

WRO
BOMBAY HOOK
NATIONAL WILDLIFE REFUGE
Smyrna, Delaware 19977

ANNUAL NARRATIVE REPORT
Calendar Year 1991

U.S. Department of the Interior
Fish and Wildlife Service
NATIONAL WILDLIFE REFUGE SYSTEM

REVIEWS AND APPROVALS

BOMBAY HOOK NATIONAL WILDLIFE REFUGE

Smyrna, Delaware

ANNUAL NARRATIVE REPORT

Calendar Year 1991

Brent D. Day
REFUGE MANAGER

3-19-92
DATE

Tom M. Andrews
ASSOCIATE MANAGER-S.

7 May 92
DATE

Donald Young
REGIONAL OFFICE APPROVAL

5/8/92
DATE

INTRODUCTION

Bombay Hook National Wildlife Refuge was established under the authority of the Migratory Bird Conservation Act in 1937 as a refuge for migratory and wintering waterfowl. The refuge is located in Kent County along the western shore of the Delaware Bay. It is within two hours driving time of metropolitan Baltimore, Washington, Wilmington, and Philadelphia, and is less than 10 air miles from the state capital of Dover (population 23,507) and 8 miles from Smyrna (population 4,750). The surrounding area is characterized primarily by agricultural lands on which corn, soybeans, and wheat are the principal cash crops. The refuge currently comprises 15,122 acres of which approximately 12,500 are a broad expanse of brackish tidal marsh, mud flats, and tidal creeks and rivers. Other portions of the refuge include 1,000 acres of agricultural land, 4 freshwater impoundments comprising 1,100 acres, and the remainder wooded upland and brush. The topography is very flat with almost all of the refuge lying below the 10 foot MSL contour. In addition to waterfowl Bombay Hook supports healthy populations of white-tailed deer, cottontail rabbits, muskrats, otter, and beaver as well as large numbers of shore, wading, raptorial and passerine birds. The tidal waters within the marsh are home for the commercially important blue crab, white perch, and eels as well as myriads of other marine life forms inherent to a mid-Atlantic estuarine environment. A pair of southern bald eagles resides at the refuge and normally nests in a woodlot adjacent to one of the freshwater pools.

The initial and still basic objective for the refuge of preserving the migratory waterfowl resource is reached through preservation of the natural tidal salt marsh as well as intensive management practices such as croplands management, prescribed burning, impoundment water level manipulation and others which serve to enhance areas for waterfowl and other wildlife. Public use objectives are to provide wildlife-oriented recreational opportunities compatible with habitat and wildlife objectives. Increased emphasis has been placed on development of environmental education and interpretive programs; however, consumptive recreation in the form of waterfowl, deer, and small game hunting still forms a large portion of the refuge program.

INTRODUCTION

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A. HIGHLIGHTS

The first property turned over to the Service by the Farmers Home Administration was the 2.6 acre Dougherty property. It is singularly unimpressive. (Section C.2)

A long-term problem was solved by removal of a quantity of old chemicals which had been stored in a shed at Fischer Tract. (Section D.4)

A reliable supplementary water supply for moist soil Unit B was provided upon completion of electric service extension and installation of a submersible well pump. (Sections F.2 and I.1)

Discussions with Ducks Unlimited personnel led to their 50% funding of a moist soil development project. (Section F.2)

An outbreak of rabies in the spring decimated the refuge raccoon population. (Section G.17)

Cutbacks in the West Waterfowl Area hunt program were instituted to favor more resting areas for the declining Canada goose population. (Sections G.3 and H.8)

The new Assistant Secretary for Fish, Wildlife and Parks enjoyed a quality Bombay Hook snow goose hunt. (Section H.8)

The cooperative association sales outlet operated by "Friends of Bombay Hook", which was established in 1990, continued to exceed all sales expectations in its first full year of existence. (Section H.18)

The exterior of the old YACC building received a much needed facelift funded by the tenant, the Delaware Bay Estuary Program. (Section I.2)

B. CLIMATIC CONDITIONS

1991 was warm and dry. Temperatures were above normal most of the year while precipitation was below normal. The only weather excitement occurred on August 19 when Hurricane Bob was supposedly heading straight for us, but instead just brushed the Delaware coast and continued on north.

Temperatures this year ranged from a low of 11 in January to a high of 100 in July. The last killing frost of the spring occurred on April 3, which is just about normal for this region. Temperatures reached the 90's in late May and, except for a couple of short-lived cool fronts, the daytime highs stayed in the 90's right through the end of July. It was a hot summer! The first killing frost in the fall occurred on October 21, just about when it was supposed to.

Precipitation for the year totaled 37.67 inches, 11% below an "average" total of 42.30 inches. We had only eight inches of snow - six in January and two in February. The precipitation was rather evenly spaced throughout the year with the exception of 6.22 inches in March and only 0.66 inches in November and 1.11 inches in February.

Temperature data was collected by the Delaware Highway Department at their weather station in Dover, approximately 12 miles southwest of the refuge office; and precipitation data was gathered at a rain gauge outside refuge headquarters.

TEMPERATURE (°F)

<u>Month</u>	<u>Maximum</u>	<u>Minimum</u>	<u>Precipitation</u> <u>(Inches)</u>
Jan	62	11	5.15
Feb	73	12	1.11
Mar	81	25	6.22
Apr	88	30	2.78
May	97	38	2.60
Jun	99	50	2.85
Jul	100	60	3.49
Aug	95	61	2.82
Sep	95	42	3.33
Oct	82	32	2.18
Nov	76	20	0.66
Dec	<u>73</u>	<u>16</u>	<u>4.48</u>
Extremes	100	11	Total 37.67

C. LAND ACQUISITION

1. Fee Title

A meeting was held on January 10 concerning the Delaware Wildlands Trust property holdings in the Great Cypress Swamp in lower Delaware. Attendees at the meeting included Manager Daly, Assistant Wunderley, Refuge Biologist Smith, Refuges-South Supervisor McAndrews, Chief of Realty Miller, Ascertainment Biologist Quist, Rusty Harvey - Executive Director of Delaware Wildlands Trust, and Peter Martin - Field Ecologist for Delaware Wildlands Trust. This organization wants to divest itself of over 11,000 acres it owns in the swamp and a number of unique proposals were forwarded by Mr. Harvey whereby the FWS would take control of the property. The various proposals are to be investigated by the Service; however no further action took place during the remainder of 1991 on acquiring this highly desirable piece of wildlife habitat. The most consistently successful bald eagle nest in Delaware is on the property. It is also well known as habitat for neo-tropical birds; and many plant and animal species are found here at the northernmost extension of their range.

2. Easements

The refuge was notified in May that the Service had accepted an easement on a property which came to us through the Farmers Home Administration. It had been looked at several years previously by a biologist with the Annapolis Enhancement office. On May 21, Manager Daly and Assistant Manager Wunderley inspected the 1.3 acre (yes, that figure is correct) National Wildlife Refuge and completed a certificate of inspection. An additional 1.3 acre "grassed waterway" was never found.

We were able to locate the 1.3 acre easement which lies 25 feet on either side of a farm ditch ("Raccoon Run") on the north side of the property without difficulty. The ditch, which is about 4'-5' deep with high banks on each side, was dry for most of its length. The owner had already plowed about 15 feet on the north side of the ditch for about 350 yards within the easement. We measured 25 feet from the center of the ditch and placed flags every 100 feet or so to mark the extent of the easement. Pictures were also taken from either end of the ditch. Where the ditch enters the woods on the west side of the property, there is a grass strip to the south of the ditch for about 50 yards and woods to the north. Flags were placed out 25 feet from the center of the ditch on the south side. There were no wetlands on the easement anywhere that we could tell; it is all upland.

To say we were less than overwhelmed with this newest addition to the National Wildlife Refuge System is to understate the situation by a great deal. The Service should not have accepted the property in the first place. It looks like any other farm ditch; and most importantly, we did not locate any wetlands on the easement. The manager recommended that the Service divest itself of this property as soon as possible, and also that properties with potential for being transferred to the Service under the Farmers Home Administration Program be visited by enhancement and refuge personnel prior to being accepted; with either division having the right of refusal.

A policy similar to that recommendation was issued by the regional office later in the year.

D. PLANNING

2. Management Plan

No management plans were written or updated during 1991; all major plans are up to date. We have some minor plans due in 1992 and will be beginning a five year update schedule on our major plans.

4. Compliance with Environmental and Cultural Resource Mandates

Preparations were begun in March to remove hazardous waste from a shed on the Fischer Tract on the northern part of the refuge. A list was obtained from the state of certified hazardous waste haulers. Many phone calls were made to many companies trying to get someone to come out and look at the job. One company wanted \$75.00/hour (including 4 hour round-trip travel time) just to come and count the barrels. This would not include any sampling of the materials - "that would have to be done on a return trip" we were told. Our biggest problem was in finding someone to handle the main material involved. Penta, the common wood preservative, apparently would not be handled by any of these companies. Yes, this is the same material that some of us practically bathed in while we were applying it 20 years ago. We finally found a company, Guardian Environmental Services, that would handle the Penta. They did tell us, however, that if the concentration were too strong that the barrels would have to be shipped to Sweden for disposal! Assistant Manager Wunderley offered to go along with the shipment to make sure it got to its destination, but as it turned out the concentration was low enough so that it did not need to be shipped out of the country.

The total list of materials disposed of was as follows:

- DLD weed killer - 1 gallon
- Silver nitrate - 160 oz.
- Ethylene glycol - 2 gallons
- ROOTO - 25 lbs.
- Finisher 8004 - 5 gallons
- LV4-2,4D - 5 gallons
- Everseal sealant - 25 gallons
- 2-4D Lo-V - 2 gallons
- Anticoagulant - 24 oz.
- Lead Arsenate - 1 lb.
- BONDEX - 25 gallons
- Warfarin - 4 lbs.
- Masonry sealant - 20 gallons
- Roof coating - 10 gallons
- Various lead paints - 10 gallons
- Resin 276 - 4 liters
- Formaldehyde - 5 gallons
- Paint thinner - 5 gallons
- PROLIN - 5 gallons
- DURAFLEX - 5 gallons
- GULF Spray - 1 quart
- CYANOGAS & pump - 5 lbs.
- PENTACHOLOROPHENOL - 165 gallons

The main problem with most of these various materials, was that they were in unlabeled containers and we had no idea what most of them were. We had been budgeted \$25,000 for the job, however, the final cost was \$11,675.

When all was said and done we still had two containers that were unidentified. Guardian offered to have a chemist look at the materials at no cost (considering we had just paid them over \$11,000, we considered this a very gracious offer). After two weeks they got back to us and said that the containers were . . . sand! We have some doubts on this so we will turn the two one-gallon containers over to the county on their next "pesticide amnesty day".

In March, Assistant Manager Wunderley discovered two 55-gallon oil drums on the shoulder of Route 9, luckily just off the refuge on the highway right-of-way. One of the drums was leaking and had a peculiar smell. The state Hazardous Materials team was called and responded with two investigators. The verdict: dog feces from a nearby kennel.

5. Research and Investigations

1. Bombay Hook NR89 - Response of Greater Snow Geese (*Chen caerulescens atlantica*) To Hunting at Bombay Hook National Wildlife Refuge and Related Wetland Changes
(Conducted by refuge staff in cooperation with Delaware Division of Fish and Wildlife) 51550-1

This project was begun during 1989 and is presently in the third year of data collection. Following is an abstract from the 1991 progress report.

Snow goose populations were monitored through two wintering seasons by the use of aerial surveys and ground observations within and around Bombay Hook and Prime Hook National Wildlife Refuges. Surveys were flown during two different periods of the day i.e. dawn and mid-morning in an effort to enumerate roosting and feeding populations of geese along the Delaware coast. Mid-morning flights included a survey route into several counties of Maryland's eastern shore as well as areas in western Delaware and a limited number along the Delaware Bay Shore of New Jersey. Habitats utilized by each flock were recorded. Permanent vegetational transects were established and run within the marshes of Bombay Hook and Prime Hook as well as the impoundments at the Little Creek Wildlife Management Area during the late summer of 1989 and 1990. Aerial slides and video tapes of the marsh eatouts created by the feeding activities of the birds were taken periodically throughout each winter period and were compiled on a plastic overlay to determine total acreage denuded by the geese on Bombay Hook and Prime Hook. Results of the special snow goose hunt within the Bombay Hook salt marshes were analyzed in conjunction with the activities of the geese in an attempt to correlate goose use with hunting activity. The extent of snow goose denudation on Bombay Hook was similar but slightly less than the previous year's although the same preferred areas are stripped annually. Extent of the eat-outs on Prime Hook, however increased significantly during the two years of data analysis. The impact of hunting the Bombay Hook marshes on the activities of the birds is difficult to assess. The timing of the major eatouts at Bombay Hook appears to be influenced by the hunt. The westward and southward flock movements, which occur primarily after the Bombay Hook marshes are hunted may also be influenced by activities of the hunts; however, it is also possible that the extent of total marsh

denudation by feeding snow geese at Bombay Hook over the wintering period is influenced very little by hunting.

Data collection continued through the fall of 1991 and the winter of 1992.

2. Bombay Hook NR91 - Movement Patterns and Habitat Use of Greater Snow Geese in Delaware (A cooperative effort by the U.S. Fish and Wildlife Service, Delaware Division of Fish and Wildlife and Eastern Kentucky University) 51550-2

Field work for this project was completed during April 1991. Data analysis continues and will be summarized in a Master of Science Thesis during 1992. Some of the preliminary findings were reported by Michael Hill at the 7th North American Arctic Goose Conference and Workshop in Vallejo, California January 7-12, 1992. Following is an abstract of the paper presented there:

During the late 1960s, the wintering population of greater snow geese (Chen caerulescens atlantica) at Bombay Hook National Wildlife Refuge (BHNWR) in Delaware was approximately 1,500 birds, but in the mid-1980s peak populations at the refuge reached 75,000. This large concentration of birds combined with their voracious foraging habits caused destruction of parts of the refuge tidal saltmarsh. During the winter of 1990-91, we studied the local movements, feeding patterns, and roost-site use of 33 radio marked adult female greater snow geese captured at BHNWR. During October-November (early season), marked birds did not move large distances from roosting to feeding sites ($x=5.4\text{km}$) or between roosting sites ($x=3.9\text{ km}$). Habitats most often utilized for roosting during early season were freshwater impoundments (26%), farm ponds (29%), and the tidal saltmarsh (42%), and harvested corn fields were the most heavily visited type of feeding habitat (49%). Total distance moved by a goose in one day averaged 15.5 km. Large areas of denuded tidal saltmarsh became apparent in November and early December coinciding with observations of night movements by marked birds into the tidal saltmarsh. Mean distances travelled per day increased ($P<0.05$) in December and January (mid season; $x=21.0\text{ km}$) with some feeding flights up to 37 km from the roosting area. During January, there was minimal use of BHNWR, when many marked birds were found roosting in freshwater impoundments (37%) at Prime Hook National Wildlife Refuge in Delaware (52 km south of BHNWR) and on several farm ponds in Kent Co., Maryland (50 km west of

BHNWR). Distances travelled between roosting sites ($\bar{x}=22.9\text{km}$) and from roosting to feeding sites ($\bar{x}=11.4\text{ km}$) were considerably larger ($P<0.05$) than in early season, and harvested corn was still the most heavily utilized habitat type (37%). In February and March (late season) marked birds began to return to BHNWR, and habitats most used for feeding were harvested corn (32%) and small grains (27%). Distances moved from roosting to feeding areas declined ($P<0.05$) in late season ($\bar{x}=4.3\text{ km}$). Mean distances between roost sites ($\bar{x}=10.8\text{ km}$) and total distance moved in a day ($\bar{x}=13.5\text{ km}$) also decreased ($P<0.05$). Virtually no use of the tidal saltmarsh occurred in late season, and freshwater impoundments were the most often used roosting habitat (75%).

E. ADMINISTRATION1. Personnel

#1 Top (on deer stand L to R) Arthur Straughn, Paul Daly
Bottom (in duck blind L to R) Frank Smith, Steve
Wunderley, Suzan Staley, Howard Cottman, Teresa
Hammond and Marian Johnson-Pohlman.

12/91 R. Humbert

1. Paul D. Daly	Refuge Manager	GS-12-PFT
2. Stephen M. Wunderley	Ass't Refuge Mgr.	GS-11-PFT
3. E. Franklin Smith	Refuge Biologist	GS-11-PFT
4. Marian Johnson-Pohlman	Outdoor Rec.Planner	GS-11-PFT
5. Teresa R. Hammond	Office Assistant	GS-06-PFT
6. Suzan M. Staley	Office Auto. Clerk	GS-04-PFT
7. Howard H. Cottman	Maintenance Worker	WG-08-PFT
8. Arthur T. Straughn	Maintenance Worker	WG-08-PFT
9. Barry T. Clark	Bio. Sci. Student	GS-04
10. Debra S. Wunderley	Clerk-Typist	GS-03 TPT
11. Bob Jones	Recreation Aid	GS-03 TPT
12. Verna Price	Recreation Aid	GS-03 TPT
13. Mark Connelly	Recreation Aid	GS-03 TPT

Barry Clark was not on active duty at the refuge this year. He is expected to graduate in May or August of 1992. His plans to work for FWS or go to veterinary school are still undecided at this point.

Two seasonal recreation aids were hired in March to share one position. Verna Price and Bob Jones each worked on an intermittent basis. Verna worked mostly in the Visitor Center and conducted interpretive programs, while Bob worked with graphics and editing brochure and leaflet texts etc.



- #2 Verna Price was hired as a temporary recreation aid for the busy season to staff the Center, operate the sales outlet and work with school groups. Verna is a retired environmental science teacher and refuge volunteer.

12/91 H. Behjamin

Mark Connelly was hired as a part-time seasonal recreation aid in March, and his appointment later was extended not to exceed one year. Mark, a Delaware State College Instructor, has excellent computer programming skills as well as public relations talents.



#3 Temporary recreation aid Mark Connelly was most helpful in computer programming, working with school groups, and staffing the Visitor Center.

12/91 M. Johnson-Pohlman

Mike Meagher, RO-Personnel, performed a desk audit on the Bombay Hook/Prime Hook project leader's position on the 14th and 15th of January. The decision, that the position would remain a GS-12, was appealed but there was still no final decision by the end of the year.

Clerk-typist Suzan Staley returned to work in April after a six month maternity leave. Debra Wunderley was hired as a part-time intermittent clerk-typist to fill in for some of Suzan's duties during her absence. Debbie also helped out a couple of other times during the year when the office was short staffed.

Refuge Biologist Smith spent the period May 13-24 in upstate New York on a detail surveying projects for the private lands initiative. Assistant Manager Wunderley participated in the same program July 1-15.

Clerk-typist Suzan Staley received a well deserved promotion to GS-4 Office Automation Clerk during August.

Office Assistant Teresa Hammond participated in a week-long detail to CGS at the Regional Office in August. She enjoyed her assignment and brought back useful tips on procurement, property management, etc.

Following is a summary of the staff manpower situation at this station for the past five years:

Number of Employees

	<u>Permanent</u>			
	<u>Full-time</u>	<u>Part-time</u>	<u>Temporary</u>	<u>Total FTE</u>
FY-92	8	0	4	8.7
FY-91	8	0	4	8.5
FY-90	8	0	1 (9 weeks)	8.2
FY-89	9	0	0	9.0
FY-88	8	1 (6 days/PP)	0	8.6
FY-87	9	0	0	9.0

Following is a listing of this station's personnel and the training they received this year.

<u>Training Course</u>	<u>Location</u>	<u>Date</u>	<u>Name(s)</u>
Regional NAI Confer.	Wilmington, DE	3/15	Pohlman
Administrative Workshop	Williamsburg, VA	3/4-3/8	Hammond
Law Enforcement Refresher	Quincy, FL	3/4-3/8	Smith
Law Enforcement Refresher	Cape Charles, VA	4/1-4/5	Daly
Law Enforcement Refresher	Cape Charles, VA	4/22-4/26	Straughn Wunderley
Working with the Hearing Impaired	Gallaudet College	5/23	Pohlman

<u>Training Course</u>	<u>Location</u>	<u>Date</u>	<u>Name(s)</u>
American Sign Lang.	Dover, DE	3/15-4/30	Pohlman Staley
Aircraft Safety	Patuxent WRC	5/6	Daly Wunderley Smith Straughn
Drug Free Workplace	Patuxent WRC	5/15	Daly Wunderley
Interpretive Skills	Harpers Ferry, WV	6/10-6/15	Pohlman
Helispot Operations	Roanoke, VA	6/3-6/7	Wunderley
Performance Stds.	Baltimore, MD	7/22-7/23	Daly Wunderley
Telephone Systems	Philadelphia, PA	7/17	Hammond
Telephone Skills	Wilmington, DE	8/23	Hammond Staley
Time & Attendance	Patuxent WRC	10/3	Hammond Staley
CPR	Bombay Hook, NWR	10/30	Daly Wunderley Smith Pohlman Straughn Cottman Hammond Staley Connelly
R-Base	Eastern Neck NWR	11/5-11/7	Smith Hammond Staley
Data Management	Bombay Hook NWR	12/4-12/5	Smith

4. Volunteer Program

The volunteer program at Bombay Hook finished its ninth successful year with 87 volunteers contributing more than 2500 hours of service. This was the largest number of hours donated to date with 1813 hours being donated in visitor services. Visitor services include staffing the visitor

center, working with school and scout groups, drafting text for brochures and displays and running the cooperative association sales outlet.

Two field work students from Delaware State College completed an internship at Bombay Hook this year. Each student worked 10 hours per week during a semester and earned 4 credits. Scott Kemerling was an exceptional environmental education teacher and worked well with students and teachers alike. He also helped draft sections of the Prime Hook Public Use Plan. Mark Hogan wrote news releases, completed public use reports, researched text for exhibits and brochures, and participated in eagle watch. Both students assisted ORP Pohlman in formulating a training video for the horseshoe crab and shorebird survey. 25 individuals attended this survey training session.

Volunteers from around the state helped count horseshoe crabs during the May and June full moon, and also assisted in counting shorebirds along the Delaware Bay Beaches from Woodland Beach to Cape Henlopen State Park. They also helped tag 1000 horseshoe crabs. Volunteers for this survey covered a wide spectrum of individuals, from scouts, to high school and college biology students, to residents along the Delaware Bay beaches.

A statewide complement of volunteers helped with a second major survey (song birds) this year, which occurred on weekends from August through October. The purpose of this survey was to establish a base line for number of species and their abundance. This survey will probably be conducted every two to five years to monitor song bird populations.

In November the volunteers were recognized at a dinner given by the State of Delaware at the Bombay Hook Refuge visitor center.

ORP Pohlman conducted spring and fall volunteer workshops and orientation sessions. Twenty new volunteers joined the program this year. In addition to the mini workshops and orientation sessions, volunteers are also encouraged to attend the two day environmental education workshop offered in the spring and fall.

A variety of field trips were offered this year for volunteers. Eight individuals attended a tour of Patuxent Wildlife Research Center conducted by Nell Baldachino. Several volunteers participated in a beach study/seining activity and were given an interpretive walk along the beach trails at Cape Henlopen State Park. The canoe trip at Abbotts Mill Pond was cancelled twice because of

inclement weather. Volunteers were also invited to a beach study at Prime Hook, and several volunteers took advantage of this opportunity.

ORP Pohlman conducted a volunteer training session at Eastern Neck NWR for individuals interested in working with the 4th Grade Environmental Education Program in Kent County, Maryland. About 200 students from around the county participated in staff and volunteer led activities during October.

The Annual Christmas party and awards ceremony for volunteers was held on December 22 with 32 refuge volunteers in attendance. Awards were presented in various categories ranging from staffing the Visitor Center, and working with educational groups, to assistance with computer programming and operation of the sales outlet. Overall quality of awards presented rose significantly this year and included the following: refuge sweatshirts and T-shirts donated by the association, volunteer T-shirts and caps, service pins, mugs, bird guides, and two books for special awards--America's Wildlife Hideaways and Wildlands for Wildlife. Longtime refuge volunteer Frances Robertson died this year of a heart attack and is sorely missed by her family of volunteers. Frances was one of only two volunteers who had received the 500 hour service pin to date. About a dozen volunteers have received the 250 hour service pin. This program has proven to be extremely valuable over the years and much has been accomplished.



#4 Volunteers enjoyed each other's company at the annual volunteer award ceremony and Christmas party.
12/91 H. Benjamin



#5 Volunteer Bob Clark received a well deserved award for staffing the Visitor Center three days per week, working with school groups and assisting with our sales outlet.
12/91 H. Benjamin

5. Funding

Five Year Chronology of Station Funding (Thousands) One-Year Funds Only

	<u>1210/1520</u>	<u>1260</u>	<u>1261</u>	<u>1262</u>	<u>6860</u>	<u>Total*</u>
FY-91	-	-	285.5	136.0	2.0	423.5
FY-90	-	-	251.9	125.0	2.0	378.9
FY-89	-	-	231.3	121.5	2.0	354.8
FY-88	13.6	504.1	-	-	2.0	519.7
FY-87	-	317.7	-	-	2.0	319.7

*Does not include \$4,500 of 9100 (fire) money from FY-90 and \$1,000 from FY-91.

In addition to the funding listed above this station also had at its disposal some "no-year" monies. We had \$4,709 in activity 8610 (residence) which included \$3,937 of carryover funds; and also \$9,269 in activity 4960 (fee collection) including \$4,629 in carryover funds.

A partial list of FY-91 funding allocations per project is as follows:

Minimum Cost	\$ 328,707
Public Hunt Program	4,000
Aerial Wildlife Surveys	1,300
Equipment Maintenance	4,200
Vehicle Maintenance	4,000
Headquarters Maintenance	3,500
Boat, Motor, Trailer, Maintenance	3,000
Building and Facility Maintenance	6,500
Facilities Maintenance	1,000
Office Machines Maintenance	800
Water Control Structure Maintenance	500
Boundary Maintenance	300
Radio Maintenance, Repair	900
Gravel & Stone for Tour Route	3,000
Entrance & Directional Signs	300
Fire Equipment Maintenance	500
Wells, Pumps Installation	15,000
Pest Plant Control	3,700
Planimeter Purchase	500
Aerial Photos	500
Snow Goose Study	6,500
NUS Supplies	500
Remove Hazardous Waste	25,000
Snow Goose Telemetry Study	10,000

6. Safety

Safety meetings were held in conjunction with personnel at Prime Hook Refuge and also occasionally with personnel from the Delaware Bay Estuary Program; responsibility for developing and presenting safety topics rotated among all staff members. Following is a listing of various topics presented this year at the meetings:

1. Adult CPR Training
2. Boating Maintenance
3. Life Vest Safety
4. Boating Operations
5. Small Boats - Equipment & Judgement
6. Lyme Disease
7. Tractor Safety
8. Power Tool Safety
9. Seat Belts
10. Chain Saw Safety

Probably the most enjoyable meetings during the year were given by George O'Shea in which he set up a boating obstacle course and Frank Smith in which we tried out various life vests and float coats in the Leipsic River.

Bombay Hook and Prime Hook personnel completed the CPR refresher course as taught by the American Heart Association which was given on October 30.

A rabies outbreak hit the refuge in the spring. We placed a sign at the entrance warning people to beware of strange acting animals. (see Section G.17)

On September 19-20 Steve Wunderley and Eastern Neck NWR Manager Tom Goettel exchanged safety inspections on the two stations.

The refuge staff attended the annual combined safety meeting/Christmas party at Eastern Neck NWR on December 13. Attendees were from Blackwater, Martin, Prime Hook, Bombay Hook, and Eastern Neck as well as some Maryland LE personnel.

7. Technical Assistance

Biologist Smith, acting as Private Lands Initiative coordinator for Delaware, spent a good deal of time during the warmer months on site identification and coordination of project designs with landowners and representatives of the Soil Conservation Service and Delaware Division of Fish and Wildlife. In addition, Frank spent the period May 13-24 in upstate New York surveying projects in that area.

Assistant Manager Wunderley was also in New York working on the Private Lands program between July 1 and 15.

Manager Daly received several calls during July from individuals and agencies in the Houston, Texas area regarding technical assistance in snow goose/aircraft interaction. A new airport is planned in that area on a site which could impact large populations of lesser snow geese. Agencies included the FWS Enhancement Office, the Houston City Council and the Airport Authority. Information was provided based on our experience with the snow goose flock and the adjacent Dover AFB. The callers were also referred for additional information to the Bird Aircraft Strike Team at Tyndall AFB, Florida and the FWS Information Transfer Office.

Manager Daly and Biologist Smith reviewed the Delaware Division of Fish and Wildlife Draft Beaver Management Plan during July and submitted comments to that agency.

Manager Daly counseled a Mr. Joseph Maury of the U.S. Department of Energy during October regarding a problem with an expanding deer herd within an enclosed compound. Mr. Maury, who is located in Morgantown, WV, was advised on various hunting possibilities and possible trapping/transplanting techniques. He also was referred to USDA wildlife assistance personnel in West Virginia as well as West Virginia DNR headquarters.

Many letters and calls were received during the year from other refuges and state wildlife resource agencies nationwide concerning our hunting programs for handicapped (wheelchair bound) individuals. Most inquiries wanted designs of our waterfowl blinds and deer stands; as well as criteria which we use to determine eligibility for our hunts. Each inquiry was answered as soon as possible.

F. HABITAT MANAGEMENT

1. General

Over 12,000 acres of Bombay Hook's 15,122 total acres consist of tidal salt marsh. Other important habitats include freshwater impoundments (1,100 acres), croplands (980 acres), and scattered blocks of various forest types including upland hardwoods, hardwood swamps and shrub communities. Many of these habitats are intensively managed to meet refuge objectives for waterfowl maintenance and production, endangered species, wildlife diversity and various public uses.

North American Waterfowl Management Plan (NAWMP)

The North American Waterfowl Management Plan -- an international agreement signed between the U.S. and Canada in 1986 to protect, enhance, and restore wetland habitats across the continent -- presents a number of new opportunities and challenges for NWRs. The Plan establishes conservation goals for wetland habitats in specific regions of the continent; sets objectives for restoring waterfowl populations, and provides a framework for accomplishing local, regional, and international goals. In the United States, six key waterfowl breeding, migration, and wintering habitat regions, called Joint Ventures (JVs), have been established to implement the Plan. In Region 5, The Lower Great Lakes/St. Lawrence Basin and the Atlantic Coast JVs have coalitions of federal, state, and private partners working together to restore waterfowl populations.

The Bombay Hook NWR lies within the Atlantic Coast JV and is playing an active role in achieving the objectives of the JV and NAWMP through the management of the refuge. Bombay Hook was established in 1937 as a refuge and breeding ground for migratory birds and other wildlife. Waterfowl management centers on manipulation of water levels in the impoundments to favor growth of plant communities and habitat conditions desired by waterfowl. Black ducks and Canada geese are of particular management concern at Bombay Hook. Waterfowl foods are also provided through cooperative farming agreements with local farmers.

NAWMP Activity Highlights on Bombay Hook in 1991

Development of moist soil management Units A and B was completed with the extension of electric service underground to the Pool B site and installation of a submersible pump in the existing well. (see Sections F.2 and I.1)

Contacts were made early in the year with the coordinator of the Ducks Unlimited MARSH (Matching Aid to Restore State Habitat) program regarding proposed moist soil development on seven small sites scattered throughout the cropland management units. Following our application to DU and completion of the required NEPA documentation, we were successful in receiving a 50% "match" in funds for FY 1992 to complete the project. The total project cost is approximately \$26,900. (see Section F.2)

A rice levee plow was borrowed from Blackwater NWR and used to throw up a small levee to the east of two low-lying field sites near Bear Swamp. During 1992 we will install small water control structures in these units. (see Sections F.2 and I.1)

2. Wetlands

Tidal Marsh

Bombay Hook's salt marsh is a rather unique habitat on the east coast, in that it mostly remains in a pristine, unditched condition; having escaped the grid-ditching done for mosquito control on similar coastal marshes in previous decades. The overall acreage can be divided roughly into two-thirds high, irregularly flooded Spartina patens/Distichlis spicata/short form Spartina alterniflora association, and one-third low, regularly flooded tall form Spartina alterniflora.

Such habitat management as occurs is carried out primarily with the objective of reducing the effects of feeding by concentrations of snow geese in portions of the low marsh. When the refuge populations reached 70,000 to 75,000 birds in the mid-1980's, extensive "eat-outs" were created in the Money Marsh and Leatherberry Flats areas, as well as around George's Island (approximately 1,000 acres). Between 1988 and 1990, the extent of these areas, which were annually turned into mud flats by the geese, remained essentially unchanged, where it had been increasing each year prior to that time. During 1991 the snow goose flock devegetated about 900 acres through the end of December. Since most marsh damage normally occurs between the time of the flock's arrival in early October and early December, we are hopeful of surviving a winter season with significantly reduced acreage of marsh destroyed.

There will probably always be some room for doubt as to the cause of the decrease in marsh damage this year. The snow goose hunt, conducted as a management tool on the critical marsh sites since 1983, has obviously been a factor. The year when the marsh "eat-out" stopped its expansion coincided with the year when the Delaware Division of Fish and Wildlife went along with our request to open the State season earlier on the refuge (mid-October). Prior to that time the birds concentrated on the most vulnerable marsh sites immediately subsequent to their arrival; and usually had the sites denuded by early November when the regular hunt season began. Whether due to the early refuge hunts or not, the snow goose flock has changed its habits in recent years, never reaching the peak populations of the mid-1980's on the refuge; while setting new record high

populations at Prime Hook Refuge and elsewhere on this portion of the Delmarva Peninsula. (see Section G.3.b)

Other than the snow goose hunt, the only active management on the tidal marsh is prescribed burning; selected high marsh units are burned in mid-winter to divert the attention of snow geese away from the vulnerable low marsh. A 500 acre block of Kent Island marsh was burned on February 4, but received only sporadic use by geese.

Finis Pool (205 acres)

Twenty acres of swamp loosestrife (Decodon verticillatus), which had invaded Finis Pool in recent years crowding out more desirable waterfowl foods, were sprayed with glyphosate during August 1990. Monitoring of the sprayed area in 1991 revealed some stump sprouting of the loosestrife; however, large quantities of smartweeds, wild millet and Cyperus volunteered and grew along with the few loosestrife sprouts. In order to experiment on the best method of long-term loosestrife control, one half of the area sprayed in 1990 (the "north" 10 acres) was resprayed in 1991.



#6 A big increase in smartweed (Polygonum pennsylvanicum) production was noted in Finis Pool this year as a response to the early drawdown.

7/91 F. Smith



#7 The 10 acre block outlined in red was re-sprayed with glyphosate this year in order to compare it with the block sprayed only in 1990 for swamp loosestrife control (outlined in green).

9/91 F. Smith

The water management regime in Finis was changed a bit this year. Since Finis Pool and Finis Branch represent the freshwater runoff source for the other three major impoundments, normally water levels are held up throughout the growing season so as to serve as a supply for the others in early autumn. This year Finis was drawn down in March to stimulate production of smartweeds. Water levels were gradually raised in June so as to provide brood habitat for the many wood ducks which are produced annually from boxes in the pool.

Waterfowl use of Finis by mallards, black ducks and gadwall was extensive during the late winter months.

Sheariness Pool (560 acres)

Due to an extremely dry May and early June, Sheariness began to dewater through evaporation prior to the scheduled drawdown initiation date of June 15. Vegetation (millet, Panicum, Cyperus) volunteered almost immediately on the pool bottom as the fringes became mud flats. Because of the "staggered" nature of the drawdown this year there was

a bit more variety compared to the dominance of millet in 1990. Height of vegetation, however, never reached the robust levels of a year earlier.

Drier than normal conditions prevailed through early fall. In order to have some habitat available in Shearneck for early duck migrants, tidal water was let into the pool on September 23. About 25% of the pool was shallowly flooded by this method; which experience has shown us we can do every two to three years without affecting soil conditions and plant composition. Optimum pool levels, however, were not reached until early December, when 2.5 inches of rain fell over a two day period. Although large numbers of pintail and green-winged teal responded immediately to the shallowly flooded pool after this storm, the refuge populations of these species never reached levels attained in years when ideal conditions are present by October.

Raymond Pool (95 acres)

Drawdown of Raymond began on March 1, approximately six weeks earlier than in 1990, this in an attempt to dry the pool by summer, a feat not accomplished for several years. By the end of March there were a couple of inches of water remaining on most of the pool surface, and the response by shorebirds (mostly semi-palmated sandpipers, dowitchers and dunlin) was excellent. Avocets and black-necked stilts arrived during April and, in similar fashion to 1990, impressive numbers and variety of shorebird species remained in Raymond right through the summer months.

Total pool drawdown was unsuccessful, since heavy showers were received just prior to reaching the "mud flat" stage in July. Our plans had included scarifying the pool bottom with a tracked vehicle to be borrowed from the Delaware Division of Fish and Wildlife in order to break up the crust which forms on the top inch or two of the mud. This would encourage volunteer vegetation as we discovered several years ago.

Slowly increasing water levels in October resulted in use by snow geese and a variety of ducks, primarily mallards and shovelers. A peak for the year of 200 avocets was reached early in the month. Water levels in Raymond will not be managed at their most efficient until considerable work is performed at the main water control structure leading to the tidal marsh. Not only does the structure itself require rehabilitation, but also there is an area extending into the pool from the structure approximately 100 yards which must be dredged to clear a buildup of mud which prevents the pool from being quickly drained. Projects are planned to accomplish both objectives.

Bear Swamp Pool (240 acres)

Bear Swamp again served as the prime wood duck nesting and brooding area on the refuge. Pool water levels were generally at objective levels through the end of June; however, inadequate rainfall and high evaporation rates for the remainder of the summer resulted in levels below objective for the rest of the year. Vegetative production was again excellent as Cyperus, Panicum and spikerushes volunteered on the mud flats as the water levels dropped during July and August. There was some increase in fleabane (Pluchea) this year as encountered along the vegetation transects run in September. The increase (approximately 50%) was probably due to the pool bottom drying to a greater than normal extent during late summer. Hundreds of egrets, herons and glossy ibis then congregated in the pool to feast on bullhead concentrations made vulnerable by the drought. Even with the lower than desired autumn water levels, waterfowl use was excellent. Wood ducks, green-winged teal, mallards, pintails, Canada geese and snow geese utilized Bear Swamp extensively.

Moist Soil Management Units

Pool A (12 acres)

The newly acquired Gator pump was utilized in January to move water from Bear Swamp into this unit and shallowly flood it. Unfortunately, a couple of small breaks in the pool levee were discovered which prevented the maintenance of desired water levels. The dike was repaired during spring and near the end of August a patch of Phragmites near the control structure was treated with glyphosate. Plans are to burn and disc the pool in early 1992 to encourage moist soil plant species.

Pool B (8 acres)

Mallards, pintail and green-winged teal made good use of Pool B after late winter rains put 2"-6" of water in the unit. The late spring and summer drought, however, resulted in conditions which were so dry that very little wetland vegetation volunteered. Late in the year the pool bottom was disc harrowed in order to encourage better production in 1992.

Water supply next year should no longer be a problem. Electric service was run underground to Pool B from the Allee House (about one mile). A submersible pump was installed in the well at the northwest corner of the pool during October, giving us capability to supplement rainfall at this site throughout the year.

Straughn Pool (2 acres)

Good stands of millet and panic grasses were produced in this small pool built during 1990. Mallards and green-winged teal in flocks of 15-20 used the area frequently throughout late winter and spring. The pool levee was raised slightly during the summer to permit control of water on an additional acre.

Proposed Development - Moist Soil Units

Refuge personnel met with Ralph Bitely, Duck Unlimited MARSH Coordinator, on January 7 to discuss several proposed moist soil management sites scattered throughout the cropland units. Subsequent to the meeting a proposal in the DU format was submitted to Mr. Bitely and matching funds (50%) were granted through the program to accomplish the work in 1992. Total cost of the project is estimated at \$26,900. for seven moist soil units totalling about 30 acres. Preliminary work was done in one unit (field 33) this year.



- #8 A rice plow was borrowed from Blackwater NWR and a small levee was thrown up on the east side of field #33, creating a small (2 acre) moist soil unit.

8/91 F. Smith

Vegetation Transects

All transects within the impoundments and salt marsh were run by Biologist Smith and Maintenance Worker Straughn during the last two weeks of August.

3. Forests

Wooded habitat includes 453 acres of upland hardwoods (primarily white oak, red oak and hickory), 385 acres of hardwood swamp (black gum, sweetgum, red maple, yellow poplar) and 192 acres of shrub community (buttonbush, wax myrtle, sumac). Most acreage is in scattered woodlots and along field and marsh edges rather than in large blocks. Management in 1991 was limited to prescribed burning of areas where damage to hardwood regeneration was not a problem; and where the objective was to remove large fuel loads and stimulate legume production.

4. Croplands

Refuge shares from three cooperative farming agreements (Carrow, Snow and Hurd) were as follows in crop year 1991:

Storable Corn (banding bait)	125 bushels
Standing Corn	56.0 acres
Winter Wheat (drilled)	63.4 acres
Buckwheat/Ryegrass	61.5 acres
Milo	10.0 acres
Ladino Clover	189.4 acres
Ryegrass(overseeded on soybeans)	292.5 acres
Gamebird Mix Food Plots	10.0 acres

Emphasis continued in two main areas: increasing ladino clover for goose browse and increasing hot foods in the form of standing corn. After maintaining a field in ladino clover for 2-3 years the field is rotated back to corn as either cooperator or refuge share, and there is no need to apply nitrogen fertilizer to the corn crop. Here we must mow the clover at least two and preferably three times during the growing season to favor the clover over invading grasses, with the final mowing accomplished in early to mid-September to place it in prime condition for utilization by geese.



- #9 We have found that ladino clover seed sowed directly over winter wheat in late February at a heavy rate (5-8 pounds per acre) produces an exceptional stand after the wheat is harvested or mowed in early July.

6/91 F. Smith



#10 Maintenance Worker Straughn (6' tall) stands in our prodigious ladino clover.

9/91 F. Smith



#11 Same field (#3), same spot after the first snow goose attack in late October. Arthur left his hat.
11/91 F. Smith



#12 Field #12 ladino clover stand "before".....
9/91 F. Smith



#13 "during".....

10/91 F. Smith



#14 and "after". Fields that were consumed in late October made some limited regrowth in November, but the geese then returned in mid-winter to finish the job. Those fields to be retained in clover will get a "booster" seeding of 2 lbs. per acre the following February.

10/91 F. Smith

Refuge shares were based on charging the cooperators \$50. per acre for use of refuge fields to grow their corn or soybeans. Although 1991 was deficient precipitation-wise, all crops produced well due to timely rains and the relatively high moisture retention capacity of refuge soils. Harvested corn (329 acres) averaged 110 bushels per acre, and soybeans (249 acres) 50 bushels per acre.

Waterfowl utilization of croplands was predictable as to preferred crops, but not as much as to timing this year. Geese, especially snows, fed upon ladino clover almost immediately upon their early October arrival. Hordes of snow geese would envelop a field, feed for a day or two, and then move en masse to the next one. Location of the fields vis-a-vis disturbance factors such as the auto tour route seemed to have little effect as far as the snows were concerned. This early feeding in the clover fields took pressure off the areas of tidal marsh normally fed upon, and contributed to the smaller size of the 1991 marsh "eat-outs".

Canada geese, however, seemed to prefer fields removed from the general public as well as their white compatriots. For this reason, a new pipe gate was installed at the junction of Finis Road and Dutch Neck Road; with the road closed to all traffic between that point and the Allee house. This area, encompassing about 100 acres, was also eliminated from the West Waterfowl Hunt Area (see section H.8), and the croplands within it received heavy use by Canadas.

Standing corn was utilized by both species of geese beginning in mid-December, but plenty of corn and some green browse remained at year end.



#15 Once cold weather arrived in December, snow geese pitched right into standing corn.

12/91 F. Smith

5. Grasslands

Normal routine mowing of road and dike edges was accomplished throughout the growing season; both as a safety measure to promote visibility for visitors and as a discouragement of duck nesting (100% predation) on the dike edges. Fields which are in either sericea lespedeza or wild grasses are burned or mowed on a three year cycle to prevent invasion of shrub species.

9. Fire Management

A 500 acre block of tidal marsh (burn Unit C) was prescribe burned on February 4. Only 300 acres were originally planned for burning; the remaining 200 acres were re-burned (accomplished in 1990 also) because it was not economical to attempt to contain the prescribed burn within the original proposed boundaries. Several thousand snow geese were observed on the burn area on one occasion during the late winter. Burned vegetation was predominantly Spartina patens/ Distichlis spicata.

Thirty four acres of burn Unit A were proposed for a prescribed burn during late March. A fireline had been established on the area, which is part of the old Air Force Tract; however, proper weather conditions did not occur when sufficient manpower was available. During an aerial survey on April 12 evidence of a wildfire was noted on 330 acres including the original site proposed. Investigation through local residents revealed that the fire had occurred on April 10. Effects were 100% beneficial, since dead standing material was removed from upland fields and high salt marshes, reducing fuel loads and stimulating new early season plant growth.



#16 The Kent Island tidal marsh burn on February 4 was spectacular.

2/91 F. Smith



#17 Conditions were just right for an exceptionally complete burn on about 500 acres.

2/91 F. Smith

10. Pest Control

The following herbicides were applied on portions of the cropland management units during 1991:

<u>Herbicide</u>	<u>Crop</u>	<u>Target Species</u>
Roundup	Spot treatment in all fields necessary	Johnsongrass, Canada thistle
Dual	Corn, soybeans	Annual grasses/weeds
Prowl	Soybeans	Annual grasses/weeds
Basagran	Soybeans	Broad-leaved weeds
Scepter	Soybeans	Broad-leaved weeds
Gemini	Soybeans	Broad-leaved weeds

Excellent control was achieved on all target species. Application was by cooperative farmers with the exception of glyphosate on fields not included in the agreements.

Control of the latter was by those refuge personnel who are Certified Pesticide Applicators. No insecticides were required on refuge crops; in fact, none have been used since 1985.

Rodeo (glyphosate) was aerially sprayed during August on about 10 acres of swamp loosestrife in Finis Pool. This second consecutive year of glyphosate application is to compare loosestrife control with that on an adjacent 10 acres which was only sprayed once (in 1990). Results will not be known until monitoring of regrowth occurs in 1992.

Patches of Phragmites were also sprayed with glyphosate in September surrounding Raymond Pool, Shearness Pool, Pool A and Straughn Pool; a total of 100 acres.

1991 was an average year for salt-marsh mosquito infestations. The Delaware Mosquito Control Section made the following applications of larvicides and adulticides:

Abate	April 28, May 16, June 14, July 12 & 30, August 12
Altosid	June 17 & 21, July 15 & 31, September 12
Vectobac	April 23, June 15
Dibrom	August 2

Two of the Abate applications were by helicopter on very small acreages of marsh (April 28, May 16); as were all but one of the Altosid applications (September 12).

12. Wilderness and Special Areas

Marshall Island (50 acres) and an unnamed 70 acre island to its west in the Leipsic River form the Marshall Island Research Natural Area. Classification of the area is Type A-7 Tidal Salt Marshes. Wildlife surveys by the refuge staff were the only activities taking place in 1991 on the predominantly saltmeadow cordgrass and saltgrass islands.

The Service owns a historical residence in the Dutch Neck portion of the refuge. The Allee House, a country style brick structure of the Queen Anne period has been operated for many years by the Delaware Division of Historic and Public Affairs under long term (10 year) special use permit from the Service. The structure has been on the national Register of Historic Places since 1971. The occupants of the residence, who are State employees, open their home to the public on weekend afternoons from 2:00 pm to 5:00 pm.

G. WILDLIFE

1. Wildlife Diversity

Bombay Hook's habitat mixture supports a wide variety of animal species. There are documented records of 314 species of birds (43 being accidentals), 34 mammals and 27 reptiles/amphibians. Of the bird species, 55 are confirmed nesters, and 31 are probable nesters.

2. Endangered and Threatened Species

a. Bald Eagle

For the third consecutive year we had no successful eagle nest at Bombay Hook. A pair of adult eagles set up their territory during December 1990 and were observed constructing a nest in Finis woods in the same vicinity as nests of recent years. During the period January through early April the eagles were seen frequently at the nest and appeared to be in incubating position during March. On April 6 a bird was spotted sitting on the nest, but six days later during an aerial inspection of the nest no birds were seen. On April 25 personnel from Delaware Division of Fish and Wildlife climbed the nest tree and recovered a few fingernail size egg fragments. The fragments were taken to Patuxent Wildlife Research Center, but were not of sufficient size and condition to be adequately examined for pesticide residue.

b. Peregrine Falcon

Although peregrines are infrequently sighted during the fall, winter and spring we have never had a successful nesting attempt on our saltmarsh nesting tower. Through the use of properly installed predator guards we have been able to eliminate raccoons from the nesting platform, but are still plagued by competition from great horned owls. During an inspection of the tower during early March we discovered a pair of nesting owls. Two eggs which were present were removed. Follow up checks of the tower during the month revealed no more activity by either owls or peregrines.

3. Waterfowl

Total waterfowl use-days for CY91 were 5,484,693. This is a decrease of 1,211,471 use days from CY90. The most significant decrease occurred in snow goose use. Duck use

was down slightly as well; while both Canada goose and tundra swan use increased. Table G.3.1 compares the last four years use-day figures.

Table G.3.1 Waterfowl Use-Days 1988-91

<u>Species</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>
Tundra Swan	3,276	2,170	1,437	3,740
Ducks	2,524,247	1,598,570	1,985,995	1,781,813
Canada Geese	1,229,182	607,992	550,870	690,487
Snow Geese	<u>3,320,645</u>	<u>2,740,168</u>	<u>4,157,862</u>	<u>3,008,653</u>
TOTAL	7,077,350	4,948,900	6,696,164	5,484,693

a. Canada Geese

Canada goose use increased slightly during 1991 both on Bombay Hook and throughout Delaware. The refuge employed several techniques this year in an effort to make the area more attractive to Canada geese. More standing corn was left in the fields and increased acreage of ladino clover browse was planted; providing more of the crops most attractive to Canadas here. Several restrictions were instituted on the West Waterfowl Hunt Area, which is mostly field blinds where Canada geese form the bulk of the harvest. Some of these restrictions were cutting down to two mornings per week instead of three; and permitting only one visit per hunter for the entire season. In addition, the general public was restricted from portions of the auto tour route to give more areas for geese to feed and rest undisturbed.

The winter of 90-91 was the second in a row of quite mild temperatures, virtually no snow accumulation and therefore little weather related stress. January and February populations averaged 4,000 - 6,000 birds with peaks of nearly 8,000. Most Canadas departed the area during early March. Come autumn, the population rose slowly, and the October peak only reached 3,000 birds. November and December, however, saw continued increases; and a peak for the year was recorded on December 10 of 9,500 geese. This late increase may have been a result of the movement of birds from the Middletown, Delaware area onto the refuge subsequent to the initiation of significant hunting pressure up there.

b. Snow Geese

Snow goose populations in the area remained extremely high, although the birds seem to be using off refuge sites more frequently each year for both feeding as

well as roosting. Use days declined significantly from 1990. January and February were the two months which showed the biggest disparity between 90 and 91. During 1990 average populations for those two months were 30,000 and 35,000 birds, while during 1991 the two months averaged only 5,000 and 6,000 birds. Prime Hook NWR and other off refuge sites now seem to be supplying much more of the flock's roosting and feeding requirements than just a few years ago. For the third consecutive year our staff and the personnel from Delaware Division of Fish and Wildlife conducted aerial snow goose surveys over the upper Delmarva peninsula throughout the wintering period. Roosting sites as well as feeding sites were monitored. Populations in our survey area (Delaware, portions of Cecil, Caroline, Kent and Queen Anne Counties in Maryland) peaked at 137,000 birds. Each year the birds seem to be less and less dependent on Bombay Hook, but still manage to denude large areas of saltmarsh vegetation, eat most of the standing corn and clover, and flatten all emergent vegetation within the refuge impoundments. No habitat management on the refuge can be contemplated without first considering the impacts that the snow geese will have on our efforts. Efforts to make an area attractive to Canada geese or ducks are often obliterated by the devastating effects that large numbers of snow geese can create in a very short time. Many local hunters and landowners have expressed their concerns as to possible negative impacts of this species on the Canada goose throughout portions of Delmarva. Reports of areas such as farm ponds which may begin the fall supporting good roosting populations of Canadas being overrun with snows and subsequently losing the Canadas are common, and are an aspect of wildlife research that needs attention.

This year's peak refuge population was recorded on December 3 when slightly more than 40,000 birds were recorded. Based on our aerial photography we estimated that 519.3 acres of tall form Spartina alterniflora were removed by goose feeding during the 1990-91 season. This total is a decrease of approximately 71.5 acres from the previous year.

c. Swans

Use of the refuge by tundra swans was minor again this year, but was up somewhat from 1990. Peak numbers of 150 were recorded in late January. The birds primarily use Shearneck Pool as a roosting area and fly out to wheat fields along Rt 12 during the day to feed.

d. Ducks

Duck use days were reduced this year primarily due to the dry early fall period which precluded obtainment of optimum water levels in Shearneck Pool. Although food production within the pool was good, lack of rainfall prevented the flooding of the pool during the period when we traditionally receive the highest pintail and green-winged teal utilization. This year our peak duck populations were not achieved until December. A comparison of average and peak populations for key species is contained within tables G.3.2 and G.3.3.

Table G.3.2 - Average Populations For Blacks, Mallards, Green-winged teal and Pintails 1991

	<u>Mallard</u>	<u>Black</u>	<u>GWT</u>	<u>Pintail</u>
January	1800	1500	1000	1000
February	550	1000	1000	1300
March	600	800	1800	300
April	400	600	2500	400
May	150	125	200	---
June	600	125	3	---
July	700	300	8	1
August	700	130	250	2
September	300	250	700	500
October	1000	800	4500	2500
November	850	1000	1500	1200
December	2000	2500	4100	4000

Table G.3.3 - Peak Populations for Blacks, Mallards, Green-winged teal and Pintails 1991

	<u>Mallard</u>	<u>Black</u>	<u>GWT</u>	<u>Pintail</u>
January	2270	2500	3500	3000
February	600	1100	1400	1500
March	800	1000	2500	500
April	565	900	3500	800
May	200	150	1000	---
June	700	150	6	---
July	800	400	10	4
August	800	200	750	2
September	350	423	1600	650
October	2000	1200	6000	3500
November	1000	1200	2000	1500
December	3621	3543	6635	6200

The wood duck nest box program again received considerable attention. Maintenance Worker Arthur Straughn once again did an excellent job in monitoring

all boxes, checking each a minimum of three times during the nesting season, erecting new boxes where needed, moving boxes, and keeping detailed records of bird use and nesting success. The past three year's data was entered into the computer program developed by Bill Leenhouts. The percentage of eggs that hatched increased from 37.4% in 1990 to 47.4% during 1991. Dump nesting continues to be a problem. Bear Swamp Pool, Finis Pool, and the back of Shearneck Pool are the areas most frequented by wood ducks, and are the areas where most of the boxes are located. Both Finis and Bear Swamp also provide the best brood habitat. Table G.3.4 compares wood duck nesting success for the past 8 years.

Table G.3.4 Comparison of Wood Duck Nesting Success
1984-1991

<u>YEAR</u>	<u>#BOXES</u>	<u>TOTAL EGGS</u>	<u>EGGS HATCHED</u>	<u>MEAN CLUTCH</u>	<u>#NEST</u>
1991	157	3271	1551	19.4	169
1990	158	3123	1168	18.6	168
1989	141	2135	1510	14.4	148
1988	126	1706	1252	14.5	118
1987	95	1571	904	17.1	92
1986	78	874	408	17.5	50
1985	68	563	277	13.1	43
1984	80	551	104	13.8	40

Production estimates for waterfowl species other than wood ducks remain little more than educated guesses. We still do not have a reliable method of estimating waterfowl production in the saltmarsh. Significantly, that is precisely where most production occurs. We experimented this year with boat surveys along planned routes through the saltmarsh. Unfortunately, the data obtained provides little more than a rough idea of the species bringing off successful broods in the areas surveyed. Conditions such as creek depth, tidal stage, and time of day dictate the areas that can be surveyed with this technique.

The refuge raccoon population suffered a significant reduction this spring and summer as a result of both distemper and rabies. We were successful in locating and documenting successful upland mallard and black duck nests for the first time in several years. There is a strong feeling among us that a correlation exists between these phenomenon.

Table G.3.5 Estimated 1990 and 1991 Waterfowl Production

<u>Species</u>	<u>1990</u>	<u>1991</u>
Mallard	150	225
Black duck	250	250
Wood duck	584	776
Blue-winged teal	100	100
Gadwall	150	150
Canada geese	10	1

4. Marsh and Water Birds

Data collected by the refuge staff revealed much higher peak wading bird populations for certain species (great egrets, snowy egrets and great blue herons) during the past year. These peaks traditionally occur during impoundment drawdown during the summer. This was true again in 1991 but was even more pronounced, possibly as a result of the low water and drought-like conditions of late summer. Table G.4.1. illustrates representative peak populations of various species during 1991.

**Table G.4.1 Marsh and Water Bird Peaks 1991
(1990 peaks in parenthesis)**

<u>Species</u>	<u>Number</u>
Double-crested cormorant	400 (400)
Great egret	900 (200)
Snowy egret	1000 (200)
Glossy ibis	700 (850)
Great blue heron	235 (60)

5. Shorebirds, Gulls, Terns and Allied Species

Large concentrations of spawning horseshoe crabs along the bay shore during May and June once again served as a major attractant to migratory shorebirds. Weekly boat censuses were conducted during this period. Peak counts of the predominant species are listed in table G.5.1

**Table G.5.1 Shorebird Peaks 1991
(1990 in parenthesis)**

<u>Species</u>	<u>Number</u>	<u>Date</u>
Dunlin	2937 (4562)	5/15/91
Ruddy turnstone	8455 (11867)	5/31/91
Knots	4087 (4239)	5/22/91
Semi-palmated sandpiper	13877 (12526)	5/22/91
Dowitchers	4595 (2536)	5/15/91

Peaks for the primary species are remarkably consistent from year to year. This year we provided our data to the Manomet Bird Observatory in Massachusetts to be used in their cooperative shorebird population surveys. Avocets and black-necked stilts continue to increase on the refuge. The stilt now is quite common within the impoundments as well as the salt marsh and nests extensively. The avocet, although not confirmed as a breeder on the refuge, reached a peak of 225 birds within Raymond Pool during August. Impressive numbers of shorebirds used Raymond Pool from early spring into the autumn. This is the second year in a row that large numbers of shorebirds remained through the summer months in Raymond. Predominant species were dowitchers, although large numbers of semi-palmated sandpipers, yellowlegs, Wilson's phalaropes and semi-palmated plovers also frequented the pool.

6. Raptors

No unusual raptor population fluctuations were detected this year. Kestrels, great horned owls, screech owls, barn owls, black vultures and red-tailed hawks were all known to have successfully produced young in 1991; and it is likely that the northern harrier, red-shouldered hawk, and turkey vulture did so as well.

7. Other Migratory Birds

This was the fifth year of the bluebird nest box program and the third year in a row that saw an increase in bluebird box use. A total of 25 boxes were available for nesting bluebirds. Seven were used by bluebirds and a total of 24 young were successfully fledged. Competition with tree swallows was the main impediment to greater use of the boxes by bluebirds.

8. Game Mammals

a. Big Game

The only big game mammal present on the refuge is the whitetail deer. The population, estimated through periodic spotlight surveys, is believed to be relatively stable or increasing slightly. Currently the pre-hunt season population is estimated at 300 to 350 animals. Habitat remains in excellent condition with no browse line and no detectable increase in crop depredation. Herd health is excellent as reflected in average weight of fawns and 1.5 year old animals harvested this year. The regulated deer hunts held here for many years have helped maintain the herd size at a manageable level.

All deer harvested during the hunts are brought to an official State check station on the refuge where we collect data relative to overall condition, weight, age, and antler beam diameters. All measurements indicated a continuation of excellent herd condition. (Section H.8)

b. Muskrat

Portions of the salt marsh which historically were some of the most productive muskrat habitat on Bombay Hook have been significantly degraded in recent years by snow goose feeding activities. The areas known as Money Marsh and Leatherberry Flats have had nearly 1,000 acres of tall form Spartina alterniflora removed annually, thereby rendering them unsuitable for muskrat use. An index of the population is normally obtained by an aerial house survey each winter; although the accuracy of this technique is influenced greatly by the presence or absence of snow cover as well as tide stage. Several portions of Bombay Hook support good muskrat populations based on trapping data; but are not accurately censused due to the tendency in those areas for the animals to use bank dens rather than houses.

c. Raccoon

The raccoon has historically been extremely abundant on Bombay Hook both in the uplands and throughout the salt marshes. We know they prey heavily on waterfowl nests and have desired a much reduced population. Commercial trapping is permitted, but the annual catch is low, seldom exceeding 100 animals. This level of harvest is insignificant in terms of reducing the population. Distemper is, historically, the single most evident population control mechanism in the refuge population. During the past two years raccoon rabies became quite common in the northern portion of the state and began working its way southward. Several sick and/or dead coons began appearing in March. On May 6 a sick raccoon, collected on the refuge, was positively diagnosed with rabies by the State Department of Agriculture. Based on winter night lighting surveys as well as the testimony of the refuge trappers it appears that our raccoon population has been significantly reduced by this outbreak.

d. Otter

Otter sign is common within the refuge impoundments and salt marsh, although sightings of the animals are infrequent. We have no reliable estimate of their

population size, although we have seen nothing to indicate a change in the population from previous years.

e. Other Mammals

Beaver were seen throughout the year and are flourishing throughout Finis Pool, the upper end of Sheariness Pool as well as the back portions of Bear Swamp. Although they occasionally plug the water control structure in Finis Pool they do not create significant problems.

No changes were noted in cottontail rabbit, red fox, grey squirrel, opossum, and woodchuck populations. Red fox continue at high population levels with many mangy, diseased specimens sighted. The red fox has historically been fully protected within the state; therefore no control alternatives were available. However, during the past year a limited hunting season has been approved which may offer some future options.

10. Other Resident Wildlife

Bobwhite and ring-necked pheasant are sighted commonly on the refuge. No noticeable trends were observed which indicated anything but stable populations of both these species.

Wild turkeys were sighted several times during the year primarily in the Dutch Neck Unit, indicating that the population which moved onto the refuge from adjacent State Management areas is taking hold.

16. Marking and Banding

Bombay Hook and Prime Hook were once again assigned a combined quota for pre-season banding of wood ducks and black ducks. Considerable effort was expended at both stations. Bombay Hook wood duck banding was conducted in the southern portion of Bear Swamp and black duck banding was accomplished (although not very productively) at locations near Hay Ditch and on Sheariness Gut. Although the non-quota mallard can easily be captured at Bombay Hook, we find it extremely difficult to capture pre-season blacks. Low refuge populations during the late summer contribute to these difficulties. Fortunately, Prime Hook is much more successful. Tables G.16.1 and G.16.2 summarize our 1991 banding efforts.

Table G.16.1 Bombay Hook Waterfowl Banding Totals 1991

<u>Species</u>	<u>HY-Male</u>	<u>HY-Female</u>	<u>AHY-Male</u>	<u>AHY-Female</u>	<u>Totals</u>
Wood Duck	71	76	11	6	164
Black Duck	1	1	6	7	15
Mallard	4	5	14	36	59

**Table G.16.2 Combined Bombay Hook/Prime Hook Totals 1991
(Quota in Parenthesis)**

<u>Species</u>	<u>HY-M</u>	<u>HY-F</u>	<u>HY-UnK</u>	<u>AHY-M</u>	<u>AHY-F</u>	<u>Totals</u>
Wood Duck	83(50)	84(50)	0(0)	32(50)	11(50)	210(200)
Black Duck	70(50)	57(50)	1(0)	16(50)	14(50)	158(200)
Mallard	30	40	0	21	23	114
Pintail	2	3	0	0	0	5

17. Disease Prevention and Control

A big die-off in the raccoon population began in March and continued through May. The refuge staff suspected rabies from the initial animals noted, since the disease had been working its way south through the Delmarva Peninsula. On May 6 a sick raccoon was dispatched on the refuge and submitted for examination to the State Department of Agriculture; the result was positive for rabies. Appropriate signs had been placed at the refuge entrance and visitor center from the beginning of the disease outbreak warning the public not to approach or handle any wild animals. Our estimate is that at least 75% of the pre-outbreak raccoon population was eliminated, much to the delight of refuge waterfowl and other ground nesters.

H. PUBLIC USE**1. General**

Total public use visits were 78,133 this year. Wildlife observation accounted for 56.4% of all visitor activities, followed by environmental education (to include interpretation, outdoor classrooms, and educational assistance) 40.3%, and hunting/trapping 3.3%.

This was the third full year of charging entrance fees. Following is a comparison of the fees collected and passes issued during the past three years.

Table H.1.1 Total Entrance Fees and Passes Collected 1989-91

	<u>1989</u>	<u>1990</u>	<u>1991</u>
Daily passes (\$)	17,024.00	16,829.53	16,043.37
Golden eagle passes (#)	76	89	90
Golden eagle passes (\$)	1,900.00	2,225.00	2,250.00
Golden age passes (#)	432	446	457
Golden access passes (#)	14	4	10
Federal Duck Stamps (#)	871	796	426
Federal Duck Stamps (\$)	10,887.50	9,950.00	6,390.00

The refuge share from daily entrance fees and golden eagle passes (30%) returned as 4960 money was \$5,488.01. These funds were used for the interpretation and environmental education program and also for the funding of a seasonal position. Duck stamp sales were down this year mainly because the largest local hunting lodge bought very few duck stamps from us. Generally they buy several hundred; however, the operation is going out of business and the lodge has been sold to the Delaware Division of Fish and Wildlife.

Table H.1.2 Monthly Entrance Fees Collected for CY 1991

January	\$ 916.33
February	609.28
March	1,550.13
April	1,404.80
May	1,554.13
June	681.13
July	844.77
August	1,173.65
September	1,543.38
October	2,736.67
November	2,133.00
December	896.10

Table H.1.3 Public Use Activity 1983-1991

<u>Year</u>	<u>Total Visits</u>	<u>Interpretation</u>	<u>Outdoor Classroom</u>	<u>Observation Vehicle</u>	<u>Foot</u>	<u>Number Groups</u>
1991	78,133	52,088	2,292	69,565	6622	103
1990	81,676	60,433	1,756	70,469	7046	101
1989	78,258	36,232	1,694	70,090	6635	105
* 1988	83,347	44,648	1,597	74,519	7156	110
1987	83,286	36,194	1,337	74,968	7380	113
1986	81,987	40,313	1,786	72,626	6957	124
1985	77,752	32,564	2,093	67,735	6773	103
1984	55,890	24,860	1,672	52,302	3736	111
1983	32,079	11,041	967	26,103	3035	76

* Refuge entrance fees instituted in June, 1988.

For the first time since the opening of the visitor center in 1983, the refuge was able to hire seasonals to assist the Outdoor Recreation Planner during the busy seasons of fall and spring. Three seasonals share one temporary recreation aid position. One, Bob Jones, is an artist, writer, and environmental education teacher. Another, Verna Price, is a retired environmental science teacher, and in addition to working well with the school groups, has been a tremendous help in keeping the sales outlet running smoothly since the business manager resigned. A third, Mark Connelly, is familiar with computers and assisting in getting information on them; as well as developing programs for public use.

Outdoor Recreation Planner Marian Johnson-Pohlman worked with the Washington Office, Division of Refuges, in training hearing impaired individuals for the field. She conducted a week long training session for four hearing impaired/deaf students from Gallaudet University during July. These students were interested in positions either in the Outdoor Recreation Planner or the Refuge Manager series. Students may do a one year internship at Bombay Hook before being assigned to another location.

The ORP also continued to provide assistance to Prime Hook and Eastern Neck Refuges as requested. No requests were received from Blackwater Refuge this year. Pohlman worked on lesson plans and trained volunteers for the 4th Grade Environmental Education Days held at Eastern Neck in the fall. She also participated in the actual event. Two environmental education workshops (fall and spring) were conducted at Prime Hook this year. Each was six hours long for 2/5 inservice teacher credit. The workshop included an orientation to Prime Hook Refuge and an interpretive walk along the boardwalk trail by the assistant manager. The ORP conducted the habitat studies of forest, marsh, pond, and beach.



#18 ORP Johnson-Pohlman oriented hearing impaired students from Gallaudet who were enrolled in the Washington Office Division of Refuges program.

8/91 A. Mullins

2. Outdoor Classrooms - Students

Of the 2,531 students that toured the refuge this year, 2,011 or 79% also engaged in environmental education activities, e.g. wetland and forest studies. All students tour the refuge, and receive information about our wildlife management program. Many also take interpretive walks along the trails, with emphasis being placed on the importance of wetlands to wildlife.

Teachers and volunteers conducting the outdoor classroom studies are provided with equipment such as aquatic and aerial nets, clear plastic jars, white pans, spades for digging the leaf litter, identification guides, magnifying lenses, lesson plans, and water test kits.

More schools are now including a Delaware Bay beach study as part of their environmental education program at Bombay Hook. Schools have been making use of Woodland Beach to the north of Bombay Hook and Port Mahon to the south.

3. Outdoor Classrooms - Teachers

Outdoor Recreation Planner Pohlman conducted two (spring and fall) fifteen hour environmental education workshops for one in-service credit each. Twenty-five (25) teachers attended these workshops. Refuge workshops include an orientation slide show and wildlife management tour, sessions on management techniques and surveys, habitat studies (which include fresh and saltwater marshes and bay beach areas, forest, and meadow), educational resources review, simulated activities (from such sources as OBIS, Project Learning Tree, Project Wild and Aquatic Wild), and activities on current environmental issues and problems. Teachers also prepare their own lesson plans to be presented to the group at the end of the workshop. Attendees receive a packet of materials that includes workshop activities, all refuge brochures, and several of the service-wide brochures. The Service habitat pacs are also provided. These packets are also available to any teachers wishing to bring their classes to the refuge and/or conduct environmental education activities on school grounds. Environmental education equipment including jars, pans, trowels, water test kits, nets and identification guides are available on advance request.



#19 Meadow studies were an integral part of the habitat studies at the environmental education workshop for teachers and volunteers conducted by ORP Pohlman.

4/91 M. Connolly

This year 281 teachers spent 1,317 activity hours on the refuge, engaging in various environmental and interpretive type activities.

Karen Day from the Delaware Bay Estuary Program worked with ORP Pohlman in developing site specific lesson plans for Bombay Hook wetlands and also conducted the beach segment of the workshop held in the spring.



#20 A beach study was added to the 15 hour environmental education workshop in order to focus more comprehensively on all Delaware Bay wetlands.

4/91 S. Kemerling

A Project Wild Workshop was conducted by personnel of the Delaware Department of Natural Resources and Environmental Control at Bombay Hook during August and nine teachers attended.

4. Interpretive Foot Trails

Interpretive brochures for the Boardwalk, Bear Swamp and Parson Point trails were at the printers at year's end and will be received in time for the spring 1992 busy season. These brochures will make it easier for teachers to conduct their own interpretive walks, and also give the general public additional information when walking the trails. Two eagle scout groups will be installing posts along the trails to correspond to numbers in these brochures. Experience with counts by a traffic counter has allowed us to estimate that approximately 10% of the visitors to the refuge also walk a trail. Interpretive walks were conducted for 2,200 individuals, mainly school children.

Scout groups have been assisting in wood chipping the trails to help prevent erosion. The rope for the blind along the handicapped trail which was installed during 1990, was stolen twice this year. The next installation will include separate lengths between each post rather than one long rope along 666 feet of trail to discourage theft.



#21 Several scout groups signed up to woodchip trails or clean up litter.

5/91 M. Johnson-Pohlman

5. Interpretive Tour Routes

A twelve mile (round trip) auto tour route is interpreted by a brochure that corresponds to numbered posts along the route. Two site specific interpretive signs are presently on the route, one on the bald eagle and the other on shorebirds and the horseshoe crab connection. Six additional signs on management topics are presently out on bid and hopefully will be in place during 1992. They cover the following: waterfowl, wading birds, water control, cooperative farming, tidal salt marsh, and snow geese.

Conducted and self-guided tours emphasize the station message, which includes wildlife management techniques utilized at this refuge, species of interest, plant and animal identification and ecological principles. Ninety-seven groups (2,531 individuals) were given conducted tours this year by trained volunteers, field work students, teachers, and the outdoor recreation planner. The visiting groups fell into the following categories:

- 53 elementary or secondary schools
- 9 colleges and universities
- 9 scout groups
- 9 senior citizen and handicapped groups
- 17 miscellaneous groups (including birding, conservation, garden club, civic club, church, camp, general public, and volunteer groups)

6. Interpretive Exhibits/Demonstrations

Wildlife artists (photographers, painters and carvers) exhibited their work in the refuge auditorium on fall and spring weekends.



#22 Artist Dorsey Hudson exhibits his bird carvings at the annual field day.

11/91 M. Johnson-Pohlman

A proposal for a six panel kiosk exhibit has been submitted for bid. It will be purchased with Watchable Wildlife funds during 1992. The kiosk panels will cover the following topics: endangered species in Delaware, popular species at Bombay Hook (waterfowl and shorebirds), opportunities and facilities, North American Waterfowl Management Plan, land agencies (NPS, FWS, USFS, and BLM), and wildlife management practices at Bombay Hook. The refuge has a portable velcro exhibit which is used for various off site events. Wildlife management techniques, refuges on the Delaware and Chesapeake Bays, and the importance of wetlands are the usual topics covered on this exhibit. The refuge uses this exhibit each year at Coast Day in the fall, and also used it this year for several Earth Day events.

7. Other Interpretive Programs

Wildlife slide shows, movies, and videos continued to be offered on a regular basis in the visitor center auditorium to the general public as well as organized groups.

The Bombay Hook Annual Field Day was held on November 3. Visitors were offered refuge tours, nature walks, boat trips, beach studies and a live reptile and amphibian program.



#23 The Department of Agriculture and Natural Resources at Delaware State College provided nature games and crafts at our annual field day. The deer skeleton was drawn on a canvas and the actual deer bones were the puzzle pieces - a neat idea!

11/91 M. Johnson-Pohlman

The refuge held an Earth Day celebration on April 20 which included a wildlife management tour, bird walk, trail walk, live reptile and amphibian program and Earth Day slide show and talk. Attendance was low because of an all day heavy rain. The refuge also participated in off-site Earth Day programs at DuPont Chemical Company and the state event at Christiana Mall.

ORP Pohlman and recreation aids Mark Connelly and Verna Price conducted several off-site programs this year on various wildlife topics and opportunities for careers in fish and wildlife management.

Pepsi-Cola began producing cans with a panel listing Bombay Hook Refuge as a "place of interest to visit on Delmarva", and including the message "Managing for Waterfowl, Wildlife and Wetlands."



#24 A visit to this place of interest on Delmarva "hits the spot".

12/91 M. Johnson-Pohlman

8. Hunting

Due to the small size and relatively dense population of the State of Delaware there are heavy demands placed on lands open to public hunting. Much of the private land which can provide waterfowl hunting opportunities is leased, usually at high cost. Demand for refuge hunts is therefore high; and we conduct a variety of migratory waterfowl, upland game and deer hunts during portions of the regular state seasons.

Waterfowl-South Area

The South Waterfowl Area, also known as Kelly Island, consists of 20 blinds accessible only by boat. A user fee of \$10.00 is charged per blind, each of which will accommodate up to three hunters. Permits are issued through a daily lottery system near the public access boat ramp at Port Mahon by refuge staff until 7:00 a.m. Prospective hunters who arrive after 7:00 a.m. can register for unassigned blinds at the State's Little Creek Management Area a few miles to the south until 1:00 p.m. Delaware's duck season this year was 30 days with a daily basic bag limit of 3 birds; the Canada goose season was 39 days with a daily basic bag limit of 1 bird; and the snow goose season was 105 days with a limit of 5. The south area is primarily a duck hunting area.

This was an average year as far as ducks bagged per hunter. Black ducks (31.5%) formed the largest portion of the duck hunter's bag this season followed by green-winged teal (23.9%) and mallards (18.3%). The high take of black ducks is noteworthy considering only one black per day is permitted.

The summary on the following page shows the success on this area for the past three years; hunting is conducted only on Monday, Wednesday, Friday, and Saturday.

South Waterfowl Hunt Area

	<u>#</u> <u>Hunters</u>	<u># Ducks</u> <u>Harvested</u>	<u>#Blacks</u> <u>Harvested</u>	<u>% Kill</u> <u>Blacks</u>	<u>#Ducks</u> <u>Hunter</u>
91-92					
<u>Season</u>					
11/4-11/9 (4 days)	152	215	56	26.0	1.41
11/25-11/30 (2 days)	47	55	18	32.7	1.17
12/18-01/04 (10 days)	<u>279</u>	<u>212</u>	<u>78</u>	<u>36.8</u>	<u>0.76</u>
TOTAL	478	482	152	31.5	1.02
90-91					
<u>Season</u>					
11/1-11/7 (4 days)	96	55	17	30.9	0.57
11/20-11/24 (3 days)	90	91	14	15.4	1.01
12/19-1/05 (11 days)	<u>261</u>	<u>267</u>	<u>54</u>	<u>20.2</u>	<u>1.02</u>
TOTAL	447	413	85	20.6	0.92
89-90					
<u>Season</u>					
11/2-11/8 (4 days)	105	134	24	17.9	1.28
11/22-11/25 (3 days)	99	150	50	33.3	1.52
12/19-1/06 (2 days)	<u>42</u>	<u>57</u>	<u>14</u>	<u>24.6</u>	<u>1.36</u>
TOTAL	246	341	88	25.8	1.39

Waterfowl-West Area

Due to the decline in Canada goose use on the refuge, certain changes were implemented this year on the West Waterfowl Area. We reduced the number of refuge maintained blinds from 16 to 11 and reduced the number of days per week the area was open from 3 to 2 (Tuesday and Saturday). The size of the area open to hunting was also reduced. Hunters were charged \$10.00 per blind (maximum of 4 hunters) as a user fee. Another change was implemented this year which limited hunters to only one hunt day per year. This change was implemented since it was felt that this would offer the greatest number of different individuals a chance to participate in an activity which is in high demand with few available opportunities. Delaware's

season this year was a two-way split during the periods November 25-November 30, and December 14-January 16 with a bag limit of one bird per day. Hunting was moderate to poor throughout the year; although the refuge goose population was at its highest during late December and January. Harvest of snow geese on this area was also permitted although snows were rarely taken. The following is a summary of success during recent years on the West Waterfowl Area:

West Waterfowl Hunt Area

<u>Year</u>	<u># Hunters</u>	<u>Canadas Harvested</u>	<u>Snows Harvested</u>	<u>Canadas/ Hunter</u>	<u>All Geese/ Hunter</u>
91/92	315	107	48	0.34	0.49
90/91	662	205	22	0.31	0.34
89/90	895	502	40	0.56	0.61
88/89	1259	604	150	0.48	0.60
87/88	1378	1010	138	0.73	0.83
86/87	1311	757	13	0.58	0.59
85/86	1542	770	80	0.49	0.55
84/85	1790	1148	4	0.64	0.67
83/84	1586	1158	20	0.73	0.74
82/83	1491	698	--	0.47	0.47
81/82	1453	496	--	0.34	0.34
80/81	1557	895	--	0.57	0.57

Waterfowl-Snow Goose Area

Managed hunts on portions of the refuge tidal marsh have been employed for several years in an effort to disperse the concentrations of geese causing marsh damage in the form of "eat-outs" in the areas known as Leatherberry Flats and Money Marsh. Various other techniques have proven ineffective in deterring massive marsh denudation. This year we had hunting (without pre-constructed blinds) within the tidal marsh during the state season as well as during a period in November when Bombay Hook was the only open area within the State. The hunt appears to be only partially successful in meeting our objectives, since approximately the same acreage has been denuded annually during the past three years. Conversely, the "eat-outs" have not expanded during the same time period. During the early portion of the hunt interest was high; a significant number of hunt parties participated; and the geese were generally not feeding on the marsh grass during the day. However, by late November hunter interest wanes and the number of permittees is so low that little dispersing of the birds occurs as a result of hunter activity. The birds have altered their habits considerably in recent years and now

most of their feeding is confined to upland agricultural areas during the day, although they still use the tidal marshes for some roosting and night feeding. Hunter success was excellent during the first two weeks of the season, but experienced a sharp decline after that. Only on a few scattered occasions were hunters successful during the last two months of the season. A total of 688 birds were harvested this year with 621 being taken by November 1. Hunt results for the past six years are as follows:

Snow Goose Hunt Area

<u>Year</u>	<u># Hunters</u>	<u># Geese Harvested</u>	<u>Birds/Hunter</u>
86/87	241	139	0.58
87/88	552	757	1.37
88/89	661	1079	1.63
89/90	670	721	1.08
90/91	426	389	0.91
91/92	422	688	1.63



#25 An over-anxious snow goose hunter experienced a bit of difficulty attempting to launch his boat off the Shearneck Dike when his parking brake either didn't hold or wasn't set.

1/91 P. Daly



#26 The truck was retrieved; however it sustained considerable damage since the tidal waters in this vicinity average 40% - 50% sea strength for salinity.

1/91 P. Daly



#27 Assistant Secretary for Fish, Wildlife and Parks Mike Hayden (left) found Bombay Hook snow goose hunting quite productive during an October visit.

10/91 S. Wunderley

South Upland Area

This area, known as the "Air Force Tract" and locally as the "Davy Crockett Area", consists of 551 acres of brush, woodlands and a small amount of marsh on the southwest edge of the refuge. It is open for all types of game in accordance with applicable State and Federal regulations without the requirement of a special refuge permit. The isolation of this tract from the other refuge units makes it difficult to obtain accurate information on hunter participation or success; however random patrols during the season indicate that there is ample demand by hunters during the deer and small game seasons, as well as by fox hunt (chase) groups. The area is closed to all hunting between March 1 and September 1 to eliminate disturbance to nesting wildlife.

Deer

Public deer hunting during portions of the archery, primitive weapon, and shotgun State seasons continued to be provided this year. Interest in our hunting and participation by sportsmen remained high. This marked the second year that we have required user fees for firearm hunting. Fees were \$5.00/hunter for muzzleloader and shotgun hunting on the Regular Area and \$10.00/hunter for shotgun hunting on the Headquarters Area.

Archery hunting was permitted on the first two Saturdays of the State season on the Regular Deer Hunt Area with an 11:00 a.m. closure. For the first time we opened the Fischer Tract to self-serve archery hunting on week days during October. The Fischer Tract hunt was well received by the public, since it offered more opportunities with limited bureaucratic red tape and it was certainly not a drain on staff time or manpower.

During the primitive weapon season (October 10-12) hunting was permitted only on the Regular Deer Hunt Area. Nineteen deer were taken by the 145 hunters who participated.

During the shotgun season the Regular Deer Hunt Area was open for 3 days during the November season and 1 day during the January season. The Headquarters Area was open for 2 days during the November season. Hunter success was good on both areas, although warm weather resulted in a very low success rate on the second day of the Headquarters hunt. The total deer taken for all hunts combined was a record 78 animals. A summary of Refuge deer hunts since 1985 is on the following page:

Summary of Refuge Deer Hunt Since 1985

		<u># Hunter Visits</u>	<u># Days Open</u>	<u># Deer Harvested</u>	<u>Percent Success</u>
<u>Regular Area</u>					
SHOTGUN	1985	128	3	16	12.5
	1986	148	3	21	14.2
	1987	162	3	17	10.5
	1988	151	3	15	9.9
	1989	164	3	25	15.2
	1990-91	208	4	38	18.3
	1991-92	202	4	33	16.3
MUZZ LOAD	1985	108	3	3	2.8
	1986	136	3	3	2.2
	1987	156	3	6	3.8
	1988	157	3	13	8.3
	1989	138	3	7	5.0
	1990	109	3	2	1.8
	1991	145	3	19	13.1
ARCHERY	1985	199	5	1	0.5
	1986	173	5	2	1.2
	1987	184	5	1	0.5
	1988	181	5	2	1.1
	1989	156	6	2	1.3
	1990	86	4	0	0.0
	1991	61	2	2	3.3
<u>Headquarters/ Fischer Areas</u>					
SHOTGUN	1985	80	2	24	30.0
	1986	100	2	29	29.0
	1987	95	2	30	31.6
	1988	101	2	27	26.7
	1989	102	2	29	28.4
	1990	93	2	32	34.4
	1991	100	2	22	22.0
NON-AMBUL.	1985	8	2	3	37.5
	1986	7	2	1	14.3
	1987	3	2	0	0.0
	1988	4	2	1	25.0
	1990	4	2	2	50.0
	1991	2	2	1	50.0
ARCHERY	1991	56	19	1	1.8

Summary of Age and Weight Data-1991 (1990 Totals in Parenthesis)

<u>Age Class</u>	<u># Bucks</u>	<u># Does</u>	<u>Average wt. Bucks</u>	<u>Average wt. Does</u>
0.5	28 (19)	11 (12)	62.4 (64.0)	54.0 (45.6)
1.5	21 (13)	3 (5)	119.0 (119.5)	89.7 (99.8)
2.5	6 (5)	5 (9)	147.0 (147.4)	105.2 (107.9)
3.5+	0 (1)	4 (2)	-----(178.0)	116.0 (121.0)



#28 The noon drawing for deer stands on the Headquarters Hunt Area is always a popular local event. Usually at least one third of the stands are available from hunters who have gotten a deer during the morning. After the lottery is over and the little nimrods are safely out of the way the grill is fired up for the traditional staff Headquarters Hunt barbecue.

11/91 'A. Straughn

9. Fishing

No sport fishing is permitted from lands or within waters which are part of the fee title area of the Bombay Hook National Wildlife Refuge. The tidal waters within the refuge boundary, which are closed to waterfowl hunting by proclamation, are commercially fished with white perch and eels being the most commonly taken species. Refuge impoundment water levels are manipulated to encourage growth of emergent or submergent vegetation for waterfowl; and this management is generally contrary to that which would encourage game fish populations and sport fishing.

10. Trapping

Extremely low fur prices, the deterioration of the marsh due to snow goose feeding, and possibly the aging of our trappers resulted in very limited interest in trapping on the refuge. Total rental fees for the 1990-91 season were only 405.01 (from 2 trappers). The following fur bearers were removed by trappers during the 1990-91 season: muskrat-756, Raccoon-47, and opossum-0. Interest picked up slightly for the 1991-92 season as six trappers produced high bids of \$1,476.00 during the public bid opening in the auditorium on December 5.

11. Wildlife Observation

Wildlife observation has been and probably always will be the reason most visitors come to Bombay Hook. This year individuals or families drove their personal vehicles along the auto tour route (69,575 visitors), took walks along the trails (6,957 visitors) or photographed wildlife (3,478 visitors). Peak public use always occurs during the waterfowl season, particularly the months of October and November. The next highest visitation period is during the spring shorebird season of March through May. Visitation is much lower during the winter months and also during the summer due to large numbers of pestiferous mosquitoes and biting flies; however an interesting observation is that mild winters recently have resulted in more refuge visitors during the December through February period than was the case several years ago.

Manager Daly conducted a telephone interview with Angus Phillips of the Washington Post on October 16 regarding activities at the refuge, wildlife populations, observation opportunities, etc. Mr. Phillips followed this up with an excellent feature article on Bombay Hook and other Delmarva refuges on Sunday October 20.

12. Other Wildlife Oriented Recreation

The Delaware Bay Retriever Trial Club held field trials both in the spring (March 16 and 17) and fall (October 18, 19, and 20) this year. The group, which has conducted trials on the refuge annually for over 40 years, had about 600 individuals attending on each occasion. The trials take place on the Dutch Neck and Finis portions of the refuge.

16. Other Non-Wildlife Oriented Recreation

We continue to get a few joggers and runners plus an occasional cross-country skier. They cause no problem and hopefully are enjoying wildlife while getting the physical benefits of their exercise.

No other non-wildlife oriented recreation regularly takes place on the refuge.

17. Law Enforcement

Four members of the staff have law enforcement authority, which enables us to place adequate emphasis on special areas of concern, such as the South Waterfowl Hunt Area and the West Waterfowl Area. We are unable at this level of staff strength to give much attention to violations on off-refuge sites; however we make our presence known (and make some cases) on creeks and marshes immediately adjacent to our boundary at least a couple of times during the waterfowl seasons.

All refuge officers completed refresher training at Cape Charles, Virginia or Quincy, Florida in the spring and requalified with their service revolvers at Patuxent WRC in October.

Manager Daly traveled to the Eastern Shore of Virginia NWR on March 14 and 15 to assist the Law Enforcement Refresher Committee in filming scenarios for the 1991 refreshers.

Manager Daly traveled to both sessions of the LE Refresher held at Eastern Shore of Virginia NWR this year. He went to the second session to help out with the "car stop" scenarios and for a repeat performance from the first session as "Magistrate Paul Wapner - Mock Court Judge".

We had excellent inter-refuge cooperation this year between ourselves, Eastern Neck NWR, Mason Neck NWR and Patuxent WRC for LE details. Help was provided during our opening day of duck season from Eastern Neck and Patuxent; and in turn we helped out at deer hunts at both of those stations

and at Mason Neck. This cooperation not only benefits the stations receiving assistance, but also provides valuable experience for all officers involved. When we had extra assistance during our duck season water blinds were checked with three officers to a boat. Previously we had worked singly, or in pairs. One officer was able to stay with the boat and control it, freeing the other two officers to check the hunters. At least one case (lead shells hidden behind the blind) was made that might have been missed with only one or two officers. Things went so efficiently that we estimate more hunters were checked than two, two-person boats could have checked in the same time period.

Summary tables of 1991 violations by type and comparison with the prior ten years are as follows:

Violations Processed by Bombay Hook Officers Since 1981

<u>Calendar Year</u>	<u>Number of Individuals</u>	<u>Number of Violations</u>
1991	25	33
1990	14	16
1989	21	23
1988	23	24
1987	7	11
1986	20	27
1985	20	26
1984	20	22
1983	45	58
1982	28	38
1981	64	96

Summary of C.Y. 1991 Violations at Bombay Hook

<u>Violation</u>	<u>Written Warning</u>	<u>Forfeit Collateral</u>	<u>Pending</u>	<u>Total</u>
Hunt waterfowl with unsigned, unattached Federal Stamp		2 (\$75)		2
Hunt waterfowl without Federal Stamp		3 (\$150)	2	5
Hunt waterfowl with unsigned, unattached State Stamp		1 (\$25)		1
Hunt waterfowl without state stamp	1 (juvenile)	1 (\$50)	1	3
Hunt doves with the aid of bait		6 (\$600)	1	7
Possession of lead shot in a steel shot zone		3 (\$150)		3
Hunt waterfowl with unplugged shotgun			1	1
Hunting on refuge without valid permit		1 (\$100)		1
Snow goose hunting too close to dike	1			1
Trespass in a closed area		2 (\$50)		2
No entrance pass		2 (\$50)		2
Speeding	2	2 (\$50)		4
Wrong way on one- way road	1			1
	<u>5</u>	<u>23 (\$1,300)</u>	<u>5</u>	<u>33</u>

18. Cooperating Associations

The Friends of Bombay Hook Cooperating Association started sales in September of 1990. By September 1991, the outlet had taken in approximately \$7,000, which was a much greater total than we had anticipated. To our greater surprise though, sales for September through December of this year totalled approximately \$6,500. We now anticipate that we will probably easily top \$10,000 gross sales in our second year of operation. The outlet began by stocking only 12 items at its inception, and by the end of this year, items totalled 53. Membership is presently 101.

As with the start-up of almost any new operation, the association has traveled over a few "bumps" on the road to success. In August Business Manager Gary Mathena resigned. Unfortunately, he had been "burned out" from the uneven amount of the work initially placed on his shoulders. By years end, we were still without a Business Manager. Friends of Bombay Hook President Verna Price, volunteer Bob Clark, and the other cooperative officers have been working together and with refuge liaison ORP Pohlman to keep the outlet functioning. They will be working on finding a way to redistribute the work load and lessen the burden placed on the new business manager.

Recreation Aid Bob Jones and Karen Day from the Delaware Estuary Program (both artists) formulated a design for a "Friends of Bombay Hook" sweatshirt which has been available for sale since October. Text and artwork cover the concept of wildlife species being either abundant (snow goose), species of concern (black duck), threatened or endangered (bald eagle), or extinct (passenger pigeon) and gives the message to save our wetlands before it is too late. Bob Jones will be designing a "Friends" patch during 1992.

The Association has a quarterly newsletter and offers field trips several times a year to members. This year they visited Cape Henlopen State Park and Patuxent Wildlife Research Center. A canoe trip at Abbotts Mill was cancelled due to the rain.



- #29 The success of the sales outlet permitted the purchase of three professional looking display cases, an expansion in the number of items for sale, and self standing displays for posters, postcards, and mobiles.
12/91 M. Johnson-Pohlman

I. EQUIPMENT AND FACILITIES

1. New Construction

The Delaware Electric Cooperative was contracted to provide electric service to the new well at Pool B. The underground service was a little over a mile. A submersible pump was purchased and the whole system was up and running by late fall. (see section F.2)



#30 The view is looking west along Dutch Neck road toward the Allee House. This site is the terminus of the underground electric cable extended to the new well at Pool B.

8/91 F. Smith



#31 After a submersible pump was installed in the well and a pedestal with meter was placed by Delaware Electric Cooperative the Pool B supplemental water supply was operational.

11/91 F. Smith

A new gate was installed at the junction of the Allee House and Finis Roads in October. This gate permits closure of the entire Dutch Neck Unit from that point to the Allee House gate. This is especially important during times we want Canada geese to be able to feed undisturbed in the fields along this road.



#32 The tracks to the left of the new gate are from Service vehicles.

10/91 F. Smith

2. Rehabilitation

The Delaware Bay Estuary Program Office, located in the old YACC headquarters building, received new siding, gutters and downspouts as well as minor repairs to the building entrances and entrance steps. All modifications were made using Estuary Program funds.



#33 The Delaware Bay Estuary Program office sports new vinyl siding, a new side porch, and a new front door.

11/91 M. Johnson-Pohlman

On December 9 and 10 Richard Yee (RO-EN) visited to look at two projects scheduled for FY92 funding. The first, for an estimated \$100,000 will raise the Finis dike 1'-2' over an approximate 300' length and will stabilize the dike toe, reseed the slopes, etc. The second project will put new siding on the Headquarters building where we have experienced chronic damage by flickers over the past several years.

3. Major Maintenance

All 36 waterfowl blinds and 79 deer stands were inspected and repairs made as needed (hinges, floor boards, etc.) prior to hunt season.

Maintenance Worker Straughn re-posted the Air Force Tract with "Public Hunting" and "Blue Goose" boundary signs in anticipation of the hunt seasons. This is an annual proposition since they get shot up so bad in the remote location.

The oil house and open equipment shed received new asphalt shingle roofs.

4. Equipment Utilization and Replacement

Maintenance Worker Straughn delivered the stake/dump truck to Eastern Shore of Virginia NWR on February 5. Jerry Loomis of ESVNWR rode back to Bombay Hook with Arthur that afternoon and hauled our bulldozer back to his station. Both pieces of equipment were used in the effort to demolish old buildings at Eastern Shore of Virginia NWR.

The Case 850D dozer was loaned to the New York private wetlands restoration program on July 11 and was returned in good condition on October 11.

A John Deere 4430 farm tractor was rented (by the tractor-operated hour) while extensive repairs were made to the Massey Ferguson 1085 refuge tractor. The refuge program has begun to suffer the costs of trying to maintain a piece of equipment which is in bad need of replacement. So far we have been unable to come up with funds for the replacement regardless of the "means" (Regular O&M budget, fire money, "wish" list, etc.).

A brand, spanking new Dodge pickup was received during June to replace the 1981 Ford pickup.



#34 The newest addition to the vehicle fleet was welcome. The oil house in the background received a new roof this year.

12/91 M. Johnson-Pohlman

A Savin 9250 copier was purchased for use in the public use program. Location of the machine in the ORP work area allows volunteers to make copies (news releases, handouts etc.) in a location which will not be disruptive to the office side of the headquarters building.

6. Computer Systems

Hal Laskowski (Field Biologist-S) helped Secretary Hammond set up the new computer system that we purchased in 1990 while he was here to review our water management program in January.

Two new computer systems were purchased in August. One system which is primarily for use in the I & R program, was purchased with graphics and desktop publishing software and a laser printer. The second system was purchased for our biological program.

7. Energy Conservation

The table below reflects non-vehicular energy use at this station for the past four years.

<u>Year</u>	<u>Electricity</u>		<u>Fuel Oil</u>		<u>Propane</u>		<u>Total Energy</u>
	<u>KW</u>	<u>Cost</u>	<u>Gal</u>	<u>Cost</u>	<u>Gal</u>	<u>Cost</u>	<u>Cost</u>
1988	54,352	\$5,512.60	598	\$318.35	1507.1	\$ 970.94	\$6,801.89
1989	55,345	\$5,745.81	400	\$239.20	978.5	\$ 665.38	\$6,650.39
1990	60,040	\$4,767.93	822	\$704.04	1359.4	\$1,319.11	\$6,791.08
1991	59,239	\$5,074.32	626	\$469.18	826.5	\$ 724.79	\$6,268.29

The table below reflects vehicular energy use during the past six years.

<u>Year</u>	<u>Gasoline Use (Gallons)</u>	<u>Diesel Use (Gallons)</u>
1986	2,462.8	1,050.0
1987	1,761.2	962.8
1988	1,862.0	1,368.0
1989	1,928.8	1,530.9
1990	2,348.0	1,181.0
1991	2,533.1	1,454.0

J. OTHER ITEMS

1. Cooperative Programs

Manager Daly attended a dinner given for State hunter safety instructors at Dover AFB on July 26. Bombay Hook hosts several sessions of the hunter safety courses each year and refuge staff serve as instructors for certain portions of the course.

Frank Smith continued to serve as Delaware's Fish and Wildlife Service Field Response Coordinator (FRC) for oil and hazardous chemical spills. Prime Hook Assistant manager O'Shea is the alternate FRC. There were no major oil spills to deal with this year; however, on October 8 a "mock" oil spill occurred off Bombay Hook as part of a regionwide training exercise. The refuge was contacted several times during the day with questions regarding areas and species to be protected, locations for placement of

protective booms, sites for bird cleanup etc. The Regional Office coordinator was notified and the refuge's Oil/Hazardous Spill Plan seemed to function very well as a source during the exercise.

3. Items of Interest

Bombay Hook hosted a meeting of the Delaware Bay Estuary Program on March 28 and 29. The approximately 20 attendees included Regional Director Lambertson, ARD-FWE Pisapia and various other Service individuals who have responsibility for resources in the Delaware Estuary. The Secretary of the Delaware Department of Natural Resources and Environmental Control, Toby Clark, addressed the group at the initial session.

Manager Daly and Eastern Kentucky University student Mike Hill addressed the Atlantic Flyway Technical Section at their meeting in Easton, Maryland on March 5. Mike gave the section biologists an overview of the snow goose telemetry study results.

ORP Pohlman attended a regional conference of the NAI (National Association of Interpreters) at Ashland Nature Center during March. Information was obtained on handicapped accessibility, rapport with elementary age students, historical and natural history interpretation and volunteer programs.

Manager Daly traveled to Blackwater NWR on March 7 to assist in planning the agenda for the September project leaders meeting at the Tidewater Inn, Easton, Maryland.

Manager Daly also traveled to Eastern Shore of Virginia NWR on March 14 and 15 to assist the Law Enforcement Refresher Training Committee in filming scenarios for the April, 1991 training sessions.

Former Service Director John Gottschalk visited the refuge on April 9. Mr. Gottschalk, who has held several top positions with national and international conservation agencies since he was with FWS was extremely impressed with Bombay Hook/Prime Hook and on going programs. He followed his visit up with a complimentary letter to the Regional Director.

Biologist Frank Smith attended a Canada Goose Management symposium in Milwaukee, Wisconsin during the period April 22-25.

On May 14 Manager Daly delivered a revenue sharing check for \$62,444. to the Kent County Levy Court at their regular meeting.

A crew from The Nashville Network (Turner Broadcasting) visited the refuge on Memorial Day, May 27. The crew, which was in the area all week covering the races at Dover Downs, did a feature on the refuge for broadcast on Thursday, May 30. Thousands of shorebirds and wading birds in Raymond and Shearneck Pools were filmed for the feature, which included interviews with Manager Daly.

Linda Lyons from the Office of Environmental Project Review (DOI-Washington, D.C.) visited on May 22. Linda, who is the new reviewer of refuge chemical control proposals which must be approved in Washington, was given a thorough background on mosquito control in Delaware and progress being made in implementation of open marsh water management for biological control of mosquitoes on the Bombay Hook and Prime Hook Refuges.

On June 6 Manager Daly and Biologist Smith attended a meeting of the MD/DE Chapter of The Wildlife Society held at the Ommelanden State Area in New Castle County.

Leslie Trew with the Delaware Natural Heritage Inventory visited on July 26 to discuss plans for the neo-tropical bird survey statewide August 3 - October 26.

Manager Daly and Biologist Smith participated in the waterfowl management evaluation at Prime Hook Refuge July 29-31. George Gavutis (R.O.) and Zone Biologist Laskowski also participated.

Manager Daly, Biologist Smith, and Maintenance Worker Straughn attended a meeting to evaluate the region's aircraft management program held at Blackwater NWR on July 24.

Office Assistant Hammond participated in a week-long detail to the Regional Office (CGS) during August, helping them with Fiscal Year 1991 close-out on processing purchase orders and acquisition requests.

Manager Daly and Biologist Smith attended a workshop concerning neo-tropical migratory birds in Luray, Virginia on September 25.

ORP Johnson-Pohlman attended a career program on September 23 at Wesley College in Dover for high school students statewide. She answered questions on FWS careers and required courses of study from the approximately 300 attendees.

Manager Daly and Assistant Manager Wunderley attended the refuge project leaders meeting in Easton, MD during the period September 9-13.

The Delaware Bay Estuary Program held a Data Management Workshop in the refuge auditorium on December 4 and 5. Approximately 35 people attended, including Biologist Smith.

4. Credits

Paul Daly	Sections A, F, J, K
Steve Wunderley	Sections B, D2 & 4, E (except 4), H17, I
Frank Smith	Sections C, D5, G, H8-10
Marian Johnson-Pohlman	Sections E4, H1-7, 11, 12, 16, & 18

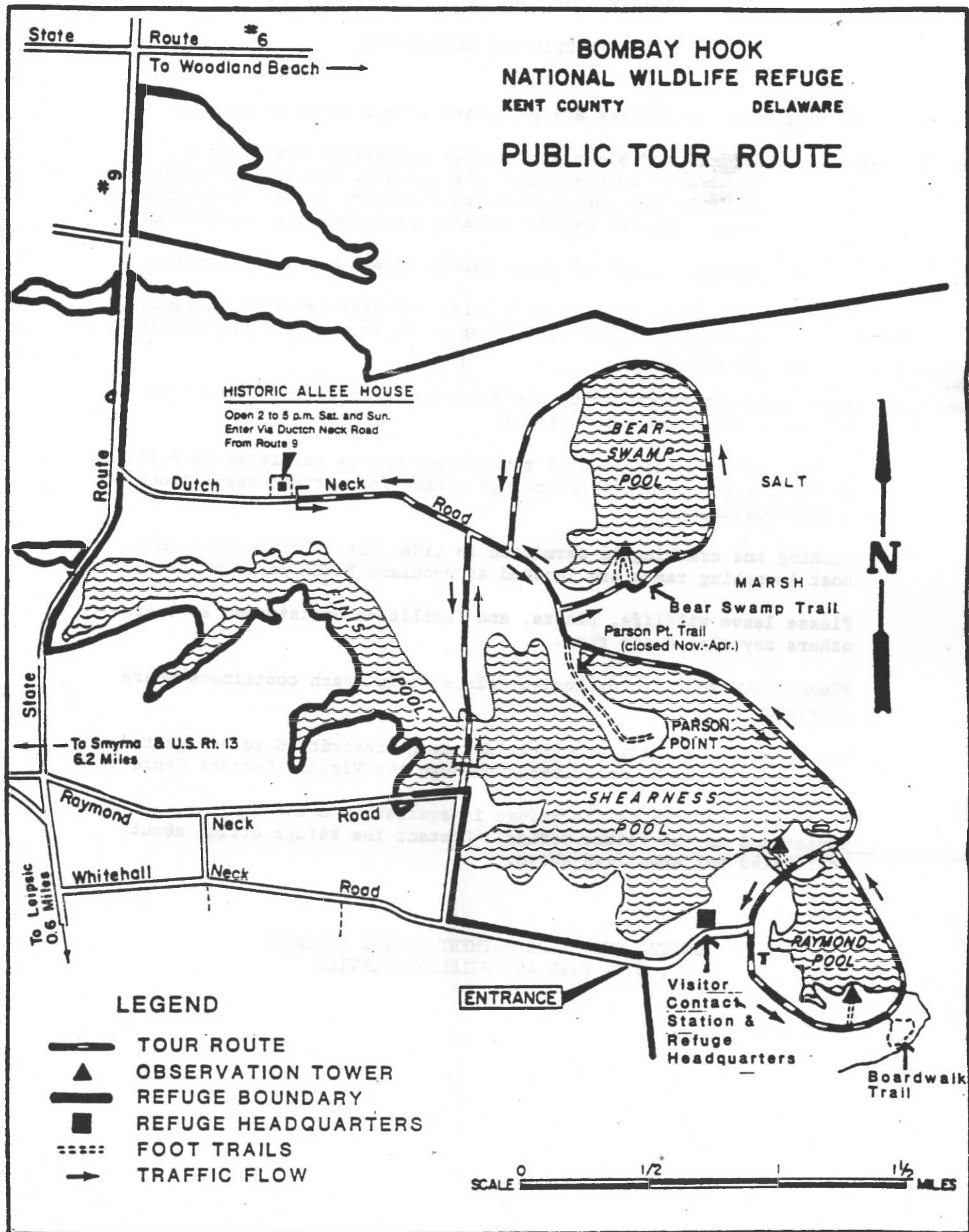
The report was typed and assembled by Office Assistant Teresa Hammond and Clerk Typist Suzan Staley. Picture credits are listed with each photo. The entire report was edited by Paul Daly.

K. FEEDBACK

Another excellent year at Bombay Hook NWR saw continued cooperation with "line" Managers in the Regional Office and most support services. The only ones in the latter group that we have problems with are those that feel somehow that we in the field exist to respond to their requests for report information by certain (usually unreasonable) deadlines. I feel as I always have - that support services in Denver or the regional office are great; but if absolutely necessary the field stations could go on functioning at a reduced level without them. The converse, however, is most certainly not true.

In a related vein, we have been blessed in recent years with much in the way of modern technological wonders such as computers (we now have 5), facsimile (FAX) machines, etc. Call me a dinosaur, but I see the possibility, if these are not managed appropriately, of their becoming our *bête noire*. I know the many advantages of being able to rapidly call up or transmit information and appreciate it; but there does seem to be a lot of time being spent in front of those screens in place of what we used to do. My main concern, however, has to do with those who require (in ever increasing quantities) reports, responses etc. etc. with much shorter deadlines due to these marvelous new machines! It is almost like every office needs to generate a new and exciting computer program to justify their having the machine in the first place; and then they send it out to the field to require us to input data which in some cases seems of little value to the refuge. FAX machines (and E-Mail) are meant to be of assistance when very rapid communication is absolutely necessary, but there is indeed the potential for abuse in this area simply due to the efficiency of the technology.

BOMBAY HOOK NATIONAL WILDLIFE REFUGE KENT COUNTY DELAWARE PUBLIC TOUR ROUTE



BOMBAY HOOK NATIONAL WILDLIFE REFUGE

PUBLIC USE REGULATIONS

The following activities are permitted from sunrise to sunset:

1. Vehicle and bicycle travel on designated roads for the purpose of nature study, photography, and general sight-seeing. The public tour route will be closed to vehicles when inclement weather creates hazardous road conditions.
2. Hiking, except in areas closed to all access by posting.
3. Exercising pets if on a leash not over ten feet in length, one end of which is secured so as to restrict the movements of the animal.

Activities not permitted by the above regulations are prohibited without a special written permit.

Public hunting under special regulations may be permitted on portions of the refuge. Contact the refuge office for current regulations before hunting.

Fishing and crabbing is permitted in tidal waters from boats only. Boat launching ramps are located at Woodland Beach and Port Mahon.

Please leave wildlife, plants, and facilities undisturbed so that others may also enjoy them.

Please take your litter home or place it in trash containers where provided.

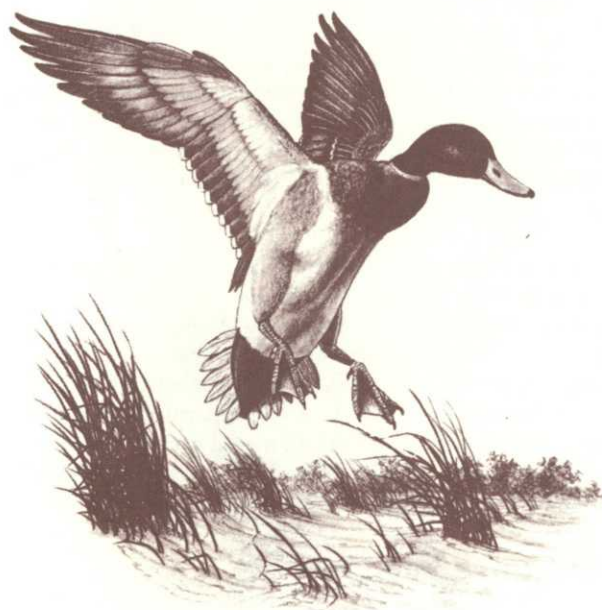
Environmental education activities may be restricted to designated sites and are to be coordinated through the Visitor Contact Center.

Literature describing the refuge is available in the Visitor Contact Center and in the refuge office. Contact the refuge office about activities not specified above.

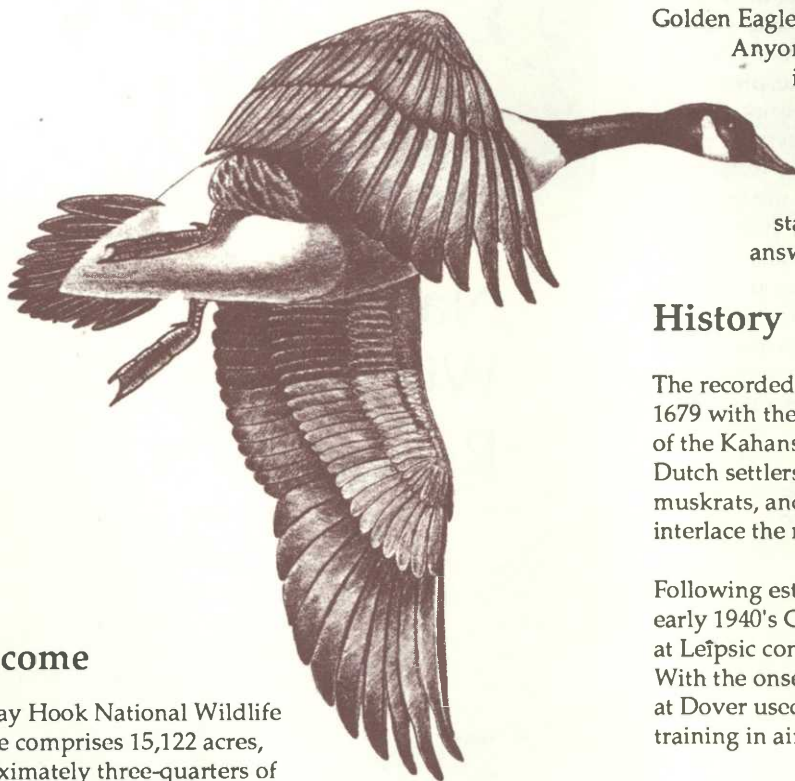
UNITED STATES DEPARTMENT OF THE INTERIOR
U.S. FISH AND WILDLIFE SERVICE

Bombay Hook

National
Wildlife
Refuge



Delaware



Welcome

Bombay Hook National Wildlife Refuge comprises 15,122 acres, approximately three-quarters of which is tidal salt marsh. It also includes 1,100 acres of impounded fresh water pools, brushy and timbered swamps, 1,000 acres of agricultural lands, and timbered and grassy upland. The general terrain is flat and less than ten feet above sea level.

Bombay Hook was established in 1937 as a link in the chain of waterfowl refuges that extends from Canada to the Gulf of Mexico. It is primarily a refuge for migrating and wintering ducks and geese, but also offers haven for numerous other species of migratory birds. The value and importance of Bombay Hook for the protection and conservation of waterfowl has increased greatly in the past 25 years, primarily due to the loss of extensive surrounding marshland to urban and industrial development.

Entrance Fee Options

To help pay for the purchase of more wildlife habitat and for management of refuges, Congress passed the Emergency Wetlands Resources Act in 1986. The law authorized the Fish and Wildlife Service to charge entrance fees at National Wildlife Refuges such as Bombay Hook.

Visitors may pay the daily fee of \$3.00 per vehicle or purchase one of two annual passes - the Duck Stamp and Golden Eagle Passport. Both are sold at the refuge.

Anyone who is 62 years of age or older, or who is disabled, is eligible for a free pass that will admit you and your passengers or family. Children under 16 are admitted free. Educational and scientific groups may enter free with prior notice. Refuge staff will be happy to issue a pass and answer any questions.

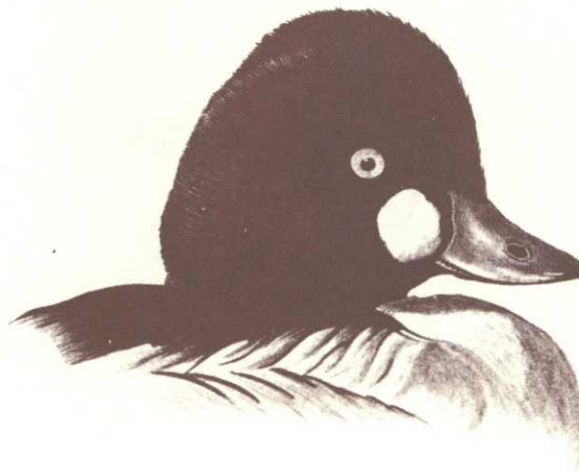
History

The recorded history of the Bombay Hook area began in 1679 with the sale of marshland from Mechacksett, Chief of the Kahansink, to Peter Bayard of New York. Early Dutch settlers cut salt hay from the marsh, trapped muskrats, and hunted waterfowl. The tidal streams that interlace the marsh were plied for fish, crabs, and oysters.

Following establishment of the refuge and through the early 1940's Civilian Conservation Corps members based at Leipsic constructed dikes and buildings on the refuge. With the onset of World War II, the Army Air Corps based at Dover used parts of the refuge for experimentation and training in air-to-ground rockets.

Refuge Management and Objectives

The refuge management programs are primarily aimed at developing and protecting desirable habitat for waterfowl and other migratory birds, including the endangered bald eagle. The refuge is located at a focal point for waterfowl migrating between their northern breeding grounds and various wintering areas. Large numbers of ducks and geese arrive each fall to either spend the winter or merely stop-over on their way southward.



Water levels in refuge impoundments are manipulated to produce desirable emergent and underwater plants for waterfowl. While pools are drawn down, excellent populations of shore and wading birds use the mudflats. Upland agricultural crops are produced on approximately 1,000 acres to provide a supplemental food supply to waterfowl and other migratory birds.

Tidal salt marsh is the most valuable wildlife habitat in the State of Delaware. Large portions of the refuge have been maintained in a near pristine state. The marsh, with its intersecting tidal streams and rivers, provides excellent natural habitat for the birds and mammals of the area and also serves as a nursery and breeding area for marine organisms, many of which are of sporting and commercial interest.



Wildlife Calendar

Though wildlife can be seen year round at Bombay Hook, fall and spring offer the best opportunity for observing peak concentrations of migratory birds.

The period from October 1 through November 30 is generally the most interesting to the refuge visitor as this is the season during which waterfowl populations are at their peak. Over 100,000 ducks and geese utilize the refuge at this time.

Spring is another preferred season for the visiting public. March is the second peak for waterfowl as they travel through on their return to northern breeding grounds. April brings early shorebird migrants and the emergence of reptiles and amphibians from winter hibernation. Shorebirds are at their highest concentrations during May and June, primarily due to the arrival of horseshoe crabs laying eggs along the bay shore and mud flats. These eggs provide the shorebirds with needed energy to complete their northward migration. Wading birds such as herons, egrets, and glossy ibis, reach their peak numbers during

the summer months. Mammals can be seen year round, particularly in the early morning and evening hours. These include white-tailed deer, beaver, muskrat, red fox, river otter, woodchuck and Virginia opossum.

Public Use

The public is welcome to visit the refuge for wildlife observation, nature study, and photography year round during daylight hours.

Visitor facilities include a visitor center, auto tour route, observation towers, and nature trails.

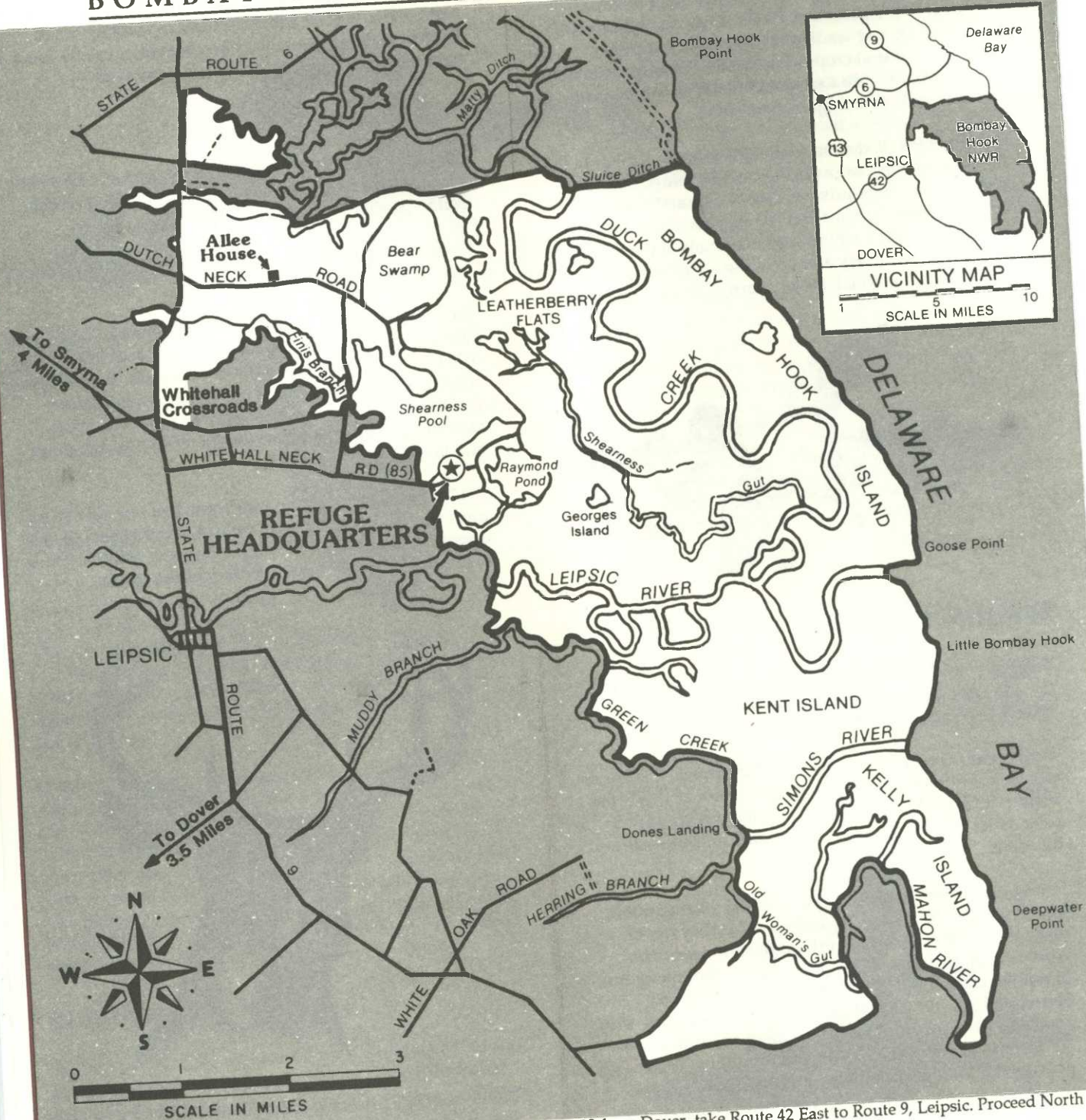
The Visitor Center is normally open Monday-Friday from 8:00 a.m. to 4:00 p.m., and on weekends from 9:00 a.m. to 5:00 p.m. It is closed on summer weekends. Tours, habitat studies, nature walks, and audiovisual programs are available to groups upon advance request. Volunteer, teacher, and leader workshops are offered in the spring and fall.

A 12-mile round-trip auto tour route and several nature trails (ranging from 1/4 to 1 mile in length) provide opportunities to observe and photograph wildlife. Three of the trails also have 30-foot observation towers.



Public hunting, primarily for waterfowl and deer, is permitted under special regulations on portions of the refuge during the legal State season.

BOMBAY HOOK NATIONAL REFUGE



DIRECTIONS

Heading North on Route 13 from Dover, take Route 42 East to Route 9, Leipsic. Proceed North on Route 9 for 2 miles to Road 85 which ends at the refuge entrance.
 Heading South on Route 13 from Smyrna, take Route 12 East until it merges with Route 9 (5 miles), and take a left on Road 85 after 1/4-mile.

Mission: As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally-owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historic places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. Administration.

For further information, contact:

Refuge Manager
Bombay Hook National Wildlife Refuge
RD 1, Box 147
Smyrna, Delaware 19977
Telephone: (302) 653-9345

Illustrations by Julien Beauregard

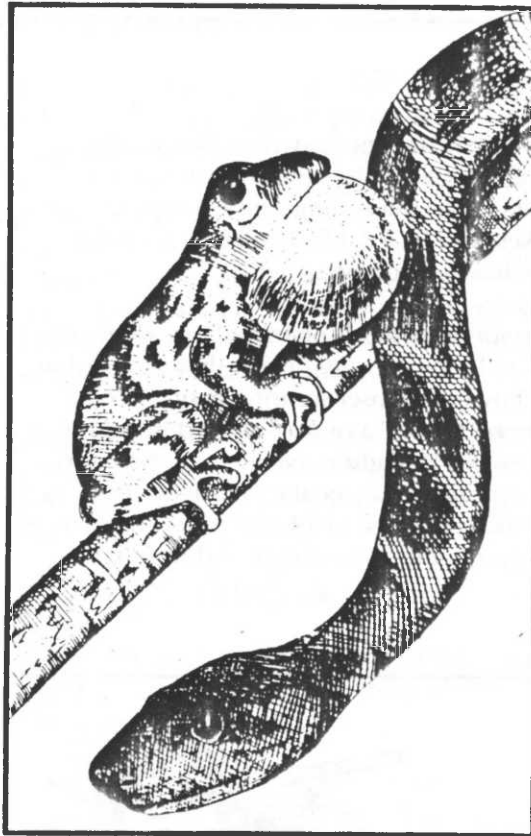


UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

RL--51550-1

September 1988

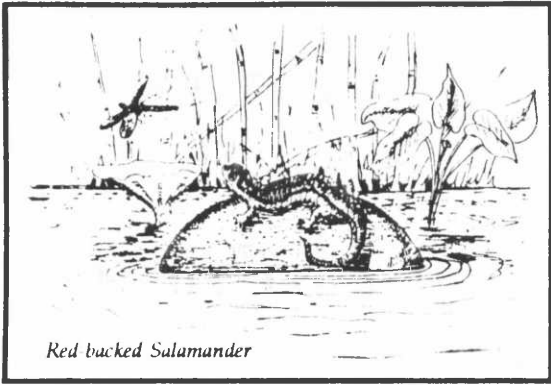
Reptiles and Amphibians



Bombay Hook

National Wildlife Refuge

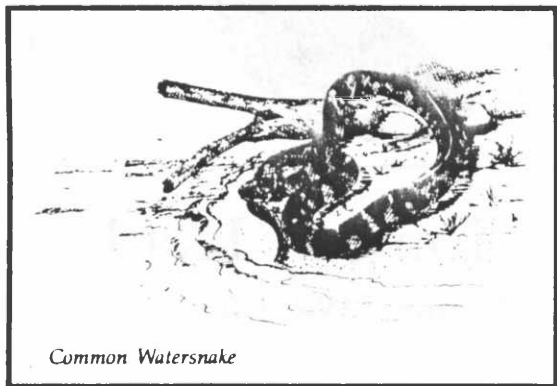
Smyrna, Delaware



Red backed Salamander

The variety of habitats within Bombay Hook Refuge provides the essential living requirements for an interesting array of reptiles (turtles, snakes, and lizards) and amphibians (salamanders, toads and frogs).

Many of these kinds of animals are often overlooked by visitors. By design they are hard to see, however, closer scrutiny may expose a "clump of moss" as a frog or "part of a vine" to be a snake. A slight movement on their part as you approach may be the giveaway. The frogs and toads can also be identified by their voices which ring out in loud chorus during spring nights.



Common Watersnake

REPTILES

TURTLES

Common Snapping Turtle (*Chelydra s. serpentina*). Common in the freshwater pools. Also inhabits brackish waters. Lays eggs in the upland fields during the late spring.

Stinkpot (*Sternotherus odoratus*). Common. Lives in the freshwater pools.

Eastern Mud Turtle (*Kinosternon s. subrubrum*). More common than the stinkpot which it resembles. Inhabits fresh and brackish water.

Spotted Turtle (*Clemmys guttata*). Common. Inhabits shallow freshwater in the pools, ponds, and ditches.

Eastern Box Turtle (*Terrapene c. carolina*). Common. This is a dry-land turtle most frequently seen in the woodlands.

Northern Diamondback Terrapin (*Malaclemys t. terrapin*). Lives in the unpolluted salt marsh and brackish water habitats. Lays eggs on the dikes in late June and early July.

Eastern Painted Turtle (*Chrysemys p. picta*). The most frequently seen turtle. Basks in the warm sunlight on logs or stumps in the freshwater pools.

Red-Bellied Turtle (*Pseudemys rubriventris*). Uncommon. Inhabits the freshwater pools. Basks like the painted turtle but is much larger.

LIZARDS

Five-lined Skink (*Eumeces fasciatus*). Lives in cut-over woodlands that have rotting stumps and logs. Mainly terrestrial, but can climb trees.

Northern Fence Lizard (*Sceloporus undulatus hyacinthinus*). Uncommon. Favors rotting logs and open woodlands. Primarily arboreal, seldom far from a tree.

SNAKES

Northern Water Snake (*Nerodia s. sipedon*). Common in and about freshwater habitats.

Eastern Garter Snake (*Thamnophis s. sirtalis*). Frequently seen. Inhabits fields, woods, and marsh edges.

Eastern Ribbon Snake (*Thamnophis s. sauritis*). A semi-aquatic snake found along the edges of the freshwater pools, swamps, and ditches.

Ringneck Snake (*Diadophis punctatus*). Secretive. Hides under stones and bark slabs in woodlands, especially near damp spots.

Northern Black Racer (*Coluber c. constrictor*). A large snake, active during the day. Seen fairly frequently in the woods and along field edges.

Rough Green Snake (*Opheodrys aestivus*). Difficult to observe because it blends with the background. Favors dense vegetation along shallow bodies of freshwater.

Black Rat Snake (*Elaphe o. obsoleta*). A large, thick-bodied snake. Seen occasionally, usually in the upland woods or on field edges.

Eastern Kingsnake (*Lampropeltis g. getulus*). Uncommon. Often secretive, hiding under boards and logs. Hunts along the banks of freshwater pools and swamps.

Eastern Milk Snake (*Lampropeltis t. triangulum*). Uncommon. Secretive about farm buildings and in fields and woods.

Eastern Hognose Snake (*Heterodon platyrhinos*). Uncommon. Prefers cultivated fields and woodland meadows. Feeds on toads and frogs.

Eastern Worm Snake (*Carphophis u. amoenus*). Uncommon. Inhabits farmland bordering woodlands; dwells in damp situations under rocks, decaying logs, and loose soil.

AMPHIBIANS

SALAMANDERS

Red-backed Salamander (*Plethodon cinereus*). A fairly common woodland salamander. Hides beneath logs, bark slabs, and stones during the daytime. In this area, it is usually in the "lead" phase.

Marbled Salamander (*Ambystoma opacum*). Uncommon. Found in woodland areas hiding under logs. Fall breeder. A mole salamander, spending most of its life underground.

Spotted Salamander (*Ambystoma maculatum*). Uncommon. Found in woodland and pond areas. Early spring breeder. Hides beneath logs during the day.

TOADS AND FROGS

Fowler's Toad (*Bufo woodhousei fowleri*). Common in woodland and grassy areas. Has three or more warts in each dark spot.

Northern Cricket Frog (*Acris c. crepitans*). Common. Inhabits the emergent and shoreline vegetation of the freshwater pools.

Green Tree Frog (*Hyla cinerea*). Common in woodland areas adjacent to ponds. Seen particularly during spring. Visits windows at night, seeking insects attracted by light.

NOTES

Gray Tree Frog (*Hyla versicolor*). Uncommon. Breeds in quiet shallow waters. Forages aloft in small trees and shrubs near water.

Northern Spring Peeper (*Hyla c. crucifer*). Common. Congregates in early spring where shrubs stand in shallow water.

New Jersey Chorus Frog (*Pseudacris triseriata kalmi*). Common. Congregate during the spring in low vegetation along the edges of freshwater pools and ponds.

Bullfrog (*Rana catesbeiana*). A common large frog of the freshwater pools.

Green Frog (*Rana clamitans melanota*). Inhabits the shallow freshwater of the pools, ponds, and ditches.

Southern Leopard Frog (*Rana sphenoccephala*). Common in shallow freshwater areas. Travels into grass fields, far from water, during the summer.

Pickerel Frog (*Rana palustris*). Inhabits shallow, freshwater areas. Travels into grass fields during the summer.

Wood Frog (*Rana sylvatica*). Should be looked for in shallow woodland pools during the early spring.

The 35 species on this list have been identified on the Bombay Hook Refuge by refuge personnel with cooperation from the staff of the Philadelphia Zoological Garden. Other species no doubt exist on the refuge and reports of their identification will be welcomed at the refuge headquarters.

U.S. FISH AND WILDLIFE SERVICE

Bombay Hook is one of more than 430 refuges in the National Wildlife Refuge System administered by the U.S. Fish and Wildlife Service. The National Wildlife Refuge System is a network of lands and waters managed specifically for the protection of wildlife and wildlife habitat and represents the most comprehensive wildlife resource management program in the world. Units of the system stretch across the United States from northern Alaska to the Florida Keys, and include small islands in the Caribbean and South Pacific. The character of the refuges is as diverse as the nation itself.

The Service also manages National Fish Hatcheries, and provides Federal leadership in habitat protection, fish and wildlife research, technical assistance and the conservation and protection of migratory birds, certain marine mammals and threatened and endangered species.

For further information, contact:

Refuge Manager
Bombay Hook National Wildlife Refuge
R.D. #1, Box 147
Smyrna, Delaware 19977
Telephone: (302) 653-9345 (Office)
(302) 653-6872 (Visitor Center)



UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE



MAMMALS
of
BOMBAY HOOK

National
Wildlife
Refuge

Delaware

MAMMALS of the BOMBAY HOOK National Wildlife Refuge

Bombay Hook National Wildlife Refuge is located in coastal Delaware. The 15,099-acre refuge is relatively flat with most elevations less than ten feet above sea level. The major habitat type, consisting of 12,257 acres, is tidal marsh intersected by winding rivers and creeks. Landward of the marsh are freshwater impoundments, timbered swamps, mixed deciduous woodlands, brushy thickets, grassy fields, and croplands.

This variety of habitats provide essential food and cover requirements for an interesting combination of mammal species. Those most frequently seen, especially in the early morning and the late afternoon, are the cottontail rabbit, woodchuck, gray squirrel, muskrat, and white-tail deer. Less commonly observed are the raccoon, skunk, opossum, and red and gray foxes.

Because of a combination of small size, secretive habits, or nocturnal activity, many mammals are seldom seen. However, the careful observer will see tracks, trails, tunnels, burrows, nests, and other signs that reveal their presence.

The following list of 34 species was prepared by refuge personnel with the cooperation of Frederick A Ulmer, Jr. of the Philadelphia Zoological Garden. Order of listing and scientific names generally follow Hall, *Mammals of North America*. Common names are from Burt and Grossenheider, *A Field Guide to the Mammals*.

- **Opossum** (*Didelphis virginiana*).
Commonly found in all sheltered habitats.
Normally active only at night.
- **Masked Shrew** (*Sorex cinereus*).
Common on all land areas. Hunts for insects and other food day or night.
- **Shorttail Shrew** (*Blarina brevicauda*).
Most abundant in damp woods with thick leaf mold.
- **Least Shrew** (*Cryptotis parva*).
Found in open, grassy areas.
- **Eastern Mole** (*Scalopus aquaticus*).
Inhabits moist, upland soils where it tunnels its way under the surface.
- **Starnose Mole** (*Condylura cristata*).
Prefers low, wet ground where it burrows for insects.

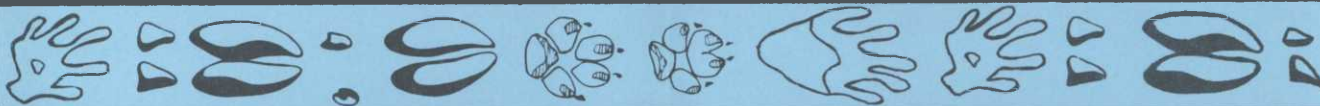


- **Little Brown Myotis** (*Myotis lucifugus*).
Present during the warm months. Seen in flight at dusk near the woods and over the pools.
- **Silver-haired Bat** (*Lasionycteris noctivagans*).
Found in the swamps flying among the flooded trees.
- **Eastern Pipistrel** (*Pipistrellus subflavus*).
Active during summer evenings. One of the smallest bats.
- **Big Brown Bat** (*Eptesicus fuscus*).
Active on warm evenings when beetles are flying.
- **Red Bat** (*Lasiurus borealis*).
A common woodland bat that roosts in trees all day, until deep dusk.
- **Hoary Bat** (*Lasiurus cinereus*).
The largest eastern bat, it is found in the woodlands; flies late, high and solitary.
- **Eastern Cottontail** (*Sylvilagus floridanus*).
Abundant. Lives in bushy areas and grassy fields. Often seen from the roads in the early morning and late afternoon.
- **Woodchuck** (*Marmota monax*).
Abundant. Lives in deep burrows excavated in fields, woods, and along dikes.
- **Eastern Chipmunk** (*Tamias striatus*).
Uncommon among logs and stumps in the hardwood areas.
- **Eastern Gray Squirrel** (*Sciurus carolinensis*).
Common in the oak-hickory woodlands.
- **Southern Flying Squirrel** (*Glaucomys volans*).
Inhabits hollow trees to emerge only after darkness fills the wetlands.
- **Beaver** (*Castor canadensis*).
Discovered during the fall of 1977 after an approximate twenty year absence. Presently beaver inhabit Finis and Upper Sheariness Pools.
- **Rice Rat** (*Oryzomys palustris*).
Common in the salt marsh areas. Chiefly nocturnal.
- **White-footed Mouse** (*Peromyscus leucopus*).
Abundant in wooded and brushy areas. Very white belly.
- **Meadow Vole** (*Microtus pennsylvanicus*).
Abundant in grassy, upland fields and among the grasses of the salt marsh.



- **Pine Vole** (*Microtus pinetorum*).
Tunnels through the carpet of leaf mold and loose soil on the forest floor.
- **Muskrat** (*Ondatra zibethicus*).
Common in the freshwater impoundments and in the salt marsh.
- **Norway Rat** (*Rattus norvegicus*).
Lives around buildings, grain fields, and marsh edges. Often moves into tidal debris along beaches.
- **House Mouse** (*Mus musculus*).
Found about buildings and in weedy and grassy fields.
- **Meadow Jumping Mouse** (*Zapus hudsonius*).
Inhabits the grassy fields. Might be mistaken for frogs as they leap through the grass.
- **Red Fox** (*Vulpes vulpes*).
Common in the upland habitats.
- **Gray Fox** (*Urocyon cinereoargenteus*).
Uncommon in the upland areas. Normally active by night.
- **Raccoon** (*Procyon lotor*).
Common in the woodlands, along the field edges, and in the salt marsh. Most active at night.

- **Longtail Weasel** (*Mustela frenata*).
A few are present in the upland areas.
- **Mink** (*Mustela vison*).
An occasional mink may be found in the marsh or along the streams.
- **Striped Skunk** (*Mephitis mephitis*).
Common in the upland areas at night.
- **River Otter** (*Lutra canadensis*).
A few live in the refuge impoundments.
- **Whitetail Deer** (*Odocoileus virginianus*).
Common in the uplands and along the marsh edges. Most active at early morning and evening.





Other species are probably present on the refuge but have not yet been verified. Reports of additional species are welcome. Please contact:

Refuge Manager
Bombay Hook National Wildlife Refuge
RD #1, Box 147,
Smyrna, Delaware 19977
Telephone: (302) 653-9345.

*Take Pride in Bombay Hook
National Wildlife Refuge*



RL-51550-3
August 1986



**UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE**

Birds

Bombay Hook National Wildlife Refuge



Delaware

Bombay Hook National Wildlife Refuge lies low and flat on the Atlantic Coastal Plain along the western shore of Delaware. Nearly two-thirds of its more than 15,000 acres spreads out into tidal salt marsh and cordgrass meadows interrupted by winding rivers and creeks. Away from the bay and marsh are man-made freshwater ponds called impoundments. Upland woods, swamps, brushy thickets, grassy fields, and croplands complete the diversity of habitat which attracts a wide variety of bird life.

Look for greatest numbers of waterfowl during March and November. Shorebirds, wading birds and songbirds are most abundant during May, August and September.



This folder lists 261 birds that have been identified on the Refuge, and is in accordance with the Sixth American Ornithologists Union Checklist.

Most birds are migratory, therefore, their seasonal occurrence is coded as follows:

SEASON:

s - Spring March - May
S - Summer June - August
F - Fall September - November
W - Winter December - February

† - Birds known to nest on or near the Refuge
 Italics indicate threatened/endangered species

RELATIVE ABUNDANCE:

a - abundant a species which is very numerous
c - common likely to be seen or heard in suitable habitat
u - uncommon present, but not certain to be seen
o - occasional seen only a few times during a season
r - rare may be present but not every year

LOONS - GREBES

___ Red-throated Loon			r	r
___ Common Loon		r		
___ Pied-billed Grebe †	o	o	u	o
___ Horned Grebe	o	u	o	u
___ Eared Grebe				r

PELICAN - CORMORANT

___ American White Pelican		r		r
___ Double-crested Cormorant	u	u	c	u

BITTERNS - HERONS - IBISES

___ American Bittern †	o	u	u	o
___ Least Bittern †	o	u	o	
___ Great Blue Heron	c	c	a	c
___ Great Egret	u	a	c	o
___ Snowy Egret	o	a	c	r
___ Little Blue Heron	o	c	c	
___ Tricolored Heron	o	u	o	r
___ Cattle Egret	o	u	o	
___ Green-backed Heron †	c	c	c	r
___ Black-crowned Night-Heron	c	c	c	u
___ Yellow-crowned Night-Heron	o	o	o	o
___ Glossy Ibis	c	c	u	

SWANS - GEESE - DUCKS

___ Fulvous Whistling-Duck	r	r	r	
___ Tundra Swan	o	r	c	u
___ Mute Swan	r	r	r	o
___ Greater White-fronted Goose	r		r	r
___ Snow Goose	c	r	a	a
___ Ross' Goose	r		r	r
___ Canada Goose †	a	c	a	a
___ Wood Duck †	c	c	a	o
___ Green-winged Teal	a	o	a	c
___ American Black Duck †	c	c	c	c
___ Mallard †	a	c	a	a
___ Northern Pintail	a	o	a	a
___ Blue-winged Teal †	c	u	a	r
___ Northern Shoveler †	c	o	a	u
___ Gadwall †	c	a	a	u
___ Eurasian Wigeon	r	r	r	o
___ American Wigeon	c	o	a	c
___ Canvasback			o	o
___ Redhead	o		o	o
___ Ring-necked Duck	o		u	o
___ Greater Scaup	u	o	u	u
___ Lesser Scaup	u		u	u
___ Oldsquaw		r	u	o
___ Black Scoter	o	r	o	o

___ Surf Scoter	o		o	o
___ White-winged Scoter	o		o	o
___ Common Goldeneye	u	r	u	u
___ Bufflehead	c	r	c	c
___ Hooded Merganser	u	o	u	c
___ Common Merganser	u	r	c	c
___ Red-breasted Merganser	u	r	u	u
___ Ruddy Duck	c	o	c	c

VULTURES - HAWKS - FALCONS

___ Black Vulture	o	o	o	o
___ Turkey Vulture †	c	c	c	c
___ Osprey †	o	o	o	
___ Bald Eagle †	u	u	u	u
___ Northern Harrier †	c	o	c	c
___ Sharp-shinned Hawk	o	o	o	o
___ Cooper's Hawk	o	r	o	o
___ Red-shouldered Hawk †	o	o	o	o
___ Broad-winged Hawk	r	r	r	
___ Red-tailed Hawk †	u	o	c	c
___ Rough-legged Hawk	o		o	c
___ Golden Eagle			r	r
___ American Kestrel †	u	u	c	c
___ Merlin	r		o	r
___ Peregrine Falcon	r		u	r

PHEASANT - QUAIL - TURKEY

___ Ring-necked Pheasant †	c	c	c	c
___ Wild Turkey	u	u	u	u
___ Northern Bobwhite †	c	c	c	c

RAILS - COOT

___ Black Rail	r	r	r	
___ Clapper Rail †	c	c	c	o
___ King Rail †	c	c	c	o
___ Virginia Rail †	u	u	u	o
___ Sora	u	o	u	
___ Common Moorhen †	o	u	o	r
___ American Coot †	u	u	u	u

PLOVERS - SANDPIPERS

___ Black-bellied Plover	c	u	c	o
___ Lesser Golden-Plover	o	r	o	
___ Semipalmated Plover	c	u	c	r
___ Killdeer †	c	c	c	u
___ American Oystercatcher	r			
___ Black-necked Stilt †	u	c	o	
___ American Avocet	u	c	u	r
___ Greater Yellowlegs	c	c	a	o
___ Lesser Yellowlegs	c	c	c	o
___ Solitary Sandpiper	o	o	o	

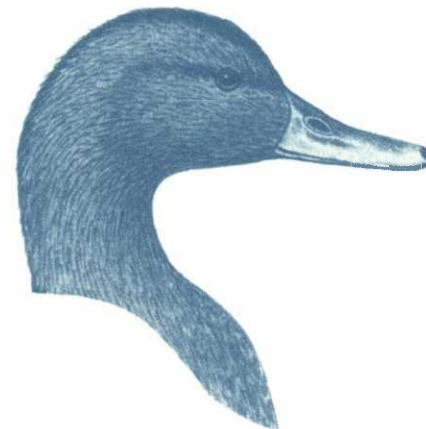
	s	S	F	W
Willet †	a	a	o	r
Spotted Sandpiper	u	o	u	
Upland Sandpiper	r		r	
Whimbrel	r	r	r	
Hudsonian Godwit	r	o	o	
Marbled Godwit		r	r	
Ruddy Turnstone	a	o	u	
Red Knot	a	o	o	
Sanderling	c	o	c	
Semipalmated Sandpiper	a	c	a	
Western Sandpiper	o	o	c	r
Least Sandpiper	c	c	c	r
White-rumped Sandpiper	u	o	u	
Baird's Sandpiper	r	r	r	
Pectoral Sandpiper	o	c	c	r
Dunlin	a	o	a	c
Curlew Sandpiper	r	r	r	
Stilt Sandpiper	u	c	u	
Buff-breasted Sandpiper		r	r	
Ruff	r	o	o	
Short-billed Dowitcher	c	c	a	r
Long-billed Dowitcher		o	o	
Common Snipe	c	o	c	u
American Woodcock †	c	u	c	r
Wilson's Phalarope	o	u	o	
Red-necked Phalarope	o		r	
GULLS - TERNS				
Laughing Gull	c	c	c	
Bonaparte's Gull	o	o	o	
Ring-billed Gull	c	u	a	c
Herring Gull	c	c	a	c
Great Black-backed Gull	c	c	c	c
Gull-billed Tern	o	o		
Caspian Tern	o	u	u	
Royal Tern		o	r	
Common Tern	o	o	o	
Forster's Tern	o	c	c	
Least Tern	o	c		
Black Tern	r	o	o	
Black Skimmer	o	u	o	
DOVES - CUCKOOS - OWLS				
SWIFTS - HUMMINGBIRDS				
Rock Dove †	o	o	o	o
Mourning Dove †	c	c	a	c
Black-billed Cuckoo †	o	o	o	
Yellow-billed Cuckoo †	c	c	c	
Barn Owl †	u	u	u	u

	s	S	F	W
Eastern Screech-Owl †	u	u	u	u
Great Horned Owl †	c	c	c	c
Barred Owl †	c	c	c	c
Long-eared Owl			r	r
Short-eared Owl †	o		o	o
Northern Saw-whet Owl	r		r	r
Common Nighthawk	o	o	o	
Whip-poor-will	o	o		
Chimney Swift	c	c	c	
Ruby-throated Hummingbird †	c	c	c	
Belted Kingfisher †	c	u	c	c
WOODPECKERS - FLYCATCHERS				
Red-headed Woodpecker	r		r	r
Red-bellied Woodpecker †	c	c	c	c
Yellow-bellied Sapsucker	o		o	o
Downy Woodpecker †	c	c	c	c
Hairy Woodpecker †	u	u	u	u
Northern Flicker †	c	c	c	o
Eastern Wood-Pewee †	c	a	c	
Acadian Flycatcher †	u	c	o	
Alder Flycatcher	r		r	
Willow Flycatcher †	o	c	o	
Least Flycatcher	o		o	
Eastern Phoebe †	c	u	c	r
Great Crested Flycatcher †	c	c	c	
Eastern Kingbird †	c	a	c	
LARKS - SWALLOWS - JAYS - CROWS				
Horned Lark †	u	o	u	u
Purple Martin †	c	c	o	
Tree Swallow †	c	a	a	r
Northern Rough-winged Swallow	u	o	u	
Bank Swallow	o	c	c	
Barn Swallow †	c	c	c	r
Blue Jay †	c	c	c	c
American Crow †	c	c	c	c
Fish Crow †	c	c	c	o
TITMICE - NUTHATCHES - WRENS				
Black-capped Chickadee			r	r
Carolina Chickadee †	c	c	c	c
Tufted Titmouse †	c	c	c	c
Red-breasted Nuthatch	o		u	u
White-breasted Nuthatch	u	o	u	u
Brown Creeper	c		c	c
Carolina Wren †	c	c	c	c
House Wren †	c	c	c	r
Winter Wren	u		c	c
Sedge Wren †	o	o	o	r

	s	S	F	W
___ Marsh Wren †	c	c	c	o
KINGLETS - THRUSHES - THRASHERS				
___ Golden-crowned Kinglet	o		c	c
___ Ruby-crowned Kinglet	c		c	o
___ Blue-gray Gnatcatcher †	c	u	o	r
___ Eastern Bluebird †	u	u	u	u
___ Veery	c	o	c	
___ Gray-cheeked Thrush	o		o	
___ Swainson's Thrush	u		u	
___ Hermit Thrush	c		c	o
___ Wood Thrush †	c	c	c	
___ American Robin †	c	c	c	o
___ Gray Catbird †	c	c	c	o
___ Northern Mockingbird †	c	c	c	c
___ Brown Thrasher †	c	c	c	o
WAXWINGS - SHRIKES - STARLINGS				
___ American Pipit	u		u	o
___ Cedar Waxwing	o	r	o	o
___ Loggerhead Shrike	r		r	r
___ European Starling †	a	a	a	a
VIREOS - WOOD WARBLERS				
___ White-eyed Vireo †	c	c	c	
___ Solitary Vireo	o		o	
___ Yellow-throated Vireo †	o	o	o	
___ Red-eyed Vireo †	a	a	a	
___ Blue-winged Warbler	o		o	
___ Golden-winged Warbler	o		o	
___ Tennessee Warbler	o		o	
___ Nashville Warbler	o		o	
___ Northern Parula	c	o	c	
___ Yellow Warbler †	c	c	c	
___ Chestnut-sided Warbler	c	o	c	
___ Magnolia Warbler	c		c	
___ Cape May Warbler	o		o	
___ Black-throated Blue Warbler	c		c	
___ Yellow-rumped Warbler	a		a	c
___ Black-throated Green Warbler	c		c	
___ Blackburnian Warbler	o	o	o	
___ Pine Warbler	c	o	o	
___ Prairie Warbler	c	o	o	
___ Palm Warbler	c		c	r
___ Bay-breasted Warbler	o		o	
___ Blackpoll Warbler	c		c	
___ Cerulean Warbler	r			
___ Black-and-white Warbler	c	o	c	
___ American Redstart †	c	o	c	
___ Prothonotary Warbler †	u	o	o	

	s	S	F	W
___ Worm-eating Warbler	o		r	
___ Ovenbird	c	u	c	
___ Northern Waterthrush	c	o	c	
___ Louisiana Waterthrush †	o	o	o	
___ Kentucky Warbler †	u	u	o	
___ Common Yellowthroat †	c	a	c	r
___ Hooded Warbler	r	r	r	
___ Wilson's Warbler	o		o	
___ Canada Warbler	c	o	o	
___ Yellow-breasted Chat †	u	u	u	r
TANAGERS - SPARROWS				
___ Scarlet Tanager †	c	c	c	
___ Northern Cardinal †	c	c	c	c
___ Rose-breasted Grosbeak	o	u	o	
___ Blue Grosbeak †	c	c	u	
___ Indigo Bunting †	c	c	u	
___ Rufous-sided Towhee †	c	c	c	o
___ American Tree Sparrow	o		u	u
___ Chipping Sparrow †	u	u	u	r
___ Field Sparrow †	c	c	c	c
___ Savannah Sparrow	c	r	c	c
___ Grasshopper Sparrow †	o	u	o	
___ Sharp-tailed Sparrow †	a	a	a	o
___ Seaside Sparrow †	a	a	a	o
___ Fox Sparrow	o		u	u
___ Song Sparrow †	c	c	c	c
___ Swamp Sparrow †	c	c	c	c
___ White-throated Sparrow	a		a	a
___ White-crowned Sparrow	o		o	o
___ Dark-eyed Junco	c		c	c
___ Lapland Longspur				o
___ Snow Bunting			o	u
BLACKBIRDS - FINCHES				
___ Bobolink		u	c	c
___ Red-winged Blackbird †	a	a	a	a
___ Eastern Meadowlark †	u	u	u	u
___ Rusty Blackbird	c		c	u
___ Boat-tailed Grackle	o	o	u	u
___ Common Grackle †	a	c	a	c
___ Brown-headed Cowbird †	c	c	c	c
___ Orchard Oriole †	c	u	o	
___ Northern Oriole	u	u	o	
___ Purple Finch	o		r	r
___ House Finch †	o		u	u
___ Common Redpoll			r	r
___ Pine Siskin	r		r	r
___ American Goldfinch †	u	c	c	u

	s	S	F	W
___ Evening Grosbeak	r		r	r
___ House Sparrow †	u	u	u	u



NOTES

Date _____ Time _____

Observers _____

Weather _____

Tides _____

U.S. Fish and Wildlife Service

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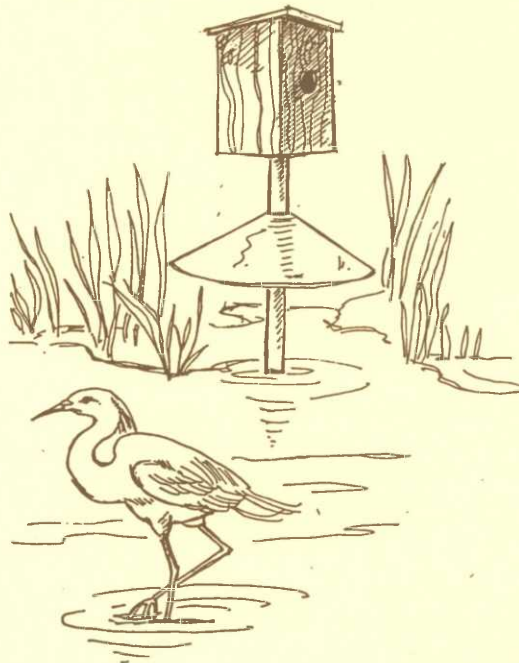
Refuge Manager
Bombay Hook National Wildlife Refuge
RD 1, Box 147
Smyrna, Delaware 19977-9764
Telephone: (302) 653-9345

Illustrations by Julien Beauregard



DEPARTMENT OF THE INTERIOR
U.S. FISH AND WILDLIFE SERVICE

Auto Tour



Bombay Hook
National Wildlife Refuge

Welcome to Bombay Hook National Wildlife Refuge, haven for wildlife and nature lovers seeking to study, photograph, and simply enjoy the environment at its scenic and protected best. This refuge is managed primarily for migrating and wintering ducks, geese, shorebirds, and other migratory birds, including the endangered southern bald eagle and peregrine falcon.

1. History

Recorded history of the area began in 1679 when the Indian Machacksett, Chief Sachem of Kahansink, sold some marshland called "Boompies Hooch" for a price of "...one gun, fower hands full of powder, three Mats coats, one anckor of Liquors and one Kittle..."

The settlers that followed cut salt hay, trapped muskrats and terrapins, hunted waterfowl, and plied the tidal streams for fish, crabs, and oysters.



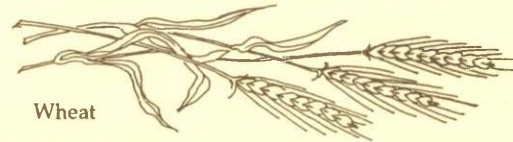
Muskrat house

Bombay Hook Refuge, comprising 15,122 acres, was established March 16, 1937. Soon afterward, Civilian Conservation Corps members began constructing pools for wildlife habitat as well as buildings to administer the area.

Waterfowl habitat management is very active here, and is done in conjunction with the North American Waterfowl Plan's Atlantic Coast Joint Venture. The North American Plan is an agreement by several federal agencies, states, Canada, and the private sector to conserve, restore and enhance wetlands habitat.

2. Cooperative Farming

A major refuge wildlife objective is to support migrating geese and ducks. Much food for these birds is supplied by the aquatic environment. However, crops are planted on about 1,000 acres of the refuge to provide additional food. Corn and soybeans are the primary crops harvested by refuge farmers for market, while other crops (winter wheat, buckwheat, grass/clover pasture) are left for wildlife. Farmers supply some corn for the refuge to use in conjunction with waterfowl banding.

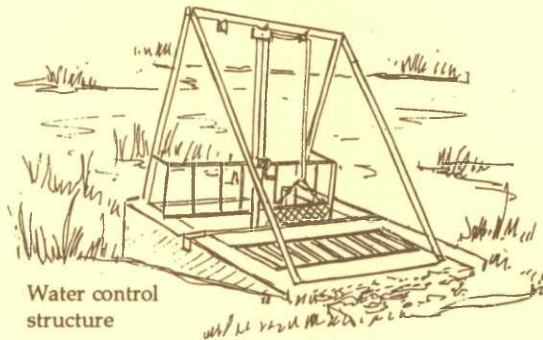


Wheat

The gray-green tower on your left is a lookout used during goose banding. To capture geese, corn is spread on the field in front of a carefully-spread net. Several cannons with black powder charges are attached to the net. When enough birds have been attracted by the corn, the cannons are fired. This hurls the net over the geese without harming them. All birds are released after numbered bands have been placed on their legs.

3. Freshwater Impoundments

The ability to manipulate water levels in these pools is the key to creating necessary habitats. Pool levels are maintained by the use of water control structures (the yellow bar structure). In the spring, excess water in the pool is released to the salt marsh to create mudflats which provide a food source for wading birds.



Water control structure

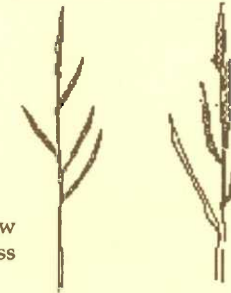
During the summer, emergent plants like wild millet, three-square bullrush, cattail, pond weed, widgeon grass, and wild rice thrive and produce seed in the shallow waters and exposed pool margins. Low pool levels that favor the growth of waterfowl foods also favor invertebrate species that are a food source for shorebirds.

Fall rains permit pool water levels to flood the seed-bearing plants. This flooding provides suitable conditions for waterfowl to feed on the plants, maximizing the food supply.

4. Tidal Saltmarsh

Tidal saltmarsh supplies organic materials for the food chain, circulates nutrients, provides nesting habitat for waterfowl and serves as a nursery area for fish.

A variety of waterfowl nest in the marsh, including black ducks, mallards, gadwalls, and blue-winged teal.



Saltmeadow cordgrass



Saltmarsh cordgrass

Bombay Hook Refuge hosts up to 75,000 migrating greater snow geese every year. Large numbers of geese can "eat out" salt marsh vegetation when they feed on the roots of wetland plants. To lessen this damage, managed snow goose hunts are used on the refuge to disperse the flocks.

The mud and reed mounds scattered across the tidal salt marsh are muskrat houses. Because a large population of muskrats can damage marsh vegetation, trapping by permit is used to control muskrat numbers.

5. Shearness Pool

Shearness Pool, on your left, is the largest of the four freshwater impoundments. It is the most likely area on the refuge to see southern bald eagles, which may be perched in trees, or feeding on fish, crippled ducks, or geese. Bald eagles nest on the refuge.

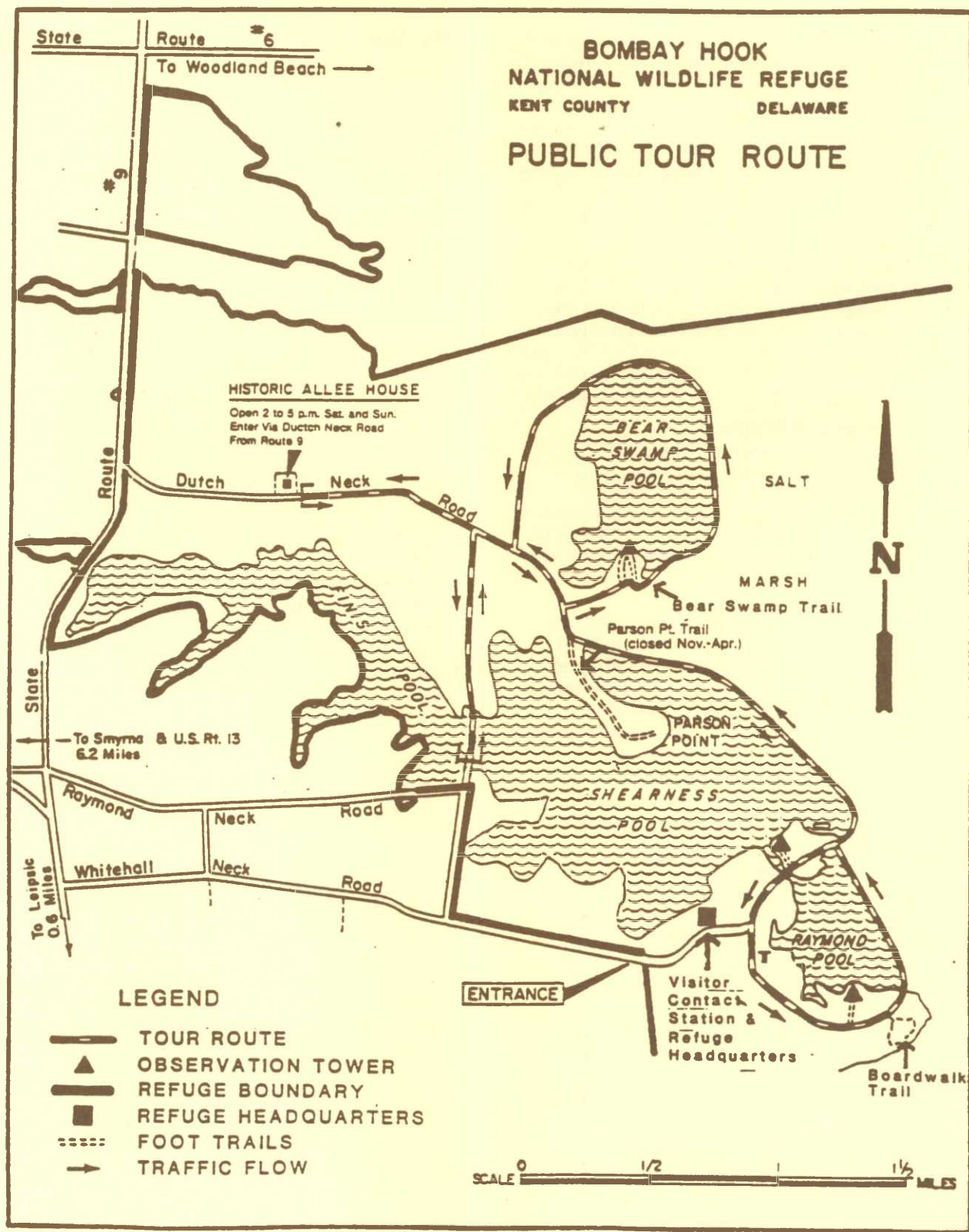
The trap beyond the Shearness Pool parking lot is used to capture ducks for banding. The trap, which is baited with corn, allows ducks to enter, but does not allow them to escape.

6. Wildlife Food Plot

To your left is a wildlife food plot, planted with bicolor lespedeza. Other food plots on the refuge may consist of buckwheat, millet, or autumn olive. These food plots attract a variety of wildlife, and supplement natural food sources. Food plots also provide habitat for ground-nesting birds and breeding areas for small mammals.



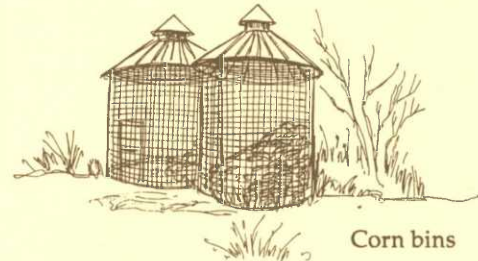
Buckwheat



Food plots are usually prepared and planted by neighboring farmers as part of their cooperative farming agreements with the refuge.

7. Loafing Area

The islands to your left in the Bear Swamp Pool are loafing (or resting) areas for wading birds. Throughout the summer, these islands are used by snowy egrets, great egrets, great blue herons, and black-crowned night herons. During the fall hunting season, you may see grass-covered water blinds, used by Young Waterfowlers. Under this program, youths aged 12 to 18 are taught hunting safety, ethics, regulations, and waterfowl identification before participating in a refuge hunt.



Corn bins

8. Corn Bins

The bins to your left store corn used during waterfowl banding. When banding takes place, the age and sex of captured birds is recorded and matched with the numbers on the band. Information on the birds is sent to the Migratory Bird Banding Laboratory in Laurel, Maryland. If you recover a banded bird, the band, along with information about where the bird was found, should be sent to the Bird Banding Laboratory. Through bird band returns, much valuable information is gained about waterfowl populations and migration patterns.



Bird band

9. Old Field

This old field has been retired from agricultural production and planted to a grass/lespedeza mixture. Areas like this throughout the upland portions of the refuge provide ideal nesting or breeding cover for a wide variety of birds and mammals, including ducks, quail, rabbits, pheasants, and white-tailed deer. The old fields are mowed every two or three years to prevent the growth of woody vegetation.

10. Woodland

Beyond the water to your left is a 410-acre woodland. It is managed to provide habitat for many species of plants and animals. Sweet gum, white oak, and black tupelo are the larger trees in these woods. American holly, jack-in-the-pulpit, and pink lady slipper also grow here.

Animal species that use these woods for food and cover include white-tailed deer, opossums, skunks, raccoons, and fox. Each spring, the woodland is alive with the sound of warblers.



Fox

11. Grassed Waterway

The depression to the right, which separates the two fields, is a grass-covered waterway, graded to carry excess water away from the fields without causing erosion. This type of waterway is mowed during the non-nesting seasons to prevent woody plants from growing in the drainage.



Allee House

12. Allee House

This small country-style dwelling of the Queen Anne period, preserves a bit of history on the refuge. Built about 1753, it is on the National Register of Historic Places. Today, the Delaware Division of Historical and Cultural Affairs maintains the Allee House, which is open to the public on weekend afternoons.

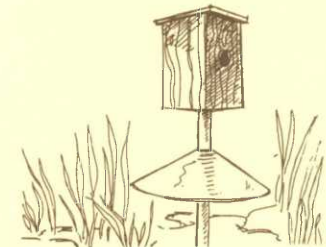
During the fall, you may notice goose blinds and elevated deer stands (platforms) in fields and woodlands along the road near the Allee House. On specified days, this area is open to waterfowl and deer hunting on a permit basis.



Beaver

13. Finis Pool

Finis Pool contains the freshest water of any impoundment on the refuge. Beyond the pool is Finis Branch, the primary fresh water source for all impoundments. Beavers are occasionally trapped and relocated from here to reduce the potential for beaver dams to clog the water control structures and flood the road.



Nest box

Wood ducks, which need cavities for nesting, use the wooden boxes you see here. The cone skirts prevent raccoons and snakes from getting into the nest and destroying the eggs or ducklings.

The refuge staff hopes you enjoyed your tour. Please let us know about your wildlife encounters.

To do this, either stop at the visitor center or record your sightings on the observation list kept in the brochure rack near the restrooms.

Mission: As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally-owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historic places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. Administration.

For further information contact:

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Bombay Hook National Wildlife Refuge
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Office: (302) 653-9345
Visitor Center: (302) 653-6872

Illustrations by Sandy Rhodes



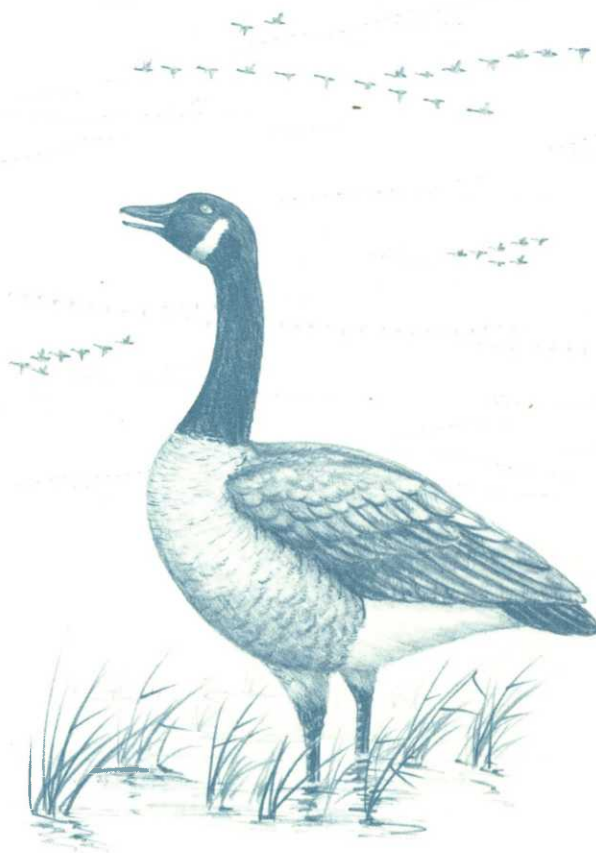
DEPARTMENT OF THE INTERIOR
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July 1990

Boardwalk Trail

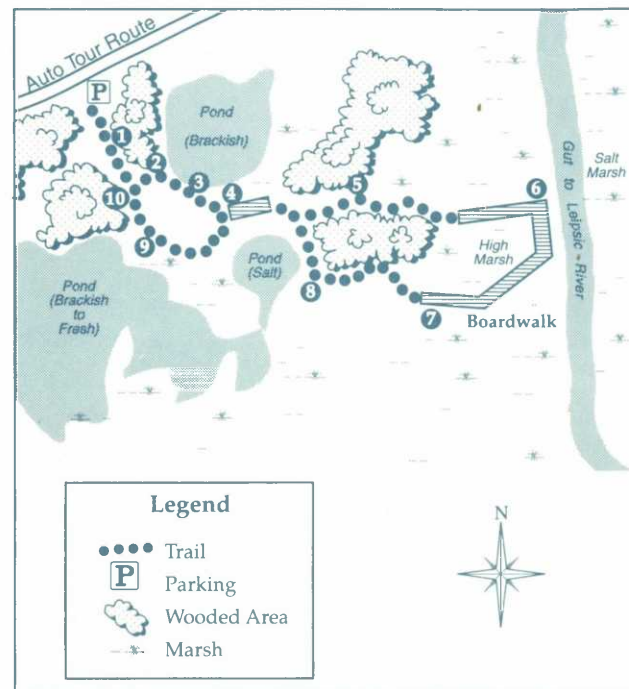
Bombay Hook
National
Wildlife
Refuge



Delaware

Welcome!

Welcome to Bombay Hook National Wildlife Refuge. The Boardwalk Trail passes through four different refuge habitats: woodland, freshwater pond, brackish pond, and saltmarsh. The Trail is about one-half mile long and will take you about 30 minutes to complete.



1 Each season brings changes along the Boardwalk Trail. In spring, many low plants grow and reproduce before leaves appear on the trees, making this an excellent time for sighting songbirds. During the late spring and summer months, shady woods along the Boardwalk Trail provide a home for many wildlife species which alert visitors may notice. Warmer weather also increases the number of ticks, mosquitoes, and flies along the trail. When insects are present, most visitors feel comfortable wearing a long-sleeved shirt, slacks, and insect repellent, but headnets are sometimes needed. During the fall, leaves change color and many wildlife species prepare for winter.

The winter season helps create different patterns, shapes, textures, and colors along the trail. Many animals and birds remain active all winter and may be easily seen as their search for food intensifies.

2 There are three types of wetland habitats at Bombay Hook Refuge. Freshwater habitat may be recognized by the lily pads and frogs living there. In brackish water habitat, transition plants such as three square and other bulrushes (*Scirpus sp.*) can be seen. The pond you see at this stop is brackish. In saltmarsh habitat, vegetation consists mostly of cordgrasses (*Spartina cynosuroides*, *S. patens*, *S. alterniflora*) and spike grass or saltgrass (*Distichlis spicata*). The saltmarsh at Bombay Hook becomes more salty during droughts, and becomes less salty during and immediately after heavy rain. Ocean water is always more salty than the saltmarsh at Bombay Hook.



Notice the wood duck box near the edge of the pond. Although wood ducks usually nest in tree cavities, they will use man-made nests if hollow trees are not available. The cone skirt under the box prevents predators such as snakes or raccoons from getting into the nest and destroying eggs or young ducklings. Wildlife managers maintain many nest boxes to increase the number of wood ducks produced at Bombay Hook Refuge. If you own similar habitat, you can help wildlife by installing your own nest boxes.

Careful management of Bombay Hook wetlands benefits man as well as wildlife. Some of these benefits include: nesting, migration, and wintering habitat for waterfowl, shorebirds, and other wildlife

(such as river otters, rare fur-bearers in Delaware); habitat for marine and freshwater fish; water pollution and sediment control; saltwater intrusion control, reduction of coastal storm damage; and recreational, educational, and scientific uses.

3 Many trees in this area are persimmon trees, an important food source for wildlife such as raccoons, foxes, and opossums. Persimmon fruit is round, smooth and orange, and remains on the tree long after the leaves have fallen. Persimmon tree bark is rugged and corrugated and looks a lot like alligator skin.

Japanese honeysuckle, introduced into the United States in 1898, is found in patches along this section of the trail. This plant spreads rapidly, and can dominate and shade out native plants. The flowering vine and its berries, however, are a good food source for game birds, songbirds, rabbits and deer.

Another non-native plant, Phragmites (or common reed), was introduced to the United States from Eurasia. Unlike the Japanese honeysuckle, it has very little wildlife value. Phragmites crowds out native plants such as cattails, pond lilies,



bulrushes, and smartweed in freshwater areas, and cordgrasses in saltwater areas. Refuge managers are controlling Phragmites with water level manipulation and herbicides in late summer followed by burning during the winter months. Individual sites are treated for two consecutive years. Because this process destroys the root system of Phragmites, native plants can regrow without competition.



4 If you stand on the short boardwalk and look to your left, you may see poison ivy plants entangled with marsh reeds. The white berries produced by this plant can often be seen along the Boardwalk Trail during the fall and winter months. Although poison ivy berries provide food for pheasants, quail, catbirds, flickers, finches and sparrows, humans can catch a severe rash from handling the berries, the leaves, or even the hairy vine.

During the warm months, minnows and killifish may be seen in the water under and adjacent to the boardwalk. If you are a quiet observer, you may also see northern water snakes sunning themselves here.

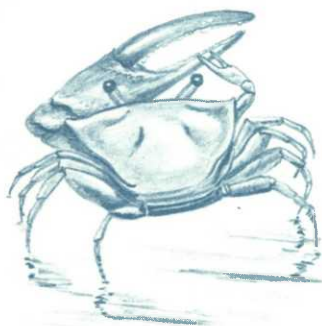
5 This woodland area contains several sweetgum trees, an early successional species. Sweetgums are medium-sized trees with star-shaped leaves, winged corky bark, and a large prickly fruit smaller than a golf ball and brown when ripe.

You may also see wild cherry trees in this area. Older cherry trees develop a rough, shaggy, dark bark, while younger trees can be identified by the lenticels or lines in the bark. Birds and mammals prefer cherries over the fruit produced by the sweetgum tree.

Near the boardwalk are many bayberry or wax myrtle bushes, whose berries are popular with songbirds. Humans have used the waxy coating of the berries to make candles and scent soaps.

6 This is a high marsh, made up mostly of salt meadow cordgrass (*Spartina patens*) or salt grass (*Distichlis spicata*). This marsh type is only flooded during spring tides or by major storms. The major low marsh species is saltmarsh cordgrass (*Spartina alterniflora*). Low marshes are flooded during every high tide, normally twice per day.

If the tide has gone out, you may see small fiddler crab holes in the mud during warm weather. Fiddler crabs are smaller than the familiar blue crab which is abundant in many local tidal marshes. Male fiddler crabs have one claw larger than the other. Marsh crabs may also be found here, along with many different species of waterbirds and shorebirds that use the marsh for feeding and resting.



The mounds you see in the saltmarsh are muskrat houses, made of mud and vegetation. Some visitors mistakenly think they are beaver lodges. Beaver lodges, however, are not found in the saltmarsh, but in freshwater only and consist of mud and sticks. Muskrats are mainly vegetarians, although they may eat clams, fish, crayfish and snails. Raccoon scat, or droppings, can often be seen on the boardwalk. The scat usually contains persimmon tree seeds, other seeds, and the remains of fiddler crabs. Look for raccoon tracks in the marsh mud along the sides of the boardwalk and along the railing.

7 Wetlands are ideal places for nesting ducks. Ducks that nest at Bombay Hook Refuge include black ducks, mallards, blue-winged teals, gadwalls, and shovelers. To help save ducks and geese, the Migratory Bird Hunting Stamp Act was passed by Congress in 1934. Today this is known as the Federal Duck Stamp Program. Money from duck stamps purchased by waterfowl hunters, conservationists, and stamp collectors provides funding for the acquisition and leasing of wildlife refuges. Today, 3.7 million acres of wetland refuges are preserved for North American waterfowl and other wildlife. Many of the more than 450 national wildlife refuges in the United States were purchased in whole or in part with money from the sale of Duck Stamps.



8 The wooden structure seen from here is a deer stand used by hunters. Deer hunting is permitted at Bombay Hook Refuge to control deer population numbers and to provide a form of wildlife-oriented recreation. These elevated deer stands are located in the headquarters hunt area and the regular deer hunt area. Six hunt sites are reserved for hunters in wheelchairs. If you would like to hunt at Bombay Hook, check at the refuge office before you leave today.



9 This pond is one of the best spots along the Boardwalk Trail to see waterfowl in the fall and shorebirds in the spring. Waterfowl often sighted include black ducks, gadwalls, blue-winged teals, and mallards. Willets, yellowlegs, and dowitchers are the most common shorebirds seen. The saltmarsh is a nesting area for willets.

To help ensure that healthy populations of ducks, geese and swans will exist in the future, the United States and Canada signed the North American Water-fowl Management Plan in 1986. The Plan establishes population goals for waterfowl through the year 2000, and gives special attention to species with declining populations. The Plan identifies habitat conservation needs in regions of both

countries, and encourages international cooperation by other countries such as Mexico, where many waterfowl populations spend the winter. The North American Plan is a bold step which needs the support of private citizens as well as government agencies if its goals are to be reached and maintained.

10 We hope you enjoyed your walk along the Boardwalk Trail. This trail was built by members of the Youth Conservation Corps in 1973. YCC is a summer program for youths 15 to 18 which combines environmental education opportunities with meaningful work experience. Trail maintenance projects include laying down wood chips to prevent erosion, outlining the trail with logs, and clearing brush growing onto the trail. If you would like to become a volunteer at Bombay Hook Refuge, or would like more information about the Youth Conservation Corps, please ask at the refuge office before you leave today.

After walking the Boardwalk Trail, you may realize that wetlands have many values. Wetland values include wildlife resting, feeding, and production; ground water replenishment; pollution and sediment control; flood prevention; educational and scientific uses; recreation and esthetics. Healthy wetlands provide benefits for everyone. Please do your part to protect them.

U.S. Fish and Wildlife Service

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Smyrna, DE 19977
Telephone: (302) 653-9345 Office
(302) 653-6872 Visitor Center

Illustrations by Bob Jones



DEPARTMENT OF THE INTERIOR
U.S. FISH AND WILDLIFE SERVICE

Bear Swamp Trail

Bombay Hook
National
Wildlife
Refuge

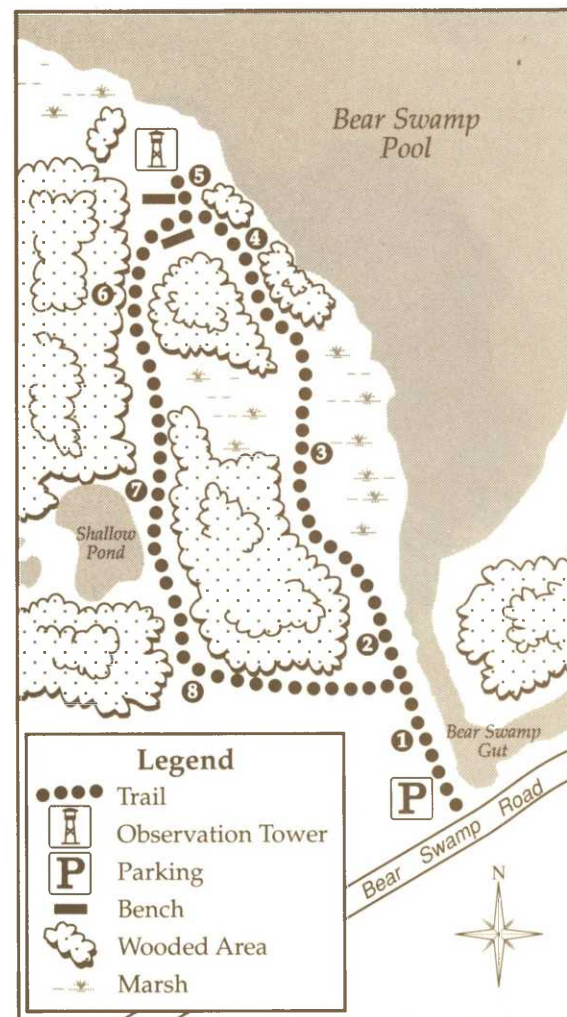


Delaware

Welcome!

Welcome to Bombay Hook National Wildlife Refuge! The Bear Swamp Trail was constructed in 1961 and is located on the south end of Bear Swamp Pool. Bear Swamp is the name given to the wetland area beyond the dike, according to early records. Bears no longer live in Delaware; the last recorded sighting was in 1905.

As you walk the trail today, please use caution to avoid poison ivy shrubs and vines. Although poison ivy provides food for flickers, woodpeckers, and other birds, it can cause a serious skin rash in humans.



1 In this part of the United States, abandoned fields usually give way to a variety of shrubs and trees including bayberry, winged sumac, and sweetgum. Next, trees such as maple and beech appear. Finally, oak and hickory trees emerge. This slow changing of vegetation is called forest succession.



Here, you can see the first stage of forest succession. The large sweetgum trees produce spiny "monkey balls." The dark red fuzzy fruit clusters of winged sumac are eaten by wildlife when other foods are scarce. Bayberry, or wax myrtle, is a plentiful shrub in Refuge wetlands, and provides a waxy-coated fruit eaten by many bird species.

2 Near this stop, the trail passes through the forest and along the marsh. The red maple trees indicate this area is in the second stage of forest succession. Look here for the sassafras, which produces a fleshy blue fruit eaten by song-birds and quail.

The marsh just ahead is important for breeding, migrating, and wintering ducks and geese. Because it is so important, protection of this kind of wetland is being addressed by several conservation groups and plans. The North American Waterfowl Management Plan, a joint effort between the United States and Canada, outlines population goals for waterfowl and focuses on preserving and improving habitats needed to produce healthy populations of ducks, geese and swans.

The Federal Duck Stamp Program also helps preserve wetlands. The money collected from the

sale of Duck Stamps to waterfowl hunters, conservationists, and stamp collectors is used to purchase waterfowl habitat for the National Wildlife Refuge System. Over 3.7 million acres of waterfowl habitat have been preserved through this program since the 1930's.

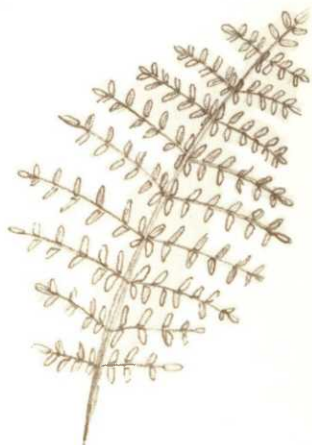
3 Along the water's edge is Phragmites, or common reed, which flourishes where man has disturbed the soil by dredging or ditching. This plant grows from 5 to 15 feet tall and has a feathery plume-like top. The stem is round and jointed like a bamboo. Introduced from Eurasia, Phragmites is not desirable because it crowds out native vegetation and has very little value for wildlife. Refuge managers are trying to control Phragmites at Bombay Hook by manipulating water levels, chemical spraying, and burning.



4 Along the trail are many shrubs, bushes and tall trees to study and admire. The forest floor, or understory, offers many plants interesting to human visitors and important to wildlife.

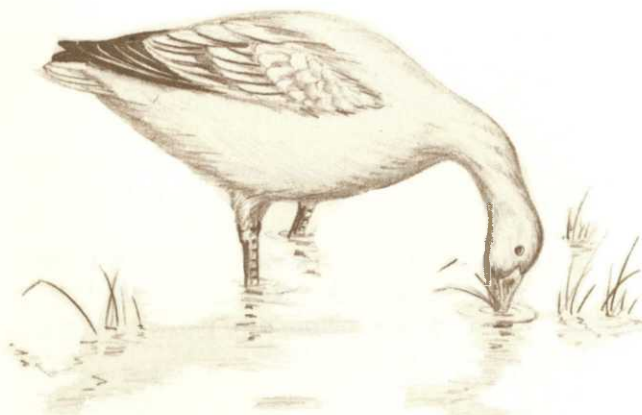
Ferns are common along the Bear Swamp Trail due to ideal growing conditions. Fern species you may see include bracken, royal, cinnamon, New York, lady's, sensitive, and marsh ferns.

Ferns are delicate, flowerless plants usually found in moist, shady areas. They reproduce by spores enclosed in small, brownish cases found on the backs of leaves or on separate stalks. When the spores ripen, the cases burst open and the spores fall on the ground where they develop into tiny, green, heart-shaped plants. These plants then develop a female sex cell, an egg, and a male sex cell which fertilizes the egg. The fertilized egg then grows into a mature fern.



5 The 30-foot observation tower is a good place to observe waterfowl and other wildlife on Bear Swamp Pool. Bear Swamp is a 240-acre freshwater impoundment constructed in 1961. Water in Bear Swamp is manipulated by Refuge managers to produce desired vegetation within the pool. In the spring, water levels are lowered to promote desirable plant growth. Migrating shorebirds are attracted to the warmer, shallow water and to the newly-created mudflats. In the fall, water levels are raised by rainfall. Arriving waterfowl respond to these conditions and to the seed-bearing plants which will become a winter food source for them.

Snow geese are one of the many species of waterfowl that arrive in the fall. Each year, Bombay Hook and Prime Hook Refuges attract the largest



wintering populations of greater snow geese in the country. Unfortunately, such large numbers of birds can destroy the saltmarsh by "eating out" large areas of vegetation. To help prevent this problem, Refuge managers provide alternative food crops to attract geese to other areas, burn sections of the marsh to attract birds who will feed on the plant roots, and permit snow goose hunts to disperse the flocks.

Another waterfowl species that uses Bear Swamp is the small, colorful wood duck. The nest boxes visible from the tower were built to increase the number of wood duck nesting sites. The metal collar below the box prevents raccoons and snakes from getting into the box and preying on the female, her young, or the eggs. These nest boxes are helping to reverse damage done to wood duck populations when timber harvesting early in the 20th century removed most of the mature trees. Very liberal hunting regulations also contributed to wood duck population decline. The Migratory Bird Treaty Act of 1918, implementing a treaty signed between the United States and Canada, may have saved the wood duck from extinction.



From the observation tower, you may be able to spot muskrat houses scattered across the saltmarsh. Because a large population of muskrats can damage marsh vegetation, trapping by permit is used by Refuge managers to control muskrat numbers.

Grass-covered water blinds, used in the Young Waterfowlers Program, can be seen in the impoundment during the fall hunting season. Young Waterfowlers are youths between 12 and 18 who are taught hunting regulations, safety, ethics, and waterfowl identification before they participate in regular Refuge hunts.



6 Look here for evidence of the third stage of forest succession - oak and hickory trees. Below these large trees on the forest floor are mushrooms and fungi, "Mother Nature's house cleaners." These non-flowering plants break down dead plant and animal products, thus supplying minerals to other plants.

In late summer, look for blackberry, wild raspberry, and wild strawberry plants which provide fruit for songbirds. Jack-in-the-Pulpit is another plant which yields clusters of berries enjoyed by ring-necked pheasants and wood thrushes.

While studying the low-growing plants, you may discover tracks of deer or other animals. Deer populations are closely monitored on the Refuge, to prevent overbrowsing of vegetation. Regulated deer hunts are used at Bombay Hook and other refuges as a management technique to control deer and to provide wildlife-oriented recreation.



7 This small pond is a good place to look for frogs and salamanders, and is a favorite area for woodpeckers and barred owls. Although barred owls are nocturnal, or active at night,

they will sometimes hunt or hoot during the day. Owls like this area because they can find crayfish, frogs, and fish here.

8 We hope you enjoyed your walk today. Freshwater ponds such as Bear Swamp Pool add a whole group of plants and animals to Bombay Hook Refuge. These ponds give waterfowl and shorebirds a place to rest, feed, and nest. Mammals attracted to freshwater ponds include beavers, otters, raccoons, and mink. Bear Swamp and other freshwater ponds are favorite places for bald eagles to catch fish for dinner.

Thoughtful management of Bombay Hook wetlands benefits man as well as wildlife. Wetlands help replenish groundwater, control pollution and limit soil loss, prevent floods, and provide places for educational, scientific and recreational activities. Healthy wetlands provide benefits for everyone. Please do your part to protect them.



U.S. Fish and Wildlife Service

Bombay Hook is one of more than 470 refuges in the National Wildlife Refuge System administered by the U.S. Fish and Wildlife Service. The National Wildlife Refuge System is a network of lands and waters managed specifically for the protection of wildlife and wildlife habitat and represents the most comprehensive wildlife management program in the world. Units of the system stretch across the United States from northern Alaska to the Florida Keys and include small islands in the Caribbean and South Pacific. The character of the refuges is as diverse as the nation itself.

The Service also manages National Fish Hatcheries, and provides Federal leadership in habitat protection, fish and wildlife research, technical assistance and the conservation and protection of migratory birds, certain marine mammals and threatened and endangered species.

For further information please contact:

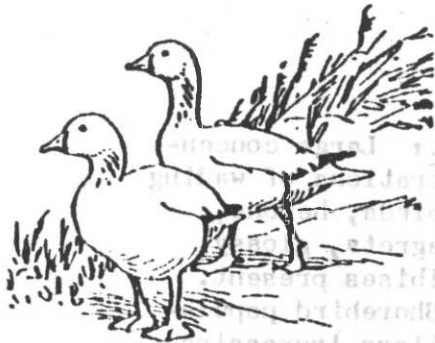
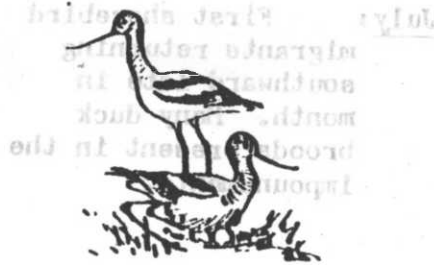
Refuge Manager
Bombay Hook National Wildlife Refuge
RFD #1, Box 147
Smyrna, DE 19977
Telephone: (302) 653-9345 Office
(302) 653-6872 Visitor Center

Illustrations by Bob Jones



DEPARTMENT OF THE INTERIOR
U.S. FISH AND WILDLIFE SERVICE

October: Best month for
avocets. Canada
geese arriving.
Bur marigold in
blossom in fresh
water pools.



November: Fall peak of
migrant Canada
geese, snow geese
and ducks.



December: Numerous hardy
waterfowl and other
birds usually remain
all winter but the
first heavy freeze
speeds the less
hardy birds southward.

The refuge is open to visitors through daylight hours.
Further information is available from the Refuge Manager,
Rt D.#1, Box 147, Smyrna, Delaware 19977, and the tele-
phone number is (302) 653-9345.



April: Early spring songbird migration. Leopard and chorus frogs in full voice. Purple martins return. Spring wild flowers in the woodlands.

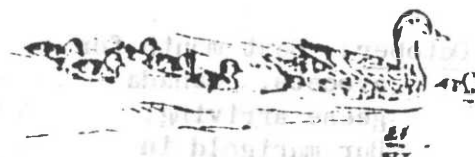


May: largest variety of wading birds present. Peak concentrations of shorebirds. Swamp chorus of bullfrogs and green frogs. Warbler migration peaks. Snapping turtles laying eggs. Spring wild flowers abundant. Tulip tree in blossom.

June: Duck broods appear. Terrapins laying eggs on dikes. First fawns seen. Water lilies in bloom.

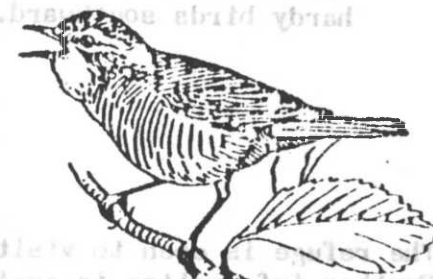


July: First shorebird migrants returning southward late in month. Many duck broods present in the impoundments.



August: Large concentrations of wading birds, herons, egrets, glossy ibises present. Shorebird populations increasing. Cardinal flower, rose mallow and meadow beauties in flower. First duck migrants.

September: Late migrating shorebirds and songbirds present. Tick-seed sunflower, goldenrods and joe-pye-weeds in blossom.



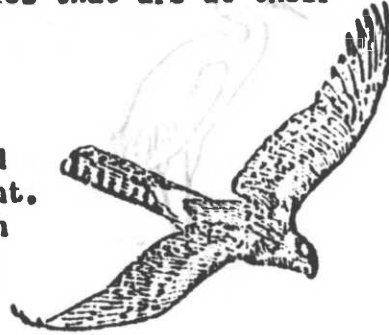


BOMBAY HOOK NATIONAL WILDLIFE REFUGE

CALENDAR OF NATURE EVENTS

This calendar of the seasonal progression of the most interesting natural occurrences is meant to aid you in planning visits to Bombay Hook Refuge. The Tour Route, open through daylight hours, will provide an easy means of viewing the following--free of mosquitoes and greenhead flies that are at their worst June 15 to September 15.

January: Red-tailed, marsh and rough-legged hawks abundant. White-tailed deer herds in fields at dusk.



February: Large flocks of pintails arrive during first mild weather. Bald eagles begin incubation.

March: Spring peak of migrant Canada geese, snow geese, ducks. Woodchucks and turtles emerge from hibernation. Ospreys return to nest. Woodcock courtship flights occur. Alders and red maples flower.

