AB - 555

FLORIDA POWER & LIGHT COMPANY

ST. LUCIE UNIT 2

ANNUAL ENVIRONMENTAL

OPERATING REPORT

1984

APRIL 1985

FLORIDA POWER & LIGHT COMPANY
MIAMI, FLORIDA
APPLIED BIOLOGY, INC.
ATLANTA, GEORGIA

ENVIRONMENTAL OPERATING REPORT

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TABLE OF CONVERSION FACTORS FOR METRIC UNITS

To convert	Multiply by	To obtain
centigrade (degrees)	(°C x 1.8) + 32	fahrenheit (degrees)
centigrade (degrees)	°C + 273.18	kelvin (degrees)
centimeters (cm)	3.937×10^{-1}	inches
centimeters (cm)	3.281×10^{-2}	feet
centimeters/second (cm/sec)	3.281×10^{-2}	feet per second
cubic centimeters (cm^3)	1.0×10^{-3}	liters
grams (g)	2.205×10^{-3}	pounds
grams (g)	3.527×10^{-2}	ounces (avoirdupois)
hectares (ha)	2.471	acres
kilograms (kg)	1.0×10^{3}	grams
kilograms (kg)	2.2046	pounds
kilograms (kg)	3.5274×10^{1}	ounces (avoirdupois)
kilometers (km)	6.214×10^{-1}	miles (statute)
kilometers (km)	1.0×10^{6}	millimeters
liters (l)	1.0×10^{3}	cubic centimeters (cm3)
liters (l)	2.642×10^{-1}	gallons (U.S. liquid)
meters (m)	3.281	feet
meters (m)	3.937×10^{1}	inches
meters (m)	1.094	yards
microns (μ)	1.0×10^{-6}	meters
milligrams (mg)	1.0×10^{-3}	grams
milligrams/liter (mg/l)	1.0	parts per million
milliliters (ml)	1.0×10^{-3}	liters (U.S. liquid)
millimeters (mm)	3.937×10^{-2}	inches
millimeters (mm)	3.281×10^{-3}	feet
square centimeters (cm^2)	1.550×10^{-1}	square inches
square meters (m2)	1.076×10^{1}	square feet
square millimeters (mm^2)	1.55×10^{3}	square inches

EXECUTIVE SUMMARY

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-MW units; Unit 1 was placed on-line in March 1976 and Unit 2 in May 1983. This document has been prepared to satisfy the requirements contained in the United States Nuclear Regulatory Commission's Appendix B Environmental Protection Plan (EPP) to St. Lucie Unit 2 Facility Operating License No. NPF-16 and covers environmental protection activities conducted during 1984 primarily related to sea turtles, as required by Subsection 4.2 of the EPP.

TURTLES

There have been considerable year-to-year fluctuations in sea turtle nesting activity on Hutchinson Island since monitoring began in 1971. In the vicinity of the plant, low nesting activity in 1975 and 1981 - 1983 was attributed to construction of plant intake and discharge systems. Nesting returned to normal levels following both periods of construction. No relationship between total nesting on the island and power plant operation or intake/discharge construction was indicated.

Since plant operation began in 1976, 1135 turtles have been removed from the intake canal. Differences in the numbers of turtles found during different years and different months were attributed to natural variations in the occurrence of turtles in the vicinity of the plant, rather than to any influence of the plant itself. The majority (over 90 percent) of the turtles removed from the intake canal were captured alive and released back into the ocean. The cause of death for those turtles found dead in the canal was, for the most part, unknown. Evidence did not suggest that drowning or injury sustained from passage through the intake pipes were significant factors causing mortality. Similarly, studies showed that turtles entrapped in the intake canal were caught and released within a relatively short time span, so length of time in the canal was not considered a mortality related factor. The poor condition of many turtles found alive in the canal suggested the possibility that some individuals, already in poor condition, may have entered the ocean intakes seeking refuge and died in the intake canal from causes unrelated to plant operations.

OTHER RELATED ACTIVITIES

No EPP noncompliance activities have occurred during the reporting period and no station design and operation changes, tests or experiments affecting the environment have occurred. Nonroutine reports previously submitted have been itemized.

Replantings of the Australian pine light screen along the dune line were completed in December 1983. The success of the plantings were assessed in 1984. Findings from studies to evaluate and/or mitigate intake entrapment and turtle mortality were presented to regulatory agencies during 1984 in a report entitled "Sea Turtle Intake Entrapment Studies." This report is presently under review.

INTRODUCTION

BACKGROUND

This document has been prepared to satisfy the requirements contained in the United States Nuclear Regulatory Commission's (NRC) Appendix B Environmental Protection Plan to St. Lucie Unit 2 Facility Operating License No. NPF-16.

In 1970, Florida Power & Light Company (FPL) was issued Permit No. CPPR-74 by the United States Atomic Energy Commission, now the Nuclear Regulatory Commission, that allowed construction of Unit 1 of the St. Lucie Plant, an 850-MW nuclear-powered electric generating station on Hutchinson Island in St. Lucie County, Florida. St. Lucie Plant Unit 1 was placed on-line in March 1976. Unit 1 operation was intermittent during the remainder of 1976 but, except for brief outages, has been in operation from 1977 through February 1983, when it was taken off-line for a maintenance outage. In May 1977, FPL was issued Permit No. CPPR-144 by the NRC for the construction of a second 850-MW nuclear-powered unit. Unit 2 was placed on-line in May 1983 and began commercial operation in August.

St. Lucie Plant 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 use have been the subject of FPL-sponsored studies at the site.

The Florida Department of Natural Resources (DNR) Marine Research Laboratory conducted baseline environmental studies of the marine environment adjacent to the St. Lucie Plant from September 1971 to July 1974. From these studies, a series of reports was published by the Florida DNR entitled "Nearshore Marine Ecology at Hutchinson Island, Florida: 1971-1974" (Florida DNR, 1977, 1979). These publications describe the marine environment off Hutchinson Island prior to operation of the St. Lucie Plant.

In order to provide Unit 1 operational and Unit 2 preoperational monitoring of the aquatic environment at the St. Lucie Plant, Applied Biology, Inc. (ABI) was contracted by FPL in 1975 to conduct the ecological studies program. The results and interpretation of the ABI monitoring program conducted from 1976 through 1981 have been presented in six annual reports. Two of these annual reports were entitled "Ecological Monitoring at the Florida Power & Light Co. St. Lucie Plant, Annual Report" (ABI, 1977, 1978) and four were entitled "Florida Power & Light Company St. Lucie Plant Annual Non-Radiological Environmental Monitoring Report, Biotic Monitoring" (ABI, 1979, 1980, 1981a, 1982).

In January 1982, a National Pollutant Discharge Elimination System (NPDES) permit was issued to FPL by the U.S. Environmental Protection Agency (EPA). The NPDES permit provided the EPA guidelines for the St. Lucie site biological studies. Guidelines were based on the ABI (1981b) document entitled "Proposed St. Lucie Plant Preoperational and Operational Biological Monitoring Program - August 1981". In May 1982, the NRC biological study requirements were deleted from the NRC

Environmental Technical Specifications. With the exception of those studies related to sea turtles, jurisdiction of biological studies at the St. Lucie Plant was thus passed from the NRC to the EPA.

Jurisdiction for sea turtle studies remained with the NRC, considered to be the lead federal agency relative to consultation under the Endangered Species Act. Sea turtle study guidelines relative to a light screen to prevent turtle disorientation are included in the St. Lucie Unit 1 Appendix B - Part II Environmental Protection Plan Technical Specifications. The majority of the sea turtle studies, including the beach nesting survey and intake canal monitoring, are contained in the NRC Environmental Protection Plan to St. Lucie Unit 2.

The present plan of study was fully instituted in May 1982. Final summaries of previous study efforts and the first-year results using the new study plan were presented in the document entitled "Florida Power & Light Company St. Lucie Plant Annual Non-Radiological Aquatic Monitoring Report" (ABI, 1983). Results for 1983, the second year of study under the new plan, were presented in an environmental monitoring report (ABI, 1984a), which covers nektonic organisms, macroinvertebrates and sea turtles, and in the previous environmental operating report (ABI, 1984b). This document covers 1984 results of the environmental protection activities, primarily related to sea turtles, as required by Subsection 4.2 of the St. Lucie Plant Unit 2 Environmental Protection Plan.

AREA DESCRIPTION

The St. Lucie Plant is located on a 457-ha site on Hutchinson Island on Florida's east coast (Figures A-1 and A-2). The plant is approximately midway between the Ft. Pierce and St. Lucie Inlets. It is bounded on its east side by the Atlantic Ocean and on its west side by the Indian River, a shallow lagoon.

Hutchinson Island is a barrier island that extends 36 km between inlets and obtains 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. Island vegetation is typical of southeastern Florida coastal areas; dense stands of Australian pine, palmetto, sea grape and Spanish bayonet are present at the higher elevations, and mangroves abound at the lower elevations. Large stands of black mangroves, including some on the plant site, have been killed by flooding for mosquito control over past decades.

The ocean bottom immediately offshore from the plant site consists entirely of sand and shell sediments with no reef obstructions or rock outcroppings. The unstable substrate limits the establishment of rooted macrophytes or permanent attached benthic communities. Worm reefs occur in some intertidal areas and provide a substrate more suitable for plant and animal habitation. However, worm reefs are limited both in locations found and area covered.

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.

PLANT DESCRIPTION

The St. Lucie Plant consists of two 850-MW nuclear-fueled electric generating units that use nearshore 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. Each of the intake structures is equipped with a velocity cap to minimize fish entrapment. Horizontal intake velocities are less than 30 cm/sec. From the intake structures, the water passes through submerged pipes under the beach and dunes that lead to a 1500-m long intake canal. This canal transports the water to the plant. After passing through the plant, the heated water is discharged into a 670-m 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.

Heated water leaves the first discharge line from a Y-shaped nozzle (diffuser) at a design velocity of 396 cm/sec. This high-momentum jet entrains ambient water resulting in rapid heat dissipation. The ocean depth in the area of the first discharge is about 6 m. Heated water leaves the second discharge line through a series of 48 equally spaced

high velocity jets along a 323-m manifold (multiport diffuser). This diffuser starts 168 m beyond the first discharge and terminates 856 m from shore. The ocean depth at discharge along this diffuser is from about 10 to 12 m. As with the first diffuser, the purpose of the second diffuser is to entrain ambient water and rapidly dissipate heat. From the points of discharge at both diffusers, the warmer water rises to the surface and forms a surface plume of heated water. The plume then spreads out on the surface of the ocean under the influence of wind and currents and the heat dissipates to the atmosphere.

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____________________. 1977. Nearshore marine ecology at Hutchinson Island, Florida: 1971-1974. Parts VI through X. Florida Marine Research Publication No. 34. Florida Department of Natural Resources Marine Research Laboratory.

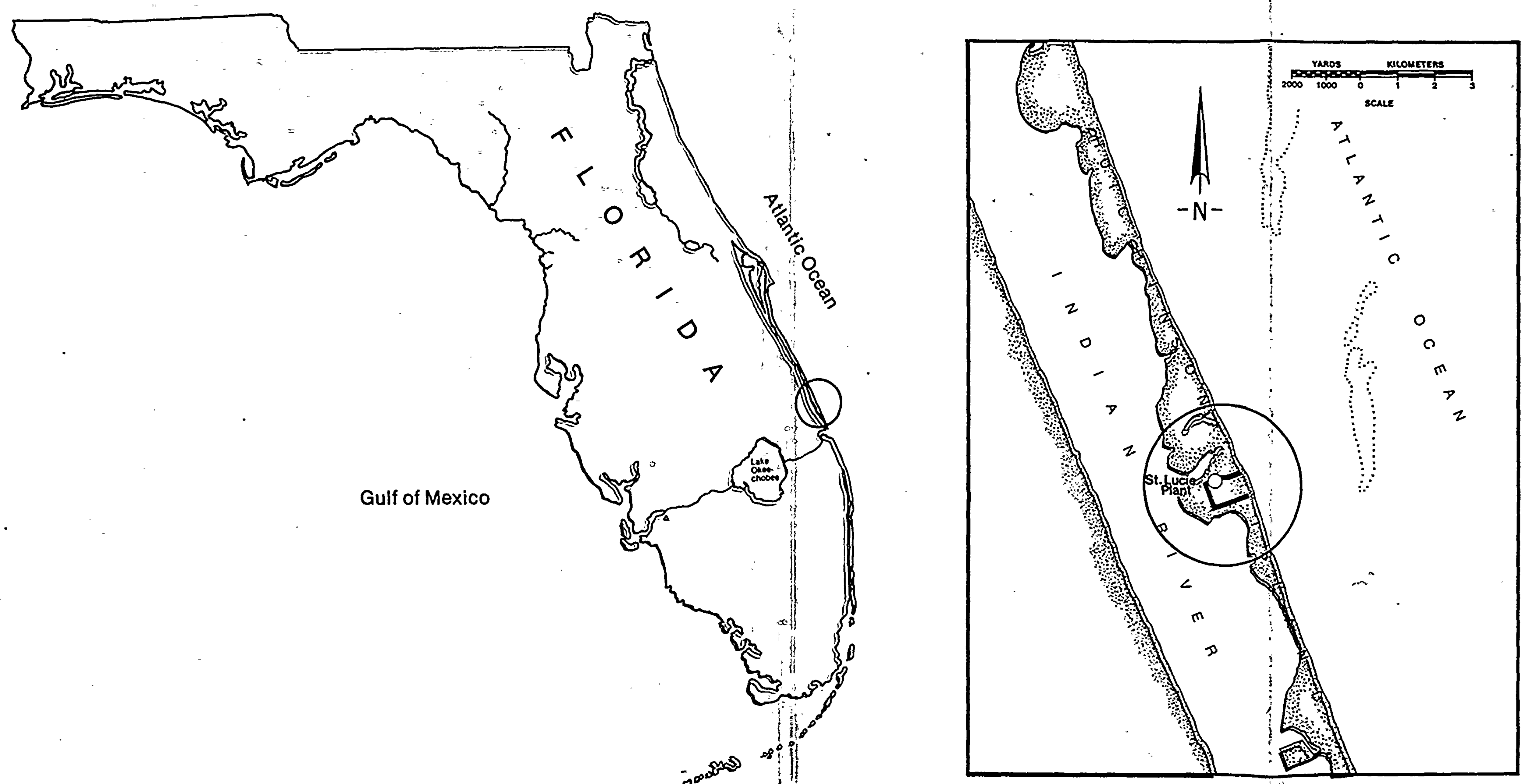

Figure A-1. Location of the St. Lucie Plant.

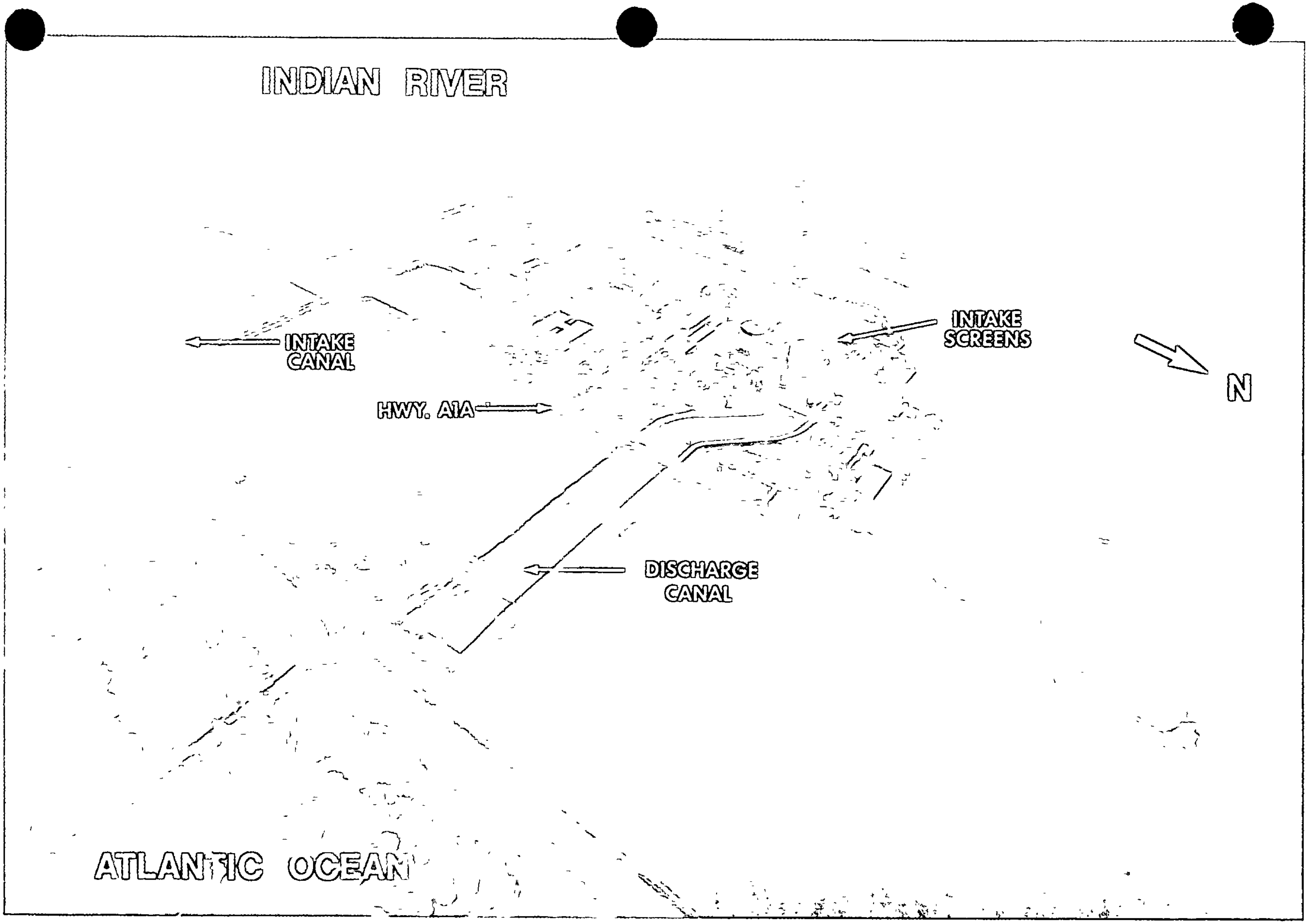

Figure A-2. St. Lucie Plant aerial photograph.

TURTLES

The NRC's St. Lucie Unit 2 Appendix B Environmental Protection Plan issued April 1983 contains the following technical specifications:

4.2 Terrestrial/Aquatic Issues

Issues on endangered or threatened sea turtles raised in the Unit 2 FES-OL [NRC, 1982] and in the Endangered Species Biological Assessment (March 1982) [Bellmund et al., 1982] will be addressed by programs as follows:

4.2.1 Beach Nesting Surveys

Beach nesting surveys for all species of sea turtles will be conducted on a yearly basis for the period of 1982 through 1986. These surveys will be conducted during the nesting season from approximately mid-April through August.

The Hutchinson Island beach will be divided into 36 one-km long survey areas. In addition, the nine 1.25-km long survey areas used in previous studies (1971-1979) will be maintained for comparison purposes. Survey areas will be marked with numbered wooden plaques and/or existing landmarks.

The entire beach will be surveyed seven days a week. All new nests and false crawls will be counted and recorded in each area. After counting, all crawl tracks will be obliterated to avoid recounting. Predation on nests by raccoons or other predators will be recorded as it occurs. Records will be kept of any seasonal changes in beach topography that may affect the suitability of the beach for nesting.

4.2.2 Studies to Evaluate and/or Mitigate Intake Entrapment

A program that employs light and/or sound to deter turtles from the intake structure will be conducted. The study will determine with laboratory and field experiments if sound and/or light will result in a reduction of total turtle entrapment rate.

The study shall be implemented no later than after the final removal from the ocean of equipment and

structures associated with construction of the third intake structure and the experiments shall terminate 18 months later. Four months after the conclusion of the experimental period, a report on the results of the study will be submitted to NRC, EPA, National Marine Fisheries Service (NMFS), and the U.S. Fish and Wildlife Service (USFWS) for their evaluation. If a statistically significant reduction in annual total turtle entrapment rate of 80 percent or greater can be demonstrated, using the developed technology and upon FPL receiving written concurrence by NRC, EPA, NMFS, and USFWS then permanent installation of the deterrent system shall be completed and functioning no later than 18 months after the agencies' concurrence. The design of this study needs to take into account the significant annual variation in turtle entrapment observed in the past.

If an 80 percent reduction of turtle entrapment cannot be projected to all three intake structures, then an interagency task force composed of NRC, EPA, NMFS, USFWS, and FPL shall convene 18 months after completion of the third intake and determine if other courses of action to mitigate and/or reduce turtle entrapment are warranted (such as physical barrier, emergence of new technology or methods to deter turtles).

4.2.3 Studies to Evaluate and/or Mitigate Intake Canal Mortality

Alternative methods or procedures for the capture of sea turtles entrapped in the intake canal will be evaluated. If a method or procedure is considered feasible and cost effective and may reduce capture mortality rates, it will be field tested in the intake canal.

4.2.4 Light Screen to Minimize Turtle Disorientation [NOTE: This is also Section 4.2 of the NRC St. Lucie Unit 1 Appendix B Technical Specifications issued May 1982]

Australian pine or other suitable plants (i.e., native vegetation such as live oak, native figs, wild tamarine and others) shall be planted and maintained as a light screen, along the beach dune line bordering the plant property, to minimize turtle disorientation.

4.2.5 Capture and Release Program

Sea turtle removal from the intake canal will be conducted on a continuing basis. The turtles will be captured with large mesh nets, or other suitable nondestructive device(s), if deemed appropriate. A formalized daily inspection, from the shoreline, of the capture device(s) will be made by a qualified individual when the device(s) are deployed. The turtles will be identified to species, measured, weighed (if appropriate), tagged and released back into the ocean. Records of wounds, fresh or old, and a subjective judgement on the condition of the turtle (e.g., barnacle coverage, underweight) will be maintained. Methods of obtaining additional biological/physiological data, such as blood analyses and parasite loads, from captured sea turtles will be pursued. Dead sea turtles will be subjected to a gross necropsy, if found in fresh condition.

INTRODUCTION

Hutchinson Island, Florida, is an important rookery for the Atlantic loggerhead turtle, *Caretta caretta*, and also supports some nesting of the Atlantic green turtle, *Chelonia mydas*, and the leatherback turtle, *Dermochelys coriacea* (Caldwell et al., 1959; Routa, 1968; Gallagher et al., 1972; Worth and Smith, 1976; Williams-Walls et al., 1983). All three species are protected by state and federal statutes. The federal government classifies the loggerhead turtle as a threatened species. The leatherback turtle and the Florida nesting population of the green turtle are listed by the federal government as endangered species. Because of reductions in world populations of marine turtles resulting from coastal development and fishing pressure (NMFS, 1978), maintaining the vitality of the Hutchinson Island rookery is important.

It has been a prime concern of FPL that the construction and subsequent operation of 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.

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. The St. Lucie Plant began operation in 1976; therefore, the first three survey years (1971, 1973 and 1975) were preoperational. Though the power plant was not operating during 1975, St. Lucie Plant Unit No. 1 ocean intake and discharge systems were installed during that year. Installation of these systems included construction activities conducted offshore from and perpendicular to the beach. Construction activity 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 system for St. Lucie Plant 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 1984, thirty-six 1-km long survey areas comprising the entire island were monitored seven days a week during the nesting season. The St. Lucie Plant Unit No. 2 discharge system was installed during the 1981 nesting season. Offshore and beach construction of the Unit 2 intake system proceeded throughout the 1982 nesting season and was completed near the end of the 1983 season. Construction activities associated with installation of both systems were similar to those conducted when Unit 1 intake and discharge systems were installed. Eggs from turtle nests potentially endangered by construction activities were relocated during all three years.

In addition to monitoring sea turtle nesting activities and relocating nests away from plant construction areas, monitoring of turtles in the intake canal and removal of trapped turtles have been integral parts of the St. Lucie Plant environmental monitoring program. Turtles that enter the ocean intake structures are carried with the intake cooling water through the intake pipe and into that portion of the intake canal between the intake headwall and the barrier net located at the Highway A1A bridge. Since the plant became operational in 1976, turtles that entered the intake canal have been captured, measured, tagged and released alive back into the ocean.

Previous reports have presented results of the nesting surveys and nest relocation activities (Gallagher et al., 1972; Worth and Smith, 1976; ABI, 1978, 1980, 1981, 1982, 1983, 1984; Williams-Walls et al., 1983) and documented studies on the potential effects of the discharge plume on turtle hatchlings (ABI, 1978; O'Hara, 1980). The purpose of this section is to 1) present 1984 sea turtle nesting survey data and summarize observed spatial and temporal trends in nesting activities, 2) document and summarize predation on turtle nests since 1971, and 3) present 1984 results of intake canal monitoring and summarize findings since 1976.

MATERIALS AND METHODS

Nesting Survey and Nest Relocation

Methodologies used during previous turtle nesting surveys on Hutchinson Island were described by Gallagher et al. (1972), Worth and Smith (1976) and ABI (1978, 1980, 1981, 1982, 1983, 1984). Methods used during the 1984 survey were designed to allow comparisons with these previous studies.

From 17 April through 1 May 1984, nest surveys were conducted every two to three days along Hutchinson Island from Ft. Pierce Inlet south to St. Lucie Inlet. After 1 May, surveys were conducted daily through 17 September 1984. 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 thirty-six 1-km long survey areas comprising the entire island (Figure D-1). The nine 1.25-km long survey areas established by Gallagher et al. (1972) also were monitored so comparisons could be made with previous studies.

During the daily turtle nest monitoring, the beach was continually monitored to detect any major changes in topography that may have affected the beach's suitability for nesting. In addition, on numerous occasions during the nesting season, each of the 36 1-km long survey areas was systematically analyzed and categorized based on beach slope (steep, moderate, etc.), width from high tide line to the dune, presence of benches (areas of abrupt vertical relief) and miscellaneous characteristics (packed sand, scattered rock, vegetation on the beach, exposed roots on the primary dune, etc.).

In a cooperative effort, the Florida Department of Natural Resources (DNR) was notified of all green turtle nests. Eggs from some of these nests were collected as part of the Florida DNR Headstart Program.

Intake Canal Monitoring

Turtles were removed from the intake canal with large-mesh nets fished between the intake headwall and the barrier net located at the Highway A1A bridge. Nets were usually set Monday mornings and removed Friday afternoons. The nets were checked for turtles several times per day by either Applied Biology or plant security personnel. Applied Biology was on call 24 hours per day to remove turtles from the intake.

Various sizes, numbers and locations of nets have been used to date as capture techniques continue to be refined. Nets in recent use were from 32 to 61 m in length, 2.7 to 3.7 m in depth and 30 to 40 cm in stretch mesh. Large floats kept the nets at the surface and, because nets were not weighted with lead lines, turtles which became entangled remained at the water's surface until removed.

The utmost care was taken in handling the turtles to prevent injury or trauma. After removal from the nets, turtles were identified to species, measured, weighed, tagged, examined for overall condition (wounds, abnormalities, parasites, etc.) and released back into the ocean. Since 1982, blood samples have been collected and analyzed to investigate the potential occurrence and significance of anemia in these animals and to determine the sex of immature turtles. During 1984, blood samples were

provided to the National Marine Fisheries Service for the purpose of developing and refining methods which will be used to conduct turtle stock analysis.

Sick or injured turtles were treated and occasionally held for observation prior to release. When treatment was warranted, injections of antibiotics and vitamins were administered by a local veterinarian. 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. Only two animals were found suitable for necropsy in 1984. Necropsy was conducted by S.N. Wampler, DVM, Jensen Beach, Florida.

Florida Power α Light Company and Applied Biology, Inc. continued to assist other sea turtle researchers in 1984. In addition to the Florida DNR's Headstart Program, data, specimens and/or assistance have been given to the National Marine Fisheries Service, U.S. Army Corps of Engineers, Smithsonian Institution, South Carolina Wildlife and Marine Resources Division, Texas A α M University, University of Rhode Island, University of South Carolina and the Western Atlantic Turtle Symposium.

Studies to Evaluate and/or Mitigate Intake Entrapment

A program that employs light and/or sound to deter turtles from the intake structure was conducted in 1982 and 1983 and completed in January 1984. As required by the specification, the results were written up and a presentation was made to the NRC, National Marine Fisheries Service and

the Florida Department of Natural Resources on 11 April 1984. Findings from these studies are under review.

Light Screen to Minimize Turtle Disorientation

Periodic inspections in 1983 by FPL personnel have verified the integrity of the beach dune light screen created to minimize turtle disorientation. Replanting was conducted in December 1983 to restore the Australian pine light screen where it was disturbed for the Unit 2 discharge line, a modification to the Unit 1 discharge headwall, and the third intake line. The success of these plantings were periodically assessed in 1984.

RESULTS AND DISCUSSION

Nesting Survey

Distribution of Nests Within the Nine 1.25-km-long Survey Areas

Nest density has varied considerably within each study area from year to year (Table D-1). However, distribution of nest densities with respect to the location of the nine survey areas has consistently shown a gradient of increasing nest density from north to south along the island Figure D-2). Nest densities were fairly uniform among the nine areas only in 1973. That year, Worth and Smith (1976) attributed this uniform nest distribution to beach accretion in Areas 1 through 3 (Figure D-1). The strongest gradient observed corresponds with the severe erosion of the northern portion of the island in 1979 (Williams-Walls et al., 1983). The changes in nest density gradients during periods of observed erosion and accretion indicate that these processes may influence the selection

of nesting sites by loggerhead turtles. However, no consistent relationship was apparent when field observations of beach widths during 1983 and 1984 were compared to the distribution of nests along the island during those years. Additional factors, such as offshore bottom contours, spatial distribution of nearshore reefs, type and extent of dune vegetation, and degree of human activity on the beach at night also may affect the spatial distribution of nests (Caldwell, 1962; Hendrickson and Balasingam, 1966; Bustard and Greenham, 1969; Hughes, 1974a; Davis and Whiting, 1977; Mortimer, 1982). Furthermore, relationships between spatial distributions of nests and environmental factors may be complicated by nest site tenacity of nesting turtles. Schulz (1975) suggests that nest site tenacity forces turtles to maintain their nesting site as long as possible, even though those sites may be undergoing changes.

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 (Baldwin and Lofton, 1959; Schulz, 1975; Davis and Whiting, 1977; Talbert et al., 1980). Davis and Whiting (1977) suggested that relatively high percentages of false crawls may 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 deposited in an area to the number of false crawls in that area is useful in estimating the postemergence suitability of that 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.

The observed gradients of increasing nest densities from north to south along the island were consistent with gradients of increasing emergences from north to south (Table D-2; Figure D-3). In contrast, variations in nesting success along the island were not consistent with observed gradients of nest densities (Table D-3; Figure D-4). Therefore, greater nest densities along the southern portion of the island were the result of more turtles coming ashore there rather than to more preferable nesting conditions being encountered by turtles after they emerged.

Hughes (1974a) and Bustard (1968) found that loggerheads preferred beaches adjacent to outcrops of rocks or subtidal reefs. Williams-Walls et al. (1983) suggested that the nesting gradient on Hutchinson Island may be influenced by the offshore reefs if female turtles concentrate on the reefs closest to the beach to rest or feed. Williams-Walls et al. (1983) further stated that the proximity of offshore reefs would put the greatest concentration of turtles near the southern portion of the island. Therefore, the apparent gradient in loggerhead emergences and nest densities may be influenced by nearshore reef distribution, as well as beach accretion and erosion.

Relatively low nest densities in Area 4 (adjacent to the power plant) appeared to be restricted to years of intake and discharge construction. In order to determine whether construction of power plant intake and discharge systems has had a significant effect on nesting adjacent to the St. Lucie Plant, nest densities in Areas 4 and 5 were compared between construction years (1975, 1981, 1982 and 1983) and non-

construction years (1971, 1973, 1977, 1979, 1980 and 1984). Because construction activities did not proceed seaward of the dune until late in the nesting season, 1980 was considered a non-construction year. Area 5 was chosen as a control because it was similar to Area 4 with respect to beach topography and was outside of the area expected to be influenced by either power plant operation or intake/discharge construction.

Results of a G-test of independence (Sokal and Rohlf, 1981) indicated that nest densities in Areas 4 and 5 were not significantly ($P \leq 0.05$) different during the two baseline years (1971 and 1973). However, nest densities in Area 4 were significantly ($P \leq 0.05$) lower during years of intake/discharge construction.

Turtles are very sensitive to alarming stimuli just prior to emerging onto beaches (Schulz, 1975) and as they ascend beaches (Hirth, 1971). Among these alarming stimuli, moving lights will frighten nesting sea turtles of all species (Mortimer, 1982). Moving lights and other nocturnal activities associated with intake/discharge construction may have contributed to reduced emergences and, consequently, reduced nest densities relative to adjacent areas (Figure D-3). However, nesting success values in Area 4 during construction years were not markedly different from those in Area 5. Similar nesting success values between these two areas suggest that part of Area 4 was outside the influence of construction activities and that the turtles that emerged in Area 4 primarily emerged beyond the area influenced by construction activities. Though nest densities were reduced in Area 4 during 1981, 1982 and 1983, they returned to normal levels in 1984 after construction activities were completed, as was observed during years following construction in 1975.

A G-test of independence also was used to determine if nest densities differed significantly before and after power plant operation (exclusive of intake/discharge construction). After excluding years during which intake/discharge construction occurred (1975, 1981, 1982 and 1983), nest densities in Areas 4 and 5 were compared between preoperational years (1971 and 1973) and operational years (1977, 1979, 1980 and 1984). No significant ($P \leq 0.05$) effect of power plant operation on nest densities was indicated.

No long-term overall reductions in nesting, total emergences or nesting success in the nine 1.25-km long survey areas have been indicated by data collected through 1984.

Distribution of Nests Along the Entire Island (1981-1984)

From 1981 through 1984, distributions of nest densities among the thirty-six 1-km long survey areas comprising the entire island also showed a gradient of increasing densities from north to south (Figure D-5). However, this gradient was primarily restricted to the northern half of the island. No gradient was apparent south of Area S, and nest densities generally remained relatively high along the southern half of the island. The distribution of loggerhead turtle emergences among the thirty-six survey areas followed the same general pattern as nest densities (Figure D-6). Although differences in nesting success contributed

to differences in nest densities in a number of instances, general patterns of nesting success were not consistent with general patterns of nest densities (Figure D-7). Thus, as was found for the nine survey areas, greater nest densities along the southern portion of the island were primarily due to more turtles coming ashore there rather than to more preferable nesting conditions being encountered by turtles after they emerged.

During all four survey years (1981-1984), nest densities were lowest in Area A and increased substantially from north to south through Area E (Figure D-5). Numbers of emergences in Areas A through E parallel this pattern of substantial increase from north to south (Figure D-6). The presence of deep water close to shore has been suggested as a factor which might influence sea turtles to emerge on particular beaches (Hendrickson and Balasingam, 1966; Mortimer, 1982). The distance from shore to the thirty-foot water depth contour continuously decreases from Area A through Area E. This may partially account for the observed pattern of increased emergences from north to south along this particular stretch of beach. Furthermore, large public beach accesses in Areas A through C, combined with considerable artificial lighting in those areas, provide the potential for extensive and highly visible human activity on the beach at night. As previously stated, turtles just prior to emerging onto beaches are very sensitive to alarming stimuli, therefore, human activity in these areas at night may deter turtles from emerging. Human activity also may discourage turtles from nesting after they have emerged onto the beach, and may contribute to the somewhat lower nesting success

in Areas A through C (Figure D-7). Low nesting success in Areas A and B also may be related to beach characteristics such as persistent and extensive areas of vertical relief (benches), accumulations of rocks and shells, and compact sand in these areas. Apparently, a combination of factors that affected both emergence and nesting success resulted in the extremely low nest densities along the northern four kilometers of the island.

Nest densities, numbers of emergences and, to a lesser extent, nesting success have remained relatively low in Area Z from 1981 through 1984. Since this area includes a large public beach access, a motel and considerable artificial lighting, nocturnal human activity in this area may account for these relatively low values. Another area that had relatively low nest densities compared to adjacent areas was Area HH. Relatively low numbers of nests in Area HH correspond with relatively low numbers of emergences in that area. Emergence in this area may be hindered by the presence of an intertidal reef system extending obliquely from shore along a portion of the area.

Relatively low nest densities, numbers of emergences and nesting success in Area O (Power Plant Site) during 1981, 1982 and 1983 were apparently associated with construction activities during the installation of the St. Lucie Plant Unit No. 2 intake and discharge systems. Reasons for reductions in nest densities and emergences during construction activities have been discussed. During construction years, reductions in nesting success were apparent in Area O though they were not evident for Area 4. This may simply reflect the fact that Area 0 is smaller than Area 4; therefore, a greater percentage of Area 0 was within the influence of construction activities. During 1984, nest densities, numbers of emergences and nesting success were comparable between Area 0 and adjacent areas and apparently were not affected by power plant operation.

No long-term trend towards decreased nest densities, numbers of emergences or nesting success were indicated by data for the thirty-six 1-km long survey areas.

Number of Nests and Population Estimates

Various methods were used during surveys prior to 1981 to estimate the total number of nests on Hutchinson Island, based on the number of nests found in the nine 1.25-km survey areas (Gallagher et al., 1972; Worth and Smith, 1976; ABI, 1980). The most reliable methods appeared to be either extrapolation of the nine area total to the whole island or an estimate resulting from linear regression analysis. The latter method was based on the apparent linear relationship between nest densities in the nine study areas and their distance from Ft. Pierce Inlet. Since all nests on the entire island were counted from 1981 through 1984, the accuracy of the estimation techniques can be determined for these four years.

The regression method overestimated the total number of nests on the island by 23 to 32 percent during the last four survey years (Table D-4).

The inaccuracy of this method is probably related to differences between the distribution of nests among the nine study areas and the actual distribution of nests along the entire island (ABI, 1984). The extrapolation method produced more accurate estimates of total nesting on the island. This method overestimated the actual total number of nests by only 6 to 11 percent during the last four years (Table D-4). Additional data on the relationship between nest densities in the nine areas and nest densities along the entire island may reveal a more accurate predictive method. Based on present data, however, extrapolation appears to be the most accurate method.

Regardless of the method used to estimate total nesting, it is clear that nesting activity on Hutchinson Island fluctuates considerably from year to year (Table D-4). Year-to-year variations in nest densities also are common at other rookeries (Hughes, 1976; Davis and Whiting, 1977; Ehrhart, 1979) and may result from the overlapping of non-annual breeding populations. No relationships between total nesting activity on the island and power plant operation or intake/discharge construction were indicated.

In order to determine the total number of female loggerhead turtles nesting on Hutchinson Island during a given season, an estimate of the number of nests produced by each female must be determined. A comparison of the number of nests produced by tagged turtles during the 1975, 1977 and 1979 surveys indicated that an average of two nests per female were produced during a nesting season (ABI, 1980). Thus, estimates of the

total numbers of females nesting during previous survey years may be obtained by dividing the calculated total number of nests by two. Based on extrapolation estimates of total nesting, the number of female loggerhead turtles nesting on Hutchinson Island varied from approximately 1,500 to 2,300 individuals during survey years 1971 through 1979. Based on whole-island nest counts, the estimated total number of nesting females varied from 1,558 to 2,372 individuals during survey years 1981 through 1984.

Temporal Nesting Patterns

The loggerhead turtle nesting season usually begins in early May, when ocean temperatures reach 23° to 24°C, attains a maximum during June or July, and ends by late August or early September. Nesting activity during 1984 followed this pattern (Figure D-8). Shifts in the temporal nesting pattern on Hutchinson Island (Figure D-9) may be influenced by fluctuations in water temperature. This was observed during 1975 and 1982 when early nesting in April coincided with average ocean temperatures above 24°C (ABI, 1983; Williams-Walls et al., 1983).

Cool water intrusions frequently occur off southeastern Florida during the summer (Taylor and Stewart, 1958; Smith, 1982). Worth and Smith (1976) and Williams-Walls et al. (1983) suggested that cool water intrusions may have been responsible for reductions in loggerhead turtle nesting activity on Hutchinson Island. Considerable decreases in ocean temperatures during mid-July and early August 1984 may have been due to such cool water intrusions. Sharp declines in nesting coincided with,

and were probably related to, the decreases in water temperature during those periods (Figure D-8). However, declines in nesting were of short duration and were followed by sharp increases. Cool water intrusions were not considered to have significantly affected total nesting activity in 1984.

To determine if plant operation affected seasonal nesting patterns (nest density on a month-to-month basis), the nesting patterns for Area 4 (plant site) and Area 5 (control site) during each study year were compared statistically (Kolmogorov-Smirnov test; Sokal and Rohlf, 1981). There was no significant ($P \leq 0.05$) difference in temporal nesting patterns between Areas 4 and 5 during any study year, either before or during power plant operation. The results of these analyses indicated that plant operation has not significantly affected temporal nesting patterns.

Predation on Turtle Nests

Since nest surveys began in 1971, raccoon predation probably has been the 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 (Davis and Whiting, 1977; Ehrhart, 1979; Hopkins et al., 1979; Talbert et al., 1980). 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 (Table D-5). Overall predation rates for survey years 1971 through 1977 were between 21 and 44 percent, with the 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 remained below 10 percent during the last four years. For the entire island, five percent (200) of the loggerhead nests (n=4277) in 1984 were depredated by raccoons. Decreased predation by raccoons probably reflects a decline in the raccoon population which may be due to habitat destruction associated with the development of the island (Williams-Walls et al., 1983). However, diseases also may be responsible for reductions in raccoon populations. Apparently, raccoon populations in Florida's coastal areas are occasionally decimated by canine distemper (Ehrhart, 1979).

As during 1981, 1982 and 1983, predation was greatest in the primarily undeveloped areas north and south of the power plant during 1984 (Figure D-10). Reduced raccoon predation in the immediate vicinity of the plant (Area 0) may be attributed to limited raccoon habitat upland of Area 0.

Ghost crabs have been reported by numerous researchers as important predators on sea turtle nests (Baldwin and Lofton, 1959; Schulz, 1975; Diamond, 1976; Fowler, 1979; Stancyk, 1982). Though turtle nests on Hutchinson Island may have been depredated by ghost crabs since nesting surveys began in 1971, this source of predation did not become apparent as a cause of nest destruction until 1983. During 1983, the first year ghost crab predation was quantified, one percent (58) of the loggerhead nests (n=4743) on the island were depredated by ghost crabs. The overall predation rate by ghost crabs increased to two percent (89 nests) during

1984 (n=4277). Stancyk (1982), referring to ghost crab predation on loggerhead turtle nests in Cape Romain, South Carolina, states that a reduction in the population of crab predators (raccoons) could have allowed increased crab predation. Such a hypothesis also may apply to Hutchinson Island where a reduction in raccoon predation on turtle nests probably reflects a decline in the raccoon population.

During 1983 and 1984, predation by ghost crabs occurred in the same general areas where predation by raccoons occured. During 1984, 25 nests were destroyed by a combination of raccoon and ghost crab predation. These combination predations are included as raccoon predations in Table D-5 and in the total number of nests predated by raccoons for the entire island.

Abiotic Destruction of Turtle Nests

Physical destruction of turtle nests by erosion associated with wave action and mortality of developing sea turtle embryos due to inundation by sea water (e.g., high tides) have been recorded at other rookeries (Baldwin and Lofton, 1959; Schulz, 1975; Fowler, 1979; Hopkins et al., 1979; Small, 1982). Nest destruction due to these two factors may have been considerable on Hutchinson Island during 1984. During early September and again in late September 1984, tropical storms caused abnormally high tides and extremely high waves in the Hutchinson Island area. During both storms, waves washed up to the dune line along the entire island, and washed over the dune line in several areas. In each case, these conditions prevailed for several days.

Though nest destruction due to erosion was evident by the presence of numerous unhatched turtle eggs scattered along the beach, destruction due to erosion and inundation could not be quantified. However, since all nests on Hutchinson Island were enumerated daily, the number of nests containing incubating eggs during the passage of each storm can be calculated. A minimum of 750 loggerhead nests and 23 green turtle nests were estimated to be incubating on the island during the passage of the first storm and 200 loggerhead nests and 16 green turtle nests had incubation periods which overlapped both storms.

Green and Leatherback Turtle Nesting

Green and leatherback turtles also nest on Hutchinson Island, but in fewer numbers than loggerhead turtles. Prior to 1984, the number of nests observed on the island ranged from 5 to 68 for green turtles and from 1 to 20 for leatherbacks (Figure D-11). During the 1984 survey, 44 green turtle and 19 leatherback turtle nests were recorded on Hutchinson Island. Temporal nesting patterns for these species differ from the pattern for loggerhead turtles. During the 1984 survey, leatherback turtles nested from 24 April through 20 July, and green turtles nested from 10 June through 16 September.

Prior to 1981, thirty-one kilometers of beach from Area 1 south to the St. Lucie Inlet (Figure D-1) were surveyed for green and leatherback turtle nests. During whole island surveys from 1981 through 1984, only one leatherback nest and three green turtle nests were recorded on the five kilometers of beach north of Area 1. Therefore, previous counts of

green and leatherback nests on the southern thirty-one kilometers of the island were probably not appreciably different from total densities for the entire island. Based on this assumption, green and leatherback nest densities may be compared between all survey years, except 1980, when less than fifteen kilometers of beach were surveyed.

Considerable fluctuations in green turtle nesting on the island have occurred among survey years. 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). During 1984, green turtles nested most frequently along the stretch of beach from Area AA through Area GG (Figure D-12). This is consistent with results of surveys conducted during 1971, 1973, 1975, 1982 and 1983 (ABI, 1983, 1984; Williams-Walls et al., 1983). Less than twenty green turtle nests were observed on Hutchinson Island during each of the other survey years (1977, 1979 and 1981). As in 1982, there was also considerable nesting in Areas R through U during 1984.

Leatherback turtle nest densities have remained low on Hutchinson Island; however, densities during the last five survey years have been higher than during the previous four survey years. This may reflect an overall increase in the number of nesting females or may be part of a long-term cycle of increasing and decreasing nesting activity in the Hutchinson Island area. During 1984, leatherback turtles nested from Area C through Area HH.

Intake Canal Monitoring

Species, Number and Temporal Distribution

In 1984, 148 loggerhead and 69 green turtles were removed from the St. Lucie Plant intake canal (Tables D-6 and D-7). Since intake canal monitoring began in May 1976, 969 loggerheads, 159 greens, seven leatherbacks, three Kemp's ridley and two hawksbill turtles have been removed.

The yearly catch of loggerhead turtles increased from 33 individuals in 1976 (partial year of sampling) to 175 in 1979, decreased to 61 in 1981, and increased to 148 in 1984 (Figure D-13). The monthly catch of loggerheads ranged from two to 28 individuals (Table D-6). Over the past nine study years, the most loggerheads were collected during January (mean of 17.5 individuals) and the fewest were collected during May (mean of 5.1 individuals). Differences in the number of loggerhead turtles found among years or among months were not statistically significant ($P \leq 0.05$; two-way ANOVA), primarily because of the large within-year and within-month variation in catch.

The yearly catch of green turtles ranged from 0 to 6 individuals between 1976 and 1979, increased to 13 in 1980 and 32 in 1981, decreased to 8 in 1982 and increased to 69 in 1984 (Figure D-13). One hundred ten of the 159 green turtles (69 percent) found during intake canal monitoring were taken during the winter months of January through March.

Three of the seven leatherback turtles were found in 1978 (Figure D-13); four of the seven leatherbacks (57 percent) were found during the

month of March. The two hawksbill turtles were taken in March 1978 and September 1984, and the three Kemp's ridley turtles were found in January and February.

Variations in the number of sea turtles found during different years and months are attributed to natural variations in the occurrence of turtles in the vicinity of the St. Lucie Plant, rather than to any influence of the plant itself. Intake cooling water flow rate variations do not appear to have influenced the numbers of turtles found. The variation in yearly loggerhead and green turtle occurrence patterns (Figure D-13) indicates that the observed differences are inherent in the species, rather than plant related.

<u>Size Distribution and Sex Ratio</u>

The majority of the loggerhead turtles captured in the canal ranged from 51 to 70 cm in straight line carapace length (SLCL) and the majority of the green turtles ranged from 21 to 40 cm SLCL (Figure D-14). Based on minimum lengths of nesting females (Gallagher et al., 1972; Hirth, 1980) and morphometric analyses (F.H. Berry, National Marine Fisheries Service, personal communication), individuals of both species attain adulthood somewhere between 70 and 85 cm SLCL. Most of the loggerhead and green turtles found in the intake canal thus were considered to be sub-adults or juveniles.

The leatherback turtles ranged in size from 111 to 150 cm SLCL (Figure D-14) and were adults. The two hawksbill turtles ranged from 37

to 46 cm SLCL and the three Kemp's ridley turtles ranged from 32 to 47 cm SLCL and were subadults.

Sea turtles cannot be externally sexed until they reach a size where male secondary sexual characteristics are developed. In loggerheads, this is usually greater than 70 cm SLCL. In developed males, the tail is long and extends well beyond the carapace, and the cloacal opening is located near the tip of the tail beyond the posterior margin of the carapace. In mature females, the tail is much shorter and the cloacal opening is located under the posterior margin of the carapace (Pritchard et al., 1983).

Eighty-six large loggerheads have been externally sexed since 1979 when these efforts began. Of these loggerheads, 74 were listed as females and 12 as males. Sex has only been recorded for four green turtles; these were all males and all were 93 cm SLCL or larger.

Since 1982, 59 immature loggerheads have been sexed by measuring testosterone levels in blood samples. These samples were analyzed by Dr. David W. Owens and his associates at Texas A α M University. The turtles ranged from 50 to 73 cm SLCL and had a sex ratio of 3.2 females to 1 male (45 females and 14 males; Wibbels, 1984). The 3.2:1 female:male sex ratio compares to the 1.7:1 ratio found in the Cape Canaveral ship channel (N=168 turtles) and 1.4:1 found in the Indian River (N=24). The sex ratios of the Hutchinson Island and Indian River samples were not significantly different from the sex ratio of the Cape Canaveral samples

(Wibbels, 1984). It appears that the sex ratios of these immature loggerhead populations are significantly biased toward females. For the Hutchinson Island collections, the discrepancy between the ratios of the large adults that were sexed externally (6.2:1) and the immature turtles sexed by blood analysis (3.2:1) may mean that some of the large turtles recorded as females were still too small for external differentiation and were, in fact, males. Alternatively, there may be actual differences in the sex ratios of immature and mature loggerheads off Hutchinson Island.

Mortalities

Over the eight years of monitoring, 73 of the 969 loggerhead turtles (7.5 percent) and 16 of the 159 green turtles (10.1 percent) found in the intake canal were dead (Tables D-6 and D-7). All of the leatherbacks, the hawksbill and the Kemp's ridley were found alive.

Of the 73 dead loggerheads, 57 individuals (78 percent) were found floating in the canal, either along shore, against the barrier net or, in a few cases, against the bar screens (grizzlies) at the plant. Most of these turtles were in advanced stages of decomposition. Seven of the loggerheads were found dead in the turtle nets, two in the gill nets used for fish sampling and one in the barrier net; it is presumed that these 10 individuals (14 percent of the mortalities) drowned. Of the seven other loggerheads found dead, two had been accidentally killed by the rake at the grizzlies and information on five is lacking. Of the 16 dead green turtles, 11 were found in either the turtle nets or the fish gill nets, three were found floating, information on one is lacking and one did not recover after treatment for injuries.

To reduce or eliminate mortalities caused by the nets, particularly among smaller green turtles, the turtle nets have been modified so that they are lighter, and the fish gill nets have not been used east of the Highway A1A bridge since 1981. Reducing mortalities of those turtles found floating in the canal is more of a problem because the causes of death are generally unknown. Drowning may occur during infrequent periods of reduced flow when the plant is off-line. When the plant is not in operation, a turtle entering the intake pipe might not find its way out and could drown because the flow would not be sufficient to carry the turtle through the pipe (this will be less of a possibility now that Unit 2 is operational). Under normal operation, flow is high enough that the amount of time a turtle would be in the pipe is well within the time span that turtles can safely stay submerged (ABI, 1983).

Injury sustained during passage through the intake pipes is another possible cause of mortalities. However, only 75 (6.6 percent) of the 1140 sea turtles removed from the intake canal had recent lacerations, abrasions or other injuries that may have resulted from passage through the pipes. Wounds were considered minor in 51 of these 75 animals and major (deep cuts, broken flippers, etc.) in 24. The intake pipes in present use are 3.7 and 4.9 m in inside diameter, and it appears that the vast majority of the turtles are carried through the pipes without hitting the walls and sustaining injury.

Length of time spent in the intake canal was not considered a factor in mortality because turtles entrapped in the canal were caught and

released within a relatively short time span (average of 10.3 days) and, during this time, body weights did not change appreciably (ABI, 1983).

The majority (61 percent) of the turtles found alive and released back into the ocean were considered to be in good physical condition, 19 percent were in poor condition and 21 percent were in excellent condition. Criteria used to evaluate condition were weight, activity, parasite coverage and wounds or injury (Table D-8). Some of the turtles found floating in the canal in various stages of decomposition may already have been in poor condition in the ocean. These may have entered the ocean intakes seeking refuge and ended up in the canal where they died from causes unrelated to plant operations.

Blood samples were analyzed to determine hemoglobin levels in order to see if there was a correlation between hemoglobin levels and condition of the turtles. Low hemoglobin (anemia) could reflect poor condition and potentially be a mortality factor. Mean hemoglobin levels were generally higher for animals in good to excellent condition (Table D-9), but there was considerable variation and overlap in values among the relative condition categories. Additional measurements, particularly in the "poor" and "poor-good" categories (Table D-9) have indicated that hemoglobin levels may not be a useful measure of condition.

Two green turtles were necropsied in 1984. One of the turtles appeared normal upon examination and the other showed signs of parasite infestation and was underweight. Both turtles apparently died suddenly as a result of severe blows. External examination showed injury to the carapace of one turtle indicative of damage from being struck by a boat.

SUMMARY

A gradient of increasing nest densities from north to south along Hutchinson Island has been shown during all survey years. This gradient may result from variations in beach topography, substrate suitability, 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 construction of power plant intake and discharge systems. Nesting returned to normal levels following both periods of construction. Power plant operation, exclusive of intake/discharge construction, has had no significant effect on nest densities.

There have been considerable year-to-year fluctuations in nesting activity on Hutchinson Island from 1971 through 1984. Fluctuations are common at other rookeries and may result from overlapping of non-annual breeding populations. No relationship between total nesting on the island and power plant operation or intake/discharge construction was indicated.

Results of three years of tagging studies on Hutchinson Island indicated that an average of two nests per year were produced by each nesting loggerhead turtle. Based on this average, the nesting population of

loggerhead turtles on the island has varied from approximately 1500 individuals in 1977 to nearly 2400 in 1983. The temporal nesting pattern of this population may be influenced by fluctuations in water temperature. Though natural temperature fluctuations have apparently affected temporal nesting patterns on Hutchinson Island, no significant effect due to power plant operation was indicated.

Since nest surveys began in 1971, raccoon predation was considered the major cause of turtle nest destruction on Hutchinson Island. However, a pronounced decrease in raccoon predation occurred after 1977, and overall predation rates for the nine survey areas have remained below ten percent during the last four years. Decreased predation by raccoons probably reflects a decline in the raccoon population. An increase in nest destruction by ghost crabs during the last two years may be related to this decrease in the raccoon population.

Nest destruction due to erosion and inundation of nests may have been considerable during 1984. Two tropical storms caused abnormally high tides and extremely high waves on the island during September 1984. An estimated 750 loggerhead nests and 23 green turtle nests were incubating on the island during the passage of the first storm and were presumed lost.

Forty-four green turtle and nineteen leatherback turtle nests were recorded on Hutchinson Island during 1984. Green turtle nesting activity exhibited considerable annual fluctuations, as has been recorded at other rookeries. Annual leatherback nest densities during the last five survey years were higher than during any of the previous four survey years.

Intake canal monitoring began in May 1976. Since that time, 969 loggerhead turtles, 159 green turtles, seven leatherback, three Kemp's ridley and two hawksbill turtles were removed from the intake canal. The yearly catch of loggerhead turtles ranged from 33 individuals in 1976 (partial year of sampling) to 175 in 1979. The yearly catch of greens has ranged from 0 in 1976 to 69 in 1984. Differences in the number of turtles found during different years and months were attributed to natural variations in the occurrence of turtles in the vicinity of the St. Lucie Plant, rather than to any influence of the plant itself.

The majority of the loggerhead turtles captured in the canal ranged from 51 to 70 cm in straight-line carapace length and most of the green turtles ranged from 21 to 40 cm. Turtles within these size ranges are considered to be sub-adults or juveniles. Sex ratios of immature loggerheads in the canal are biased toward females. Sixty-one percent of the turtles found alive and released back into the ocean were categorized as being in good physical condition, 19 percent were in poor condition and 21 percent were in excellent condition.

Of the turtles removed from the intake canal since 1976, 7.5 percent of the loggerheads and 10.1 percent of the greens were dead. All of the leatherbacks, the hawksbill and the Kemp's ridley were alive. The majority of the dead turtles were found floating in the canal, while a

few others were found dead in the nets. The turtle nets have been modified and the fish gill nets removed from the area to eliminate or reduce drowning mortalities caused by nets. The causes of death for the turtles found floating are generally unknown. Drowning may occur if the plant is off-line, but this is an infrequent occurrence. Similarly, only 6.6 percent of all turtles were found with injuries that could have been sustained during passage through the intake pipe and, for the most part, these injuries were minor. It appeared that the vast majority of the turtles were carried through the pipes without hitting the walls and sustaining injury. Length of time spent in the canal was not considered a mortality factor because turtles were caught and released within a relatively short time span after entrapment. A possible reason for dead turtles in the canal is that turtles in already poor condition enter the ocean intakes seeking refuge and die in the intake canal from causes unrelated to plant operations. The poor condition of many live turtles found in the canal supports this as a possible cause of mortalities.

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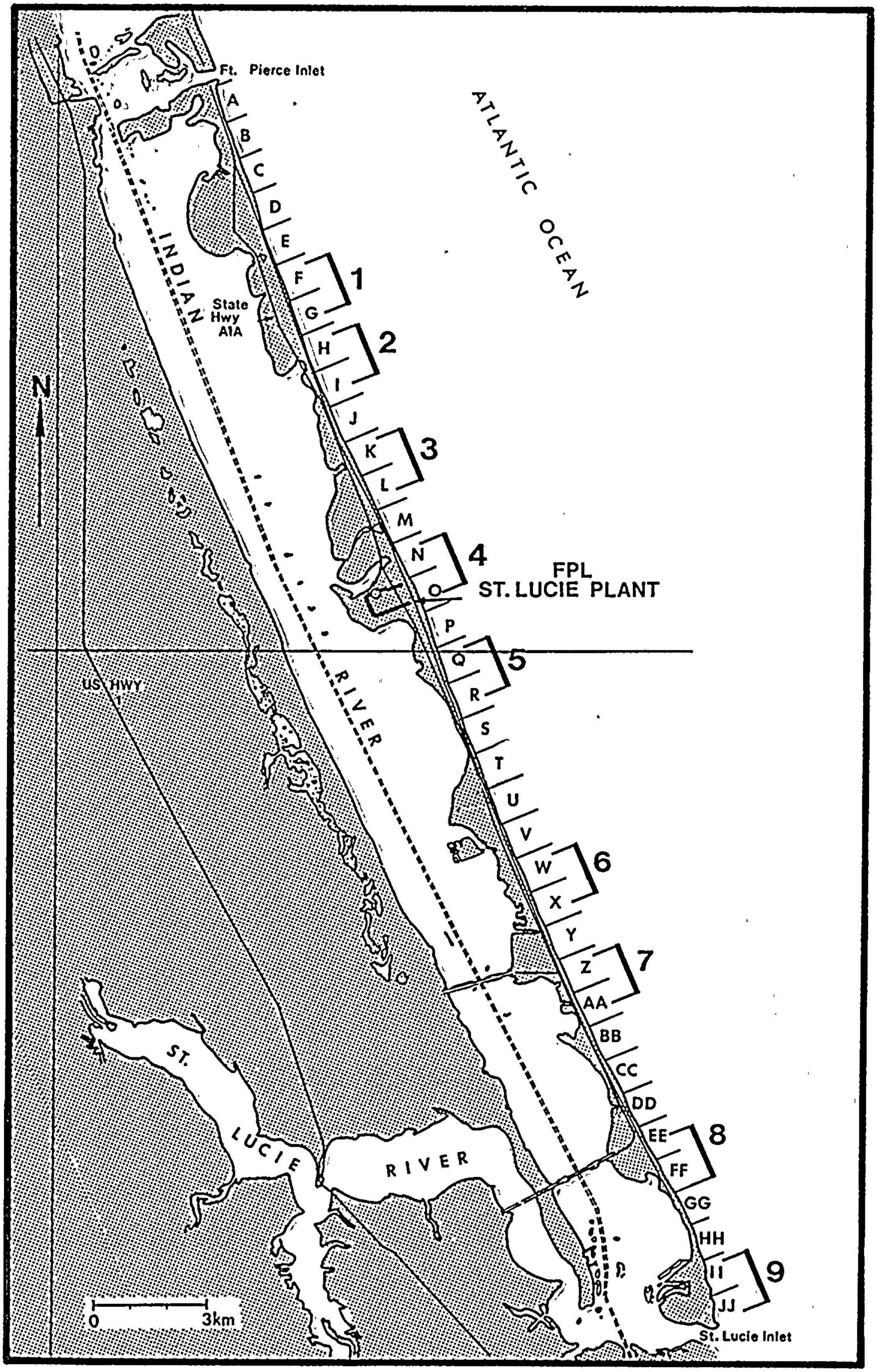


Figure D-1. Designation and location of nine 1.25-km segments and thirty-six 1-km segments surveyed for sea turtle nesting, Hutchinson Island, 1971-1984.

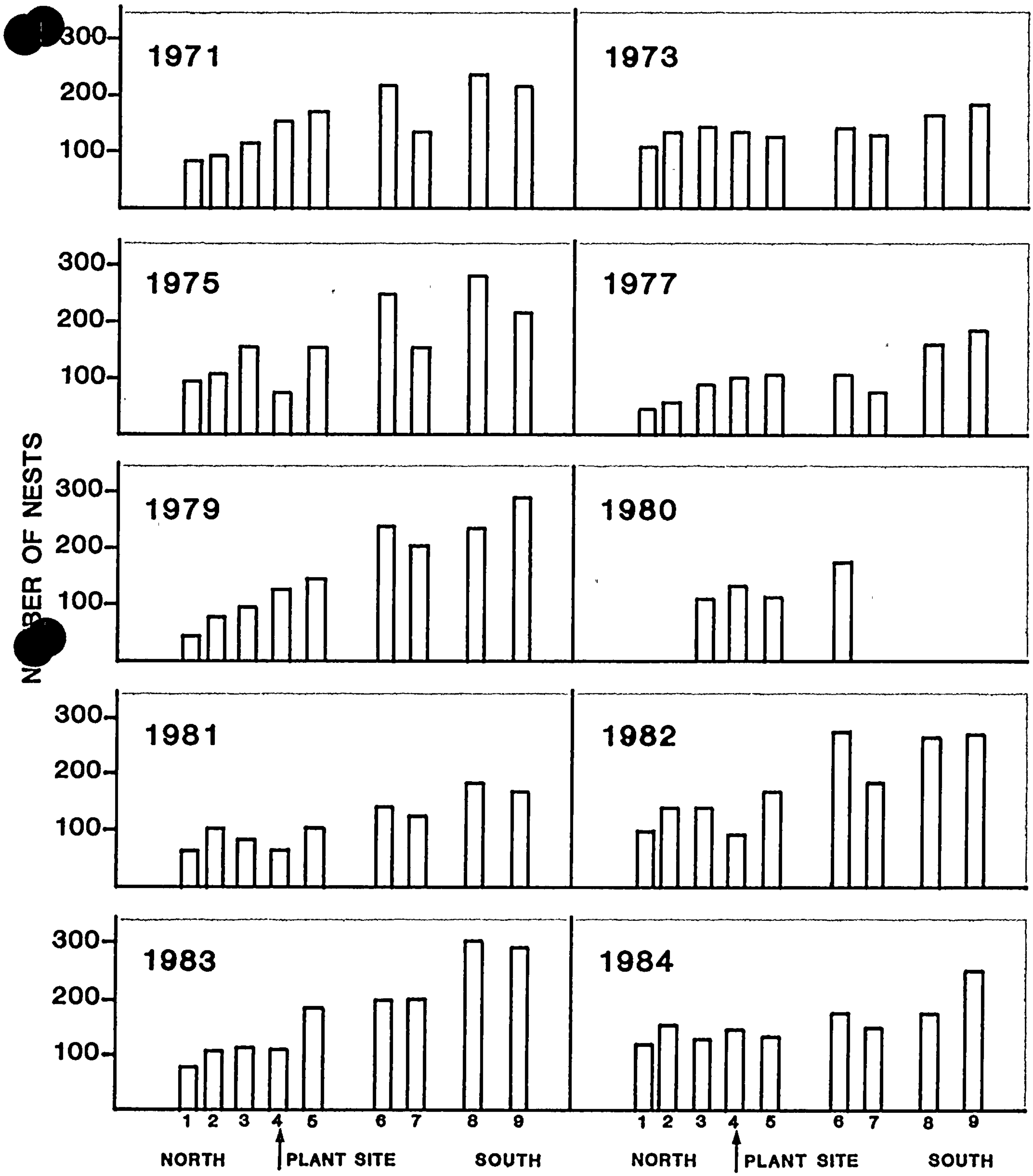


Figure D-2. Number of loggerhead turtle nests in each of the nine 1.25-km -long survey areas, Hutchinson Island, 1971-1984. (Only Areas 3 through 6 were surveyed during 1980.)

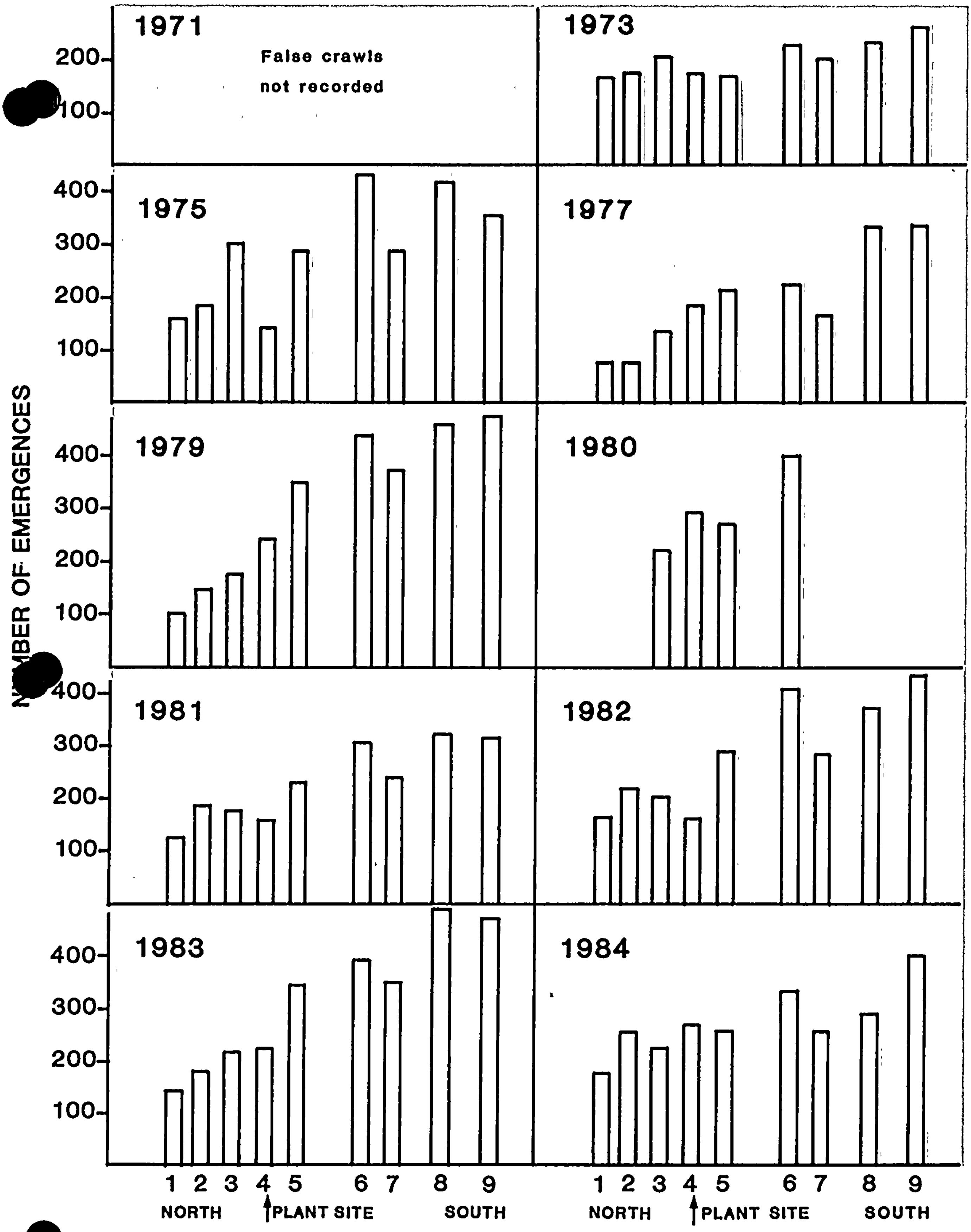


Figure D-3. Number of emergences by loggerhead turtles in each of the nine 1.25-km-long survey areas, Hutchinson Island, 1973-1984. (Only Areas 3 through 6 were surveyed during 1980.)

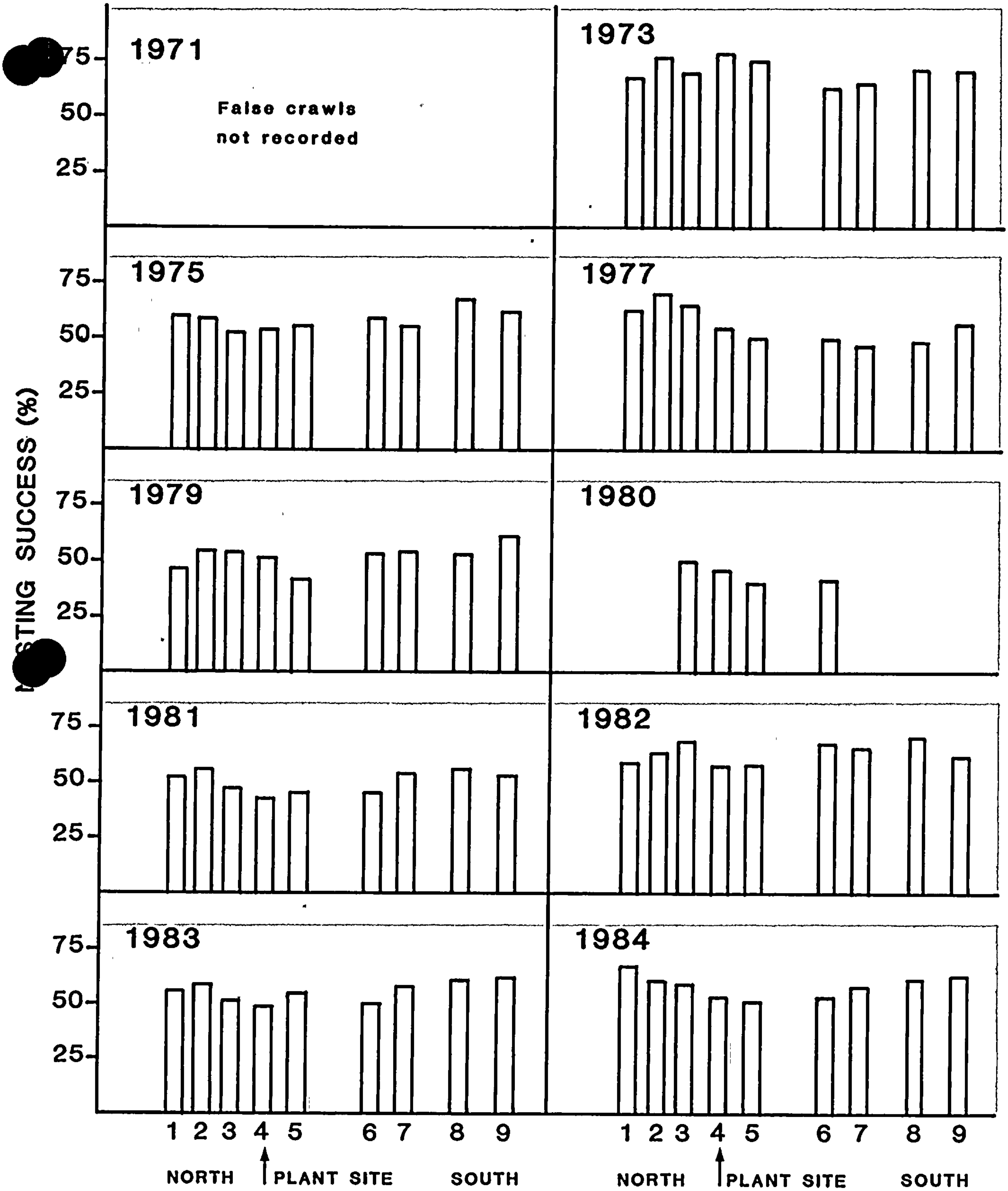


Figure D-4. Loggerhead turtles nesting success (percentage of total crawls that result in nests) for each 1.25-km-long survey area, Hutchinson Island, 1973-1984. (Only areas 3-6 were surveyed in 1980.)

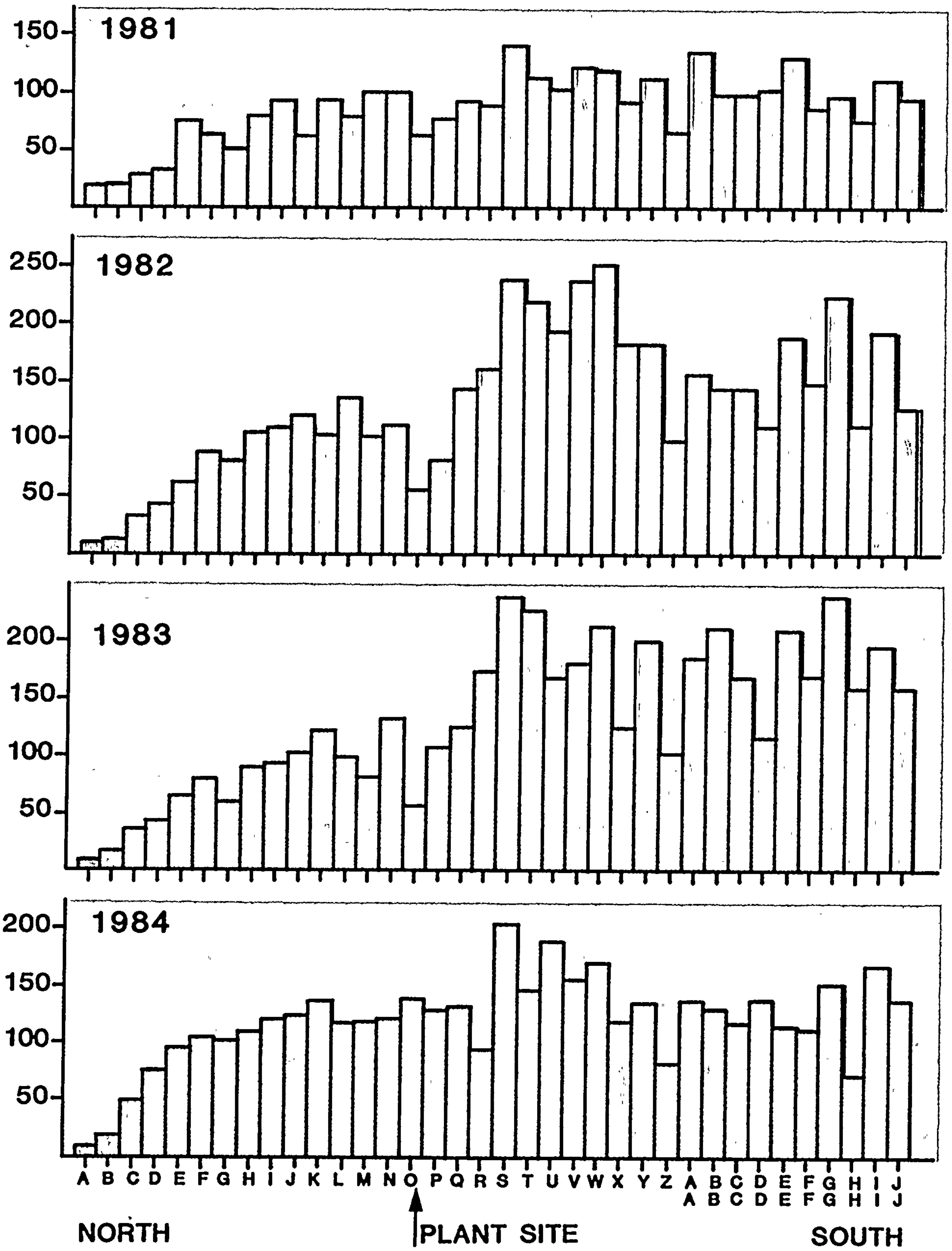


Figure D-5. Number of loggerhead turtle nests in each of the thirty-six 1-km-long survey areas, Hutchinson Island, 1981-1984.

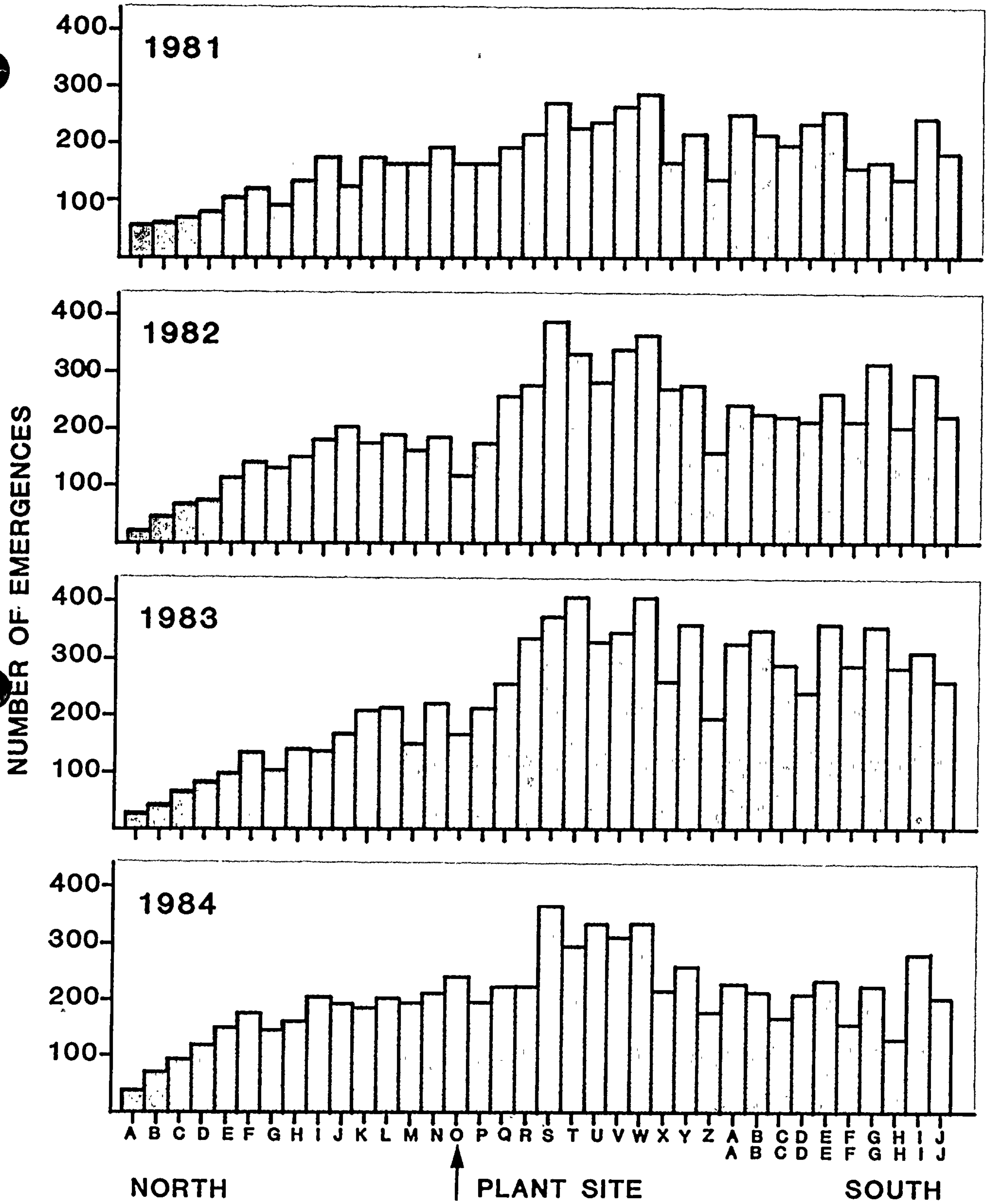


Figure D-6. Number of emergences by loggerhead turtles in each of the thirty-six 1-km-long survey areas, Hutchinson Island, 1981-1984.

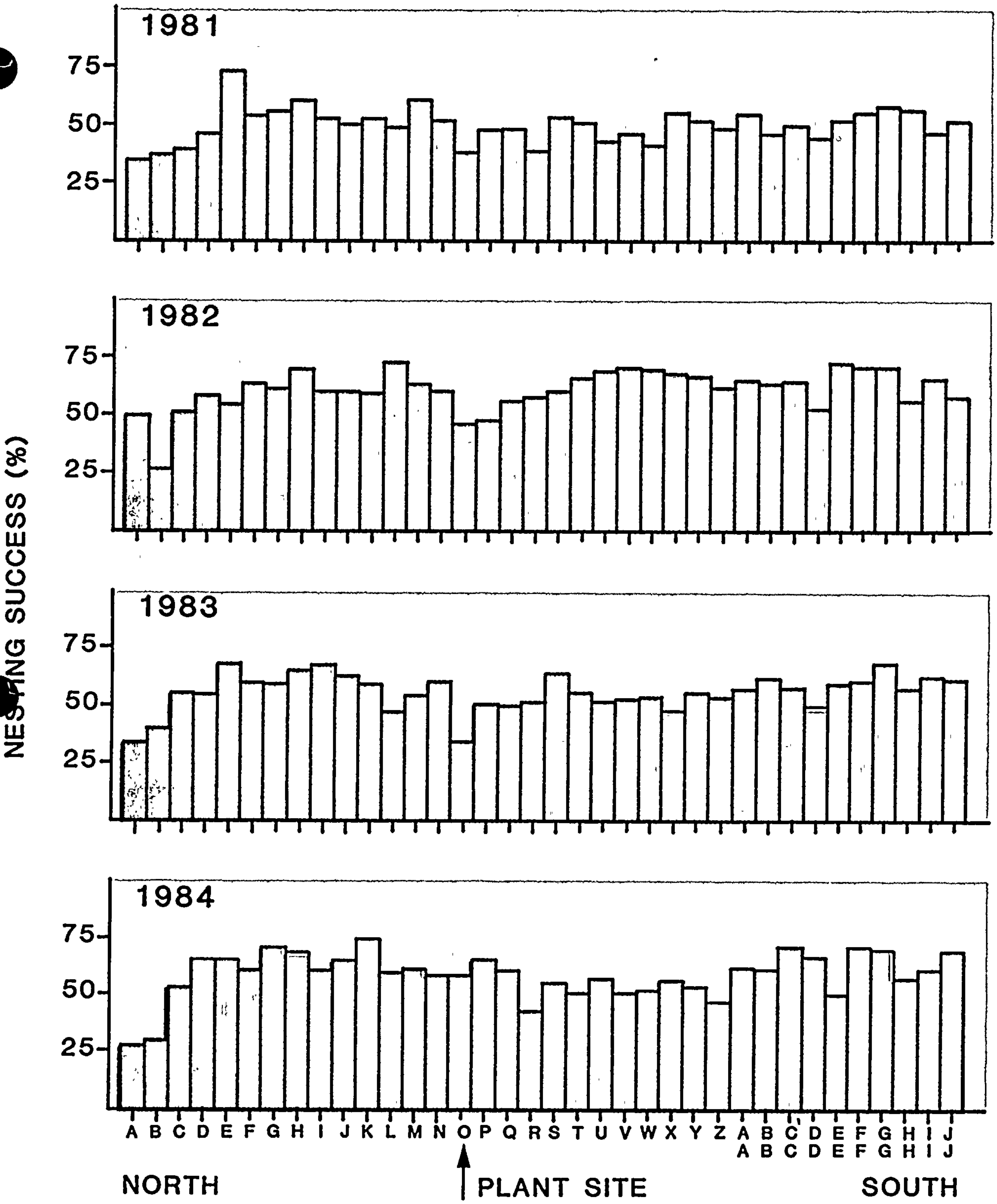


Figure D-7. Loggerhead turtle nesting success (percentage of emergences that result in nests) for each 1-km-long survey area, Hutchinson Island, 1981-1984.

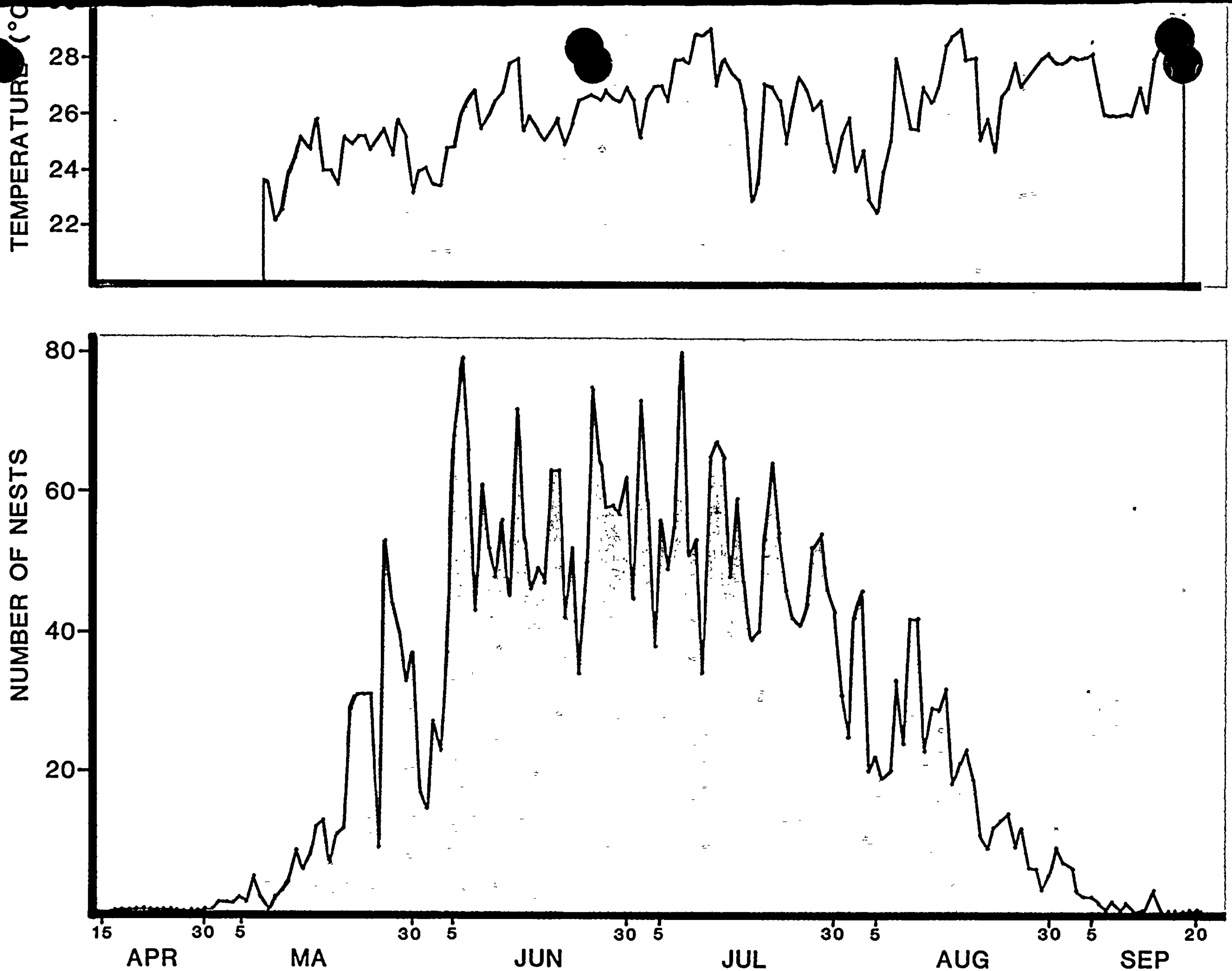


Figure D-8. Daily loggerhead turtle nesting activity and water temperature, Hutchinson Island, 1984.

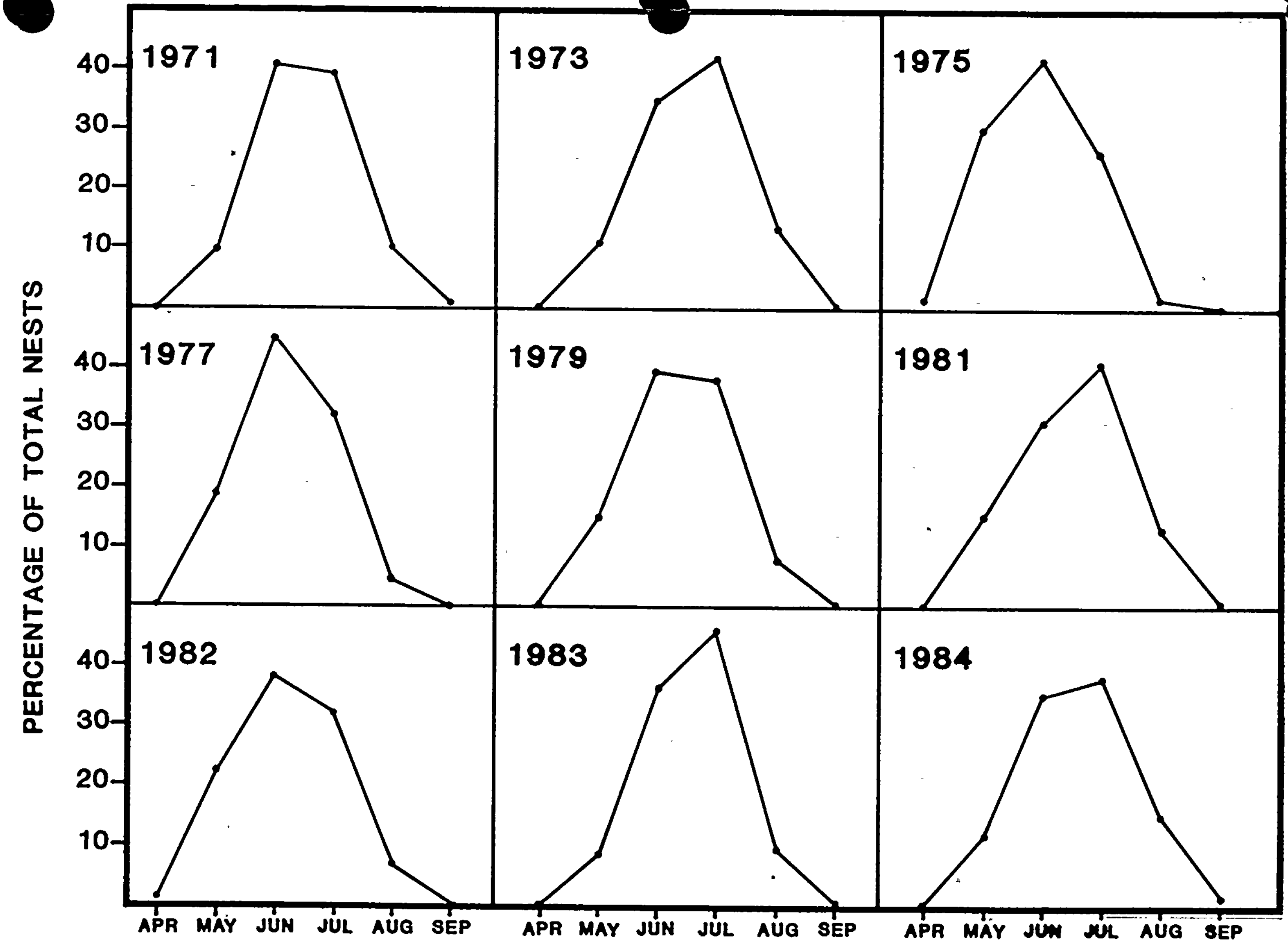


Figure D-9. Percentage of the total number of loggerhead turtle nests observed in the nine 1.25-km-long survey areas during each month, 1971-1984, Hutchinson Island. (Only four of the nine areas were surveyed in 1980.)

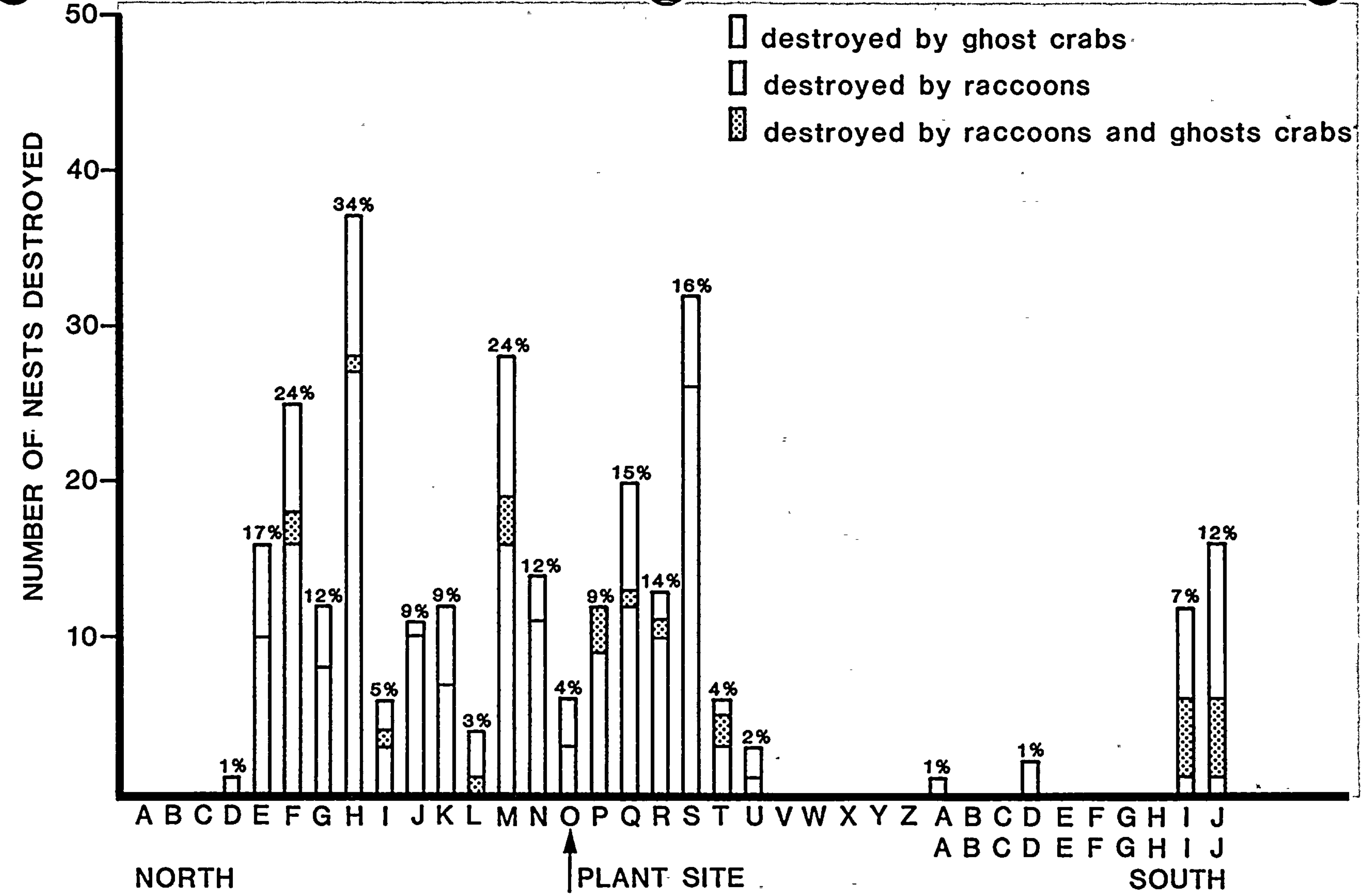


Figure D-10. Number of loggerhead turtle nests destroyed by raccoons and ghost crabs and destroyed nests as a percentage of the total number of nests for each 1-km-long survey area, Hutchinson Island, 1984.

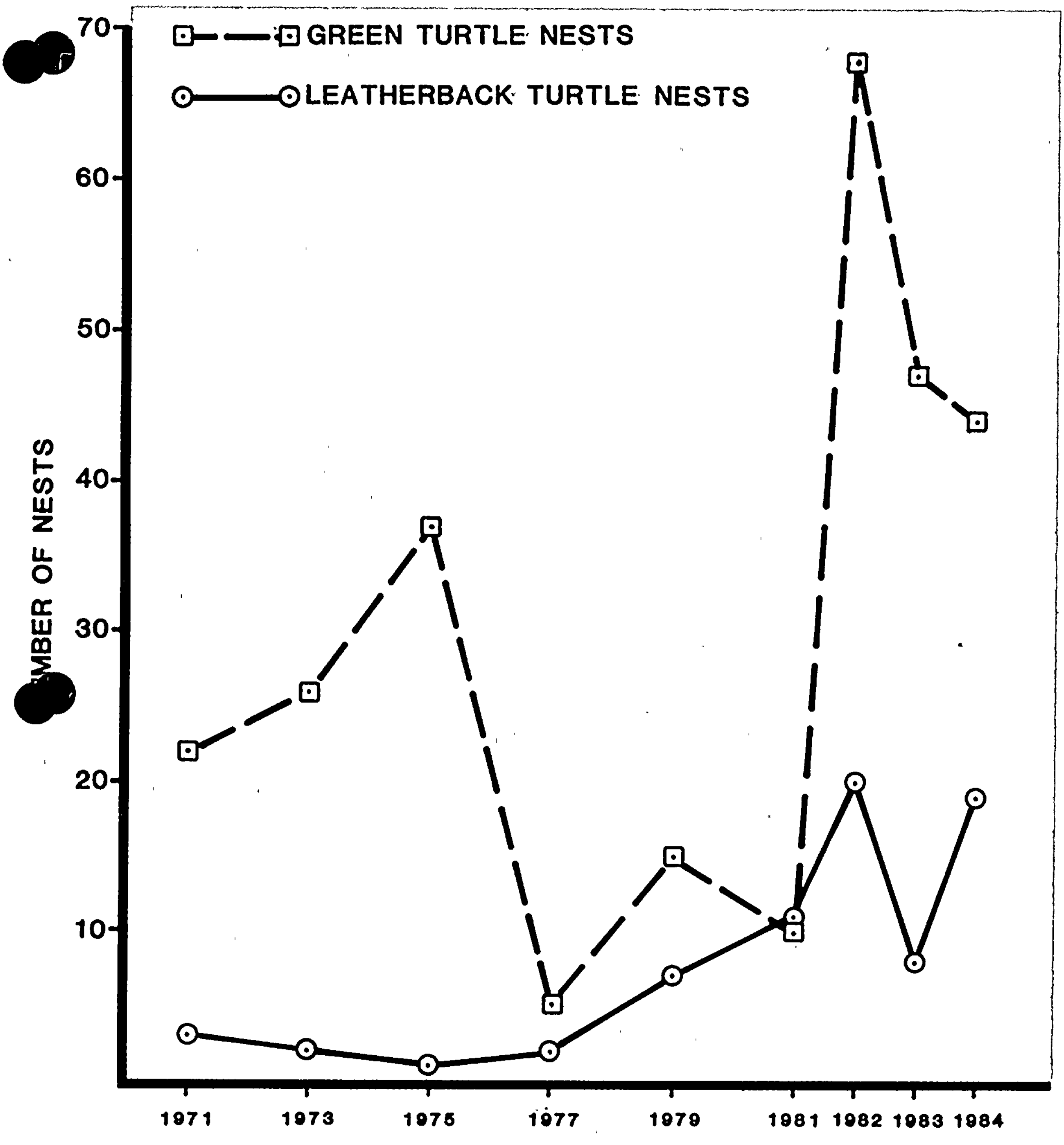


Figure D-11. Number of green turtle and leatherback turtle nests observed, Hutchinson Island, 1971-1984.

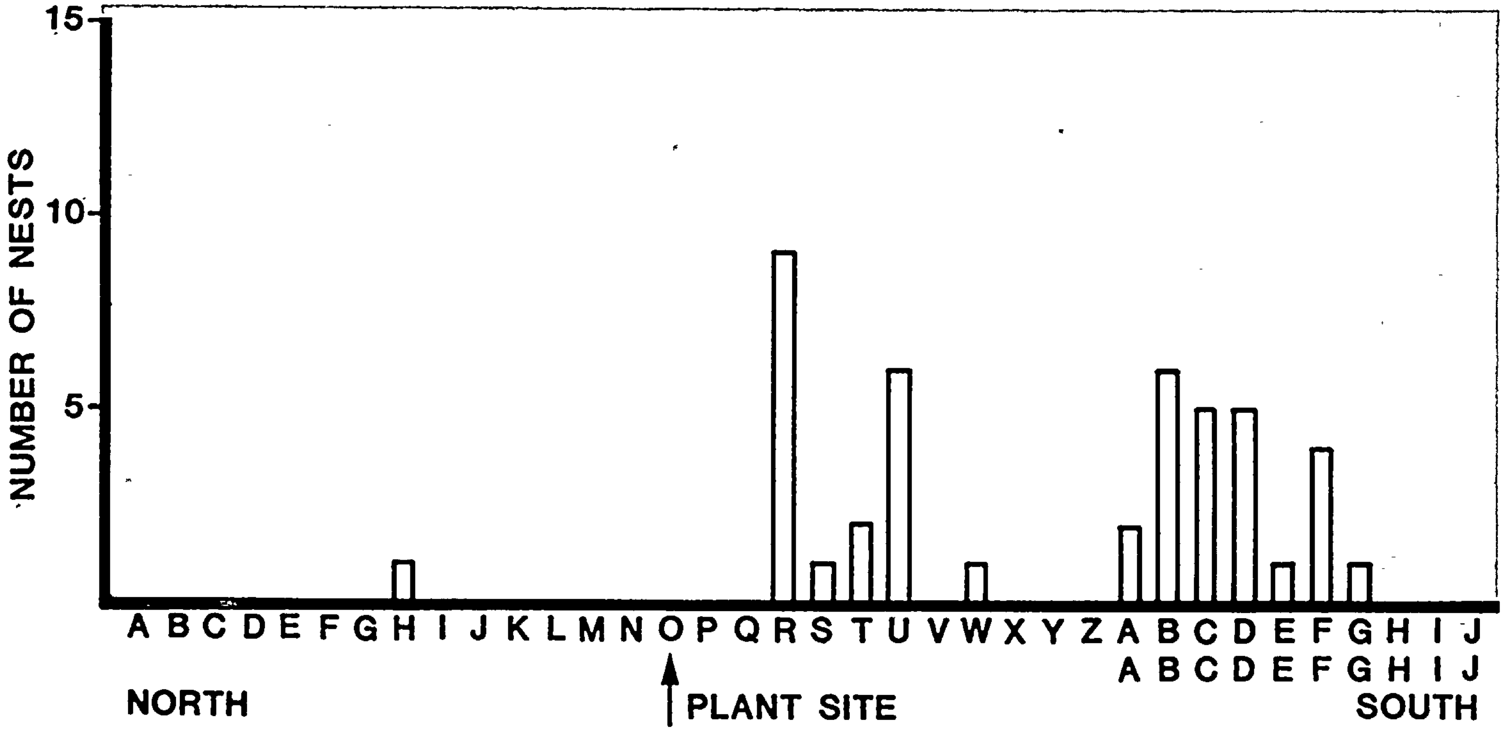


Figure D-12. Number of green turtle nests found in each 1-km-long survey area, Hutchinson Island, 1984.

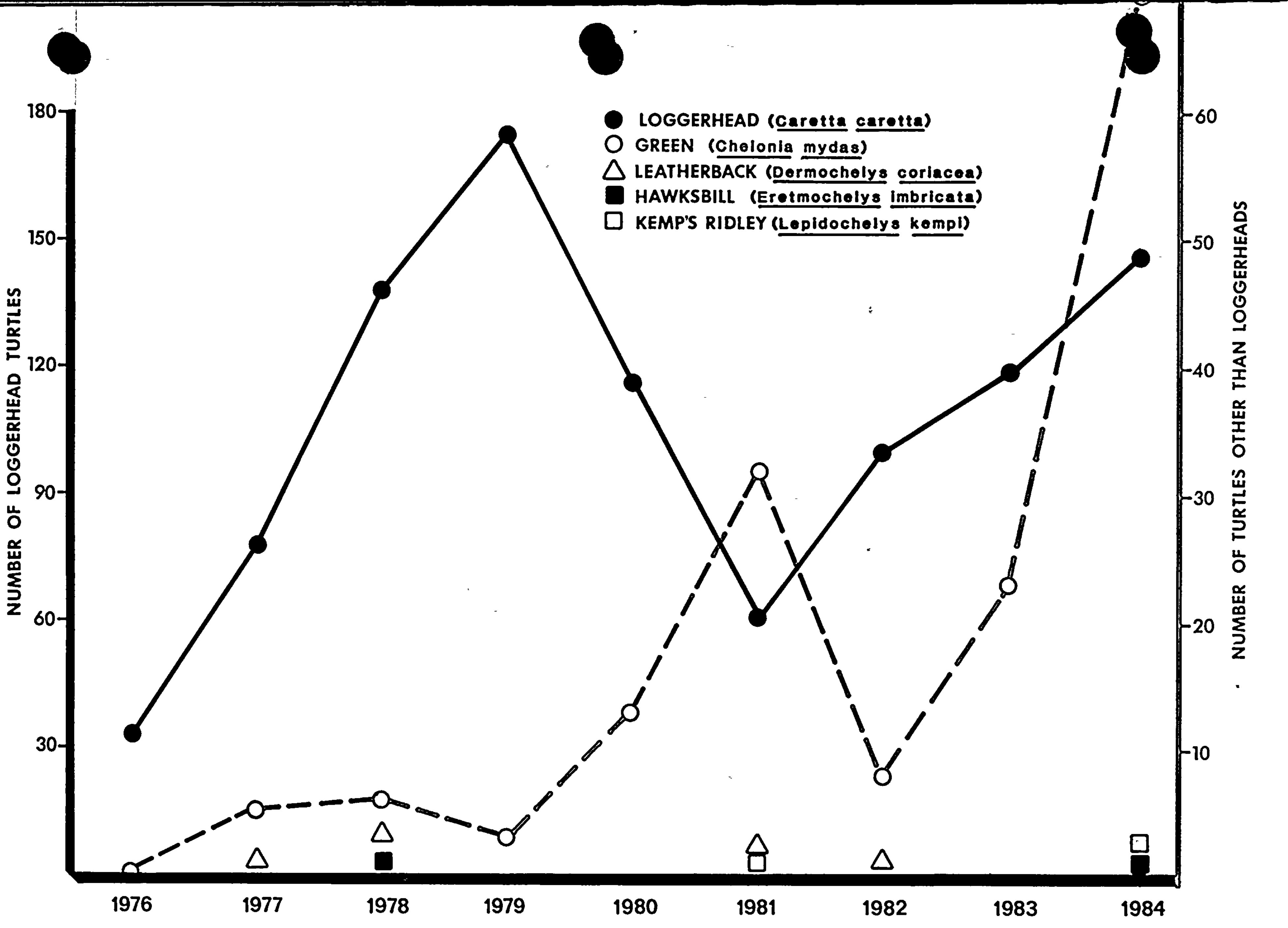
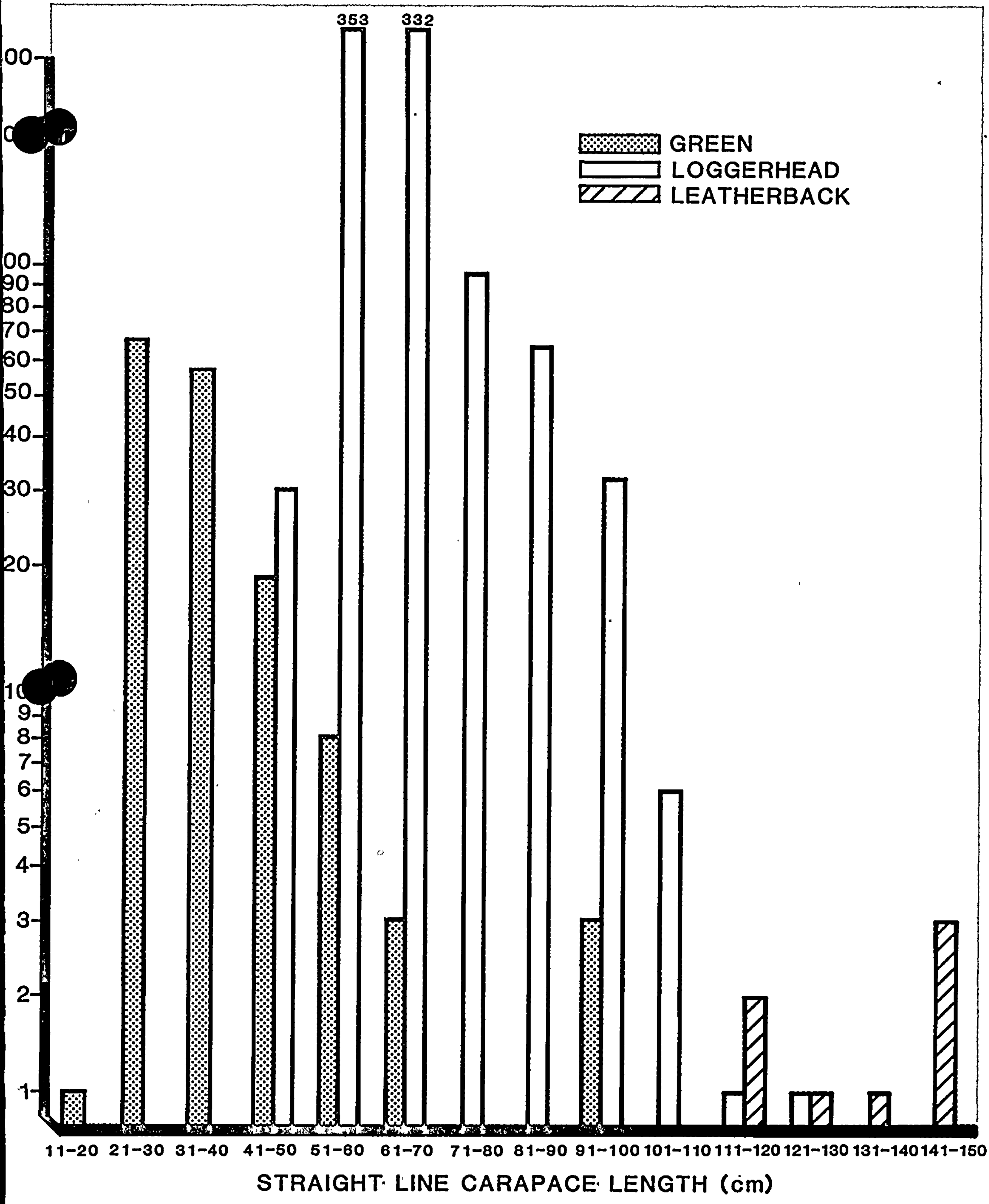


Figure D-13. Number of turtles removed from the intake canal, St. Lucie Plant, 1976-1984.



gure D-14. Length distribution of sea turtles removed from the intake canal, St. Lucie Plant, 1976-1984.

LE D-1

NUMBER OF LOGGERHEAD TURTLE NESTS IN EACH
OF THE 1.25-KM LONG SURVEY AREAS
HUTCHINSON ISLAND
1971 - 1984

	Preoperational			Operational						
Area	1971	1973	1975	1977	1979	1980[a]	1981	1982	1983	1984
1	85	110	96	48	47	-	66	98	80	120
2	92	132	108	55	80	-	101	139	107	154
3	113	144	156	90	93	109	83	140	112	130
4[b]	152	134	73	100	123	133	67	91	110	144
5	171	126	158	106	144	111	104	169	186	133
6	218	141	250	109	233	175	139	278	199	177
7	136	127	155	76	204	-	126	184	202	150
8	238	164	281	161	237	-	181	265	302	177
9	215	182	216	187	288	-	164	270	294	254
TOTAL	1420	1260	1493	932	1449	528	1031	1634	1592	1439

[a]Only Areas 3-6 were surveyed during 1980.

[b]St. Lucie Plant Site.

84LUCIE1
TABLED-1

TABLE D-2

NUMBER OF EMERGENCES BY LOGGERHEAD TURTLES IN EACH OF THE 1.25-KM LONG SURVEY AREAS HUTCHINSON ISLAND 1973-1984[a]

	Preoperational		Operational						
Area	1973	1975	1977	1979	1980[b]	1981	1982	1983	1984
1	164	161	77	102	-	126	165	143	176
2	173	182	79	149	-	182	220	180	253
3	210	301	138	176	220	177	203	218	222
4[c]	172	139	187	242	292	159	161	227	271
5	168	288	212	350	271	229	292	346	259
6	227	433	224	438	401	309	410	399	337
7	200	283	164	377	-	239	283	349	258
8	230	420	333	459	-	324	375	494	289
9	259	354	333	476	-	314	434	471	403
TOTAL	1803	2561	1747	2769	1184	2059	2543	2827	2468

[a]Non-nesting emergences were not recorded during 1971.

[b]Only Areas 3-6 were surveyed during 1980.

[c]St. Lucie Plant Site.

84LUCIE1
TABLE

TABLE D-3

LOGGERHEAD TURTLE NESTING SUCCESS[a] IN EACH
OF THE 1.25-KM LONG SURVEY AREAS
HUTCHINSON ISLAND
1973 - 1984[b]

	Preoperational		Operational						
Area	1973	1975	1977	1979	1980[c]	1981	1982	1983	1984
1	67	60	62	46	-	52	59	56	68
2	76	59	70	54	-	56	63	59	61
3	69	52	65	53	50	47	69	51	59
4[d]	78	53	54	51	46	42	57	49	53
5	75	55	50	41	41	45	58	54	51
6	62	58	49	53	44	45	68	50	53
7	64	55	46	54	-	53	65	58	58
8	71	67	48	52	-	56	71	61	61
9	70	61	56	61	-	52	62	62	63

[a]Nesting success is the percentage of emergences that result in nests.

[b]False crawls (non-nesting emergences) were not recorded during 1971.

[c]Only Areas 3-6 were surveyed during 1980.

[d]St. Lucie Plant Site.

84LUCIE1
TABLED-3

TABLE D-4

ESTIMATES OF THE NUMBERS OF LOGGERHEAD TURTLE NESTS BASED ON SURVEYS OF NINE 1.25-KM SURVEY AREAS IN 1971-1984 AND THE ACTUAL NUMBER OF NESTS FOUND 1981-1984 HUTCHINSON ISLAND

Year	Linear regression equation (Y=a+bx)[a]	r^2	Number of nests in the nine 1.25-km survey areas	Estimates of the number of nests on the entire island		Actual number of nests on the entire island
				Regression	Extrapolation	
1971	Y = 65.87 + 4.71x	0.73	1420	5423	4544	-
1973	Y = 108.34 + 1.62x	0.60	1260	4950	4032	-
1975	Y = 61.31 + 5.36x	0.61	1493	5680	4778	-
1977	Y = 29.26 + 3.81x	0.74	932	3522	2982	-
1979	Y = 7.53 + 7.87x	0.96	1449	5371	4637	-
1981	Y = 44.24 + 3.61x	0.82	1031	3932	3299	3115
1982	Y = 62.35 + 6.11x	0.74	1634	6204	5229	4690
1983	Y = 27.35 + 7.67x	0.93	1592	5955	5094	4743
1984	Y = 63.21 + 4.60x	0.70	1439	5256	4605	4277

[a]Y = The number of nests;
a = The Y intercept;
b = The slope of the regression line;
x = The distance (km) south of Ft. Pierce Inlet.

84LUCIE1
TABLED-2

TABLE D-5

NUMBER AND PERCENTAGE OF LOGGERHEAD TURTLE NESTS DESTROYED BY RACCOONS IN EACH OF THE NINE 1.25-KM LONG SURVEY AREAS HUTCHINSON ISLAND 1971-1984

	Preoperational					
	1971		1973		1975	
Area	Number	Percent	Number	Percent	Number	Percent
1	28	33	79	72	40	42
2	30	33	71	54	27	25
3	66	58	115	80	101	65
4[b]	32	21	44	33	9	12
5	60	35	69	55	16	10
6	30	14	13	9	0	0
7	5	4	2	2	1	1
8	63	26	66	40	24	9
9	79	37	90	49	92	43
TOTAL	393	28	549	44	310	21

[a]Only Areas 3-6 were surveyed during 1980.

TABLE CONTINUED

[b]St. Lucie Plant Site.

84LUCIE1
TABLED-4

TABLE D-5
(continued)
NUMBER AND PERCENTAGE OF LOGGERHEAD TURTLE NESTS DESTROYED BY RACCOONS IN EACH OF THE NINE 1.25-KM LONG SURVEY AREAS
HUTCHINSON ISLAND
1971-1984

	Operational					
	1977		1979		1980[a]	
Area	Number	Percent	Number	Percent	Number	Percent
1	36	75	2	4	-	-
2	18	33	4	5	-	-
3	63	70	5	5	10	9
4[b]	47	47	8	7	5	4
5	25	24	47	33	35	32
6	0	0	0	0	0	0
7	13	17	10	5	-	-
8	3	2	1	<1	-	-
9	146	78	49	17	-	-
TOTAL	351	38	126	9	50	10

[a]Only Areas 3-6 were surveyed during 1980.

TABLE CONTINUED

[b]St. Lucie Plant Site.

84LUCIE1
TABLED-4,A

TABLE D-5
(continued)
NUMBER AND PERCENTAGE OF LOGGERHEAD TURTLE NESTS DESTROYED BY
RACCOONS IN EACH OF THE NINE 1.25-KM LONG SURVEY AREAS
HUTCHINSON ISLAND
1971-1984

	Operational							
	1981		1982		1983		1984	
Area	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1	9	14	0	0	1	1	17	14
2	14	14	3	2	12	11	20	13
3	7	8	2	1	24	21	1	1
4[b]	2	3	1	1	6	5	2	1
5	9	9	47	28	47	25	14	11
6	1	1	0	0	1	1	0	0
7	0	0	0	0	1	<1	0	0
[illegible]	0	0	0	0	1	<1	0	0
9	10	6	1	<1	25	9	12	5
TOTAL	52	5	54	3	118	7	66	5

[a]Only Areas 3-6 were surveyed during 1980.

[b]St. Lucie Plant Site.

84LUCIE1
TABLED-4,A,B

TABLE D-6

TOTAL NUMBER AND (NUMBER OF DEAD) LOGGERHEAD TURTLES
REMOVED EACH MONTH FROM THE INTAKE CANAL
ST. LUCIE PLANT
1976 - 1984

Month	1976	1977	1978	1979	1980	1981	1982	1983	1984	Total	Monthly Mean
January	-	13	19	24(3)	16	10	6(2)	39	13	140(5)	17.5
February	-	8(1)	11(2)	29(1)	21(2)	11(3)	11	13(1)	11	115(10)	14.4
March	-	6	27(2)	11	14	6	14	1	6	85(2)	10.6
April	-	6(2)	19(5)	17	0	10	14	0	2(1)	68(8)	8.5
May	2	0	3(1)	0	7	6	17(4)	4	7	46(5)	5.1
June	0	4	10	3(1)	8(3)	6	7	7(1)	28(1)	73(6)	8.1
July	7(1)	4	0	27(2)	0	1	7	7	12(1)	65(4)	7.2
August	2	3	12	17(2)	12	6	2(1)	6	26	86(3)	9.6
September	1	15(1)	1	8(1)	19	2(1)	9(1)	8(2)	16	79(6)	8.8
October	7	9(1)	17(2)	15(3)	7	0	9(5)	17	10	91(11)	10.1
November	5(3)	5	15(7)	13	4	0	4(2)	5	9	60(12)	6.7
December	9	5	4	11	8	3	1(1)	12	8	61(1)	6.8
Total	33(4)	78(5)	138(19)	175(13)	116(5)	61(4)	101(16)	119(4)	148(3)	969(73)	-

84LUCIE1
TABLED-5

TABLE D-7

TOTAL NUMBER AND (NUMBER OF DEAD) SEA TURTLES
OTHER THAN LOGGERHEADS REMOVED FROM THE INTAKE CANAL
ST. LUCIE PLANT
1976 - 1984

Species	1976	1977	1978	1979	1980	1981	1982	1983	1984	Total	Annual Mean[a]
green		5(2)	6(1)	3(1)	13(4)	32(2)	8	23(4)	69(2)	159(16)	19.9
leatherback		1	3			2	1			7(0)	1.0
hawksbill			1						1	2(0)	0.2
Kemp's ridley						1			2	3(0)	0.4

[a]Excludes 1976 (partial year of plant operation).

84LUCIE3
TABLED-7

RELATIVE CONDITION OF LIVE SEA TURTLES
REMOVED FROM THE INTAKE CANAL
ST. LUCIE PLANT
1976 - 1984

Species	Poor[a]		Good[b]		Excellent[c]		Total[d]	
	Number of individuals	Percent	Number of individuals	Percent	Number of individuals	Percent	Number of individuals	Percent
hawksbill			1	(50)	1	(50)	2	(100)
Kemp's ridley	1	(33)	1	(33)	1	(33)	3	(100)
leatherback			6	(86)	1	(14)	7	(100)
green	10	(7)	72	(54)	53	(39)	135	(100)
loggerhead	177	(20)	533	(62)	155	(18)	865	(100)

[a]Poor - emaciated
slow or inactive
heavy barnacle and/or leach infestation
debilitating wounds or missing appendages

[b]Good - normal weight
active
light to medium coverage of barnacles and/or leaches
wounds absent, healed or do not appear to debilitate the animal

[c]Excellent - normal or above normal weight
active
very few or no barnacles or leaches
no wounds

[d]Thirty loggerheads and eight greens were not included because of insufficient information.

84LUCIE1
TABLED-7

TABLE D-9

HEMOGLOBIN VALUES RECORDED FOR LOGGERHEAD TURTLES
REMOVED FROM THE INTAKE CANAL
ST. LUCIE PLANT
JANUARY - DECEMBER 1984

Relative condition of turtles[a]	Number of turtles	Range of hemoglobin values (g/100 ml)	Mean hemoglobin value (g/100 ml)
Poor	3	-	-
Poor-Good	43	7.2-13.5	9.1
Good	43	7.0-12.5	10.1
Good-Excellent	38	8.0-11.5	10.3
Excellent	18	8.0-12.5	10.1

[a]See Table D-7 for criteria used to evaluate condition.

84LUCIE1
TABLED-8

OTHER ROUTINE REPORTS

Listed by section number from the NRC's Appendix B Environmental Protection Plan:

5.4.1(a) EPP NONCOMPLIANCES AND CORRECTIVE ACTIONS TAKEN

No EPP noncompliance activities occurred during 1984.

5.4.1(b) STATION DESIGN AND OPERATION CHANGES, TESTS AND EXPERIMENTS AFFECTING THE ENVIRONMENT

No activities of this nature occurred during 1984.

5.4.1(c) NONROUTINE REPORTS SUBMITTED IN ACCORDANCE WITH SUBSECTION 5.4.2

1) The Environmental Protection Plan Unusual Event report concerning the handling of two brown pelicans was submitted to NRC on March 8, 1984.

2) The Sea Turtle Necropsy Reports was submitted to NRC on March 8, 1984.

3) The Occurrence of Nonroutine Event report concerning actions taken in response to elevated water levels in the discharge canal was submitted to NRC on April 6, 1984.

4) The Environmental Protection Plan Unusual Events report concerning the handling of brown pelicans was submitted to NRC on April 6, 1984.

5) The Quarterly Turtle Activities Report, First Quarter, 1984 was submitted to NRC on May 10, 1984.

6) The Quarterly Turtle Activities Report Second Quarter, 1984 was submitted to NRC on September 6, 1984.

7) The Environmental Protection Plan Report concerning EPA and FPL correspondence relating to an unreported NPDES Permit Violation was submitted to NRC on October 22, 1984.

8) The Environmental Protection Plan Report concerning a noncompliance NPDES Permit discharge was submitted to NRC on October 29, 1984.

9) The <u>Quarterly Turtle Activities Report</u>, Third Quarter, 1984 was submitted to NRC on November 16, 1984.

10) The <u>Sea Turtle Necropsy Report</u> was submitted to NRC on January 7, 1985.

11) The <u>Quarterly Turtle Activities Report,</u> Fourth Quarter, 1984 was submitted to NRC on February 19, 1985.

12) The <u>Modification of NPDES Permit No. FL0002208</u> was submitted to NRC on February 19, 1985.

ENCLOSURE 1
SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
RELATED TO THE INSERVICE TESTING PROGRAM REQUESTS FOR RELIEF
FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT, UNIT 2
DOCKET NUMBERS 50-389

1.0 INTRODUCTION

The Code of Federal Regulations, 10 CFR 50.55a, requires that inservice testing (IST) of certain ASME Code Class 1, 2, and 3 pumps and valves be performed in accordance with Section XI of the ASME Boiler and Pressure Vessel Code and applicable addenda, except where alternatives have been authorized or relief has been requested by the licensee and granted by the Commission pursuant to Sections (a)(3)(i), (a)(3)(ii), or (f)(6)(i) of 10 CFR 50.55a. In proposing alternatives or requesting relief, the licensee must demonstrate that: (1) the proposed alternatives provide an acceptable level of quality and safety; (2) compliance would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety; or (3) conformance is impractical for its facility. NRC guidance contained in Generic Letter (GL) 89-04, *Guidance on Developing Acceptable Inservice Testing Programs*, provides alternatives to the Code requirements determined acceptable to the staff.

Section 10 CFR 50.55a authorizes the Commission to approve alternatives and to grant relief from ASME Code requirements upon making the necessary findings. The NRC staff's findings with respect to authorizing alternatives and granting or not granting the relief requested as part of the licensee's IST program are contained in this Safety Evaluation (SE).

Furthermore, in rulemaking to 10 CFR 50.55a effective September 8, 1992, (see 57 Federal Register 34666), the 1989 edition of ASME Section XI was incorporated in ¶ (b) of § 50.55a. The 1989 edition provides that the rules for IST of pumps and valves shall meet the requirements set forth in ASME Operations and Maintenance Standards Part 6 (OM-6), *Inservice Testing of Pumps in Light-Water Reactor Power Plants*, and Part 10 (OM-10), *Inservice Testing of Valves in Light-Water Reactor Power Plants*. Pursuant to (f)(4)(iv), portions of editions or addenda may be used provided that all related requirements of the respective editions or addenda are met, and subject to Commission approval. Because the alternatives meet later editions of the Code, relief is not required for those inservice tests that are conducted in accordance with OM-6 and OM-10, or portions thereof, provided all related requirements are met. Whether all related requirements are met is subject to NRC inspection.

The IST program evaluated in this SE covers the first ten-year IST interval for St. Lucie Plant, Unit 2. The interval began August 8, 1983, and ends August 8, 1993. The first ten-year interval IST program is based on the requirements of the 1980 Edition, included addenda through the Winter 1980 Addenda, of the ASME Section XI Code which were incorporated by reference in § 50.55a(b) by Volume 46 Federal Register 63208 effective February 1, 1982.

The second ten-year interval begins August 9, 1993. The relief requests which

are approved for an interim period of one year, or until the next refueling outage, whichever is later, may continue into the next interval, if applicable. This will allow the licensee time to evaluate the concerns identified in the attached Technical Evaluation Report associated with these relief requests. Otherwise, the licensee should implement the updated IST program developed for the second ten-year interval, which has not yet been submitted to the NRC, at the second interval start date in accordance with the requirements of 10 CFR 50.55a(f)(4)(ii).

2.0 EVALUATION

The Mechanical Engineering Branch, with technical assistance from Brookhaven National Laboratory (BNL), has reviewed the information concerning IST program requests for relief submitted for the St. Lucie Plant, Unit 2, in Florida Power & Light Company's letters dated September 15, 1992, and January 13, 1993. A previous Safety Evaluation for the St. Lucie Plant, Unit 2, IST Program was issued for the first ten-year interval in NRC's letter dated January 13, 1986. The September 1992 revised program renumbered the relief requests. The licensee identified several relief requests in Attachment 1 of their September 15, 1992, submittal which they indicated required review and approval by the NRC. The remaining relief requests which were not listed in Attachment 1 were not reviewed. The relief requests submitted for the second ten-year program will be reviewed in total.

The staff adopts the evaluations and recommendations for granting relief or authorizing alternatives contained in the attached Technical Evaluation Report (TER) prepared by BNL. Relief is granted from, or alternatives are authorized to, the testing requirements which have been determined to be impractical to perform, where compliance would result in a hardship without a compensating increase in safety, or where the proposed alternative testing provides an acceptable level of quality and safety. Certain relief requests have been approved pursuant to 10 CFR 50.55a (f)(4)(iv) where it has been determined that the proposed alternative is in accordance with the requirements of the 1989 Edition of ASME Section XI, and therefore, relief from Code requirements is not required. When an alternative is approved pursuant to (f)(4)(iv), any applicable related requirements, as listed in the TER, must be implemented, and such implementation is subject to NRC inspection. A summary of the NRC actions is provided in Table 1.

The IST program relief requests which are granted, authorized, or approved are acceptable for implementation provided the action items identified in Section 4 of the TER are addressed within one year of the date of the SE or by the end of the next refueling outage, whichever is later. As noted above, the St. Lucie Plant, Unit 2, ten-year interval updated program will be implemented August 9, 1993. Any interim relief continues for the next interval, if applicable, in order that the licensee have a period of time to address the concerns identified in the TER.

Additionally, the granting of relief is based upon the fulfillment of any commitments made by the licensee in its basis for each relief request and the alternatives proposed.

Program changes involving new or revised relief requests should not be implemented prior to approval by the NRC except as authorized by GL 89-04. New or revised relief requests that meet the positions in GL 89-04, Attachment 1, should be submitted to the NRC but may be implemented provided the guidance in GL 89-04, Section D, is followed. Program changes that add or delete components from the IST program should also be periodically provided to the NRC.

3.0 RELIEF REQUEST VR-13, SAFETY INJECTION TANK TO REACTOR COOLANT SYSTEM CHECK VALVES V-3215, V-3225, V-3235, AND V-3245, AND RELIEF REQUEST VR-14, SAFETY INJECTION HEADERS TO REACTOR COOLANT SYSTEM CHECK VALVES V-3217, V-3227, V-3227, AND V-3247

In addition to the evaluations in Section 3.2.2 and 3.2.3, and discussion in Action Items 4.9 and 4.10, of the TER, the staff provides the following information for the licensee to consider in evaluating the extension of the disassembly and inspection for the safety injection tank discharge check valves and the safety injection headers check valves.

Disassembly and inspection of a check valve is not considered a true substitute for an operability test conducted under operating flow conditions,
but is allowed when no other means for testing is available. Under operating conditions the valve internal parts are subjected to dynamic flow loads, pressure gradients, differential temperature and gradients, and flow-induced and system-generated mechanical vibration. Pipe loading on the valve body can affect the alignment of valve internal parts. Any of these conditions, or a combination of these conditions, can alter the valve performance and the effects could be diagnosed during operational testing. However, these operating conditions are not duplicated, and the results may not be apparent, in a disassembly and inspection effort. There have been instances where operational problems were discovered after disassembly/inspections. There are also examples of latent problems caused by the disassembly and inspection efforts, such as installing a bonnet-hung check valve is an incorrect orientation. Certain of these problems could be identified during a partial- flow test or a leakage test following disassembly/inspection, if performed.

In the past, conditions limiting testing of certain check valves justified the use of disassembly and inspection since no other practical test method was available. With the acceptance of nonintrusive methods and the development of other test methods, this justification requires a re-examination (reference NUREG/CP-0123, "Proceedings of the Second NRC/ASME Symposium on Pump and Valve Testing"). GL 89-04, Position 2, was developed prior to wide-spread use of nonintrusive techniques. It allowed disassembly and inspection (D&I) conditionally when other methods were impractical; however, in the public meetings, in response to questions on use of D&I, the staff indicated the use of other alternate techniques, including nonintrusives, were under investigation and were being encouraged by NRC. Allowing D&I on a sampling basis was an extension of the Code required time interval for valve testing. The D&I sample was small and valves in the group were identical in type, size, service conditions, exposure to operating environments, and age. The GL 89-04 sampling interval extension was justified on the basis that one valve in the group would be examined during each refueling outage and the performance of each valve in the group was representative of all the others.

GL 89-04, Position 2, allowed the use of a limited sampling plan to reduce the burden on the licensee to D&I all valves in the group during each refueling. The sampling plan allowed that only one valve in each group be D&I at each refueling rather than disassembling and inspecting all valves in the group. The sampling plan further allowed a different valve in the group be D&I at each refueling and the process be repeated until all valves were inspected. With an 18-month operating fuel cycle, this would ensure that no valve D&I interval would be greater than six years. Position 2 also suggested conditions of <u>extreme</u> hardship for consideration in extending the inspection interval beyond once every 6 years. In Position 2 the staff, in part, stated "[i]n order to support extension of the valve disassembly and inspection interval to longer than once every 6 years, the licensee should develop the following information: "a. Disassemble and inspect each valve in the grouping and document in detail and the condition of each valve and the valves's capability to be full stroked. . . ."

Although GL 89-04 suggested information to be considered by the licensee in developing justification for an interval extension it was not all inclusive. The staff expected the licensee would conduct an in-depth review of all the safety effects as discussed during the public meetings. The staff expectations for justification of an interval extensions were amplified in the responses to questions during the GL 89-04 public meetings. Included in the staff justification expectations was a licensee's detailed evaluation of the effects on public safety, the maintenance history, service history, and other information relative to valve reliability and that the review and evaluation would rely on known and recorded valve condition of each valve from previous inspection data rather than subjective qualitative judgement. The licensee's justification for extending the inspection interval appears to be based on concerns of mid-loop operation. The evaluation presented in the relief request is considered inadequate for justifying extending the inspection interval per the guidance delineated in GL 89-04, Position 2. Further, the concerns regarding personnel exposure and potential loss of decay heat removal are the result of performing disassembly and inspection. In addition to attempting to provide additional justification to comply with GL 89-04, Position 2, for the <u>extreme</u> hardship of performing D&I each refueling outage, the licensee should consider the advantages of other test methods available, including nonintrusive techniques, to reduce exposure and avoid the potential loss of decay heat removal. A discussion of the results of the efforts to apply other testing techniques should be included in the licensee's response to Action Items 4.9 and 4.10.

4.0 <u>CONCLUSION</u>

The licensee's IST program requests for relief from the requirements of Section XI have been reviewed by the staff with the assistance of its contractor, Brookhaven National Laboratory (BNL). The Technical Evaluation Report (TER) provided as Attachment 1 is BNL's evaluation of the licensee's IST program relief requests. The staff has reviewed the TER and concurs with the evaluations and recommendations for granting relief or authorizing alternatives. A summary of the relief request determinations is presented in Table 1. The authorizing of alternatives or granting of relief is based upon the fulfillment of any commitments made by the licensee in its basis for each relief request and the alternatives proposed. The implementation of IST program is subject to inspection by NRC.

Relief requests which are in accordance with the 1989 Edition of ASME Section XI (which incorporated OM-6 and OM-10) have been approved pursuant to 10 CFR 50.55a ¶ (f)(4)(iv) as listed in Table 1; however, because these meet the Code requirements, these are listed as "relief is not required." Certain other relief requests are authorized for an interim period to provide the licensee a period of time to review the testing.

The licensee should refer to the TER, Appendix A, for a discussion of IST program anomalies identified during the review. The licensee should resolve all items in accordance with the guidance therein. The IST program relief requests acceptable for implementation provided the action items identified in Section 4 of the TER are addressed within one year of the date of this SE or by the end of the next refueling outage, whichever is later. The action, where applicable, should address the licensee's updated second ten-year program as well. The licensee should respond to the NRC within one year of the date of this SE describing actions taken, actions in progress, or actions to be taken, to address each of these items, noting which issues have been resolved by the updated second ten-year interval program.

The staff concludes that the relief requests as evaluated and modified by this SE will provide reasonable assurance of the operational readiness of the pumps and valves to perform their safety-related functions. The staff has determined that granting relief pursuant to 10 CFR 50.55a (f)(6)(i), authorizing alternatives pursuant to 10 CFR 50.55a (a)(3)(i) and (a)(3)(ii), and approving alternatives pursuant to 10 CFR 50.55a (f)(4)(iv) is authorized by law and will not endanger life or property, or the common defense and security and is otherwise in the public interest. In making this determination, the staff has considered the impracticality of performing the required testing and the burden on the licensee if the requirements were imposed.

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