BOMBAY HOOK NATIONAL WILDLIFE REFUGE

Smyrna, Delaware

WILDLIFE INVENTORY PLAN

February 1989

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INTRODUCTION

The Bombay Hook National Wildlife refuge consists of 15,122 acres originally established for conservation of migratory waterfowl. The refuge is still managed principally for the benefit of ducks and geese, but important secondary objectives include the maintenance of a diversity of wildlife species and their habitats. Wildlife inventories provide data on the size, composition and reproduction of populations; information needed to appraise the success of management and development programs in attaining the wildlife goals.

Selection of species to receive priority inventory efforts include those for which there are mandatory reporting requirements. All formal surveys will be conducted by refuge personnel, in some cases with volunteer assistance. Following is a listing of the proposed survey procedures with a breakdown of staff manpower and costs to the Service for each:

Procedure No.	Species Inventoried	Title	(Days) Staff Time	Cost To Service
BH-1	Waterfowl	Population Survey-Aerial	5.5	$ 1,555.00
BH-2	Waterfowl	Population Survey-Ground	9.5	1,525.00
BH-3	Woodduck	Population Survey-Roost Count	2.25	354.50
BH-4	Ducks	Breeding Pair Count	1.0	350.00
BH-5	Waterfowl	Brood Productivity Survey	8.0	800.00
BH-6	Marsh & Waterbirds, Shorebirds, Gulls, Terns, Raptors	Population Survey	10.0	1,644.80
BH-7	Woodcock	Singing Ground Survey	0.25	37.50
BH-8	Whitetail Deer	Population Survey	1.5	165.00
BH-9	Muskrat	House Count	0.5	175.00
BH-10	Waterfowl	Nest Drag Survey	27.0	2,830.00
				$ 9,436.80

It should be noted that additional manpower and time will be devoted to gathering supplemental inventory data over and above the costs and time of these formalized procedures. For example, observation of bald eagles to determine their reproductive status on the refuge can often require numerous hours of observation. Similarly, refuge personnel involved in other routine duties such as law enforcement patrol can and should provide meaningful data relative to a species occurrence and its population size.

REFUGE: Bombay Hook **PROCEDURE NO:** BH-1
SPECIES: Waterfowl
TITLE: Population Survey - Aerial

I. Purpose

The principle objective in establishing the Bombay Hook National Wildlife Refuge was to preserve and enhance the waterfowl resource at Bombay Hook. This remains the basic objective for which the refuge is managed. A waterfowl census provides the population data needed to assist in evaluating attainment of this objective. Comparison of the data collected over the long term by species serves as an indicator of a population's trend and can alert the staff to a decline or an increase in any particular species. This data is needed therefore, as primary input for management decisions.

II. Procedure

An aerial survey of all species and numbers of geese, ducks, swans, and coots on the refuge should be made at a minimum of once a month during the months of September through March. Aerial surveys should be conducted more frequently when ground observations indicate that significant population changes have occurred (e.g. severe changes in the weather, arrival or departure of large numbers of waterfowl, opening of the hunting season, etc.). Since Delaware Division of Fish and Wildlife observers also fly aerial counts and provide data to the refuge, counts should be coordinated with that agency to allow the best coverage of any particular time period.

One observer capable of identifying waterfowl by species in flight or at rest and estimating their numbers is required. In the interest of continuity it is preferred that the same observer make the counts on each survey to reduce possible bias between individual estimates. The count is made from a light single engine aircraft flying 100 mph at an altitude of 200 feet. The census route is shown on the map titled "Route of Aerial Waterfowl Census" (Exhibit A). Optimum weather conditions are clear and windless. The census is not made if there is precipitation, fog, or wind exceeding 20 mph. The census is taken during the time of the day when it is believed that the greatest number of waterfowl are present on the Refuge. For example, since snow geese roosting on the Refuge frequently depart the area shortly after dawn the census would optimally be taken as close to dawn as possible so as to include departing birds in the population estimate. Further, a ground observer should be stationed along the flight path of departing birds to

record numbers of geese which may leave prior to the arrival of the plane.

The waterfowl observed are recorded by species and management unit on a small portable tape recorder. Following the flight the information on the tape is transcribed onto a "Wildlife Observation Data Form" (Exhibit B). At the end of each month these sheets are compiled and population data for each species is recorded on the "Monthly Waterfowl Populations" output form (Exhibit C).

III. Special Considerations

Typical waterfowl populations encountered at Bombay Hook are as follows:

	Snow Geese	Canada Geese	Ducks	Swans	Coot
Spring	20,000-40,000	500-2,000	2,500-6,000	10-60	100-200
Summer	0	50	1,500-3,000	2	5
Fall	20,000-75,000	5,000-30,000	10,000-30,000	10-60	100-200
Winter	10,000-40,000	5,000-10,000	12,000-15,000	10-60	100

During aerial counts most species of waterfowl (wood duck being the most significant exception) are readily observable in the impoundments and on most of the salt marsh during all seasons. A small unknown percentage of ducks (principally black ducks) in narrow tidal channels are not visible. Mixtures of species in flocks, especially when feeding, present an estimating problem. A minor amount of duplication in counting waterfowl on the salt marsh probable occurs; however it is probably offset by birds not being visible in the tidal channels.

In an effort to provide a partial basis for estimating the waterfowl population during weeks when aerial surveys are not made and to supplement the aerial count data by providing information on species present in small numbers and unidentified on the flight (e.g. mergansers and ring-necked ducks), a ground census is made at least bi-weekly to determine the species and numbers of geese, swans, and coots present on the freshwater impoundments and the immediately adjacent areas of the salt marsh (Procedure BH-2). Further, wood duck populations are monitored by Procedure BH-3.

IV. Manpower and Costs

Manpower - 8 aerial surveys each involving approximately 2 hours of staff time (Grade GS 11-7) = 2 Staff Days @ $150.00 = $300.00

- During 4 of the aerial surveys have a ground observer counting departing geese involving 2 hours of staff time (Grade GS 5-1) = 1 Staff Day @ $80.00 = $80.00

- Data tabulation and report preparation 20 hours of staff time (Grade GS 11-7) = 2 1/2 Staff Days @ $150.00 = $375.00

Equipment rental of airplane and pilot = 8 surveys each 1 1/2 hours @ $100.00 = $800.00

Total cost of 8 aerial surveys and data compilation = $1,555.00

REFUGE: Bombay Hook **PROCEDURE NO:** BH-2
SPECIES: Waterfowl
TITLE: Population Survey - Ground

I. Purpose

The principle objective in establishing the Bombay Hook National Wildlife Refuge was to preserve and enhance the waterfowl resource at Bombay Hook. This continues to be the basic objective for which the Refuge is managed. A waterfowl census provides the population data needed to assist in evaluating attainment of this objective. Comparison of the data collected over the long term by species serves as an indicator of a population's trend and can alert the staff to a decline or an increase in any particular species. This data is needed therefore, as primary input for management decisions.

II. Procedure

A ground waterfowl census is made bi-weekly to determine the species and numbers of geese, ducks, swans and coots present on the freshwater impoundments and the immediately adjacent area of the salt marsh. This count is made to: (1) provide a partial basis for estimating the waterfowl population during weeks when an aerial count is not made and (2) supplement the aerial count data by providing data on species present in small numbers and unidentified on the flight, e.g., hooded merganser and ring-necked ducks on Shearness Pool. When this count is used to supplement the aerial count it is made as soon after the flight as possible.

One man capable of identifying all species of waterfowl and estimating their numbers is required. The count is made from a pick-up or passenger vehicle with binoculars and a window mounted spotting scope. The count is made in the early morning when glare is at a minimum and the sun is behind the observer as he views the impoundments. Optimum weather conditions are clear and windless. The count is not made if there is precipitation, fog or wind exceeding 20 mph.

The census route is shown on the map titled "Route of Ground Waterfowl Census" (Exhibit D). The number, location and duration of stops made is variable depending upon the number and distribution of waterfowl. At a minimum, stops are made where indicated on the route map. At each stop the waterfowl in the impoundment are identified and counted. At stops on Raymond, Shearness

and Bear Swamp dikes the waterfowl visible in the salt marsh are also identified and counted. The waterfowl observed are recorded by species and management unit on a small portable tape recorder. Following the survey the information on the tape is transcribed onto a "Wildlife Observation Data Form" (Exhibit B). At the end of each month these sheets are compiled and population data for each species is recorded on the "Monthly Waterfowl Populations" output form (Exhibit C).

III. Special Considerations

Typical waterfowl populations encountered at Bombay Hook are listed in BH-1. Supplemental waterfowl population data is gathered during the months of April through September while conducting the shorebird inventory within the salt marsh (see Procedure BH-6). These data, when compiled with BH-1 data and the wood duck survey BH-3, provide a good indication of the total refuge waterfowl population throughout the year.

IV. Manpower and Costs

Manpower - 26 Surveys each involving approximately 2 hours of staff time (Grade GS 11-7) = 6.5 Staff Days @ $150.00 = $975.00

- Data tabulation and report preparation 3 Staff Days @ $150.00 = $450.00

Vehicle Costs - Figure $.20/mile; 500 total miles = $100.00

Total costs of 26 Surveys and data compilation = $1,525.00

REFUGE: Bombay Hook **PROCEDURE NO:** BH-3
SPECIES: Wood duck
TITLE: Population Survey - Roost Count

I. Purpose

The principle objective in establishing the Bombay Hook National Wildlife Refuge was to preserve and enhance the waterfowl resource at Bombay Hook. This remains the basic objective for which the refuge is managed. A waterfowl census provides the population data needed to assist in evaluating attainment of this objective. Comparison of the data collected over the long term by species serves as an indicator of a population's trend and can alert the staff to a decline or an increase in any particular species. This data is needed therefore, as primary input for management decisions.

II. Procedure

During the late summer and fall a count of wood ducks is made once a week from the Finis dike mid-way between the two water control structures (See Exhibit E). The count is made from one hour before sunset until it is too dark to observe flying birds (average count time two hours). Optimum weather conditions are clear and windless. The count is not made when there is precipitation, fog or wind exceeding 20 mph.

The wood ducks are counted as they fly to roost in Finis Pool or the northwest section of Shearness Pool. One observer capable of distinguishing wood ducks from other duck species in flight is required. A pair of binoculars is necessary. Observations are recorded on a small tape recorder. Following the survey the information on the tape is transcribed onto a "Wildlife Observation Field Data Sheet" (Exhibit B). At the end of each month these sheets are compiled and population data for the wood duck is recorded on the "Monthly Waterfowl Populations" output form (Exhibit C).

III. Special Conditions

Due to the preference of the wood duck for wetlands normally located within brushy or timbered areas, they are almost impossible to census by aerial or normal ground surveys. Their tendency to fly in established flight lanes to nightly roost spots during late summer and early fall offers the refuge manager the best opportunity for censusing the population. Although all wood ducks at Bombay Hook do not fly across the Finis dike to their nightly roosts, it is believed that a large majority does,

and counts of these birds will provide a useful index as to the late summer and fall populations of wood ducks at Bombay Hook.

IV. Manpower and Costs

Manpower - 7 surveys each involving approximately 2 hours of Staff Time (Grade GS 11-7) =
1.75 Staff Days @ $150.00 = $262.50

- Data tabulation and report preparation
0.50 Staff Days @ $150.00 = $75.00

Vehicle Costs - Figure $.20/mile total 85 miles = $17.00

Total Costs of 7 surveys and data compilation = $354.50

REFUGE: Bombay Hook **PROCEDURE NO:** BH-4
SPECIES: Ducks
TITLE: Breeding Pair Count

I. Purpose

A major objective of the refuge is duck production (primarily black and wood ducks) with an annual production goal of 3,000. A count of breeding pairs provides information on the size, composition and distribution of breeding populations. This information is necessary for the evaluation of current management practices and the planning of future management and development.

II. Procedure

An aerial count is flown twice in the spring to determine the number of breeding pairs of the major ground nesting species: black duck, mallard, gadwall, and blue-winged teal. One observer capable of identifying these duck species in flight and at rest is required. The count is made from a light single engine plane flying 100 mph at an altitude of 150 feet. The census route is shown on the map titled "Route of Aerial Breeding Pair Count" (See Exhibit F). The count is made in the early morning and is completed in one hour. The optimum weather conditions are clear and calm, and the count is not made if there is precipitation, fog or wind exceeding 20 mph. The target dates for the counts are April 15 and May 1.

Observations are recorded on a small portable tape recorder. Following the survey the data are transcribed onto a field data sheet (Exhibit G). One data sheet is used for each management unit. Each pair of ducks observed is recorded by a mark in the appropriate species column. Lone ducks are identified by sex and recorded by a mark in the male or female box for the appropriate species. All lone black ducks are tallied in the male box. The number of breeding pairs of each species is tabulated. For each except the black duck:

1. Total the pairs recorded.
2. Total the lone males recorded.
3. Total the lone females recorded that are in excess of the lone males.
4. Add the totals from 1, 2, and 3 to obtain the breeding pair total.

For the black duck:

1. Total the pairs recorded.

2. Total the lone individuals (male box) recorded and divide this number by two.
3. Add the figures from 1 and 2 to obtain the breeding pair total.

The total of breeding pairs for each species is entered on the "Breeding Pair Count Summary Sheet" (Exhibit H). After the second count the average number of each species is calculated. The field data sheets and the summary sheets are filed as a permanent record. Production figures are also recorded on the "Monthly Waterfowl Populations" output form (Exhibit C).

III. Special Considerations

The size of the breeding duck population counted in recent years has been 100 to 300 pairs. isolated pairs and individuals are most readily counted. The presence of several hundred to several thousand non-resident ducks in early April can mask the occurrence and observation of some breeding pairs. A variable number of pairs in narrow channels in the salt marsh will be unobserved in Finis Pool and part of Shearness Pool because of the shrub cover.

IV. Manpower and Costs

Manpower - 2 aerial surveys each involving approximately 2 hours of Staff Time (Grade GS 11-7) = 0.5 Staff Days @ $150.00 = $75.00

- Data Tabulation and Report Preparation 0.5 Staff Days @ $150.00 = $75.00

Airplane and pilot rental 2 hours @ $100.00 = $200.00

Total cost of 2 aerial surveys and data compilation = $350.00

REFUGE: Bombay Hook **PROCEDURE NO:** BH-5
SPECIES: Waterfowl
TITLE: Brood Production Survey

I. Purpose

Beginning in 1986, refuges in Region 5 made an effort to standardize methods of estimating brood production; in order to have comparable data from one year to the next at any given station as well as to make comparisons among different field stations. The technique as described by Bennett (1969) is used (with modification) at Bombay Hook.

II. Procedure

With Bennett's technique, broods are observed from elevated platforms at predetermined observation points around impoundments, flowages, marshes, etc. Observations are made from these sites twice daily, at sunrise and sunset. Only a random selection of observation points are visited during any one day. Each observation point is visited a minimum of two times and the entire survey is done in about a week. This method assumes that it becomes harder to observe a new (previously unrecorded) brood as the number of broods seen (over a period of days) increases. It also assumes that the rate that these "new" brood sightings decreases is predictable and can be used to determine the total broods in the area.

A. Observation Points

Eight observation points have been chosen (Exhibit I) surrounding three impoundments, Raymond Pool, Shearness Pool and Bear Swamp Pool. Finis Pool will not be surveyed due to the heavy vegetation minimizing the probability of observing duck broods present. Salt marsh areas will also not be surveyed due to the vast area involved and the limited availability of personnel. A description of the survey observations points is as follows (acreages observed approximate):

Point 1: Raymond Tower - will cover all of Raymond Pool (95 acres).

Point 2: Shearness Tower - will cover from point 3 east to Shearness dike (100 acres).

Point 3: Shearness-unnamed island - will cover from point 3 west to the end of Shearness Pool (180 acres).

Point 4: North Shearness Structure - will cover Shearness Dike to Colliers Island and east shore of Parson Point (100 acres).

Point 5: Parson Point, deer stand #75 - to cover remaining area west toward Finis dike and west shore of Parson Point (180 acres).

Point 6: Bear Swamp Tower - to cover 1/3 of Bear Swamp Pool closest to tower (80 acres).

Point 7: Bear Swamp Dike - will cover 1/3 of Bear Swamp Pool closest to dike (80 acres).

Point 7A: Bear Swamp north shoreline near deer stand #68 - will cover 1/3 of Bear Swamp Pool closest to deer stand (80 acres).

Ideally, every brood on impoundments surveyed should have an equal chance of being seen; that is, each brood should move into an observation area sometime between hatching and flying age. Bennett estimated that 1 point for every 40 acres of marsh should be the minimum number of points needed, but that the area per point can be increased with larger, more open areas such as occur on the Bombay Hook pools.

B. Number of Observations

A minimum of two counts (either morning or evening) for each observation point are necessary. Observation points are visited randomly, except that points on the same wetland unit (Raymond, Shearness, Bear Swamp) are treated as a unit with all points visited simultaneously.

C. Time of Observations

There are two possible daily observation periods, each lasting 2-3 hours. The first should start one hour

before sunrise and the second should end 1 hour after sunset. Counts should not be made on days when visibility is poor (fog, rain) or when brood movement is restricted (high winds, cold). Observations may be made on two consecutive days if weather conditions are suitable.

D. Data Recorded

All observers should be equipped with binoculars or a spotting scope.

For all brood observed the observer should record:

a. species
b. number of young
c. class of young
d. approximate location in wetland
e. date

The number of broods observed on any given wetland can be made by comparing observation dates and number and age of ducklings. By back-dating it should be possible to tell whether or not most brood sightings were repeats (some intuition will be necessary). If an observed brood resembles a previously recorded brood by having the same or a lesser number of ducklings of approximately the same age, call it one brood. Therefore, two identical broods in the same area could be recorded as one until both broods are seen during one count.

E. Calculating Brood Estimates

In order to calculate the estimate you need two numbers: 1) total number of different broods seen (B) and 2) total brood sightings, including repeats (N).

Step 1

Divide total broods by the logarithm (base 10) of the brood sightings plus one.

$$Q = \frac{B}{\log (N+1)}$$

Step 2

Multiply this value (Q) by the logarithm of this value multiplied by 54.

$$\text{Total broods in sample area} = Q \times \log (54 \times Q)$$

Example

Using 8 broods (B) with 12 brood sightings (N)

$$Q = \frac{8}{\log (12+1)}$$

$$= 7.2$$

Total Broods in Area Sampled $= 7.2 \times \log (54 \times 7.2)$

$= 18.6$

$= 19$ broods

After production data has been calculated it will be included in the annual narrative (waterfowl production) and the Annual Waterfowl Production Output Report (Exhibit Q).

IV. Manpower and Costs

The following is an estimate of the total funds needed for the survey (includes data compilation).

Raymond Pool 1 person for 2 days at 4 hrs/day = 8 hrs (1 staff-day)
Shearness Pool 4 persons for 2 days at 4 hrs/day = 32 hrs (4 staff-days)
Bear Swamp Pool 3 persons for 2 days at 4 hrs/day = 24 hrs (3 staff-days)

Total 8 staff days at $100.00 = $800.00

REFUGE: Bombay Hook **PROCEDURE NO:** BH-6
SPECIES: Marsh and Water Birds, Shorebirds, Gulls and Terns, Predacious Birds
TITLE: Population Survey

I. Purpose

A major objective of the Bombay Hook Refuge is to provide habitat for and protect a wide diversity of wildlife. The habitats on the refuge, and the land and water management practices employed to benefit waterfowl, provide excellent living conditions for an interesting array of other bird species. The refuge staff is frequently asked to provide information on the species that are or will be present, their abundance and the best time and places to observe them. For this reason a method of survey has been developed to assist in arriving at this information.

II. Procedure

During the period November 1 through March 31 the species covered by this procedure are counted as observed during routine refuge travel or while conducting other duties or inventory procedures. All refuge personnel capable of identifying the species will contribute to this survey. The number of species and individuals will be generally low for the shore, marsh and water birds during this time span. The number of predacious birds will be higher during these months then at other times.

From April 1 to October 31, a ground and water count will be made twice per month to determine the occurrence and abundance of species. The variety and numbers of shore, marsh and water birds will be high. Predacious bird numbers will be lower during this period. Observations from the ground/water counts will be supplemented by observations made during routine refuge travel by vehicle and boat.

One observer capable of identifying all the species covered by this procedure is required. The count is made from a land vehicle with spotting scope and binoculars, and from an outboard motor boat. The count is made at no set time of day; however, a tide at half-stage or lower is preferred. Optimum weather conditions are clear and windless. The count is not made if there is precipitation, fog, or wind exceeding 20 mph.

The census route is shown on the map titled "Route of Shore, Marsh, and Water Bird Census" (Exhibit J). The observer traverses the route slowly, and stops as often as

necessary to identify and count species. The time needed to census birds on this route is five hours.

Observations are recorded using a portable tape recorder. Data for each survey is the transferred to the "Wildlife observation Field Data Sheet" (Exhibit B). At the end of each quarter data is summarized and placed on the "Wildlife Information Report" (Exhibit K).

III. Special Considerations

The normal occurrence of the species covered by this procedure is as follows:

Group	Number of Species	Peak Numbers
Shorebirds	25-30	20,000 - 30,000
Water & Marsh Birds	15-20	2,000 - 3,000
Gulls and Terns	7-10	3,000 - 5,000
Predacious Birds	15-20	150 - 300

Some species can be counted very accurately since they occur in small numbers and concentrate in particular locations, e.g. black-necked stilts in Raymond Pool. Other species are present in much higher numbers over larger, less readily observed areas, e.g. dunlins on salt marsh mudflats. Large mixed flocks of similar appearing species, e.g. semi-palmated, least and western sandpipers, present estimating problems. Some groups such as rails and owls are secretive and other species such as egrets and willets are quite conspicuous. Generally the inventory procedure should provide an accurate picture of the species present and the dates of occurrence, but much less reliable data on numbers.

IV. Manpower and Costs

Manpower - 12 surveys each involving approximately 6 hours of staff time (Grade GS 11-7) =
9.0 Staff Days @ $150.00 = $1,350.00

- Data tabulation and report preparation
1 Staff Day of data tabulation @ $150.00 = $150.00

Vehicle Costs - land vehicle $.20/mile x 224 miles = $44.80
boat 12 surveys (gas & oil) = $100.00

Total cost of 12 surveys and data compilation = $1,644.80

REFUGE: Bombay Hook **PROCEDURE NO:** BH-7
SPECIES: Woodcock
TITLE: Singing Ground Survey

I. Purpose

As part of its courtship behavior the male American woodcock (Scolopax minor) produces both aerial and vocal displays each evening during the breeding season. Surveys done throughout the United States and Canada during this period provide data that gives an index of the population size in North America. Surveys done on the refuge also provide information on the numbers and locations of breeding birds from year to year. This data is of great value in monitoring the effect of both natural succession and active habitat management on refuge lands.

II. Procedure

The survey is to be conducted within the time frame of April 15 thru May 5. The time of day that the survey is initiated is dependent on weather conditions. If the sky is clear or up to 3/4 overcast begin the survey at 22 minutes after sunset. If the sky is more than 3/4 overcast begin the survey at 15 minutes after sunset.

The survey is conducted by driving a vehicle along a predetermined route (See Exhibit L). At the starting point and time the observer will shut off the vehicle, step several feet away and listen for a period of two minutes, recording the number of different woodcock heard peenting. Then the observer gets into the vehicle and drives 0.4 mile, stops and repeats the same process. This is repeated until 10 stops have been recorded.

Results will be recorded on the North American Woodcock Singing Ground Survey form (3-156) (See Exhibit M).

On this form, in addition to pertinent weather conditions, levels of disturbance at each of the 10 stops will be recorded. The different levels of disturbance and their description are as follows.

Disturbance	Descriptions
No	No appreciable effect on count
Lo	Slightly affecting count
Mod	Moderately affecting count
Hi	Seriously affecting count

Survey weather conditions should be such that they do not present problems to an observer of normal hearing ability.

e.g. No heavy precipitation or strong wind. The temperature should also be above 40°F.

After the survey the results along with a map showing the location of birds recorded will be placed in station files. A copy of the survey may also be sent to: Woodcock Surveys, U.S. Fish and Wildlife Service, Laurel, MD 20708-9619 (if the route is added to the nationwide system of woodcock routes).

III. Special Considerations

This survey will be of particular importance in determining woodcock response to various habitat management strategies, such as the management of Lespedeza bicolor plantings which are thought to be of both diurnal and singing ground value.

IV. Manpower and Costs

Manpower - 1 survey per year, involving a maximum of 2.0 hours from one staff person (including data preparation).

0.25 Staff Days @ $150.00 = $37.50

REFUGE: Bombay Hook **PROCEDURE NO:** BH-8
SPECIES: Whitetail Deer
TITLE: Whitetail Deer Population Survey

I. Purpose

the interspersed woodlands, crop fields, grasslands, and marshes on the refuge provide food and cover for a substantial population of whitetail deer. Hunting is permitted within the framework of State regulations to maintain a healthy, productive herd, prevent habitat deterioration and provide recreational opportunity. In order to assist in evaluating hunt results and monitoring herd health it is necessary to estimate the number of deer present on the refuge.

II. Procedure

Three surveys will be conducted between February and early March, prior to the tilling of agricultural fields. Surveys will be initiated approximately two hours after sunset. Favorable conditions will be low wind and little or no precipitation. A minimum of two staff observers will be required.

A pick-up truck containing an operator and an observer (in back) equipped with a spot-light will traverse the refuge recording deer numbers as they are seen. In addition to total numbers, areas of high concentrations will be noted and recorded.

The survey will be initiated at the refuge headquarters and will proceed around the entire auto tour loop, to the Fischer tract, the Carrow property, boathouse road, back to headquarters. Exhibit N depicts the suggested areas to be driven. Animals observed just off the refuge will be considered as part of the refuge population and recorded as such. Subsequent to each survey the results will be placed in station files.

The allay refuge neighbor's concerns regarding our spotlighting activities; the following people will be contacted prior to each of our surveys:

Station Radio Room	736-4580
Harvey Carrow	653-7633
John & Joyce Hennessey	653-5746
George Gage	653-7912
Elizabeth Virdin	653-6407
Bruce Snow	653-7536
Edith Steller	653-6974

III. Special Considerations

Although the deer population at Bombay Hook is concentrated within the uplands and accompanying marsh fringe, deer do range over virtually the entire 15,122 acres. Their greatest concentrations is within the area around the headquarters where large numbers of animals will be grouped in fields at night during the survey time frame. We feel that this count, despite the obvious fact that not all deer will be visible, will yield a valid index of population levels.

IV. Manpower and Costs

Manpower - Three surveys each involving approximately 2.0 hours of time from 2 staff persons.
Staff time (one observer Grade GS 11-7; one observer Grade GS 5-1)
1.5 Staff Days @ $100.00/day = $150.00 (includes data tabulation)

Vehicle Cost - $.20/mile - 75 miles = $15.00

Total cost of 3 surveys = $165.00

REFUGE: Bombay Hook **PROCEDURE NO:** BH-9
SPECIES: Muskrat
TITLE: Muskrat House Count

I. Purpose

The extensive natural salt marshes and, to a lesser extent, the man-made fresh water impoundments provide an excellent habitat for muskrats. Proper management of the muskrat population can assist in the maintenance of vegetation at a successional stage and density beneficial to waterfowl. A knowledge of the size and distribution of the muskrat population is necessary for determining the need for commercial trapping, the allowable size of the harvest and the units to be trapped in any given year. A count of muskrat houses provides an index to the population and a basis for making these management decisions.

II. Procedure

An aerial count of muskrat houses is made once each year. One observer is required. The count is mad from a single engine light aircraft flying at minimum speed at an altitude of 800 to 1000 feet. Optimum weather conditions are clear and windless with a light snow cover. The count should be made at high tide for best visibility of the houses. The count is not made if there is precipitation, fog or winds exceeding 20 mph. The count is made during late December or January and takes approximately one hour.

The houses are counted by muskrat census units. These units are shown on the map titled "Muskrat Census Units" (Exhibit O). A complete count is made in a unit before the flight proceeds to the next unit. The size and shape of a unit determine the direction of the flight path, e.g. unit 19 is counted on a single flight around its perimeter; unit 15 is covered by east to west transects and unit 22 by north to south transects. The count generally proceeds back and forth across the tier of units from north to south.

A hand counter is used in making the census in each unit. At the completion of each unit count, the unit number and the house total are recorded on a portable tape recorder. At the completion of the aerial census the data are transferred to a "Muskrat House Count Sheet" (Exhibit R). The sheet, properly completed, is retained in the files as a permanent record. Data from this survey is utilized in developing a population estimate of the muskrat and ise recorded on the "Wildlife Information Report" (Exhibit K).

III. Special Considerations

The muskrat population in the northern portion of the refuge salt marshes is largely restricted to the use of grass houses, thereby simplifying estimates of the population size in that area. Simply count the houses and multiply by 5, the estimated number of rats per house. The muskrat population on Kent and Kelly Islands is almost exclusively confined to bank dens. This census technique does not take into account the bank rat population. Therefore, the number of house rats is multiplied by 1.33 to account for an estimated 1/3 of the population that is not counted because it lives in the banks.

IV. Manpower and Costs

Manpower - 1 survey involving 2 hours of Staff time (Grade GS 11-7) =
0.25 Staff Days @ $150.00 = $37.50

- Data compilation 0.25 Staff Days @ $150.00 = $37.50

Plane and Pilot Rental - 1 hour @ $100.00 = $100.00

Total cost of 1 survey and data compilation = $ 175.00

REFUGE: Bombay Hook **PROCEDURE NO:** BH-10
SPECIES: Waterfowl
TITLE: Nest Drag Survey

I. Purpose

The refuge is composed primarily of tidal salt marsh, freshwater impoundments, upland fields and small woodlots. The first three of these habitat types contain suitable nesting areas for ground nesting waterfowl. Until 1987, only the refuge impoundments were regularly surveyed for nesting ducks and broods. The salt marsh contains a large expense of nesting habitat, but it cannot be surveyed accurately using survey techniques described in BH-5. Upland fields near water can also provide habitat for ground nesting waterfowl. Nest dragging is an accepted technique for documenting nesting success by waterfowl in these habitat types.

II. Procedure

The survey procedure will be composed of two sections: upland field nest drags and salt marsh nest drags.

A. Upland Field Nest Drags

About one-third of the total field habitat on the refuge is maintained in grassland (Sericea lespedeza, clover, orchardgrass, etc.) or in wildlife food or cover crops (winter wheat, ryegrass, millet, etc.). All upland fields which provide suitable nesting cover for waterfowl will be searched for nests.

Two vehicles are used to pull a cable-chain drag (90 ft. long) between them. Three staff persons, two drivers and one observer, conduct each survey. The technique is described in detail in Construction and Operation of Cable-chain Drag for Nest Searches, Kenneth F. Higgins et.al, FWS Leaflet 512, 1977. Once a nest is located, it is marked with a wire flag (or other marker) 25' north of the nest. Proper alignment is achieved by the use of a compass and 25' length of light rope. Nests are rechecked about 3 to 4 weeks from the original discovery date. Date recorded includes species, date, vegetative type, number of eggs hatched/unhatched, subsequent success of nest and whether predation occurs. A nest number is assigned. This data is placed on a nest drag data sheet (Exhibit R). The nest location is also marked on a nest drag map (Exhibit S).

Surveys will be conducted twice annually, in April and

in June. Since all suitable fields will be surveyed, the actual number of nest located will be used when estimating waterfowl production from upland field locations.

B. Salt Marsh Nest Drags

Of the total tidal marsh on the refuge (12,250 acres), about 7,354 acres contain suitable waterfowl nesting habitat. Excluded from this figure are expanses of tall form (regularly flooded) Spartina alterniflora marsh and mud flats created by snow goose "eat outs". The nesting habitat is generally either Spartina patens and Distichlis spicata marsh or similar marsh mixed with short form Spartina alterniflora. Permanent transects have been established in the suitable nesting habitat (Exhibit T). A 1/2" diameter rope (60' length) is hand dragged across the marsh. Besides the two draggers, one observer follows to mark nest locations and a second observer relieves the draggers by pulling the rope over hang-ups on bushes, marsh clumps etc. The drag is made in two adjacent parallel swaths; the first going up the right side of the transect and the second returning on the left side to the point of origin. Total marsh width covered is about 150 feet.

Once a nest is located, similar data to that described in the upland field drag is collected. In addition, distance to a permanent pond or tidal creek is estimated. The nest is marked in the same manner as for upland field drags.

The survey is accomplished once per year beginning in mid-May. Nests are revisited three-four weeks later to attempt to document nest success (or failure). The formulas used to estimate duck production on the tidal marsh are as follows:

Step 1 Find total acres surveyed.

Multiply the width of the transect by the distance surveyed and divide by the number of square feet in one acre to determine the acres surveyed (H).

$$\text{acres surveyed (H)} = \frac{\text{width of transect} \times \text{distance surveyed}}{43{,}560}$$

Example: There were 10 miles of surveys conducted.

$$= \frac{150' \times 52{,}800'}{43{,}560}$$

$$= 182$$

Step 2 Find nests per acre surveyed (Nx) by species

Divide the number of nest, by species (Xx) found during survey by the number of acres surveyed to find nests per acre surveyed.

$$\text{Nests per acre surveyed (N)} = \frac{Xx}{H}$$

Example: Black Duck
There are 9 black duck nests found during the survey.

$$N_{black} = \frac{X_{black}}{H}$$

$$= \frac{9}{182}$$

$$= .049$$

Step 3 Find total nests present on salt marsh.

Multiply the number of nest per acre surveyed by the total suitable habitat(s) to find the total nests, by species present on the salt marsh (E).

Suitable habitat(s) = 7,354 acres
Total Nests (E) = Nx x S

Example: = N black x S

= .049 x 7,354

= 360

Steps 4 and 5 are used to determine the approximate number of young produced to flight stage.

Step 4 Find total number of successful nest per species (Tx).

Multiply total nests present (E) by the percent of nests found to be successful (P) to determine the number of successful nests (T).

$$T = E \times P$$

Example: T black = 360 x 50%

= 360 x .50

= 180

Step 5 Estimate the number of young fledged.

To estimate the number of young fledged you need three variables to be identified. First, an average clutch is determined by revisiting nests to determine the numbers of eggs hatched. Second, if possible, observations of broods are collected from the salt marsh. Assuming that all class III broods seen will fledge successfully, class III sightings are averaged. Third you need the number of successful nests.

Multiply the number of successful nests (Tx) by the average class III brood seen (Bx) to determine the successfully fledged birds (Fx). In the absence of Bx, a figure of 50% of the average number of eggs hatched (Qx) will be used.

$$Fx = Tx \times Bx \quad \text{or} \quad Fx = Tx \times \frac{Qx}{2}$$

Example 1: The average black duck brood (class III) sighting was 5.

F black = 180 x 5
= 900

Example 2: No observations were made of class III black duck broods. The average number of eggs hatched was 7.5.

F black = $180 \times \frac{7.5}{2}$

= 180 x 3.75

= 675

III. Special Consideration

Experimentation with this technique during the field seasons of 1987 and 1988 has led to some helpful hints and cautions in conducting this survey.

It is possible to use a minimum of three people in conducting the survey, although four is recommended. In this way everyone can switch from dragging to observing, equally sharing the rather strenuous task of dragging the rope. In this connection anyone with heart problems, asthma, or any other condition which would be aggravated by hard work, should not participate in the drag.

Areas of marsh to be surveyed involve crossing tidal ditches at various tidal ranges. Proper attire should be clothes which can risk being stained and soiled. Plan on becoming wet and muddy. Sneakers are preferred to waders or hip boots, since the latter are heavy and cumbersome; while sneakers are light and drain easily. Old sneakers of non-leather material are preferred.

IV. Manpower and Costs

Upland Field Nest Drag

Manpower - 3 persons x 1 day per survey x 2 surveys = 48 hours.
6 Staff Days @ $100.00 = $600.00

Fuel - 35 gallon per survey x 2 surveys = 70 gallon
70 gallon x $.70/gal. = $50.00

Subtotal - $650.00

Salt marsh Nest Drag

Manpower - 4 persons x 5 days = 20 staff days
20 Staff Days x $100.00 = $2,000.00

Fuel - 30 gallon x $1.00/gallon = $30.00

Subtotal - 2,030.00

Data Tabulation (both sections) 1 Staff Day @ $150.00 = $150.00

Total cost of Nest Drag Survey = $2,830.00

APPENDIX

EXHIBIT

A. Route of Aerial Waterfowl Census
B. Wildlife Observation Field Data Sheet
C. Monthly Waterfowl Populations - Output Form
D. Route of Ground Waterfowl Census
E. Wood Duck Roost Count Map
F. Route of Aerial Breeding Pair Count
G. Breeding Pair Count Field Data Sheet
H. Breeding Pair Count Summary Sheet
I. Brood Census Survey Data Sheet
J. Route of Shore, Marsh, and Water Census
K. Wildlife Information Report
L. Woodcock Survey Route Map
M. Woodcock Survey Form (3-156)
N. Deer Survey Route
O. Muskrat Census Units
P. Muskrat House Count
Q. Annual Waterfowl Production Output Report Form
R. Nest Drag Data Sheet
S. Nest Drag Field Maps
T. Nest Drag Salt Marsh Transects

APPENDIX EXHIBIT A

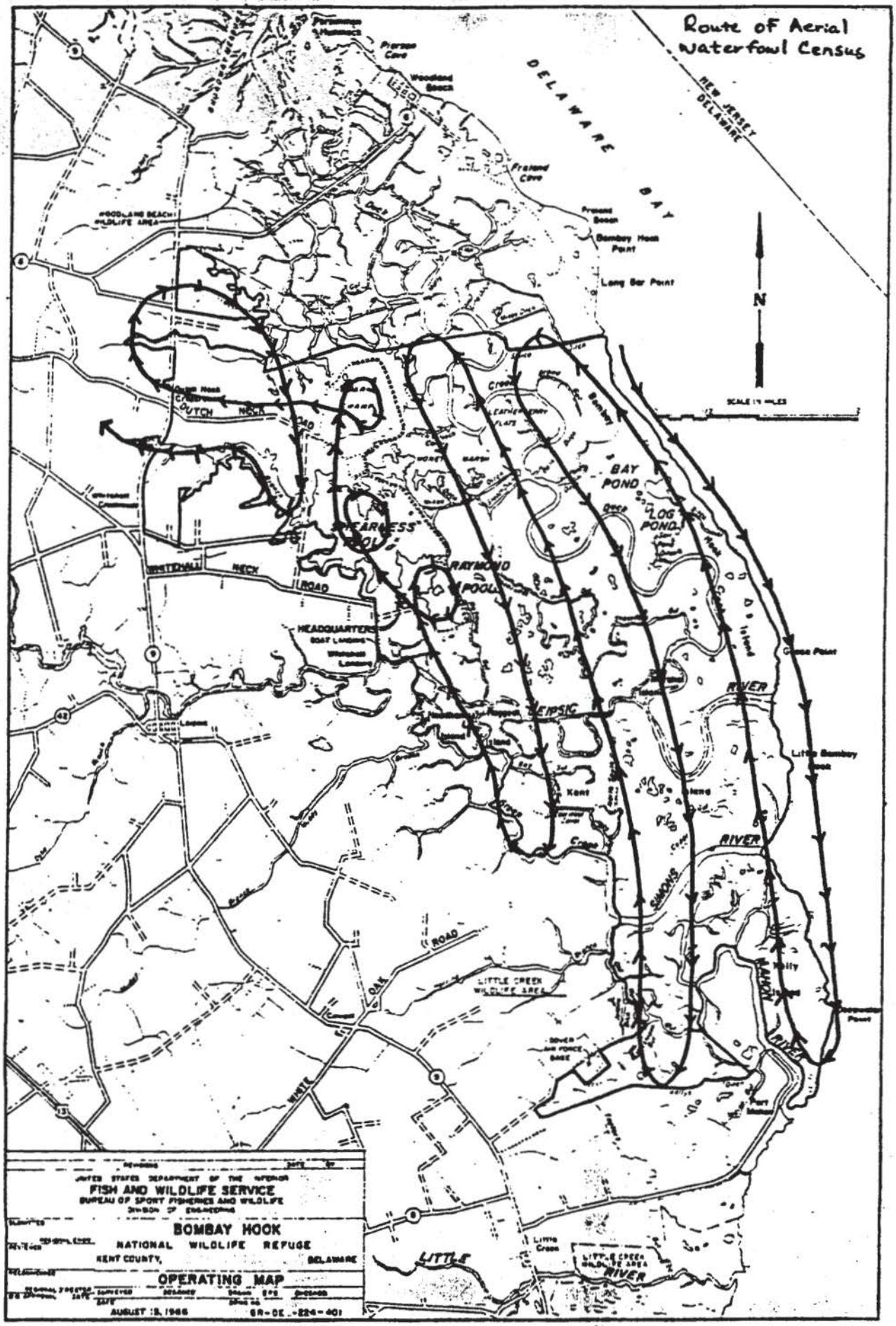


EXHIBIT B. Wildlife Observation Data Form

DATE:_____ WEATHER: clr. pcdy. cldy. 20 30 40 50 60 70 80

TIME:_____ POOL ELEVATIONS: R._____ S._____ BS._____ F._____

INIT:_____ TIDE: R F H L

SURVEY TYPE:

TOT.	SPECIES	RAYMOND POOL	RAYMOND TIDAL	SHEARNESS POOL	SHEARNESS TIDAL	BEAR SWAMP POOL	BEAR SWAMP TIDAL	FINIS POOL	FINIS TIDAL	UPLAND	
	G.B.H.										
	G.eg.										
	S.eg.										
	C.eg.										
	G-BH.										
	BCNH										
	T.Sw.										
	S.G.										
	C.G.										
	Wood										
	GWT										
	Blk										
	Mld										
	Pin										
	BWT										
	Shov										
	Gad										
	Wig										
	Buff										
	Hood										
	Comm										
	Scaup										
	Ruddy										
	T. Vult										
	Bald										
	N. Herr										
	Red S.										
	Red T.										
	Kest.										
	Per.										
	Ring.										
	Bob.										
	BBP										
	SPP										
	B-NST										
	Avoc.										
	Y-legs										
	Willet										
	RT										
	Knot										
	SPSP										
	LSP										
	Dunlin										
	Dow										
	Laugh										
	Ring B.										
	Herr.										
	C. Tern										
	F. Tern										
	Mour.										

APPENDIX EXHIBIT C
Fish and Wildlife Service
Division of Wildlife Refuges

TX Code				Organization Number							Name			Report Period Yr	-Mo	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	0	4	0						0	0						

MONTHLY WATERFOWL POPULATIONS

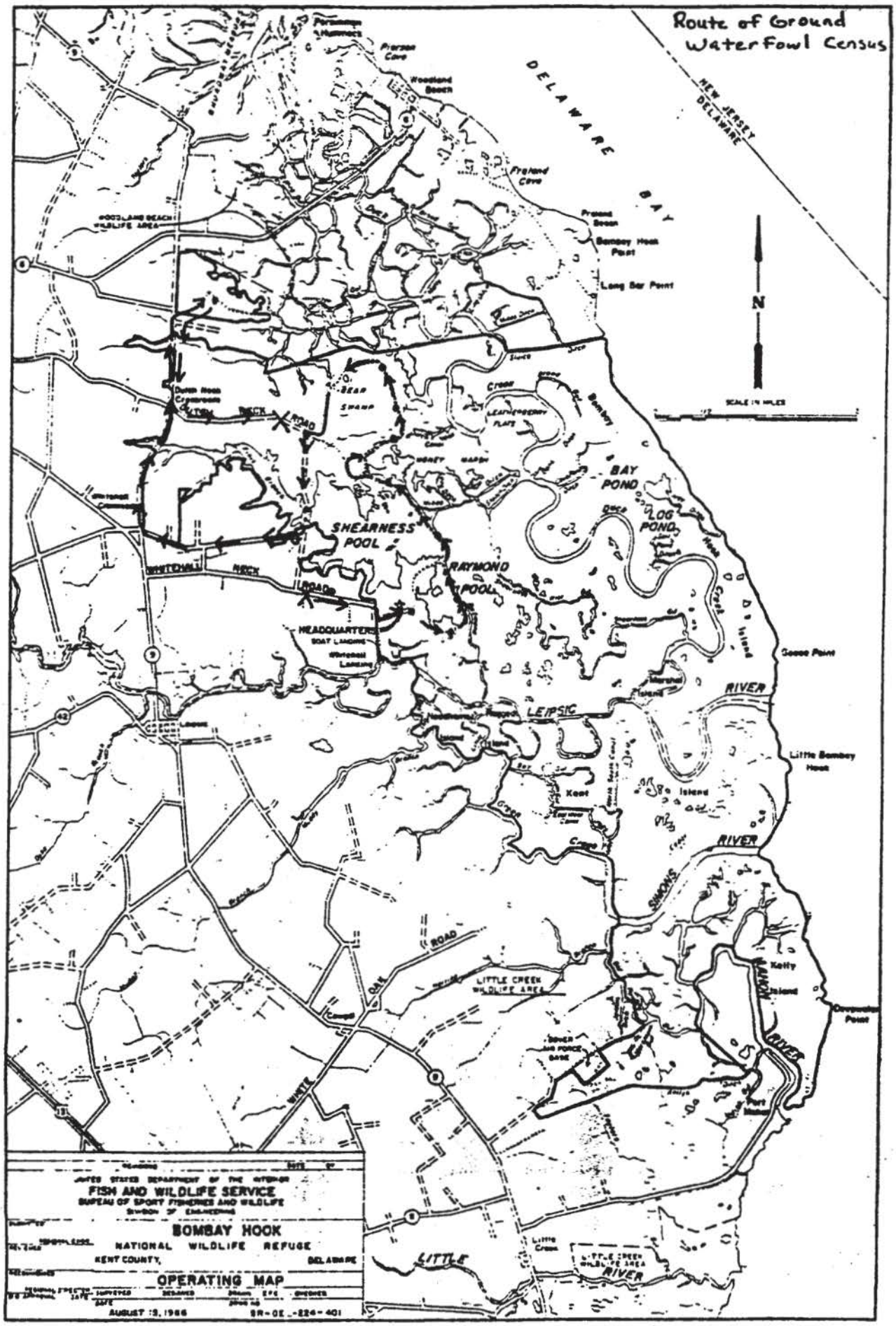
SPECIES NAME	LINE CODE									NO. HARVESTED	AVERAGE POPULATION	UNIT RBU	PEAK POPULATION NUMBER	DAY	
	18	19	20	21	22	23	24	25	26	27-35	36-45	46-55	56-65	66	67
AMERICAN COOT	7	2	1	2	2	1	0	W	P						
SWANS:	7	1	1					W	S						
GEESE: White-Fronted	7	1	2	1	7	1	0	W	G						
Snow-blue	7	1	2	1	6	9	0	W	G						
Canada	7	1	2	1	7	2		W	G						
DUCKS: Mallard	7	1	3	1	3	2	0	W	D						
Black	7	1	3	1	3	3	0	W	D						
Gadwall	7	1	3	1	3	5	0	W	D						
Pintail	7	1	3	1	4	3	0	W	D						
Green-winged Teal	7	1	3	1	3	9	0	W	D						
BW/Cinn Teal	7	1	3	1	4	0	0	W	D						
Am. Widgeon	7	1	3	1	3	7	0	W	D						
Shoveler	7	1	3	1	4	2	0	W	D						
Wood Duck	7	1	3	1	4	4	0	W	D						
Redhead	7	1	3	1	4	6	0	W	D						
Ring-necked Duck	7	1	3	1	5	0	0	W	D						
Canvasback	7	1	3	1	4	7	0	W	D						
Lesser Scaup	7	1	3	1	4	9	0	W	D						
Bufflehead	7	1	3	1	5	3	0	W	D						
Ruddy	7	1	3	1	6	7	0	W	D						
CONTROL TOTALS	9	9	5	0	0	0	0	W	≡						

Region _____ Station _____ Date Prepared _____

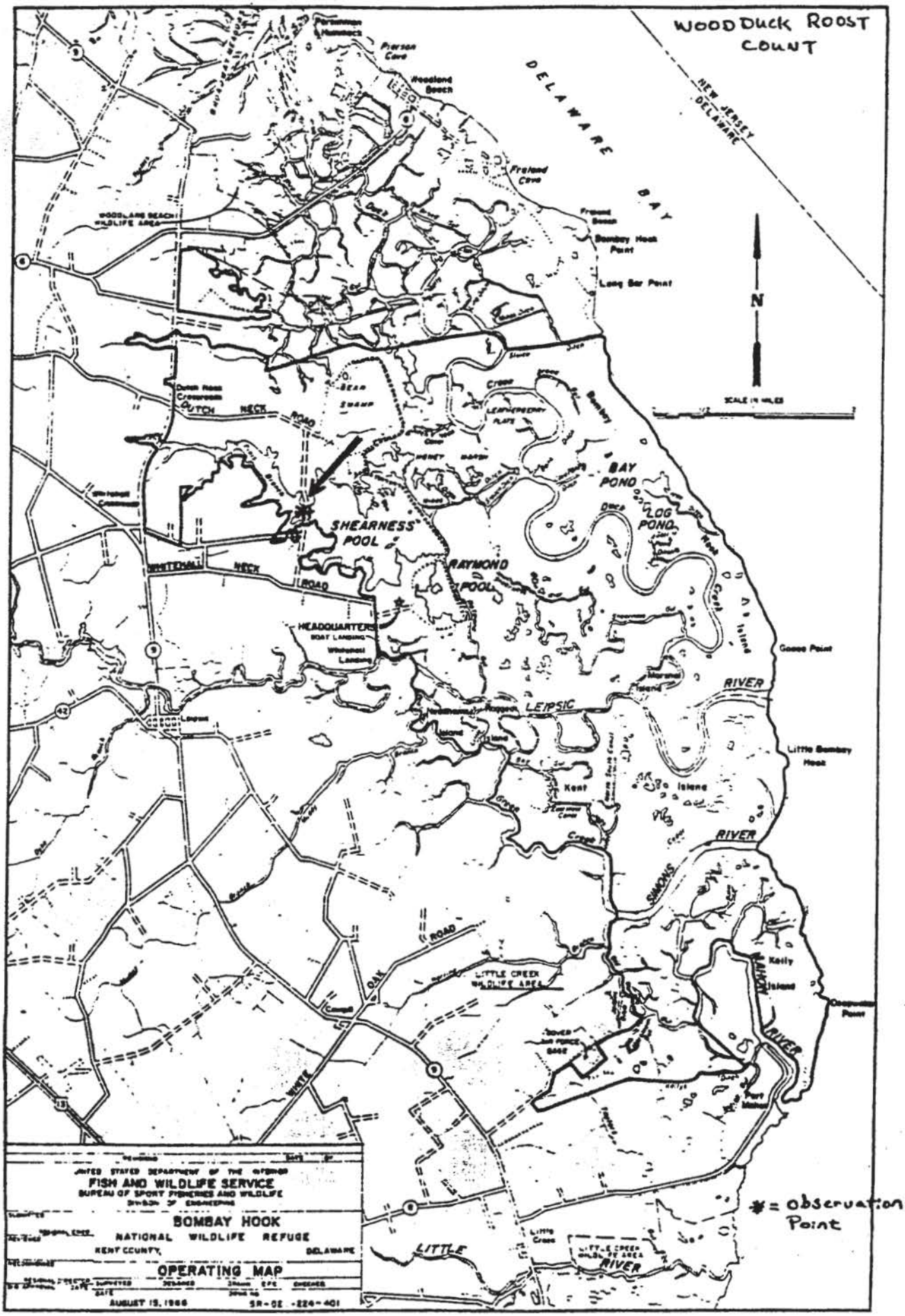
Name

Form 3-243

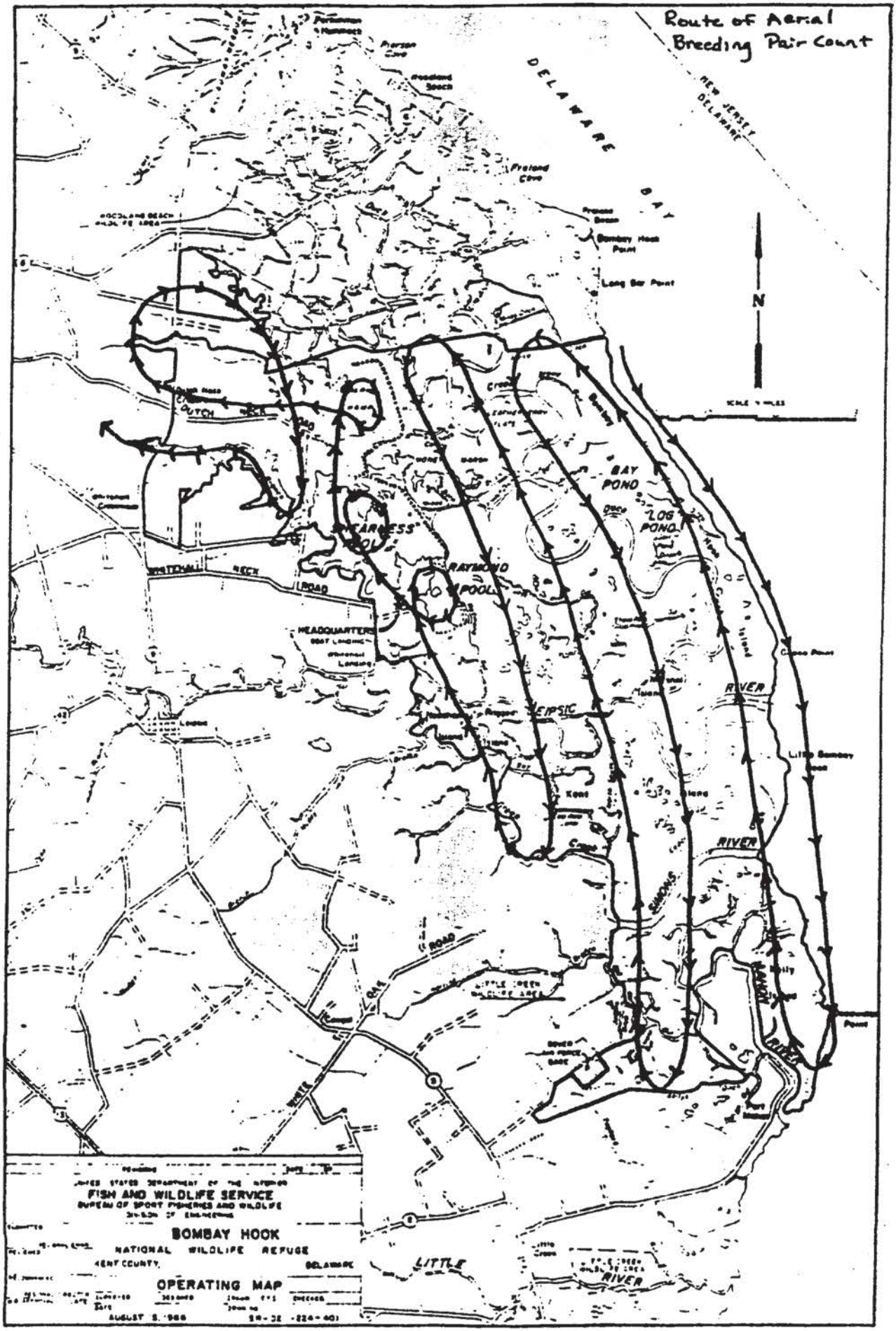
APPENDIX
EXHIBIT D



APPENDIX
EXHIBIT



APPENDIX EXHIBIT F



Breeding Pair Count Field Data Sheet

Unit _____

Date _____

Time _____

Weather _____

	Pair	Male	Female
Mallard			
Black Duck			
Gadwall			
Blue-Winged Teal			
Wood Duck			

Appendix Exhibit G

YEAR _____

DATE, COUNT 1 _____

DATE, COUNT 2 _____

BREEDING PAIR SUMMARY SHEET

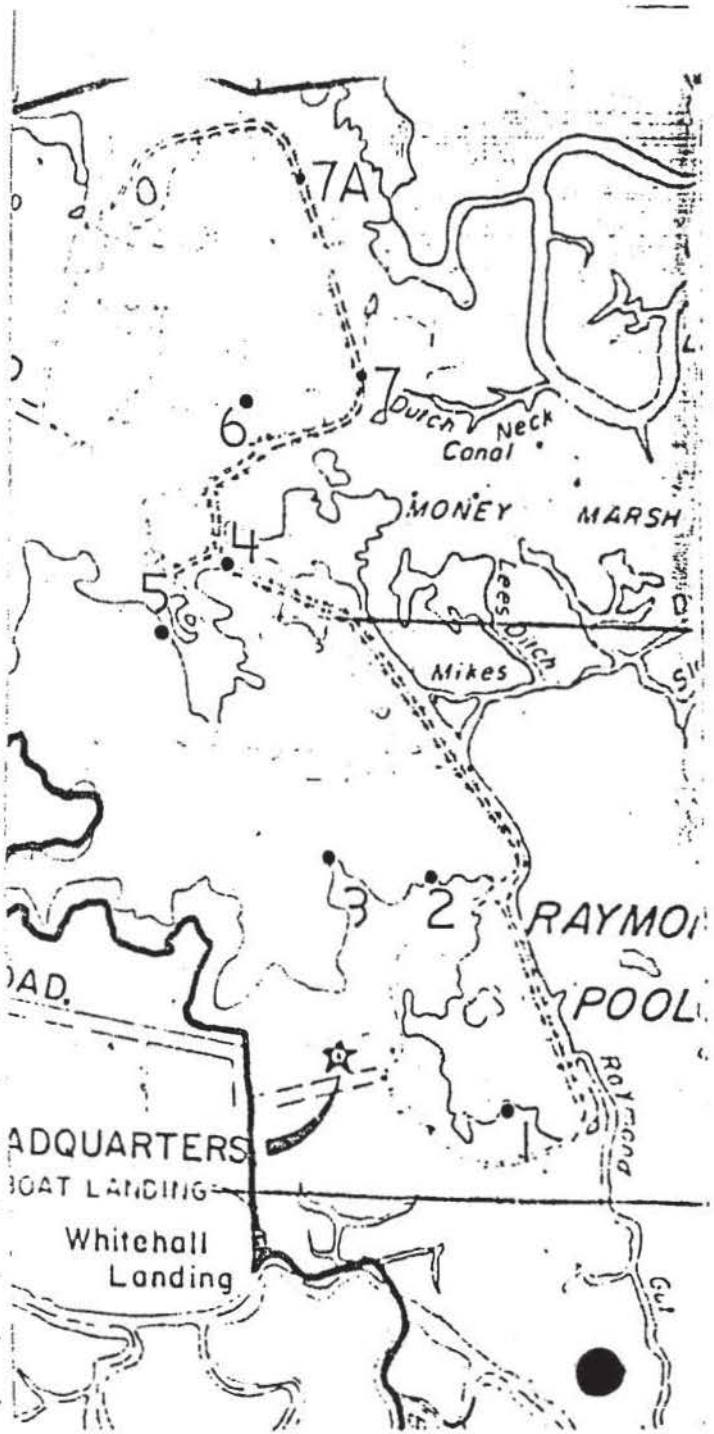
	RAYMOND			SHEARNESS			BEAR SWAMP			FINIS			SALT MARSH			TOTAL		
	1	2	AVE.	1	2	AVE.	1	2	AVE.	1	2	AVE	1	2	AVE.	1	2	AVE.
MALLARD																		
BLACK DUCK																		
GADWALL																		
BLUE-WINGED TEAL																		
WOOD DUCK																		
TOTAL PAIRS																		

APENDIX EXHIBIT H Breeding Pair Summary Sheet

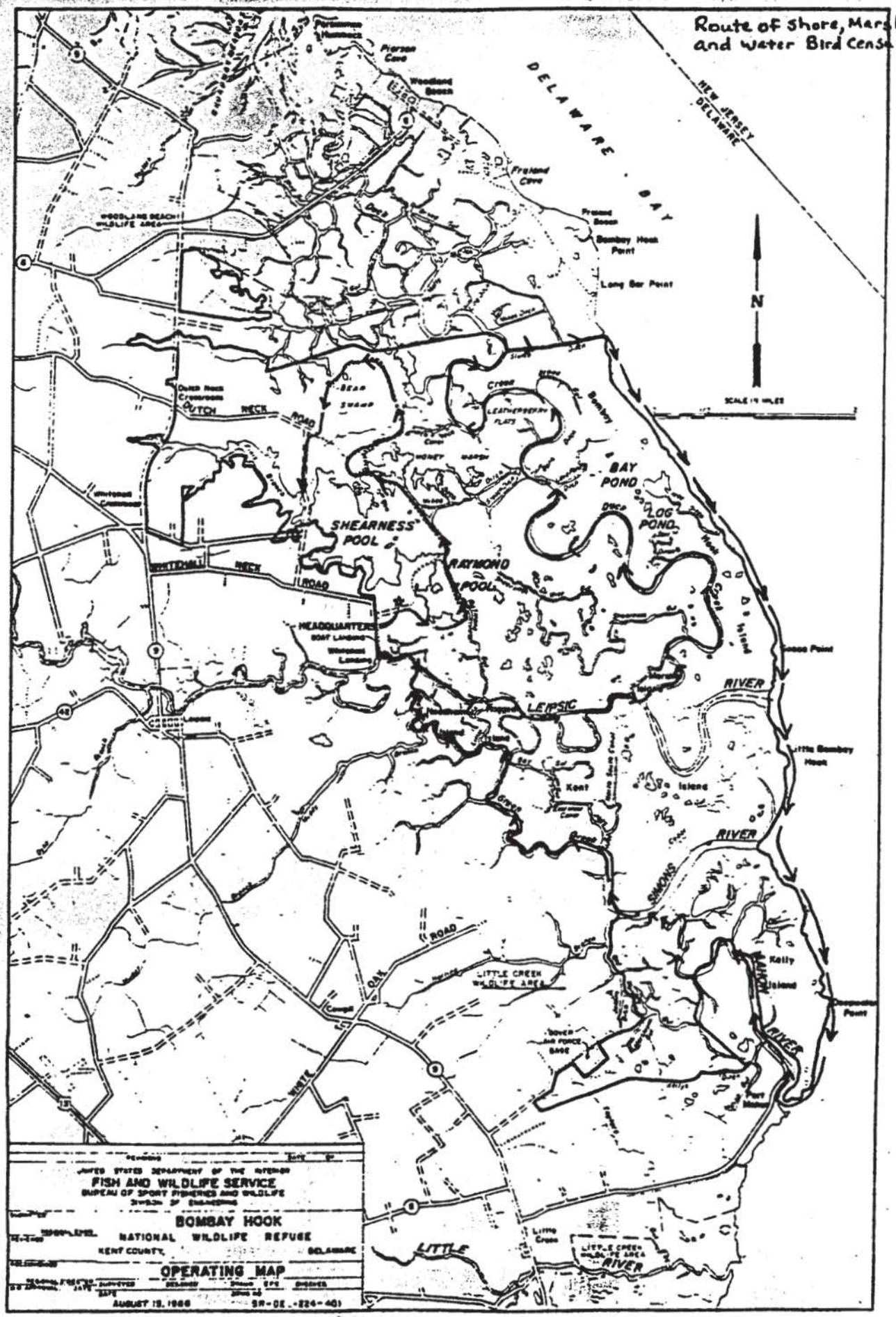
APPENDIX EXHIBIT I ck Brood Survey Data Sheet

DATE	STAND#	BROOD #	SPECIES	# YOUNG	CLASS	

LOCATION



APPENDIX
EXHIBIT J



1 0 0 5 1 5 5 0 0 0 B M H

WILDLIFE INFORMATION REPORT

SPECIES NAME	LINE CODE 18	19	20	21	22	23	24	25	26	NO. HARVESTED 27-35	USE DAYS 36-45	BREEDING POPULATION 46-55	PEAK POPULATION Number 56-65	Mo. 66	DQ 67	68	69	NO. PRODUCED 70-79
Pied billed Grebe	7	2	1	0	0	6	0	W	W									
Double-crested Cormorant	7	2	1	1	2	0	0	W	W									
Great Blue Heron	7	2	1	1	9	4	0	W	W									
Tricolored Heron	7	2	1	1	9	9	0	W	W									
Green-backed Heron	7	2	1	2	0	1	0	W	W									
Little Blue Heron	7	2	1	2	0	0	0	W	W									
Cattle Egret	7	2	1	3	0	0	1	W	W									
Great Egret	7	2	1	1	9	6	0	W	W									
Snowy Egret	7	2	1	1	9	7	0	W	W									
Black-crowned Night Heron	7	2	1	2	0	2	0	W	W									
American Bittern	7	2	1	1	9	0	0	W	W									
Glossy Ibis	7	2	1	1	8	6	0	W	W									
Least Bittern	7	2	1	1	9	1	0	W	W									
Clapper Rail	7	2	1	2	1	0	0	W	W									
Virginia Rail	7	2	1	2	1	2	0	W	W									
King Rail	7	2	1	2	0	8	0	W	W									
Sora	7	2	1	2	1	4	0	W	W									
Common Moorhen	7	2	1	2	1	9	0	W	W									
CONTROL TOTALS	9	9	7	0	0	0	0	1	8									

Region 5 Station Bombay Hook NWR Date Prepared Page 1 of

APPENDIX EXHIBIT K

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
L	0	0	5	1	5	5	0	0	0	B	M	H				

SPECIES NAME	LINE CODE 18	19	20	21	22	23	24	25	26	NO. HARVESTED 27-36	USE DAYS 36-45	BREEDING POPULATION 46-55	PEAK POPULATION Number 56-65	PEAK POPULATION No. DQ 66	67	68	69	NO. PRODUCED 70-79
Ring-billed Gull	7	2	2	0	5	4	0	W	S									
Laughing Gull	7	2	2	0	5	8	0	W	S									
Herring Gull	7	2	2	0	5	1	0	W	S									
Great Black-backed Gull	7	2	2	0	4	7	0	W	S									
Common Tern	7	2	2	0	6	3	0	W	S									
Killdeer	7	2	2	2	7	3	0	W	S									
Woodcock	7	2	2	2	2	8	0	W	S									
Common Snipe	7	2	2	2	3	0	0	W	S									
Greater Yellowlegs	7	2	2	2	5	4	0	W	S									
Lesser Yellowlegs	7	2	2	2	5	5	0	W	S									
Dunlin	7	2	2	2	4	3	0	W	S									
Short-billed Dowitcher	7	2	2	2	3	2	0	W	S									
American Avocet	7	2	2	2	2	5	0	W	S									
Black-Necked Stilt	7	2	2	2	2	6	0	W	S									
Pectoral Sandpiper	7	2	2	2	3	9	0	W	S									
Semi-palmated Sandpiper	7	2	2	2	4	6	0	W	S									
Western Sandpiper	7	2	2	2	4	7	0	W	S									
Least Sandpiper	7	2	2	2	4	2	0	W	S									

1 0 0 5 1 5 5 0 0 0 B M H

SPECIES NAME	LINE CODE 18	19	20	21	22	23	24	25	26	NO. HARVESTED 27-36	USE DAYS 38-45	BREEDING POPULATION 46-55	PEAK POPULATION Number 56-65	PEAK POPULATION No. 66 67	PEAK POPULATION DQ 68 69	NO. PRODUCED 70-79
American Bald Eagle	7	0	1	3	5	2	1	W	T							
Peregrine Falcon	7	0	1	3	5	6	1	W	T							
Osprey	7	0	4	3	6	4	0	W	U							
Mourning Dove	7	2	4	3	1	6	0	W	Ø							
Bobwhite	0	7	1	2	8	9	0	W	R							
Ring-necked Pheasant	0	7	1	3	0	9	1	W	R							
Common Crow	0	7	1	4	8	8	0	W	R							
Fish Crow	0	7	1	4	9	0	0	W	R							
PROGRAM TOTALS	9	9	7	0	0	0	0	F	R							

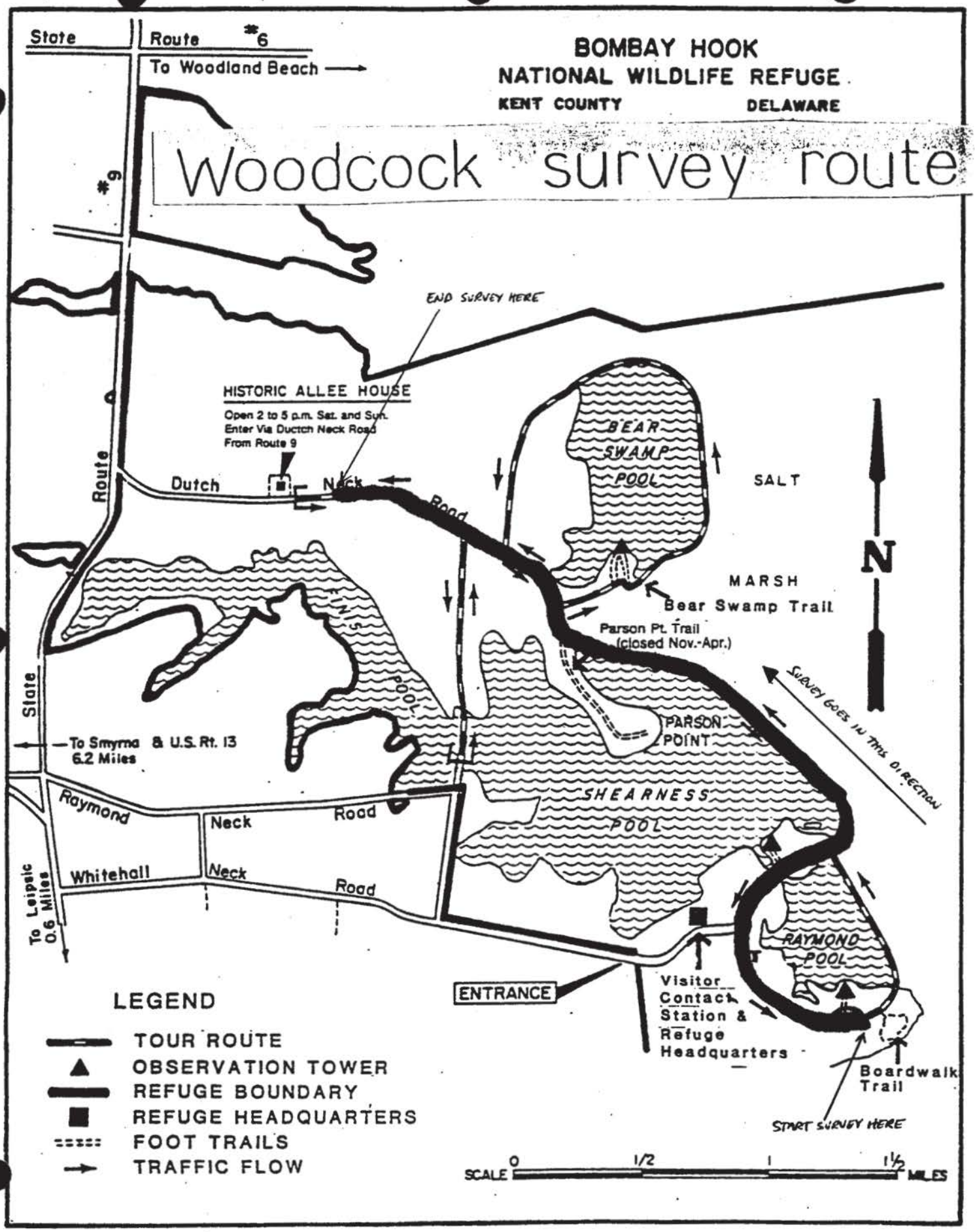
Region 5 Station Bombay Hook NWR Date Prepared Page 4 of

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	1	0	0	5	1	5	5	0	0	0	B	M	H			

SPECIES NAME	LAND CODE 18	19	20	21	22	23	24	25	26	NO. HARVESTED 27-33	USE DAYS 34-36	BREEDING POPULATION 45-55	PEAK POPULATION Number 56-66	Mo. 66	67	DQ 68	69	NO. PRODUCED 70-79
Virginia Opossum	0	7	2	8	0	1	0	W	B									
Eastern Cottontail	0	7	2	8	0	4	0	W	B									
Gray Squirrel	0	7	2	8	1	7	0	W	B									
Muskrat	0	7	2	8	2	3	5	W	B									
Red Fox	0	7	2	8	2	9	0	W	B									
Raccoon	0	7	2	8	3	5	5	W	B									
Striped Skunk	0	7	2	8	4	3	0	W	B									
River Otter	0	7	2	8	4	4	5	W	B									
White-tailed deer	0	7	2	8	5	4	0	W	B									
Wood chuck	0	7	2	8	1	1	0	W	B									
CONTROL TOTALS	9	9	1	0	0	0	0	1	8									

Region 5 Station Bombay Hook NWR Date Prepared Page 5 of

EXHIBIT L: WOODCOCK SURVEY ROUTE.



Appendix Exhibit M: Woodcock Survey Form

NORTH AMERICAN WOODCOCK SINGING GROUND SURVEY

U.S. FISH AND WILDLIFE SERVICE,
OFFICE OF MIGRATORY BIRD MANAGEMENT, LAUREL, MARYLAND USA 20708-9019

CANADIAN WILDLIFE SERVICE, DEPARTMENT OF THE ENVIRONMENT
OTTAWA, ONTARIO, CANADA K1A OH3

SURVEY YEAR

STATE OR PROVINCE

COUNTY

ROUTE NUMBER

DATE OF SURVEY — YEAR / MONTH / DAY

OBSERVER'S NAME (PRINT)

AGENCY 1 ☐ STATE 3 ☐ PROV. 5 ☐ FED., 7 ☐ OTHER

WAS THIS ROUTE RUN BY YOU LAST YEAR? 1 ☐ YES 3 ☐ NO

MAILING ADDRESS STREET _____ CITY _____ STATE/PROVINCE _____ ZIP CODE _____

OFFICIAL SUNSET : PM

ROUTE NAME

SKY CONDITION (ADD 22 MIN. TO SUNSET FOR STARTING TIME)
0 ☐ CLEAR
1 ☐ 1/4 OVERCAST
3 ☐ 1/2 OVERCAST
5 ☐ 3/4 OVERCAST
7 ☐ >3/4 OVERCAST - ADD 15 MIN

TEMPERATURE

°F		°C
35-39	31 ☐	2-4
40-49	41 ☐	5-9
50-59	51 ☐	10-15
60+	60 ☐	16+

WIND
1 ☐ CALM
2 ☐ GENTLE (1-3 mph)
3 ☐ LIGHT (4-7 mph)
4 ☐ MODERATE (8-12 mph)
5 ☐ STRONG (>12 mph)

PRECIPITATION
0 ☐ NONE
1 ☐ MIST
3 ☐ SNOW, HEAVY RAIN
5 ☐ FOG
7 ☐ LIGHT RAIN

	STOP NUMBER	ODOMETER READING 1 ☐ MILES OR 3 ☐ KM	TIME	NUMBER HEARD PEENTING	DISTURBANCE (SEE BACK) NO[0]	LOW[1]	MOD[3]	HI[5]	REMARKS
	1		:						
	2		:						
	3		:						
	4		:						
	5		:						
	6		:						
	7		:						
	8		:						
	9		:						
	10		:						
	TOTAL WOODCOCK HEARD PEENTING								

DO NOT WRITE IN THIS LINE

TOTAL STOPS	ACCEPTABLE STOPS	TOTAL WOODCOCK ON ACC. STOPS	ROUTE STATUS	

SUNSET TIMES FOR THIS ROUTE:

DATE
DAYLIGHT SAVINGS TIME
STANDARD TIME

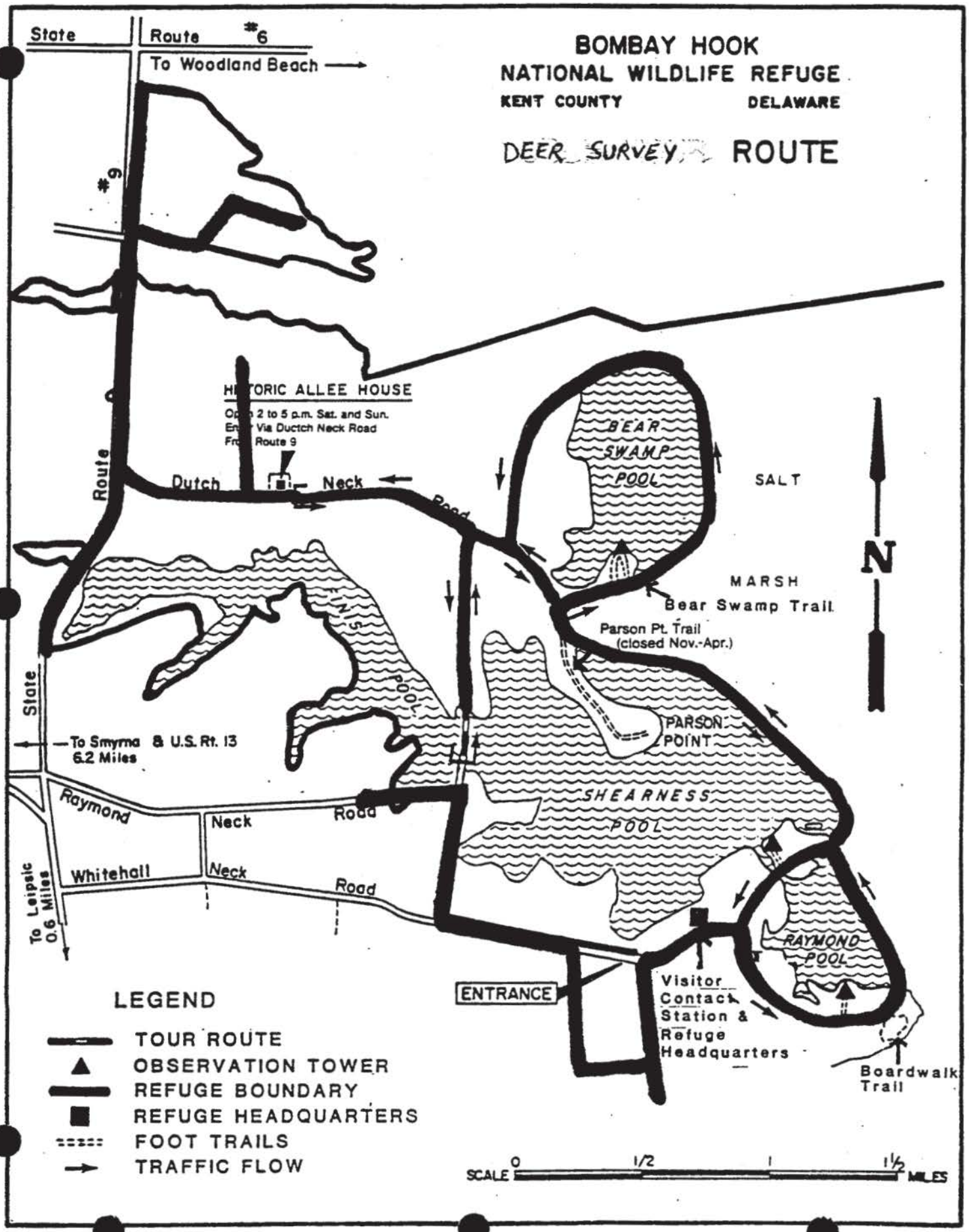
STATE/PROVINCIAL COORDINATOR:

PLEASE READ INSTRUCTIONS ON REVERSE SIDE CAREFULLY AND COMPLETELY.
Main Points to consider are listed below.
(1) Conduct survey within dates shown on map (see reverse).
(2) Make sure to conduct survey at proper time for sky condition.
(3) Stops should be at 0.4 mi (0.6 km) intervals, listen for exactly 2 minutes at each stop.
(4) Do not conduct survey if temperature is below 40°F (5°C), in strong wind, or in heavy precipitation.
(5) Contact your state coordinator promptly if u[illegible] to run your route within the designated dates.
(6) Fill out all sections of this form and immediately mail form.

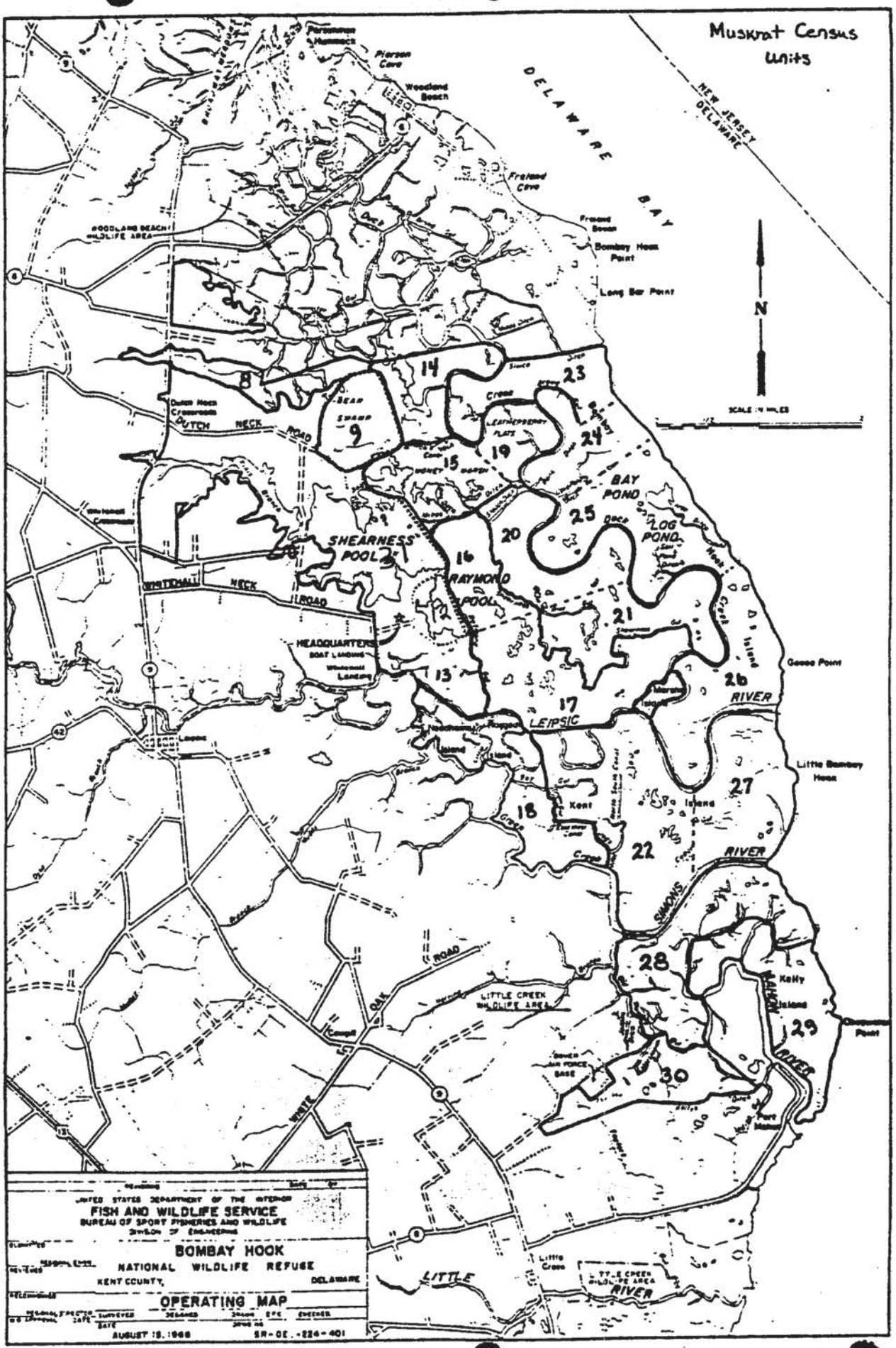
FORM 3-156
(REV. AUG. 1987)

OMB NO. 1018-0019
APPROVAL EXP. AUG 1989

EXHIBIT N: BOMBAY HOOK NWR DEER SURVEY ROUTE



APPENDIX Q
EXHIBIT



Appendix Exhibit R

MUSKRAT HOUSE COUNT

Refuge _____ Weather _____

Date _____ Time _____

Unit	No. of Houses
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
TOTAL	

APPENDIX EXHIBIT Q

Fish and Wildlife Service
Division of Wildlife Refuge

TR Code			Organization Number							Name			Report Period		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	FY 15	16	17
3	0	5	0						0	0						

ANNUAL WATERFOWL PRODUCTION

SPECIES NAME	LINE CODE									BREEDING POP.	ESTIMATED PRODUCTION	UNIT RBU
	18	19	20	21	22	23	24	25	26	27-35	36-45	46-55
AMERICAN COOT	0	8	0	2	2	1	0	L	C			
SWANS: Trumpeter	8	0	1	1	8	1	0	L	S			
GEESE: Canada	8	0	2	1	7	2		L	G			
DUCKS: Mallard	8	0	3	1	3	2	0	L	D			
Black	8	0	3	1	3	3	0	L	D			
Gadwall	8	0	3	1	3	5	0	L	D			
Pintail	8	0	3	1	4	3	0	L	D			
Green-winged Teal	8	0	3	1	3	9	0	L	D			
BW/Cinn. Teal	8	0	3	1	4	0	0	L	D			
Am. Widgeon	8	0	3	1	3	7	0	L	D			
Shoveler	8	0	3	1	4	2	0	L	D			
Wood Duck	8	0	3	1	4	4	0	L	D			
Redhead	8	0	3	1	4	6	0	L	D			
Ring-necked Duck	8	0	3	1	5	0	0	L	D			
Canvasback	8	0	3	1	4	7	0	L	D			
Lesser Scaup	8	0	3	1	4	9	0	L	D			
Common Goldeneye	8	0	3	1	5	1	0	L	D			
Barrows Goldeneye	8	0	3	1	5	2	0	L	D			
Bufflehead	8	0	3	1	5	3	0	L	D			
Ruddy	8	0	3	1	6	7	0	L	D			
CONTROL TOTALS	9	9	6	0	0	0	0	L	X			

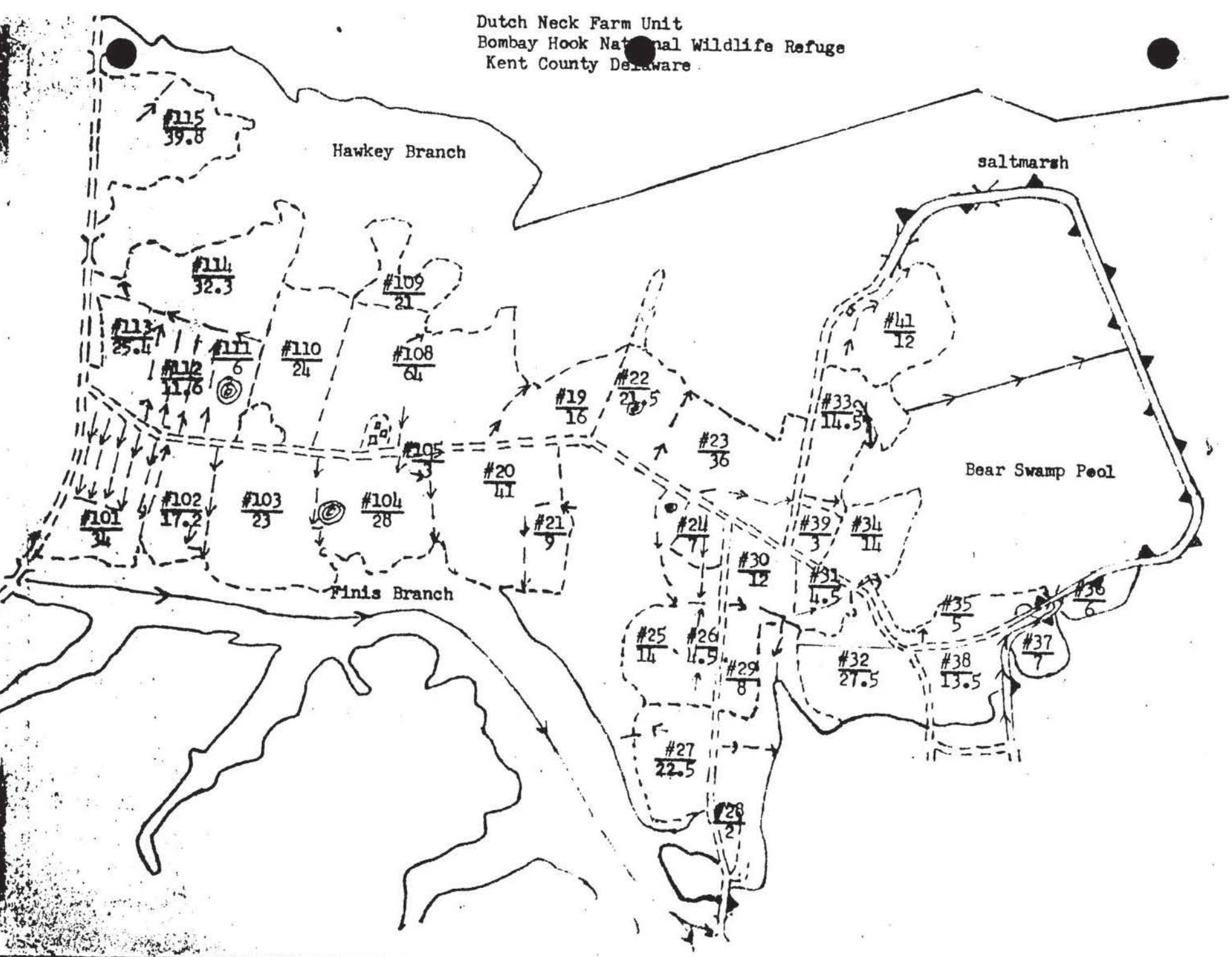
Region _____ Station _____ Date Prepared _____

Name _____

Form 3-244
Rev. 12/75

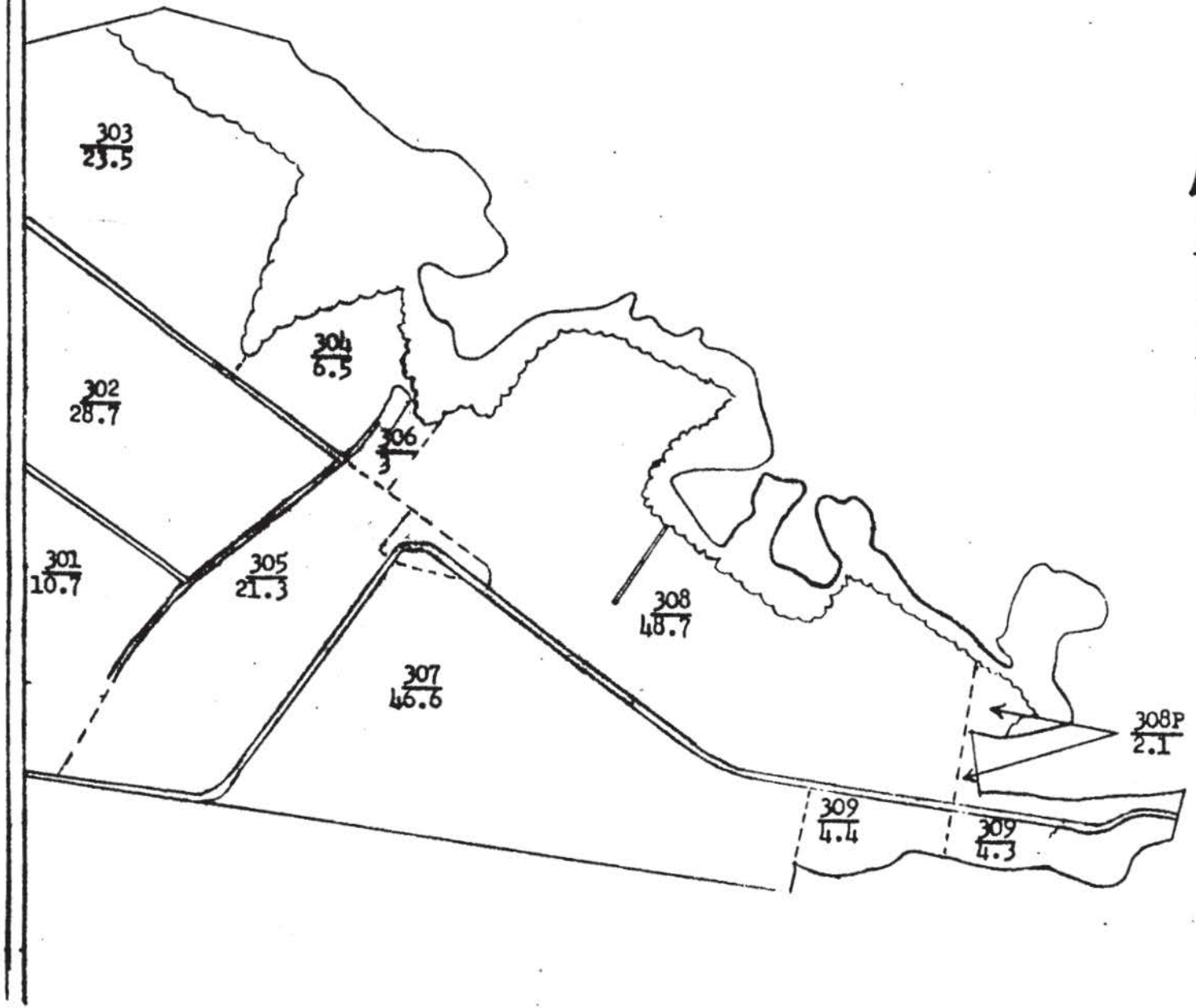
DATE	P/T	#	SPECIES	EGGS	HATCHED	UNHATC	VEGETATION GIVE % EACH SPECIES	DISTANCE TO H_2O	DEPREDATED Y/N BY WHAT

Dutch Neck Farm Unit
Bombay Hook National Wildlife Refuge
Kent County Delaware

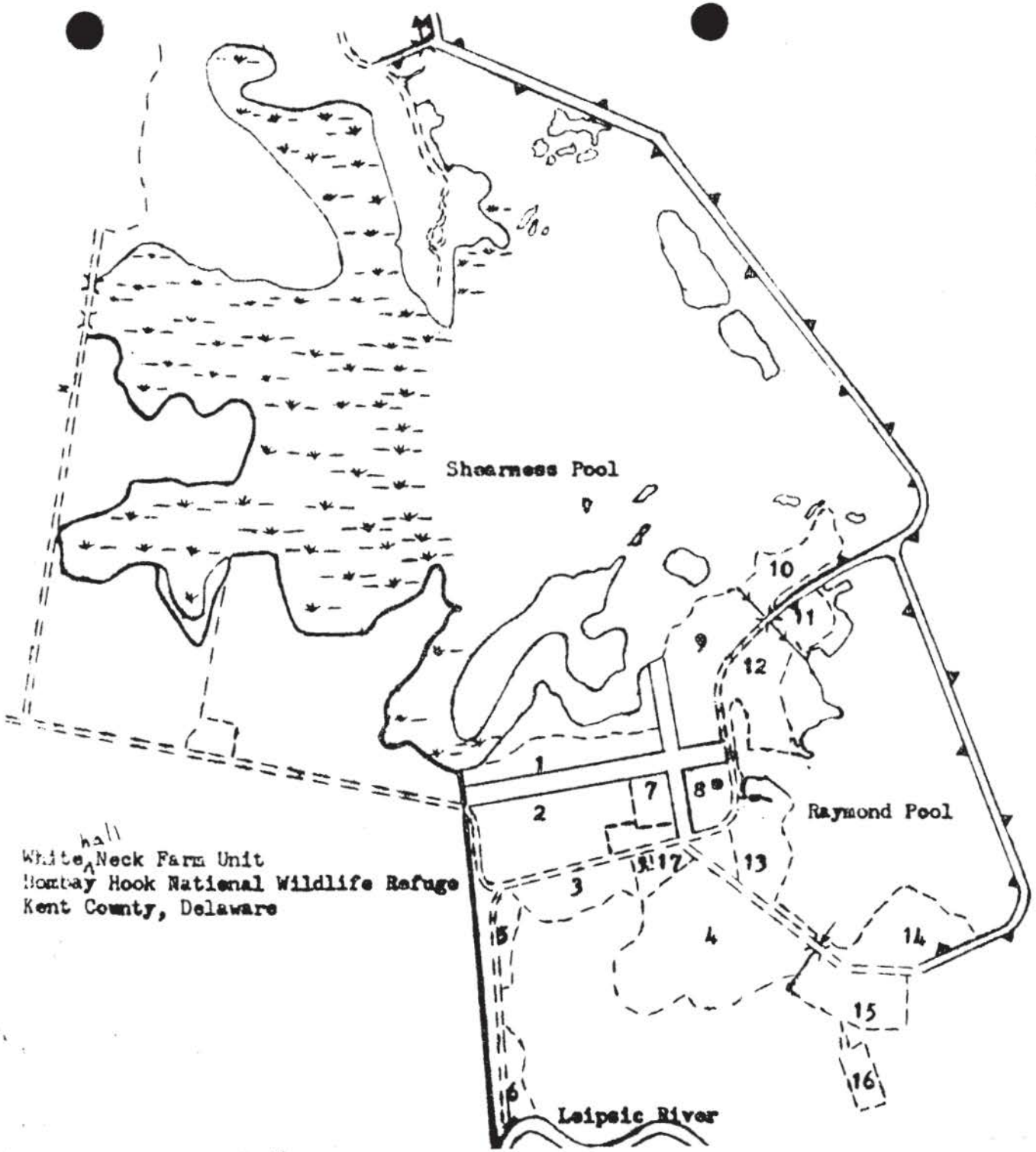


APPENDIX EXHIBIT S NEST DRAG MAP

Fischer Farm Unit
Bombay Hook National Wildlife Refuge
Kent County, Delaware
(76)



APPENDIX EXHIBIT S (Con't)



White Hall Neck Farm Unit
Bombay Hook National Wildlife Refuge
Kent County, Delaware

LEGEND

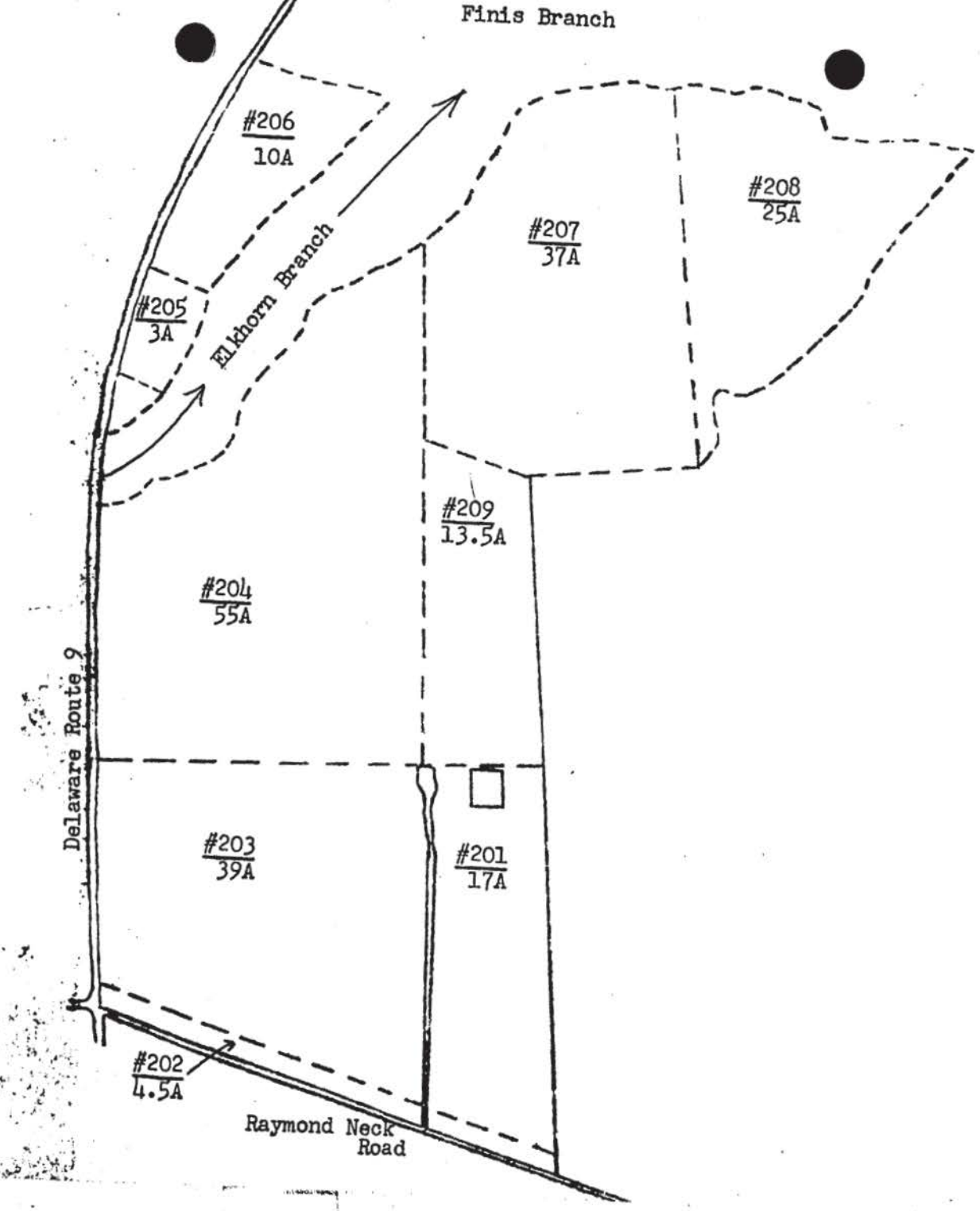
- Boundary line
- Field boundary
- Stream flowing
- Canal
- Pond
- Existing dike and road
- Road, graveled
- Road, dirt
- Bridge
- Building
- Marsh

AGRICULTURE

#Field	#Acres
1	10.7
2	19
3	9
4	34
5	3
6	2
7	3
8	5
9	16
10	7
11	4
12	8
13	11
14	8.5
15	8.5
16	4
	152.7

APPENDIX EXHIBIT S (Con't)

RAYMOND NECK FARM UNIT
Bombay Hook National Wildlife Refuge
Kent County, Delaware



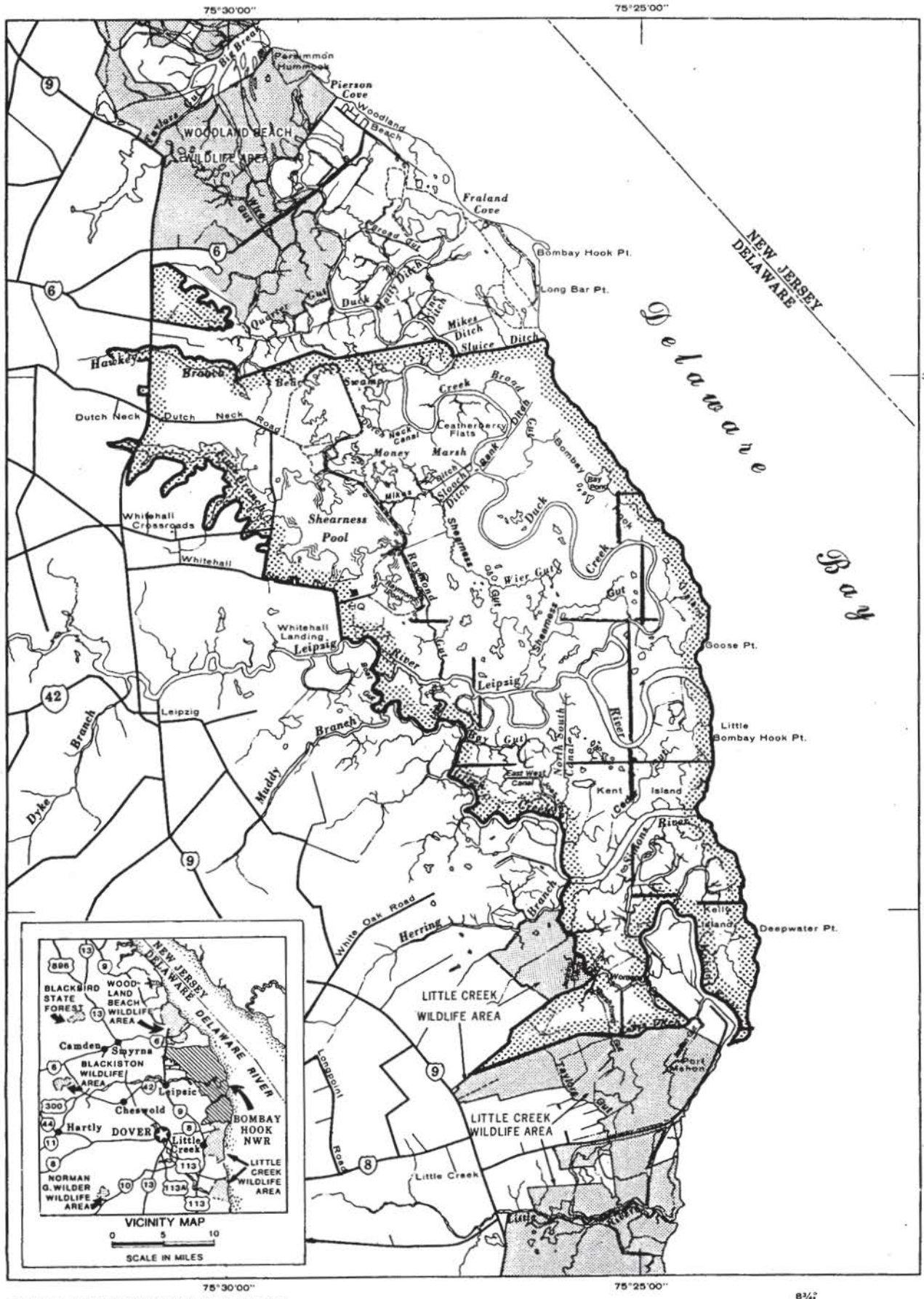
2/72 NEH

APPENDIX EXHIBIT T Nest Drag Transects
BOMBAY HOOK NATIONAL WILDLIFE REFUGE

KENT COUNTY, DELAWARE

UNITED STATES
DEPARTMENT OF THE INTERIOR

UNITED STATES
FISH AND WILDLIFE SERVICE



COMPILED IN THE DIVISION OF REALTY FROM SURVEYS OF THE U.S.G.S. AND U.S.F.&W.S.

0 4000 8000 12000 16000 FEET

0 1 2 3 4 KILOMETERS

8¾° Magnetic N. True N.

MEAN DECLINATION 1981

NEWTON CORNER, MASSACHUSETTS
REVISED: NOVEMBER 1985

5R DE 224

DATE: 25 May 1989

TO: Refuge Manager, Bombay Hook NWR
U.S. Fish and Wildlife Service
Smyrna, DE 19977

FROM: Field Biologist (South), Division of Refuges
U.S. Fish and Wildlife Service
Cambridge, MD 21613 Richard Sayka

SUBJECT: Wildlife Inventory and Animal Control Plans

I have reviewed and sent your Animal Control Plan to the RO for approval. There are some problems with interpreting data from dummy nest studies. I am attempting to gather some information on that and will send it to you later.

I have approved your Wildlife Inventory Plan.

As we discussed, I have some question about needing to fly at 200' AGL when conducting the aerial waterfowl survey and at 150' AGL for the breeding pair survey. My concerns are from a safety standpoint, especially when snow geese are around during the former. Most of my experience has been attempting to estimate large numbers of birds in the midwest, and we rarely had the need to get below 500'. I realize counting ducks in the salt marsh may be quite different. I spoke with Bill Leenhouts and he used altitudes similar to yours in Florida. Pat Brown has mentioned flying at 700' for counting pairs in the prairies. Next fall and spring, please experiment with the altitudes at which you are flying just to see if there is room for increasing them and still get the job done.

I have requested some information on conducting duck nesting studies and will send that to you later as well. You may need to increase the number of times you are dragging an area to assess aspects of renesting, as well as re-visit nests more frequently. This will allow you to utilize the Mayfield method of calculating a less biased estimate of nest success. It also is lots more time consuming! The trade-off is worth it. You will likely have to drag fewer areas more frequently. That procedure can be amended later, if necessary. The important thing is that you are trying to get a handle on duck production, and you deserve much credit for that.

cc: Gavutis
McAndrews

Paul-
the refuge has been particularly short handed clerically lately. Can you have a copy of inventory plan made & sent back to me, please? Thanks. No hurry-
Rich