. Green turtle captures were down sharply in 1997, but showed a modest rebound in 1998. Additional years of capture data will be required before any long-term trends can be established.

During 1998, the monthly catch of loggerheads ranged from 10 (November) to 60 (March), with a monthly mean of 32.7 (Table 2). Over the entire history of the capture program, monthly catches have ranged from 0 to 87, with the greatest number of captures occurring during July 1996.

During 1998, the monthly catch of green turtles ranged from 7 (July) to 58 (February), with a monthly mean of 23.3 (Table 3). The March 1996 catch of 147 green turtles is the largest number of captures for this species for any month on record. Seasonal abundance patterns of

green turtles have typically been much more pronounced than for loggerheads, with over 50 percent of all captures occurring between January and March. In 1995 through 1998, however, no such seasonal pattern was evident, with captures distributed more or less evenly throughout the year.

Catches of leatherbacks, hawksbills, and Kemp's ridleys have been infrequent and scattered throughout the years. Each species has shown rather pronounced seasonal occurrences; over 60 percent of all leatherbacks were captured in March and April, over 60 percent of the hawksbills were captured between July and September, and almost 90 percent of the Kemp's ridleys were caught between December and April.

3.3.2.3 Size-Class Distributions

The size-class distribution for loggerheads removed from the intake canal in 1998 is presented in Figure 11. The size class distribution for green turtles removed from the intake canal in 1998 are presented in Figure 12. ABI (1994) presents size-class data for turtles removed from the intake canal from 1976-1993. The leatherback captured in 1998 was an adult, with a straight-line carapace length (SLCL) of over 121 cm (Hirth, 1980). Both hawksbills captured in 1998 were adults (SLCL > 63cm) (Witzell, 1983). Both Kemp's ridleys captured in 1998 were juveniles SLCL < 60cm) (Hirth, 1980).

3.3.2.4 Sex Ratios

Of the 390 loggerheads captured in 1998 for which straight line carapace lengths are available, 276 were juveniles with a straight line carapace length (SLCL) less than or equal to 70 cm, 81 were adults (SLCL > 85 cm) and 33 were transitional (SLCL 71-85 cm) (Hirth, 1980). The latter group probably includes both mature and immature individuals. Of the 81 individuals classified as adults for whom sex was recorded, 76 were females and five were males, with females predominating by a ratio of 15:1.

Of the 267 green turtles captured in 1998 for which straight line carapace lengths are available, 263 were juveniles or sub-adults (SLCL < 83 cm) (Whitherington and Ehrhart, 1989). Of the 4 adult green turtles captured in 1998, 2 were males and 2 were females. ABI (1994) discusses sex ratio data for previous years.

3.3.2.5 Capture Efficiencies

Netting methodologies have been under continual review and refinement as net materials, configurations, and placement be varied in an effort to minimize sea turtle entrapment times. Additionally, alternative capture techniques have been evaluated, and potential deterrent systems tested in the laboratory. Current capture procedures have proven to provide a safe, efficient, and cost-effective program for removing entrapped turtles from the intake canal.

Formal daily inspections of the intake canal are conducted every day that capture nets are deployed, and the number, location and relative size of entrapped turtles are recorded on field observation forms. Better utilization of currents and eddies, adjustments to tethering lines, multi-

net deployments and increased efforts to hand capture turtles have contributed to reduced entrapment times during recent years.

Entrapment times may be extended for turtles swimming past the A1A barrier net (ABI, 1987). Because capture efforts west of the A1A bridge were generally less effective than those near the intake headwalls, most turtles breaching the barrier net were not caught until they entered the intake wells of Units 1 and 2. Because of their relatively small sizes, virtually all the turtles reaching the intake wells are green turtles. During 1998, 5 of the 268 green turtle captures (1.8 percent) occurred at the intake wells. The substantial decrease in the percentage of captures at the plant intake wells compared to the 1995 figure of 14.5 percent is attributed to the effectiveness of the new small mesh barrier net installed east of AIA in January 1996.

During 1998, 99.1 percent of all turtles entrapped in the canal were captured east of the A1A Bridge, 547 by tangle nets and 119 by hand or dip net capture. The effective confinement of turtles east of A1A has been a major contributor to the high capture efficiency achieved during recent years. The installation of an improved barrier net completed in January 1996 has further increased capture efficiency by more effectively confining turtles of all sizes to a smaller area east to the A1A barrier net.

3.3.2.6 Barrier Net Maintenance

Barrier net maintenance is critical in reducing the opportunity for mortalities in the plant intake well area and in reducing residence times for turtles in the intake canal system. Daily inspections are performed from a small boat to remove floating debris and to repair holes near or at the water surface. When underwater visibility conditions permit, a weekly underwater inspection is conducted. A formal inspection is conducted monthly, including hole repair, debris removal, and airlift dredging of accumulated silt if needed. Maintenance conducted in 1998 included the repair of any holes in the mesh discovered during the daily, weekly and monthly inspections and extensive debris removal and airlift dredging of accumulated sediment conducted in November. In September, October, and November 1998, large influxes of jellyfish into the intake canal required the primary barrier net to be lowered periodically, sometimes for days at a time, to prevent the net from failing under the weight of accumulated jellyfish. The lowering mechanism functioned as designed and no damage was sustained.

3.3.2.7 Relative Condition

Turtles captured alive in the intake canal of the St. Lucie Plant were assigned a relative condition based on weight, activity, parasite infestation, barnacle coverage, wounds, injuries and any other abnormalities which might have affected overall vitality. During 1998, 95.2% percent (373) of all loggerheads found in the canal were alive and in good condition. Only 4.8 percent (19) loggerhead captures involved individuals in fair or poor condition, and one was dead. Of the 268 green turtles removed from the intake canal during 1998, 254 (94.8 percent) were in good condition, 14 (5.2 percent) were in fair or poor condition, and none were dead. The 2 hawksbills, 2 Kemp's ridleys, and the leatherback captured in 1998 were all in good condition.

Relative condition ratings can be influenced by a number of factors, some related and others unrelated to entrainment and/or entrapment in the intake canal. A rating of good indicates that turtles have not been negatively impacted by their entrapment in the canal, at least as evidenced by physical appearance. Although ratings of fair or poor imply reduced vitality, the extent to which entrainment and entrapment is responsible is often indeterminable. In some instances, conditions responsible for lower ratings, such as boat collision or fisheries gear entanglement injuries obviously were sustained prior to entrainment.

During 1998, 71 of the 666 turtles captured (10.7 percent) had notable injuries such as missing appendages, broken or missing pieces of carapace, or deep lacerations. Many of these were old, well-healed wounds, and did not require veterinary attention.

Of the 665 live removals during 1998, 652 were released into the ocean the day of capture. Nine turtles (all loggerheads) in obvious ill health or suffering serious injuries were transported to Sea World of Florida or the Marinelife Center of Juno Beach for treatment and rehabilitation. Two had serious carapace damage, presumably from a boat collision, one had ingested monofilament fishing line, and six were weak, lethargic, and emaciated when captured. Fifteen green turtles with fibropapilloma tumors were removed from the canal in 1998. Three turtles with extensive tumors were transferred to the Florida DEP for transportation to a rehabilitation facility. Twelve turtles with minor tumors were tagged and released. One green turtle was held overnight for installation of a satellite-tracking transmitter and was later released.

3.3.2.8 Mortalities

Sea turtle mortalities have been closely monitored throughout the life of the canal capture program in an attempt to assign probable causes and take appropriate remedial action to minimize future occurrences. Previous analyses of capture data identified drowning in nets (A1A barrier net, UIDS barrier, and tangle nets), drowning in the intake pipes during periods of reduced intake flow, injuries sustained from dredging operations, and injuries sustained from the mechanical rakes used in the intake wells as probable mortality factors (ABI, 1987) (FPL, 1995). Although difficult to quantify, the entrapment and subsequent demise of injured or sick turtles has probably accounted for a portion of observed mortalities.

Over the entire monitoring program history, 135 (3.8 percent) of the 3578 loggerheads and 52 (2.1 percent) of the 2432 green turtles entrapped in the canal were found dead. Mortalities spanned the range of size classes for loggerheads (SLCL = 47.5-103 cm), while all green turtle mortalities involved juveniles less than 42 cm in length. The four Kemp's ridley mortalities documented at the plant during 1987 and 1988 were the only deaths for this species to date; no dead leatherback or hawksbill turtles have been recovered at the St. Lucie Plant.

Modifications to capture procedures, improvements to barrier nets, and virtual elimination of low flow conditions within the canal have resulted in a substantial reduction in sea turtle mortalities over the life of the canal capture program. Mortality rate, expressed as the percentage of total captures involving dead animals, declined from 7.8 percent during the period 1976-1984 to 2.1 percent since 1984, and 1.0% since 1990 (Table 1).

In 1998, one turtle (a loggerhead) was removed dead from the intake canal, for an overall mortality rate of 0.15percent. The turtle was found floating up against the A1A barrier net during a period when the primary barrier net was lowered due to a jellyfish influx. The turtle was moderately decomposed, and no cause of death could be determined.

In response to the 1995 mortalities and the dramatic increase in intake canal captures in 1995, consultation was initiated with FPL, NRC, and the NMFS under Section 7 of the Endangered Species Act. As a result of that consultation, FPL has designed and constructed an improved, smaller mesh barrier net located between the A1A barrier net and the intake canal headwalls (Figure 2). Construction of the net was completed in January 1996. This barrier net prevents turtles from reaching the intake wells or UIDS barrier and increases capture efficiency by confining turtles to a smaller area of the intake canal.

3.3.2.9 Recapture Incidents

Since the St. Lucie Plant capture program began, most turtles removed from the intake canal have been tagged and released into the ocean at various locations along Hutchinson Island. Consequently, individual turtles can be identified as long as they retain their tags. Over the history of the program at the St. Lucie Plant, 700 recaptures (222 loggerheads and 478 green turtles) have occurred, and a number of turtles have been recaptured more than once. The recapture rate for green turtles in 1998 was 37 percent and the recapture rate for loggerheads was only 5.3 percent. The large number of green turtle recaptures probably reflects the saturation of local green turtle populations with turtles tagged at the St. Lucie Plant and possibly indicates a difference in site fidelity between green turtles and loggerheads. Several other turtles with tag scars have also been recovered indicating that the actual number of recaptures may be higher.

3.3.3 SUMMARY

A gradient of increasing loggerhead turtle nest densities from north to south along the northern half of Hutchinson Island has been shown during most survey years. This gradient may result from variations in beach topography, offshore depth contours, distribution of nearshore reefs, onshore artificial lighting, and human activity on the beach at night. Low nesting activity in the vicinity of the power plant during 1975 and from 1981 through 1983 was attributed to nighttime construction activities associated with installation of power plant intake and discharge structures. Nesting returned to normal or above normal levels following both periods of construction. During 1991, daytime construction activities associated with velocity cap repairs had no apparent effect on nesting. Statistical analyses indicate that power plant operation, exclusive of nighttime construction, has had no significant effect on nest densities near the plant. In 1998, 7962 loggerhead turtle nests were recorded on Hutchinson Island. There have been considerable year-to-year fluctuations in loggerhead nesting activity on Hutchinson Island from 1971 through 1998. Fluctuations are common at other rookeries and may result from non-annual reproductive behavior. Despite these fluctuations, loggerhead-nesting activity has remained high during recent years and may reflect an overall increase in the number of nesting females in the Hutchinson Island area. No relationship between total nesting on the island and power plant operation or intake/discharge construction was indicated.

Temporal nesting patterns of the Hutchinson Island population may be influenced by natural, large scale fluctuations in water temperature, such as those produced by the cool water intrusions that frequently occur over the continental shelf of southeast Florida during the nesting season. However, localized fluctuations in water temperature associated with power plant operation have had no apparent effect on nesting.

Since nesting surveys began in 1971, raccoon predation has been one of the major causes of turtle nest destruction on Hutchinson Island. From 1971 through 1977, overall predation rates in the nine survey areas were between 21 and 44 percent. However, a pronounced decrease in raccoon predation occurred after 1977, and overall predation rates in the nine survey areas have not exceeded ten percent since 1979. Decreased predation by raccoons probably reflects a decline in the raccoon population. More years of survey data will be required to determine if the extremely low level of raccoon predation in 1996 through 1998 is an isolated occurrence or part of a continuing trend. Ghost crab predation on the turtle nests may be more significant than previously documented but remains relatively minor compared to raccoon predation.

During 1998, 258 green turtle and 77 leatherback turtle nests were recorded on Hutchinson Island, a record high for both species. Nesting activity by these two species has exhibited considerable annual fluctuations, as has been recorded at other rookeries, but has remained relatively high during recent years. This may reflect an overall increase in the number of nesting green and leatherback turtles in the Hutchinson Island area.

During 1998, 393 loggerheads, 268 green turtles, 2 hawksbills, 2 Kemp's ridleys, and one leatherback were removed from the St. Lucie Plant intake canal. Since monitoring began in May 1976, 3578 loggerhead, 2432 green, 21 leatherback, 21 hawksbill and 33 Kemp's ridley turtles have been captured and tagged. Over the life of the monitoring program, annual catches for loggerhead turtles have ranged from 33 in 1976 (partial year of plant operation and monitoring) to a high of 393 in 1998. Yearly catches of green turtles have ranged from 0 in 1976 to 673 in 1995. Differences in the number of turtles entrapped during different years and months are attributed primarily to natural variation in the occurrence of turtles in the vicinity of the offshore intake structures, rather than to plant operation characteristics.

Size-class distributions of loggerhead turtles removed each year from the canal have consistently been dominated by juveniles between 50 and 70 cm in straight-line carapace length. Over 75 percent of all green turtles entrapped in the canal were juveniles 40 cm or less in length. For both species, the largest number of captures for all years combined occurred during winter, but, with the exception of 1995, and to lesser extent 1996, these seasonal peaks were much more pronounced for green turtles. The sex ratio of loggerheads caught in the canal continued to be biased towards females.

During 1998, about 95 percent of all loggerheads and green turtles removed from the canal were categorized by physical appearance as being in good condition.

About 10 percent of the turtles removed from the intake canal during 1998 had substantial injuries, and the vast majority of those were well healed and apparently sustained prior to entrapment. Once in the canal, turtles confined east of A1A had very brief residency times. Thus

the relative condition of most turtles was not affected by their entrapment.

During 1998, only one mortality was recorded in the intake canal. Program modifications, including continual surveillance of tangle nets during periods of deployment, improvements to the integrity of the barrier net system, and greater effort to hand capture turtles have contributed to a substantial decline in sea turtle mortalities during recent years. The design and construction of an improved barrier net completed in January 1996 was expected to reduce mortalities and entrapment times for turtles in the intake canal. Data since then indicate that the new barrier net configuration has been highly effective in excluding turtles from the plant intake wells, but has not been as effective in reducing the overall mortality rate as anticipated, although the 1998 mortality rate of 0.15%, the lowest mortality rate in the program's history, was an outstanding achievement and a hopeful sign for the future.

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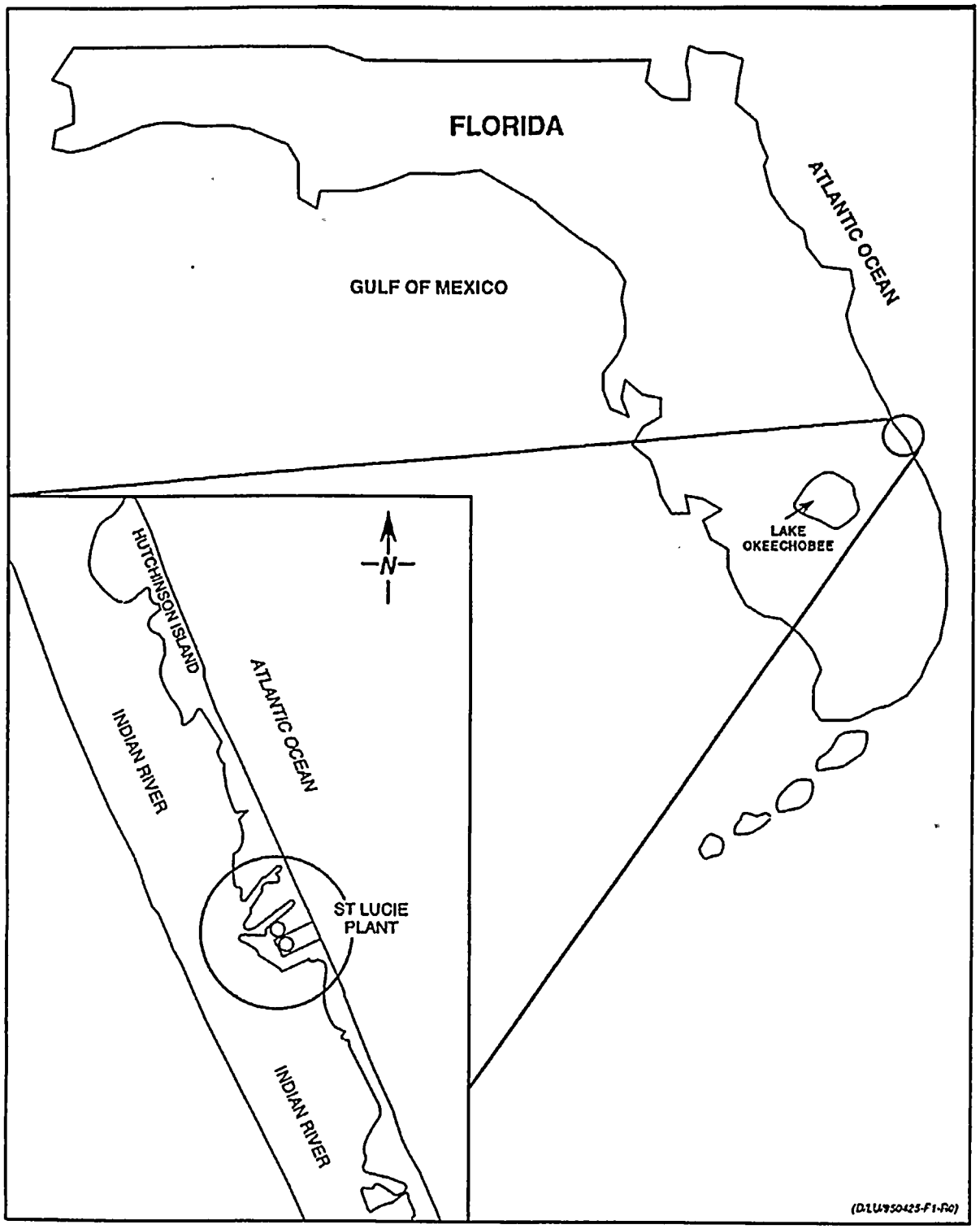

Figure 1. Location of St. Lucie Plant

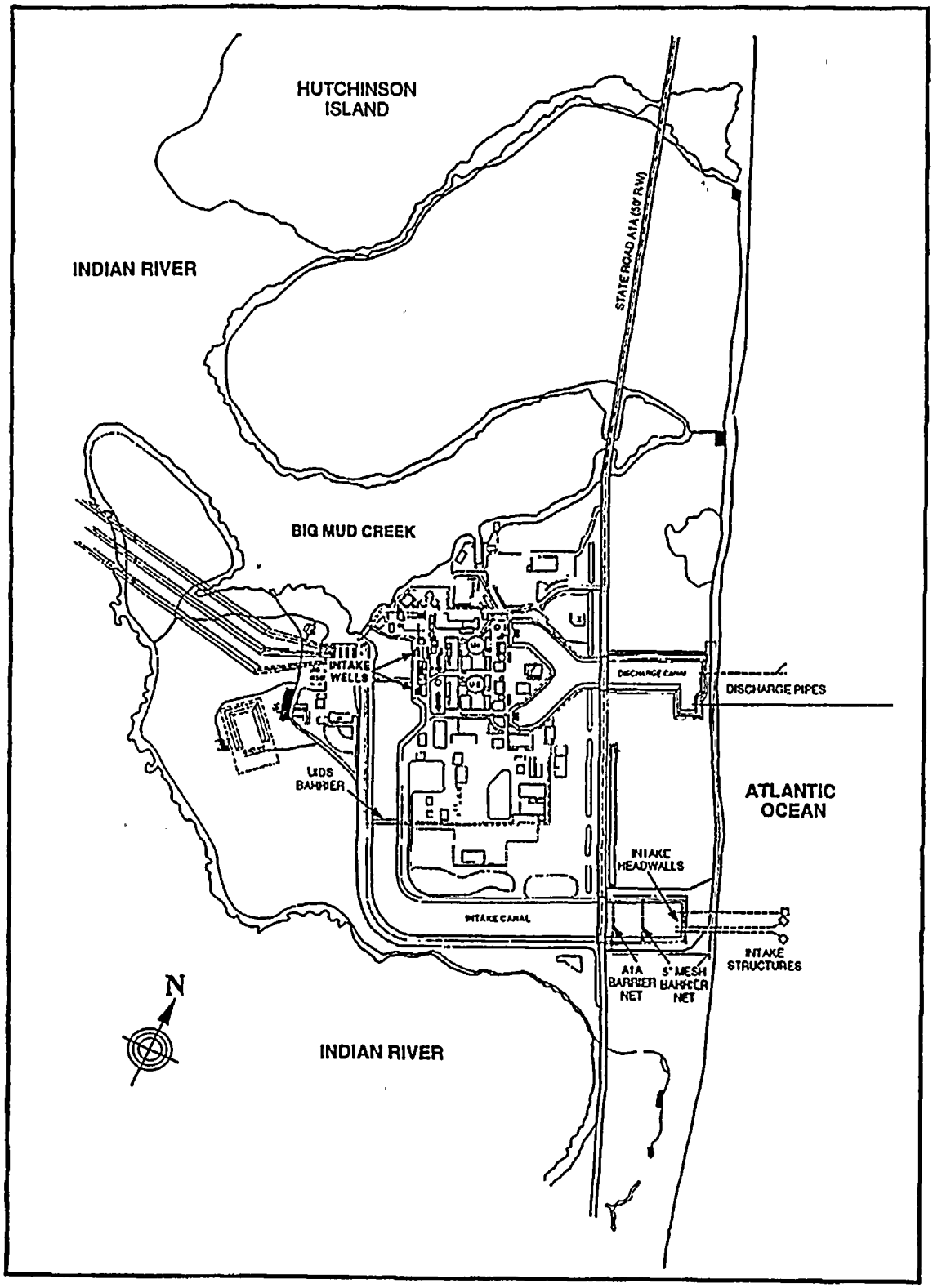

Figure 2. St. Lucie Plant Cooling Water Intake and Discharge System

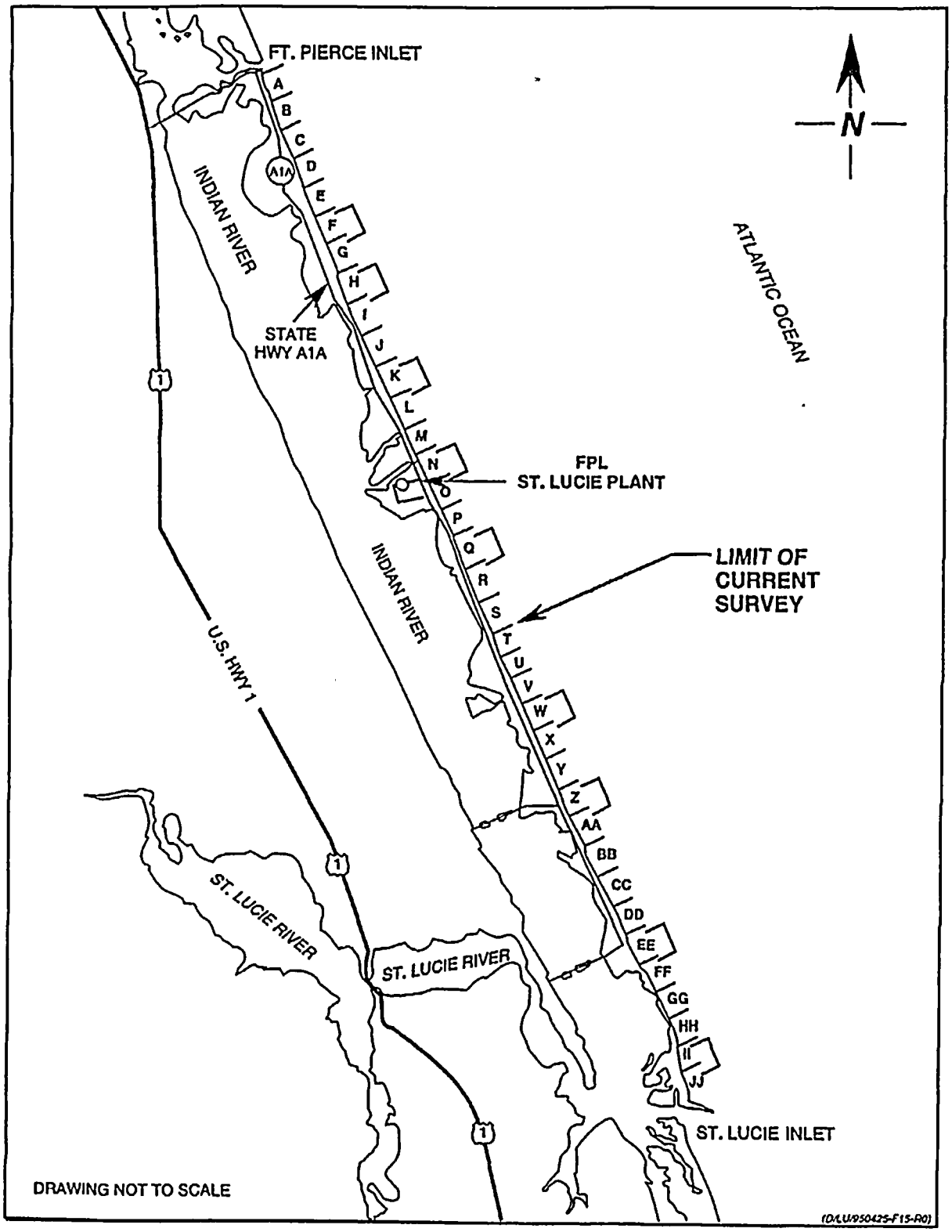

Figure 3. Designation and Location of Nine 1.25-Km Segments and Thirty-Six 1-Km Segments Surveyed for Sea Turtle Nesting, Hutchinson Island. 1971-1998.

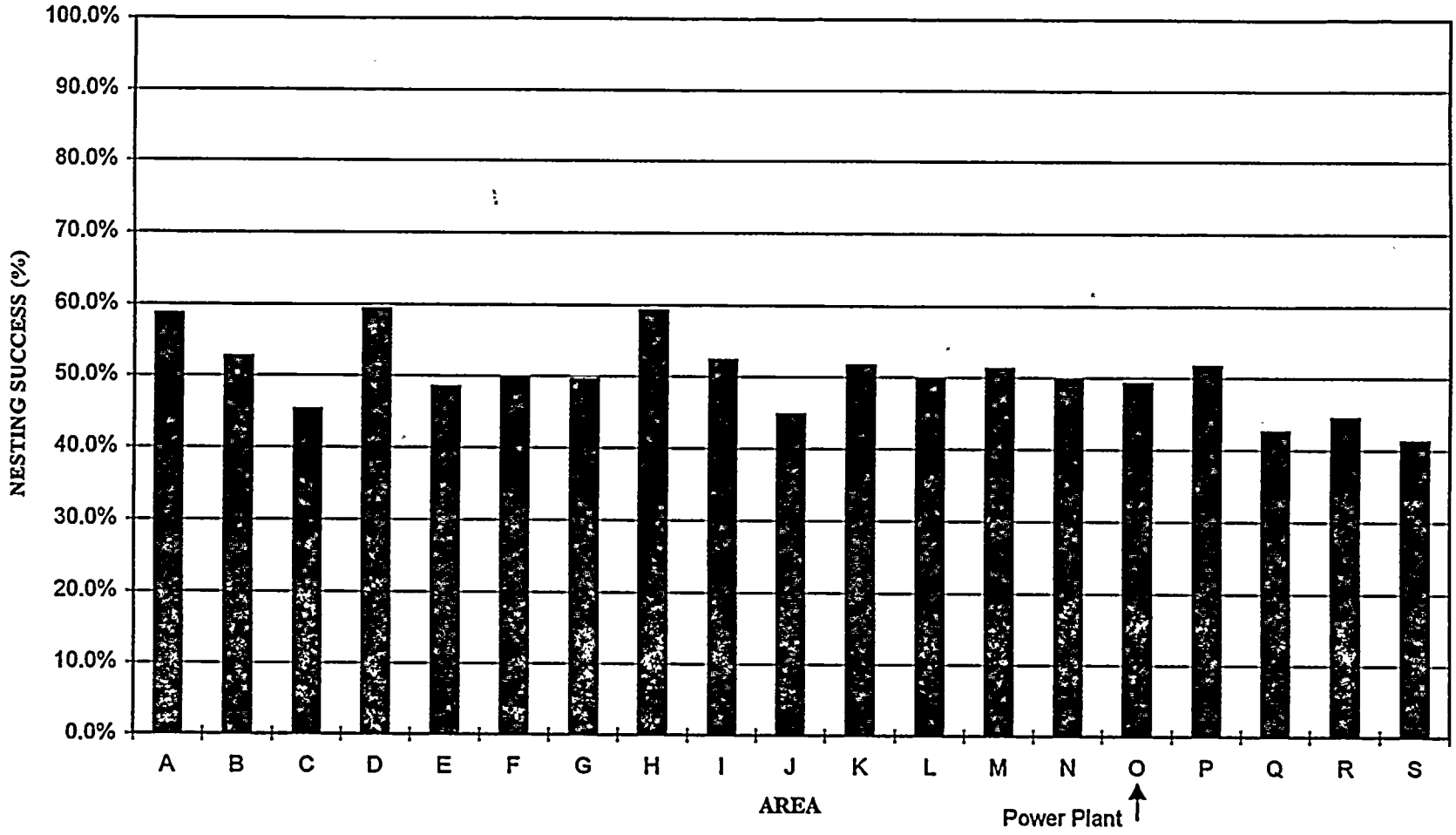

Figure 4. Number of Loggerhead Turtles Nests and Emergences for Areas A Through S, Hutchinson Island, April Through September 1998.

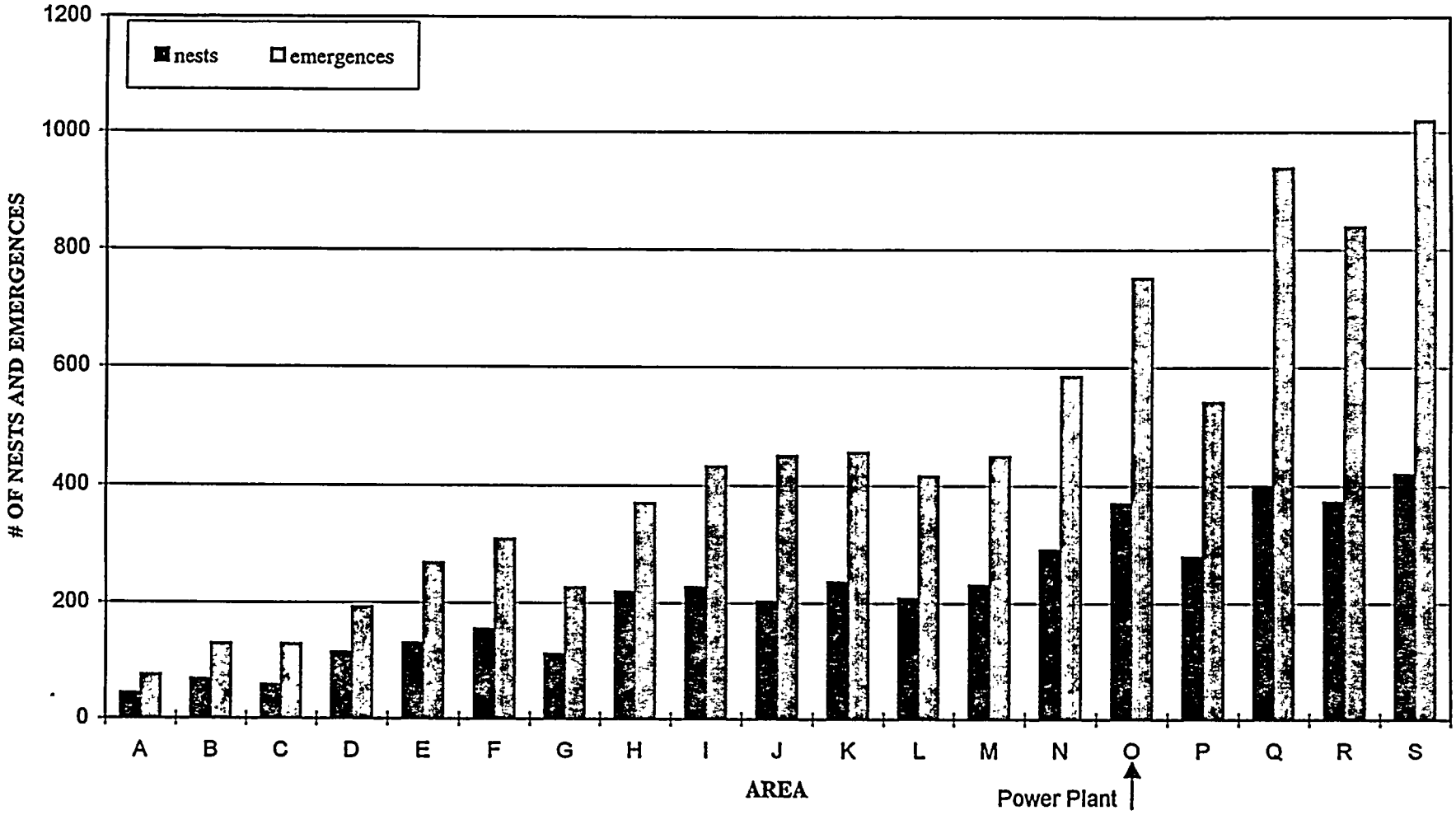

Figure 5. Loggerhead Turtle Nesting Success (Percentage of Emergences Resulting in Nests) for Areas A Through S, Hutchinson Island, April Through September 1998.

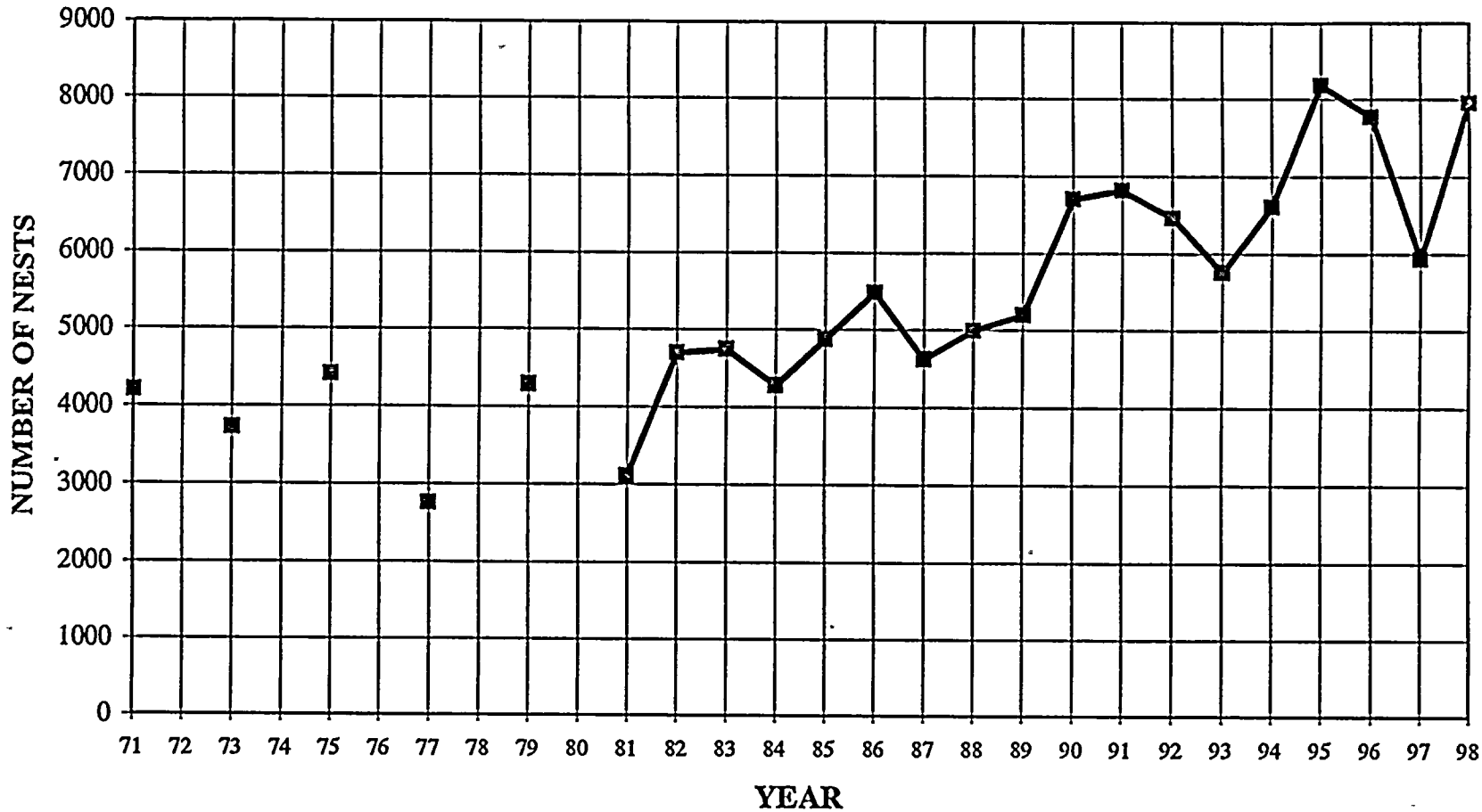

Figure 6. Number of Loggerhead Turtle Nests, Hutchinson Island 1971 Through 1998. Values for 1971 Through 1979 Are Estimates (See Text); Values for 1981 Through 1998 Are From Whole Island Surveys.

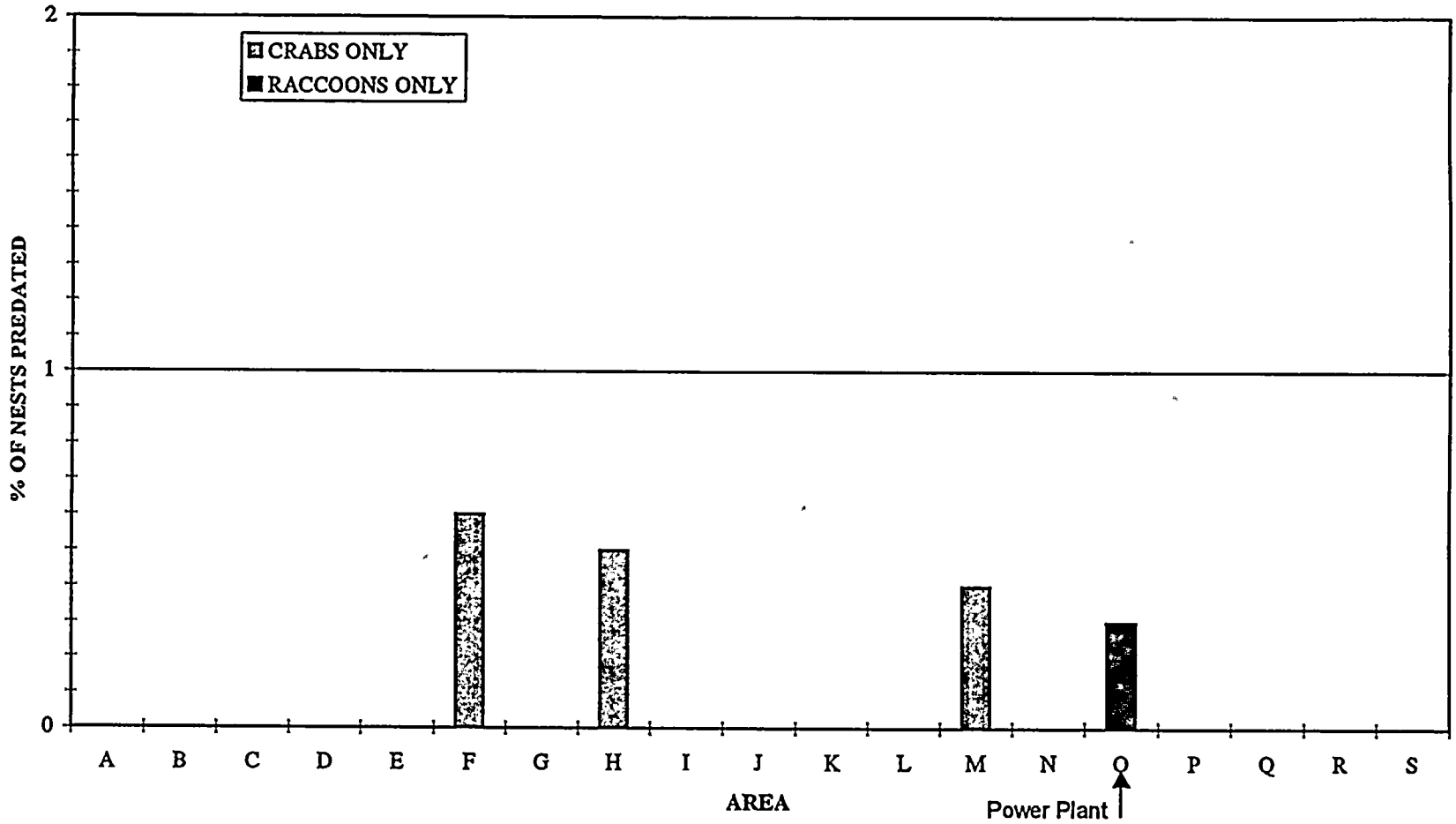

Figure 7. Percentage of Loggerhead Turtle Nests Predated by Raccoons and/or Ghost Crabs in Areas A Through S, Hutchinson Island, April Through September 1998.

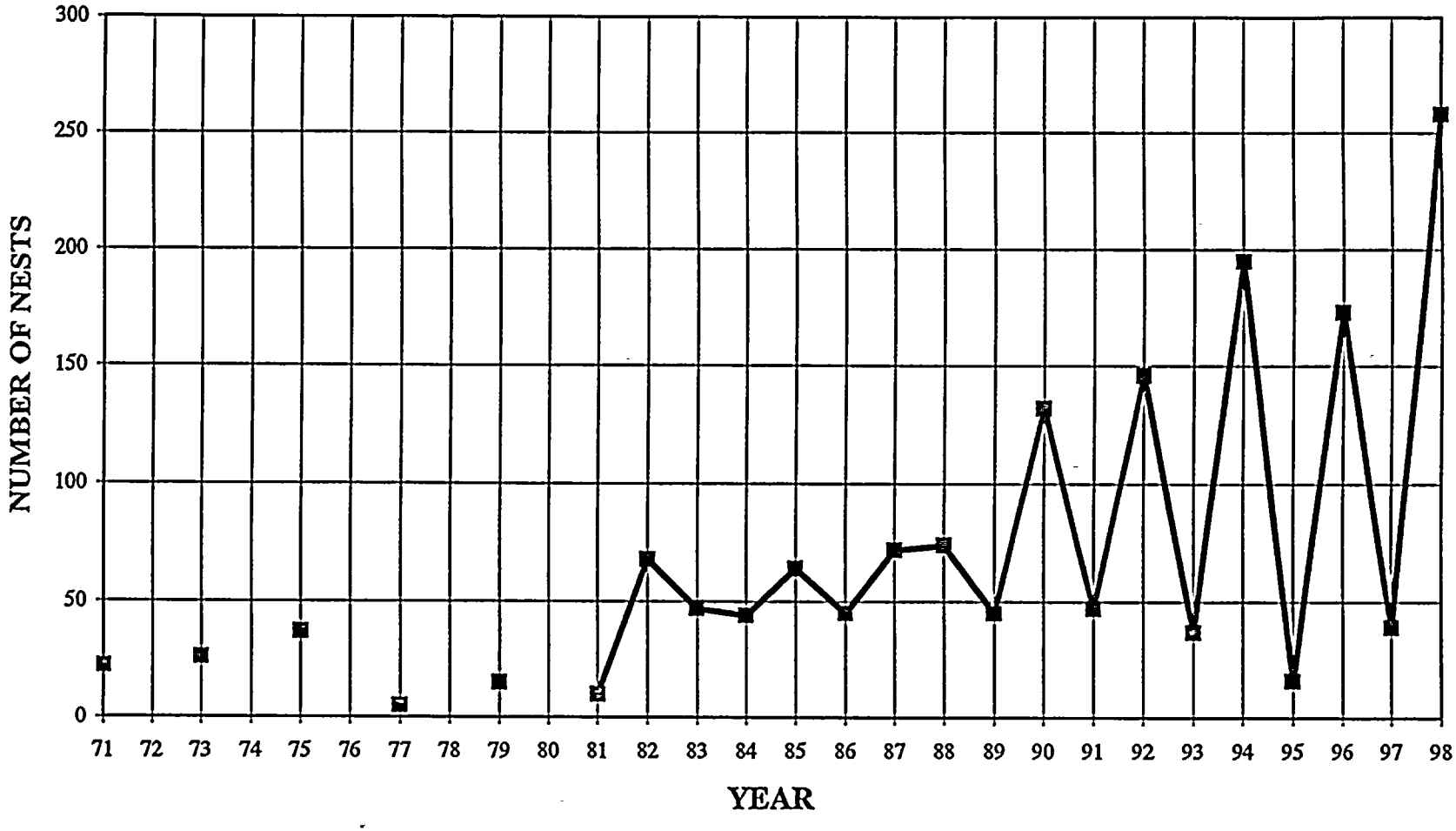

Figure 8. Number of Green Sea Turtle Nests, Hutchinson Island, 1971 Through 1998. Values for 1971 Through 1979 Are Estimates (See Text). Values for 1981 Through 1998 Are from Whole Island Surveys.

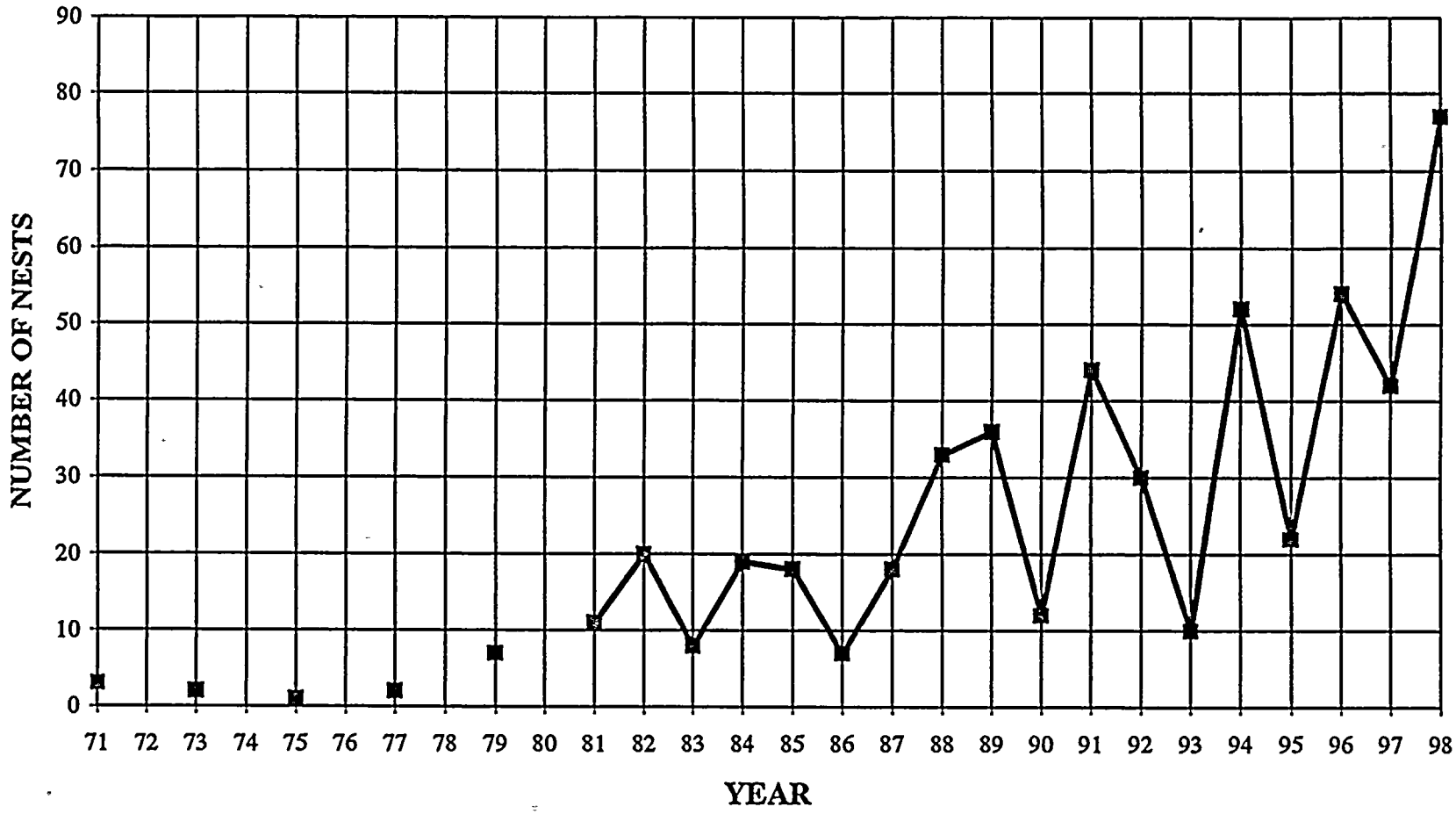

Figure 9. Number of Leatherback Turtle Nests, Hutchinson Island, 1971 Through 1998. Values for 1971 Through 1979 Are Estimates (See Text). Values for 1981 Through 1998 Are from Whole Island Surveys.

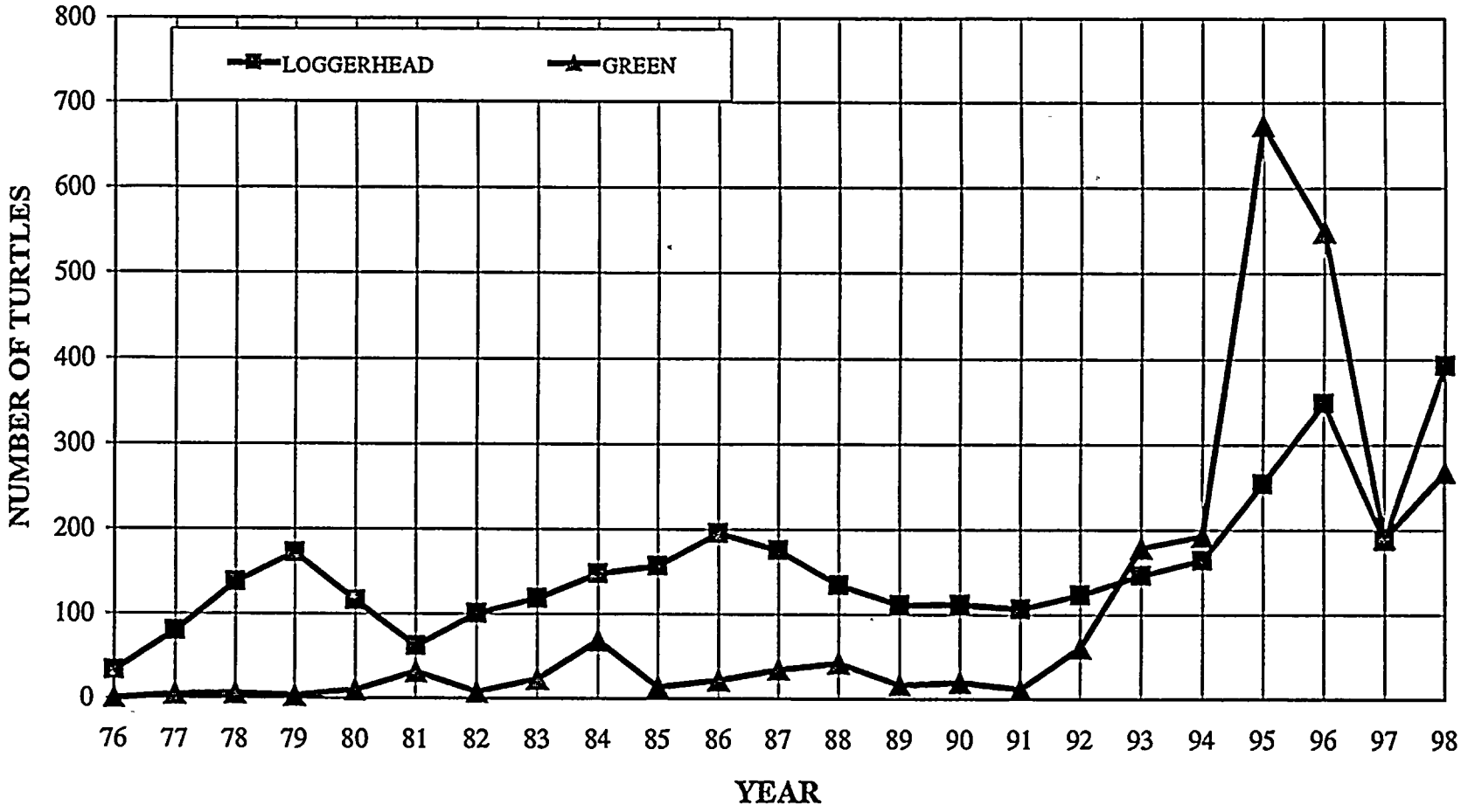

Figure 10. Number of Loggerhead and Green Turtles Removed Each Year from the Intake Canal, St. Lucie Plant, 1976 Through 1998.

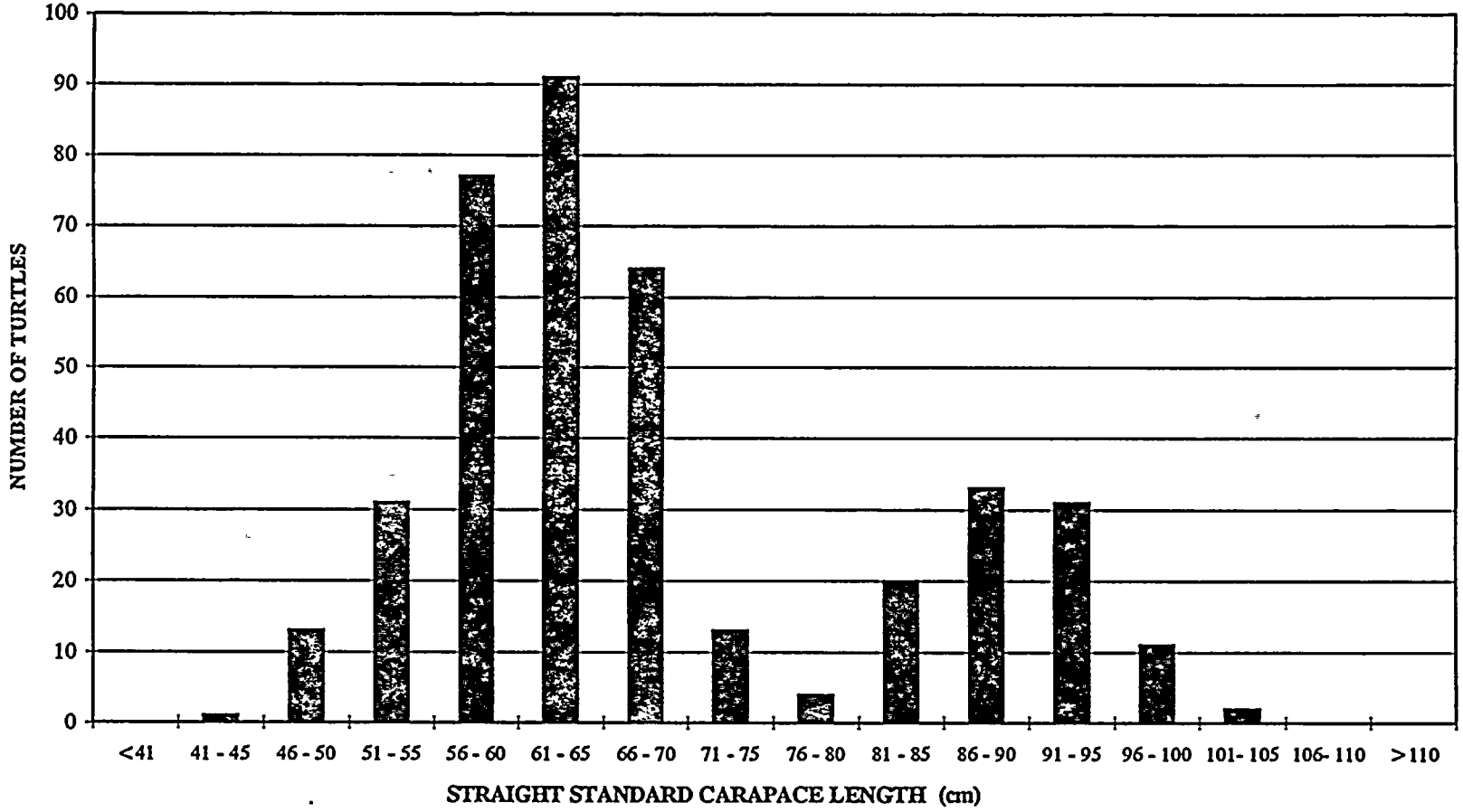

Figure 11. Size Distribution (SSCL) of Loggerhead Turtles (N=391) Removed from the Intake Canal, St. Lucie Plant, 1998.

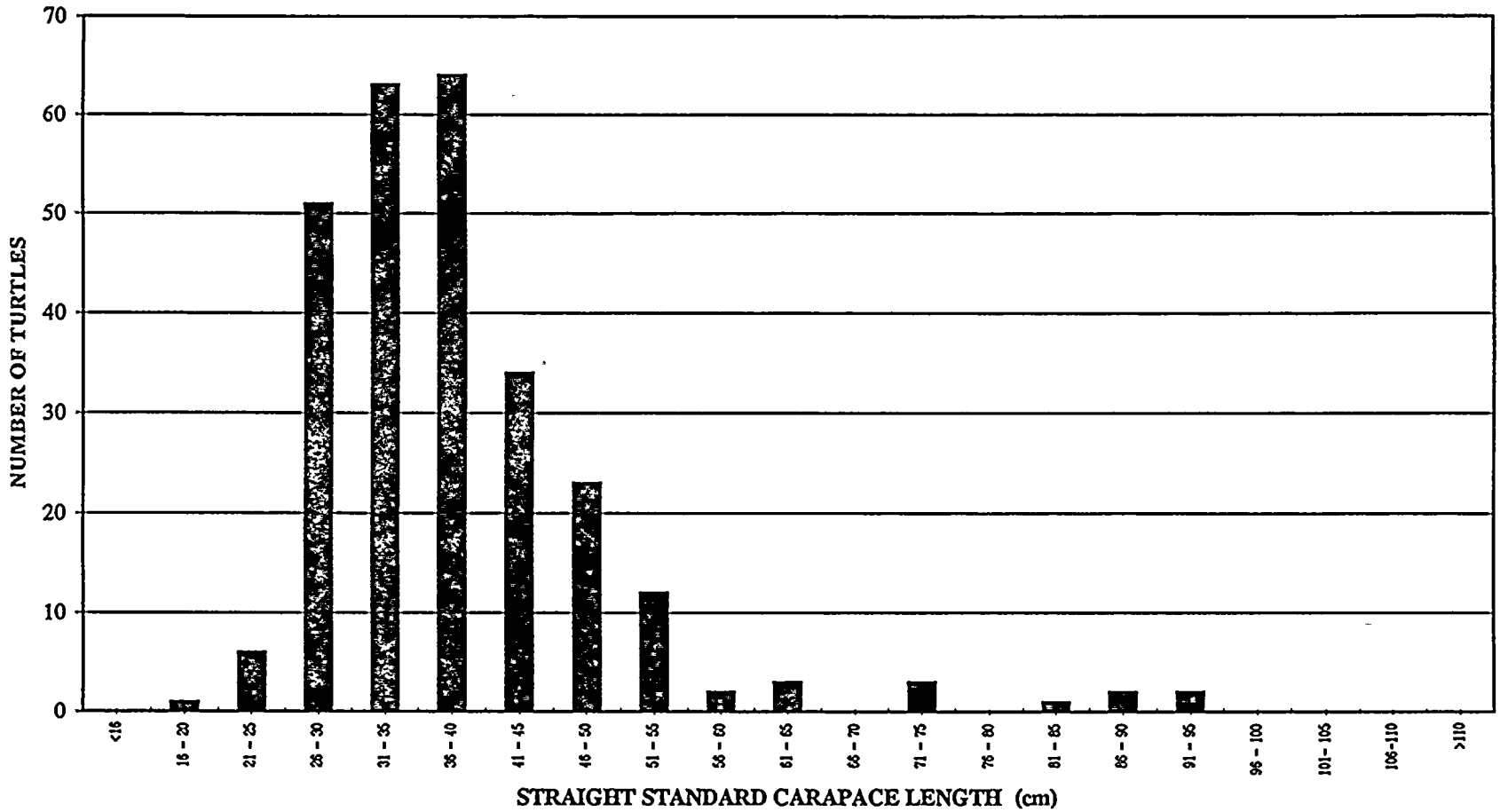

Figure 12. Size Distribution (SSCL) of Green Turtles (N=267) Removed from the Intake Canal, St. Lucie Plant, 1998.

YEAR	Loggerhead	Green	Leatherback	Hawksbill	Kemp's Ridley	Total
			Species			
1976	33 (4)					33 (4)
1977	80 (5)	5 (2)	1			86 (7)
1978	138 (19)	6 (1)	3	1		148 (20)
1979	172 (13)	3 (1)				175 (14)
1980	116 (5)	10 (3)				126 (8)
1981	62 (5)	32 (2)	2		1	97 (7)
1982	101 (16)	8	1			110 (16)
1983	119 (4)	23 (4)				142 (8)
1984	148 (3)	69 (2)		1	2	220 (5)
1985	157 (4)	14		1		172 (4)
1986	195 (27)	22 (1)	1	1	1	220 (28)
1987	175 (11)	35		2	6 (2)	218 (13)
1988	134 (6)	42 (2)			5 (2)	181 (10)
1989	111 (4)	17 (1)	1	2	2	133 (5)
1990	112 (1)	20 (2)				132 (3)
1991	107 (1)	12		1	1	121 (1)
1992	123 (2)	61 (2)	1	2		187 (4)
1993	147	179 (1)	5	2	4	337 (1)
1994	164	193 (4)	2		2	361 (4)
1995	254 (1)	673 (15)	1		5	933 (16)
1996	349 (3)	549 (4)		5	3	906 (7)
1997	188	191 (5)	2	1		382 (5)
1998	393 (1)	268	1	2	2	666 (1)
Total	3578 (135)	2432 (52)	21	21	34 (4)	5420 (191)
Annual Mean*	162.6	110.5	1.0	1.0	1.5	275.1

* Excludes 1976 (partial year of plant operation).

Table 1. Total Number of Captures and (Number of Dead) Turtles Removed from the Intake Canal

Month	Number of Captures	Percent of All Captures	Minimum	Maximum	Mean	Standard Deviation	1998
January	421	11.9%	6	39	19.1	10.2	36
February	335	9.4%	5	34	15.2	8.4	28
March	354	10.0%	1	60	16.1	14.7	60
April	364	10.3%	0	47	16.5	12.7	47
May	304	8.6%	0	40	13.8	10.4	29
June	364	10.3%	3	42	16.5	11.1	26
July	405	11.4%	0	87	18.4	20.1	57
August	324	9.1%	2	43	14.7	12.2	43
September	194	5.5%	1	19	8.8	5.2	17
October	193	5.4%	0	27	8.8	6.3	27
November	125	3.5%	0	15	5.7	3.9	10
December	162	4.6%	1	13	7.4	4.1	13
Total	3545		0	87			393
Mean					13.4		32.8
Std. Deviation					4.6		16.3

* First full year of plant operation. An additional 33 loggerheads were captured during 1976.

Table 2. Total Number of Loggerhead Turtles Removed Each Month from Intake Canal, St. Lucie Plant, 1977 – 1998.

Month	Number of Captures	Percent of All Captures	Minimum	Maximum	Mean	Standard Deviation	1998
January	284	11.7%	0	59	12.9	15.5	25
February	289	11.9%	0	64	13.1	18.3	58
March	370	15.2%	0	147	16.8	35.6	30
April	210	8.6%	0	64	9.5	17.3	20
May	180	7.4%	0	91	8.2	20.2	35
June	137	5.6%	0	52	6.2	12.6	16
July	125	5.1%	0	61	5.7	14.1	7
August	151	6.2%	0	64	6.9	15.2	23
September	148	6.1%	0	77	6.7	17.8	10
October	198	8.1%	0	54	9.0	15.4	25
November	150	6.2%	0	42	6.8	10.8	10
December	190	7.8%	0	68	8.6	15.8	9
Total	2432		0	147			268
Mean					9.2		22.3
Std. Deviation					3.4		14.4

* First full year of plant operation.

Table 3. Total Number of Green Turtles Removed Each Month from the Intake Canal, St. Lucie Plant, 1977-1998.

ANNUAL ENVIRONMENTAL OPERATING REPORT

PART II

1.0 INTRODUCTION

The St. Lucie Unit 2 Environmental Protection Plan (EPP) requires the submittal of an annual report for various activities at the plant site including the reporting on sea turtle monitoring programs and other matters related to Federal and State environmental permits and certifications.

2.0 SEA TURTLE MONITORING AND ASSOCIATED ACTIVITIES

Surveillance and maintenance of the light screen to minimize sea turtle disorientation as required by Section 4.2.4 of the EPP is ongoing. The vegetation light screen located on the beach dune between the power plant and the ocean is routinely surveyed to determine its overall vitality. The vegetation line is surveyed for any gaps occurring from mortality, which would result in unacceptable light levels on the beach. Trees, vegetation, or shade cloths are replaced as necessary to maintain the overall integrity of the light screen. Plant parking lot lighting is also designed and maintained to minimize light levels on the beach.

3.0 TAPROGGE CONDENSER TUBE CLEANING SYSTEM OPERATION

A Taprogge condenser tube cleaning system (CTCS) became operational on St. Lucie Unit 2 in January 1996 and on Unit 1 in July 1996. This system utilizes sponge balls, approximately 24 mm in diameter, to clean the condenser tubes through which seawater flows to cool steam after its pass through the plant's turbines. This system improves plant performance while reducing the need for chemical treatments such and biocides or chlorine to control biofouling.

Normally, the St. Lucie CTCS utilizes about 1800 sponge balls, which are continually recirculated through each of four "water boxes" on each unit. These sponge balls are retained in the system by a ball strainer located on the outlet of each water box. The ball strainers (mesh size 5 mm) are opened routinely to discharge debris, which can decrease flow and obstruct sponge ball movement through the system. The sponge balls are collected prior to opening, or back flushing, the ball strainers. At that time, the sponge balls are examined and replaced if they are worn to the point that they can no longer effectively clean the condenser tubes.

Sponge ball inventories and estimates of sponge ball loss to the environment have been performed since system start-up on both units. Number of ball strainer back flushes has also been tracked. In addition, daily beach surveys have been performed on plant property (approximately 2.5 miles) to note any sponge balls that may have appeared as a result of loss from the plant. This survey area has been extended during the turtle-nesting season to almost 12 miles.

The results of the program for 1998 are presented in Table 1. Larger sponge ball losses occurred on Unit 2 for the year. These losses are probably related to the fact that 1998 represents the end of fuel cycle for that unit. Estimated sponge ball loss from both units was 20.2 balls per day for 1998. Fifty sponge balls were found whole in the environment near the plant. This is an increase

over previous years, but the number indicates that few balls actually reach the environment whole. Figure 1 indicates that estimated sponge ball loss generally increased through the month of April of 1998. Average daily ball loss in 1998 increased from the 1996 and 1997 totals (Figure 2). It is believed that much of the losses are caused by increased growth inside the waterboxes. New coatings on these surfaces are being used to try to eleviate this problem. These coating were applied to Unit 2 in December 1998. If the coating proves effective it will be applied to Unit 1 in September 1999.

4.0 OTHER ROUTINE REPORTS

The following items for which reporting is required are listed by section number from the plant's Environmental Protection Plan:

5.4.1(a) EPP NONCOMPLIANCES AND CORRECTIVE ACTIONS TAKEN

No noncompliance's under EPP Section 5.4.1(a) were determined to have occurred during 1998.

5.4.1(b) CHANGES IN STATION DESIGN OR OPERATION, TESTS, AND EXPERIMENTS IN ACCORDANCE WITH EPP SUBSECTION 3.1

FPL letter L-98-180 transmitted the request for modification of Wastewater Permit Application to FDEP. The modification includes the use of biocide in the plant closed cooling water systems and the use of dimethylamine and carbohydrazide in the plant steam generator blowdown. This letter was transmitted June 26, 1998.

5.4.1(c) NONROUTINE REPORTS SUBMITTED TO THE NRC FOR THE YEAR 1998 IN ACCORDANCE WITH EPP SUBSECTION 5.4.2

1. Report concerning the mortality Least Terns at the plant Nuclear Training Center July 6, 1998 and July 17, 1998. Deaths occurred in the building's drainage system during heavy rainfall. Events were reported to NRC by FPL letter L-98-196 on July 23, 1998.

2. Report concerning an increase of jellyfish and subsequent effect of plant operation on September 9, 1998; reported to the NRC by FPL letter L-98-250 on October 1, 1998.

TABLE 1

1998 ST. LUCIE PLANT CONDENSER TUBE CLEANING

SYSTEM SUMMARY

MONTH	STRAINER BACK FLUSHES		ESTIMATED BALL LOSS		BALLS FOUND ON THE BEACH
	UNIT 1	UNIT 2	UNIT 1	UNIT 2	
January	5*	10	26	169	13
February	7	22	+26***	86	11
March	8	22	254	276	1
April	8	25	241	852	3
May	0^	29	242	580	3
June	2	24	+22***	448	3
July	33	23	130	586	1
August	29	27	66	744	8
September	25	20	114	483	3
October	31	23	129	228	1
November	24	1**	623	229	1
December	25	8**	76	759	2
Total	197	234	1853	5510	50

^ Due to poor sponge ball recovery, strainers were not back-flushed. Unit was down-powered, waterboxes taken out of service for manual removal of growth and balls.

* Unit 1 system shutdown during refueling, 1/1 to 1/19/98.

** Unit 2 system shutdown during refueling, 11/6 to 12/12/98.

*** Net gain in inventory.

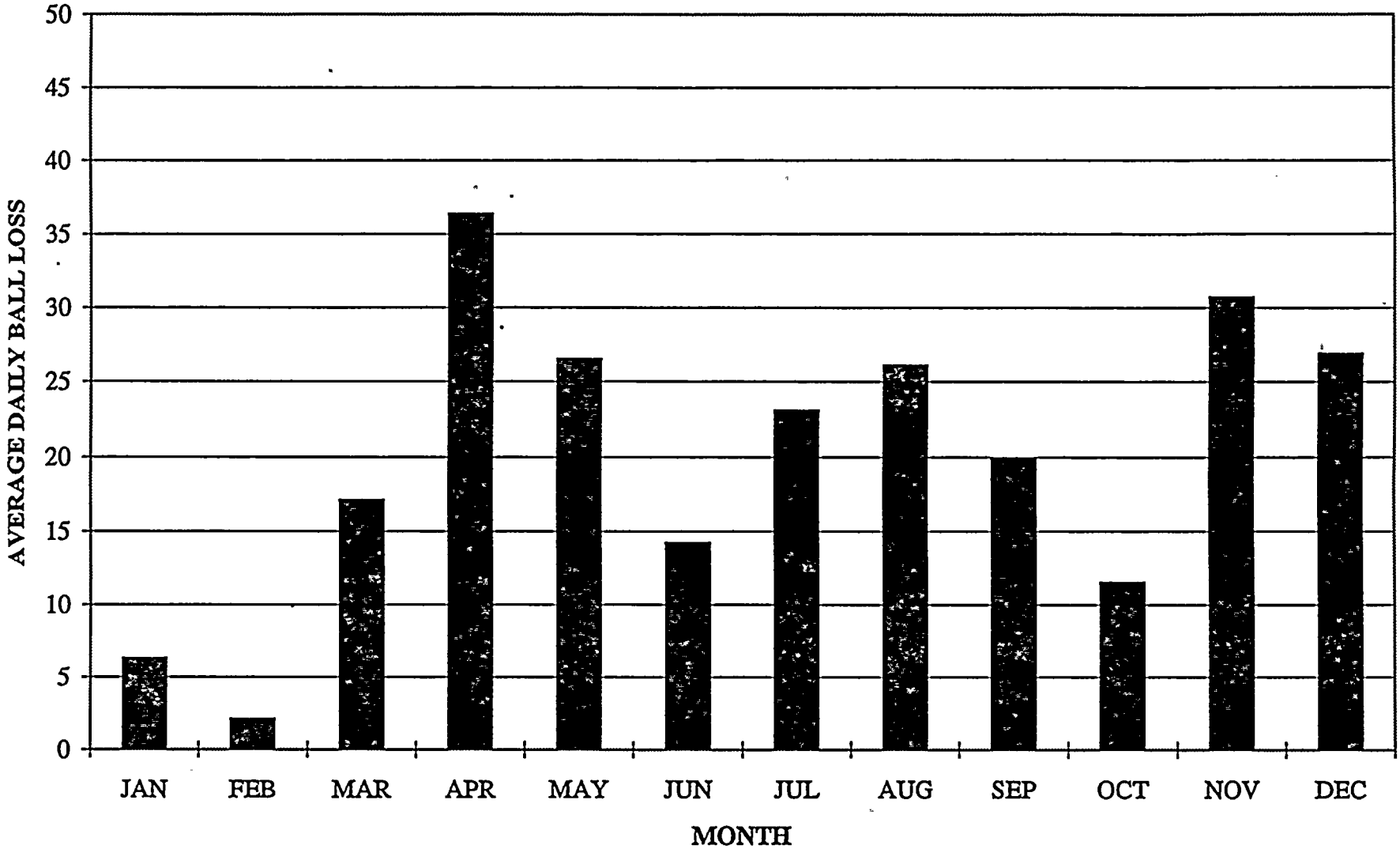

Figure 1. Estimated Average Daily Sponge Ball Loss by Month from St. Lucie Plant (Both Units) for 1998.

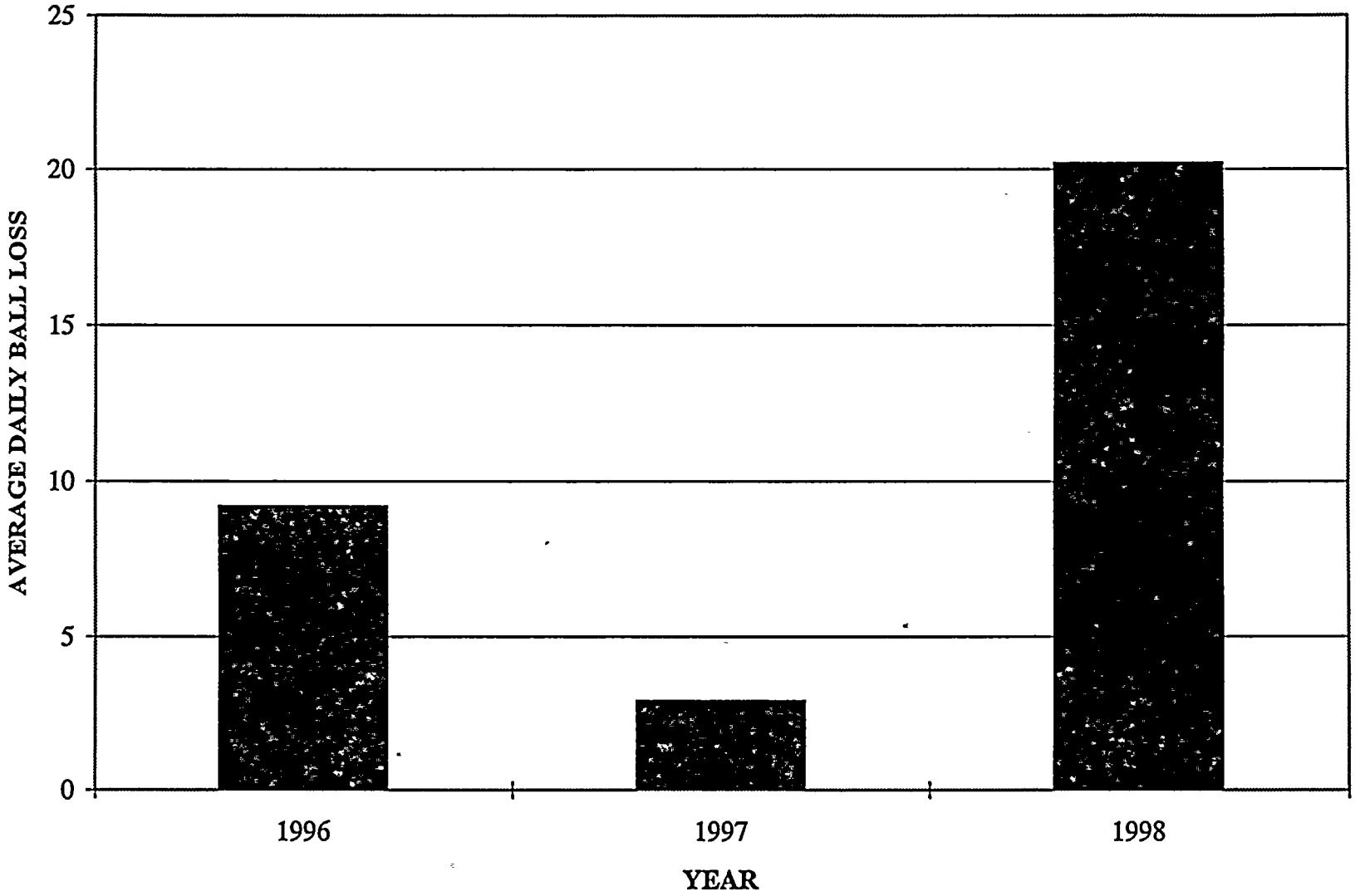

Figure 2. Average Daily Sponge Ball Loss from the St. Lucie Plant (Both Units) Since System Start-Up (January 1996)

FLORIDA POWER & LIGHT COMPANY

ST. LUCIE UNIT 2

ANNUAL ENVIRONMENTAL OPERATING REPORT

1998

FLORIDA POWER & LIGHT COMPANY

JUNO BEACH, FLORIDA

QUANTUM RESOURCES, INC.

PALM BEACH GARDENS, FLORIDA

ENVIRONMENTAL OPERATING REPORT

TABLE OF CONTENTS

PART I

PART II

1.0 EXECUTIVE SUMMARY

1.1 INTRODUCTION

The St. Lucie Plant is an electric generating station on Hutchinson Island in St. Lucie County, Florida. The plant consists of two nuclear-fueled 850 net MWe units; Unit 1 was placed on-line in March 1976 and Unit 2 in April 1983. This document has been prepared to satisfy the requirements contained in Appendix B, Environmental Protection Plan (EPP), to St. Lucie Unit 2 Facility Operating License No. NPF-16. This report primarily discusses environmental protection activities related to sea turtles as required by Subsection 4.2 of the EPP. Other routine annual reporting requirements are addressed in Volume 2.

1.2 TURTLE NESTING SURVEY

Since monitoring began in 1971, there have been considerable year-to-year fluctuations in sea turtle nesting activity on Hutchinson Island. However, data collected through 1998 have shown no long-term reductions in nesting on the island. Relatively high nesting during recent years may actually reflect an increase in the number of nesting females in the study area. On a smaller scale, power plant operation has had no significant effect on nesting near the plant. Low nesting activity in 1975 and again in 1981-1983 in the vicinity of the plant was attributed to nighttime construction activities associated with installation of plant intake and discharge structures. Nesting returned to normal or above normal levels following both periods of construction. During 1991, daytime construction activities associated with velocity cap repairs had no apparent effect on nesting. Formal requirements to conduct nesting surveys expired in 1986, but this program has been continued through 1998 with agreement from federal and state agencies. In 1998, the continuation of the nesting survey program was mandated as part of the biological opinion and incidental take statement issued by the National Marine Fisheries Service.

1.3 INTAKE CANAL MONITORING

Since plant operation began in 1976, 6086 sea turtles (including recaptures) representing five different species have been removed from the intake canal. The majority of the turtles captured (59 percent) were loggerheads. Differences in the numbers of turtles found during different months and years, including dramatic increases in green turtle captures in recent years, have been attributed primarily to natural variation in the occurrences of turtles in the vicinity of the plant, rather than to operational influences of the plant itself. The majority of turtles removed from the intake canal (about 97 percent) were captured alive and released back into the ocean. Ongoing evaluations and improvements to the canal capture program have substantially reduced mortalities of entrapped sea turtles during recent years. Turtles confined between the barrier net and intake headwalls typically reside in the canal for a relatively short period prior to capture, and most are in good to excellent condition when caught. An improved design barrier net completed in January 1996 is expected to further reduce the residence times and potential for mortalities to sea turtles in the intake canal system.

2.0 INTRODUCTION

2.1 BACKGROUND

This document has been prepared to satisfy the requirements contained in Appendix B, Environmental Protection Plan, to St. Lucie Unit 2 Facility Operating License NPF-16.

St. Lucie Units 1 and 2 use the Atlantic Ocean as a source of water for once-through condenser cooling. Since 1971, the potential environmental effects resulting from the intake and discharge of this water have been the subject of FPL sponsored biotic studies at the site. Jurisdiction for sea turtle studies is with the NRC, which is considered to be the lead federal agency relative to consultation under the Endangered Species Act. Previous results dealing with sea turtle studies are contained in fourteen annual environmental operating reports covering the period from 1983 through 1997. This report describes the 1998 environmental protection activities related to sea turtles, as required by Subsection 4.2 of the St. Lucie Unit 2 Environmental Protection Plan.

2.2 AREA DESCRIPTION

The St. Lucie Plant is located on a 457-hectare site on Hutchinson Island on Florida's East Coast (Figures 1 and 2). The plant is approximately midway between the Ft. Pierce and St. Lucie Inlets. It is bounded on the East Side by the Atlantic Ocean and on the West Side by the Indian River Lagoon. Hutchinson Island is a barrier island that extends 36 km between inlets and attains its maximum width of 2 km at the plant site. Elevations approach 5 m atop dunes bordering the beach and decrease to sea level in the mangrove swamps that are common on much of the western side. The Atlantic shoreline of Hutchinson Island is composed of sand and shell hash with intermittent rocky promontories protruding through the beach face along the southern end of the island. Submerged coquinoid rock formations parallel much of the island off the ocean beaches. The ocean bottom immediately offshore from the plant site consists primarily of sand and shell sediments. The Florida Current, which flows parallel to the continental shelf margin, begins to diverge from the coastline at West Palm Beach. At Hutchinson Island, the current is approximately 33 km offshore. Oceanic water associated with the western boundary of the current periodically meanders over the inner shelf, especially during summer months.

2.3 PLANT DESCRIPTION

The St. Lucie Plant consists of two 850 net MWe nuclear-fueled electric generating units that use near shore ocean waters for the plant's once-through condenser cooling water system. Water for the plant enters through three submerged intake structures located about 365 m offshore (Figure 2). Each of the intake structures is equipped with a velocity cap to minimize fish entrainment. From the intake structures, the water passes through submerged pipes (two 3.7 m and one 4.9 m in diameter) under the beach and dunes that lead to a 1,500 meter long intake canal, which transports water to the plant. After passing through the plant, the heated water is discharged into a 670 meter long canal that leads to two buried discharge pipelines. These pass underneath the dunes and beach and along the ocean floor to the submerged discharges, the first of which is approximately 365 m offshore and 730 m north of the intake.

3.0 TURTLES

3.1 INTRODUCTION

Hutchinson Island, Florida, is an important rookery for the loggerhead turtle, Caretta caretta, and also supports some nesting of the green turtle, Chelonia mydas, and the leatherback turtle, Dermochelys coriacea. State and federal statutes protect all three species. The federal government has classified the loggerhead turtle as a threatened species. The federal government endangered species lists include the leatherback turtle and the Florida nesting population of the green turtle. It has been an FPL goal that the St. Lucie Plant would not adversely affect the Hutchinson Island rookery. Because of this concern, FPL has sponsored monitoring of marine turtle nesting activity on the island since 1971.

Daytime surveys to quantify nesting, as well as nighttime turtle tagging programs, were conducted in odd numbered years from 1971 through 1979. During daytime nesting surveys, nine 1.25 km-long survey areas were monitored five days per week (Figure 3). The St. Lucie Plant began operation in 1976; therefore, the first three survey years (1971, 1973, and 1975) were pre-operational. Though the power plant was not operating during 1975, St. Lucie Plant Unit 1 ocean intake and discharge structures were installed during that year. Installation of these structures included nighttime construction activities conducted offshore from and perpendicular to the beach. Construction had been completed and the plant was in full operation during the 1977 and 1979 surveys.

A modified daytime nesting survey was conducted in 1980 during the preliminary construction of the ocean discharge structure for St. Lucie Unit 2. During this study, four of the previously established 1.25 km-long survey areas were monitored. Additionally, eggs from turtle nests potentially endangered by construction activities were relocated.

Every year from 1981 through 1998, 36 one-km-long survey areas comprising the entire island were monitored seven days a week during the nesting season (Figure 3). Beginning in 1994, the southern half of the island has been surveyed by Ecological Associates of Jensen Beach, Florida, and their data is included in this report. The St. Lucie Unit 2 discharge structure was installed during the 1981 nesting season. Offshore and beach construction of the Unit 2 intake structure proceeded throughout the 1982 nesting season and was completed near the end the 1983 nesting season. Construction activities associated with installation of both structures were similar to those conducted when Unit 1 intake and discharge structures were installed. Eggs from turtle nests potentially threatened by construction activities were relocated.

During 1991, another major offshore construction project was undertaken to replace damaged velocity caps on the three intake structures. A large elevated platform, from which repair activities were conducted, was erected around the three structures. Construction occurred throughout the nesting season. However, in contrast to previous offshore projects, work was restricted almost entirely to daylight hours, nighttime lighting of the work area was minimal, and no equipment or materials were used on the beach. A sea turtle protection plan implemented in support of the project included caging of nests along a 1,500 meter section of beach west of the platform and release of hatchlings to unaffected areas to the north and south. This plan was

intended to mitigate any negative effects potentially resulting from required safety and navigational lighting on and near the platform.

Requirement 4.2.1 of the St. Lucie Unit 2 Appendix B Environmental Protection Plan was complete with submission of the 1986 nesting survey data (ABI, 1987). The nesting survey was continued voluntarily through 1998 with agreement from federal and state agencies. Results are presented in this report and discussed in relation to previous findings.

In addition to monitoring sea turtle nesting activities and relocating nests away from plant construction areas, removal of turtles from the intake canal has been an integral part of the St. Lucie Plant environmental monitoring program. Turtles entering the ocean intake structures are entrained with cooling water and rapidly transported through the intake pipes into an enclosed canal system where they must be manually captured and returned to the ocean. Since the plant became operational in 1976, turtles entrapped in the intake canal have been systematically captured, measured, weighed, tagged, and released.

Previous publications and technical reports have presented findings of the nesting surveys, nest relocation activities and canal capture program (ABI, 1994) (Quantum, 1995, 1996, 1997, 1998). Results of studies to assess the effects of thermal discharges on hatchling swimming speed have also been reported (ABI, 1978). In July 1994, responsibility for sea turtle research and conservation activities was transferred from Ecological Associates, Inc. (formerly Applied Biology, Inc.) to Quantum Resources, Inc. Methodologies employed in both the nesting surveys and canal capture operations remained essentially unchanged so that data collected in 1994 through the present are directly comparable to previous year's data. The purpose of this report is to: 1) present 1998 sea turtle nesting survey data and summarize observed spatial and temporal nesting patterns since 1971, 2) document and summarize predation on turtle nests since 1971, and 3) present 1998 canal capture data and summarize comparable data collected since 1976.

3.2 MATERIALS AND METHODS

3.2.1 Nesting Survey

Methodologies used during previous turtle nesting surveys on Hutchinson Island were described in earlier reports (ABI 1994). Methods used during the 1998 survey were designed to allow comparisons with these previous studies.

In 1998, only areas A-S were surveyed by Quantum Resources biologists (Figure 3). Data supplied by Ecological Associates, Inc. are used to provide whole island nesting totals in Figures 6, 8, and 9.

From March 24, 1998 through April 14, 1998, several preliminary nest surveys were conducted along Hutchinson Island in areas A-S. No nesting was recorded in areas A-S prior to the beginning of formal nesting surveys on April 15, 1998. From April 15, 1998 through September 8, 1998, nest surveys were conducted on a daily basis. The last nest recorded in area A-S was on September 7, 1998. Biologists used small off-road motorcycles to survey the island each morning. New nests, non-nesting emergences (false crawls), and nests destroyed by

predators were recorded for each of the 1-km-long survey areas A - S (Figure 3). The 1.25-km-long survey areas that were established in earlier studies also were monitored so comparisons could be made with previous studies.

Data collected from beach nesting surveys were reported to the Florida Department of Environmental Protection (FDEP) as part of the FDEP Index Nesting Beach Survey. In a cooperative effort, data from stranded turtles found during beach surveys were routinely provided to the Florida Department of Environmental Protection and the National Marine Fisheries Service (NMFS) through the Sea Turtle Stranding and Salvage Network.

3.2.2 Intake Canal Monitoring

Most turtles entrapped in the St. Lucie Plant intake canal were removed by means of large-mesh tangle nets fished near the intake canal headwalls at the extreme eastern end of the intake canal (Figure 2). Nets used during 1998 were from 30 to 40 m in length, 3 to 4 m deep and composed of 40 cm stretch mesh multifilament nylon. Large floats were attached to the surface, and unweighted lines used along the bottom. Turtles entangled in the nets generally remained at the water's surface until removed. Since its inception in 1976, the canal capture program has been under continual review and refinement in an attempt to minimize both entrapment time and injuries/mortalities to entrapped sea turtles. Prior to April 1990, turtle nets were usually deployed on Monday morning and retrieved on Friday afternoon. During periods of deployment, the nets were inspected for captures at least twice each day (mornings and afternoons). Additionally, St. Lucie Plant personnel checked the nets periodically, and biologists were notified immediately when a capture was observed. Sea turtle specialists, that retrieve captured turtles from the plant intake canal system, were on call 24 hours a day.

Beginning April 1990, after consultation with NMFS, net deployment was scaled back to daylight hours only. Concurrently, surveillance of the intake canal was increased and biologists remained on site for the duration of each day's netting activities. This measure decreased response time for removal of entangled turtles from nets and provided an opportunity to improve daily assessments of turtle levels within the canal. Records of daily canal observations were compared with capture data to assess capture efficiencies.

In 1978, a barrier net at the A1A Bridge was constructed to confine turtles to the easternmost section of the intake canal, where capture techniques have been most effective. This net is constructed of large diameter polypropylene rope and has a mesh size of 20.3 cm x 20.3 cm. A cable and series of large floats are used to keep the top of the net above the water's surface, and the bottom is anchored by a series of concrete blocks. The net is inclined at a slope of 1:1, with the bottom positioned upstream of the surface cable. This reduces bowing in the center and minimizes the risk of a weak or injured turtle being pinned underwater by strong currents.

In the past, the integrity of the barrier net was occasionally compromised, and turtles were able to move west of A1A. These turtles were further constrained downstream by an underwater intrusion detection system (UIDS) consisting, in part, of a large barrier positioned perpendicular to the north-south arm of the canal (Figure 2). The UIDS security barrier has a mesh size of 22.9 cm x 22.9 cm. Prior to completion of the UIDS in December 1986, turtles unconfined by the

A1A barrier net were usually removed from the canal at the intake wells of Units 1 and 2 (Figure 2). There they were retrieved by means of large mechanical rakes or specially designed nets. Following construction of the UIDS barrier, all but the smallest individuals were unable to reach the intake wells. Improvements made to the A1A barrier net during 1990 have effectively confined all turtles larger than 32.5-cm carapace length (28.7-cm carapace width) to the eastern end of the canal. In response to the large numbers of small turtles encountered in the intake canal in recent years, an improved design, small mesh barrier net was erected east of the A1A barrier net. Construction was complete in January 1996. This improved barrier net is designed to confine all turtles with a carapace width greater than 18 cm to the extreme eastern portion of the intake canal.

Formal daily inspections of the intake canal were made to determine the numbers, locations, and species of turtles present. Surface observations were augmented with periodic underwater inspections, particularly in and around the barrier nets.

In addition to the use of tangle nets, dip nets and hand captures using snorkel and SCUBA were also employed. Long handled dip nets, employed from small boats, the canal banks and headwall structures were moderately effective in capturing turtles with carapace lengths of about 30 cm or less. Divers were employed to hand capture turtles whenever underwater visibility permits, and this technique has proven highly effective in the capture of turtles of all sizes, particularly less active individuals often found partially buried in the sediment in the vicinity of the barrier nets. Hand capture efforts have had a significant impact in reducing entrapment times for turtles in the intake canal.

Regardless of capture method, all turtles removed from the canal were identified to species, measured, weighed, tagged and examined for overall condition (wounds, abnormalities, parasites, etc.). Beginning in July 1994, all turtles captured have been photographed dorsally and ventrally prior to release, and the photographs retained for future reference. Healthy turtles were released into the ocean the same day of capture. Sick or injured turtles were treated and occasionally held for observation prior to release. When treatment was warranted, turtles were transported to an approved rehabilitation facility.

Resuscitation techniques were used if a turtle was found that appeared to have died recently. Beginning in 1982, necropsies were conducted on dead turtles found in fresh condition.

Florida Power & Light Company and Quantum Resources, Inc. continued to assist other sea turtle researchers in 1998. Since the program began, data, specimens and/or assistance have been given to the Florida Department of Environmental Protection, National Marine Fisheries Service, US Fish and Wildlife Service, US Army Corps of Engineers, Smithsonian Institution, South Carolina Wildlife and Marine Resources Division, Center for Sea Turtle Research (University of Florida), Florida Atlantic University, University of Central Florida, Texas A & M University, University of Rhode Island, University of South Carolina, University of Illinois, University of Georgia, Virginia Institute of Marine Science, Western Atlantic Turtle Symposium, South Atlantic Fishery Management Council, Florida Marine Fisheries Commission, Harbor and Branch Oceanographic Institution and the National Research Council.

3.3 RESULTS AND DISCUSSION

3.3.1 Nesting Survey

3.3.1.1 1998 Loggerhead Nesting Summary

In 1998, 7962 loggerhead turtle nests were recorded in the 36 one-kilometer segments comprising Hutchinson Island. This figure is in accordance with a general increase in loggerhead turtle nesting on Hutchinson Island since surveys began in 1971, although significant year to year fluctuations are evident. loggerhead nests and emergences for survey areas A-S is presented in Figure 4.

3.3.1.2 Spatial Distribution of Loggerhead Turtle Nests

From 1981 through 1998, 36 one-km-long segments comprising the island's coastline have been surveyed. The distribution of nests among these 36 survey areas has shown an increase in nesting from north to south along the northern half of the island (ABI, 1987, 1994). Along the southern half of the island there has been either no gradient or a gradient of decreasing nesting from north to south. Though beach dynamics may sometimes affect the selection of nesting sites by loggerhead turtles, relationships between spatial nesting patterns and specific environmental conditions are often difficult to establish because of the interrelationship of the factors involved.

Not all ventures onto the beach by a female turtle culminate in successful nests. These "false crawls" (non-nesting emergences) may occur for many reasons and are commonly encountered at other rookeries. Davis and Whiting (1977) suggested that relatively high percentages of false crawls might reflect disturbances or unsatisfactory nesting beach characteristics. Therefore, certain factors may affect a turtle's preference to emerge on a beach, while other factors may affect a turtle's tendency to nest after it has emerged. An index, which relates the number of nests to the number of false crawls in an area, is useful in estimating the post-emergence suitability of a beach for nesting. In the present study this index is termed "nesting success" and is defined as the percentage of total emergences that result in nests. loggerhead nesting success for areas A - S in 1998 is presented in Figure 5.

Historically, the pattern of loggerhead emergences on the island has generally paralleled the distribution of nests (ABI, 1987, 1994). In contrast, nesting success by loggerheads along the island has typically lacked gradients (ABI, 1987, 1994). Thus, the relatively high numbers of loggerhead nests observed in certain areas are usually a result of more turtles coming ashore in those areas rather than of more preferable nesting conditions being encountered by the turtles after they emerged. A variety of environmental factors (i.e., offshore bottom contours, distribution of reefs, type and extent of dune vegetation, and human activity on the beach at night) may effect loggerhead turtle emergence patterns and several have been reported to affect emergence patterns on Hutchinson Island (ABI, 1988, 1989). Undoubtedly, a combination of factors accounts for the overall distribution of emergences and therefore the overall nesting pattern on the island.

Nesting surveys on Hutchinson Island were initiated in response to concerns that the operation of the St. Lucie Plant might negatively impact the local sea turtle rookery. Previous

analysis, using log-likelihood tests of independence (G-test; Sokal and Rohlf, 1981) demonstrated that the construction of the plant's offshore intake and discharge structures significantly reduced nesting at the plant site during construction years -- 1975, 1981, 1982, 1983 (ABI, 1987). However, nesting at the plant consistently returned to levels similar to or greater than those at a control site in years following construction. During 1991 when offshore construction was restricted almost entirely to daylight hours, nests were more abundant at the plant site than at the control site. Data collected through 1998 have shown that power plant operation exclusive of nighttime intake/discharge construction has had no apparent effect on nesting.

3.3.1. 3 Long-Term Trends in Loggerhead Turtle Nesting

Various methods were used during surveys prior to 1981 to estimate the total number of loggerhead nests on Hutchinson Island based on the number of nests found in the nine 1.25 km-long survey areas (ABI, 1980a). Each of these methods was subsequently found to consistently overestimate island totals (ABI, 1987). Since whole-island surveys began in 1981, it has been possible to determine the actual proportion of total nests deposited in the nine areas. This has allowed extrapolation from the nine survey areas to the entire island for years prior to 1981.

From 1981 through 1993 the total number of nests in the nine areas varied from 32.5 to 35.6 percent of the total number of nests on the island. This is slightly higher than the 31.3 percent, which would be expected, based strictly on the proportion of linear coastline comprised by the nine areas. Using the thirteen-year mean of 33.81 percent, estimates of the total number of nests on Hutchinson Island can be calculated by multiplying the number of nests in the nine areas by 2.958. This technique, when applied to the nine survey areas during the thirteen years in which the entire island was surveyed, produced whole-island estimates within 5.3 percent of the actual number of nests counted. Because the proportion of nests recorded in the nine survey areas remained relatively constant over the last thirteen years, this extrapolation procedure provides a fairly accurate estimate of total loggerhead nesting for years prior to 1981, and is used to generate data points for 1971 through 1979 in Figure 6.

It is clear that loggerhead-nesting activity on Hutchinson Island fluctuates considerably from year to year (Figure 6). Annual variations in nest densities also are common at other rookeries, and may result from non-annual reproductive behavior. Despite high variability, data collected through 1998 suggest an overall increase in nesting on Hutchinson Island since surveys began in 1971. Total nesting activity was greatest during 1995 when 8184 loggerhead nests were recorded. No relationships between total nesting activity and power plant operation or intake/discharge construction were indicated by year-to-year variations in total nesting on Hutchinson Island.

3.3.1.4 Seasonal Patterns of Loggerhead Turtle Nesting

The loggerhead turtle nesting season usually begins between mid-April and early May, attains a maximum during June or July, and ends by mid-September (ABI, 1987). Nesting activity during 1998 followed this same pattern.

Cool water intrusions frequently occur over the continental shelf of southeast Florida

during the summer (Smith, 1982). These intrusions may have been responsible for the temporary declines in loggerhead turtle nesting activity previously observed on Hutchinson Island (ABI, 1994). Though natural fluctuations in temperature have been shown to affect temporal nesting patterns on Hutchinson Island, there has been no indication that power plant operation has affected these temporal patterns (ABI, 1988).

3.3.1.5 Predation on Loggerhead Turtle Nests

Since nest surveys began in 1971, raccoon predation has been a major cause of turtle nest destruction on Hutchinson Island. Researchers at other locations have reported raccoon predation levels as high as 70 to nearly 100 percent (Hopkins et al., 1979). Raccoon predation of loggerhead turtle nests on Hutchinson Island has not approached this level during any study year, though levels for individual 1.25 km-long areas have been as high as 80 percent. Overall predation rates for survey years 1971 through 1977 were between 21 and 44 percent, with a high of 44 percent recorded in 1973. A pronounced decrease in raccoon predation occurred after 1977 and overall predation rates for the nine areas have not exceeded 10 percent since 1979. A decline in predation rates on Hutchinson Island may be attributable to trapping programs, construction activities, habitat loss, and disease.

During 1998, raccoon predation levels were extremely low, with only one loggerhead nest in areas A-S depredated by raccoons (Figure 7). In previous years (ABI, 1994), predation of turtle nests was primarily restricted to the more undeveloped portions of the island.

Ghost crabs have been reported by numerous researchers as important predators of sea turtle nests (Hopkins etal, 1979; Stancyk, 1982). Though turtle nests on Hutchinson Island probably have been depredated by ghost crabs since nesting surveys began in 1971, quantification of ghost crab predation did not begin until 1983.

Overall predation rates by ghost crabs have varied from 0.1 to 2.1 percent from 1983-1998. During 1998, three loggerhead nest in areas A-S were depredated by ghost crabs (Figure 7). Nests destroyed by a combination of raccoon and ghost crab predation have been included as raccoon predations in previous discussions. When these combination predations are included as crab predations, the overall predation rates by ghost crabs range from 0.1 to 4.7 percent. During 1998, no such combination predations were recorded.

3.3.1.6 1998 Green and Leatherback Nesting Summary

In 1998, 258 green turtle and 77 leatherback turtle nests were recorded in the 36 one-km segments comprising Hutchinson Island. The green turtle total represents a new record for Hutchinson Island green turtle nesting and a substantial increase from last year's totals. 1998 was also a record year for leatherback turtle nesting on Hutchinson Island (Figures 8 and 9). Although strong year to year fluctuations are common, the general trend since 1971 may reflect an increase in the numbers of nesting females in the Hutchinson Island area.

3.3.1.7 Trends in Green and Leatherback Turtle Nesting

Green and leatherback turtles nest on Hutchinson Island, but in fewer numbers than loggerhead turtles. Prior to 1981, both survey (nine 1.25 km-long sections) and inter-survey areas were monitored for the presence of green and leatherback nests. Thirty-one kilometers of beach from Area 1 south to the St. Lucie Inlet were included in that effort. During whole-island surveys from 1981 through 1993, only 2.6 percent (7) of the leatherback nests (n=266) and only 1.4 percent (12) of the green turtle nests (n=831) were recorded on the five kilometers of beach north of Area 1. Therefore, previous counts of green and leatherback nests within the 31 kilometers surveyed probably were not appreciably different from total densities for the entire island. Based on this assumption, green and leatherback nest densities may be compared among all survey years, except 1980, when less than 15 kilometers of beach were surveyed.

Since surveys began in 1971, the number of nests observed on the island ranged from 5 to 258 for green turtles and from 1 to 77 for leatherbacks (Figures 8 and 9). Temporal nesting patterns for these species differ from the pattern for loggerhead turtles. Green turtles typically nest on Hutchinson Island from mid-June through the first or second week of September. Leatherback turtles usually begin nesting in March or April and continue to nest through early to mid-July. Considerable fluctuations in green turtle nesting on the island have occurred among survey years (Figure 8). This is not unusual since there are drastic year-to-year fluctuations in the numbers of green turtles nesting at other breeding grounds (Carr et al., 1982). Despite these fluctuations, data collected through 1998 suggest an overall increase in nesting since 1971 and may reflect an increase in the number of nesting females in the Hutchinson Island area. During 1998, green turtles nested most frequently along the southern half of the island. This is consistent with results of previous surveys.

Leatherback turtle nest densities have remained low on Hutchinson Island, however, increased nesting during recent years (Figure 9) may reflect an overall increase in the number of nesting females in the Hutchinson Island area.

3.3.2 INTAKE CANAL MONITORING

Entrainment of sea turtles at the St. Lucie Plant has been attributed to the presumed physical attractiveness of the offshore structures housing the intake pipes rather than to plant operating characteristics (ABI, 1980b and 1986). The velocity caps, which are supported above the openings to each intake pipe, eliminate vertical water entrainment and substantially reduce current velocities near the structures by spreading horizontal draw over a wider area. Even when both units are operating at full capacity, turtles must actively swim into the mouth of one of the pipes before they encounter current velocities sufficiently strong to effect entrainment. Consequently, a turtle's entrapment relates primarily to the probability that it will detect and subsequently enter one of the intake structures.

3.3.2.1 1998 Canal Capture Summary

In 1998, 666 sea turtles were captured in the intake canal of the St. Lucie Plant. Captures included 393 loggerheads, 268 green turtles, 1 leatherback, 2 hawksbill, and 2 Kemp's ridley turtles (Table 1).

3.3.2.2 Relative Abundance and Temporal Distribution

Since intake canal monitoring began in May 1976, 3578 loggerhead (including 222 recaptures), 2432 green (including 478 recaptures), 21 leatherback, 33 Kemp's ridleys, and 21 hawksbill capture have taken place at the St. Lucie Plant. Annual catches for all species combined ranged from a low of 33 in 1976 (partial year of plant operation and monitoring) to 933 in 1995.

Except for 1993 through 1997, when the green turtle was the most abundant species in the canal, loggerheads have dominated annual captures. Since 1977, the first full year of plant operation, the number of loggerheads captured each year ranged from 62 in 1981 to 393 in 1998 (Figure 10). Numbers have exhibited considerable year-to-year fluctuations with no persistent trends evident, although recent year's data are suggestive of a possible increasing trend.

The number of green turtles captured each year since 1977 have ranged from 3 in 1979 to a record high of 673 in 1995 (Figure 10). Increasing numbers of captures over recent years may reflect an increase in the number of turtles inhabiting the nearshore coastal area near the plant or may simply represent statistical variation. Green turtle captures were down sharply in 1997, but showed a modest rebound in 1998. Additional years of capture data will be required before any long-term trends can be established.

During 1998, the monthly catch of loggerheads ranged from 10 (November) to 60 (March), with a monthly mean of 32.7 (Table 2). Over the entire history of the capture program, monthly catches have ranged from 0 to 87, with the greatest number of captures occurring during July 1996.

During 1998, the monthly catch of green turtles ranged from 7 (July) to 58 (February), with a monthly mean of 23.3 (Table 3). The March 1996 catch of 147 green turtles is the largest number of captures for this species for any month on record. Seasonal abundance patterns of

green turtles have typically been much more pronounced than for loggerheads, with over 50 percent of all captures occurring between January and March. In 1995 through 1998, however, no such seasonal pattern was evident, with captures distributed more or less evenly throughout the year.

Catches of leatherbacks, hawksbills, and Kemp's ridleys have been infrequent and scattered throughout the years. Each species has shown rather pronounced seasonal occurrences; over 60 percent of all leatherbacks were captured in March and April, over 60 percent of the hawksbills were captured between July and September, and almost 90 percent of the Kemp's ridleys were caught between December and April.

3.3.2.3 Size-Class Distributions

The size-class distribution for loggerheads removed from the intake canal in 1998 is presented in Figure 11. The size class distribution for green turtles removed from the intake canal in 1998 are presented in Figure 12. ABI (1994) presents size-class data for turtles removed from the intake canal from 1976-1993. The leatherback captured in 1998 was an adult, with a straight-line carapace length (SLCL) of over 121 cm (Hirth, 1980). Both hawksbills captured in 1998 were adults (SLCL > 63cm) (Witzell, 1983). Both Kemp's ridleys captured in 1998 were juveniles SLCL < 60cm) (Hirth, 1980).

3.3.2.4 Sex Ratios

Of the 390 loggerheads captured in 1998 for which straight line carapace lengths are available, 276 were juveniles with a straight line carapace length (SLCL) less than or equal to 70 cm, 81 were adults (SLCL > 85 cm) and 33 were transitional (SLCL 71-85 cm) (Hirth, 1980). The latter group probably includes both mature and immature individuals. Of the 81 individuals classified as adults for whom sex was recorded, 76 were females and five were males, with females predominating by a ratio of 15:1.

Of the 267 green turtles captured in 1998 for which straight line carapace lengths are available, 263 were juveniles or sub-adults (SLCL < 83 cm) (Whitherington and Ehrhart, 1989). Of the 4 adult green turtles captured in 1998, 2 were males and 2 were females. ABI (1994) discusses sex ratio data for previous years.

3.3.2.5 Capture Efficiencies

Netting methodologies have been under continual review and refinement as net materials, configurations, and placement be varied in an effort to minimize sea turtle entrapment times. Additionally, alternative capture techniques have been evaluated, and potential deterrent systems tested in the laboratory. Current capture procedures have proven to provide a safe, efficient, and cost-effective program for removing entrapped turtles from the intake canal.

Formal daily inspections of the intake canal are conducted every day that capture nets are deployed, and the number, location and relative size of entrapped turtles are recorded on field observation forms. Better utilization of currents and eddies, adjustments to tethering lines, multi-

net deployments and increased efforts to hand capture turtles have contributed to reduced entrapment times during recent years.

Entrapment times may be extended for turtles swimming past the A1A barrier net (ABI, 1987). Because capture efforts west of the A1A bridge were generally less effective than those near the intake headwalls, most turtles breaching the barrier net were not caught until they entered the intake wells of Units 1 and 2. Because of their relatively small sizes, virtually all the turtles reaching the intake wells are green turtles. During 1998, 5 of the 268 green turtle captures (1.8 percent) occurred at the intake wells. The substantial decrease in the percentage of captures at the plant intake wells compared to the 1995 figure of 14.5 percent is attributed to the effectiveness of the new small mesh barrier net installed east of AIA in January 1996.

During 1998, 99.1 percent of all turtles entrapped in the canal were captured east of the A1A Bridge, 547 by tangle nets and 119 by hand or dip net capture. The effective confinement of turtles east of A1A has been a major contributor to the high capture efficiency achieved during recent years. The installation of an improved barrier net completed in January 1996 has further increased capture efficiency by more effectively confining turtles of all sizes to a smaller area east to the A1A barrier net.

3.3.2.6 Barrier Net Maintenance

Barrier net maintenance is critical in reducing the opportunity for mortalities in the plant intake well area and in reducing residence times for turtles in the intake canal system. Daily inspections are performed from a small boat to remove floating debris and to repair holes near or at the water surface. When underwater visibility conditions permit, a weekly underwater inspection is conducted. A formal inspection is conducted monthly, including hole repair, debris removal, and airlift dredging of accumulated silt if needed. Maintenance conducted in 1998 included the repair of any holes in the mesh discovered during the daily, weekly and monthly inspections and extensive debris removal and airlift dredging of accumulated sediment conducted in November. In September, October, and November 1998, large influxes of jellyfish into the intake canal required the primary barrier net to be lowered periodically, sometimes for days at a time, to prevent the net from failing under the weight of accumulated jellyfish. The lowering mechanism functioned as designed and no damage was sustained.

3.3.2.7 Relative Condition

Turtles captured alive in the intake canal of the St. Lucie Plant were assigned a relative condition based on weight, activity, parasite infestation, barnacle coverage, wounds, injuries and any other abnormalities which might have affected overall vitality. During 1998, 95.2% percent (373) of all loggerheads found in the canal were alive and in good condition. Only 4.8 percent (19) loggerhead captures involved individuals in fair or poor condition, and one was dead. Of the 268 green turtles removed from the intake canal during 1998, 254 (94.8 percent) were in good condition, 14 (5.2 percent) were in fair or poor condition, and none were dead. The 2 hawksbills, 2 Kemp's ridleys, and the leatherback captured in 1998 were all in good condition.

Relative condition ratings can be influenced by a number of factors, some related and others unrelated to entrainment and/or entrapment in the intake canal. A rating of good indicates that turtles have not been negatively impacted by their entrapment in the canal, at least as evidenced by physical appearance. Although ratings of fair or poor imply reduced vitality, the extent to which entrainment and entrapment is responsible is often indeterminable. In some instances, conditions responsible for lower ratings, such as boat collision or fisheries gear entanglement injuries obviously were sustained prior to entrainment.

During 1998, 71 of the 666 turtles captured (10.7 percent) had notable injuries such as missing appendages, broken or missing pieces of carapace, or deep lacerations. Many of these were old, well-healed wounds, and did not require veterinary attention.

Of the 665 live removals during 1998, 652 were released into the ocean the day of capture. Nine turtles (all loggerheads) in obvious ill health or suffering serious injuries were transported to Sea World of Florida or the Marinelife Center of Juno Beach for treatment and rehabilitation. Two had serious carapace damage, presumably from a boat collision, one had ingested monofilament fishing line, and six were weak, lethargic, and emaciated when captured. Fifteen green turtles with fibropapilloma tumors were removed from the canal in 1998. Three turtles with extensive tumors were transferred to the Florida DEP for transportation to a rehabilitation facility. Twelve turtles with minor tumors were tagged and released. One green turtle was held overnight for installation of a satellite-tracking transmitter and was later released.

3.3.2.8 Mortalities

Sea turtle mortalities have been closely monitored throughout the life of the canal capture program in an attempt to assign probable causes and take appropriate remedial action to minimize future occurrences. Previous analyses of capture data identified drowning in nets (A1A barrier net, UIDS barrier, and tangle nets), drowning in the intake pipes during periods of reduced intake flow, injuries sustained from dredging operations, and injuries sustained from the mechanical rakes used in the intake wells as probable mortality factors (ABI, 1987) (FPL, 1995). Although difficult to quantify, the entrapment and subsequent demise of injured or sick turtles has probably accounted for a portion of observed mortalities.

Over the entire monitoring program history, 135 (3.8 percent) of the 3578 loggerheads and 52 (2.1 percent) of the 2432 green turtles entrapped in the canal were found dead. Mortalities spanned the range of size classes for loggerheads (SLCL = 47.5-103 cm), while all green turtle mortalities involved juveniles less than 42 cm in length. The four Kemp's ridley mortalities documented at the plant during 1987 and 1988 were the only deaths for this species to date; no dead leatherback or hawksbill turtles have been recovered at the St. Lucie Plant.

Modifications to capture procedures, improvements to barrier nets, and virtual elimination of low flow conditions within the canal have resulted in a substantial reduction in sea turtle mortalities over the life of the canal capture program. Mortality rate, expressed as the percentage of total captures involving dead animals, declined from 7.8 percent during the period 1976-1984 to 2.1 percent since 1984, and 1.0% since 1990 (Table 1).

In 1998, one turtle (a loggerhead) was removed dead from the intake canal, for an overall mortality rate of 0.15percent. The turtle was found floating up against the A1A barrier net during a period when the primary barrier net was lowered due to a jellyfish influx. The turtle was moderately decomposed, and no cause of death could be determined.

In response to the 1995 mortalities and the dramatic increase in intake canal captures in 1995, consultation was initiated with FPL, NRC, and the NMFS under Section 7 of the Endangered Species Act. As a result of that consultation, FPL has designed and constructed an improved, smaller mesh barrier net located between the A1A barrier net and the intake canal headwalls (Figure 2). Construction of the net was completed in January 1996. This barrier net prevents turtles from reaching the intake wells or UIDS barrier and increases capture efficiency by confining turtles to a smaller area of the intake canal.

3.3.2.9 Recapture Incidents

Since the St. Lucie Plant capture program began, most turtles removed from the intake canal have been tagged and released into the ocean at various locations along Hutchinson Island. Consequently, individual turtles can be identified as long as they retain their tags. Over the history of the program at the St. Lucie Plant, 700 recaptures (222 loggerheads and 478 green turtles) have occurred, and a number of turtles have been recaptured more than once. The recapture rate for green turtles in 1998 was 37 percent and the recapture rate for loggerheads was only 5.3 percent. The large number of green turtle recaptures probably reflects the saturation of local green turtle populations with turtles tagged at the St. Lucie Plant and possibly indicates a difference in site fidelity between green turtles and loggerheads. Several other turtles with tag scars have also been recovered indicating that the actual number of recaptures may be higher.

3.3.3 SUMMARY

A gradient of increasing loggerhead turtle nest densities from north to south along the northern half of Hutchinson Island has been shown during most survey years. This gradient may result from variations in beach topography, offshore depth contours, distribution of nearshore reefs, onshore artificial lighting, and human activity on the beach at night. Low nesting activity in the vicinity of the power plant during 1975 and from 1981 through 1983 was attributed to nighttime construction activities associated with installation of power plant intake and discharge structures. Nesting returned to normal or above normal levels following both periods of construction. During 1991, daytime construction activities associated with velocity cap repairs had no apparent effect on nesting. Statistical analyses indicate that power plant operation, exclusive of nighttime construction, has had no significant effect on nest densities near the plant. In 1998, 7962 loggerhead turtle nests were recorded on Hutchinson Island. There have been considerable year-to-year fluctuations in loggerhead nesting activity on Hutchinson Island from 1971 through 1998. Fluctuations are common at other rookeries and may result from non-annual reproductive behavior. Despite these fluctuations, loggerhead-nesting activity has remained high during recent years and may reflect an overall increase in the number of nesting females in the Hutchinson Island area. No relationship between total nesting on the island and power plant operation or intake/discharge construction was indicated.

Temporal nesting patterns of the Hutchinson Island population may be influenced by natural, large scale fluctuations in water temperature, such as those produced by the cool water intrusions that frequently occur over the continental shelf of southeast Florida during the nesting season. However, localized fluctuations in water temperature associated with power plant operation have had no apparent effect on nesting.

Since nesting surveys began in 1971, raccoon predation has been one of the major causes of turtle nest destruction on Hutchinson Island. From 1971 through 1977, overall predation rates in the nine survey areas were between 21 and 44 percent. However, a pronounced decrease in raccoon predation occurred after 1977, and overall predation rates in the nine survey areas have not exceeded ten percent since 1979. Decreased predation by raccoons probably reflects a decline in the raccoon population. More years of survey data will be required to determine if the extremely low level of raccoon predation in 1996 through 1998 is an isolated occurrence or part of a continuing trend. Ghost crab predation on the turtle nests may be more significant than previously documented but remains relatively minor compared to raccoon predation.

During 1998, 258 green turtle and 77 leatherback turtle nests were recorded on Hutchinson Island, a record high for both species. Nesting activity by these two species has exhibited considerable annual fluctuations, as has been recorded at other rookeries, but has remained relatively high during recent years. This may reflect an overall increase in the number of nesting green and leatherback turtles in the Hutchinson Island area.

During 1998, 393 loggerheads, 268 green turtles, 2 hawksbills, 2 Kemp's ridleys, and one leatherback were removed from the St. Lucie Plant intake canal. Since monitoring began in May 1976, 3578 loggerhead, 2432 green, 21 leatherback, 21 hawksbill and 33 Kemp's ridley turtles have been captured and tagged. Over the life of the monitoring program, annual catches for loggerhead turtles have ranged from 33 in 1976 (partial year of plant operation and monitoring) to a high of 393 in 1998. Yearly catches of green turtles have ranged from 0 in 1976 to 673 in 1995. Differences in the number of turtles entrapped during different years and months are attributed primarily to natural variation in the occurrence of turtles in the vicinity of the offshore intake structures, rather than to plant operation characteristics.

Size-class distributions of loggerhead turtles removed each year from the canal have consistently been dominated by juveniles between 50 and 70 cm in straight-line carapace length. Over 75 percent of all green turtles entrapped in the canal were juveniles 40 cm or less in length. For both species, the largest number of captures for all years combined occurred during winter, but, with the exception of 1995, and to lesser extent 1996, these seasonal peaks were much more pronounced for green turtles. The sex ratio of loggerheads caught in the canal continued to be biased towards females.

During 1998, about 95 percent of all loggerheads and green turtles removed from the canal were categorized by physical appearance as being in good condition.

About 10 percent of the turtles removed from the intake canal during 1998 had substantial injuries, and the vast majority of those were well healed and apparently sustained prior to entrapment. Once in the canal, turtles confined east of A1A had very brief residency times. Thus

the relative condition of most turtles was not affected by their entrapment.

During 1998, only one mortality was recorded in the intake canal. Program modifications, including continual surveillance of tangle nets during periods of deployment, improvements to the integrity of the barrier net system, and greater effort to hand capture turtles have contributed to a substantial decline in sea turtle mortalities during recent years. The design and construction of an improved barrier net completed in January 1996 was expected to reduce mortalities and entrapment times for turtles in the intake canal. Data since then indicate that the new barrier net configuration has been highly effective in excluding turtles from the plant intake wells, but has not been as effective in reducing the overall mortality rate as anticipated, although the 1998 mortality rate of 0.15%, the lowest mortality rate in the program's history, was an outstanding achievement and a hopeful sign for the future.

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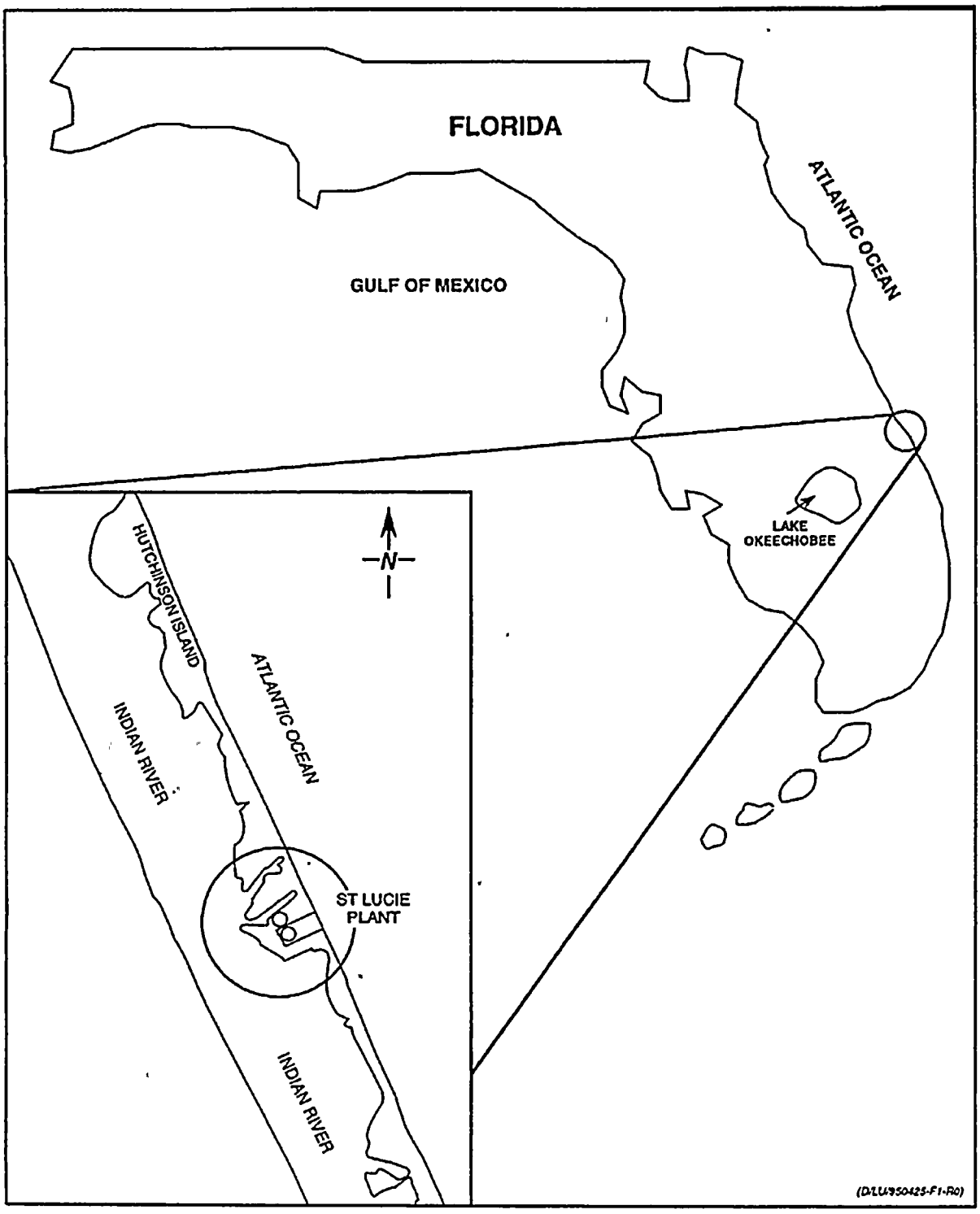

Figure 1. Location of St. Lucie Plant

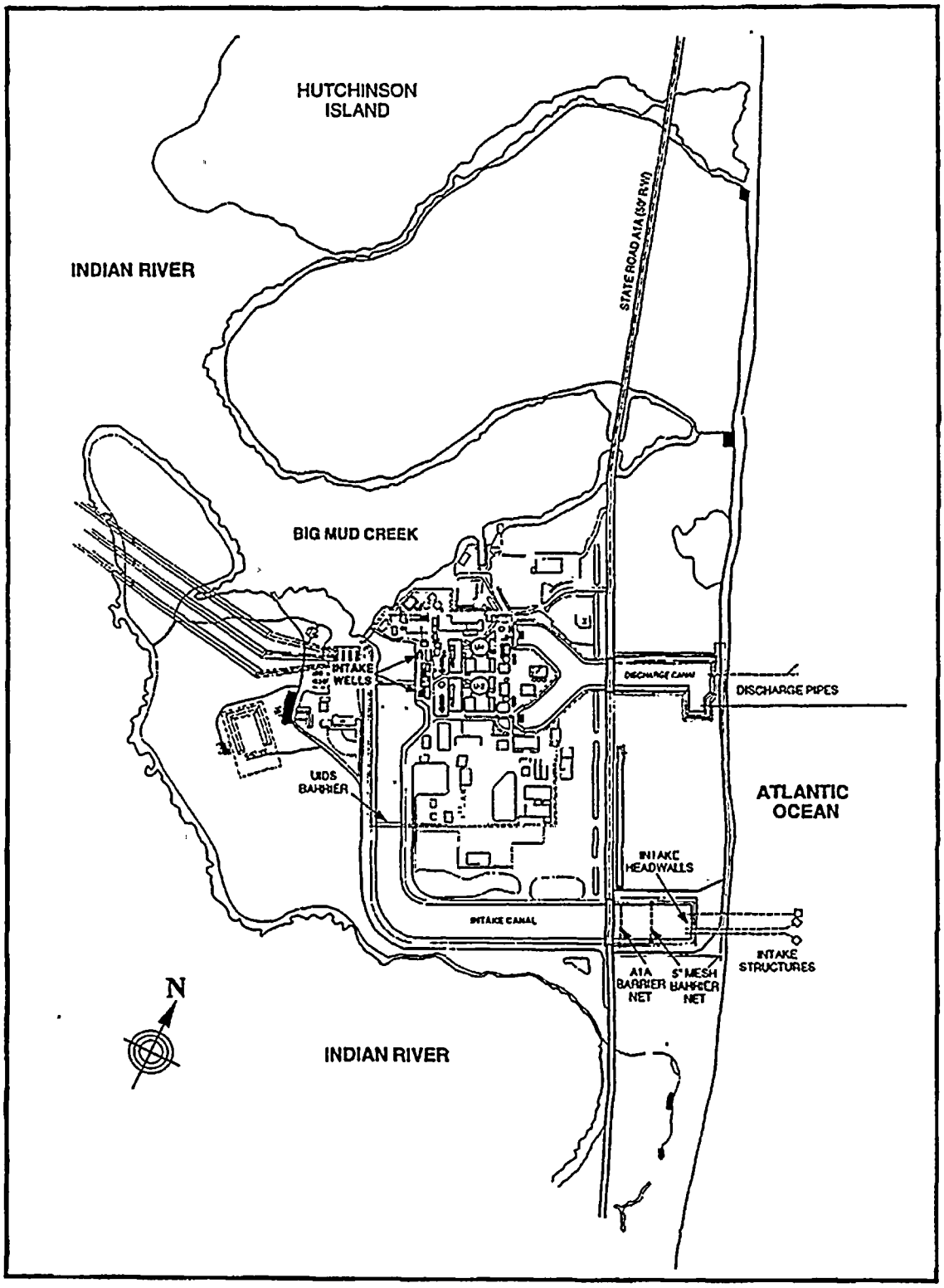

Figure 2. St. Lucie Plant Cooling Water Intake and Discharge System

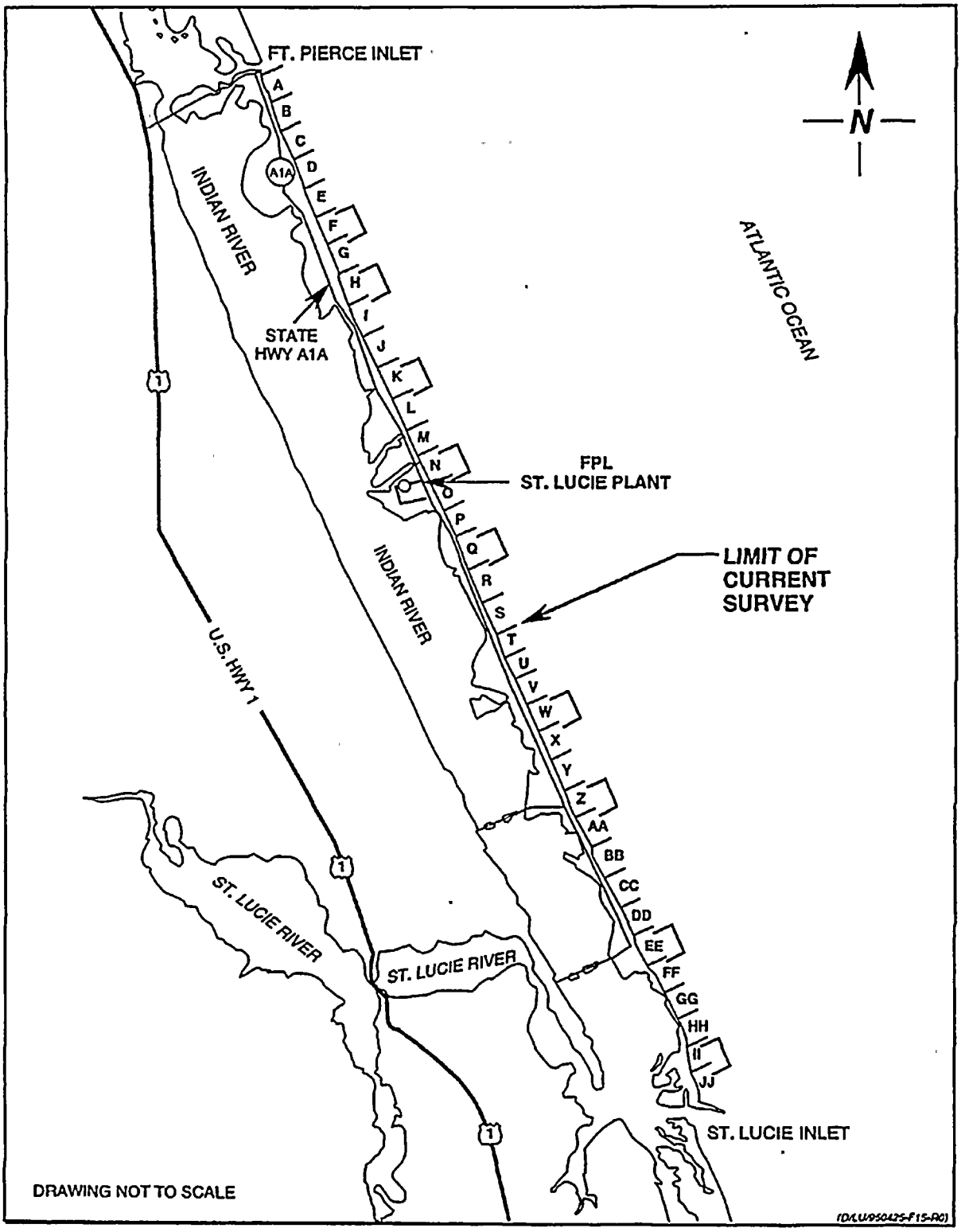

Figure 3. Designation and Location of Nine 1.25-Km Segments and Thirty-Six 1-Km Segments Surveyed for Sea Turtle Nesting, Hutchinson Island. 1971-1998.

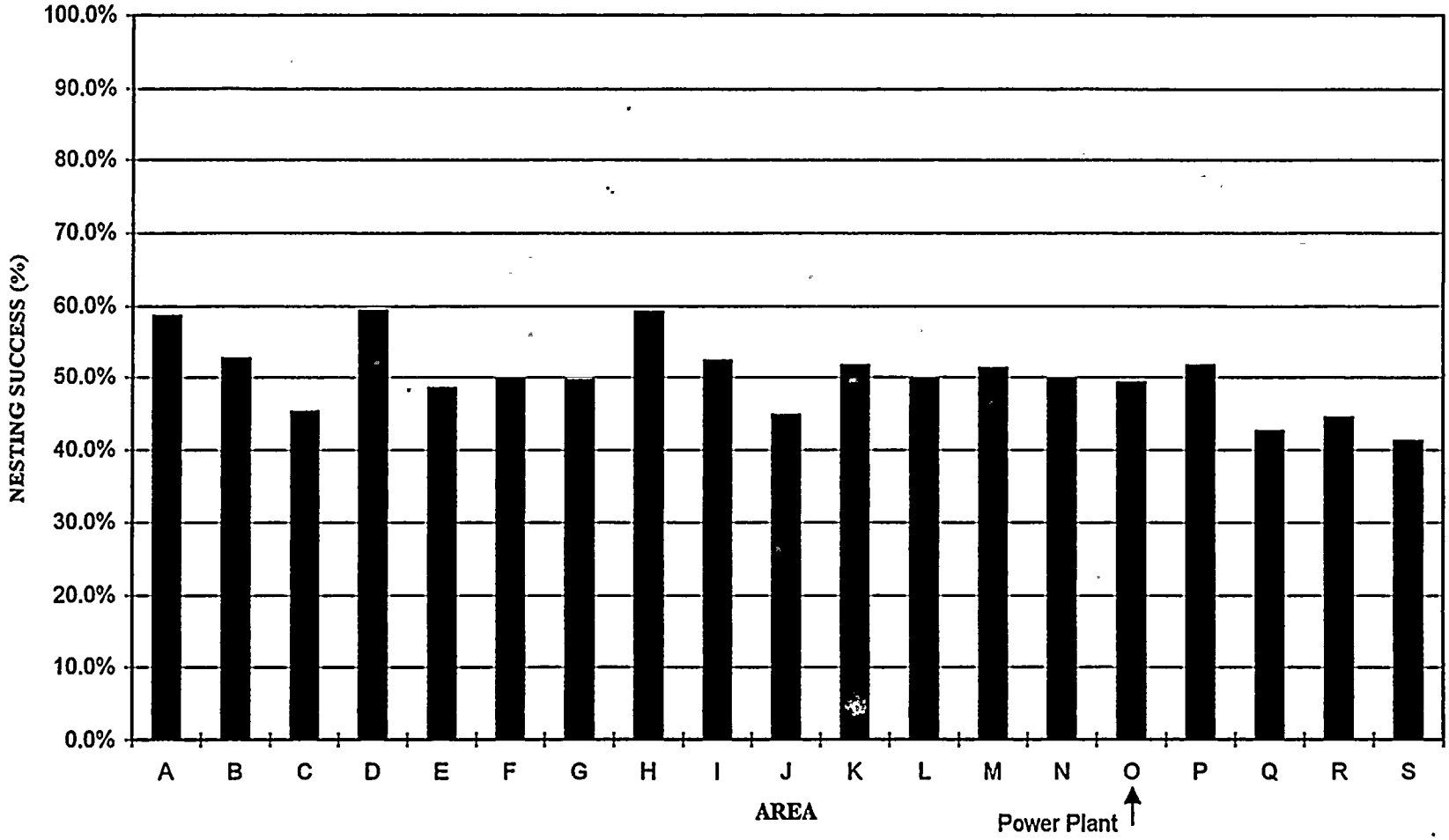

Figure 4. Number of Loggerhead Turtles Nests and Emergences for Areas A Through S, Hutchinson Island, April Through September 1998.

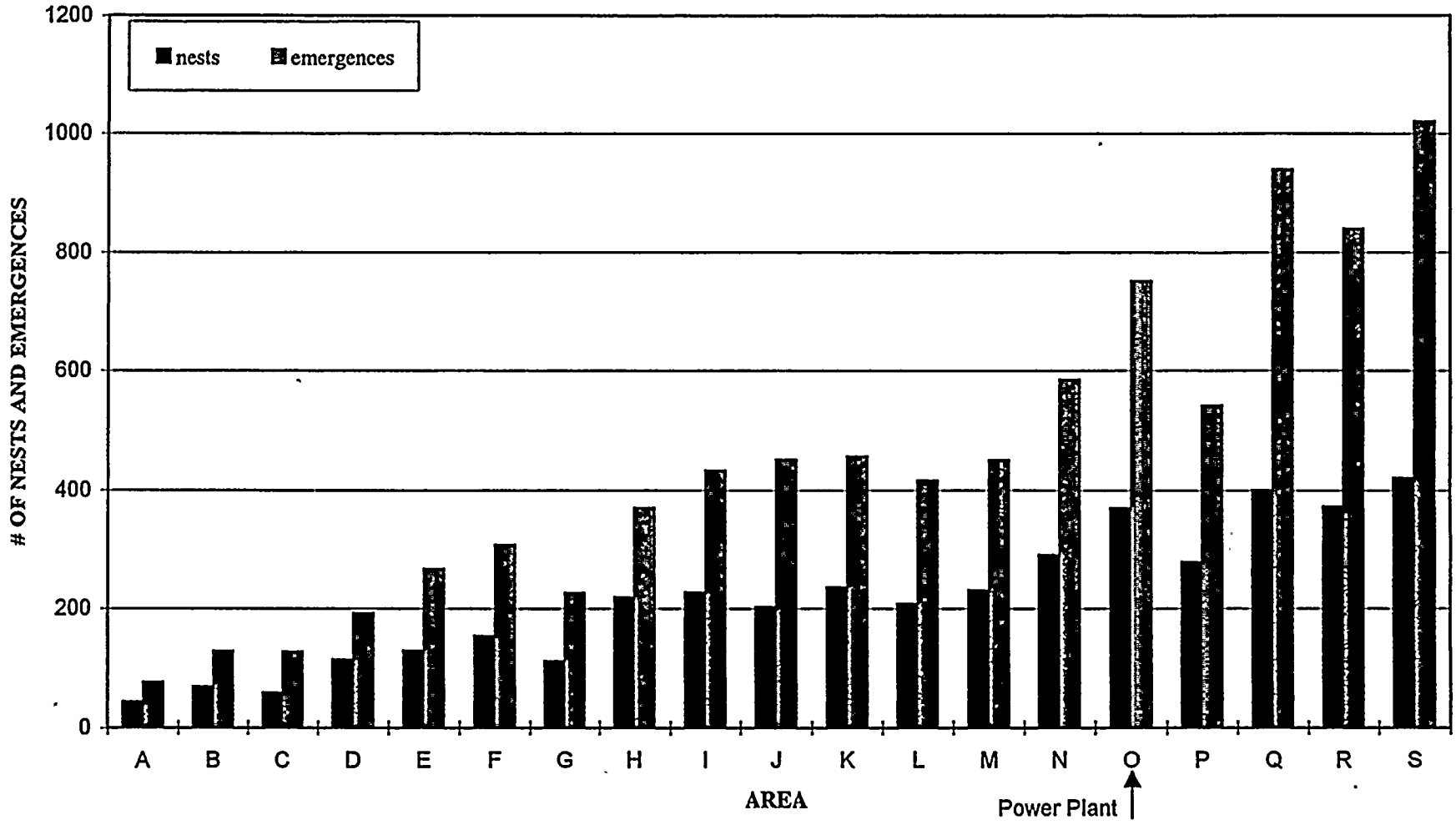

Figure 5. Loggerhead Turtle Nesting Success (Percentage of Emergences Resulting in Nests) for Areas A Through S, Hutchinson Island, April Through September 1998.

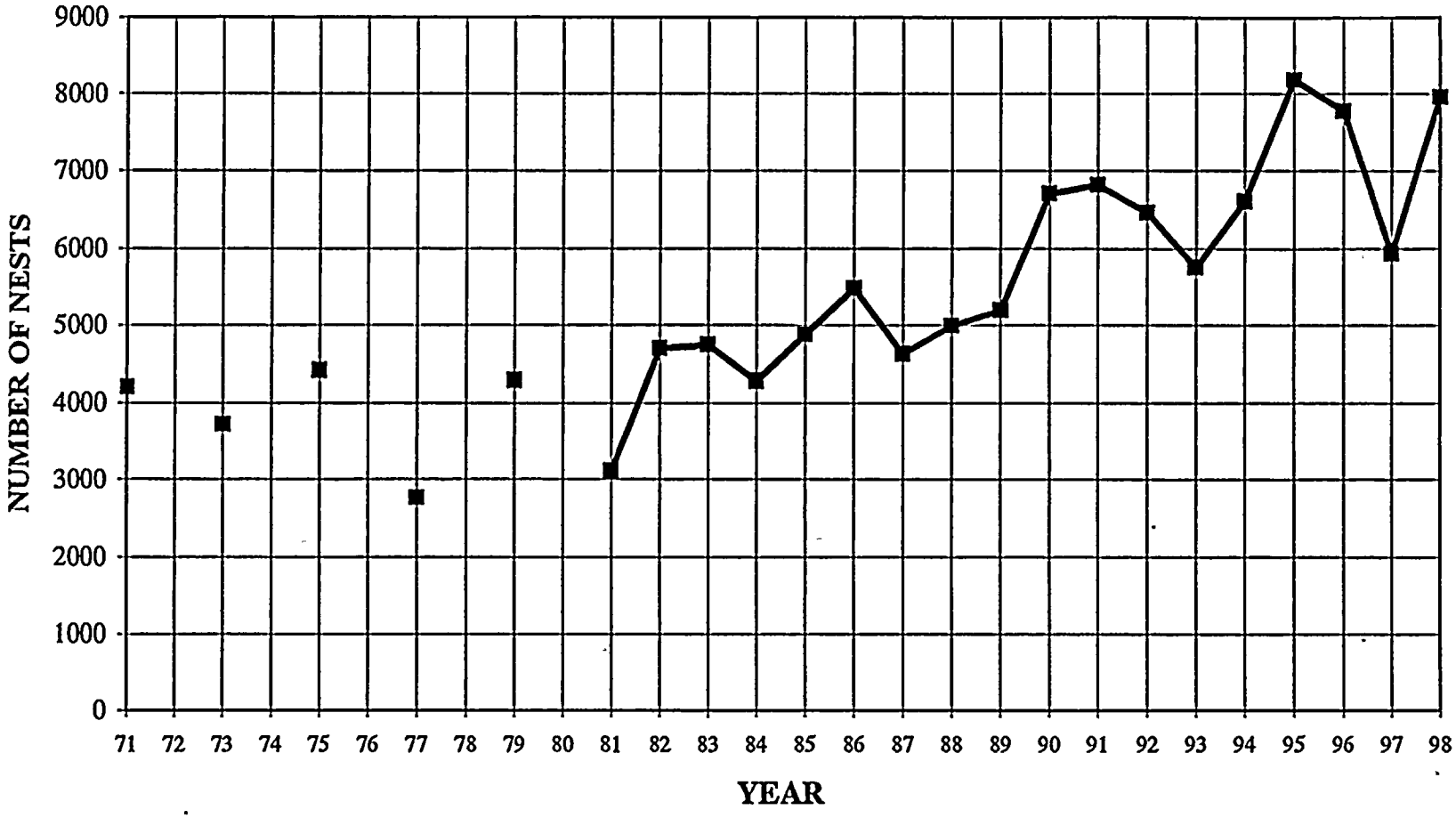

Figure 6. Number of Loggerhead Turtle Nests, Hutchinson Island 1971 Through 1998. Values for 1971 Through 1979 Are Estimates (See Text); Values for 1981 Through 1998 Are From Whole Island Surveys.

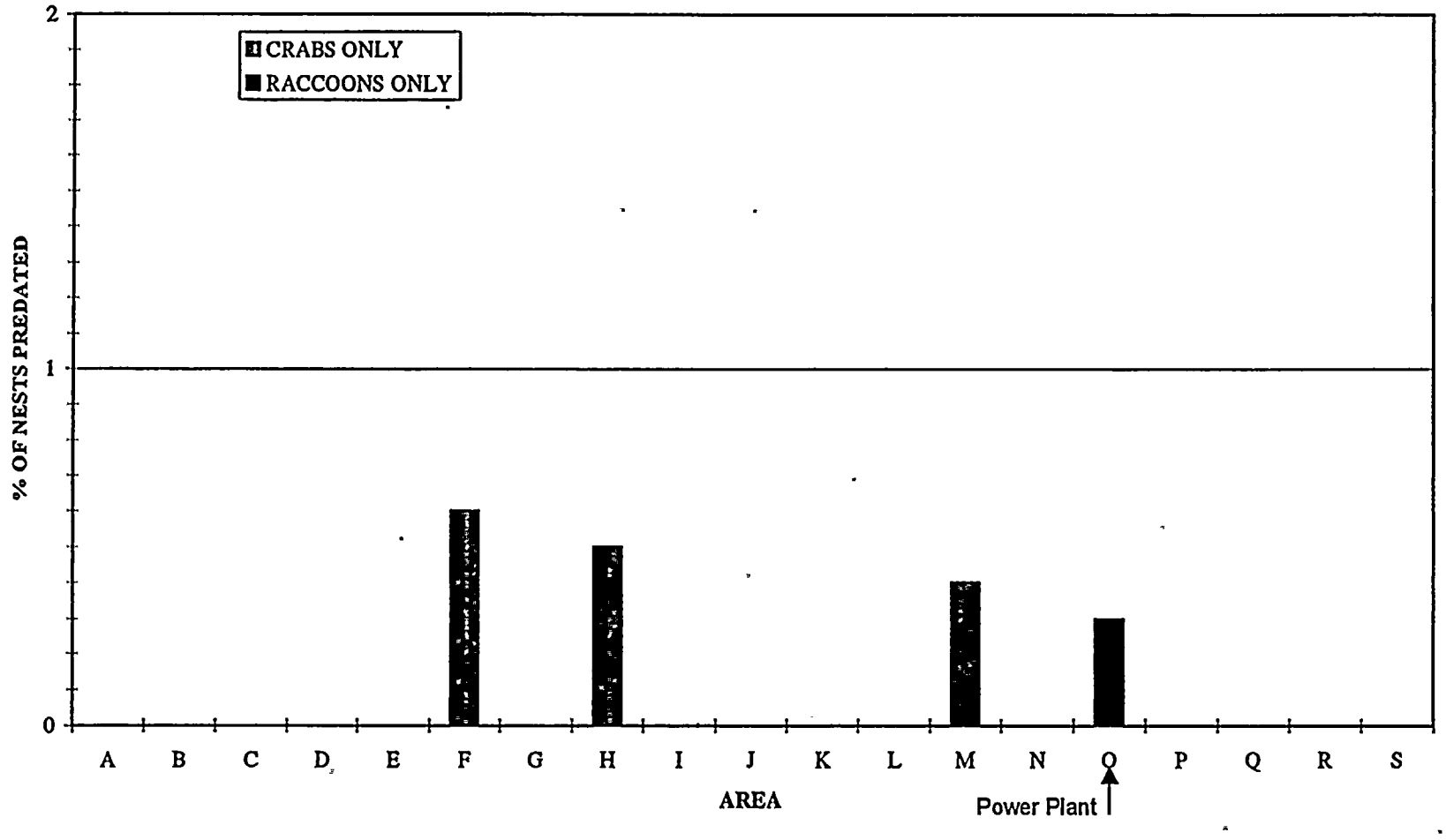

Figure 7. Percentage of Loggerhead Turtle Nests Predated by Raccoons and/or Ghost Crabs in Areas A Through S, Hutchinson Island, April Through September 1998.

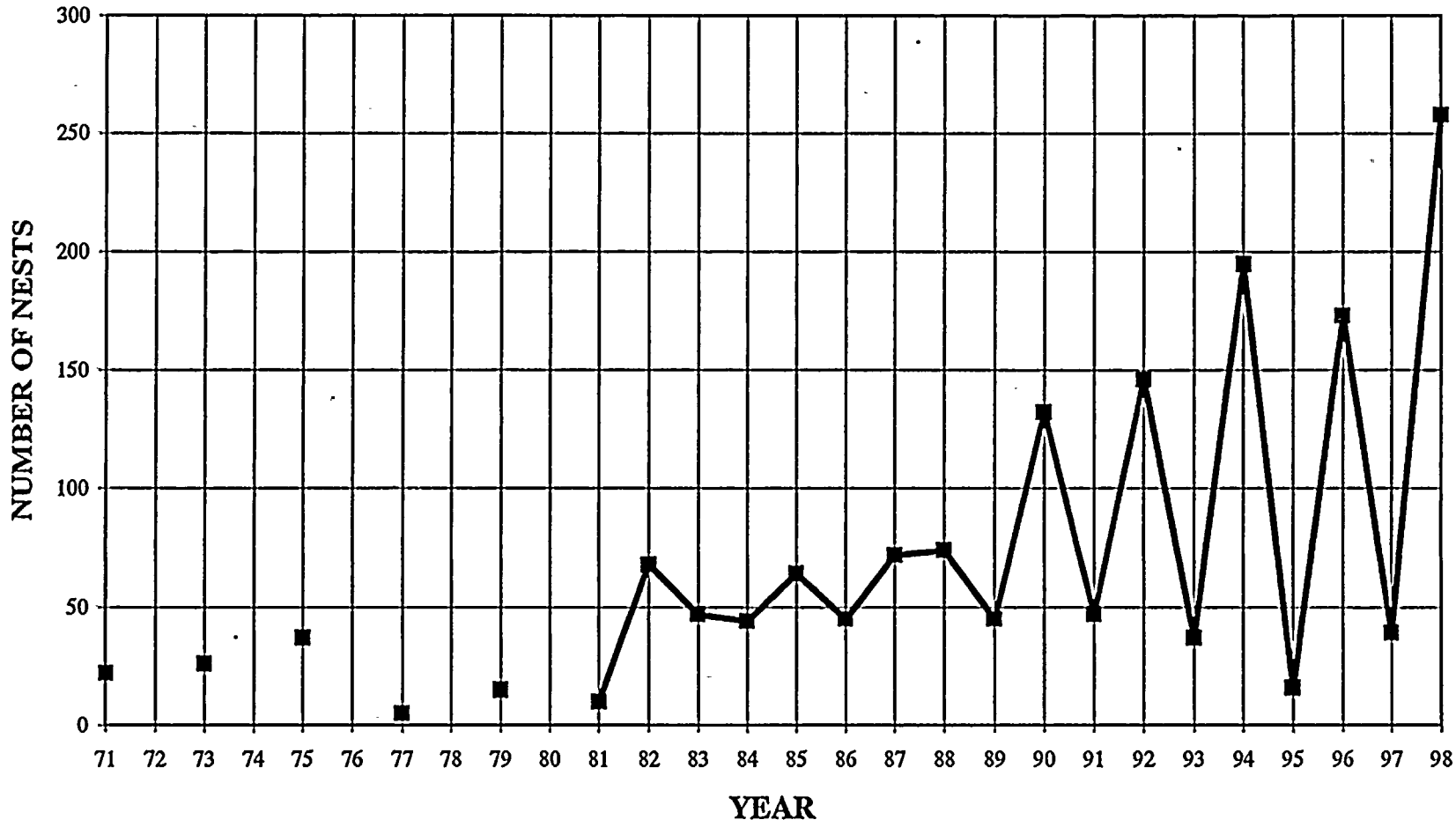

Figure 8. Number of Green Sea Turtle Nests, Hutchinson Island, 1971 Through 1998. Values for 1971 Through 1979 Are Estimates (See Text). Values for 1981 Through 1998 Are from Whole Island Surveys.

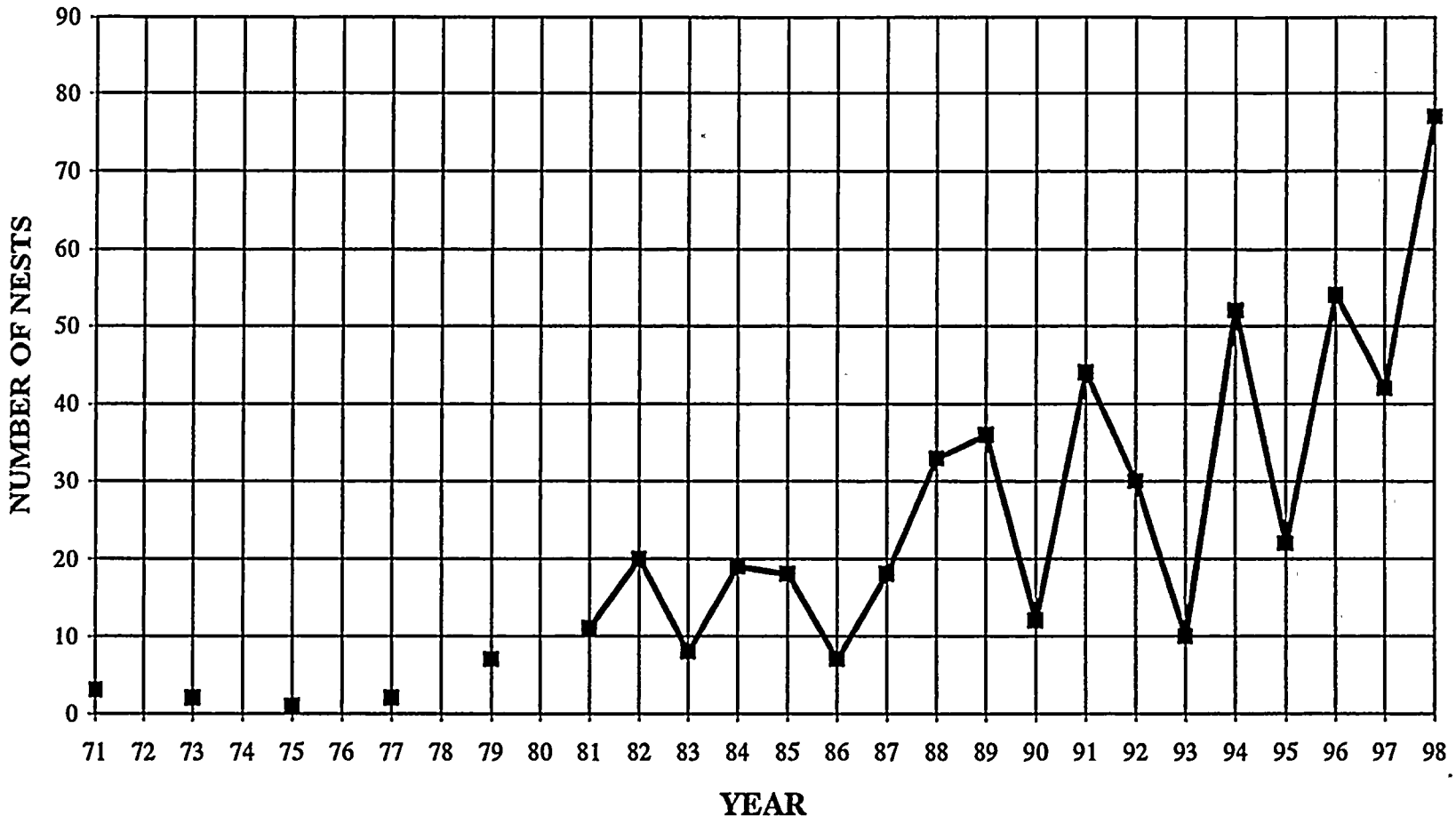

Figure 9. Number of Leatherback Turtle Nests, Hutchinson Island, 1971 Through 1998. Values for 1971 Through 1979 Are Estimates (See Text). Values for 1981 Through 1998 Are from Whole Island Surveys.

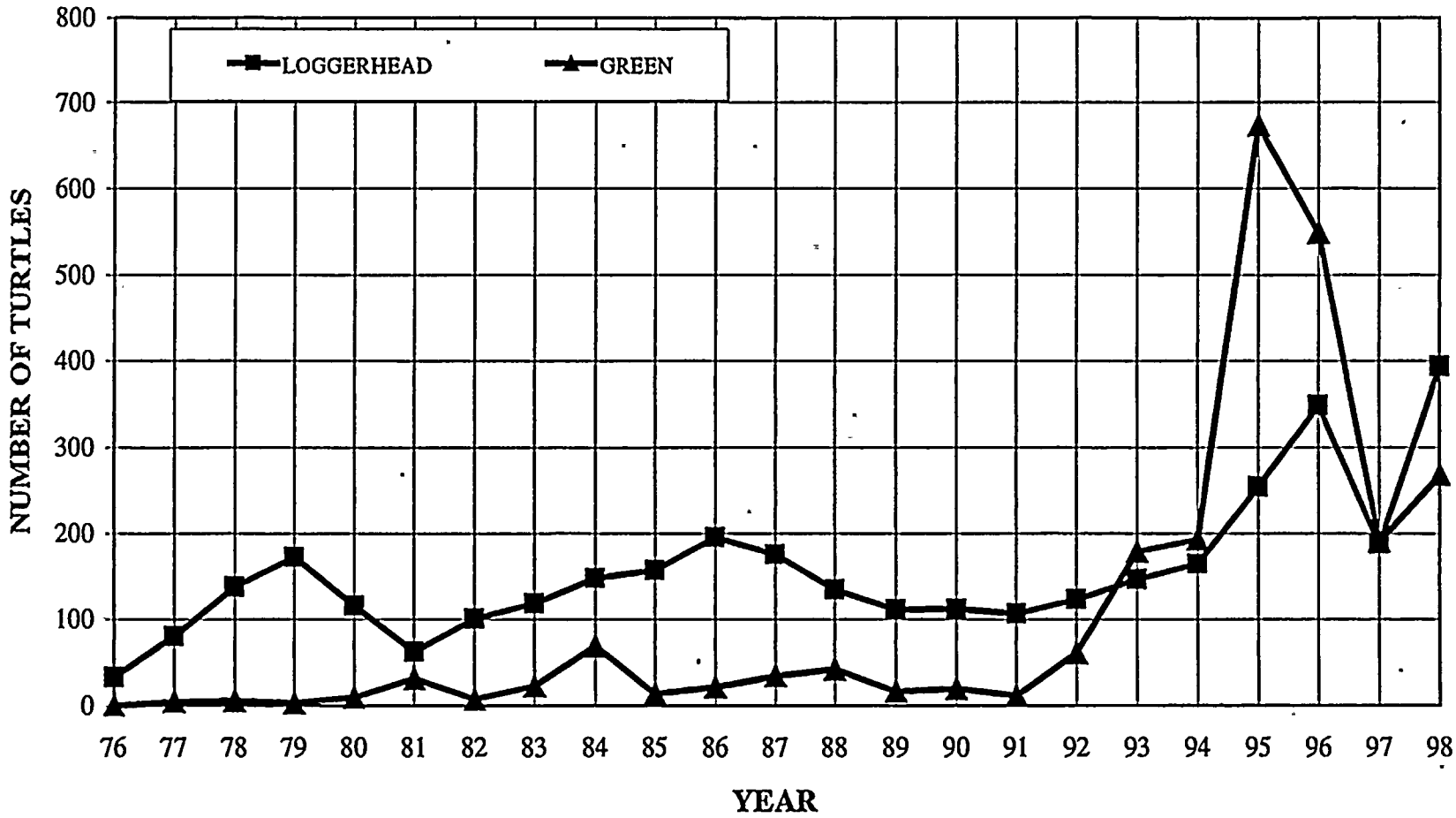

Figure 10. Number of Loggerhead and Green Turtles Removed Each Year from the Intake Canal, St. Lucie Plant, 1976 Through 1998.

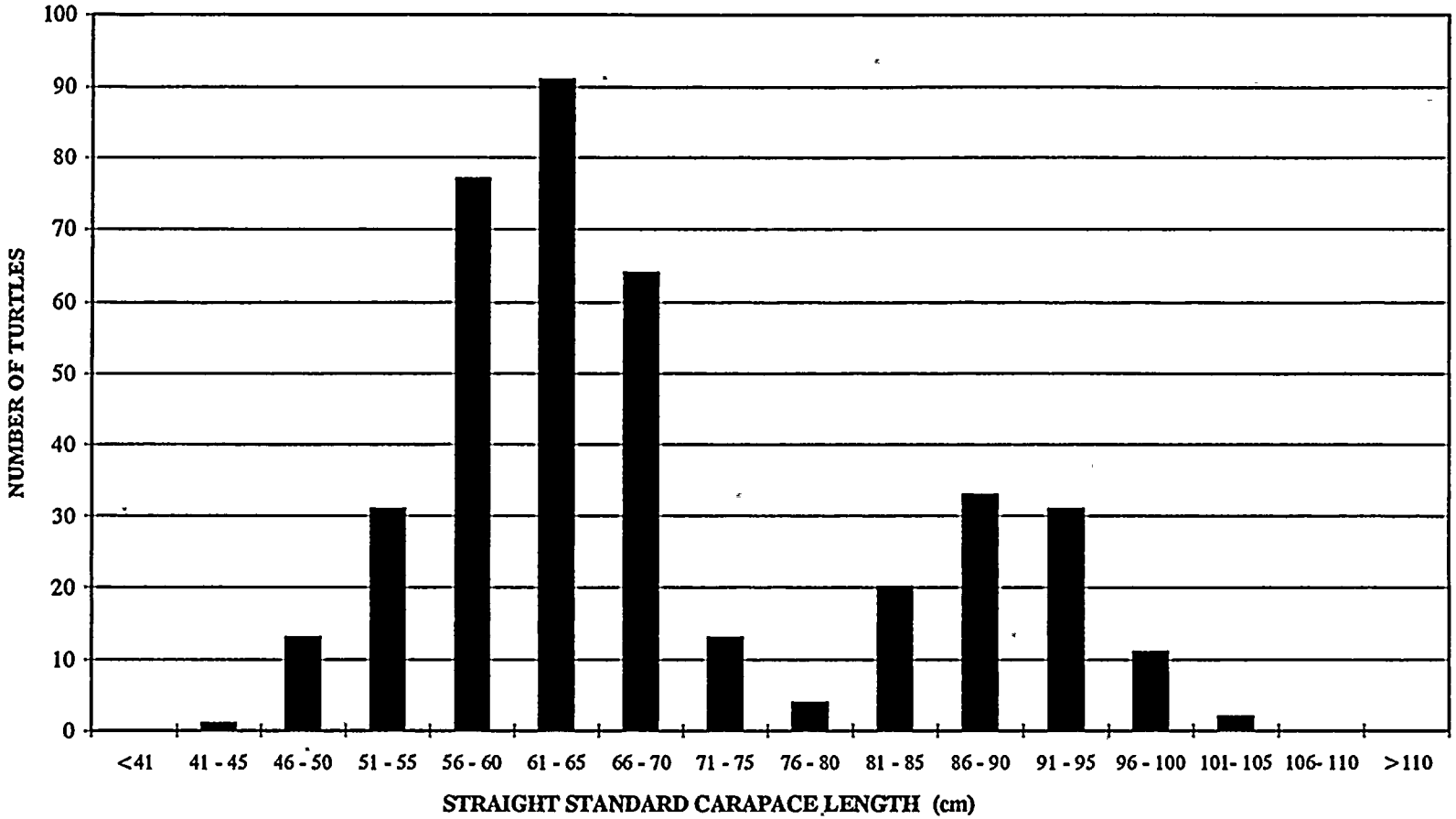

Figure 11. Size Distribution (SSCL) of Loggerhead Turtles (N=391) Removed from the Intake Canal, St. Lucie Plant, 1998.

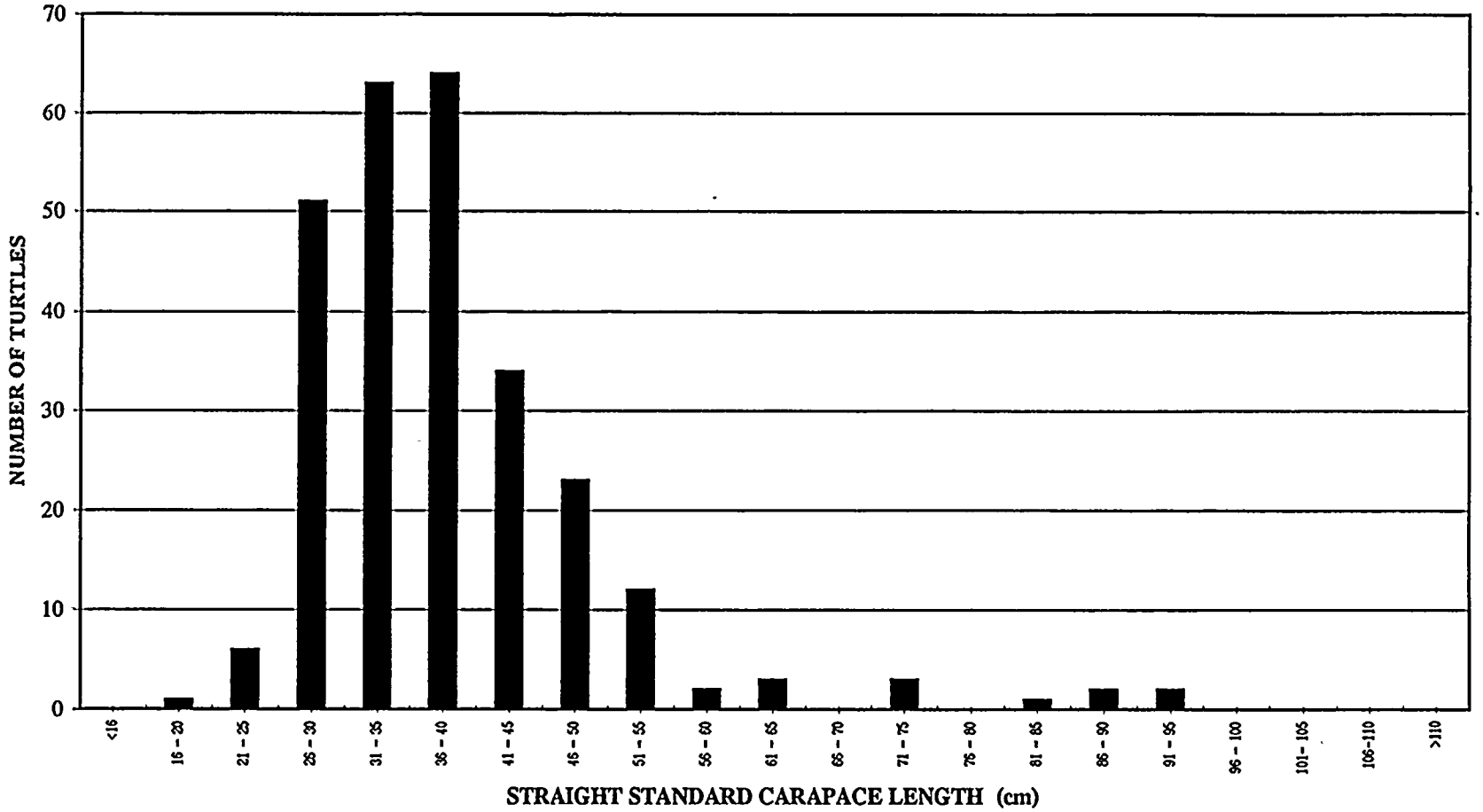

Figure 12. Size Distribution (SSCL) of Green Turtles (N=267) Removed from the Intake Canal, St. Lucie Plant, 1998.

6.0 TABLES

YEAR	Species					
	Loggerhead	Green	Leatherback	Hawksbill	Kemp's Ridley	Total
1976	33 (4)					33 (4)
1977	80 (5)	5 (2)	1			86 (7)
1978	138 (19)	6 (1)	3	1		148 (20)
1979	172 (13)	3 (1)				175 (14)
1980	116 (5)	10 (3)				126 (8)
1981	62 (5)	32 (2)	2		1	97 (7)
1982	101 (16)	8	1			110 (16)
1983	119 (4)	23 (4)				142 (8)
1984	148 (3)	69 (2)		1	2	220 (5)
1985	157 (4)	14		1		172 (4)
1986	195 (27)	22 (1)	1	1	1	220 (28)
1987	175 (11)	35		2	6 (2)	218 (13)
1988	134 (6)	42 (2)			5 (2)	181 (10)
1989	111 (4)	17 (1)	1	2	2	133 (5)
1990	112 (1)	20 (2)				132 (3)
1991	107 (1)	12		1	1	121 (1)
1992	123 (2)	61 (2)	1	2		187 (4)
1993	147	179 (1)	5	2	4	337 (1)
1994	164	193 (4)	2		2	361 (4)
1995	254 (1)	673 (15)	1		5	933 (16)
1996	349 (3)	549 (4)		5	3	906 (7)
1997	188	191 (5)	2	1		382 (5)
1998	393 (1)	268	1	2	2	666 (1)
Total	3578 (135)	2432 (52)	21	21	34 (4)	5420 (191)
Annual Mean*	162.6	110.5	1.0	1.0	1.5	275.1

* Excludes 1976 (partial year of plant operation).

Table 1. Total Number of Captures and (Number of Dead) Turtles Removed from the Intake Canal

Month	Number of Captures	Percent of All Captures	Minimum	Maximum	Mean	Standard Deviation	1998
January	421	11.9%	6	39	19.1	10.2	36
February	335	9.4%	5	34	15.2	8.4	28
March	354	10.0%	1	60	16.1	14.7	60
April	364	10.3%	0	47	16.5	12.7	47
May	304	8.6%	0	40	13.8	10.4	29
June	364	10.3%	3	42	16.5	11.1	26
July	405	11.4%	0	87	18.4	20.1	57
August	324	9.1%	2	43	14.7	12.2	43
September	194	5.5%	1	19	8.8	5.2	17
October	193	5.4%	0	27	8.8	6.3	27
November	125	3.5%	0	15	5.7	3.9	10
December	162	4.6%	1	13	7.4	4.1	13
Total	3545		0	87			393
Mean					13.4		32.8
Std. Deviation					4.6		16.3

* First full year of plant operation. An additional 33 loggerheads were captured during 1976.

Table 2. Total Number of Loggerhead Turtles Removed Each Month from Intake Canal, St. Lucie Plant, 1977 - 1998.

Month	Number of Captures	Percent of All Captures	Minimum	Maximum	Mean	Standard Deviation	1998
January	284	11.7%	0	59	12.9	15.5	25
February	289	11.9%	0	64	13.1	18.3	58
March	370	15.2%	0	147	16.8	35.6	30
April	210	8.6%	0	64	9.5	17.3	20
May	180	7.4%	0	91	8.2	20.2	35
June	137	5.6%	0	52	6.2	12.6	16
July	125	5.1%	0	61	5.7	14.1	7
August	151	6.2%	0	64	6.9	15.2	23
September	148	6.1%	0	77	6.7	17.8	10
October	198	8.1%	0	54	9.0	15.4	25
November	150	6.2%	0	42	6.8	10.8	10
December	190	7.8%	0	68	8.6	15.8	9
Total	2432		0	147			268
Mean					9.2		22.3
Std. Deviation					3.4		14.4

* First full year of plant operation.

Table 3. Total Number of Green Turtles Removed Each Month from the Intake Canal, St. Lucie Plant, 1977-1998.

ANNUAL ENVIRONMENTAL OPERATING REPORT

PART II

1.0 INTRODUCTION

The St. Lucie Unit 2 Environmental Protection Plan (EPP) requires the submittal of an annual report for various activities at the plant site including the reporting on sea turtle monitoring programs and other matters related to Federal and State environmental permits and certifications.

2.0 SEA TURTLE MONITORING AND ASSOCIATED ACTIVITIES

Surveillance and maintenance of the light screen to minimize sea turtle disorientation as required by Section 4.2.4 of the EPP is ongoing. The vegetation light screen located on the beach dune between the power plant and the ocean is routinely surveyed to determine its overall vitality. The vegetation line is surveyed for any gaps occurring from mortality, which would result in unacceptable light levels on the beach. Trees, vegetation, or shade cloths are replaced as necessary to maintain the overall integrity of the light screen. Plant parking lot lighting is also designed and maintained to minimize light levels on the beach.

3.0 TAPROGGE CONDENSER TUBE CLEANING SYSTEM OPERATION

A Taprogge condenser tube cleaning system (CTCS) became operational on St. Lucie Unit 2 in January 1996 and on Unit 1 in July 1996. This system utilizes sponge balls, approximately 24 mm in diameter, to clean the condenser tubes through which seawater flows to cool steam after its pass through the plant's turbines. This system improves plant performance while reducing the need for chemical treatments such and biocides or chlorine to control biofouling.

Normally, the St. Lucie CTCS utilizes about 1800 sponge balls, which are continually recirculated through each of four "water boxes" on each unit. These sponge balls are retained in the system by a ball strainer located on the outlet of each water box. The ball strainers (mesh size 5 mm) are opened routinely to discharge debris, which can decrease flow and obstruct sponge ball movement through the system. The sponge balls are collected prior to opening, or back flushing, the ball strainers. At that time, the sponge balls are examined and replaced if they are worn to the point that they can no longer effectively clean the condenser tubes.

Sponge ball inventories and estimates of sponge ball loss to the environment have been performed since system start-up on both units. Number of ball strainer back flushes has also been tracked. In addition, daily beach surveys have been performed on plant property (approximately 2.5 miles) to note any sponge balls that may have appeared as a result of loss from the plant. This survey area has been extended during the turtle-nesting season to almost 12 miles.

The results of the program for 1998 are presented in Table 1. Larger sponge ball losses occurred on Unit 2 for the year. These losses are probably related to the fact that 1998 represents the end of fuel cycle for that unit. Estimated sponge ball loss from both units was 20.2 balls per day for 1998. Fifty sponge balls were found whole in the environment near the plant. This is an increase

over previous years, but the number indicates that few balls actually reach the environment whole. Figure 1 indicates that estimated sponge ball loss generally increased through the month of April of 1998. Average daily ball loss in 1998 increased from the 1996 and 1997 totals (Figure 2). It is believed that much of the losses are caused by increased growth inside the waterboxes. New coatings on these surfaces are being used to try to eleviate this problem. These coating were applied to Unit 2 in December 1998. If the coating proves effective it will be applied to Unit 1 in September 1999.

4.0 OTHER ROUTINE REPORTS

The following items for which reporting is required are listed by section number from the plant's Environmental Protection Plan:

5.4.1(a) EPP NONCOMPLIANCES AND CORRECTIVE ACTIONS TAKEN

No noncompliance's under EPP Section 5.4.1(a) were determined to have occurred during 1998.

5.4.1(b) CHANGES IN STATION DESIGN OR OPERATION, TESTS, AND EXPERIMENTS IN ACCORDANCE WITH EPP SUBSECTION 3.1

FPL letter L-98-180 transmitted the request for modification of Wastewater Permit Application to FDEP. The modification includes the use of biocide in the plant closed cooling water systems and the use of dimethylamine and carbohydrazide in the plant steam generator blowdown. This letter was transmitted June 26, 1998.

5.4.1(c) NONROUTINE REPORTS SUBMITTED TO THE NRC FOR THE YEAR 1998 IN ACCORDANCE WITH EPP SUBSECTION 5.4.2

1. Report concerning the mortality Least Terns at the plant Nuclear Training Center July 6, 1998 and July 17, 1998. Deaths occurred in the building's drainage system during heavy rainfall. Events were reported to NRC by FPL letter L-98-196 on July 23, 1998.

2. Report concerning an increase of jellyfish and subsequent effect of plant operation on September 9, 1998; reported to the NRC by FPL letter L-98-250 on October 1, 1998.

TABLE 1

1998 ST. LUCIE PLANT CONDENSER TUBE CLEANING

SYSTEM SUMMARY

MONTH	STRAINER BACK FLUSHES		ESTIMATED BALL LOSS		BALLS FOUND
	UNIT 1	UNIT 2	UNIT 1	UNIT 2	ON THE BEACH
January	5*	10	26	169	13
February	7	22	+26***	86	11
March	8	22	254	276	1
April	8	25	241	852	3
May	0^	29	242	580	3
June	2	24	+22***	448	3
July	33	23	130	586	1
August	29	27	66	744	8
September	25	20	114	483	3
October	31	23	129	228	1
November	24	1**	623	229	1
December	25	8**	76	759	2
Total	197	234	1853	5510	50

^ Due to poor sponge ball recovery, strainers were not back-flushed. Unit was down-powered, waterboxes taken out of service for manual removal of growth and balls.

* Unit 1 system shutdown during refueling, 1/1 to 1/19/98.

** Unit 2 system shutdown during refueling, 11/6 to 12/12/98.

*** Net gain in inventory.

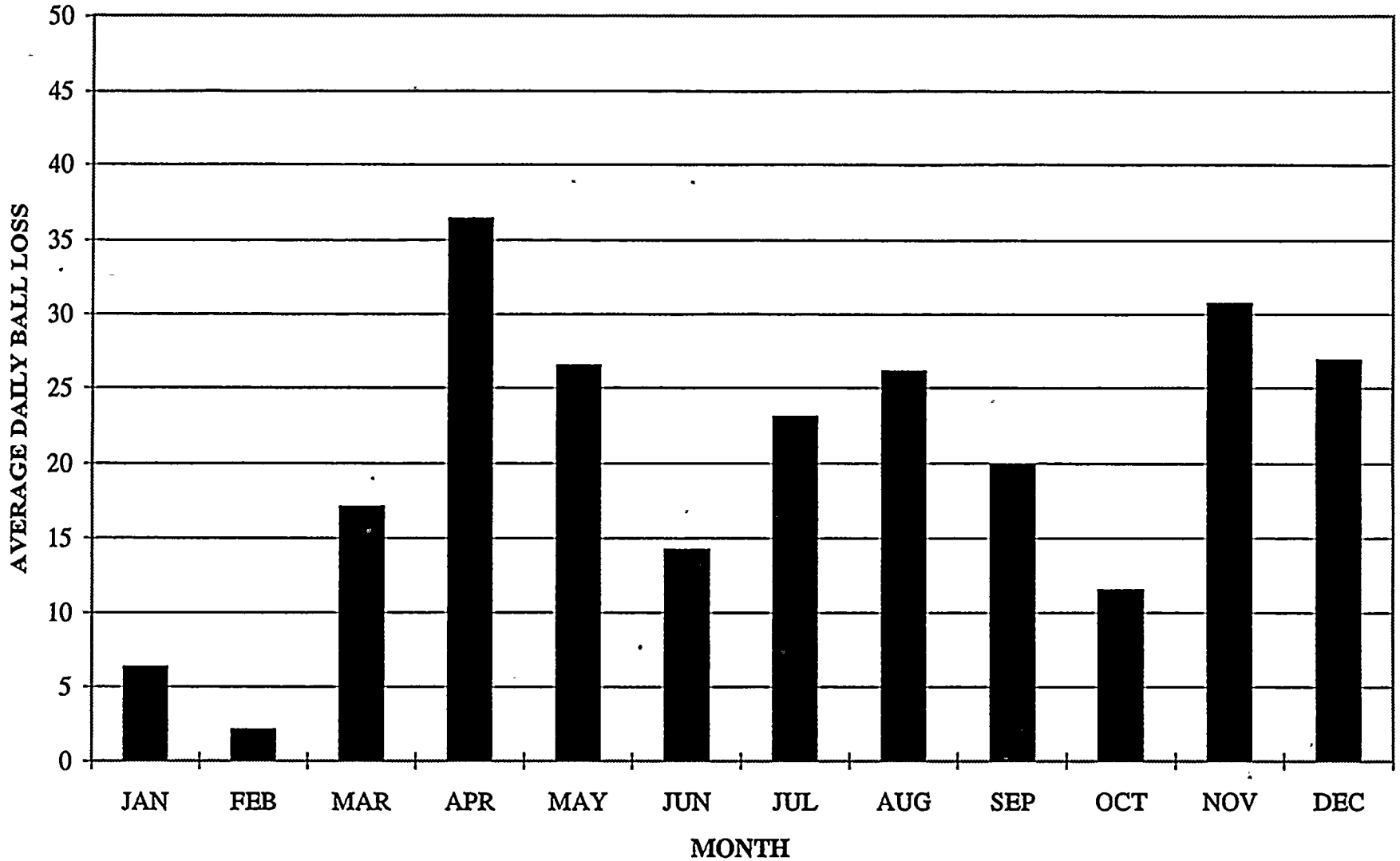

Figure 1. Estimated Average Daily Sponge Ball Loss by Month from St. Lucie Plant (Both Units) for 1998.

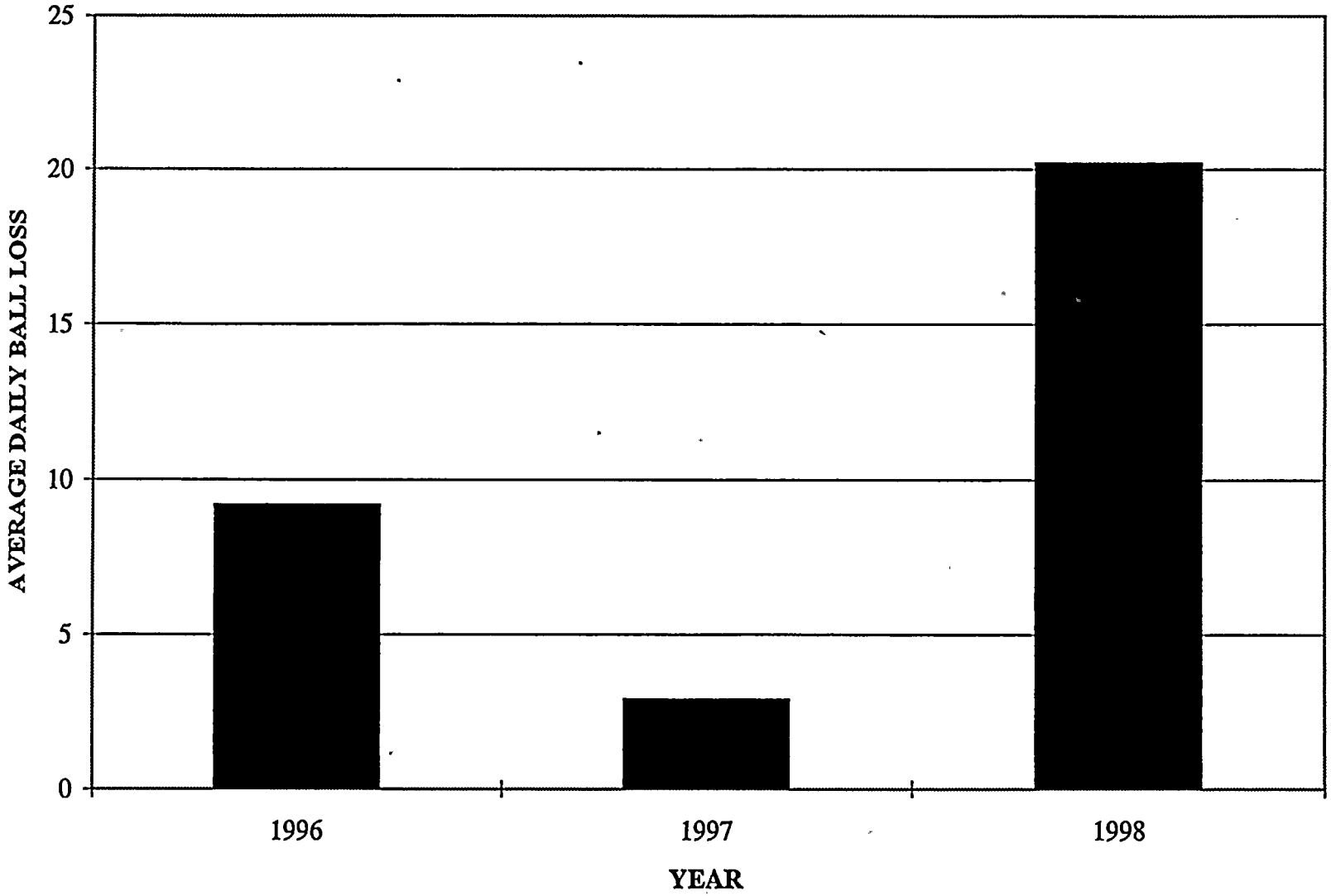

Figure 2. Average Daily Sponge Ball Loss from the St. Lucie Plant (Both Units) Since System Start-Up (January 1996)