REPORT

on

SPOTTED TURTLES'

(*Clemmys guttata*)

use of

MOSQUITO-CONTROL DITCHES

in

SUFFOLK COUNTY, NEW YORK

submitted by

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INTRODUCTION

The Spotted Turtle (*Clemmys guttata*) is a small, secretive, semi-aquatic species that inhabits a wide variety of shallow wetland habitats and adjacent upland areas. It was once considered one of the most common turtle species in New York State and the New York City region (DeKay, 1842; Eckel and Paumier, 1902; Ditmars, 1905). Today it is listed as a "Species of Special Concern" by the New York State Department of Environmental Conservation. This designation is given to species of fish and wildlife found by the department to be at risk of becoming either endangered or threatened in New York State.

A mark-recapture study of Spotted Turtles on eastern Long Island initiated by John Behler of the Wildlife Conservation Society in 1996 documented this turtle's use of mosquito-control ditches during the spring and summer seasons, and surmised that they may be hibernating in the ditches during the winter. Over the years 1996-1999, Behler compiled information on 59 individual Spotted Turtles in a 30-acre ditched wetland study area. During the winter of 1999-2000, Suffolk County Vector Control conducted ditch maintenance operations in a portion of the study area, using mechanical equipment to deepen and widen mosquito-control ditches in order to improve drainage and tidal flow. In the spring and summer 2000 trapping season, a significant number of Behler's previously marked turtles were not found. Behler speculated that the turtles were overwintering in the ditches where they were vulnerable to direct damage and mortality from ditch maintenance equipment and indirect mortality via damage to hibernacula and exposure (Behler, pers. comm.).

In the fall of 2004, funding was secured from Suffolk County, NYSDEC, and Andy Sabin (president of the South Fork Natural History Society) to determine Spotted Turtle use of mosquito-control ditches in the winter and spring seasons. Additional funding was secured in the winter of 2005 to continue the research through the summer months, and to describe some of the physical characteristics (salinity, temperature, water level fluctuations) of the ditches inhabited by Spotted Turtles.

The study site is located in a large protected preserve that was acquired in 1976. There is no development immediately adjacent to the study area, although roads border it on two sides. There are four other known populations of Spotted Turtles in the vicinity: three are within a mile and the fourth is two miles distant. All but the closest are separated from each other by roads and residential development.

The study site is an unusual mix of salt- and freshwater vegetation that may have been impacted by changes to tidal flow related to road construction, culverting, and ditching. A large portion of the study area contains upper salt marsh vegetation (*Spartina patens, Distichlis spicata, Juncus gerardii*) found growing in the flats between mosquito-control ditches that, in turn, support less saline species (e.g. *Typha angustifolia* and *Scirpus americanus*). There is also a freshwater fen encompassing a large portion of the study area. Staff from the New York Natural Heritage Program have surveyed portions of the study area and surroundings on several occasions, most recently in 2003. At that time they documented over 10,000 Slender Blue Flag (*Iris primatica*) plants in the fen, making it one of the top two occurrences for this species in New York State (New York Natural Heritage Program Supplemental Report, 2004). Heritage botanists have identified twelve plant species in the vicinity of the study area that are listed as rare, threatened, or endangered in New York State. Most of these are associated with wetland habitat.

STUDY GOALS

This study was undertaken to provide information about Spotted Turtles' use of mosquito-control ditches, and to describe some of the physical and biological characteristics of those ditches most commonly inhabited by this species. This information may be valuable in refining ditch maintenance practices to ensure that they do not conflict with turtle conservation efforts. It may also be useful for designing Spotted Turtle surveys of other ditched marshes in Suffolk County, and provide preliminary information as regards the uniqueness of the Napeague situation.

Specific study goals are listed as follows:

I. Determine Spotted Turtle use of mosquito-control ditches during the following seasons:
   a) winter (as hibernating sites);
   b) spring (as courtship and mating sites); and
   c) summer (as estivating sites).

II. Determine if Spotted Turtles can be found in other ditched wetlands in Suffolk County.

III. Describe water level, salinity and water temperature fluctuations of the mosquito-control ditches inhabited by Spotted Turtles.

METHODS

I. Spotted Turtle use of mosquito-control ditches.

a) Capture and fix radio transmitters onto 14 Spotted Turtles (7 males and 7 females) at the study site during the fall of 2004. This number is robust enough to allow for some equipment failure and loss, and still account for well over 10 percent of the marked population at the study site. Radio transmitter units and a receiver were fabricated by L. L. Electronics of Mahomet, Illinois. Weights of transmitter units (including material used to attach them to turtles) varied from 7 - 11 grams, and were not used on turtles where the units weighed more than 10% of an animal's body weight. A Pesola scale (300 gram capacity calibrated every 2 grams) was used for recording weights. Transmitter units were attached to the carapace and held in place using wraps of electrical tape over the unit and around the carapace and plastron (crossing at the bridge so as not to impede leg movement). The flexible antennae trailed behind (Photos 4 & 5).

Turtles were captured using rectangular wire box traps having a 12-inch width and height, a length of 24 inches, and a 3.5 inch-square funnel entrance at one end. Several trap modifications were made: back doors were replaced with removable entrance funnels to enable turtles to enter from either end of the trap; wire mesh wings were positioned between trap entrances and the sides of ditches to catch turtles who were moving through but not necessarily interested in the bait and feeding; and one-way gates were placed over entrances to prevent captured turtles from escaping, a possibility at sites where water levels fluctuated due to tides (Photos 1 & 3). A total of fifteen traps were set and baited with canned fish on October 16, 2004.

b) Locate turtles fitted with transmitters, map locations, note plants in the immediate vicinity, and measure water temperature and change in position (in meters) since the previous location. An effort was made to sight or palpate the turtles' position in the ditch. This enabled additional useful information to be collected regarding the position and orientation of turtles in the ditches.

Radio-tagged turtles were located twice a week or 8 times per month during the fall. During the winter months, turtle locations were determined a minimum of once every 10 days or 3 times per month to ensure that transmitters were working properly and to determine if turtles moved during that period. During the spring courtship and mating period (estimated to be mid-March through April in 2005), they were located 22 times (an average of every other day), and 4 times during the month of May. During July and August, 156 relocations were mapped in the field, an average of twice per week per turtle.

II. Determine Spotted Turtles' presence in other ditched wetlands in Suffolk County.

Three other ditched wetlands in Suffolk County were surveyed for Spotted Turtles. Site selection was based on consultations with Al Breisch (NYSDEC), Norm Soule (Cold Spring Harbor Fish Hatchery), Andy Sabin (South Fork Natural History Society), and Jim Ash (South Fork Natural History Society). Traps were set in ditches at each site and checked daily for up to five days. The sites were as follows:

a) East Hampton: TNC preserve (April 25-29);
b) East Hampton: County Park site (April 14-19); and
c) Southampton: County Park site (May 1-5).

III. Describe water level, salinity, and water temperature fluctuations of the mosquito-control ditches.

Six monitoring stations were established in the study area to record changes in water levels, salinity, and water temperature in the mosquito-control ditches throughout four tidal cycles (including one spring tide event). Stations were marked with vertical stakes driven into the center of the ditch at selected locations.

a) Water Level. Changes in water levels were determined by measuring the distance from the top of the stake to the surface of the water.

b) Salinity. Salinity was measured at each location using a portable salt refractometer.

c) Water Temperature. Water temperature was recorded in the upper 15 cm of the water column near the stakes. Water temperatures were also recorded at the site of many telemetry relocations and hand captures.

RESULTS

I. Spotted Turtle use of mosquito-control ditches.

a) Winter.

By the first week of December, 8 Spotted Turtles (4 females and 4 males) had been captured and fitted with radio transmitters. Based on 159 radio telemetry relocations for these 8 turtles during the fall and winter months (October 21, 2004 - March 14, 2005), Spotted Turtles showed a strong preference for mosquito-control ditches, with these ditches accounting for 97% of Spotted Turtle telemetry locations during that time period.

Turtles showed a preference for those ditches characterized as supporting emergent vegetation in the form of Cattail (*Typha latifolia* and *T. angustifolia*) and Phragmites (*Phragmites communis*). Habitat use during this period is summarized in Table 1 below..

2,739 meters of movement were noted during this period, for an average movement between relocations of 17 meters per turtle [NOTE: this is considered a minimum movement figure between relocation dates]. These movements were generally back and forth within the linear ditches. Water temperatures in the ditches fluctuated between -1°C and 8°C from November 1 through February. During the first two weeks in March, ditch water temperatures ranged between 4°C and 11°C.

The meteorological station in Bridgehampton reported unusually mild weather through November, with temperatures averaging 3°F to 5°F above normal (Hendrickson, 2004). Spring Peepers were heard vocalizing at the study site on 11/22/04. Water temperatures in the ditches ranged between 6°C and 8°C during the month. 1,263 meters of movement were recorded during the month, for an average movement between relocations of 29 meters/turtle.

HABITAT TYPE	# OF RELOCATIONS	% OF TOTAL RELOCATIONS
Ditch w/ Cattail and Phragmites	94	59%
Twig and leaf debris-filled ditch	43	27%
Open (no aquatic vegetation) ditch	13	8%
Burrow linked to ditch	3	2%
Not in ditch	5	3%

TABLE 1. SPOTTED TURTLES' FALL AND WINTER HABITAT.

Mild fall weather continued into mid-December. Average daily temperatures dropped below freezing on nine days in December (the 14th,15th,16th, 20th and 21st, and over the four days of the 25th through the 28th) before significantly rewarming again at the end of the month (Hendrickson, 2004). By the third week in December, skim ice had formed on most of the ditches in the study area. Water temperatures in the ditches during December ranged from 0°C to 4°C. Total movements recorded for the month were 995 meters, for an average movement between relocations of 20 meters/turtle.

Two turtles settled into a short section of a shallow, water-saturated, debris-filled ditch (leaf and twig litter): one (notch code L12 R9) remained there from 11/18/04 until 3/31/05; the other (notch code L1-4 R4) from 11/28/04 until 3/31/05. Their movements for December averaged 5 meters each, most of which was limited to changing position from one side of the ditch to the other. The other 6 turtles accounted for movements totaling 990 meters in December, for an average movement of 27 meters per relocation (very similar to the average for November).

Detailed notes were taken of each turtle's position on 12/29/04 (with the exception of L12 R9 which could not be seen or palpated by hand). All other turtles were found hugging the bank of the ditch no deeper than 20 cm below the water surface. Two turtles were found aligned against the nearly vertical bank sides with heads and part of their shells out of the water. Most were beneath roots and mat-like masses of sedge, grass and rush leaves overhanging the sides of the ditch. None were in burrows or buried in bottom sediments.

The New Year brought a warm spell with the air temperature reaching 15°C on January 1, 2005. It remained unseasonably warm through mid-January, with an air temperature of 9°C recorded on 1/13/05. On 1/27/05, 25-30 cm of snow covered the study area, daytime air temperature was -10°C, and all ditches in the study area were covered with ice. Movements noted on that survey date were shorter in distance compared to all previous survey dates. Total recorded movements in January 2005 were 172 meters for an average movement between relocations of 6 meters/turtle. One turtle (L1 R1) was found to travel at least 81 meters during the month. The transmitter on another (L1-4 R12) failed on 1/20/05.

Cold winter weather continued through February, with all but one night recording a temperature below freezing (Hendrickson, 2005). Total recorded movements in February 2005 were 298 meters for an average movement between relocations of 14 meters/turtle.

Despite rising air temperatures, ice covered some of the ditches into early March, and patches of snow persisted in the study area through March 14. Ditch water temperatures ranged between 4°C and 8°C on March 5, and 6°C and 11°C on March 14. There was little movement noted on the March 5 and 14 checks (the greatest change in position was 4 meters; 9 of 14 relocations recorded on these dates had movements of one meter or less). Total recorded movements for March 5 and 14, 2005 were 11 meters for an average movement between relocations of <1 meter/turtle.

All turtles showed some movement during the winter months, although, as stated earlier, the 2 turtles that chose to overwinter in a section of ditch characterized as being filled with leaf and twig debris showed no significant change in position over these months. Movements of these 2 females were less than one meter and were often from one side of the ditch to the other. This ditch appeared to have the least amount of groundwater movement and was covered with ice more than the other ditches occupied by radio-tagged turtles. All turtles were always found within 25 cm of the water surface, and usually within 10 to 15 cm. I did not find any turtles buried deep in the bottom sediments of any ditches.

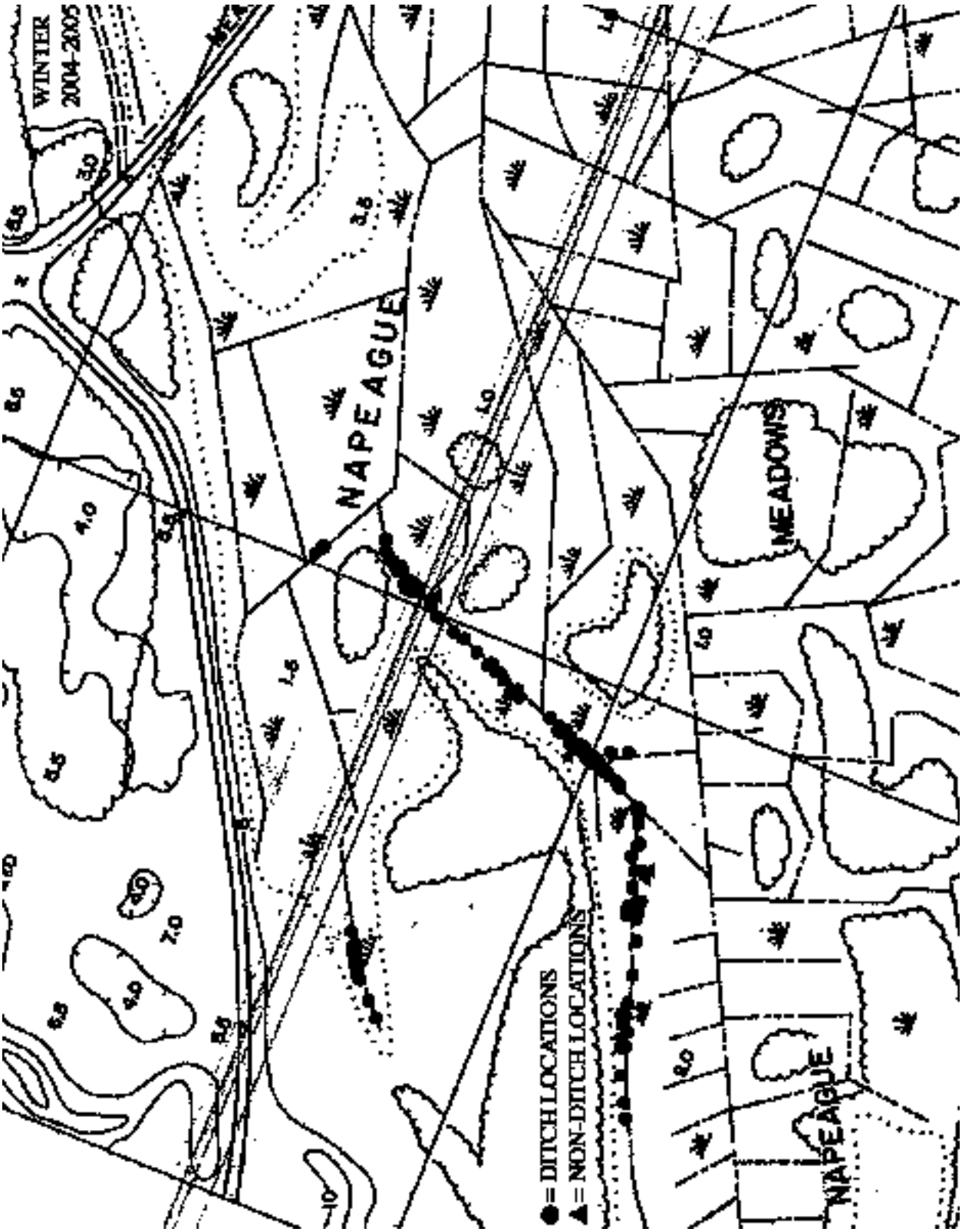

FIGURE 1. MAP OF SPOTTED TURTLE LOCATIONS: FALL AND WINTER SEASON.

The turtle (R4) that chose a ditch with the warmest recorded water temperatures during the months of January and February moved 43 meters over those months and was always found in a different location. This ditch did not have ice at any point during February's field surveys, and only had ice on one visit in January (1/27/05).

The Bridgehampton weather station reported 49.5 inches of snow for the months January, February and March 2005, nearly twice the long-term average (25 inches) for these 3 months (Hendrickson, 2005). Water levels in freshwater wetlands, including the study area, were exceedingly high at the end of March.

On March 17, a Spotted Turtle hatchling was found east of the study site near Montauk Point. It is thought to have recently emerged from the nest where it overwintered due to the condition of the scar where its yolk sac was attached. The first Osprey on the East End was sighted as well, and on the 18th, Red-winged Blackbirds and Spring Peepers were vocalizing at the study area -- all harbingers of spring.

b) Spring.

The spring study commenced on March 18, 2005. There was little movement noted on March 5 and 14. That changed on March 18, when 4 turtles moved over 10 meters, and one moved 67 meters (the 2 turtles in the debris-filled ditch, where water temperatures remained under 8°C through March 25, were the exceptions). Movements increased with time: the largest changes in position for March were recorded on the 31st when 7 of 8 turtles moved over 35 meters, and one moved 103 meters.

Over the course of the spring season (March 18 - May 27, 2005), an additional 6 Spotted Turtles (2 males; 4 females) were trapped or hand-captured and fitted with radio transmitters. Transmitter #31 (R10) failed after 2 relocations, and spring seasons results were largely based on the remaining 12 radio-tagged turtles: 6 males and 6 females.

Between March 18 and May 27, a total of 211 relocations were mapped. Turtles' preference for mosquito-control ditches remained strong through the spring season: 194 relocations (92% of total) were in ditches. Spotted Turtles continued to show a strong preference for those ditches characterized as supporting emergent vegetation in the form of Cattail (*Typha latifolia* and *T. angustifolia*) and Phragmites (*Phragmites communis*); these habitats accounted for 72% of relocations in ditches and 66% of total relocations during the spring season. The leaf and twig debris-filled ditch that was used extensively by two radio-tagged turtles over the winter months was not revisited after they left on March 30. Of the 17 instances where turtles were not found in a mosquito-control ditch, 8 were basking (6 of these were basking within 0.3 meters of the ditch), 7 were found in flooded sections of marsh adjacent to ditches, and one was of an individual traveling overland between ditches.

Total movements recorded for the March 18 – May 27 period amounted to 11,169 meters, with an average movement between relocations of 53 meters/turtle. The greatest single change in location recorded was 294 meters (a male between April 6 and 8). 10 of the 12 turtles tracked during this time period recorded at least one position change greater than 100 meters between relocations.

In 28% of the April relocations (excluding trap results), another turtle of the opposite sex was found in contact with the individual carrying a transmitter. The notch codes of these pairs were noted. This pairing behavior, thought to be associated with courtship and mating, continued into May but was most prevalent in April.

Mosquito-control ditch water temperatures in the study area ranged from 4°C to 27°C in the spring season. Ditch water temperature averaged 9°C over the latter half of March, 13°C in April, and 17°C in May.

HABITAT TYPE	# OF RELOCATIONS	% OF TOTAL RELOCATIONS
Ditch w/ Cattail and Phragmites	140	66%
Twig and leaf debris-filled ditch	6	3%
Open (no aquatic vegetation) ditch	35	17%
Ditch covered with briar	3	1%
vegetation not noted	10	5%
flooded marsh outside of ditch	7	3%
BASKING: near ditch >0.5 m from ditch	6 2	3% 1%
caught in trap marsh outside of ditch	1	0.5%
upland (traveling between ditches)	1	0.5%

TABLE 2. SPOTTED TURTLES' SPRING HABITAT.

On June 2, 2005, a phone call from a nearby resident reported that one of the radio-tagged turtles had been hit by an automobile and taken to a local veterInarian. The location of the incident was 485 meters northeast of the closest known Spotted Turtle location in the study area. The turtle (L1-4 R4 female) was captured by Behler in 1998 and determined to be 4 years old at that time, making it 11 years old in 2005 and mature enough to mate and reproduce. The turtle was treated at the vets (the cracked shell was epoxied and anti-biotics administered), released in the marsh near the accident on 6/3/05, and found dead at the site of release on 6/4/05. This was the only documented Spotted Turtle "roadkill" during the study.

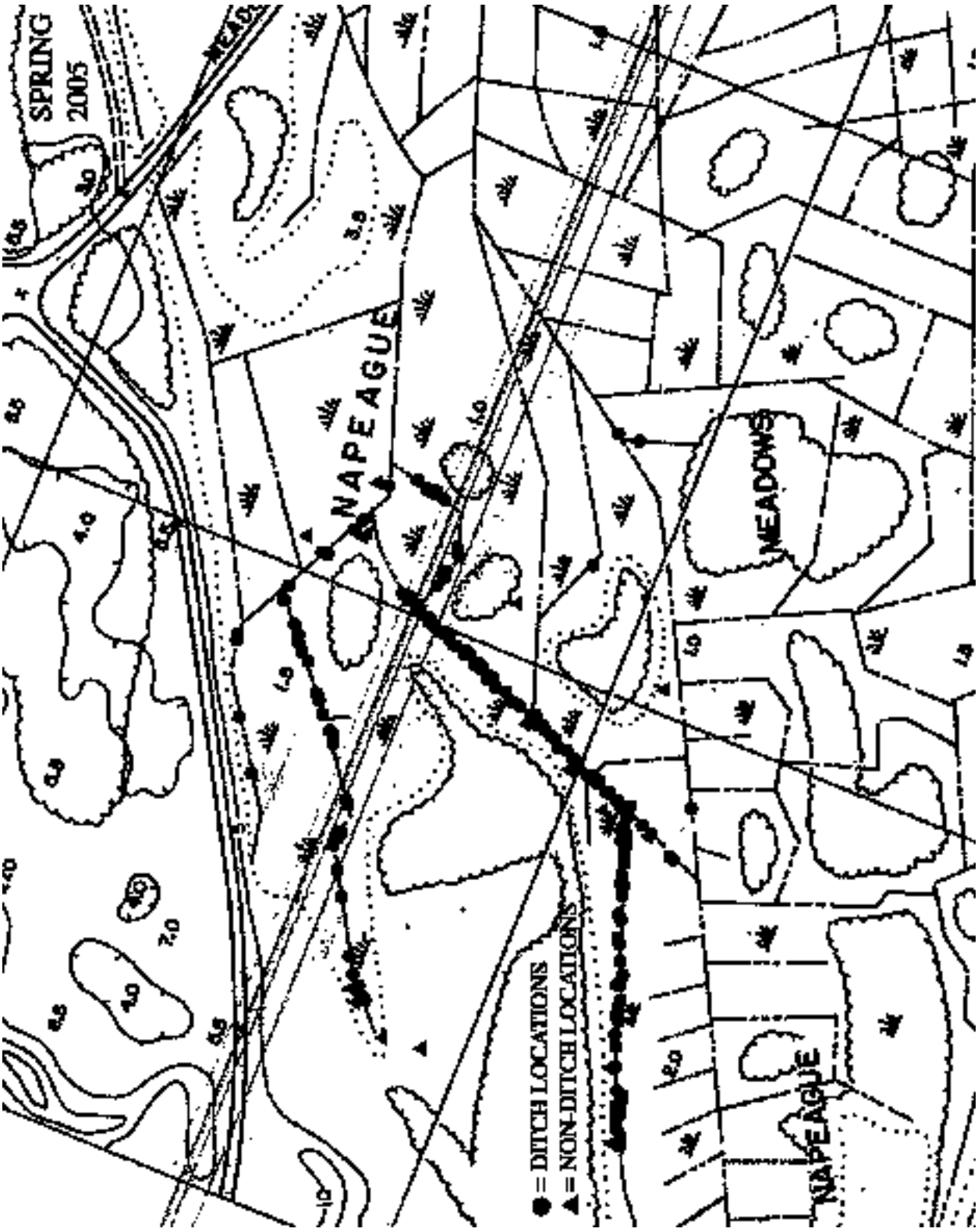

FIGURE 2. MAP OF SPOTTED TURTLE LOCATIONS: SPRING SEASON.

c) Summer

The summer season study commenced on July 5, 2005. Between July 5 and September 2, 2005 a total of 154 relocations were mapped. Data was collected on 17 individual Spotted Turtles (10 females and 7 males). Of these, 11 (6 females, 5 males) were located at least 7 times during the summer season, and 9 (5 females, 4 males) were located an average of at least once per week.

Turtles' preference for mosquito-control ditches diminished during the summer season, but the ditches still accounted for the majority of relocations (61%). Spotted Turtles continued to show a preference for those ditches characterized as supporting emergent vegetation in the form of Cattail (*Typha latifolia* and *T. angustifolia*), Phragmites (*Phragmites communis*), and Sword Grass (*Scirpus americanus*). These areas accounted for 60% of relocations in ditches and 37% of total relocations during the summer season. Second in terms of habitat use (29% of total relocations) was marsh thatch. This is comprised of a wide variety of dead plant material found in the marsh adjacent to the ditches, including leaves and stems of *Spartina patens*, *Distichlis spicata*, *Typha angustifolia*, *Phragmites communis*, and *Juncus canadensis*, which the turtles would burrow beneath. Thatch accounted for 76% of non-ditch relocations. The third most common habitat type for the summer months was found in the mosquito-control ditches and classified as open water (22% of total relocations). These sections of ditch had no emergent vegetation, but developed a thick, floating layer of brownish-green material (possibly algae) and provided excellent cover for the turtles swimming beneath.

5,395 meters of movement were noted during the summer season, for an average movement between relocations of 38 meters per turtle. Only 16 relocations (11% of total relocations excluding each turtle's first summer location) indicated no movement, and only one turtle (L2 R2 female) had more than 2 consecutive "no movement" results. That turtle remained in a waterless ditch filled with Phragmites, positioned on the slope of the ditch wall, for a minimum of 8 days and maximum of 12 days.

HABITAT	# OF RELOCATIONS	% OF TOTAL RELOCATIONS
Ditch w/ Cattail, *Scirpus* spp. and Phragmites	57	37%
Open (no aquatic vegetation) ditch	35	23%
in ditch beneath mud	2	1%
Burrow linked to ditch	1	<1%
Marsh (under thatch)	42	27%
Marsh (Groundsel, salt hay, Phragmites, Cattail)	12	8%
Upland (briars)	3	2%
Basking <0.5 m from ditch	2	1%

TABLE 3. SPOTTED TURTLES' SUMMER HABITAT.

Mosquito-control ditch water temperatures averaged 24°C for the summer season (24°C in July and 26°C in August). Where a turtle was found out of the water, the air temperature within 2 cm the ground at that location was measured. Those temperatures averaged 27°C in July and 28°C in August. The weather station in Bridgehampton reported unusually high temperatures (12 days of 90+°F temperatures) and low precipitation for July and August of 2005. Total rainfall for the 2 months was 2.01 inches; the long-term average for these 2 months is 6.59 inches (Hendrickson, 2005).

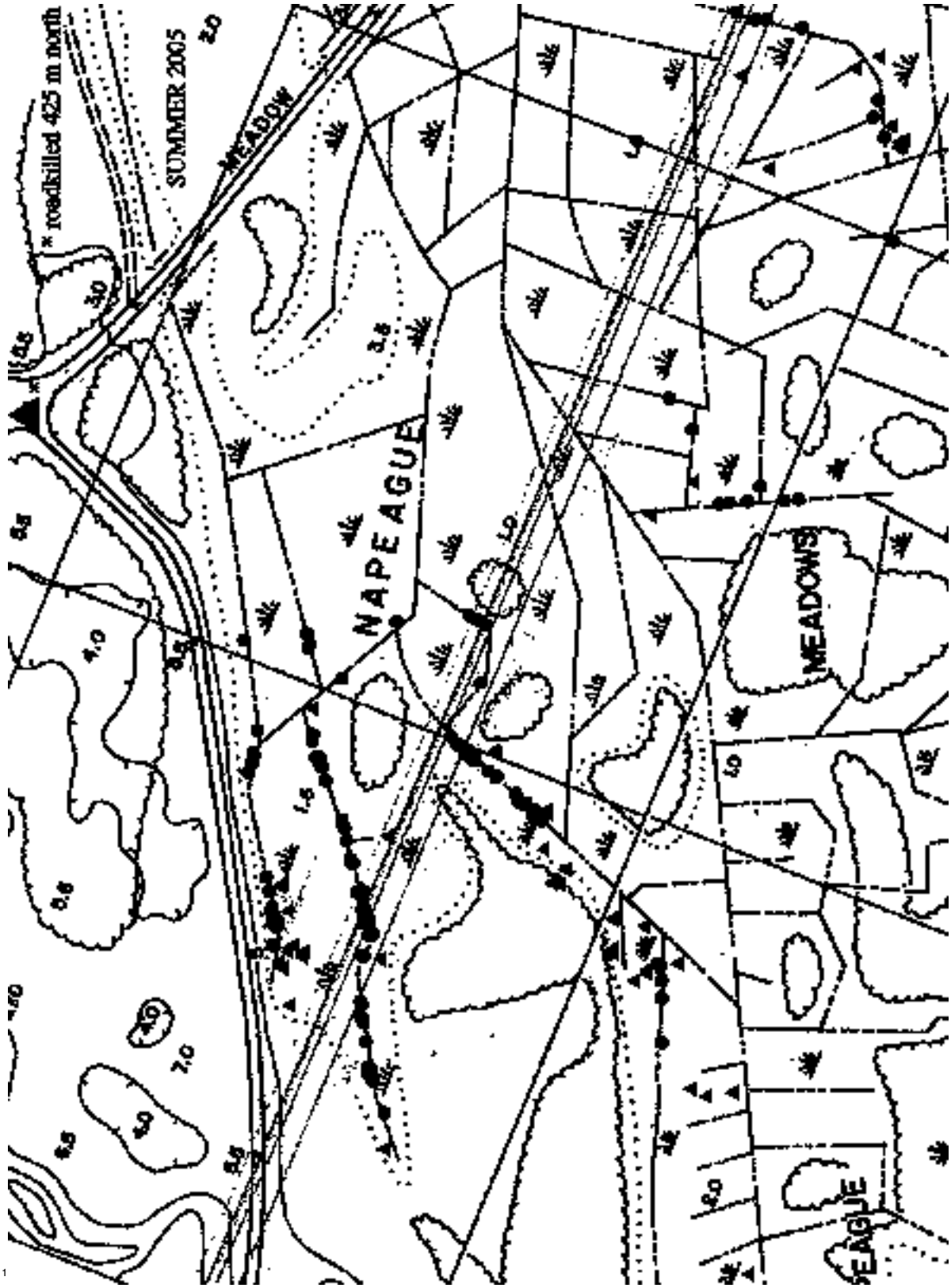

FIGURE 3. MAP OF SPOTTED TURTLE LOCATIONS: SUMMER.

II. Spotted Turtles' presence in other ditched wetlands in Suffolk County.

1) East Hampton: TNC preserve.
This site is a mixed hardwood swamp owned by The Nature Conservancy. The ditches extend from a hardwood swamp, through a large stand of Phragmites, and into a larger expanse of salt marsh before emptying into tidal waters. Trapping and surveying were limited to ditches in the hardwood swamp (Photo 6), which has a canopy dominated by Red Maple (*Acer rubrum*) and Tupelo (*Nyssa sylvatica*), and a dense shrub understory of Sweet Pepperbush (*Clethra alnifolia*). Several patches of marsh dominated by Tussock sedge (*Carex stricta*) are found where there are openings in the forest canopy. Despite what appeared to be excellent habitat and a report of Spotted Turtles at this site (Jim Ash, pers. comm.), no Spotted Turtles were seen or trapped here.

2) East Hampton: County Park site.
This study site has a series of steep-sided, firm-bottomed, mosquito-control ditches beneath a closed canopy Pitch Pine (*Pinus rigida*) and White Pine (*Pinus strobus*) forest with a sparse understory shrub layer. The ditches are connected to the tidal waters of a small embayment. Separating the embayment from the forest is a large stand of Phragmites and a large expanse of salt marsh. Trapping and surveying were limited to ditches in the forested area (Photos 7 & 8). These ditches had significant flow towards the creek, and lacked emergent vegetation.

45 Spotted Turtles were captured over 5 trapping days. A total of 20 individual Spotted Turtles were documented at this site: 15 males and 5 females. Turtles were weighed, measured (carapace and plastron lengths) and marked with marginal notches. Notch codes and measurements are provided in Appendix III.

3) Southampton: County Park site.
Traps were set in ditches that ran through three distinct habitats: a Tussock sedge (*Carex stricta*) and Phragmites marsh dotted with Muskrat lodges (Photo 9); a Red Maple (*Acer rubrum*) swamp; and a sedge (*Scirpus* spp.) and Sphagnum moss (*Sphagnum* sp.) fen. Although Spotted Turtles have been documented in a small, shallow pond within 100 meters of the closest trap (Norm Soule, pers. comm.), none were observed or captured in traps set in the mosquito-control ditches during this study.

III. Water level, salinity and water temperature fluctuations in mosquito-control ditches.
a) Water Level.
Ditch water levels in the study area fluctuated as a result of tidal influence and precipitation. Tidal influence in any particular section of ditch was found to be a function of two characteristics: distance from the bay, and physical condition of the ditch. Tidal influence generally diminished with increasing distance from the bay. The exception to this was Station #6, which was located on the most recently “cleaned” ditch in the study area.

Nearby bay water levels fluctuated between 36 cm (neap tide) and 100 cm (spring tide). Maximum water level fluctuation recorded in a ditch used by Spotted Turtles was 27 cm.

Although tides influenced water levels, highest and lowest water levels at stations inhabited by Spotted Turtles (#2-#6) were more closely correlated with water table elevation changes brought on by high precipitation or prolonged drought.

b) Salinity.
Salinity ranged from 0-23 ppt in ditches that were, at some point during the study, occupied by Spotted Turtles. It is not known whether Spotted Turtles remain in the ditch areas while salinities rose to 23 ppt, or whether they moved upgradient into less saline waters. Based on the number of salinity readings and their locations, it appears that Spotted Turtles readily tolerate salinities up to at least 13 ppt. At the station that recorded the highest salinity levels (Station #1: 12-27 ppt) there were no known Spotted Turtles. Salinity fluctuations were greatest during the summer drought when water table elevations were low (Salinity A in the chart below). During the entire tidal cycle following a heavy rain, salinity was lowered and fluctuations reduced (Salinity B in the chart below).

The influence of salinity fluctuations on Spotted Turtle movement is not known.

c) Water Temperature.
As with salinity, water temperature fluctuations were dampened, and overall temperatures lowered, when water table elevations were high.

A chart of water level changes, salinity ranges, and water temperatures for each field station in the study area in provided in Table 1 below.

FIELD STATIONS

	1	2	3	4	5	6
Level A* (cm)	52	27	18	14	9	20
Level B* (cm)	16	11	7	5	1	9
Temp A (°C)	22-28	22-26	21-28	22-28	21-27	20-28
Temp B (°C)	22-23	22-23	22-23	22-23	21-23	21-22
Salinity A (ppt)	12-27	7-23	1-12	8-16	0-1	0-13
Salinity B (ppt)	6-8	5-7	1-4	4-5	1	0-1

TABLE 4. WATER LEVELS, WATER TEMPERATURE, AND SALINITY OF MOSQUITO-CONTROL DITCHES.

***** Figures listed are maximum changes in water levels for each station.
NOTES: No Spotted Turtles were found at Field station #1.
See Map for field station locations.

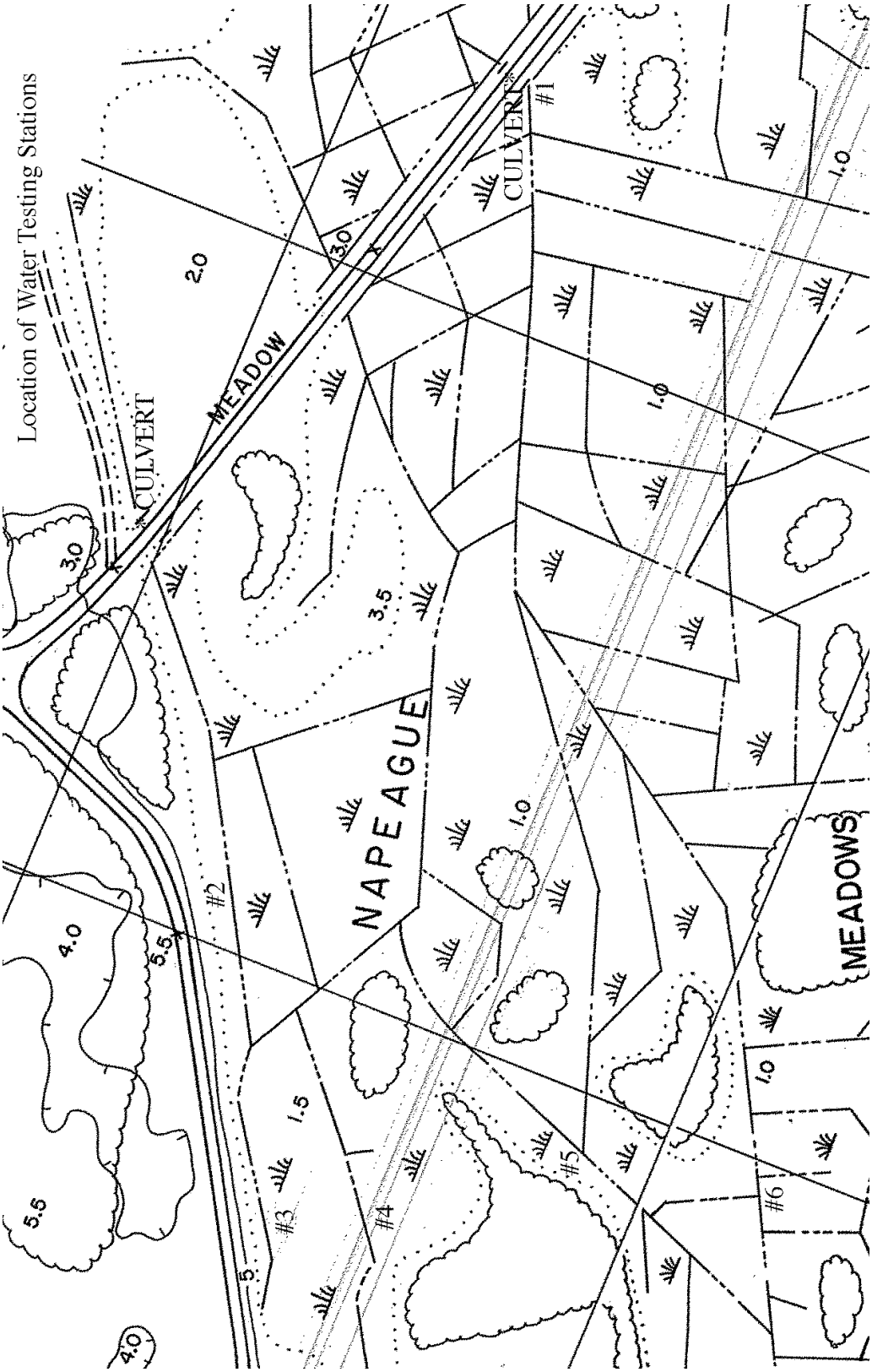

FIGURE 4. LOCATION OF WATER TESTING STATIONS.

DISCUSSION

This study revealed a strong preference among Spotted Turtles for mosquito-control ditch habitat throughout the year. It specifically identified those ditches that support emergent vegetation (*Typha*, *Phragmites*, and *Scirpus americanus*) as highly preferred habitat types throughout the year (Photos 11 & 12), and debris-filled ditches as a preferred habitat type during the winter season (Photo 10). These results present potential conflicts with current mosquito-control ditch maintenance practices, including direct impacts to Spotted Turtles by machinery, resulting in injuries and mortality, and indirect impacts by removing emergent vegetation, sediment and organic debris, resulting in habitat loss and alteration. On the other hand, conservation and management plans at this and similar sites needs to consider the turtles' preference for these man-made ditches, and whether the natural process of ecological succession and loss of these ditches should be allowed to continue. Perhaps some form of Open Water Marsh Management treatment here could meet the needs of both turtle conservation and mosquito control. Due to the presence of rare plant elements, input from Natural Heritage staff would be critical to any future management plan.

The study also indicates that Spotted Turtles' use of the mosquito-control ditches appears to be limited to the high salt marsh area where salinity levels are lower, or possibly where high salinities are of short duration. This aspect of the study area and Spotted Turtle movements warrants further study. An interesting question is whether salinity fluctuations here drive turtle movements. A related and very curious finding is the lack of trapping success in, or turtle movement into, the southwestern part of the study area having the most uniform freshwater environment. This area includes a very large *Typha angustifolia* marsh, and another large bog area supporting *Sphagnum*, cranberry, and a variety of freshwater shrubs, all of which are suitable Spotted Turtle habitat.

Based on salinity data collected in the study area over the summer months (salinity readings were not taken during the winter) it apears that the wintering areas chosen by the radio-tagged Spotted Turtles were located in ditch sections containing pure freshwater (0-1 ppt) with minimal, if any, salinity fluctuation. The exception to this was the turtle wintering in the ditch where salinity varied (during the summer months) between 8 ppt and 16 ppt. This ditch also registered the most ice-free days and warmest temperatures during the winter season, possibly related to the rate of groundwater sepage (Photo 13). The turtle that resided in this ditch also logged the greatest movements during the winter.

The study revealed that the turtles remained fairly active throughout the winter months, and did not enter a prolonged state of hibernation or inactivity. Nor did they show signs of prolonged estivation, or summer dormancy. Both behaviors are thought to be strategies designed to cope with adverse temperatures: avoidance of subfreezing temperatures during winter and 30+°C during summer. It appears that the mosquito-control ditch, in this case a man-altered habitat that intersects the groundwater table, provides a micro-environment in which critical temperature extremes (0°C and 30°C) are not reached.

Another interesting aspect of Spotted Turtle movements at this site is their use of the mosquito-control ditches as travel corridors to travel throughout the study area, a behavior that indicates a strong fidelity to the ditches. With two exceptions, turtles choose to follow the longer and less direct routes the ditches offer rather than travel overland, or through what appears to be suitable habitat in the form of flooded marshes, to reach other ditch habitat in their range.

The physical layout of the study area and surroundings, a several hundred acre, road-less, protected area containing a mosaic of wetland types and uplands that should meet all the needs of a large population of Spotted Turtles, might lead one to surmise that roadkills would not be a significant factor here. Yet, the documented roadkill of one of the study animals over the course of this ten-month study may indicate otherwise.

There were several problems encountered with equipment during the course of this study. Interference over the frequency band 150.910 - 150.960 MHz often rendered the receiver useless. The cause of this interference is unknown. Few of the transmitters lasted the ten month period they were designed for, and at least four died before the end of two months. The electrical tape method of securing the transmitters worked well until the summer when the warm temperatures softened the black tape, allowing it to stretch considerably. And on several occasions the trailing antennae became so entangled in vegetation that the turtles could not move. After discussing this with L.L. Electronics, the antennae were shortened in the field by 5 - 8 cm. This did not seem to appreciably effect transmitter range.

A light gauge, vinyl-coated wire mesh was used to form wings on the box traps, making them a more effective interruption trap. These worked very well, enabling me to capture 8 turtles in the late fall when turtles would not have been attracted to bait. When trapping resumed in the spring, one of the radio-tagged turtles managed to get into an opening where the mesh had broken, became trapped, and drowned (Photo 2). This was particularly unfortunate since this turtle was one of the first captured and marked by Behler in 1996. The original wire mesh material has since been replaced with mesh having a thicker gauge and smaller openings.

Radio telemetry revealed some interesting behavior related to trapping. Despite the turtles' fidelity to the ditches, radio-tagged turtles often bypassed traps set there. Evidence was found of turtles burrowing under the traps, momentarily leaving the ditch to get around traps, and moving through traps by pushing aside the one-way gates, turning sideways and exiting (not unlike their method of moving through a dense stand of cattail or phragmites). Perhaps after ten years of seasonal trapping at this site, we are witnessing some learning behavior there.

This study, as well as past work done by others at this site since 1996, has not provided any information on nesting sites or the habitat preferences of young Spotted Turtles (hatchlings through age three). Very few Spotted Turtles under 6 years of age have been caught and marked at the site, and none under 4 years. This information would be important for future management plans and activities.

This interesting mosaic of wetlands and uplands warrants a detailed habitat and vegetation map. Although much botanical work has been done in the area by New York State Natural Heritage staff, their field work has largely focused on monitoring populations of rare plant species. Mapping and surveying of plant communities and areas outside of known rare plant locations were done in a general fashion with the aid of aerial photographs, and there are several errors. For example, the Natural Heritage vegetation map entitled "Ecological Communities of Napeague State Park," labels most of the wetland area in the southwest portion of the turtle study site as "High Salt Marsh," described in the document as containing *Spartina alternifolia*, *Spartina patens*, *Distichlis spicata*, and other salt-tolerant species (Evans et al. 2000). Yet these species are poorly represented in that area. Instead, this portion of the large wetland complex is dominated by freshwater species, including large areas of cranberry (*Vaccinium macrocarpon*), Canada rush (*Juncus canadesis*), Highbush Blueberry (*Vaccinium corymbosum*), *Typha* spp. and *Sphagnum* spp.

One obvious question that arises from this research is: what type of habitat were the Spotted Turtles using prior to the marsh being ditched? Much of the mosquito-control ditching was first done on a large scale on Long Island in the 1930's. The goal of the ditching was to facilitate draining of marshes and swamps by linking them to tidal waters, thereby eliminating shallow pools of standing water that might be suitable mosquito breeding habitat. It is possible that, in the case of the Napeague study site, the ditching was effective in eliminating the larger, deeper permanent freshwater bodies and vernal pools located in the upper marsh that were suitable for Spotted Turtle feeding, courtship and mating, and overwintering. In response, the turtles adapted to the modified environment and exploited the ditches as a replacement habitat. The results of this study point to the possibility that these resilient animals not only adapted to a sudden, and major, habitat alteration, but they have also modified their behavior, choosing not to hibernate or estivate in their new environment because, to quote John Behler, "they can!"

CONCLUSION

Spotted Turtles (*Clemmys guttata*), a species in decline throughout its range and listed as a "Species of Special Concern" in New York State, shows a strong habitat preference for mosquito-control ditches containing emergent vegetation located in brackish and freshwater wetlands. Their use of these areas throughout the year poses an important management challenge for the Suffolk County Department of Vector Control, which maintains the ditches. A long term management plan needs to be developed by the County in conjunction with NYSDEC, the NYS Natural Heritage Program, and landowners, to best ensure that mosquito-control programs and maintenance work do not conflict with turtle and rare plant conservation efforts.

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APPENDIX I. SELECTED LITERATURE REVIEW OF THE SPOTTED TURTLE

PHYSICAL CHARACTERISTICS

The Spotted Turtle is relatively small turtle (shell length less than 5 inches or 12.5 cm) with a smooth, dark carapace (upper shell) containing scattered yellow or orange spots that give this species its common

name. The spots can be highly variable in brightness, size and number among individuals within a population and between disjunct populations. Juveniles generally have brighter spots than adults. Most of the mature Spotted Turtles at the Napeague study site have few and very dull spots, or lack them entirely (Photo 14), while those at the western East Hampton site have many bright-colored spots (Photo 15). Careful scraping of the carapace of the spotless individuals removes a very thin layer of mud, and possibly algae, revealing spots beneath (Photo 16). Tannin in surface waters and the high iron content of the groundwater at Napeague may also contribute to staining of the shells, reducing the brightness of the yellow spots.

Although some references state that spots are absent from the tail and legs (Hulse et al. 2001), yellow and orange spots are found on the legs, tail, head and neck of eastern Long Island's Spotted Turtle population. These spots are brightly colored and, unlike spots on the shell, seem to remain so with age. Many references describe a large yellow spot or band on the head behind the ear (Carr, 1952). This is distinctly orange among many individuals on eastern Long Island (Photo 17). The carapace is low in profile and oval (circular among hatchlings) when viewed from above. The plastron is slightly smaller than the carapace in length and width, and highly variable in its pattern of dull, light, yellow-orange and dark brown coloration. Many of the mature individuals at the East Hampton study sites have uniform dark brown-colored plastrons (Photo 18), while juveniles have a high proportion of light yellow-orange area in addition to patches of dark brown (Photo 19).

This species lacks webbing between its toes, a feature that may limit its ability as a swimmer and contribute to its preference for shallow water habitats.

RANGE

The Spotted Turtle's range is limited to eastern North America where it inhabits a discontinuous area extending from southern Maine south to northern Florida, and as far west as Wisconsin and southern Ontario (Carr, 1952 and Hulse et al, 2001).

LIFESPAN

Much of the literature on Spotted Turtles cites a maximum age of 35 to 50 years, but recent, unpublished research indicates that wild Spotted Turtles may live over 100 years (J. Litzgus, pers. comm.).

HABITAT and MOVEMENTS

The Spotted Turtle is considered an aquatic or semi-aquatic species that inhabits a variety of shallow wetland types including marshes, wet meadows and fens, bogs, wooded swamps, seasonal pools (defined as areas flooded for at least two consecutive months and free of fish), and the shallow borders of ponds, lakes, and streams (Hulse et al, 2001; Milam and Melvin, 2001). In The Handbook of Turtles, turtle biologist Archie Carr states that "It is nearly always rare in regions where ponds are few." This species is known to utilize man-altered environments such as commercial cranberry bogs and roadside ditches (DeGraaf and Rudis, 1983). Radio telemetry studies have shown that Spotted Turtles also use forested and open uplands for nesting, dormancy (summer and winter) and traveling between wetlands (Litzgus and Brooks, 2000; Milam and Melvin, 2001; Joyal et. al., 2001). In a publication dated 1919, H.L. Babcock writes, "I have frequently taken it [Spotted Turtles] in salt marshes" (Babcock, 1919). I was unable to locate any recent published reports documenting Spotted Turtle use of salt marshes or brackish wetlands. There is also very little information related to habitat selection of hatchlings through one-to-three-year age classes. An undated publication from Massachusetts reports that hatchling Spotted Turtles were found in

commercial cranberry bog ditches in late September, in the flooded bogs during the fall harvest, and in the bog ditches in early spring (Manomet Center for Conservation Sciences, undated).

Spotted Turtles follow a seasonal pattern of habitat use. In spring they travel from hibernation sites to seasonal wetlands and ponds for courtship and mating. In June, gravid females travel to nesting sites and males and non-gravid females travel to estivation sites for part of the summer. Some remain at these estivation sites through the fall and winter. In the fall, they all return to the vicinity of their hibernation sites (Ernst, 1976).

A seasonal, two-year, mark-recapture and radio telemetry study of Spotted Turtles in southern Maine determined that some individuals occupied one of several wetland types (forested swamps, scrub-shrub swamps, wet meadows, small seasonal pools (<1 ha), remnant beaver flowages, farm ponds, and an acidic fen) the entire year. Wetlands were used for winter hibernation, spring courtship and mating, and part of the summer while active as well as for summer dormancy. One turtle nested both years on root hummocks in Red Maple swamps. Upland habitats (forests, pastures, roadsides and yards) were used for travel between wetlands, nesting, and late summer dormancy periods of 15-89 days. This study did not relocate turtles during the months of December through April. The researchers reported that “Wetlands started to freeze by the time last contact was made in October-November, so we assumed that turtles overwintered in the wetland where they were last radiolocated.” (Joyal et al., 2001).

A seasonal (late March to December), three-year study of Spotted Turtles at two sites in central Massachusetts found that most (22 of 26 radio-tagged turtles) moved in late March - early April from overwintering sites to seasonal pools located in upland forests. Turtles exited the seasonal pools in May or June depending upon water levels (leaving earlier in dry years) and, for gravid females, the onset of nesting season. Gravid females traveled overland to nesting sites in upland fields and emergent wetlands. The latter was dominated by sedges (*Carex* spp.), Jewelweed (*Impatiens capensis*), Phragmites, and Cattail (*Typha latifolia*). Males and non-gravid females moved to estivation sites in upland forests, emergent wetlands, scrub-shrub swamps, or to other seasonal pools. After nesting and estivating, a majority of radio-tagged turtles moved to seasonal pools that retained water. All returned to the vicinity of winter hibernacula by late September. All hibernacula were located in wetlands; 9 of 19 were in emergent wetlands (Milam and Melvin, 2001).

A two-year study of Spotted Turtles near the northern limit of their range in Ontario also found distinct seasonal shifts in habitat use. Turtles traveled to ponds for courtship and mating in May-June. In late June, gravid females traveled to open rock outcrops to nest (the outcrops being thermally stable habitats). Half of July and August was spent estivating on outcrops or in forest habitat, and half was spent in wetlands, active and presumably feeding. Hibernating occurred in sphagnum swamps from September to April (Litzgus and Brooks, 2000).

Seasonal movements and behavior are strongly correlated to temperature. A fifteen year-long study of a population Spotted Turtles in Pennsylvania found that they became active in the early spring when water temperatures reached 5°C. They began mating at water temperatures of 8.5°C, and they began feeding when water temperatures reached 14°C. On the other end of the temperature spectrum, Spotted Turtles sought estivation sites and became inactive when water temperatures reached 30°C. Most remained at these summer dormancy sites through the fall and winter, emerging the following spring (Ernst, 1982).

A study of Spotted Turtle hibernation over 4 winters near the northern limit of their range in Ontario also found a correlation between temperature hibernating behavior. Turtles entered hibernacula when their body temperature was between 12°C and 16°C, and exited them when ambient temperatures ranged between 1°C and 5°C. Hibernacula were located in swamps and were either rock caverns or moss hummocks. Both were thermally stable microenvironments that protected turtles from freezing. Body temperatures in hibernacula ranged from 0.3°C to 3.9°C during winters where air temperatures dropped to -35°C and varied as much as 37°C over a 5 day period. Of the 18 hibernacula studied, 7 were used communally by as many as 9 individuals. No mortality was observed in the hibernacula over the 4 study

seasons, and loss of body mass during the 6 month-long hibernation period was insignificant (Litzgus et al., 1999).

FEEDING

Spotted Turtles are omnivores whose diet consists chiefly of aquatic insect larvae, small crustaceans, amphibian eggs and tadpoles, snails, stems of aquatic grasses, and filamentous green algae [NOTE: Fowlers Toad egg masses and tadpoles are abundant at the Napeague study site]. They also scavenge on carrion. Although terrestrial insects have been noted in analyses of Spotted Turtles' stomachs, it is thought that the terrestrial insects either fell into the water or were captured on land and carried to the water where they were consumed. No Spotted Turtles have been observed feeding on land, as this species can only swallow food underwater (Ernst, 1976).

Feeding commences in the spring when water temperatures reach 14°C (Ernst, 1982). Feeding is limited by the fact that digestive enzymes do not function at temperatures below 14°C to 15°C (J. Litzgus and N. Soule, pers. comm.). Feeding was observed from March through September at air temperatures ranging between 11°C to 30°C and water temperatures between 14°C to 32°C (Ernst, 1976 and Ernst, 1982).

CONSERVATION

Most turtle species, including Spotted Turtles, have high egg and juvenile mortality, low adult mortality, and are very long-lived. Most literature cites maximum ages of wild Spotted Turtles in the 35-50 years range, but recent research indicates that Spotted Turtles may live over 100 years (J. Litzgus, pers. comm.). Either figure implies that adults need to be protected, since population replacement is infrequent.

The Spotted Turtle was once much more common and widespread than it is today. Reports published in the mid-1800's through early 1900's mention the Spotted Turtle as one of the most common species of turtle in New York State (DeKay, 1842), common in ponds all over New York State (Eckel and Paumier, 1902), and rivaling the Painted Turtle as the most common turtle in the vicinity of New York City (Ditmars, 1905). Similar reports can be found in the literature for Massachusetts, where the Spotted Turtle was considered to be the first or second most common turtle species in that state (Storer, 1839; Babcock, 1919; Dunn, 1930).

The Spotted Turtle is currently listed by the New York State Department of Environmental Conservation as a "Species of Special Concern." Loss of habitat is cited as the major cause of Spotted Turtle population decline throughout its range. Much of this turtle's wetland habitat, such as vernal ponds, swamps and shallow marshes, were filled for residential and commercial development before the passage of state and federal wetland protection acts. Even today, the New York State Freshwater Protection Act does not implicitly protect the small wetlands (under 12.6 acres in size) that many Spotted Turtle populations utilize, unless those wetlands have been specifically recognized as "wetlands of unusual local significance." Many state and federal wetland protection regulations, including New York State's, do not protect large enough upland buffers areas to include important nesting, hibernation, and estivation habitat for the long-term conservation of this species (Milam and Melvin, 2001; Joyal et al., 2001). Illegal pet collecting is also responsible for the loss of significant numbers of Spotted Turtles from the wild, and poses a serious problem on Long Island where most sites are very easy to access.