An Environmental Monitoring Program
1974-1984

on

Diamondback Terrapin Nesting
and
Osprey Nesting/Bald Eagle Occurrence
In the Vicinity of Artificial Island

a Summary

for

Public Service Electric and Gas Co.
Nuclear Department
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TABLE OF CONTENTS

LIST OF TABLES

TABLE OF CONTENTS
CONTINUED

LIST OF FIGURES

SECTION 1.0
INTRODUCTION

Annually from 1972 through 1984, various aspects of the terrestrial ecology of Artificial Island and vicinity have been studied as part of the Salem Nuclear Generating Station (SNGS) Environmental Technical Specifications (Tech Specs), as required by the U.S. Nuclear Regulatory Commission (NRC). Findings have been presented in Annual Progress Reports (Schuler, 1974-1977; PSE&G, 1978-1984), and summary reports by Hardin (1980) covering 1972-1978 and PSE&G (1983) covering 1974-1981.

Early studies generated a perception of the pre SNGS-operation local terrestrial community and representative elements. Later studies traced variously-selected elements in the post SNGS-operation environment. Vegetative associations were studied during 1972-1974, small-mammal populations during 1972-1973, and bird seasonal/migratory occurrence during 1972-1979.

The two topic studies of this summary report, osprey nesting/bald eagle occurrence and diamondback terrapin nesting, were begun in 1974 and 1975, respectively, and continued through 1984. This report integrates the annual information collected over the decade of observations. It presents general ranges, means, and trends reflected in the data and attempts to describe the ecological impact of SNGS on these species.

SECTION 2.0
DIAMONDBACK TERRAPIN NESTING

Perhaps the most common reptile in the river and marshes of the Delaware Bay is the northern diamondback terrapin, Malaclemys terrapin terrapin. The literature generally describes the environment of this subspecies as the salt and brackish coastal waters from Cape Cod to Cape Hatteras. In the early part of this century, market-for-table demand was high and populations were heavily exploited, some to the point of serious regulatory concern. As a result, capture seasons were closed, and possession was prohibited. This protection allowed a population recovery and a coincident drying-up of market interest, and populations have again become well established.

Hurd et al. (1979), in a two-year study of a population in a Delaware salt-marsh designed to reflect on seasonal population phenomena related to ecology, described a terrapin density of 1.8 individuals per linear meter of tidal creek, which they described as a large population. They also commented on the paucity of information concerning population dynamics and ecological relationships of diamondback terrapin in nature. This present study provides some useful insight into the biology of the local terrapin population and its utilization of local nesting areas.

2.1 STUDY SCOPE

Study of diamondback terrapin focused on reproduction-related parameters which could be monitored at local nesting-beaches. Observations of nesting activity and effort, age of nesting females, nest activity and hatching success, and predation were made, typically from June-November, in all years. From 1975-1982, three local beaches which had been determined to support nesting were monitored. Two were on the New Jersey shore and proximal to Salem; the other was established in Delaware to possibly reflect behavioral differences at east- versus west-shore beaches. Data through 1982 failed to evidence such differences, and in 1983 effort was restricted to the one beach in Delaware and the up-river site in New Jersey.

2.2 STUDY AREA

Observations through 1984 were made just north of Liston Point, Delaware and at Sunken Ship Cove and, through 1982, at Hope Creek in New Jersey (Figure 1).

Sunken Ship Cove is at the southeastern end of Artificial Island. The beach is partially bounded by a breakwater and lies half within the cove and half east of the cove. The area monitored is 213 m (700 ft) long and from 15 to 38 m (49-125 ft) wide. Primary vegetation consists of a dense stand of saltmeadow cordgrass (*Spartina patens*) with reed canary grass, *Phalasis arundinacea*; sea rocket, *Cakile endentula*; and wild radish, *Raphanus raphanistrum*, occurring in clumps.

Hope Creek beach is some 209 m (680 ft) southeast of the mouth of Hope Creek. The site is 213 m (700 ft) long and 3 to 5 m (10-16 ft) wide. Vegetation originally included a 3 m (10 ft) wide stand of saltmarsh cordgrass in the intertidal zone, with common reed, *Phragmites australis* (formerly *P. communis*); saltmeadow cordgrass, and groundsel bush, *Baccaris halimifolia*, occurring above mean high tide. Behind this strip of beach is an intermediate type tidal marsh. The site has become almost entirely covered with common reed during the period of study.

The Liston Point site is 397 m (1,300 ft) long and from 20 to 24 m (60-80 ft) wide. Primary vegetation includes saltmeadow cordgrass and American beachgrass, *Ammophila brenliqulata*, in sparse to dense stands, with marsh elder, *Iva frutescens*, and sedge, *Cyperus* sp., occurring in clumps. This is located behind a 7 to 12 m (20-40 ft) wide shoreline strip of sand. An intertidal stand from 3 to 5 m (10-16 ft) wide of mostly saltmarsh cordgrass occurs on the southern half of the site.

Liston Point has the highest elevation and Hope Creek beach the lowest of the three sites. Sections of the Hope Creek site are occasionally inundated during storms.

The amount of human disturbance varies greatly at the three sites. Sunken Ship Cove is used for fishing, swimming, and picnicing. Hope Creek is rather isolated and probably visited only by present-study personnel during sampling. Liston Point is used occasionally for recreation by local inhabitants.

2.3 MATERIALS AND METHODS

The study sites were searched during daylight, typically from June through November. Weekly searches for evidence of nesting were made in early June. After first evidence of nesting, beaches were monitored several times (2-5) a week through July. Searches for depredated nests and emerging hatchlings were made several times a week from August through September and occasionally (if weather stayed warm) into November. Weather and tide occasionally prevented visiting all beaches on the same day. Each visit consisted of walking the beach and counting turtles, crawl tracks (incoming only), depredated nests, and eggs.

Effort was taken to minimize disturbance of nesting terrapins. Wherever possible they were not disturbed until after nesting; females typically attempted to leave the area when they sensed the observers. It is probable that disturbance from beaching the boat and subsequent monitoring activities interrupted turtles at the various stages of nesting.

Females were caught by hand and the length and width (mm) of the carapace and plastron were measured. A numbered spaghetti tag was placed in a hole drilled in either the eleventh marginal or one of the postcentral laminae after Porter (1972), with the hole location being part of a binary code which keyed to the tagging event. This location enables easy drilling and placement of the tag and offers minimal interference to the activities of the terrapin.

Hatchlings were enumerated from crawl tracks or by digging them out of nests. Young were returned to the point of capture.

The number(s) of the tag(s) attached, length and width measurements, general location of the nest, time, date, tidal stage, weather, number of turtles observed but not tagged, and number of terrapin tracks observed on the beaches were recorded. Tide data were taken from National Oceanic and Atmospheric Administration (NOAA) (1977) and measurements of cloud cover from NOAA (1972).

In all years except 1976 and 1977, nests that contained unbroken eggs were marked with a stake, and the number of eggs was recorded. These nests were located by following tracks, finding females on the nests, and by random search. Depredated nests were counted and the number of eggs destroyed at each nest estimated by counting egg shells in and near the nest. Scattered individual egg shells were not counted. All shell fragments were buried or removed from the study area after counting. In 1976 and 1977, nests were covered with a wire enclosure to prevent depredation, and weekly measurements of temperature and soil moisture (g/100c) were taken.

2.4 DATA ANALYSIS

Intensity of nesting activity for each study site was annually estimated for the period from the first observed occurrence of nesting turtles or adult tracks to the last observed occurrence. A log (x+1) transformation was employed to allow for the occurrence of zero observed turtles and tracks in the data. Plots of the annual mean log (x+1) number of turtles and adult tracks for each year are presented for comparison.

2.5 DISCUSSION

Findings on the discrete behavioral, biologic and ecologic parameters monitored during the study are summarized categorically. Collectively, they characterize the schedules and relationships exhibited by local diamondback terrapin during their usage of the studied beaches.

2.5.1 Nesting Period

Nesting has regularly begun during early- to mid-June and continued through mid- to late July (Figures 2, 3, 4). The earliest date of observed nesting evidence was June 4, 1981 at Liston Point beach. Nesting at the different study sites has always commenced within a few days of each other, suggesting a synchronization in the local population. Nesting also appears cyclic in that there are typically two major peaks and perhaps a third to several lesser peaks during a season. This implies a hormonal synchrony, the existence of which is supported by a general correlation of nesting pattern with photoperiod, temperature, and even lunar stage. Photoperiod is suggested in first nesting evidence being annually observed about June 10, the time of earliest sunrise in the year. Burger and Montevecchi (1975) also observed first nesting on about June 10 at a site on the Atlantic coast of southern New Jersey. Earlier, Burger (1937) had stated that sexual behavior of turtles might be controlled by light. Temperature is suggested as a factor since in years when the period April through mid-June has been relatively cool nesting started in mid-June but did not peak until warming had occurred. The actual temperature probably affects date of emergence from hibernation, subsequent mating, and timing as well as number of individuals involved in movement into the rookery. Lunar stage correlation might be evidenced by the apparent 14-day cycles within the nesting data curves in Figures 2, 3, and 4.

2.5.2 Nesting Activity

Nesting at the three study sites has followed a general pattern in which the Liston Point site has annually, based on the mean number of observed turtles and tracks per visit, been the most intensively used, and Sunken Ship Cove the least (Figure 5). Further, each site has evidenced a relatively similar increase or decrease in annual usage, i.e., population activity trends could be reasonably inferred from any one of the studied beaches. Liston Point, being the largest beach and relatively isolated, is explainably the most used. The Hope Creek beach has been physically diminished by erosion and encroaching marsh vegetation. The Sunken Ship Cove site, based on its size and appearance, might be expected to support more terrapin utilization were it not for the heavy usage by fishermen throughout the summer.

This pattern of usage is also reflected in numbers of nests, eggs, and hatchlings (Tables 1, 2, 3). Of course, these counts are conservative (low) and should be used only as relative indices for inter-beach comparisons and not for actual production or population-size inference. During 1975-1984, 3,741 nests were identified at Liston Point, 99 at Sunken Ship Cove, and 1,415 at Hope Creek. Observed nest depredation was greatest at Liston Point; of the 3,741 nests seen, only 247 had been undisturbed. Sunken Ship Cove evidenced the least; of 99 total nests, 43 had been undisturbed. The range of mean eggs per nest at the three sites was reasonably close; 8.25 at Liston Point, 7.15 at Sunken Ship Cove, and 6.12 at Hope Creek. Similar to the mean number eggs-per-nest patterns, the numbers of hatchlings represented in Column III in Tables 1, 2 and 3 are not as dissimilar as numbers of nests and eggs might suggest. Liston Point beach evidenced 37.8 x the number of total nests at Sunken Ship Cove, and 5.7 x the number of non-depredated nests and 6.12 x the number of non-depredated eggs. Yet, the ratio of hatchlings at the two sites was 1.83:1. Compared with Hope Creek beach, the ratio was somewhat higher at 2.92:1.

During monitoring of non-depredated nests, incubation took from as few as 49 days (in 1977) to as many as 100 days (in 1982). Typically, hatching occurred 65-75 days after eggs were laid. Carr (1952) reported that incubation periods for turtles normally range from 60-90 days, but are so strongly affected by temperature and humidity that no given species adheres very closely to a definite schedule. Spearman's coefficient of rank correlation on several year's data verified that length of incubation was negatively correlated with mean nest temperatures (i.e., as temperature decreases incubation time increases). In general, nests laid under vegetation had longer incubation periods, probably reflecting cooler temperatures due to shading. In the present study, soil moisture was not found to affect length of incubation of successful eggs. However, it did affect hatching success of fertile eggs. Unsuccessful embryo development (percent of embryos that died) was greater at the wetter nest sites. This mortality could reflect lower temperatures, decreased air availability, and perhaps fungal occurrence, that could accompany higher moisture levels.

Hatching typically began during the latter half of August, peaked during the next two weeks, decreased sharply during late September and occasionally continued at a low level into early October. Burger (1976) observed that young terrapin spent several days in the nest before emerging, perhaps as many as 11 days. In the present study in 1977, turtle nests were excavated and many fully-formed hatchlings were found, accompanying the unhatched eggs. We did not observe synchrony in either egg hatching or hatchling emergence. We did observe, as did Burger (1976), that most hatchlings emerge between 1200 and 1700 hrs, normally the warmest part of the day.

2.5.3 Predators

As described above, depredation of nests and predation on hatchlings was a significant statistic in this study (Tables 1, 2, 3). Most local common predators and scavengers likely exploit these early life stages. At Sunken Ship Cove, tracks of the Norway rat, Rattus norvegicus, and striped skunk, Mephitis mephitis, were occasionally observed. Tracks of mink, Mustela vison; Norway rat; common crow, Corvus brachyrhynchos; and, occasionally, muskrat, Ondatra zibethicus, were observed at Hope Creek beach. Mink; Norway rat; and raccoon, Procyon lotor, tracks were commonly observed at Liston Point. Track evidence indicated that mink; raccoon; Norway rat; crow; great black-backed gull, Larus marinus; and occasionally, great blue heron, Ardea herodias, and turkey vulture, Cathartes aura, also preyed on hatchlings both in and out of the nests. Fox (whether red or gray is unknown) tracks were also seen at all locations.

2.5.4 Age and Size of Nesting Females

From 1975-1984, 380 nesting females were captured, examined and tagged. These were distributed as 202 at Liston Point, 175 at Hope Creek, and three at Sunken Ship Cove.

Mean plastron length was annually similar, typically 17.5-18 cm, as was plastron width at 12-14 cm. Carapace length was annually about 16.5 cm and width was 9-13 cm.

Age of captured specimens ranged from 5 to 20+ years. More than half had smooth shells, which Hildebrand (1932) stated may indicate age to perhaps 40+ years.

The turtle recapture pattern evidenced several factors. Only 25 specimens of the 380 tagged were recaptured, a recapture rate of only six percent. However, although population estimates were neither planned nor possible, the results do reflect on the parameters at which tagging was directed, namely, beach fidelity and, perhaps, growth information. All recaptures were at the beach of initial capture and tagging. Time to recapture ranged from 2 days to 5 years. Many recaptures were within days or weeks of tagging, showing a persistence to nesting or the act of re-nesting during the same season. Re-nesting was observed in cultured terrapin, from one to five nests per year, by Hildebrand (1932). The long-term recaptures are evidence of beach fidelity, a feature reported by Carr and Ogren (1960) and Carr and Carr (1972). Perceived change in physical size was slight; during a five-year interval one capture had increased in carapace length by only two percent, from 16.4 cm to 16.7 cm.

2.6 Overview

All observations on local diamondback terrapin suggest behavior, and response to environmental conditions, typical of the species and of a healthy biological population. During the near-decade of study, construction of SNGS Units 1 and 2 was completed and both units underwent power-level staging and reached 100 percent, or commercial, operation (Unit 1 on June, 1977 and Unit 2 on October 18, 1981). There is no evidence that operational levels or characteristics of SNGS have affected, in any way, the activities or success of local diamondback terrapin. It is probable that the Artificial Island access road has indirectly had a negative effect on the degree of utilization of the Sunken Ship Cove beach as a nesting site. The road provides ready, and literally the only, land access to Sunken Ship Cove and the local Delaware River, and there is an established use pattern by fishermen, boaters and picnickers. This human recreational activity during the nesting period probably discourages or disrupts nesting behavior. However, it is unlikely that this very localized action has any substantive effect on the regional diamondback terrapin population.

SECTION 3.0
OSPREY NESTING/BALD EAGLE OCCURRENCE

The osprey, Pandion haliaetus, is a common summer-resident raptor in the study area, occurring annually between March and August during which time it breeds, nests, and rears its young. Nests built of sticks, reeds, and debris are constructed in natural and man-made structures including dead or dying trees, channel markers, and, increasingly in this area, electric transmission towers.

The species is listed as "endangered" in New Jersey (NJDEP, 1984). It had been federally classified as "status undetermined" (USDI, 1973) but has since been deleted from the Federal list. In New Jersey, prior to 1950 there were some 500 nesting pairs of osprey (Frier, 1982). However, chemical contamination (primarily DDT) of the environment and coincident loss of nesting sites caused a severe population reduction, and in 1974 there were only 50 known nesting pairs in the State (Frier, 1982). The cessation of DDT usage (in 1966) and, to a degree, the increase in nesting sites have encouraged a population recovery. This trend can be perceived in the local population discussed in this report.

The bald eagle, Haliaetus leucacephalus, has historically wintered along major rivers and bays in New Jersey. Throughout much of its range the species has evidenced reduced reproductive success as a result of infertile or thin-shelled eggs, these being attributed to use of DDT and its occurrence in the food chain. The species is federally classified as "endangered". Frier (1982) listed one breeding pair remaining in New Jersey. Annually during 1974-1984, special note was taken of eagle sitings and reports in the course of all terrestrial studies. However, due to the absence of nesting activity in the area, no special study program or area was established.

3.1 STUDY SCOPE

Monitoring of osprey focused on nesting-related activities, behavior, and reproductive success. Numbers and locations of nests, vacant and occupied, and counts/estimates of eggs and number young fledged were the standard parameters. Monitoring was done each year, 1974-1984. Records were kept of bald eagle sightings and awareness of nesting activity was maintained.

3.2 STUDY AREA

Observations were made at historical and regularly-used nesting locations contained within the area shown in Figure 6. The most striking and dominant physical feature of the 232 km^2 region is the array of electric transmission lines, and the associated towers which support most of the local nesting. The region features a variety of habitats, e.g., bay, riverine, marsh, upland field, and wooded, and with availability of suitable nesting locations appears capable of supporting a local seasonal osprey population.

3.3 MATERIALS AND METHODS

Observations were made by boat and foot travel during 1974-1976, and from a PSE&G helicopter from 1975-1984. In 1974 and 1976, nests were closely inspected and exact counts of eggs, nestlings, and fledglings were recorded. These counts were possible when climbing-visits coincided with the feeding or other absence of the sitting female. In the mid-1970's, when helicopter became the prime observation mode, a reasonable distance (ca. 50 yards) from the nest was maintained to avoid frightening or otherwise disturbing the sitting birds. Observations were made with binoculars and data should be considered as semi-quantitative.

3.4 DISCUSSION

3.4.1 Osprey

During the decade of study, adult osprey have been annually recorded in the study area, as early as March 15 and as late as October 15. Soon after first sightings, activity at nesting sites was observed as the birds began nest building or refurbishment. Eggs were usually laid, and clutches were complete, by mid-April. Incubation takes about 28 days, and eggs hatched typically during mid- to late May. The young birds fledged by mid-July, and by mid-August most were independent of the nest. By mid-September, young and adults were leaving or had already left the study area for overwintering grounds in the West Indies and South America (Henny and Van Velzen, 1972).

Table 4 presents all data on nesting collected during the period of study. It shows the temporal and spatial expansion of site utilization and presents statistics and notations on osprey activity and success over the years.

Figure 6 shows nesting locations (historical and present) in non-PSE&G sites (e.g., nesting platforms, snag trees, transmission-line towers), and in the PSE&G transmission lines that emanate from SNGS. The locations of towers in PSE&G lines, with notations to those used by osprey, are shown in Figures 7 and 8. Most local nesting activity occurs in the PSE&G towers.

Table 4 does not list data collected in 1974 and 1976 during close-up inspection of nests and clutches. During these years, annual mean clutch size was 2.4 and 3.0 eggs, and mean hatching success was 33.3 and 44.4 percent. Mean success from nestling, or young, to fledgling stage was 75.0 and 87.5 percent. These levels approximate those described as generally good for a healthy population by Parnell and Walton (1972) in a discussion of osprey reproductive success in North Carolina. We have no local information on these parameters since 1976.

With completion of the Salem transmission towers in 1971, the number of local potential osprey nesting sites greatly increased. Commencing ca. 1975-1977 there has been an apparent shift in nesting activity from the old natural structures and man-made platforms to the transmission towers. In 1980, utilization of towers in the Salem-Keeney line was pronounced, and since 1981 utilization of the Salem-New Freedom North line has increased. The DP&L towers have been regularly used since 1981. Several towers, most notably tower 6/1 of the Salem-New Freedom North line, have accommodated coincident nests, although not all were active (breeding) nests. It would appear that the tower sites may offer some subtle attraction over the natural sites such as at Reedy Island or off the Smyrna River. The shift may also reflect the increasing human activity on the river vis a vis boating and fishing. The continued use of the Raccoon Ditch location invites speculation; it could reflect the site's relative isolation, or perhaps territorial partitioning by osprey pairs.

As one traces the nest locations and descriptors in Table 4, the distinction between "nest" and "active nest", and the concept of territory should be kept in mind. The territory occupied by one pair of breeding ospreys contains one or more nest structures. Pairs often have more than one nest, and what might be inferred by the observer as inactive nests may in fact be second or third nests of extant pairs rather than abandoned nests with no birds. One nest is used for brooding; the others are used for resting or other behavior by the adults. This is probably the situation at tower 6/1, where although multiple nests are listed only one is "active". Although the actual number of total nests is useful, it is the number of active nests, which equate to breeding territories, that is the more useful statistic in a population sense.

The summary statistics in Table 4 evidence a plateau in number of both nests and active nests from 1975-1979 and another general stabilization, but at a somewhat higher level, from 1980-1984. The dramatic increase in both categories from 1974 to 1975, the greatest change seen during the study, may reflect over-conservatism or inexperience by the earliest observer in 1974, but there seems little reason to question the 1975 data. There is an obvious and puzzling disparity between our local observations of active nests in 1975 and reference to local 1975 osprey success in the literature. Henny et al. (1977) state, relative to 1975: "Few ospreys now nest on the Delaware Bay side of New Jersey (Cape May Point to Wilmington Bridge). One nesting pair was seen from the air and by ground investigators and a second was located from the ground. We doubt that many other nests were in the area".

Breeding success, the realistic measure of population status, is assessed from the proportion: no. fledglings produced per no. active nests. To be meaningful and statistically testable, the area covered and the number of nests should be larger than available in the present study. However, the study area "population" by itself and as part of the much larger New Jersey population can be characterized to some degree. Summary data on no. of fledglings follow the two-plateau pattern mentioned earlier, i.e., the two periods 1975-1979 and 1980-1984, as does the index, no. fledglings/no. active nests. In five of the six years 1974-1979 the proportion is at least 1.0; during 1980-1984 it is less than 1.0 except in 1983. These levels can be reflected against the oft-cited reference by Henny and Wight (1969) that "0.95-1.30 young per active nest are required for population stability in ospreys". The 1974-1979 levels are within range and appear reasonable. However, the quantitative and qualitative nature of the inputs, and their potential effect on the index, should be considered. The lower number of fledgling to active nest ratios for 1980 to 1984 may be a result of overestimating the number of active nests. Nest-presence by two-year immature birds or three-year old non-breeders was included in the "active count." Whatever the reasons for observed levels during 1980-1984, the increase during 1983 and 1984 is a positive sign.

3.4.2 Bald Eagle

A total of 22 sightings of bald eagle in the general region were reported by Project observers during 1971 through 1984; 15 of these were through 1978. In 1979 there was one; in 1980, none; in 1981, four; in 1982, two; in 1983, none; and in 1984, none. Of the 15 sightings prior to 1979, six were in the New Jersey portion of the region; five near northern Artificial Island and one near Hope Creek. Hardin (1978) stated in the Project Annual Report that bald eagle did not currently nest in the study area, but listed historical reference to a nest on Blackbird Creek in Delaware.

Frier (1982) listed specifics on the bald eagle as it occurs in New Jersey. She described a small wintering population throughout New Jersey which concentrates in the Dingman Ferry area of the Delaware River, the Brigantine National Wildlife Refuge area, and the Dividing Creek area of Cumberland County along the Delaware River. She reported one breeding pair remaining in New Jersey, in Cumberland County, and stated that "during winter of 1980 there were 16 wintering eagles observed."

Records of New Jersey Birds (NJ Audubon Society, 1984) references a pair of bald eagles constructing a nest in the spring of 1984 at a Salem County location and the observance of an immature bird at the site in April of that year. This location was not on the Project survey route which emphasized the transmission corridors; however, NJDEP personnel have corroborated the reported sightings. Apparently, the nest was not actually used in 1984. The Records issue also describes a sighting of an adult bald eagle over Audubon, NJ on March 8, 1984.

3.5 OVERVIEW

Appraisal of the local status of these two raptors requires speculation in addition to analysis of the limited data. Fortunately in the case of the osprey, in New Jersey there is an organized statewide research/reestablishment program underway by the New Jersey Non-Game and Endangered Species Program. This program has produced a body of information on osprey in New Jersey, and the local breeding population can be considered on the basis of the statewide database. That perspective was developed in conversation with the New Jersey Non-Game and Endangered Species Program office (J. Frier-Murza, Prog. Mgr., pers. comm.) on January 31, 1985. Perhaps the most singularly important and suggestive element in that conversation is that the Non-Game and Endangered Species Group is recommending to the State, i.e., the New Jersey Department of Environmental Protection, that the osprey be de-classified. Notice of intent to recommend this de-classification was published in the State (NJ) Register on February 19, 1985. Among the evidence supporting this recommendation is the trend in number of breeding osprey pairs in New Jersey. In 1973 there were 50; in 1981, 97;

and in 1984 there were 108. The statewide population productivity index has been within the Henny and Wight (1969) range of 0.95 to 1.3. Again in the conversation, there was mutual inclination to the position that the study-area "population" is behaving similarly to the NJ population, and that the available local statistics, being based on limited sample size, should not be rigorously considered on their own. It is accepted that the PSE&G transmission towers have contributed positively to the re-establishment of the osprey breeding population in New Jersey.

Further, with the completion of the new transmission line, which parallels the Salem-New Freedom North line, and the concomitant decrease in regular human activity near the towers of both lines, the number and availability of potential nesting sites will be increased. This can only advantage the local breeding osprey population.

Definition of status and speculation on potential of bald eagle in this area is difficult. The species has experienced a variety of negative factors including shooting, egg collection by oologists and starting in the 1940's, and of perhaps the most consequence, chemical contamination. The last involves primarily pesticides, most notably the long-lived DDT, which pass through the food chain to fish and other aquatic prey of the eagle and to the eagle itself. The most notable effect was a significantly reduced hatch rate. Abbott (1982) reports that in 1962, only 5 of 37 rechecked active nests produced young, compared to 31 successful of 35 rechecked nests in 1936, before chemical pesticides were commonly used. The use of DDT was formally banned in the mid 1960's, and there is evidence that populations may be increasing.

Abbott (1982) discussed the status of the bald eagle in Delaware, Maryland and Virginia. He stated that Delaware had four active bald eagle nests in 1981 for the first time on the survey since 1939. The nest at Bombay Hook National Wildlife refuge was abandoned in 1982, and he stated it had produced young in only three of the past twenty years (1970, 1976, and 1979). He listed several successful nests in lower Delaware. For the three states, he listed 87 active nests in 1978 and 94 in 1981, and cited numbers of eagles hatched as 59 in 1978, 67 in 1979, 74 in 1980 and 97 in 1981. This trend was taken as an encouraging indication that former problems with chemical pollutants, which affected egg hatching, are being worked out. Perhaps, if this perceived trend is real and limiting factors are easing, successful eagle nesting may again be observed in the study area.

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Table 1. Annual summary data on observed nesting, nest depredation, and hatchlings of diamondback terrapin observed at a beach north of Liston Point, DE, 1975-1984.

Year	(# visits)	I Nests Non-Dep.	I Nests Dep.	II Eggs Non-Dep.	II Eggs Dep.	III Total observed Turtles	III Total observed Tracks	Hatchlings (Actual or Tracks) included in Column III	
1975	(21)	6	498	52	2,443	34	189	146	
1976	(32)	15	393	170	3,425	30	470	215	
1977	(42)	25	259	237	4,192	44	1,544	212	(32)*
1978	(46)	61	444	616	3,455	111	1,093	54	
1979	(40)	45	267	483	2,276	43	618	12	
1980	(33)	19	429	122	3,405	45	712	49	
1981	(40)	18	337	132	2,656	29	514	15	
1982	(41)	28	344	220	2,830	20	514	57	
1983	(18)	18	238	111	1,776	10	132	72	
1984	(17)	12	285	99	2,193	47	156	0	

* = hatchlings observed in nests upon excavation.

Table 2. Annual summary data on observed nesting, nest depredation, and hatchlings of diamondback terrapin observed at a beach north of Sunken Ship Cove, NJ, 1975-1984.

		I		II		III		
		Nests		Eggs		Total observed		Hatchlings (Actual or Tracks) included in
Year	(# visits)	Non-Dep.	Dep.	Non-Dep.	Dep.	Turtles	Tracks	Column III
1975	(19)	1	44	3	191	6	53	25
1976	(32)	8	0	57	0	7	112	79
1977	(39)	3	0	25	0	15	195	195 (15)*
1978	(42)	2	3	20	16	12	71	33
1979	(27)	10	4	97	28	0	92	16
1980	(32)	6	3	52	13	3	129	84
1981	(40)	3	1	17	4	0	39	8
1982	(42)	6	0	62	0	0	38	6
1983	(18)	2	0	14	0	0	4	0
1984	(17)	2	1	19	90	0	40	34

* = hatchlings observed in nests upon excavation.

Table 3. Annual summary data on observed nesting, nest depredation, and hatchlings of diamondback terrapin observed at a beach north of Hope Creek, NJ, 1975–1984.

	I		II		III		
	Nests		Eggs		Total observed		Hatchlings (Actual or Tracks) included in Column III
Year (# visits)	Non-Dep.	Dep.	Non-Dep.	Dep.	Turtles	Tracks	
1975 (21)	8	518	31	2,814	34	23	17
1976 (32)	11	132	123	915	74	68	80
1977 (45)	35	170	298	1,124	108	266	177 (62)*
1978 (44)	31	235	192	1,354	89	281	1
1979 (40)	3	64	26	473	13	132	0
1980 (26)	9	97	48	699	17	117	13
1981 (39)	5	49	20	234	8	54	12
1982 (39)	19	29	119	191	31	126	1

* = hatchlings observed in nests upon excavation.

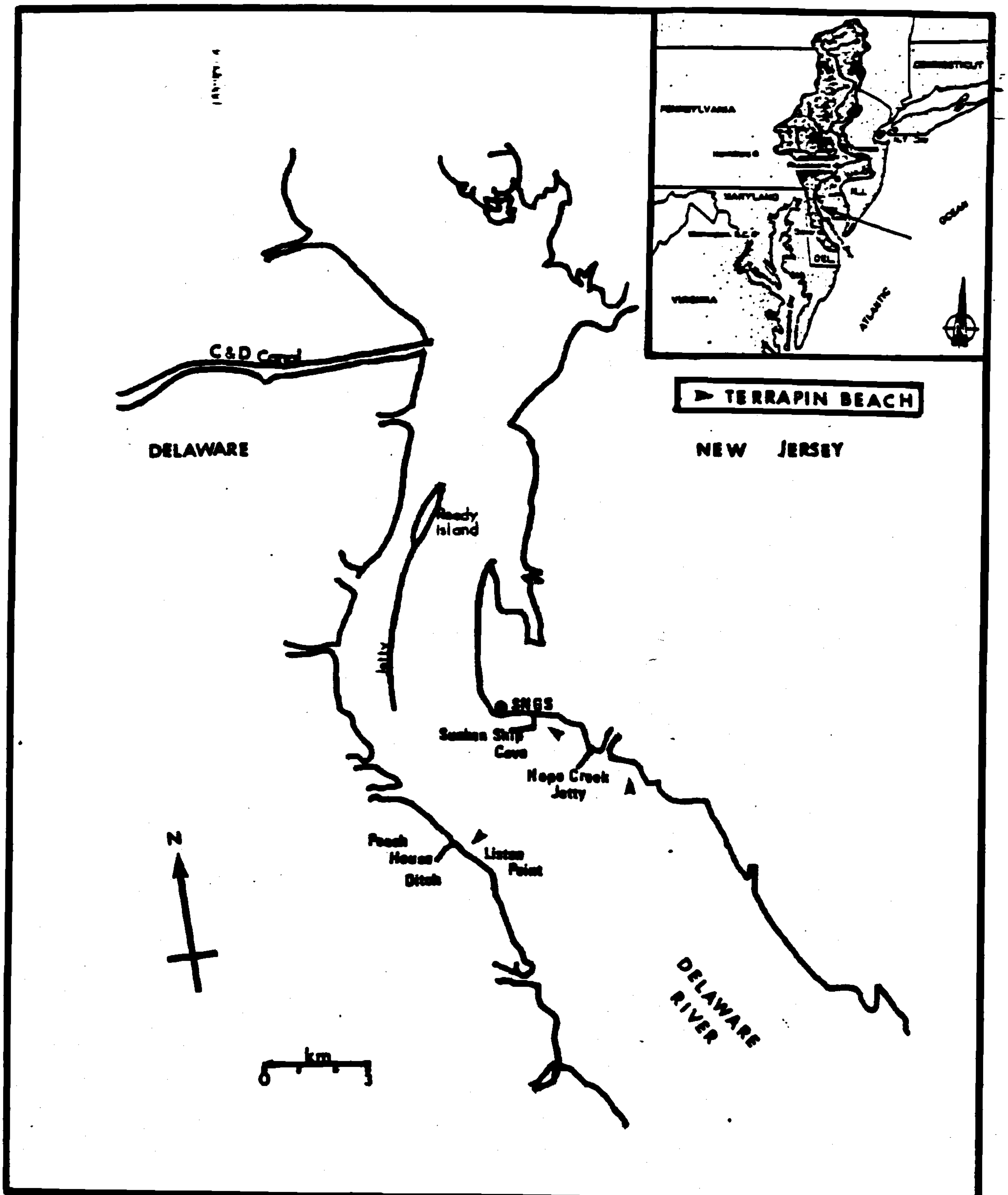
Table 4. Summary of osprey nesting activity within 16 km of southern Artificial Island: 1974-1984.

Key: Numbers indicate young fledged; *=Data collected by PSE&G Transmission & Development Dept.; N=Nest present, may have been active or constructed as housekeeping nest; A=Active nest, eggs observed or adults appeared to be incubating eggs and defending nest; Owl=great horned owl nested in former osprey nest; **=assumed number active. Helicopter observation began too late in the season to assess egg production.

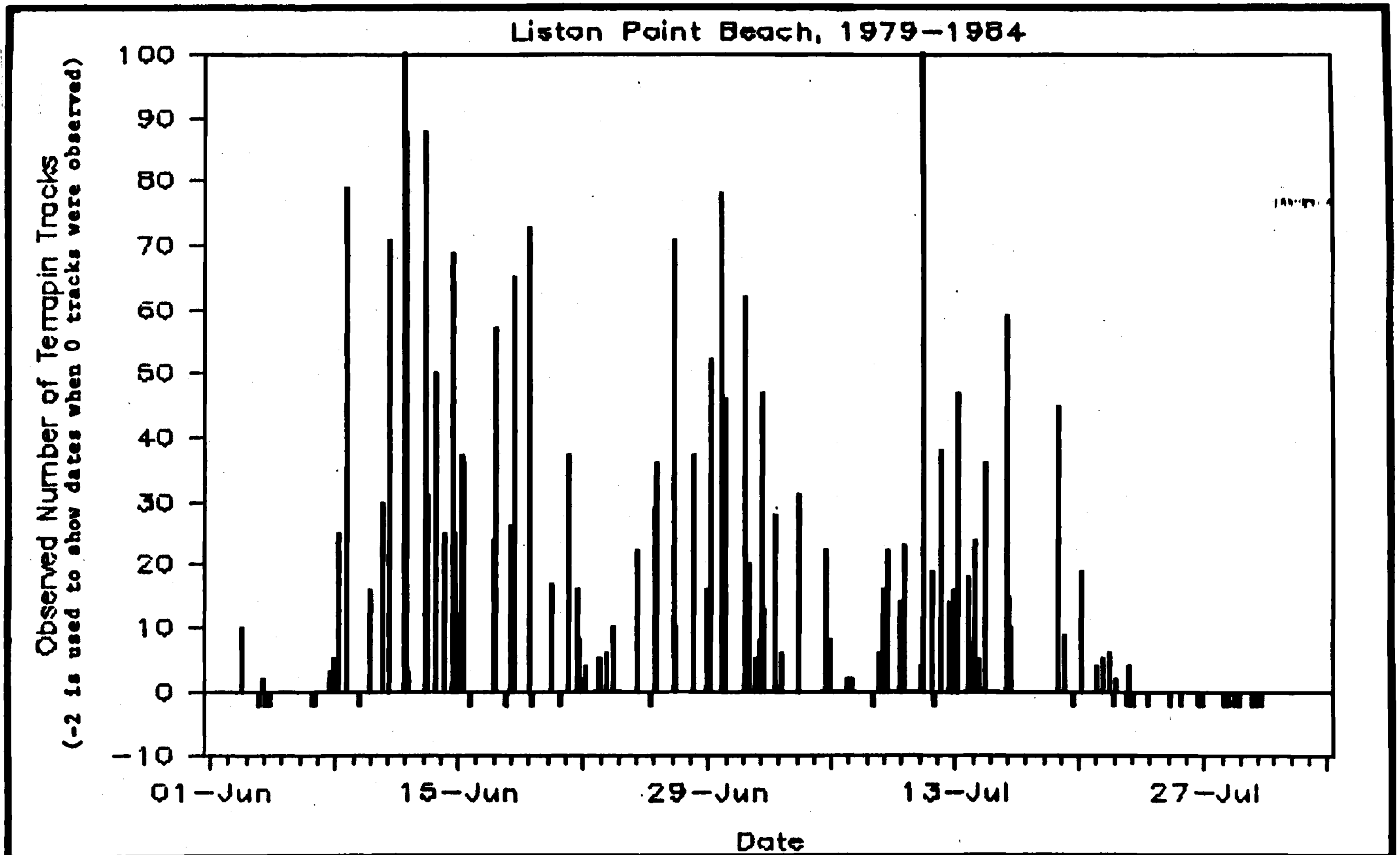
NEST LOCATION	1974	1975	1976	1977	1978	1979*	1980	1981	1982	1983	1984
NEW JERSEY											
Transmission Line Towers											
Salem-Keeney											
Tower #12/1										N,N	2
11/3									1	2	A
10/1										N	
9/3											A
8/4			A	N	N	A	N	A	N		
8/3							N				
5/1						N	A				
4/3					1	A	A	A	N	A	A
4/2				N		N	N	N			
4/1		2	A				N,N	Owl			
3/4			A			A	N				
3/3											A
3/2	A					A	N	A		A	
3/1			1	N	N		N			N	
New Freedom: South											
Tower # 5/3							A	1	A	A	
5/2								N			
5/1		2	1	1	3	A	2	2	2	A	3
4/1		N	N	N							
3/3		N	N	N			A	1	1	3	2
2/4					1	A					
2/3						N					

Table 4.
Continued.

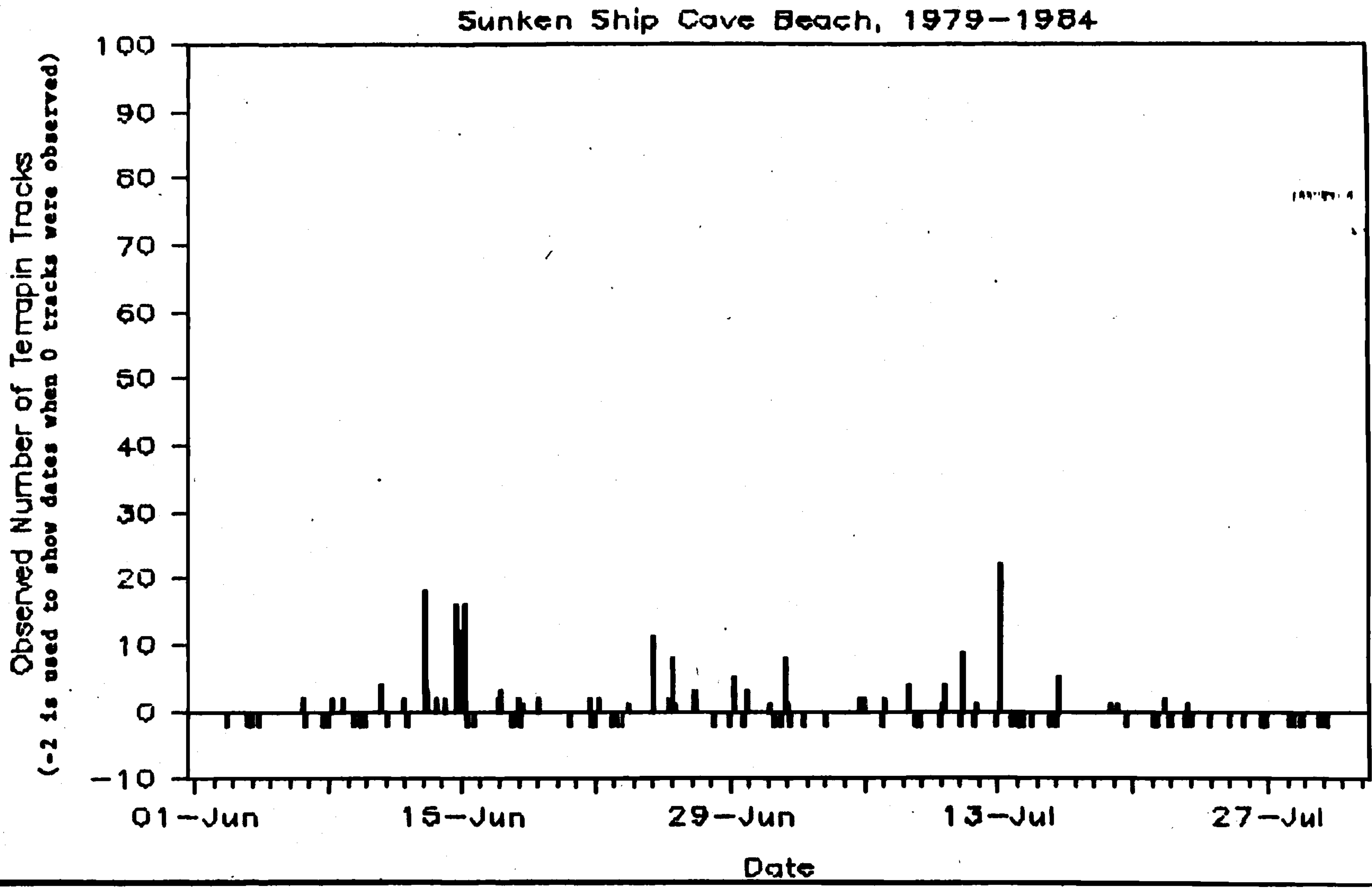
NEST LOCATION	1974	1975	1976	1977	1978	1979*	1980	1981	1982	1983	1984
New Freedom: North											
Tower # 6/1			1	2	A	A	2	A,N,N	1	A	A,N,N
4/1		N	1	1	1	A	1	A	A	A	1
3/4		N		2	3	A	A	2	A	2	A
3/3											A
2/3					1	A	1	A	A	A	
Raccoon Ditch											
Old cedar tree				Area not monitored				N	A	1	A
Nest platform								N	N	N	N
DELAWARE											
Delaware River											
Getty-Range Tower	A	2	2	2	N	A	1	A	A	2	2
Reedy Island											
East	A										
West	N	2	1								
Jetty	N	N	N	N	A						
Transmission Line Towers											
DP&L #5015/47		Under construction				Area not monitored		A	A	Owl	N
DP&L #5015/46										3	2
Smyrna River											
Range Tower	N	N	A								
SUMMARY											
Nests	6	10	13	11	11	14	18	18	14	18	18
Active nests	3	7**	10	7	8	11	10	12	11	13	14
Successful (i.e., young fledged) nests	2	4	6	5	6	10	5	4	4	6	6
Fledglings	4	8	7	8	10	16	7	6	5	13	12
Fledglings/active nest	1.33	1.14	0.70	1.14	1.25	1.45	0.70	0.50	0.45	1.00	0.85
Successful-/active nest	0.67	0.57	0.60	0.71	0.75	0.81	0.50	0.33	0.36	0.46	0.42



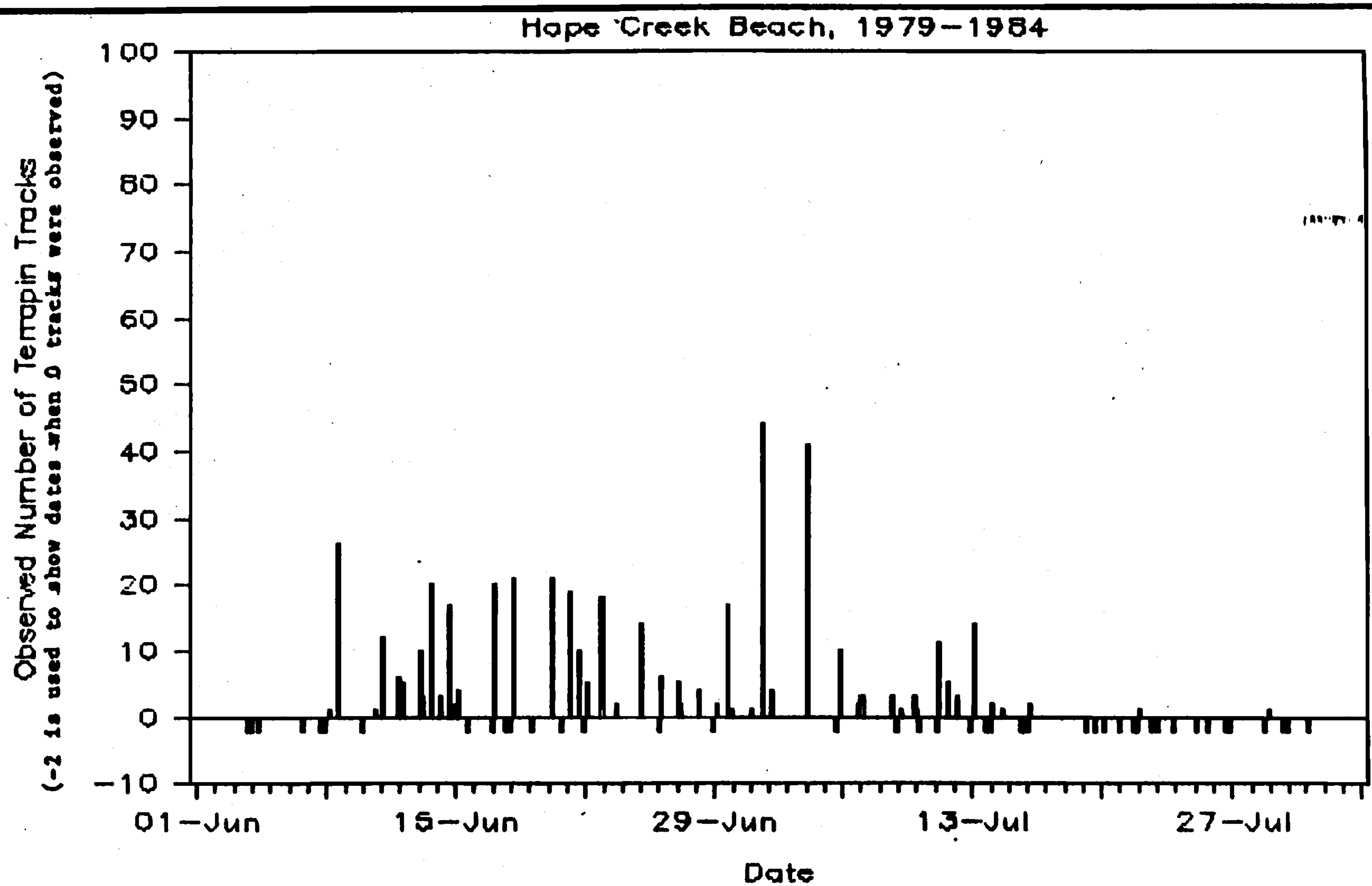
PUBLIC SERVICE ELECTRIC AND GAS COMPANY	Diamondback terrapin study sites, Salem Generating Station Tech Spec Study, 1975-1984.
	Figure 1



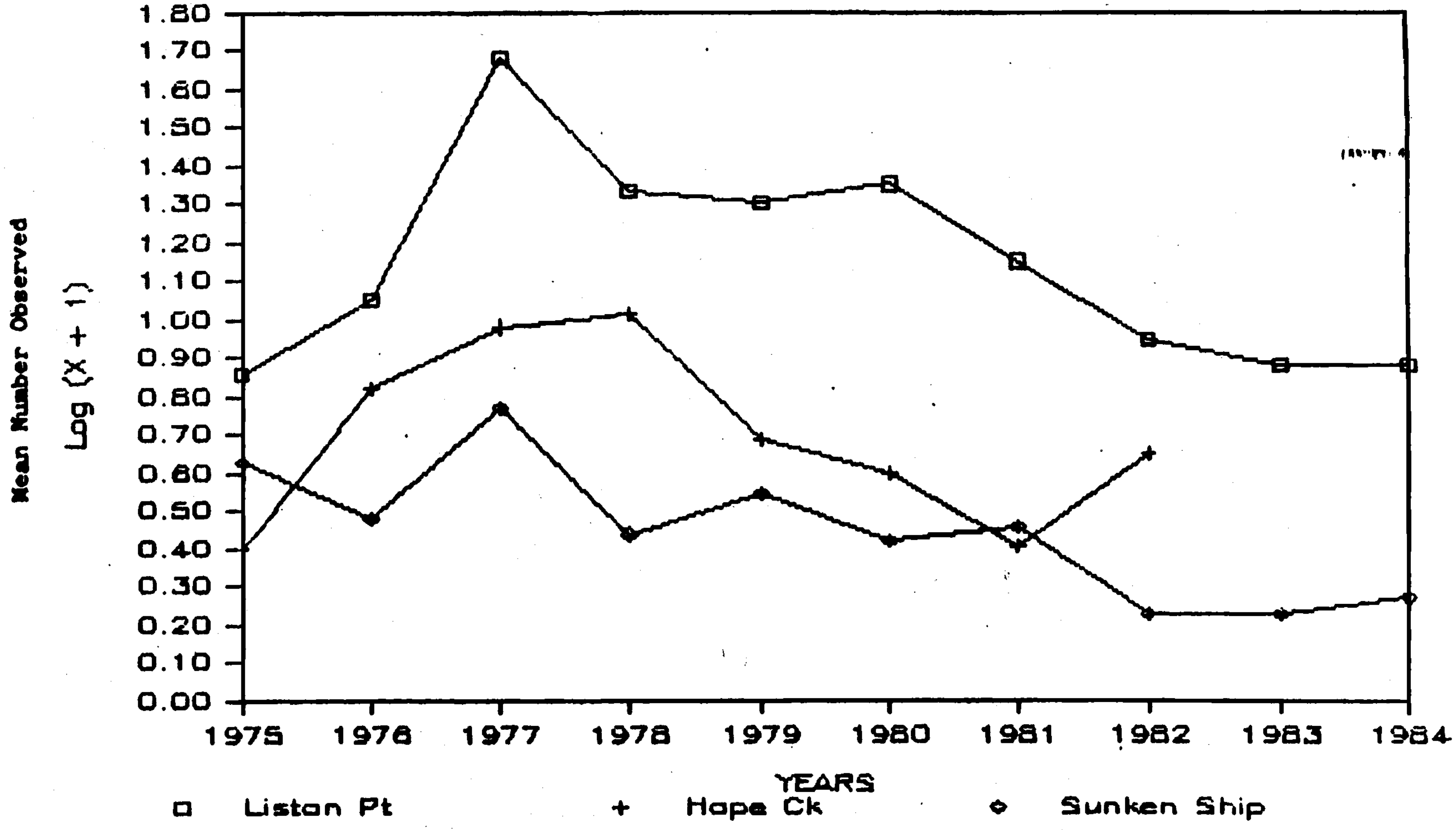
PUBLIC SERVICE ELECTRIC AND GAS COMPANY	Number of adult diamondback terrapin and tracks observed per sampling date during 1979 through 1984 at a beach on the Delaware River near Liston Point, DE.
	Figure 2



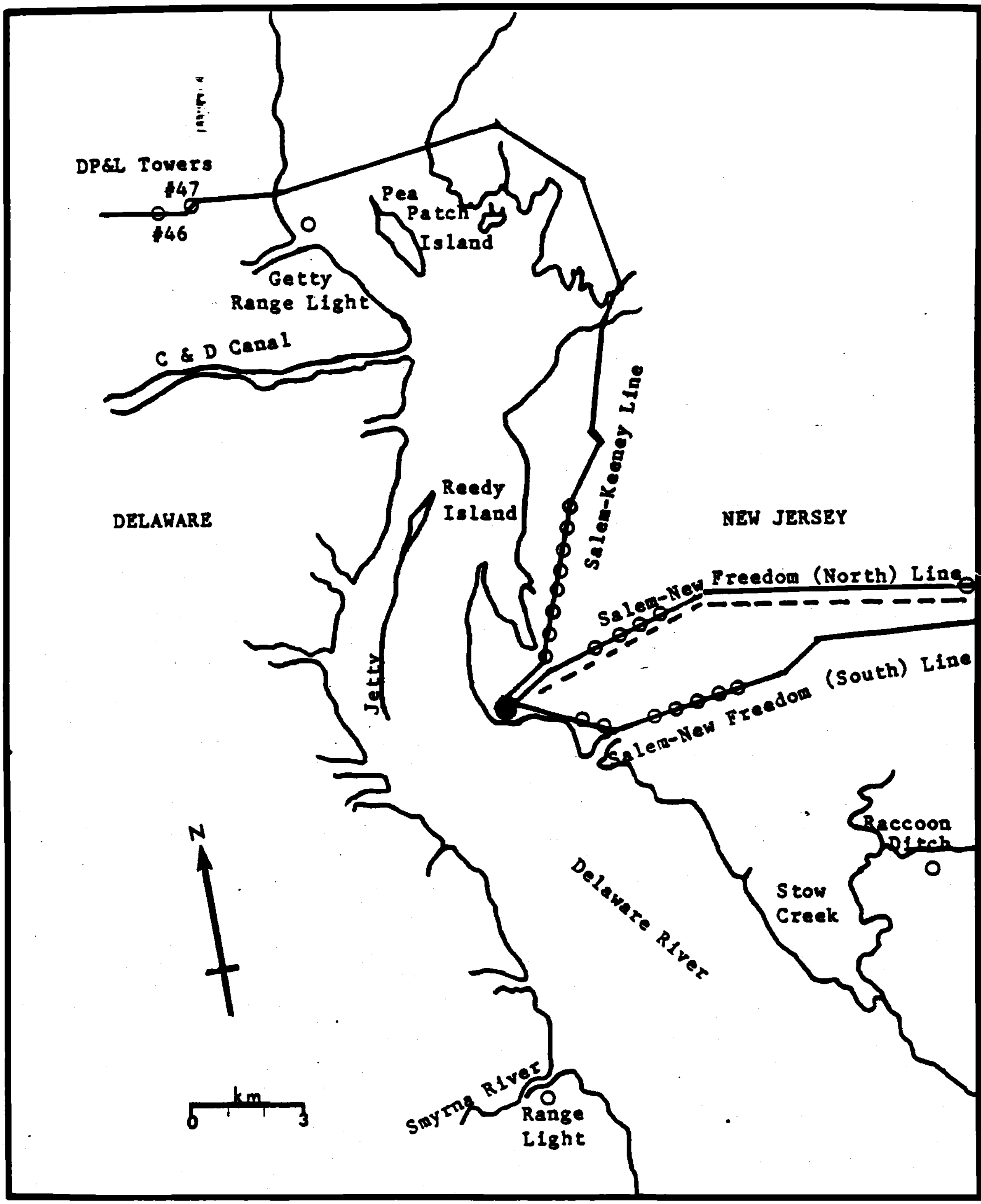
PUBLIC SERVICE ELECTRIC AND GAS COMPANY	Number of adult diamondback terrapin and tracks observed per sampling date during 1979 through 1984 at a beach on the Delaware River near Sunken Ship Cove, NJ.
	Figure 3



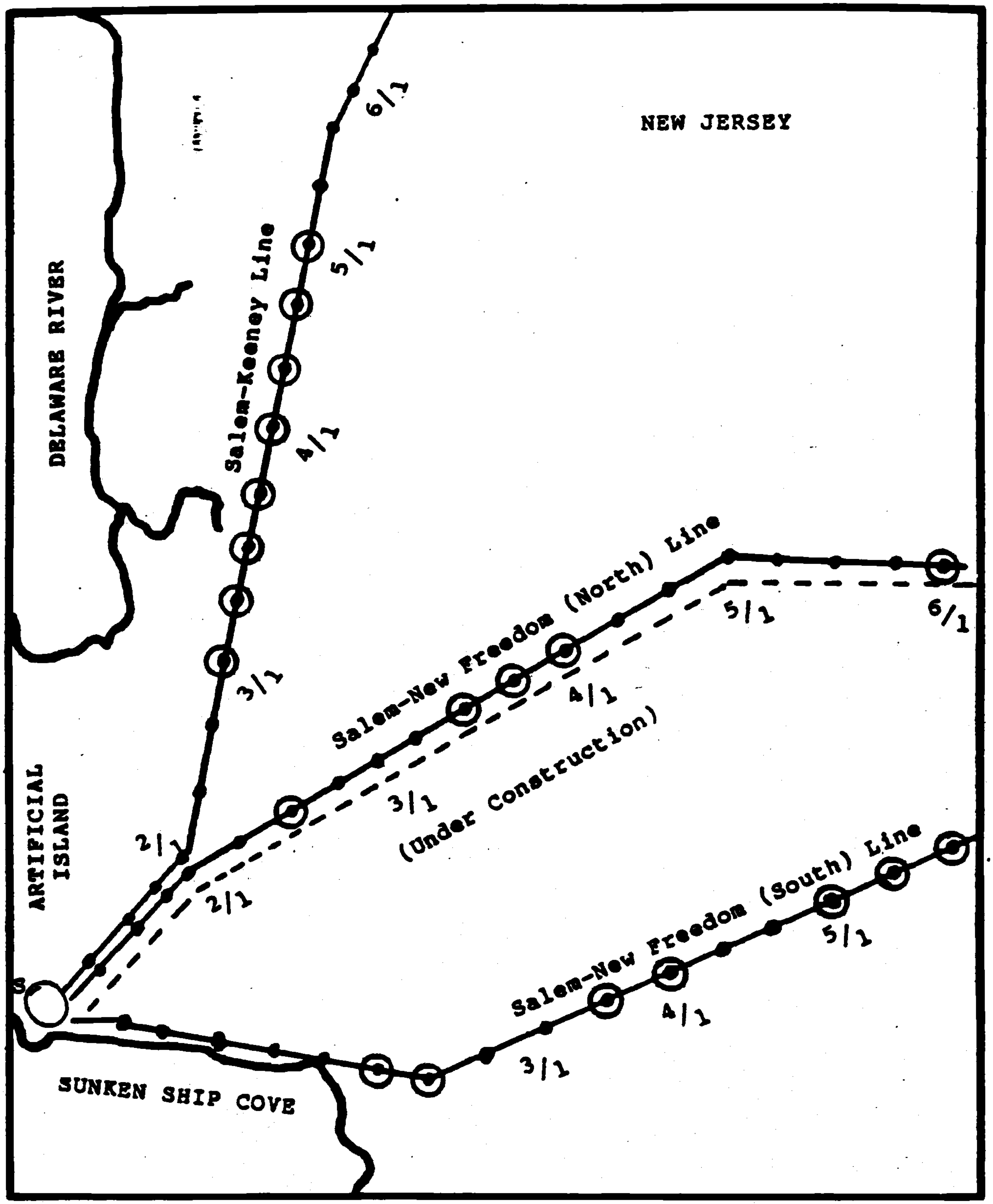
PUBLIC SERVICE ELECTRIC AND GAS COMPANY	Number of adult diamondback terrapin and tracks observed per sampling date during 1979 through 1984 at a beach on the Delaware River near Hope Creek, NJ.
	Figure 4



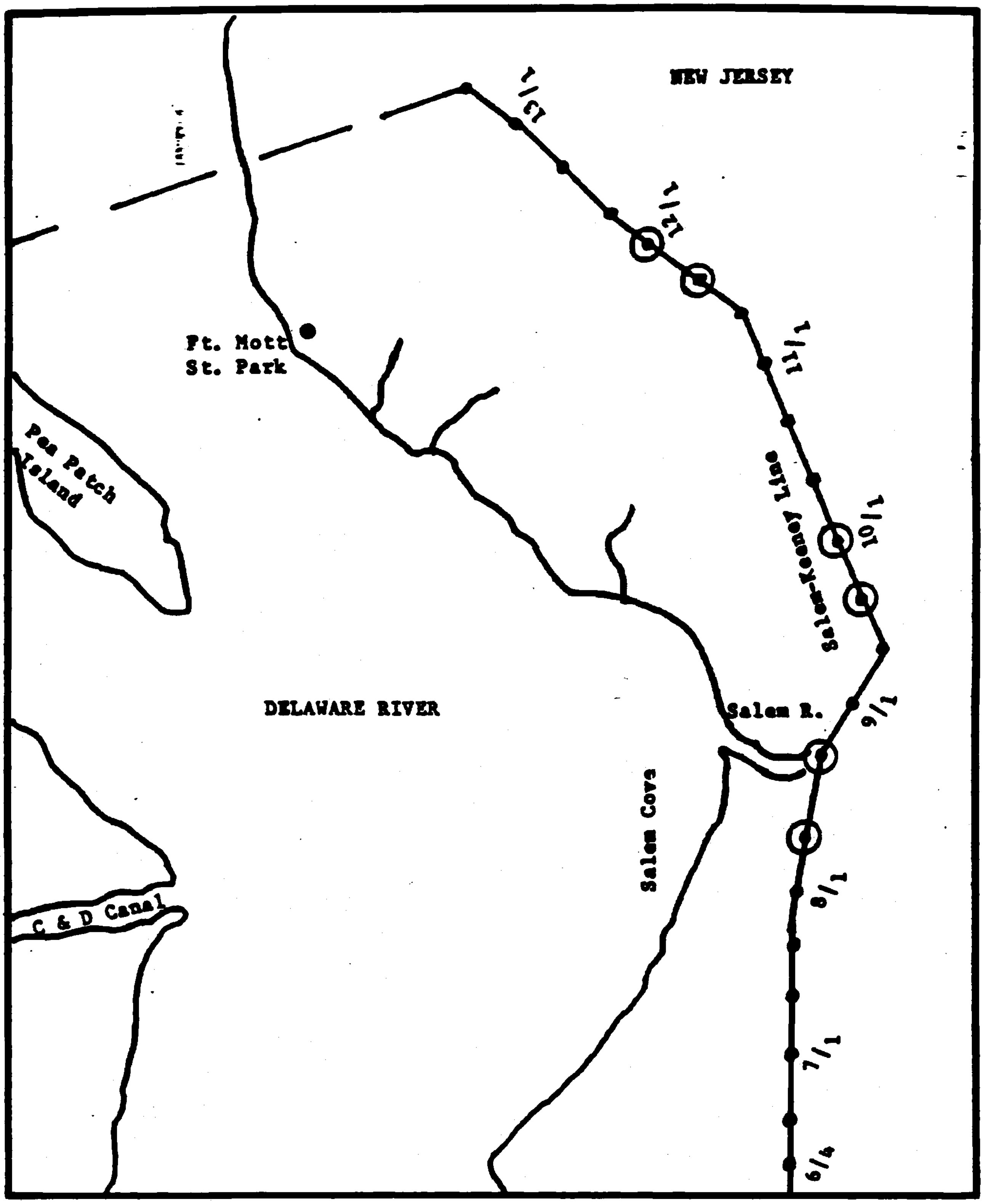
PUBLIC SERVICE ELECTRIC AND GAS COMPANY	Annual mean number of observed adult diamondback terrapin and tracks at Liston Point, DE, and Hope Creek and Sunken Ship Cove, NJ, 1975-1984.
	Figure 5



PUBLIC SERVICE ELECTRIC AND GAS COMPANY	Nesting sites (O), historical and present, observed during SNGS Osprey Study, 1974-1984. Dashed (--) line is new transmission line nearing completion in 1984.
	Figure 6



PUBLIC SERVICE ELECTRIC AND GAS COMPANY	Tower locations on transmission lines from SNGS; Osprey study, 1974-1984. ○ indicates tower used by nesting osprey.
	Figure 7



PUBLIC SERVICE ELECTRIC AND GAS COMPANY	Northern extension of Salem-Keeney line, Osprey study, 1974-1984. ○ indicates tower used by nesting osprey.
	Figure 8