PROGRESS REPORT NO. 10

Response of Greater Snow Geese (<u>Chen caerulescens</u> atlantica) to Hunting at Bombay Hook NWR and Related Wetland Changes.

May 1998

Progress Report Number 10 Table of Contents

I.	Intro	oduction	1						
II.	Obje	ectives	1						
III.	Meth	Methods							
	Α.	Aerial Survey	1						
	В.	Aerial Photography	5						
	С.	Vegetative Transects	5						
	D.	Age Ratio Surveys	5						
	E.	Other	5						
IV.	Results & Discussions								
	Α.	Dawn Surveys	. 9						
	В.	Vegetative Monitoring	9						
	C.	Snow Goose Response to the Refuge Hunt	14						
	D.	Other Observations	17						
V.	Sum	mary, Conclusions, Recommendations	17						

Table of Contents (Cont.) Tables and Figures

Table 1	Snow Goose Peaks & Use Days Bombay Hook NWR
Table 2	Dawn Surveys 1996-1998 Along DE Atlantic Coast
Table 3	Bombay Hook Dawn Snow Goose Counts 1996-1998
Table 4	Mean Snow Goose Populations Encountered During Dawn Survey
Table 5	Mean Snow Goose Populations Encountered at Bombay Hook NWR During Dawn Survey
Table 6	Percent of Dawn Survey Consisting of Birds Found within Unit 2
Table 7	Percent of Dawn Survey Consisting of Birds Found Within Bombay Hook NWR
Table 8	Spartina alterniflora cover (%) along eleven permanent saltmarsh transects at Bombay Hook NWR
Table 9	Comparison of Hunter Success with Snow Goose Age Ratio
Figure 1	Snow Goose Peaks - Bombay Hook NWR
Figure 2	Basic Survey Route for Dawn Surveys
Figure 3	Dawn Survey Units on and off the Federal Refuges
Figure 4	Bombay Hook NWR Survey Units
Figure 5	Saltmarsh Transects 1989-1998 Bombay Hook NWR

Figure 5Saltmarsh Transects 1989-1998 Bombay Hook NWRFigure 6Bombay Hook NWR Areas Denuded by Snow Geese 1989-1998

I. INTRODUCTION

Wintering snow goose populations have increased dramatically in the vicinity of Bombay Hook National Wildlife Refuge during the last 20 years. Peak populations have risen form 1,500 in 1968 to over 198,000 in 1997. (Table 1 & Figure 1) The birds concentrate their feeding activities in a relatively small portion of the refuge salt marshes and create "eat-outs", areas of marsh stripped of vegetation, following their feeding activities. Beginning with the 1983-84 season the refuge opened portions of the marshes to public snow goose hunting. Since it was noted that most damage occurred shortly after the birds arrived in October, a special early hunt was permitted prior to the regular State waterfowl season beginning in 1987-88 which has continued since that time. With the advent of snow goose hunting in Bombay Hook's marshes changes in the birds' use patterns on Bombay Hook and surrounding areas were noted. Concentrations of the birds began using Prime Hook National Wildlife Refuge, the Little Creek Wildlife Management Area as well as private lands to the west into Maryland's eastern shore. This study was proposed to document and monitor the habitat preferences, population fluctuations, and vegetational changes associated with the snow goose flocks in the Bombay Hook Area.

II. <u>OBJECTIVES</u>

- A. Document snow goose numbers roosting on the Bombay Hook National Wildlife Refuge and Prime Hook National Wildlife Refuge, as well as on the nearby state Wildlife Management Areas from arrival in the fall to departure in the spring.
- B. Determine habitat use both on and off the refuges and Wildlife Management Areas from arrival in the fall to departure in the spring.
- C. Document vegetational changes in the tidal marshes and impoundments as a result of snow goose feeding.
- D. Assess the impacts of hunting the Bombay Hook marshes on the movements and habitat use of the geese in the vicinity of Bombay Hook NWR.

III. METHODS

A. <u>Aerial Surveys</u>

In order to determine roosting locations as well as feeding locations we determined that two types of aerial surveys would be necessary. Roosting locations and flock numbers were determined by flying an aerial survey beginning at dawn over the route illustrated in Figure 2. Feeding locations were determined in the years of the study prior to the 94-95 season by flying a mid-morning route over a wider area including western Delaware and portions of Maryland's eastern shore. Dawn

Table 1

Snow Goose Peaks & Use Days - Bombay Hook

Calendar		
Year	Use Days	Peak
1976	307,542	9,100
1977	245,485	5,500
1978	407,758	10,000
1979	817,500	10,000
1980	2,388,273	20,500
1981	1,634,825	17,000
1982	3,215,250	50,500
1983*	3,469,231	66,000
1984	2,871,650	46,235
1985	3,487,726	50,000
1986	4,739,283	72,000
1987	5,122,355	75,000
1988	3,320,645	53,000
1989	2,740,168	68,000
1990	4,157,862	56,400
1991	3,008,653	40,000
1992	3,678,609	54,000
1993	6,016,103	87,125
1994	5,684,300	68,310
1995	5,944,122	89,700
1996	6,696,714	132,000
1997	11,573,488	198,930

* Year Snow Goose Hunting in Bombay Hook Marshes was First Permitted.



surveys were conducted by Delaware Fish and Wildlife personnel and mid-morning surveys by staff from Bombay Hook refuge. Unfortunately, the funding constraints precluded all mid-morning surveys since the 94-95 field season and dawn surveys were reduced from weekly counts to bi-weekly and sometimes only monthly. Information on habitat preferences by feeding snow geese was not collected during the past 3 years except within the boundaries of Bombay Hook NWR. Techniques for mid-morning surveys including areas covered are contained in previous Progress Reports.

B. Aerial Photography

Aerial color slides of the Bombay Hook marshes impacted by feeding snow geese have been collected each year of the study and were again during 97-98.

C. Vegetative Transects

Thirty meter transects established during 1989-90 within the Bombay Hook saltmarsh were run again this year. (Figure 5) Although only 7 of the 11 transects were surveyed this year. Thirty plots were established per transect by placing a steelframe 20 x 50 cm (inside dimensions) at 1 meter intervals along a tape. Percent ground cover of each plant species found at each plot was recorded for each transect. Class ranges for percent cover were 0-5, 6-25, 26-50, 51-75, 76-95, and 96-100. Mean values for percent cover were collected using mid-point values for each class. Color slides along each transect were taken at the time the transects were run in September as well as after snow goose feeding within the marshes ceased in the spring. Transects were established within areas previously denuded by geese as well as within areas adjacent but out side eat-out areas.

D. Age Ratio Surveys

Productivity and age ratio surveys of snow geese were conducted in conjunction with the Migratory Bird Office's surveys. Techniques for these surveys are delineated in the booklet "Standard Operating Procedures for Productivity Surveys for Geese, Swans, and Brant" distributed by the Migratory Bird Office.

E. Other

Daily notes of snow goose movements, areas utilized, and other significant observations were maintained in a narrative form.

IV. RESULTS AND DISCUSSIONS

The 1997-98 season marked the ninth consecutive year in which we have collected data via the methods described above. Unfortunately, the inability to fly the surveys in the manner of the first years of the study limited the amount of the information which we could collect during the past four years. Survey data for the past year is summarized in Tables 2-3.







UNITED STATES



Figure 5 - Saltmarsh Transects 1989-1998 Bombay Hook NWR



A. Dawn Surveys

Since the dawn survey flights originated within a few miles of Bombay Hook NWR the surveys were most reliable for the birds on or close to Bombay Hook. Since the southern end of the survey (e.g. Prime Hook) was surveyed later in the flight, early departing birds may have been missed more often along the southern edge of the survey route. It is suspected that many of the birds recorded in Unit 7 (primarily the cattle feedlots) during the dawn survey may have actually roosted on Prime Hook NWR before flying to the feedlots to feed. Tables 4-7 summarize data for the entire nine years of data collection. It can be easily observed, particularly in Tables 6 and 7 that the trend during the first years of data collection was for the birds to show the greatest affinity for the Bombay Hook area during the first two months of arrival (i.e. October & November) after that time other areas tend to become more attractive to the birds. Further, beginning with the 91-92 season a downward trend seemed to be developing in the percentage of the state population that roosted on and around Bombay Hook during the October and November period. However, during the past three seasons the percentages of the state population roosting in the Bombay Hook vicinity increased during those two months. We have also noticed, as one might suspect, that during harsh winters the percentages of birds within the Bombay Hook area declines sharply. This phenomenon was emphasized during the years of 92,94, and 96 when February was quite cold. Conversely, the mild winter of 1994-95 and the past 2 years resulted in the birds concentrating more in the vicinity of Bombay Hook. Favorite roosting sites on Bombay Hook have not changed during the nine years of data collection. Shearness, Raymond, and Bear Swamp pools, as well as the Money Marsh/Leatherberry Flats area, and the areas around George's Island again were the favored roosting sites. Snow geese in Sussex County continue to concentrate around the Prime Hook NWR and King Cole cattle feed lot areas. The birds regularly roost within Prime Hook and fly into the feedlots to feed on recycled corn. Numbers encountered within the feedlots during the dawn surveys were substantial from November 1 until most of the birds left the area by mid-March. The past year's dawn surveys showed significantly less birds utilizing the feedlots than in recent years. A reduction in the size of the feed lots in this area has probably caused this result.

B. <u>Vegetative Monitoring</u>

Aerial slides of the Bombay Hook marshes were taken periodically throughout the period August 1989 through May 1998. The extent of "eat-out" areas were calculated with dot grids. Figure 6 illustrates the areas of most significant "eat-out" on Bombay Hook. During the past nine years, following marsh denudation by the geese approximately 1000 acres of mud flat and open water have been exposed in the Money Marsh, Leatherberry Flats, and Broad Gut areas of Bombay Hook Refuge. Of this area, significant acreage of open water and tidal creeks occurred prior to the instigation of this study in 1989. However, vast areas of vegetated marsh (virtually 100% tall form (Spartina alterniflora) were converted to mudflat by goose feeding. During each of the previous seasons of data collection snow

Table 2									
Dawn Surveys	1997-98	Along	Delaware's	Atlantic	Coast				

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Unit 2	Unit 3	Unit 4	Unit 7	Totals
121,730	850	68,000	0	190,580
221,480	12,000	74,000	0	307,480
64,540	6,520	52,450	7,700	131,210
66,420	100	63,520	1,400	131,440
124,807	3,250	48,540	2,270	178,867
103,200	0	157,000	2,800	263,000
31,850	7,700	45,930	11,700	97,180
15,510	18,300	400	5,460	39,670
49,150	52,000	23,325	16,015	140,490
3,053	0	0	0	3,053
	Unit 2 121,730 221,480 64,540 66,420 124,807 103,200 31,850 15,510 49,150 3,053	Unit 2Unit 3121,730850221,48012,00064,5406,52066,420100124,8073,250103,200031,8507,70015,51018,30049,15052,0003,0530	Unit 2Unit 3Unit 4121,73085068,000221,48012,00074,00064,5406,52052,45066,42010063,520124,8073,25048,540103,2000157,00031,8507,70045,93015,51018,30040049,15052,00023,3253,05300	Unit 2Unit 3Unit 4Unit 7121,73085068,0000221,48012,00074,000064,5406,52052,4507,70066,42010063,5201,400124,8073,25048,5402,270103,2000157,0002,80031,8507,70045,93011,70015,51018,3004005,46049,15052,00023,32516,0153,053000

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Date	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17,	Unit 18	Total
10/07/97	65000	21000	600	0	13000	0	700	100	0	14800	0	1125	0	0	0	0	0	0	116325
10/20/97	20000	35000	20000	0	11000	17900	3620	10	0	40500	0	40000	0	0	0	0	0	0	188030
11/04/97	3500	6000	5000	0	600	30	3600	0	0	5000	12000	25000	0	0	0	0	0	0	60730
11/16/97	4000	12000	3000	0	8000	0	490	8000	50	300	700	18000	600	0	0	0	0	0	55140
11/28/97	15000	17000	5000	0	0	2000	0	0	0	16000	25000	39000	400	0	0	0	0	0	119400
12/13/97	0	45000	20000	0	0	6000	0	0	0	0	0	32000	200	0	0	0	0	0	103200
01/05/98	4000	0	3000	700	0	0	0	0	0	0	0	17000	2000	0	0	0	0	0	26700
01/30/98	900	1000	0	0	0	0	0	0	0	7250	0	5000	0	0	0	0	0	0	14150
02/13/98	0	1500	300	0	0	6500	350	0	0	6500	0	0	0	0	0	0	0	0	15150

 Table 3

 Bombay Hook NWR Dawn Snow Goose Counts 1997-98

Table 4 Mean Snow Goose Populations Encountered During Dawn Survey (October - March)

Date		Unit 2	Unit 3	Unit 4	Unit 7	Total
89-90		19,006	999	13,999		31,545
90-91		24,421	376	7,788	2,743	35,330
91-92		23,636	3,660	10,583	8,306	46,708
92-93	•	28,786	12,935	6,088	1,300	50,109
93-94		35,179	9,148	20,332	15,111	79,771
94-95		54,455	7,920	37,873	20,157	124,387
95-96		35,210	6,288	10,302	14,837	66,804
96-97		68,683	6,100	29,464	3,687	107,934
97-98		88,743	11,191	59,241	5,261	164,435

Table 5

Mean Snow Goose Populations Encountered at Bombay Hook NWR During Dawn Survey (October - March)

Date	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
89-90	15,410	24,690	24,100	8,616	12,915	7,785
90-91	26,429	33,300	26,575	6,583	3,233	5,400
91-92	14,832	32,683	27,617	5,146	3,060	788
92-93	28,661	52,050	33,943	37,467	12,717	1,568
93-94	51,200	26,644	37,400	13,598	4,527	7,877
94-95	68,310	45,775	67,500	73,000	30,000	5,900
95-96	33,283	72,833	22,250	3,801	4,615	3,100
96-97	130,950	88,100	33,608	49,125	6,050	1,200
97-98	152,178	78,492	103,200	20,425	15,150	*

* No surveys this month

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Table 6 Percent of Dawn Survey Consisting of Birds Found within Unit 2 (October - March)

Date	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
89-90	98.0	73.8	52.3	37.1	60.3	52.9
90-91	92.5	59.8	59.8	33.8	46.5	52.7
91-92	86.4	72.0	71.9	22.5	20.9	28.5
92-93	60.8	67.2	38.7	78.9	42.6	28.5
93-94	62.6	49.9	41.3	27.0	27.2	22.6
94-95	54.1	36.1	55.2	59.0	43.3	29.5
95-96	68.7	66.8	65.6	25.4	19.1	21.6
96-97	85.3	72.0	41.5	67.4	33.5	26.3
97-98	64.8	57.9	39.2	34.6	35.0	*

Table 7

Percent of Dawn Survey Consisting of Birds Found Within Bombay Hook NWR

Date	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
	Ϋ́.					
89-90	96.0	54.5	52.1	21.9	44.3	19.7
90-91	80.4	72.4	32.8	22.9	11.3	22.6
91-92	62.3	54.7	42.4	13.4	3.6	2.5
92-93	56.1	51.5	43.8	61.3	25.3	-3.1
93-94	54.3	40.1	31.1	19.6	4.7	
94-95	46.7	33.9	38.9	54.6	29.2	13.2
95-96	58.4	63.5	51.1	6.0	9.0	11.0
96-97	84.0	52.6	32.6	48.3	17.8	3.3
97-98	61.1	53.3	39.2	29.9	10.8	*

* No surveys this month

goose feeding was confined to virtually the same areas of saltmarsh each year. No evidence of pioneering into new areas was noted. However, during the past three seasons the birds have begun feeding on roots and rhizomes of tall form cordgrass in an area adjacent to Bear Swamp impoundment which had not previously been grazed. Only a couple of acres have been denuded so far but we are concerned that this could be the beginning of expanded marsh denudation in future seasons. Our estimates for the past eight years of devegetated marsh are as follows:

> 1989-90 = 590.8 acres 1990-91 = 519.3 acres 1991-92 = 510.0 acres 1992-93 = 567.7 acres 1993-94 = 590.6 acres 1994-95 = 590.0 acres 1995-96 = 595.0 acres 1996-97 = 597.0 acres 1997-98 = 597.0 acres

Portions of an additional 600 acres of marsh adjacent to Shearness Gut, George's Island, and Bombay Hook Island have been impacted by feeding geese during the past several years. In these locations, several areas of mostly higher marsh dominated by salt hay (<u>Spartina patens</u>) were impacted primarily around existing ponds which were enlarged and small tidal areas were opened up but not completely stripped of vegetation. Again, mostly cordgrass was the plant of choice by the feeding snow geese. Measuring the change in those areas is difficult with our current methods, however, damage does not appear to have changed significantly during the past seven years.

Permanent vegetative transects within the Bombay Hook tidal marshes were run during late summer during each of the seven years of the study. Table 8 summarizes the results of the vegetative surveys. The transects which were never grazed (#6 & #9)yielded relatively constant percent coverage figures throughout the period. Transect #11 was grazed only during the past two years. Some of the other transects which were grazed every year such as #5 and #8 varied considerably. While other transects such as #1, #2, and #5 yielded data which suggested and improvement or increase of % cover for a few years only to show a reversal during the next couple of years may indicate the variability of the extent to which grazing occurs on given marsh areas. Heavier prolonged grazing may have impacted more on the rhizomes than would a lighter less sustained grazing.

C. Snow Goose Response to the Refuge Hunt

Hunter interest and participation exhibited a similar predictable pattern during each of the seven years of the study. Interest and participation starts out very high, but within two weeks of opening day participation falls to such low levels that it is questionable if such low levels of hunter activity have a significant effect on goose utilization of the marsh. During 1993-94 and 1994-95 the snow goose population



Table 8	
Spartina alterniflora cover (%) along eleven permanent saltmarsh transects at Bombay Ho	ok NWR

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Transect #	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	7.8	7.5	23.6	23.0	31.0	9.0	7.0	8.0	
2	29.5	20.7	48.9	72.0	19.0	6.0	2.0	2.0	
3	42.9	56.3	79.6	73.0	48.0	91.0	70.0	52.0	46.0
4	21.0	35.9	50.8	66.0	28.0	79.0	23.0	37.0	
5	9.8	12.2	6.8	22.0	49.0	18.0	15.0	46.0	35.0
*6	47.9	53.3	42.3	55.0	46.0	73.0	77.0	46.0	62.0
7	14.3	57.8	64.1	54.0	62.0	40.0	8.0	44.0	23.0
8	3.3	23.8	15.0	23.0	0.0	0.0	1.0	0.0	0.0
*9	82.1	90.2	90.5	92.0	82.0	82.0	86.0	75.0	
10	6.2	26.4	38.8	33.0	32.0	27.0	32.0	41.0	40.0
11	52.0	41.0	53.2	61.0	52.0	28.0	34.0	39.0	45.0

* = Areas Not Grazed

had a high percentage of young of the year. Initially hunter success on the refuge was very closely tied to the percent of young birds. Years of good goose reproduction resulted in high hunter harvest. However, during recent years this has not been the case (See table 9). It now appears that a large percentage of juvenile birds may or may not result in good hunter success, however, few juvenile birds will most certainly be an indicator of poor hunter success.

D. Other Observations

Age ratio data was collected on birds at Bombay Hook during November of each year of the study as part of our participation in the Atlantic Flyway's productivity surveys. Estimates were based on samples of approximately 1,000 birds.

		Atlantic Flyway	Bombay Hook NWR
	:00:	% Young	%Young
1989		29.3	34.2
1990		17.2	33.3
1991		26.2	32.2
1992		4.5	6.8
1993		44.6	52.0
1994		13.4	31.2
1995		13.3	34.0
1996		30.5	39.7
1997		28.7	42.9

The percentage of juveniles at Bombay Hook always seems to be higher than that reported for the flyway. It is unknown if this indicates that the birds that winter at Bombay Hook are from a nesting flock that is traditionally more successful than other flocks.

V. SUMMARY, CONCLUSIONS, RECOMMENDATIONS

This report summarizes the results of the ninth year of data collection relative to the areas of concentration and impacts of snow geese on and in the vicinity of the Bombay Hook National Wildlife Refuge. It is unfortunate that funding cuts prevented the collection of feeding flock locations and habitat preferences that was collected during the first five years. We continue to believe that the information we are gathering is helpful in monitoring the population trends of snow geese on Delmarva and should enable us to better tailor our management activities to cope with these populations. Having knowledge of principle concentration areas is extremely important in regards to preventing or coping with disease outbreaks. Knowledge of the movements and habitat preference changes through the wintering period by snow geese is helpful in planning management actions to benefit the Canada goose which has been in a state of decline on the peninsula during recent years.

Table 9

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Comparison of Snow Goose Age Ratios with Hunter Success

Date	% Young Birds	Hunter Success Birds/Hunter
89-90	29.3	1.08
90-91	17.2	0.91
91-92	26.2	1.63
92-93	4.5	0.30
93-94	44.6	2.40
94-95	13.4	1.61
95-96	13.3	0.69
96-97	30.5	0.87
97-98	28.7	3.06

Several important points, all of which were listed in progress report 7-9 are repeated here for the convenience of the reader since after an additional year they still appear valid.

- A. Bombay Hook continues to serve as the focal point for arriving snow geese in September and October on the Upper Delmarva peninsula. Although now there are large numbers of snow geese that may spend a brief period at Bombay Hook they are not as dependent on it as they probably were during the 1980's.
- B. Snow goose use has dispersed over a large portion of Delaware and the eastern shore of Maryland with the establishment of certain key use areas (centers of concentration) including inland roost sites. many of these roost sites formerly were used by Canada Geese as roosting ponds.
- C. There is a gradual shift of the snow goose population from the Bombay Hook area to the Prime Hook area as the fall to winter period progresses with the birds willing and able to exploit the easily accessible food resource of the cattle feedlots in the Milton, Delaware area.
- D. The areas of primary "eat-outs" at Bombay Hook have remained virtually the same since the early 80's and has not varied by more than 100 acres during the nine years of data collection. Interestingly, the past three years were the first years when significant "pioneering" into new areas of the marsh occurred since the study began.
- E. Hunting within the tidal marsh at Bombay hook has been found to be effective in significantly altering snow goose use of the preferred "eat-out" areas for only a relatively brief period during the fall, probably due to limited participation by hunters after the opening two weeks of the season.
- F. The extent of the "eat-out" areas at Bombay Hook appears to be controlled by a series of factors including winter weather, degree of hunter disturbance, and the whims of the geese. Although opportunities for "eatout" expansion into similar habitat seemed to exist during each year, the locations and size of the "eat-outs" remain virtually identical.
- G. Dusk to dawn utilization of "eat-out" areas continued to be a significant occurrence at Bombay Hook, a condition which requires attention during any intensive dispersal efforts. During periods of high hunter utilization of the refuge marshes the birds still roosted within the hunt area and were apparently feeding there during the night time.
- H. Since the size of the "eat-out" areas at Bombay Hook seems to be relatively stable and the vegetation appears to come back each year careful analysis of the pluses and minuses of the "eat-outs" in the saltmarsh needs to be considered. The "eat-outs" provide excellent shorebird habitat but may lack the invertebrate population of an uneaten marsh. Tradeoffs

between shore birds and black ducks may be some of the consequences of snow goose eat-outs in <u>Spartina</u> alterniflora marsh.

Opportunities certainly exist for additional research into the ecological impact of denudation on other species of animal life in the saltmarsh.

I. Cropland Management on Delaware Refuges and Wildlife Management
 Areas is strongly impacted by wintering snow geese. Crops planted for the benefit of species such as ducks and Canada geese are frequently decimated in a few days by snow geese. Management plans for these areas need to carefully evaluate their Cropland Programs to ensure that they are truly beneficial to the species for which they are intended and that they don't end up as merely additional snow goose feeding areas.