

BOMBAY HOOK NATIONAL WILDLIFE REFUGE
ANNUAL WATER MANAGEMENT PROGRAM--1999

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ANNUAL WATER MANAGEMENT PROGRAM - 1999

I. Introduction

This program describes the results of 1998's water management and outlines the planned management regimes for 1999. Water management objectives and techniques are discussed in detail in the refuge's Water Management Plan dated December 1995. All water management units (WMU's), including both the four major impoundments as well as the smaller moist soil units will continue to be managed as one dynamic wetlands complex. The objectives for each area are based on water management capabilities within each unit as well as providing a variety of freshwater habitats to the overall benefit of migratory bird resources not only for this specific refuge but rather the entire flyway. Consideration is given to a diversity of wildlife species within our managed wetlands but our primary emphasis will continue to be to provide optimum habitat for wetland dependent migratory birds, in particular, waterfowl.

II. Highlights of 1998's Water Management Program

Although total rainfall for the year (42.05) was near the normal total (42.3) distribution was far from optimum. Low rainfall during the fall delayed and even precluded the flooding of wetland vegetation over a large portion of the managed wetlands.

Exclosures were erected in portions of Bear Swamp during the summer as part of an evaluation of impacts of resident canada geese on wetland vegetation. The study was designed by Zone biologist Laskowski and included Chincoteague Refuge as well.

The road/dike at Steamboat Landing (BH222) was built up from material scraped from the inside of the unit. Additional road material was also trucked in raising the road considerably. This increased the water holding capacity of the unit significantly.

The entire Straughn Pool(BMH7) dike was rebuilt, widened and re-seeded. The pipe within the water control structure was extended as well. The dike had been leaking badly from muskrat damage.

The only mosquito spraying within refuge managed wetlands occurred on August 12th when BTI granules were applied to 2 acres within Shearness and Raymond Pools.

On September 3rd 60 acres of Phragmites, 30 acres of cattail and 10 acres of maple trees were treated with Rodeo within Raymond, Shearness, Bear Swamp, and two moist soil units. Arsenal was also included in the mix for treating the maple trees.

Due to the lack of fall rainfall tidal water was introduced into Sheariness Pool on two separate occasions during October and November.

For the sixth consecutive year we utilized the vegetative plot method of collecting vegetative data in Raymond, Sheariness, and Bear Swamp Pools. Transects were run in Finis and in the saltmarsh. All sample plots and transects are marked in the field with permanent markers to insure that the areas are sampled similarly each year. Data from this sampling effort was loaded into the VEGDATA program developed by the South Zone Biologist. Summary tables of our sampling efforts for the past six years are included within the appendix of this report.

For the fifth year we utilized the WATERLEV database to monitor water level and salinity data in the WMU's. All of the tables and graphs within this report relating to water levels were developed by using this database.

For the sixth year weekly bird surveys of managed wetlands were conducted throughout the entire year. This data was logged into the wildlife inventory database (CENSUS). This data is one of the main tools with which we can evaluate the success of our management strategies. Bird utilization tables for the WMU's are included within the appendix of this report. The appendix for this report is maintained as a separate document within a looseleaf binder at the refuge office. It is quite lengthy and contains results of all surveys and reports for the past six years.

- III. As mentioned previously, the yearly rainfall total was almost exactly identical to the long term average but not favorably distributed for water level management objectives. Heavy winter and spring precipitation resulted in 26.88 inches during the first six months which gave way to only 15.17 inches of rainfall during the period July-December. Snowfall was virtually nil with only .75 inches recorded for the year. Temperature extremes were near normal to mild for the year. Fall and winter temperatures remained higher than normal. No long extended periods of impoundment freezeup were noted. Open freshwater was available virtually the entire year until the last week of December. The last day in the spring of subfreezing temperatures was March 25 and the first day of subfreezing temperatures in the fall was November 5.

<u>TEMPERATURE (F)</u>			
<u>Month</u>	<u>Maximum</u>	<u>Minimum</u>	<u>Precipitation</u>
			<u>Inches</u>
January	70	18	5.19
February	62	25	5.5
March	85	26	5.57

List of Impoundments

Date : 01/14/99

Refuge : BOMBAY HOOK NWR

Impoundment Abbreviation	Impoundment Name	Maximum Pool	Bottom Elev	WCS Invert	Acres
BMH1	Bear Swamp Pool	4.5	1.0	1.2	240.0
BMH2	Shearneck Pool	4.0	1.3	-3.0	560.0
BMH3	Finis Pool	6.2	2.5	1.2	205.0
BMH4	Raymond Pool	4.0	1.0	-3.0	95.0
bmh5	A-Pool	9.0	7.0	7.0	12.0
bmh6	B-Pool				8.0
bmh7	Straughn Pool	10.0	5.0	5.0	2.0
bmh8	Project 3a				2.0
bmh9	Project 3				1.0
bmh10	Project 4				1.0
bmh11	Nut tree				1.0
bmh12	Project 1				1.0
bmh13	Project 6				2.0
bmh14	Project 6a				2.0
bmh15	Project 2	3.0	0.0	0.5	4.0
bmh216	Allee House Plug	0.0	0.0	0.0	2.0
bmh217	Jason's House Pond	0.0	0.0	0.0	2.0
bmh218	Double Pond	0.0	0.0	0.0	2.0
bmh219	Field 109 Pond	0.0	0.0	0.0	2.0
bmh220	Field 21 Pond	0.0	0.0	0.0	1.0
bmh221	Field 403 Pool				1.0
bmh222	Field 502 pond				7.5
Tidal	Saltmarsh				13000.0

April	79	34	2.86
May	89	41	4.63
June	92	52	3.13
July	94	59	1.69
August	93	56	4.86
September	89	43	2.9
October	75	34	1.94
November	69	29	1.21
December	75	15	2.57
TOTAL			42.05

IV. Effects of Past Year's Water Levels on the Ecology of the Management Units

Below is a discussion of the conditions and events which were observed in each unit during the past year. Tables and graphs are included for each major impoundment (Units 1-4) of planned and actual water levels recorded. Results of vegetation monitoring for the units and tables depicting bird usage by managed unit are also included as appendix tables for the following species groups: waterfowl, shorebirds, and wading birds. The data contained in these tables was obtained from land based counts conducted once a week throughout the year. Normally four surveys were taken each month. Additional bird survey data was collected via aerial surveys by the staff and state waterfowl biologists. The compilation of this data makes for a rather lengthy document but by maintaining it as an actively updated appendix it serves as a handy reference throughout the year and between years by refuge staff when attempting to document changes in conditions which may result from various management practices.

A. Bear Swamp Pool (BMH1)--240 acres

This marked the fifth consecutive year that we did not intentionally dewater this unit during the growing season. Water levels through May 1 were quite high and desirable since upper reaches of the pool were flooded during periods of high waterfowl use. Levels were intentionally lowered during the month, primarily to remove standing water from one of the public trails. Water levels dropped naturally due to evaporation and transpiration throughout the summer. Water levels throughout July and August were the lowest since the 1993 drawdown. Even at the low levels standing water remained within the borrow pits and in large puddles scattered over the pool. The open water areas that remained did not produce the stands of SAV or alagae that frequently occur in this unit. We discovered that large numbers of carp had invaded the pool through a hole in one of the fish screens. As water levels dropped these creatures were very abundant and may have been responsible for the lack of vegetation in the open water areas. Soil salinities in the pool varied between 1.08 and 3.60 ppt.

Five Year Report of Water Levels

Refuge : BOMBAY HOOK NWR

Rpt. Date: 01/14/99

Impoundment: BMH1 Bear Swamp Pool

Date	Year				
	1994	1995	1996	1997	1998
01/01/	1.0	1.5	1.7	2.4	1.5
01/15/	1.0	1.1	1.9	2.5	1.5
02/01/	1.5	1.0	1.8	2.7	2.0
02/15/	1.8	1.1	1.3	2.7	2.2
03/01/	2.0	1.1	0.9	2.4	3.0
03/15/	1.5	1.4	1.0	2.0	2.6
04/01/	2.1	1.3	1.2	1.9	2.6
04/15/	2.3	1.2	1.6		2.3
05/01/	1.9	1.2	1.6	2.1	2.3
05/15/	2.0	1.1	1.7		2.3
06/01/	1.9	1.2	1.9	1.9	1.8
06/15/	1.5	1.1	2.0	1.9	1.6
07/01/	1.7	1.2	2.1	1.5	1.5
07/15/	1.6	1.3	2.0	1.5	1.4
08/01/	1.7	0.8	1.7	1.1	1.4
08/15/	1.9	1.0	1.6	0.8	
09/01/	2.0	0.8	1.4	1.3	1.3
09/15/	1.4	0.6	1.4	1.0	1.3
10/01/	1.5	0.8	1.5		1.1
10/15/	1.4	1.0		0.7	1.1
11/01/	1.3	1.1	1.9	0.9	0.9
11/15/	1.3	1.4	1.9	1.2	0.8
12/01/	1.5	1.4	1.9	1.3	0.7
12/15/	1.5	1.7	2.5	1.3	1.0
12/31/	1.5	1.6	2.5		0.9

Water & Salinity Report

Refuge Name: BOMBAY HOOK NWR

Impoundment: Bear Swamp Pool

Ave. Bottom Elev. 1.0 WCS Invert Elev. 1.2 Year : 1998

Date	Gauge Reading	Salinity (ppt)
01/05/98	1.5	3.0
01/12/98	1.5	
01/23/98	1.7	2.0
01/30/98	2.0	2.0
02/06/98	2.1	
02/18/98	2.2	
02/25/98	3.0	
03/06/98	2.5	
03/11/98	2.6	
03/16/98	2.5	
03/26/98	2.6	
04/08/98	2.3	
04/20/98	2.4	
04/28/98	2.3	
05/06/98	2.2	1.5
05/13/98	2.3	
05/21/98	2.0	
05/28/98	1.8	
06/03/98	1.7	1.5
06/10/98	1.6	
06/18/98	1.8	
06/23/98		1.0
07/07/98	1.5	1.0
07/20/98	1.4	
07/30/98	1.4	
08/07/98	1.2	
08/11/98		1.0
08/14/98	1.3	
08/24/98	1.4	
08/31/98	1.3	
09/11/98	1.3	
09/18/98	1.2	
09/28/98	1.1	3.0
10/06/98	1.1	
10/15/98	1.1	
10/21/98	1.0	
10/30/98	0.9	
11/06/98	0.8	
11/17/98	0.8	
11/25/98	0.7	
12/04/98	0.9	5.0
12/15/98	1.0	
12/15/98		5.0
12/30/98	0.9	
01/04/99		2.5
01/11/99	1.2	

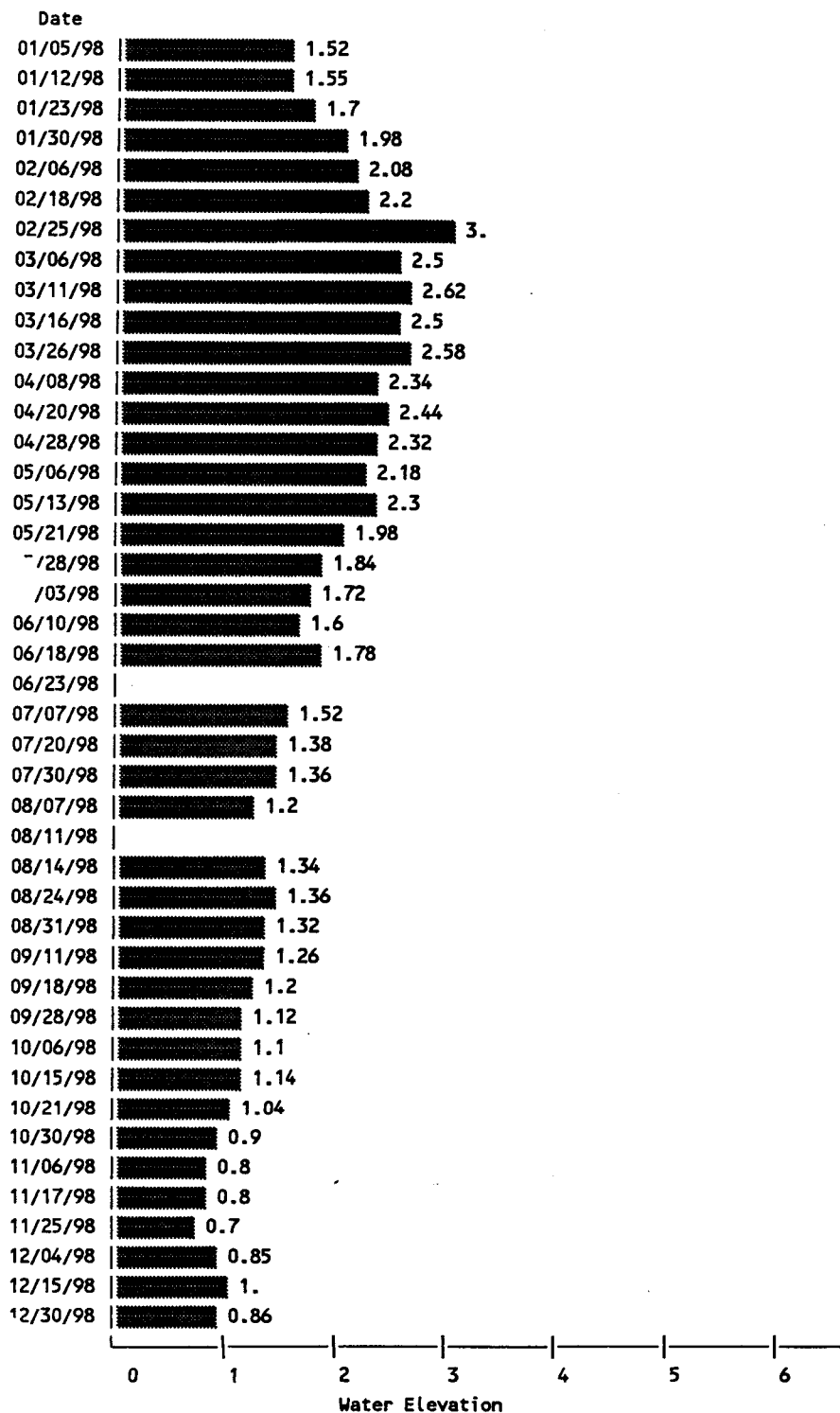
Annual Water Levels : Bear Swamp Pool

Refuge: BOMBAY HOOK NWR

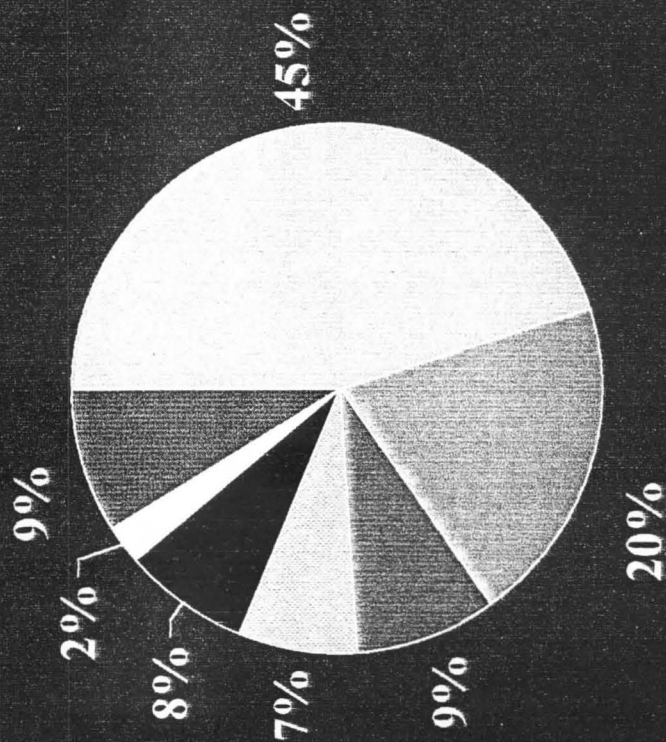
Growing Year: 1998

Impound Bottom Elev. 1.0

WCS Invert Elev. 1.2



Bear Swamp 1998



Summer vegetation sampling yielded results similar to 1997's with plant coverage estimates for umbrella grass, nutsedge and fleabane while declines were noted for spikerush and sprangletop. Percent bareground increased from 35 to 45 percent. Cattail declined slightly.

Wintering waterfowl use was similar to previous years. Green-winged teal and pintails were the most abundant ducks with peaks of 357 and 500 respectively. Both Canada (1825 peak) and snow geese (8000 peak) used the pool for feeding and roosting. Summer utilization by wood duck broods was markedly reduced this year. Absence of the algae mats and SAV with their ever present insect populations may have contributed to this. Resident Canada geese (150 birds) used the unit extensively during the spring and early summer but, for the most part, moved their activities to Shearneck Pool during July and August as emergent plants there emerged.

Lower summer water levels again attracted significant use by waders but was somewhat reduced from past years. Peaks of 19 great egrets, 10 little blue herons, and 9 great blue herons were recorded.

Black necked stilts again nested in the impoundment while yellowlegs (67 peak), dunlin (250 peak), and semipalmated sandpipers and plovers were attracted to the exposed mudflats.

Wood duck banding operations were conducted in this pool but with less success than in past years. We were unable to fill our quota of 200 birds this year. Wood duck use within the pool was noticeably reduced.

B. Shearneck Pool (BMH-2)--560 acres

The yearly hydrologic profile for this unit was characterized by higher than normal February and March water levels with near normal levels for April through mid June. The summer period resulted in a drawdown schedule which closely approximated objective levels. However, the very dry fall period delayed the flooding of most of the pool bottom until late December. In an effort to make a portion of the pool available to arriving pintails and teal tidal water was introduced into a portion of the pool during October 15-19. The gauge reading went from 0.20 prior to tidal introduction to 0.98 when the gate was closed. Response by pintails, teal and snow geese was immediate. Dry weather continued through October and rather than allow the tidal water to evaporate and deposit salt on the pool bottom additional tidal water was introduced on October 30. Objective levels within the pool were not achieved until the last week of December.

Five Year Report of Water Levels

Refuge : BOMBAY HOOK NWR

Rpt. Date: 01/14/99

Impoundment: BMH2 Shearneck Pool

Date	1994	1995	Year 1996	1997	1998
01/01/	1.3	1.2	1.8	1.8	1.6
01/15/	1.3	1.4	2.0	1.5	1.5
02/01/	2.1	1.3	2.4	2.1	2.4
02/15/	1.7	1.2	2.1	2.1	2.6
03/01/	2.2	1.5	2.3	1.5	2.0
03/15/	2.1	2.2	2.1	2.0	3.0
04/01/	3.0	1.6	2.2	1.9	2.9
04/15/	1.8	1.3	2.3		1.9
05/01/	1.4	1.3	2.0	1.5	1.3
05/15/	1.5	1.4	1.4		2.1
06/01/	1.0	1.2	1.4	1.2	1.7
06/15/	0.3	0.8	1.4	0.3	1.2
07/01/	0.1	0.9	0.8	0.2	0.3
07/15/	0.5	0.7	0.6	0.2	0.0
08/01/	0.4	0.3	0.5	0.0	0.0
08/15/	0.5	0.8	0.0	0.0	0.0
09/01/	1.2	0.5	0.8	0.9	0.2
09/15/	0.9	0.2	0.6	0.5	0.3
10/01/	0.9	0.5	1.1		0.2
10/15/	0.9	0.7		0.9	0.2
11/01/	0.8	1.1	2.3	1.1	0.8
11/15/	0.8	1.3	1.7	1.4	0.9
12/01/	1.0	1.2	1.6	1.6	0.6
12/15/	1.3	1.6	2.8	1.5	0.9
12/31/	1.3	1.7	1.8		1.1

Water & Salinity Report

Refuge Name: BOMBAY HOOK NWR

Impoundment: Sheariness Pool

Ave. Bottom Elev. 1.3 WCS Invert Elev. -3.0 Year : 1998

Date	Gauge Reading	Salinity (ppt)
01/05/98	1.6	2.0
01/12/98	1.5	
01/23/98	1.4	2.0
01/30/98	2.4	2.0
02/06/98	2.6	
02/18/98	2.6	
02/25/98	2.0	
03/06/98	2.8	
03/11/98	3.0	
03/16/98	2.8	
03/26/98	2.9	
04/08/98	1.9	
04/20/98	1.4	
04/28/98	1.3	
05/06/98	1.5	1.0
05/13/98	2.1	
05/21/98	2.1	
05/28/98	1.7	
06/03/98	1.5	1.0
06/10/98	1.2	
06/18/98	1.4	
06/23/98	0.0	1.0
07/07/98	0.3	2.0
07/20/98	0.0	
07/30/98	0.0	
08/07/98	0.0	
08/11/98	0.0	1.0
08/14/98	0.3	
08/24/98	0.1	
08/31/98	0.2	
09/11/98	0.3	
09/18/98	0.2	
09/28/98	0.2	5.0
10/06/98	0.4	
10/15/98	0.2	
10/21/98	0.9	
10/30/98	0.8	
11/02/98	1.1	
11/06/98	1.0	
11/17/98	0.9	
11/25/98	0.6	
12/04/98	0.8	15.0
12/15/98	0.9	
12/15/98		7.0
12/30/98	1.1	
01/04/99		5.0

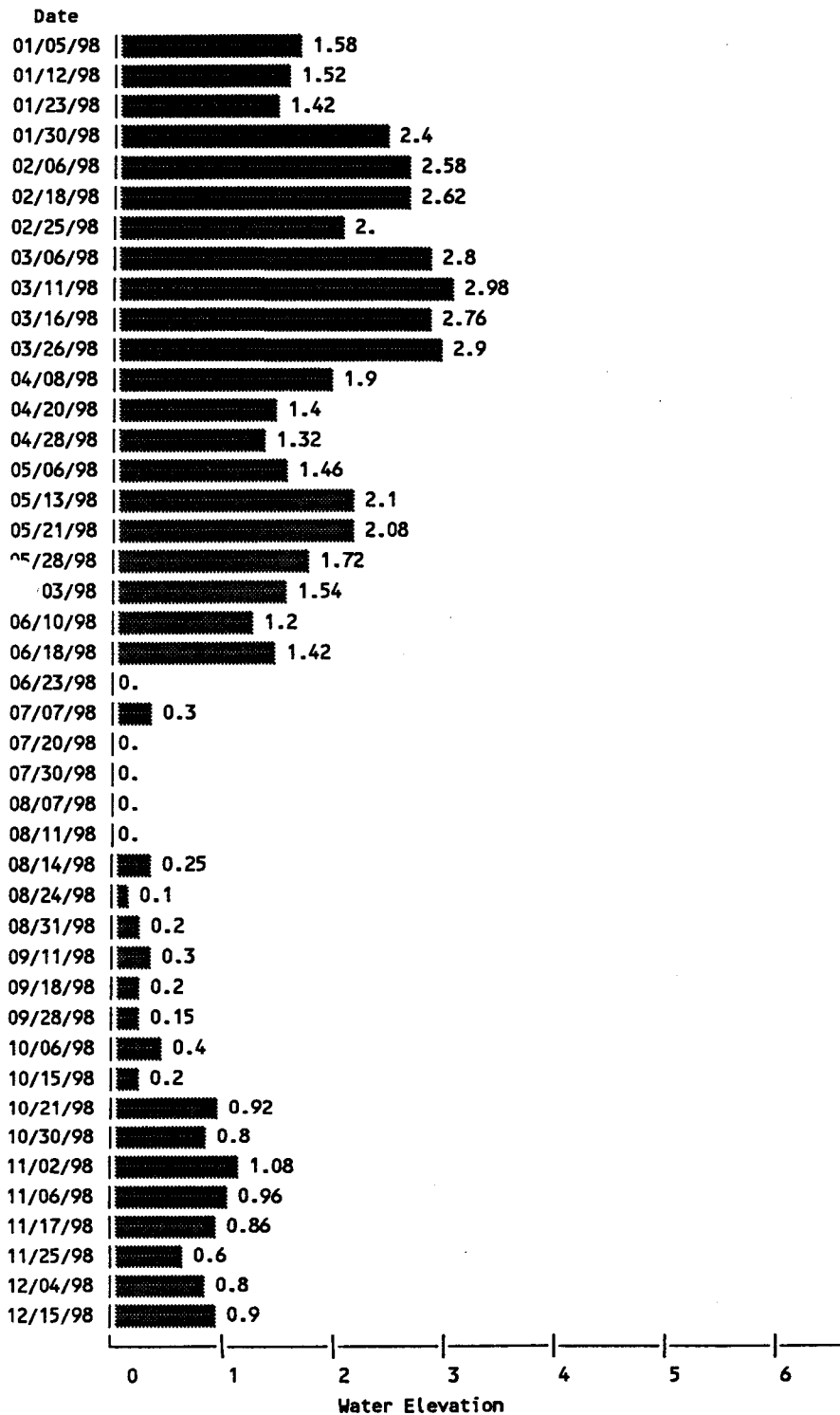
Annual Water Levels : Shearness Pool

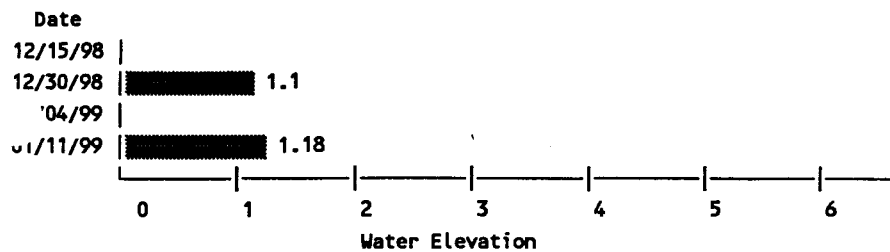
Refuge: BOMBAY HOOK NWR

Growing Year: 1998

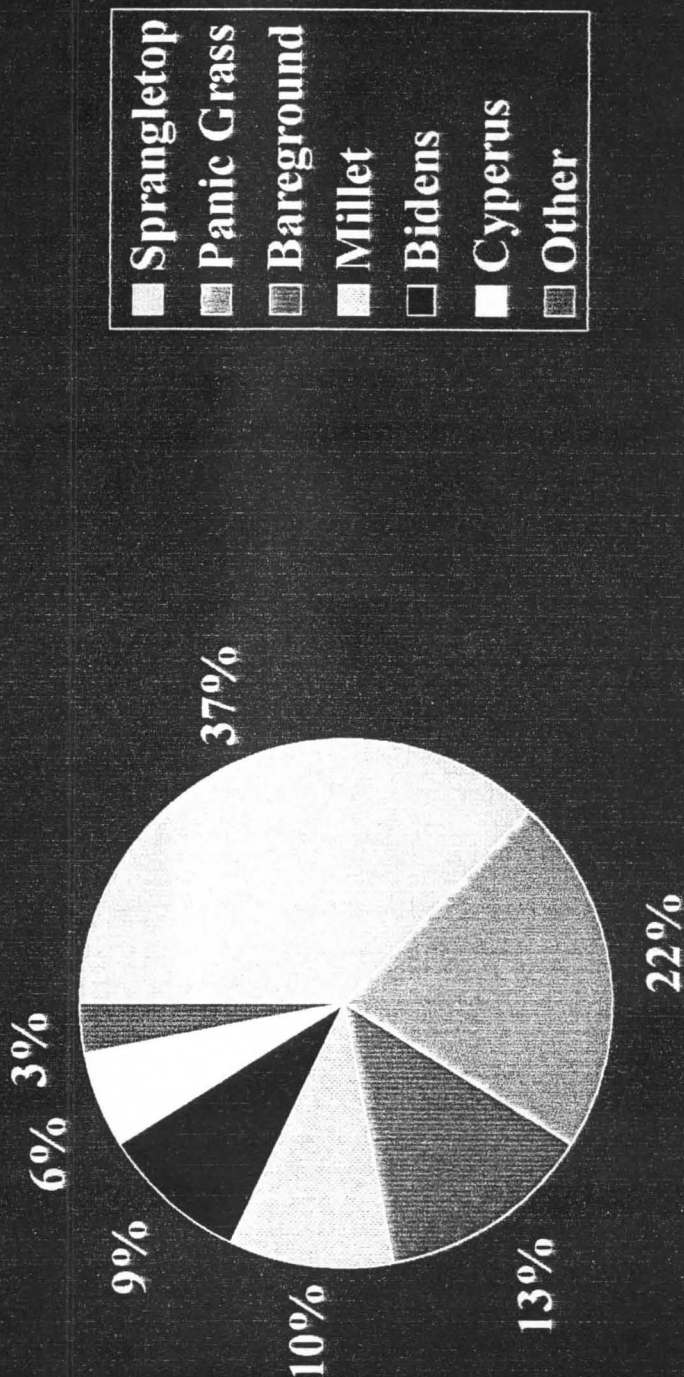
Impound Bottom Elev. 1.3

WCS Invert Elev. -3.0





Shearness Pool 1998



Vegetation response was good with similar plant composition to that of 1997. Dominant plants were sprangletop, panic grass, millet, beggarsticks, and Cyperus in similar proportions to the previous year. Bareground coverage was estimated at 13% compared to 22% the previous year. Undesirable plants in the main portion of the pool were not a problem with cattail remaining at 2%. Portions of the back of the pool were retreated with Rodeo during late summer to control Phragmites and cattail. In addition a 10 acre strip of red maples extending from Finis dike out opposite Parson's Point was treated with Rodeo and Arsenal. Preliminary results from last year's test spray of the maples was favorable in that lush stands of panic grass, millet and Cyperus grew within the spray area responding to the open canopy.

Soil salinities varied between 2.76 and 8.26 ppt. and were similar to previous years.

Winter waterfowl use was similar to 1997 in that ice-up periods were very short. Over 1000 pintails utilized the impoundment through January. Summer use by wood ducks in the borrow pit adjacent to the overlook was unusually heavy. Between 50 and 100 birds used the area consistently during July and August. We had not observed this in previous years. After emergence of millet, panic grass, and sprangletop during July and August resident Canada geese invaded the pool and fed heavily there. Unfortunately our exclosures were in Bear Swamp but it appeared heavy grazing occurred and emergent plant growth over at least 50 acres was obviously impacted. Fall and winter use was good but not up to the standards of the previous year. Pintail use peaked at 5000 birds in December. Use by green-winged teal was noticeably reduced from past years both in this unit and within the saltmarsh. Wading bird use was heavy during the drawdown with June and July peaks of 42 great blue herons, 94 great egrets, 50 snowy egrets, and 69 glossy ibis. Shorebird use during the spring, summer and fall was also significant although not as heavy as that found in Raymond Pool. Peaks of 350 dunlin were recorded in April and 370 semipalmated sandpipers and 435 dowitchers during July. Yellowlegs, semipalmated plovers, stilts, and spotted sandpipers were also encountered in less impressive numbers.

C. Finis Pool (BMH-3)--205 acres

Pool levels this year remained quite high through March and we were not able to achieve the early drawdown that we had planned due heavy spring rains. Levels were lowered during the summer and remained below objective until the end of the year. Beaver activity remains heavy

Five Year Report of Water Levels

Refuge : BOMBAY HOOK NWR

Rpt. Date: 01/14/99

Impoundment: BMH3 Finis Pool

Date	1994	1995	Year 1996	1997	1998
01/01/	4.6	5.4	5.4	5.4	5.3
01/15/	4.6	5.4	5.4	5.4	5.4
02/01/	4.8	5.0	5.4	5.9	5.8
02/15/	4.3	5.1	5.2	5.6	5.5
03/01/	5.6	5.2	5.5	5.4	5.7
03/15/	4.7	4.3	5.0	5.5	5.9
04/01/	6.0	3.6	5.3	4.7	5.7
04/15/	4.6	3.4	5.2		5.3
05/01/	4.3	3.3	5.0	3.9	4.9
05/15/	3.8	3.2	4.9		5.6
06/01/	3.7	3.3	4.8	4.0	4.3
06/15/	3.5	3.8	5.3	4.3	4.1
07/01/	3.5	3.4	4.7	3.9	4.4
07/15/	3.9	3.5	4.3	3.9	4.3
08/01/	4.4	3.3	4.4	3.4	4.2
08/15/	5.6	4.7	4.5	0.0	
09/01/	4.0	4.4	5.1	4.8	5.0
09/15/	4.7	4.2	5.1	4.7	4.9
10/01/	5.0	4.3	5.4		4.3
10/15/	4.9	4.4		4.4	4.5
11/01/	5.0	5.1	5.4	4.5	4.3
11/15/	5.1	5.7	5.6	4.7	4.4
12/01/	5.3	4.9	5.8	5.0	4.3
12/15/	5.2	5.5	5.9	4.9	4.4
12/31/	5.3	5.1	5.6		4.6

Water & Salinity Report

Refuge Name: BOMBAY HOOK NWR

Impoundment: Finis Pool

Ave. Bottom Elev. 2.5 WCS Invert Elev. 1.2 Year : 1998

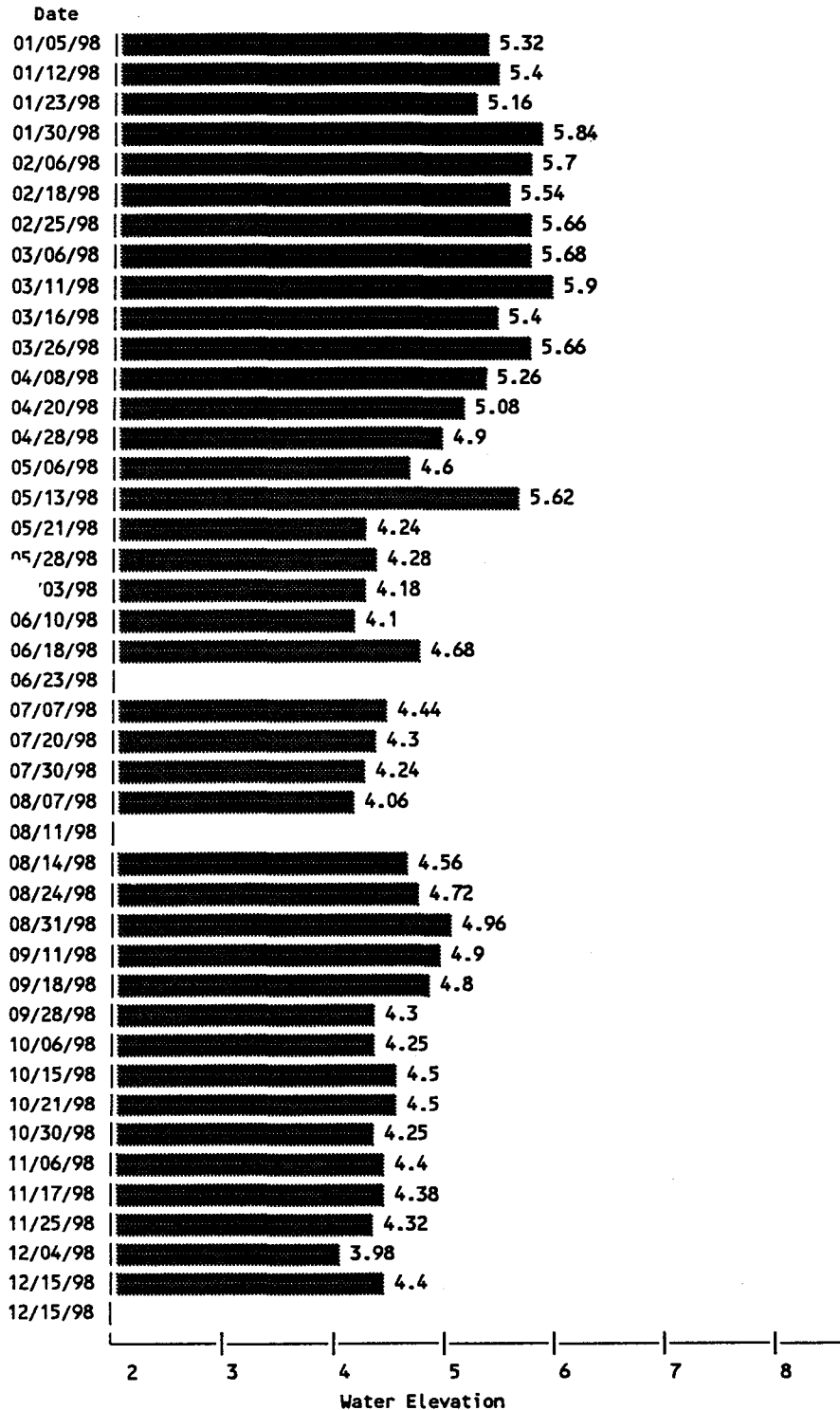
Date	Gauge Reading	Salinity (ppt)
01/05/98	5.3	0.0
01/12/98	5.4	
01/23/98	5.2	0.0
01/30/98	5.8	0.0
02/06/98	5.7	
02/18/98	5.5	
02/25/98	5.7	
03/06/98	5.7	
03/11/98	5.9	
03/16/98	5.4	
03/26/98	5.7	
04/08/98	5.3	
04/20/98	5.1	
04/28/98	4.9	
05/06/98	4.6	0.0
05/13/98	5.6	
05/21/98	4.2	
05/28/98	4.3	
06/03/98	4.2	0.0
06/10/98	4.1	
06/18/98	4.7	
06/23/98		0.0
07/07/98	4.4	0.0
07/20/98	4.3	
07/30/98	4.2	
08/07/98	4.1	
08/11/98		0.0
08/14/98	4.6	
08/24/98	4.7	
08/31/98	5.0	
09/11/98	4.9	
09/18/98	4.8	
09/28/98	4.3	0.0
10/06/98	4.3	
10/15/98	4.5	
10/21/98	4.5	
10/30/98	4.3	
11/06/98	4.4	
11/17/98	4.4	
11/25/98	4.3	
12/04/98	4.0	
12/15/98	4.4	
12/15/98		0.0
12/30/98	4.6	
01/04/99		0.0
01/11/99	5.1	

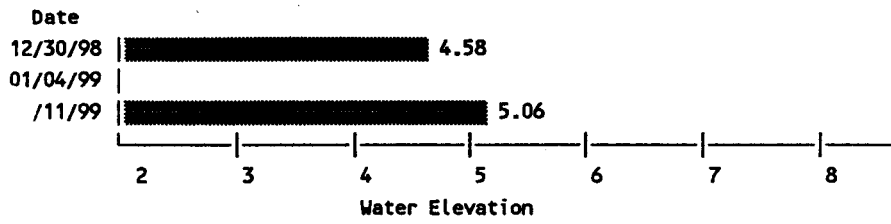
Annual Water Levels : Finis Pool

Refuge: BOMBAY HOOK NWR

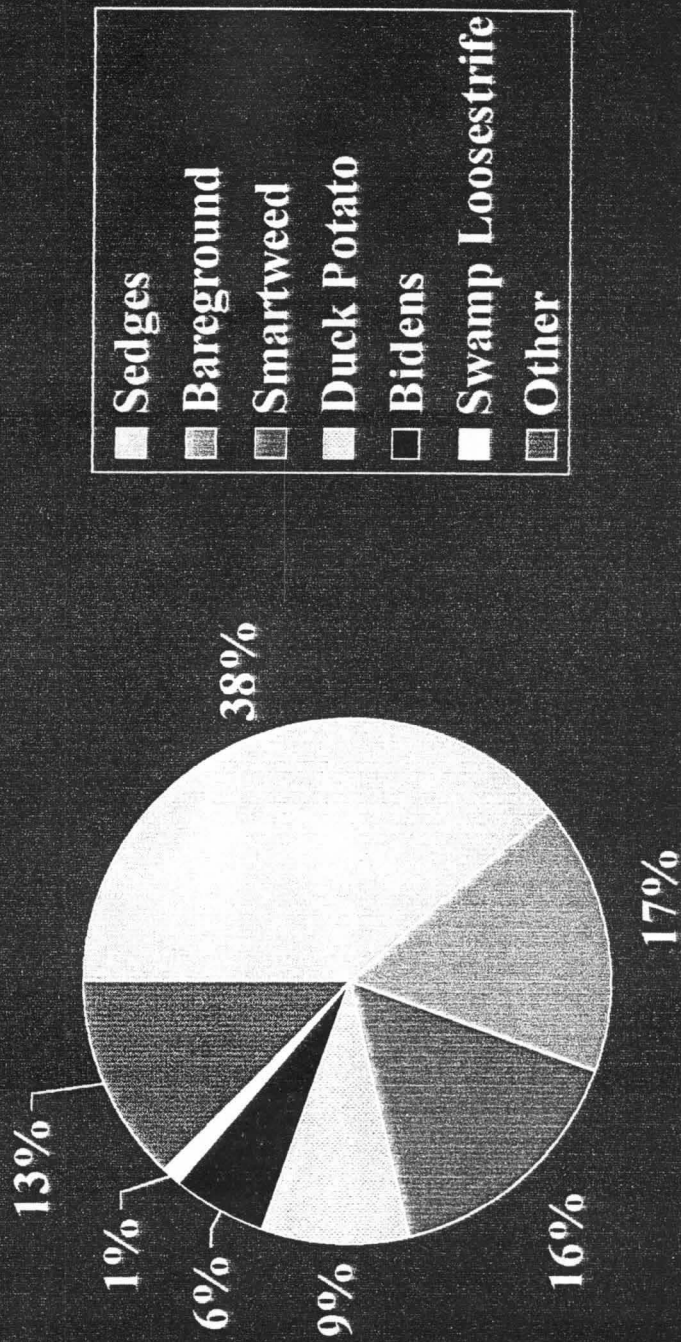
Growing Year: 1998

Impound Bottom Elev. 2.5 WCS Invert Elev. 1.2

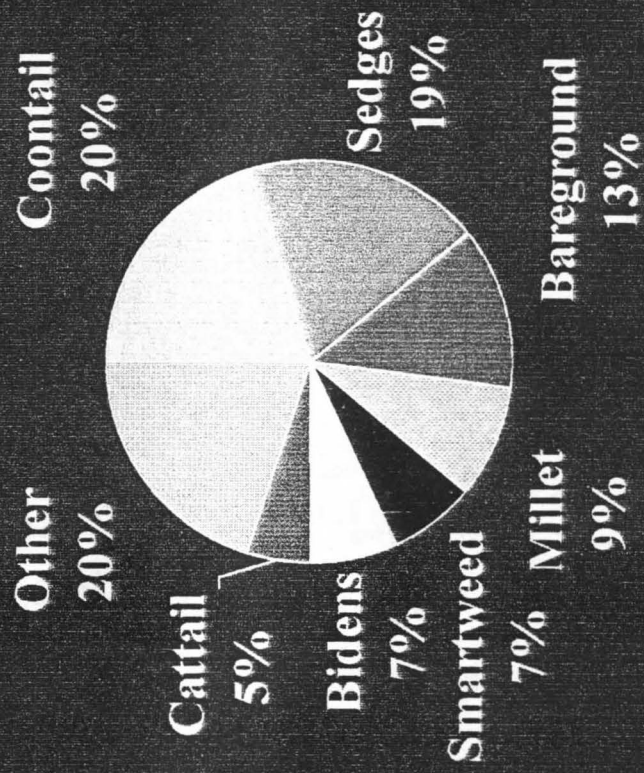




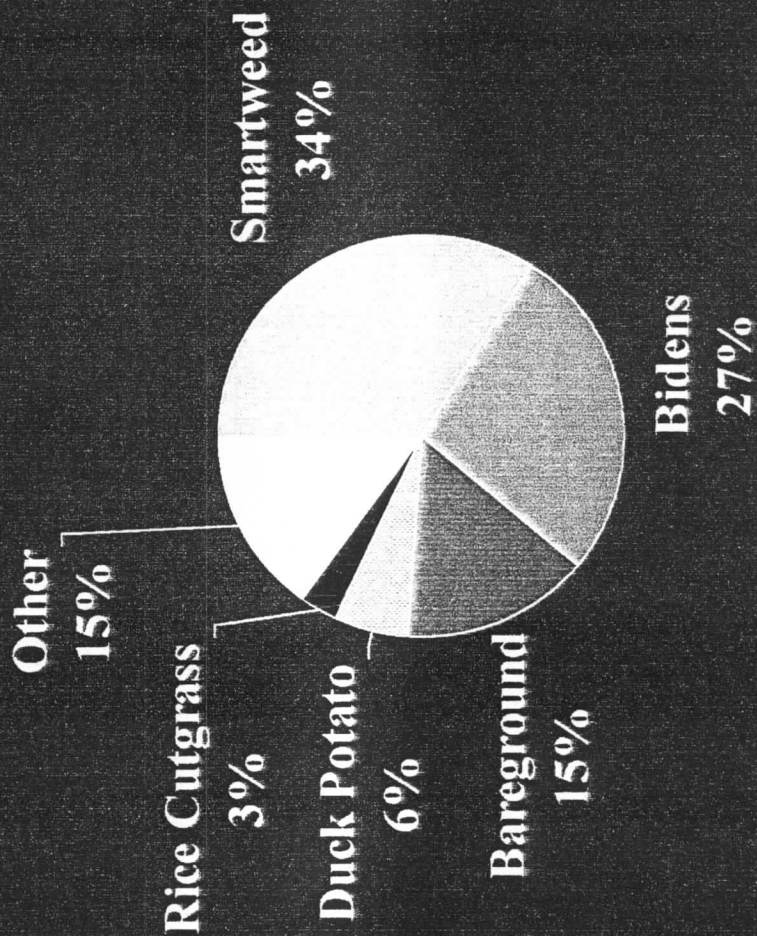
1998 Finis Transect #1



1998 Finis Transect #2



1998 Finis Transect #3



throughout the pool. Compartmentalization by these creatures is evident by the construction of several dams throughout the length of the pool.

All three transects were run during the fall and indicated good production of desirable plants. Little evidence of swamp loosestrife, a plant that has been a problem in the past, or cattail was encountered in the lower reaches of the pool. Some significant cattail stands are present within mid-pool but are not considered undesirable since utilization by least bitterns there is common. Smartweeds, sedges, duck potato, and beggarsticks were the most abundant species.

Migratory bird use of the pool followed a pattern similar to previous years. Heaviest utilization occurs during December through March. The area continues to be a favorite brood rearing area and fall roost site for wood ducks. It is difficult to survey due to the heavy wooded cover over much of the pool. Representative species peaks recorded were as follows: green-winged teal 144, mallard 101, gadwall 18, shoveller 16, and black duck 11. (All peaks were recorded during December.)

D. Raymond Pool (BMH-4)--95 acres

Water levels within this pool were near objective for most of the year through mid-July. Levels dropped during the late summer but were re-plenished by the occasional rains during August and September. Levels remained low through the fall and did not reach fall objective levels until late December. The pool retained an inch or two of water throughout most of the summer over 50% of the pool.

Vegetative growth within the pool was the best in memory. Spikerush covered much of the pool bottom and remained viable even throughout the dry fall period. Cattail established itself over most of the interior pool as it did during 1996 (it was absent during 1997) and remained there throughout the fall. Only 28% of the pool bottom was classified as bareground. This was by far the lowest figure since we began sampling during 1992. The coves within the pool vegetated with excellent stands of millet, panic grass and 3-square. As water levels remained low during the fall we were concerned that the cattail would not be utilized by snow geese as it usually is. However, once a few inches of water covered the roots of the plants during late December it was devoured within a week. At years end only a few scattered clumps of cattail were still visible in the impoundment. Soil salinities remained very good as they varied between 1.08 and 5.46ppt. Chironomid sampling during late May showed the midge larvae to be very abundant. However, as the summer progressed and the water levels dropped the larvae

Five Year Report of Water Levels

Refuge : BOMBAY HOOK NWR

Rpt. Date: 01/14/99

Impoundment: BMH4 Raymond Pool

Date	1994	1995	Year 1996	1997	1998
01/01/	0.9	0.9	1.4	1.4	1.0
01/15/	0.9	0.7	1.5	1.3	1.2
02/01/		1.0	1.4	1.5	1.7
02/15/		1.0	1.5	1.5	1.6
03/01/	2.7	1.1	1.5	1.3	1.8
03/15/	2.7	1.0	2.2	1.3	1.9
04/01/	2.7	0.9	2.1	1.3	1.7
04/15/	2.7	0.0	2.1		1.2
05/01/	0.8	0.7	1.5	1.4	0.9
05/15/	0.7	0.7	1.0		1.7
06/01/	0.4	1.0	1.0	0.9	1.0
06/15/	0.4	0.9	1.4	0.4	1.2
07/01/	0.6	0.7	1.2	0.0	1.0
07/15/	0.5	0.9	1.1	0.0	0.9
08/01/	0.7	0.5	0.9	0.0	0.7
08/15/	1.3	0.7	0.9	0.0	
09/01/	0.8	0.5	0.7	0.9	1.0
09/15/	0.6	0.3	0.7	0.8	0.8
10/01/	0.8	0.8	1.1		0.3
10/15/	0.5	0.8		0.3	0.6
11/01/	0.5	1.1	1.3	0.8	0.3
11/15/	0.7	1.4	1.2	1.0	0.4
12/01/	0.8	1.4	1.1	1.2	0.2
12/15/	0.9	1.6	2.2	0.9	0.8
12/31/	1.0	1.3	1.4		1.0

Water & Salinity Report

Refuge Name: BOMBAY HOOK NWR

Impoundment: Raymond Pool

Ave. Bottom Elev. 1.0 WCS Invert Elev. -3.0 Year : 1998

Date	Gauge Reading	Salinity (ppt)
01/05/98	1.0	3.0
01/12/98	1.2	
01/23/98	1.2	2.5
01/30/98	1.7	10.0
02/06/98	1.7	
02/18/98	1.6	
03/06/98	1.8	
03/11/98	1.9	
03/16/98	1.0	
03/26/98	1.7	
04/08/98	1.2	
04/20/98	1.0	
04/28/98	0.9	
05/06/98	1.0	2.0
05/13/98	1.7	
05/21/98	1.4	
05/28/98	1.0	
06/03/98	1.2	2.0
06/10/98	1.2	
06/18/98	1.2	
06/23/98		2.0
07/07/98	1.0	6.0
07/20/98	0.9	
07/30/98	0.7	
08/07/98	0.6	
08/11/98		1.0
08/14/98	1.0	
08/24/98	0.8	
08/31/98	1.0	
09/11/98	0.8	
09/18/98	0.7	
09/28/98	0.3	9.0
10/06/98	0.8	
10/15/98	0.6	
10/21/98	0.4	
10/30/98	0.3	
11/06/98	0.3	
11/17/98	0.4	
11/25/98	0.2	
12/04/98	0.3	17.0
12/15/98	0.8	
12/15/98		8.0
12/30/98	1.0	
01/04/99		4.0
01/11/99	0.8	

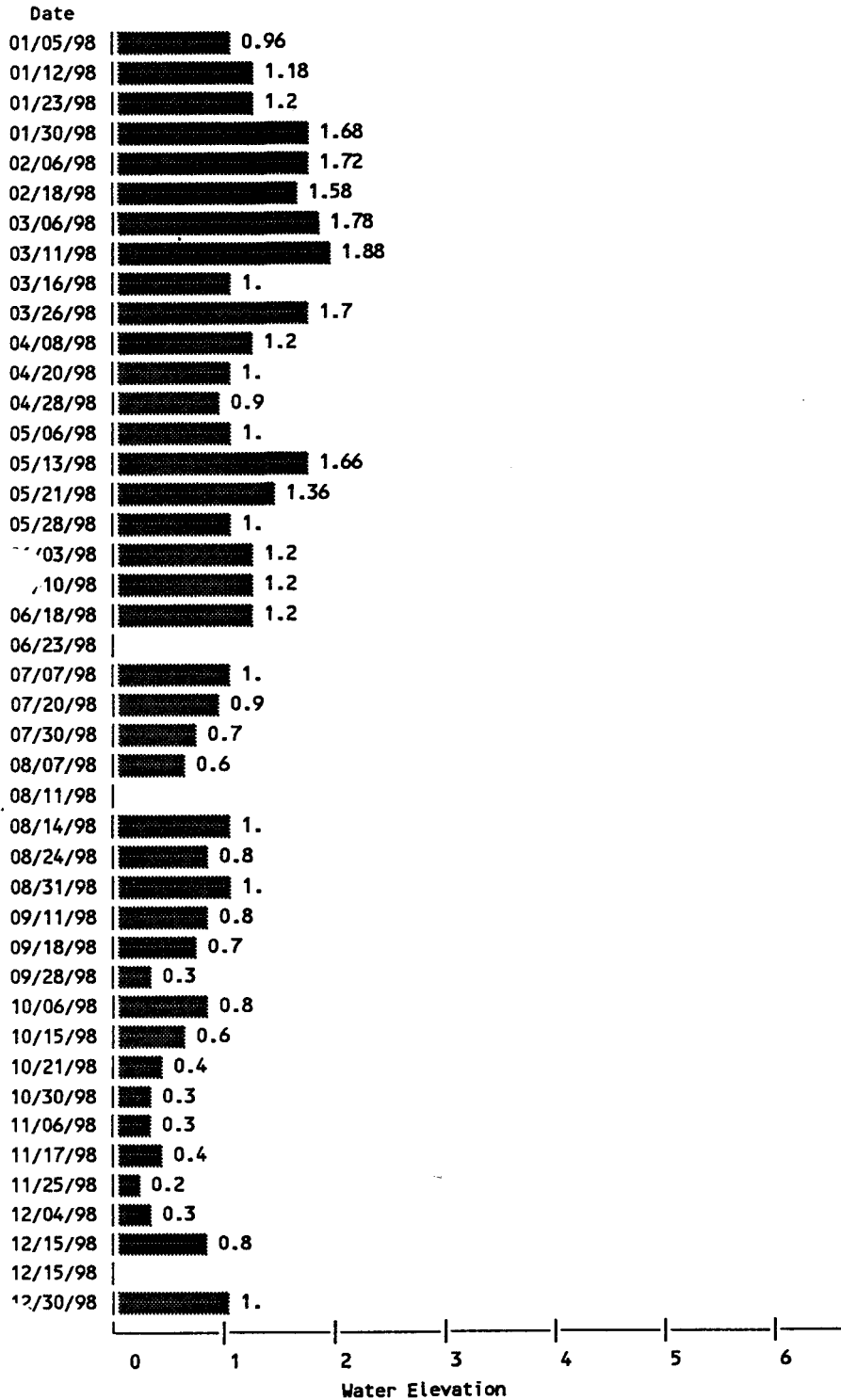
Annual Water Levels : Raymond Pool

Refuge: BOMBAY HOOK NWR

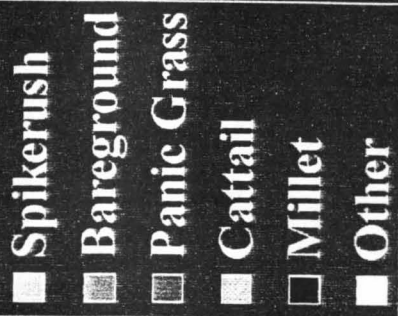
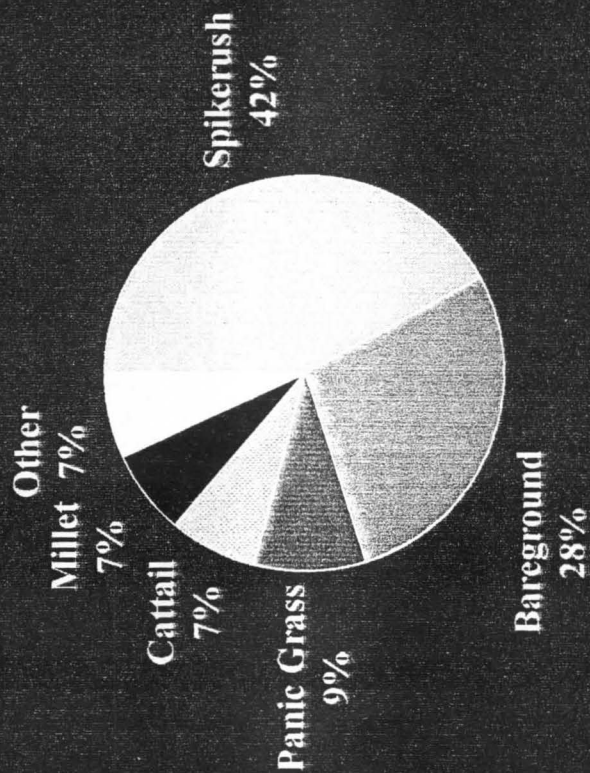
Growing Year: 1998

Impound Bottom Elev. 1.0

WCS Invert Elev. -3.0



Raymond Pool 1998



could not be found. Whenever water was present corixid populations were very high.

With the water levels within Shearneck and Bear Swamp quite low during September early waterfowl arrivals flocked to Raymond to feed on the tender spikerush. September waterfowl peaks included 120 pintails, 550 green-winged teal, 100 blue-winged teal, and 206 mallards. Duck use remained heavy into October but fell to virtually zero during November as the water within the pool evaporated. Reflooding during December resulted in some re-newed use by ducks. Snow geese utilized the pool for roosting as well as feeding. Fall roost peaks approximated 20,000 birds. This pool remained the most attractive of our impoundments to shorebirds. Spring use of dunlins, and sandpipers exceeded 300 birds. During the summer and fall this number grew to peaks of 1500 dunlin. A peak of 400 avocets was achieved during October. Yellowlegs consistently used the pool in numbers of 12-125. Dowitchers peaks exceeded 1000 during July and August.

E. Moist Soil Units

As of the writing of this program a total of 18 small moist soil units have been completed. They vary in size from 1 to 12 acres. The ability to hold water varies markedly from unit to unit. During most of January the only units that had sufficient water levels to attract feeding waterfowl were BMH7, 12, 14, and 15. The other units were still virtually dry from the lack of precipitation during late December 1997 and early January 1998. Northeast storms with heavy rains arrived during early February and supplied all units with adequate water. The dry summer and early fall period resulted in none of these units containing sufficient water to attract feeding waterfowl during the October-December period. Following is a summary of each of these units during the past year.

BMH-5 (A-Pool)--12 acres--This pool received very minor waterfowl use during February and March. Peak numbers encountered during that period were 25 green-winged teal and 10 mallards. By the first of June the pool had de-watered naturally and was not re-flooded the remainder of the year. Vegetation consisted primarily of rushes and sedges in the wetter areas to more upland type plants such as broomsedge in the higher portions. The location of this unit immediately adjacent to the auto tour route is a detriment to bird use. Most use is noted during early mornings or during periods of very limited public use.

BMH-6 (B-Pool)--8 acres--Adequate water conditions were

present only during the period late January through the end of May when the pool de-watered naturally and never re-flooded. Good late winter use by dabbling ducks was realized. March peaks of 80 pintails, 25 green-winged teal, and 75 mallards were noted. Wading and shorebird use was light and sporadic primarily by yellowlegs and great blue herons. Vegetation was a mixture of wetland species such as rushes and panic grass with upland species such as milkweed and broomsedge.

BMH-7 (Straughn Pool)--2 acres--Water conditions at the beginning of the year were marginal until February 1 when optimal levels were achieved. Adequate water was maintained until a planned drawdown commenced during mid June. The pool was completely de-watered during the summer. The dike was re-built, sloped and seeded, and the control structure drainpipe was lengthened. Chemical control of cattail and Phragmites was attempted during August. Vegetation consisted primarily of rushes, sedges, some barnyard grass and millet. As usual, mallards and black ducks made good use of the pool during February and March. Peaks of over 200 birds were noted for this small pool.

BMH-8 (Hourglass Pool)--2 Acres--The full pool levels of late January were reduced to dry bottom by June 1. Emergents such as barnyardgrass and panic grass were abundant but went unutilized during the dry fall and early winter period. Waterfowl use during January through March was noteworthy with up to 200 birds commonly seen there. Mallards, black ducks, and pintails were the most abundant species.

BMH-9&11 (Each one acre)--Both of these units are cropped fields with ditch plugs. Both areas flooded out of the ditch banks sufficiently during late winter to flood crop stubble. However, waterfowl use was negligible.

BMH-10 (one acre)--This unit has very poor water holding capabilities. Even during periods when water was present (Feb. & March) bird use was negligible. The unit was mowed during July to stress the cocklebur which had emerged.

BMH-12 (Cottman Pool--one acre)--This unit again held water remarkably well throughout the year. This year cattail became very evident and completely covered the pool surface. The cattail was treated with Rodeo during August. Bird use remained low for the third consecutive year following high use during the initial year of construction. The invertebrate population appeared high with water beetles very abundant. Spikerush and barnyardgrass was present around the pool fringe.

BMH-13 (Fischer tract dugout--2 acres)--Adequate water during January-March resulted in good migratory bird use. Peaks of 150 ducks were realized during March. Shovellers, teal, and mallards were the most common species. Nearly 40 yellowlegs were recorded there during March.

BMH-14 (Fischer tract--2 acres)--Water levels were adequate from January through June at which time the pool completely dewatered naturally. An extensive coverage of the pool bottom by cattails occurred. The fringes produced good stands of barnyardgrass and panic grass. The cattail was treated with Rodeo during August. Duck utilization from January through March was excellent with nearly 200 birds being recorded there during each survey. Diversity was excellent with more than 10 individuals of six species being commonly recorded.

BMH-15 (DU Pond--4 acres)--Water levels were good throughout the winter and spring. Logs were pulled during June to de-water the unit. The pool remained dry except for a small borrow area through the remainder of the year. Production of seedbox was abundant as was barnyardgrass on pool fringes. Waterfowl use was down from previous years. Peak populations were generally fewer than 20 birds during the period January through March.

BMH 216-BMH 221 (10 acres total)--All of these units contained sufficient water for only the period late January-April. All units were completely dry by June and none were re-flooded during the fall. Waterfowl use was sporadic but occasionally significant by dabbling ducks with peaks in each unit of up to 50 birds.

BMH 222 (Steamboat--7.5 acres)--The bottom of this unit was scraped during the summer and the road which serves as a dike was raised. The only significant waterfowl use occurred during January-April and consisted primarily of mallards, black ducks and Canada geese.

F. Tidal Marsh (12,000+ acres)

No active habitat management of the saltmarsh other than hunting was attempted during 1998. We continue to monitor the extent of the snow goose eat-outs within the marsh and have continued to permit hunting there to reduce marsh destruction. Although the major portions of Money Marsh and Leatherberry Flats are still denuded annually the total extent of the eat-outs has not expanded significantly during the past 5 years. The small 2 acre area adjacent to Bear Swamp which was grazed the past two years was re-grazed this year but does not

Five Year Report of Water Levels

Refuge : BOMBAY HOOK NWR
 Impoundment: bmh5 A-Pool

Rpt. Date: 01/14/99

Date	1994	1995	Year 1996	1997	1998
01/01/	7.2		7.5	7.5	7.2
01/15/		7.3			7.2
02/01/	7.5	7.3	7.8	7.8	7.6
02/15/	7.7	7.3	7.8	7.8	7.6
03/01/	7.7	7.3	7.7	7.6	7.7
03/15/	7.8	7.5	7.5	7.3	7.8
04/01/	7.9	7.2	7.6	7.3	7.8
04/15/	7.7	7.0	7.6		7.5
05/01/	7.5	7.0	7.4	7.3	7.5
05/15/	7.4	6.9	7.6		7.6
06/01/	7.2	7.0	7.4	7.0	7.1
06/15/	6.9		7.4	7.0	6.8
07/01/	7.4	7.2	7.5	0.0	6.8
07/15/	7.3	7.2	7.4	0.0	0.0
08/01/	7.2	7.3	7.3	0.0	5.8
08/15/	7.5		7.2	0.0	6.9
09/01/	7.6		7.1	7.1	0.0
09/15/	7.1		7.0	6.5	0.0
10/01/	7.1		7.0		0.0
10/15/		6.9		0.0	0.0
11/01/		7.1	7.4	7.0	0.0
11/15/		7.4	7.3	7.2	0.0
12/01/	7.0	7.3	7.2	7.1	0.0
12/15/	7.1	7.5	7.8	7.1	0.0
12/31/	7.1	7.5	7.7		0.0

Water & Salinity Report

Refuge Name: BOMBAY HOOK NWR

Impoundment: A-Pool

Ave. Bottom Elev. 7.0 WCS Invert Elev. 7.0 Year : 1998

Date	Gauge Reading	Salinity (ppt)

01/05/98	7.2	
01/12/98	7.2	
01/23/98	7.2	
01/30/98	7.6	
02/06/98	7.6	
02/18/98	7.6	
03/06/98	7.7	
03/11/98	7.8	
03/16/98	7.7	
03/26/98	7.8	
04/08/98	7.5	
04/20/98	7.5	
04/28/98	7.5	
05/06/98	7.3	
05/13/98	7.6	
05/21/98	7.3	
05/28/98	7.1	
06/03/98	7.0	
06/10/98	6.8	
06/18/98	7.1	
07/07/98	6.8	
07/20/98	0.0	
07/30/98	5.8	
08/07/98	0.0	
08/14/98	6.9	
08/24/98	6.8	
08/31/98	0.0	
09/11/98	0.0	
09/18/98	0.0	
09/28/98	0.0	
10/06/98	0.0	
10/15/98	0.0	
10/21/98	0.0	
10/30/98	0.0	
11/06/98	0.0	
11/17/98	0.0	
11/25/98	0.0	
12/04/98	0.0	
12/15/98	0.0	
12/30/98	0.0	
01/11/99	7.1	

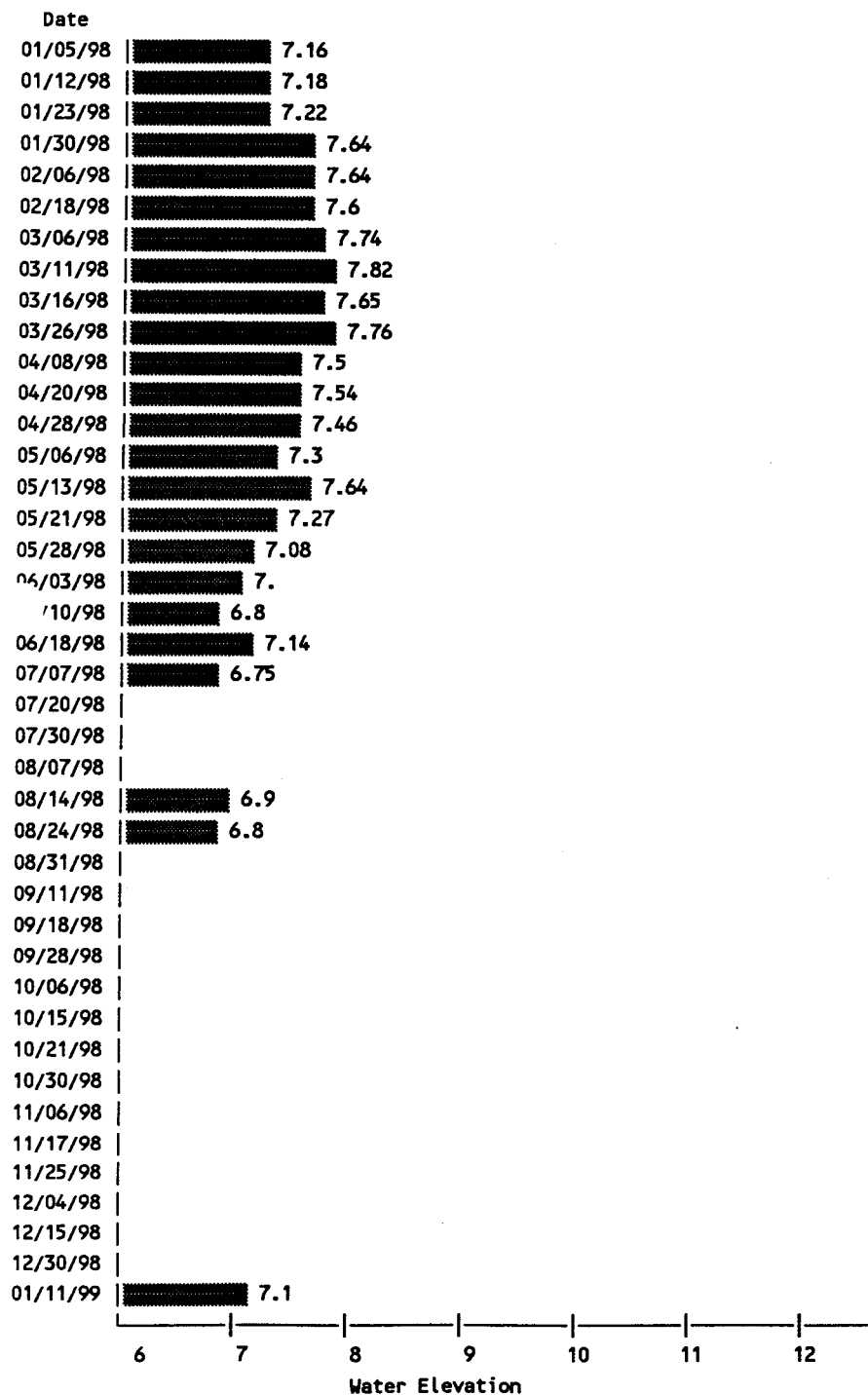
Annual Water Levels : A-Pool

Refuge: BOMBAY HOOK NWR

Growing Year: 1998

Impound Bottom Elev. 7.0

MCS Invert Elev. 7.0



Five Year Report of Water Levels

Refuge : BOMBAY HOOK NWR
Impoundment: bmh6 B-Pool

Rpt. Date: 01/14/99

Date	1994	1995	Year 1996	1997	1998
01/01/			1.6	3.0	0.0
01/15/		0.7			0.0
02/01/		1.7	2.6	2.8	1.4
02/15/		1.7	2.7	2.7	1.9
03/01/		1.7	2.9	2.8	2.7
03/15/		2.1		3.0	3.1
04/01/		1.8	3.1	2.9	3.1
04/15/	3.0	1.3	3.1		2.8
05/01/	2.7	1.0	3.0	2.3	2.5
05/15/	2.2	0.7	3.1		2.8
06/01/	1.6	0.6	2.8	1.4	2.3
06/15/	0.02	0.0	2.8	0.0	1.2
07/01/	1.0		2.9	0.0	0.0
07/15/	0.0	1.1	2.7	0.0	0.0
08/01/		1.5	2.4	0.0	0.0
08/15/	0.7		2.1	0.0	0.0
09/01/			0.7	0.0	0.0
09/15/	0.0		0.0	0.0	0.0
10/01/			0.0		0.0
10/15/	0.0			0.0	0.0
11/01/	0.0		1.4	0.0	0.0
11/15/		1.0	1.2	0.0	0.0
12/01/			0.0	0.0	0.0
12/15/		1.7	3.1	0.0	0.0
12/31/		1.4	3.1		0.0

Water & Salinity Report

Refuge Name: BOMBAY HOOK NWR

Impoundment: B-Pool

Ave. Bottom Elev.

WCS Invert Elev.

Year : 1998

Date	Gauge Reading	Salinity (ppt)
01/05/98	0.0	
01/12/98	0.0	
01/23/98	0.8	
01/30/98	1.4	
02/06/98		
02/18/98	1.9	
03/06/98	2.7	
03/11/98	3.1	
03/16/98	2.9	
03/26/98	3.1	
04/08/98	2.8	
04/20/98	2.7	
04/28/98	2.5	
05/06/98	2.3	
05/13/98	2.8	
05/21/98	2.6	
05/28/98	2.3	
06/03/98	1.9	
06/10/98	1.2	
06/18/98	1.4	
07/07/98	0.0	
07/20/98	0.0	
07/30/98	0.0	
08/07/98	0.0	
08/14/98	0.0	
08/24/98	0.0	
08/31/98	0.0	
09/11/98	0.0	
09/18/98	0.0	
09/28/98	0.0	
10/06/98	0.0	
10/15/98	0.0	
10/21/98	0.0	
10/30/98	0.0	
11/06/98	0.0	
11/17/98	0.0	
11/25/98	0.0	
12/04/98	0.0	
12/15/98	0.0	
12/30/98	0.0	
01/11/99	0.0	

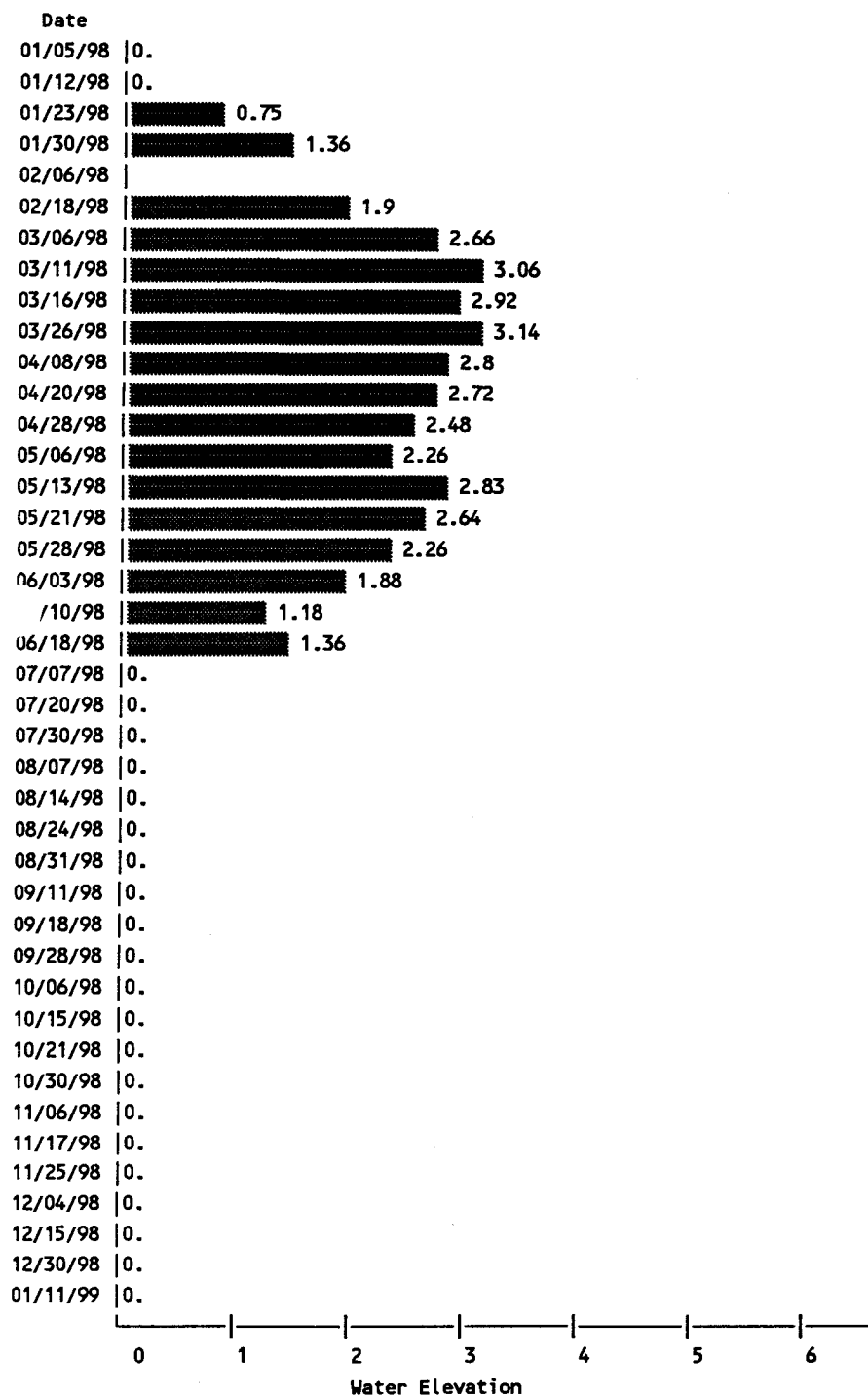
Annual Water Levels : B-Pool

Refuge: BOMBAY HOOK NWR

Growing Year: 1998

Impound Bottom Elev.

WCS Invert Elev.



Five Year Report of Water Levels

Refuge : BOMBAY HOOK NWR

Rpt. Date: 01/14/99

Impoundment: bnh7 Straughn Pool

Date	Year				
	1994	1995	1996	1997	1998
01/01/			9.1	9.3	7.8
01/15/	8.7	8.6	9.2		7.8
02/01/	8.6	9.0	9.5	9.5	8.8
02/15/	8.5	9.0	9.6	9.5	9.0
03/01/	8.2	9.0	9.5	9.4	9.0
03/15/	8.4	9.4	9.4	9.4	9.4
04/01/	8.5	9.2	9.6	9.3	9.3
04/15/	8.5	9.0	9.0		9.0
05/01/	8.3	8.9	7.0	7.4	8.9
05/15/	8.4	8.8	6.8		9.4
06/01/	8.2	8.8	6.8	6.8	8.8
06/15/	7.8	8.7	6.8	6.9	8.5
07/01/	7.6	8.0	6.8	6.0	7.3
07/15/	8.3	8.1	6.8	6.0	6.9
08/01/	8.3	7.7	6.8	6.0	6.7
08/15/	8.7	8.0	6.9	6.0	0.0
09/01/	9.2	7.7	6.8	7.0	0.0
09/15/	8.8	7.4	6.8	6.0	0.0
10/01/		7.6	6.8		0.0
10/15/	8.5	7.6		6.0	0.0
11/01/		8.0	7.7	6.0	0.0
11/15/	8.3	8.5	7.5	7.2	0.0
12/01/	8.3	8.5	7.3	7.5	0.0
12/15/	8.4	9.0	9.4	7.5	0.0
12/31/	8.3	8.9	9.4		6.5

Water & Salinity Report

Refuge Name: BOMBAY HOOK NWR

Impoundment: Straughn Pool

Ave. Bottom Elev. 5.0 WCS Invert Elev. 5.0 Year : 1998

Date	Gauge Reading	Salinity (ppt)
01/05/98	7.8	
01/12/98	7.8	
01/23/98	8.0	
01/30/98	8.8	
02/06/98	8.9	
02/18/98	9.0	
03/06/98	9.0	
03/11/98	9.4	
03/26/98	9.3	
04/08/98	9.0	
04/20/98	9.1	
04/28/98	8.9	
05/06/98	8.7	
05/13/98	9.4	
05/28/98	8.8	
06/03/98	8.8	
06/10/98	8.5	
06/18/98	8.7	
07/07/98	7.3	
07/20/98	6.9	
07/30/98	6.7	
08/07/98	0.0	
08/14/98	0.0	
08/24/98	0.0	
08/31/98	0.0	
09/11/98	0.0	
09/18/98	0.0	
09/28/98	0.0	
10/06/98	0.0	
10/15/98	0.0	
10/21/98	0.0	
10/30/98	0.0	
11/06/98	0.0	
11/17/98	0.0	
11/25/98	0.0	
12/04/98	0.0	
12/15/98	0.0	
12/30/98	6.5	
01/11/99	7.2	

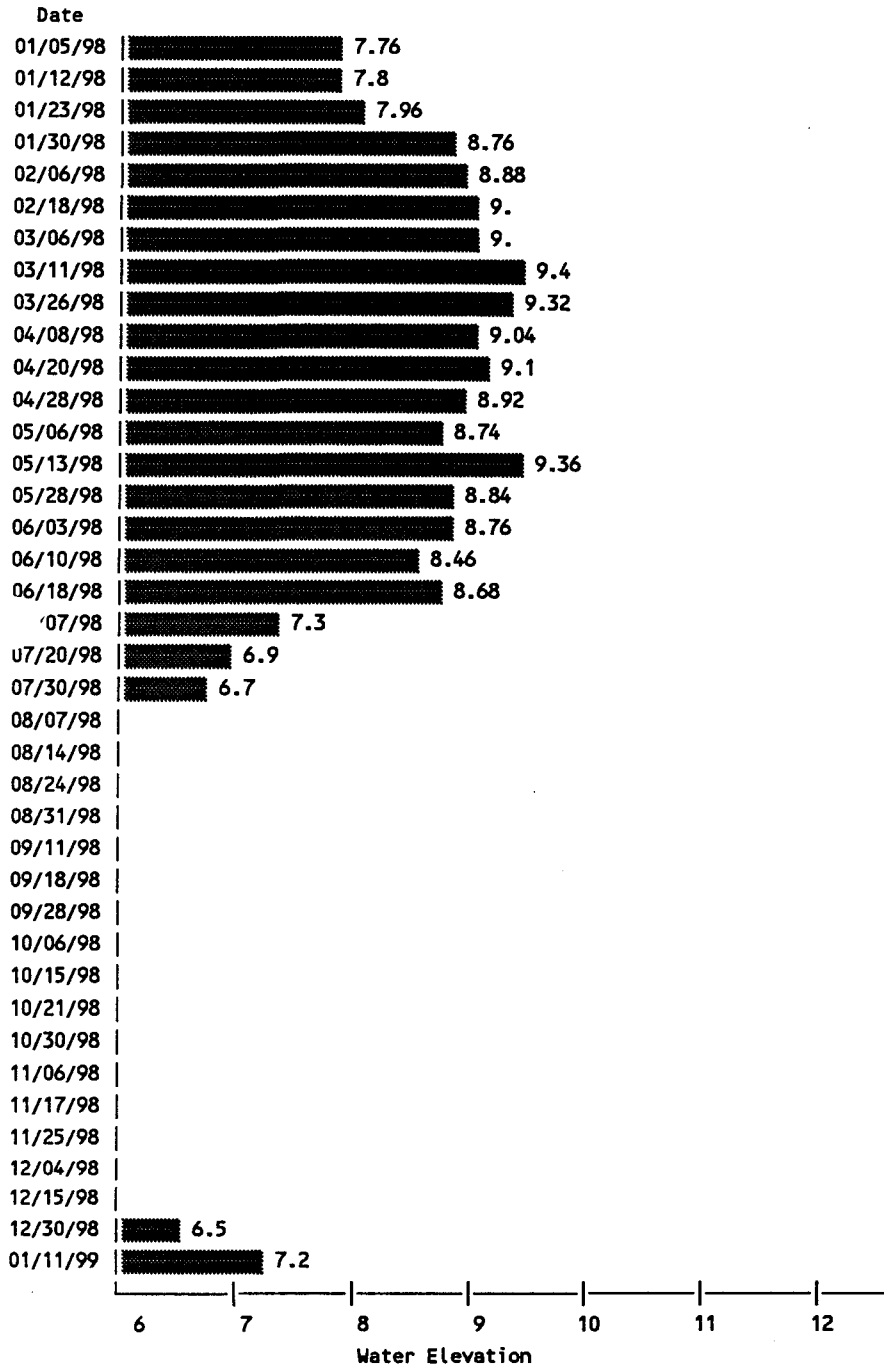
Annual Water Levels : Straughn Pool

Refuge: BOMBAY HOOK NWR

Growing Year: 1998

Impound Bottom Elev. 5.0

WCS Invert Elev. 5.0



Water & Salinity Report

Refuge Name: BOMBAY HOOK NWR

Impoundment: Project 3a

Ave. Bottom Elev.

WCS Invert Elev.

Year : 1998

Date	Gauge Reading	Salinity (ppt)
01/05/98	0.0	
01/12/98	0.0	
01/23/98	0.0	
01/30/98	1.8	
02/06/98	1.8	
02/18/98	1.8	
03/06/98	2.2	
03/11/98	2.2	
03/26/98	2.5	
04/08/98	1.8	
04/20/98	1.6	
04/28/98	1.3	
05/06/98	1.0	
05/13/98	2.0	
05/28/98	1.2	
06/03/98	0.9	
06/10/98	0.8	
06/18/98	0.9	
07/07/98	0.0	
07/20/98	0.0	
07/30/98	0.0	
08/07/98	0.0	
08/14/98	0.0	
08/24/98	0.0	
08/31/98	0.0	
09/11/98	0.0	
09/18/98	0.0	
09/28/98	0.0	
10/06/98	0.0	
10/15/98	0.0	
10/21/98	0.0	
10/30/98	0.0	
11/06/98	0.0	
11/17/98	0.0	
11/25/98	0.0	
12/04/98	0.0	
12/15/98	0.0	
12/30/98	0.0	
01/11/99	0.0	

Five Year Report of Water Levels

Refuge : BOMBAY HOOK NWR

Rpt. Date: 01/14/99

Impoundment: bmh8 Project 3a

Date	1994	1995	Year 1996	1997	1998
01/01/			1.2	2.0	0.0
01/15/	1.3	0.8	1.2		0.0
02/01/		1.4	2.0	2.1	1.8
02/15/	2.2	1.0	2.0	2.1	1.8
03/01/	2.2	1.0	2.0	2.0	2.2
03/15/	2.3	1.5	2.0	2.1	2.2
04/01/	2.3	0.9	2.1	1.9	2.5
04/15/	2.1	0.7	2.3		1.8
05/01/	1.9	0.5	2.0	1.6	1.3
05/15/	1.3		2.1		2.0
06/01/	0.6	0.5	1.7	0.8	1.2
06/15/		0.4	1.7	0.0	0.8
07/01/	1.1	1.2	1.8	0.0	0.0
07/15/	0.7	1.2	1.7	0.0	0.0
08/01/	0.6	0.4	1.5	0.0	0.0
08/15/	1.2	0.6	1.2	0.0	0.0
09/01/	1.7		0.8	0.8	0.0
09/15/			0.6	0.0	0.0
10/01/	0.8		0.6		0.0
10/15/	0.0			0.0	0.0
11/01/		0.6	1.2	0.0	0.0
11/15/		1.0	1.0	0.0	0.0
12/01/	0.4	0.8	0.9	0.0	0.0
12/15/		1.3	2.3	0.0	0.0
12/31/	0.4	1.1	2.2		0.0

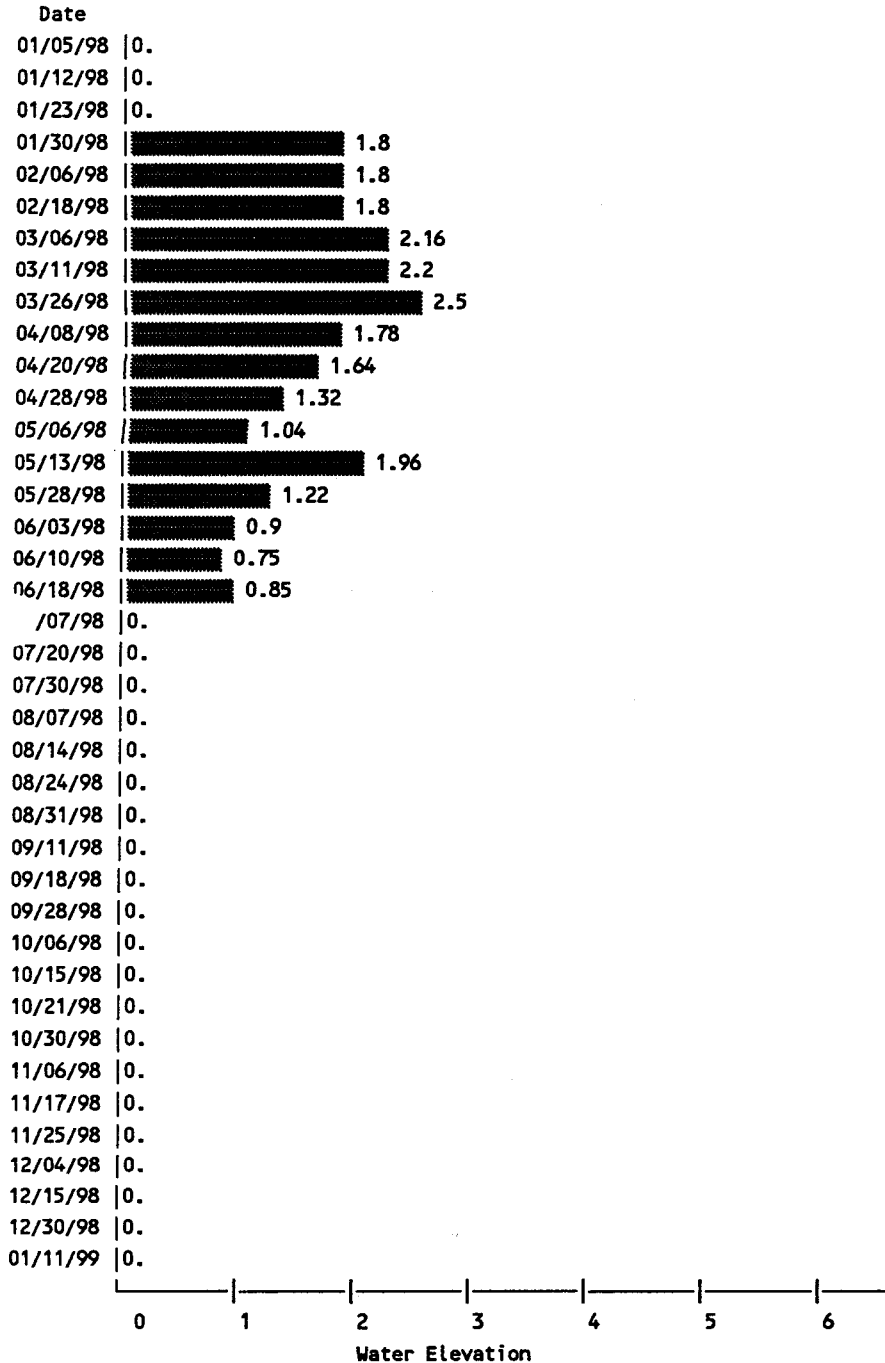
Annual Water Levels : Project 3a

Refuge: BOMBAY HOOK NWR

Growing Year: 1998

Impound Bottom Elev.

WCS Invert Elev.



Five Year Report of Water Levels

Refuge : BOMBAY HOOK NWR
Impoundment: bmh12 Project 1

Rpt. Date: 01/14/99

Date	1997	1998	Year 1999	2000	2001
01/01/		8.8			
01/15/		8.8	8.5		
02/01/		9.3			
02/15/		9.7			
03/01/		9.6			
03/15/		9.9			
04/01/		9.7			
04/15/		9.0			
05/01/		8.7			
05/15/		9.1			
06/01/		8.7			
06/15/	9.1	8.3			
07/01/	8.7	8.1			
07/15/	8.7	7.9			
08/01/	8.3	8.0			
08/15/	8.2				
09/01/	8.9	8.7			
09/15/	8.6	8.5			
10/01/		8.2			
10/15/	8.4	8.1			
11/01/	8.4	8.0			
11/15/	8.7	7.9			
12/01/	8.8	7.8			
12/15/	8.8	8.0			
12/31/		8.0			

Water & Salinity Report

Refuge Name: BOMBAY HOOK NWR

Impoundment: Project 1

Ave. Bottom Elev.

WCS Invert Elev.

Year : 1998

Date	Gauge Reading	Salinity (ppt)
01/05/98	8.8	
01/12/98	8.8	
01/23/98	8.8	
01/30/98	9.3	
02/06/98	10.0	
02/18/98	9.7	
03/06/98	9.6	
03/11/98	9.9	
03/26/98	9.7	
04/08/98	9.0	
04/20/98	8.8	
04/28/98	8.7	
05/06/98	8.6	
05/13/98	9.1	
05/21/98	8.9	
05/28/98	8.7	
06/03/98	8.5	
06/10/98	8.3	
06/18/98	8.4	
07/07/98	8.1	
07/20/98	7.9	
07/30/98	8.0	
08/07/98	7.8	
08/24/98	8.6	
08/31/98	8.7	
09/11/98	8.5	
09/18/98	8.3	
09/28/98	8.2	
10/06/98	8.1	
10/15/98	8.1	
10/21/98	8.1	
10/30/98	8.0	
11/06/98	7.9	
11/17/98	7.9	
11/25/98	7.8	
12/04/98	7.9	
12/15/98	8.0	
12/30/98	8.0	
01/11/99	8.5	

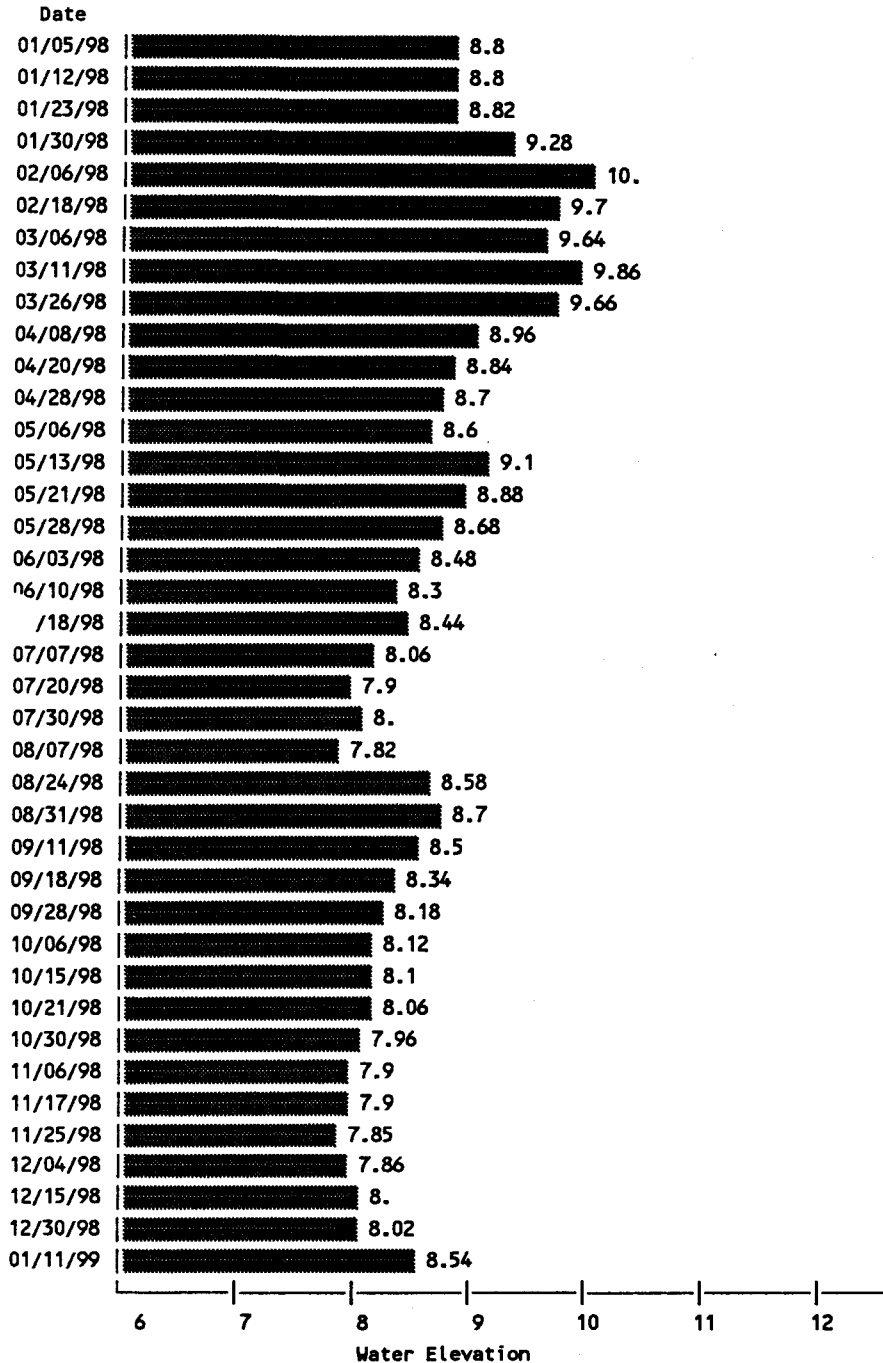
Annual Water Levels : Project 1

Refuge: BOMBAY HOOK NWR

Growing Year: 1998

Impound Bottom Elev.

WCS Invert Elev.



Five Year Report of Water Levels

Refuge : BOMBAY HOOK NWR

Rpt. Date: 01/14/99

Impoundment: bmh14 Project 6a

Date	1994	1995	Year 1996	1997	1998
01/01/			1.9	3.2	1.5
01/15/			1.9		1.5
02/01/		1.6	3.0	3.2	2.4
02/15/		1.3	2.9	3.2	2.5
03/01/		1.4	3.0	3.2	3.0
03/15/		2.0	2.9	3.2	3.3
04/01/		1.3		3.0	3.3
04/15/		0.2	2.4		3.0
05/01/		0.0	1.9	2.7	2.6
05/15/			2.0		2.8
06/01/			1.8	1.8	2.3
06/15/			1.8	1.6	1.7
07/01/		1.7	1.7	0.7	1.4
07/15/		1.6	1.6	0.7	0.9
08/01/		2.1	1.6	0.0	0.9
08/15/		1.3	1.4	0.0	1.4
09/01/			1.1	1.9	1.1
09/15/			0.9	1.4	0.0
10/01/			1.0		0.0
10/15/				0.0	0.0
11/01/		1.1	1.7	0.0	0.0
11/15/		1.6	1.7	1.5	0.0
12/01/		1.2	1.6	1.4	0.0
12/15/	0.2		3.0	1.4	0.0
12/31/		1.5	3.0		0.0

Water & Salinity Report

Refuge Name: BOMBAY HOOK NWR

Impoundment: Project 6a

Ave. Bottom Elev.

WCS Invert Elev.

Year : 1998

Date	Gauge Reading	Salinity (ppt)
01/05/98	1.5	
01/12/98	1.5	
01/30/98	2.4	
02/06/98	2.5	
02/18/98	2.5	
03/06/98	3.0	
03/11/98	3.3	
03/26/98	3.3	
04/08/98	3.0	
04/20/98	2.8	
04/28/98	2.6	
05/06/98	2.3	
05/13/98	2.8	
05/21/98	2.5	
05/28/98	2.3	
06/03/98	2.0	
06/10/98	1.7	
06/18/98	2.0	
07/07/98	1.4	
07/20/98	0.9	
07/30/98	0.9	
08/07/98	0.0	
08/14/98	1.4	
08/24/98	1.1	
08/31/98	1.1	
09/11/98	0.0	
09/18/98	0.0	
09/28/98	0.0	
10/06/98	0.0	
10/15/98	0.0	
10/21/98	0.0	
10/30/98	0.0	
11/06/98	0.0	
11/17/98	0.0	
11/25/98	0.0	
12/04/98	0.0	
12/15/98	0.0	
12/30/98	0.0	
01/11/99	0.0	

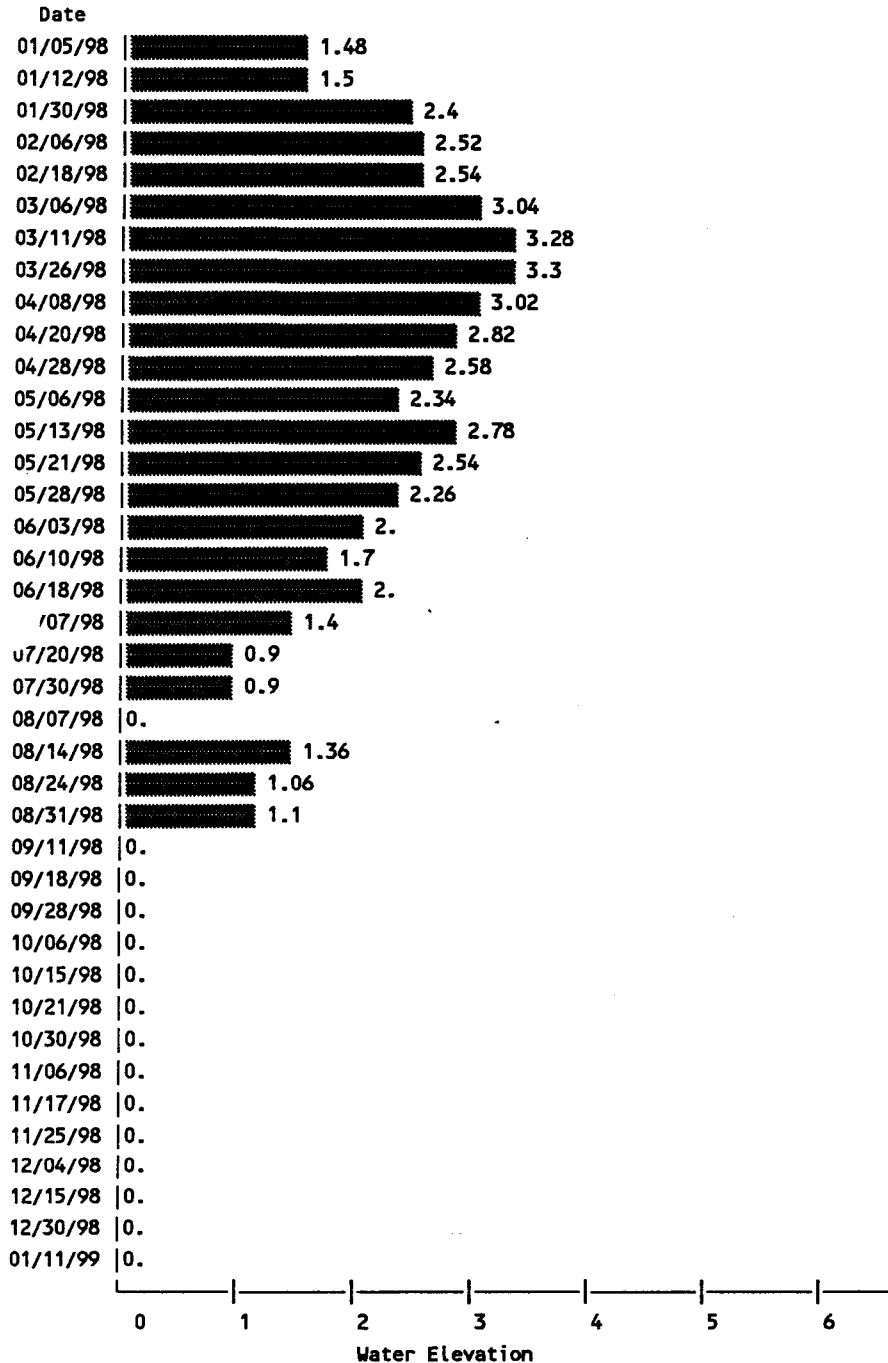
Annual Water Levels : Project 6a

Refuge: BOMBAY HOOK NWR

Growing Year: 1998

Impound Bottom Elev.

WCS Invert Elev.



Five Year Report of Water Levels

Refuge : BOMBAY HOOK NWR

Rpt. Date: 01/14/99

Impoundment: bmh15 Project 2

Date	1994	1995	Year 1996	1997	1998
01/01/			2.1	2.3	1.3
01/15/		1.5	2.3		1.3
02/01/		1.6	2.5	2.5	1.9
02/15/		1.7	2.5	2.5	2.1
03/01/		1.7	2.5	2.4	2.4
03/15/		1.8	2.4	2.4	2.5
04/01/		1.7	2.5	2.3	2.5
04/15/		1.6	2.6		2.2
05/01/		1.6	2.3	2.1	2.1
05/15/		1.5	2.4		2.4
06/01/		1.5	2.4	1.7	1.9
06/15/		1.4	1.1	0.9	1.6
07/01/		1.6	0.9	0.5	0.8
07/15/		1.6	0.9	0.5	0.6
08/01/		1.2	0.9	0.0	0.6
08/15/		1.5	0.8	0.0	0.7
09/01/		1.3	0.6	1.0	0.8
09/15/		1.0	0.6	0.8	0.6
10/01/		1.1	0.8		0.5
10/15/		1.2		0.5	0.4
11/01/		1.5	1.6	0.6	0.2
11/15/		1.8	1.6	1.0	0.2
12/01/		1.8	1.5	1.2	0.2
12/15/	1.6	2.1	2.4	1.2	0.3
12/31/	1.6	2.0	2.4		0.4

Water & Salinity Report

Refuge Name: BOMBAY HOOK NWR

Impoundment: Project 2

Ave. Bottom Elev. 0.0

WCS Invert Elev. 0.5

Year : 1998

Date	Gauge Reading	Salinity (ppt)
01/05/98	1.3	
01/12/98	1.3	
01/23/98	1.5	
01/30/98	1.9	
02/06/98	2.0	
02/18/98	2.1	
03/06/98	2.4	
03/11/98	2.5	
03/26/98	2.5	
04/08/98	2.2	
04/20/98	2.2	
04/28/98	2.1	
05/06/98	2.1	
05/13/98	2.4	
05/21/98	2.1	
05/28/98	1.9	
06/03/98	1.8	
06/10/98	1.6	
06/18/98	1.8	
07/07/98	0.8	
07/20/98	0.6	
07/30/98	0.6	
08/07/98	0.5	
08/14/98	0.7	
08/24/98	0.8	
08/31/98	0.8	
09/11/98	0.6	
09/18/98	0.6	
09/28/98	0.5	
10/06/98	0.4	
10/15/98	0.4	
10/21/98	0.4	
10/30/98	0.2	
11/06/98	0.2	
11/17/98	0.2	
11/25/98	0.2	
12/04/98	0.2	
12/15/98	0.3	
12/30/98	0.4	
01/11/99	0.9	

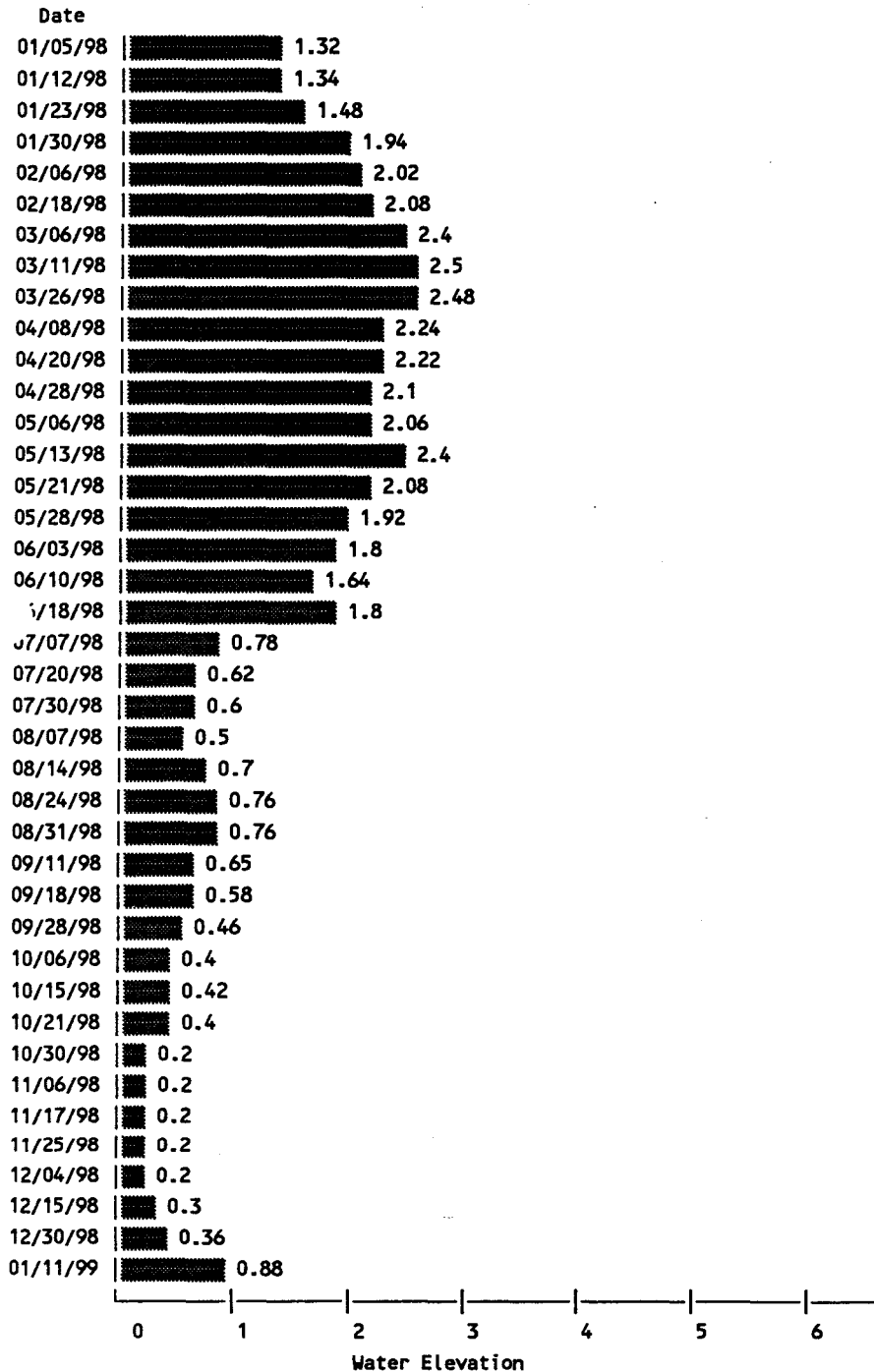
Annual Water Levels : Project 2

Refuge: BOMBAY HOOK NWR

Growing Year: 1998

Impound Bottom Elev. 0.0

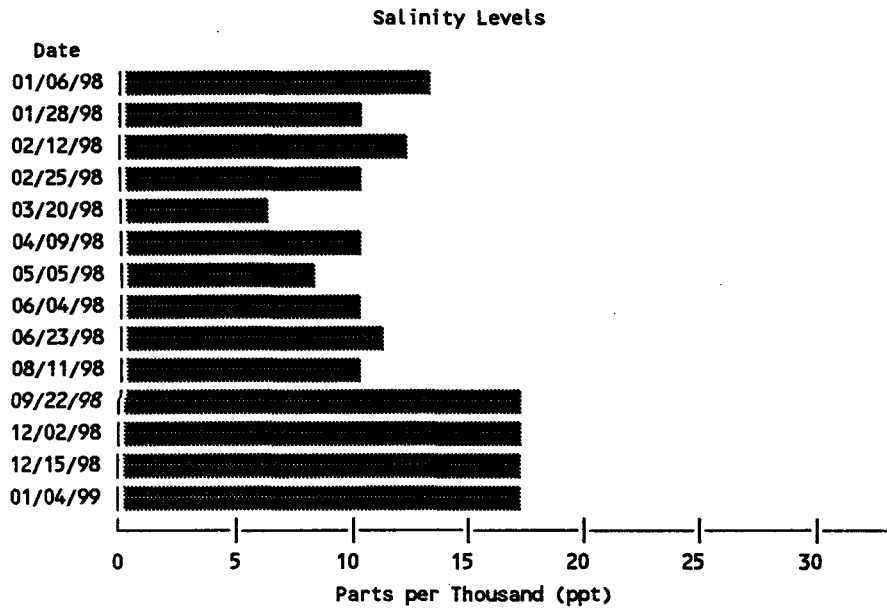
WCS Invert Elev. 0.5



Annual Salinity Levels : Saltmarsh

Refuge: BOMBAY HOOK NWR

Growing Year: 1998



appear to have expanded. Permanent vegetative transects within the Bombay Hook tidal marshes were run in late summer for the tenth consecutive year.

V. Objective and Plans for 1999 Water Level Management

Within our proposed management scheme for 1999 desirable productive waterfowl habitat will be available for migrating and wintering species from the time of arrival in the late summer to departure in the spring. In addition some brood habitat will be available within our managed wetlands as well. Other wetland dependent species groups such as waders, shorebirds, grebes, and rails will benefit as well from our proposed water regimes.

Our planned water management regimes of 1999 will differ somewhat for two of our large impoundments, i.e. Bear Swamp and Finis Pool. During the past few years and especially during 1998 waterfowl use within Bear Swamp has declined. In particular, summer use by wood duck broods was very low during 1998. Little if any production of SAV as a result of carp activities may have added to this phenomenon. Further, less desirable species such as pluchea, large spikerush, and umbrella grass seem to be increasing at the expense of annual seed producing plants. Further, percent bareground has increased significantly as well. Similar water management regimes for Bear Swamp have been maintained for the past 5 years. We propose a new regime for 1999 which will "re-charge" this unit and enhance its productivity. Since our proposed levels for Bear Swamp will not be favorable to summer use by woodduck broods during this one summer of drawdown we propose to maintain higher levels throughout the summer in Finis Pool to ensure adequate wood duck brood habitat.

We will again attempt to maximize millet and panic grass production in Shearness Pool and will hopefully reap the benefits of cattail control there with even more annual plant production. We will be interested to see the results of our maple control within the back of Shearness and see if even more acreage of the unit can be productive for waterfowl feeding and loafing. We will ideally duplicate the Raymond Pool water regime which we achieved during 1998. If so, we will continue to provide shorebird habitat by encouraging shallow flooded flats and invertebrate production. Hopefully, fall precipitation will be more optimum for all of our wetland units than we experienced during 1998 and Raymond's value to early migrant waterfowl will be enhanced.

All moist soil units will be managed primarily for late winter and spring habitat. Most will be disced during the summer if moisture conditions are favorable to set back succession, control undesirable species, and encourage annual emergent growth. Natural drawdowns will be permitted within all moist

soil units except BMH-7,14, and 15 where intentional lowering of the water levels will be practiced during the spring and summer. Phragmites and cattail stands will be treated within units where it is deemed dense and extensive enough to warrant chemical spraying. Evaluation of our efforts will continue to be practiced by utilization of our vegetation plots, weekly bird surveys, and periodic invertebrate sampling.

A. BHM-1 Bear Swamp

As mentioned previously we are proposing a deviation from the water regimes attempted during the last 5 years. The reasons for this are discussed in the previous section. We are proposing an early spring drawdown to try and stimulate beneficial annual plants such as smartweeds which germinate early in the spring and may be able to out compete the less desirable species such as pluchea which favor a later drawdown. The pool will be de-watered as low as possible to not only expose as much of the pool bottom as possible but to also eliminate some of the carp which are numerous in the borrow pits. The pool bottom will be exposed during late February and March and the dead cattail and phragmites canes will be burned. The pool will re-main dewatered throughout the summer with the boards replaced during August. That way if we should get some significant thunderstorms that water can be collected within the borrow pits and gradually re-flood portions of the pool bottom during September for the early season migrants. We realize that this may not happen and the pool may not be adequately re-flooded until mid-winter but believe that sufficient habitat will be available in the other wetland units and saltmarsh to meet the demand of the migrating birds. The area will be of little value to woodduck broods throughout the summer but hope that by achieving higher levels within Finis Pool during the summer this loss can be mitigated.

Planned Water Elevations : 1999

Refuge :	BOMBAY HOOK NWR	Max. Pool Elev.:	4.5
Impoundment:	BMH1 Bear Swamp Pool	WCS Drain Elev :	1.2
		Ave. Pool Bottom:	1.0

Past Year 1998			Program Year 1999	
Water Elev.		Salinity	Planned Elev.	

01/01/98	1.5	3.0	01/01/99	2.0
01/15/98	1.5		01/15/99	2.0
02/01/98	2.0	2.0	02/01/99	1.5
02/15/98	2.2		02/15/99	1.0
03/01/98	2.5		03/01/99	0.5
03/15/98	2.6		03/15/99	0.3
04/01/98	2.3		04/01/99	0.0
04/15/98	2.3		04/15/99	0.0
05/01/98	2.3		05/01/99	0.0
05/15/98	2.3		05/15/99	0.0
06/01/98	1.8		06/01/99	0.0
06/15/98	1.6		06/15/99	0.0
07/01/98	1.5	1.0	07/01/99	0.0
07/15/98	1.4		07/15/99	0.0
08/01/98	1.4		08/01/99	0.5
08/15/98		1.0	08/15/99	0.6
09/01/98	1.3		09/01/99	0.7
09/15/98	1.3		09/15/99	1.0
10/01/98	1.1	3.0	10/01/99	1.2
10/15/98	1.1		10/15/99	1.3
11/01/98	0.9		11/01/99	1.5
11/15/98	0.8		11/15/99	1.6
12/01/98	0.7		12/01/99	1.7
12/15/98	1.0		12/15/99	1.8
01/01/99		2.5	01/01/00	2.0
01/15/99	1.2			
02/01/99				
02/15/99				
03/01/99				
03/15/99				

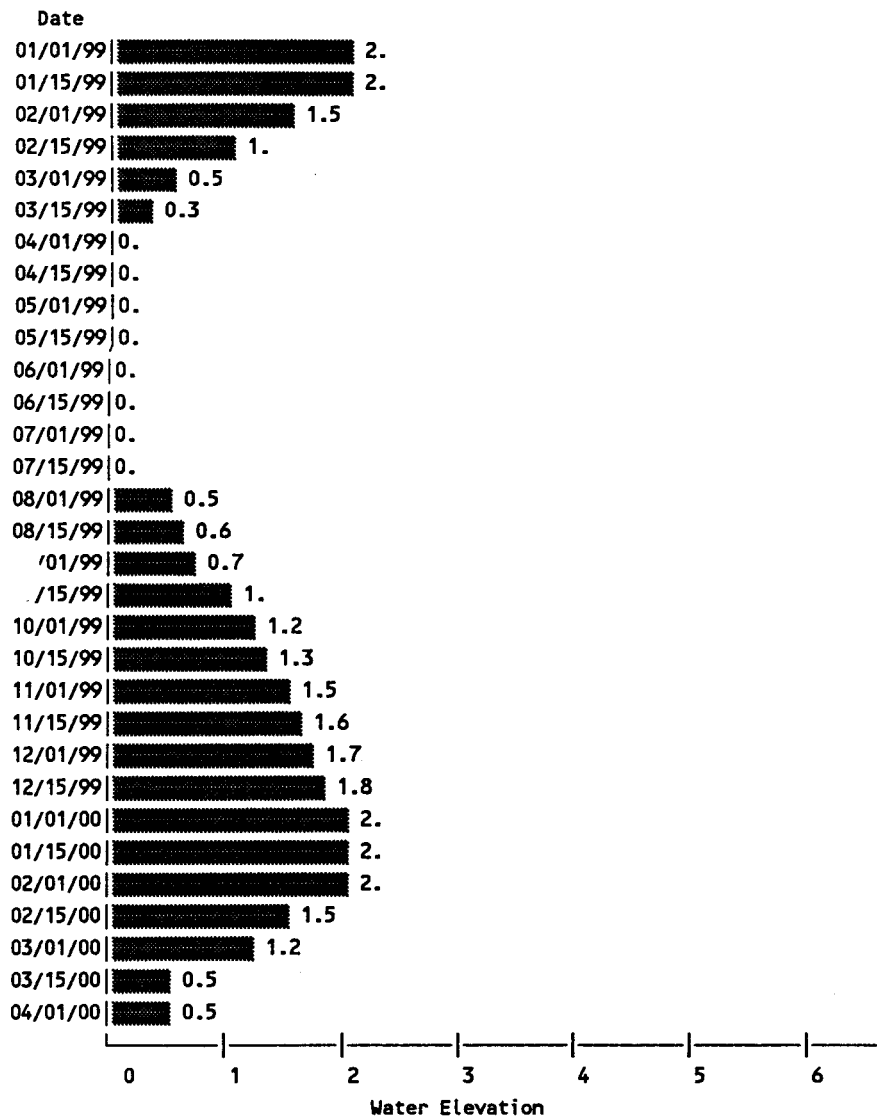
Projected Annual Water Levels : Bear Swamp Pool

Refuge: BOMBAY HOOK NWR

Growing Year: 1999

Impound Bottom Elev. 1.0

WCS Invert Elev. 1.2



B. BMH 2--Sheariness Pool

Management in this pool will continue to focus on production of small seeded annuals to provide feeding opportunities for migrating and wintering pintails and green-winged teal. In light of the current less than optimum status of the pintail in North America this approach seems justified. Although we have managed this pool similarly during the past 8 years precipitation conditions have varied enough that each year's growing conditions have not been identical.

Early year water levels will be held relatively high in order to flood the emergent vegetation in the back of the pools and make those areas available to wintering waterfowl. After March levels will be gradually reduced to achieve total drawdown by mid-July. Water levels close to the 1.30 level by mid-May should be desirable for migrating shorebirds. In addition, mud flats created by the total drawdown should once again be attractive to a variety of wading bird species. Stop logs will be replaced by September 1. Emergents will then be reflooded gradually through the end of the year.

C. BMH 3-Finis Pool

During the past 5 years we have attempted an early spring drawdown with reflooding during the late summer. Since we are proposing a summer drawdown for Bear Swamp Pool we plan to maintain relatively high stable water levels this year in Finis. This should provide more woodduck brood habitat as well as providing a diversity of habitats for summer and fall migratory birds, reptiles and amphibians. We will closely monitor any vegetative changes as a result of this proposed regime.

Planned Water Elevations : 1999

Refuge : BOMBAY HOOK NWR
 Impoundment:BMH2 Shearress Pool

Max. Pool Elev.: 4.0
 WCS Drain Elev : -3.0
 Ave. Pool Bottom: 1.3

Past Year 1998			Program Year 1999	
Water Elev.		Salinity	Planned Elev.	
01/01/98	1.6	2.0	01/01/99	1.8
01/15/98	1.5		01/15/99	1.7
02/01/98	2.4	2.0	02/01/99	1.6
02/15/98	2.6		02/15/99	1.6
03/01/98	2.8		03/01/99	1.6
03/15/98	3.0		03/15/99	1.6
04/01/98	1.9		04/01/99	1.6
04/15/98	1.9		04/15/99	1.6
05/01/98	1.3		05/01/99	1.5
05/15/98	2.1		05/15/99	1.3
06/01/98	1.7		06/01/99	1.3
06/15/98	1.2		06/15/99	1.1
07/01/98	0.3	2.0	07/01/99	0.9
07/15/98	0.0		07/15/99	0.5
08/01/98	0.0		08/01/99	0.4
08/15/98	0.0	1.0	08/15/99	0.3
09/01/98	0.2		09/01/99	0.3
09/15/98	0.3		09/15/99	0.7
10/01/98	0.2	5.0	10/01/99	0.8
10/15/98	0.2		10/15/99	0.9
11/01/98	0.8		11/01/99	1.0
11/15/98	0.9		11/15/99	1.1
12/01/98	0.6		12/01/99	1.2
12/15/98	0.9		12/15/99	1.3
01/01/99		5.0	01/01/00	1.4
01/15/99	1.2			
02/01/99				
02/15/99				
03/01/99				
03/15/99				

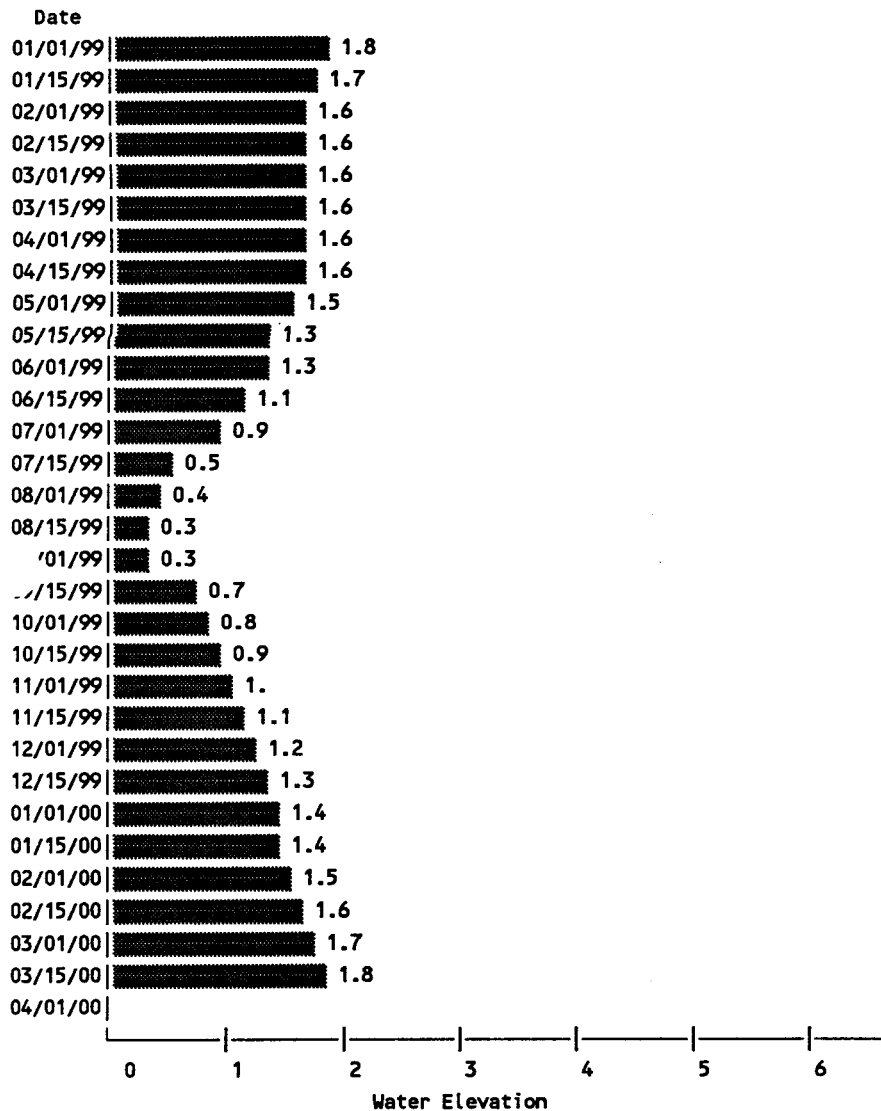
Projected Annual Water Levels : Shearress Pool

Refuge: BOMBAY HOOK NWR

Growing Year: 1999

Impound Bottom Elev. 1.3

WCS Invert Elev. -3.0



Planned Water Elevations : 1999

Refuge : BOMBAY HOOK NWR
 Impoundment:BMH3 Finis Pool

Max. Pool Elev.: 6.2
 WCS Drain Elev : 1.2
 Ave. Pool Bottom: 2.5

Past Year 1998			Program Year 1999	
Water Elev.	Salinity		Planned Elev.	

01/01/98	5.3	0.0	01/01/99	5.8
01/15/98	5.4		01/15/99	5.8
02/01/98	5.8	0.0	02/01/99	5.8
02/15/98	5.5		02/15/99	5.8
03/01/98	5.7		03/01/99	5.8
03/15/98	5.9		03/15/99	5.8
04/01/98	5.3		04/01/99	5.7
04/15/98	5.3		04/15/99	5.7
05/01/98	4.9		05/01/99	5.6
05/15/98	5.6		05/15/99	5.6
06/01/98	4.3		06/01/99	5.5
06/15/98	4.1		06/15/99	5.5
07/01/98	4.4	0.0	07/01/99	5.4
07/15/98	4.3		07/15/99	5.4
08/01/98	4.2		08/01/99	5.5
08/15/98		0.0	08/15/99	5.6
09/01/98	5.0		09/01/99	5.6
09/15/98	4.9		09/15/99	5.6
10/01/98	4.3	0.0	10/01/99	5.6
10/15/98	4.5		10/15/99	5.6
11/01/98	4.3		11/01/99	5.6
11/15/98	4.4		11/15/99	5.6
12/01/98	4.3		12/01/99	5.6
12/15/98	4.4		12/15/99	5.6
01/01/99		0.0	01/01/00	5.6
01/15/99	5.1			
02/01/99				
02/15/99				
03/01/99				
03/15/99				

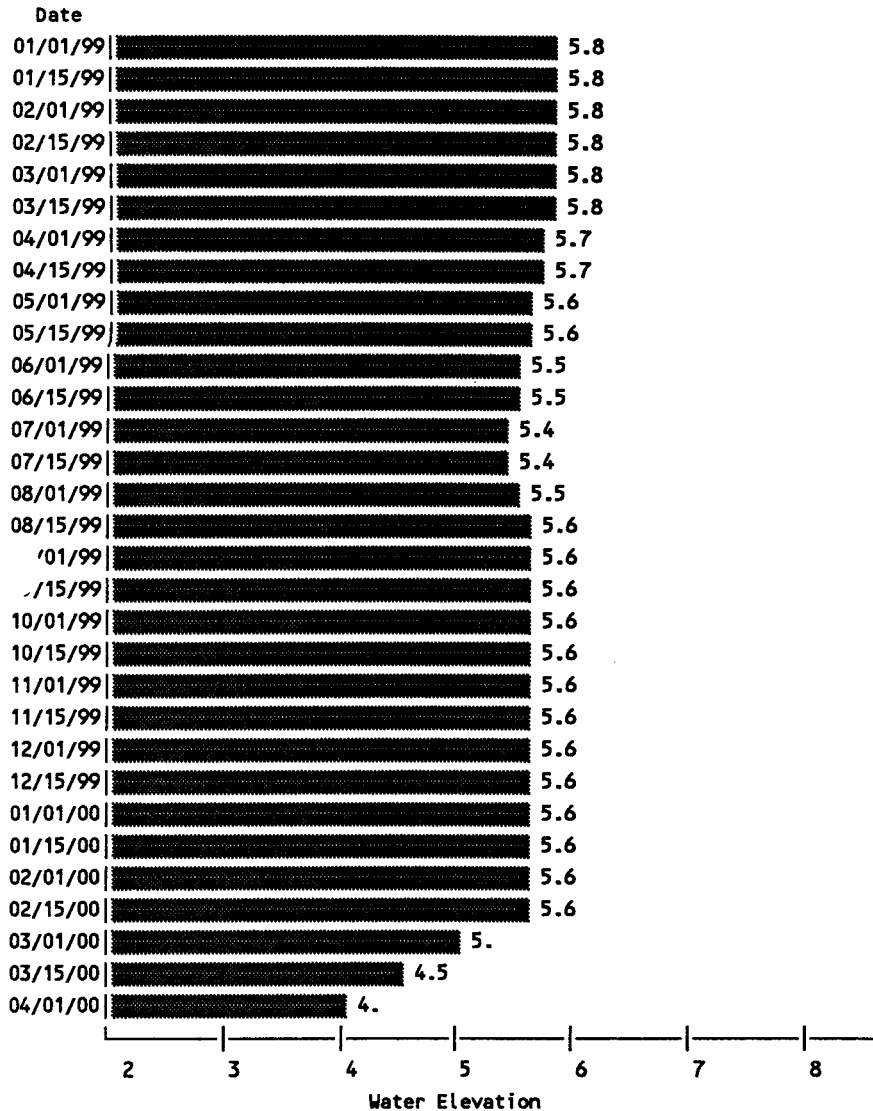
Projected Annual Water Levels : Finis Pool

Refuge: BOMBAY HOOK NWR

Growing Year: 1999

Impound Bottom Elev. 2.5

WCS Invert Elev. 1.2



D. BMH4-Raymond Pool

This impoundment has the flattest topography of the four major pools and it is difficult to maintain shallow water levels at a specific objective level for a specific period of time. Evaporation during the warmer months can quickly turn a shallow water area into a mud flat. Once lost, water is hard to come by during the summer months. However, we will attempt to duplicate the hydrologic conditions of most of 1998 to the extent possible and also maintain shallow water habitat during the late summer and fall.

Water levels of 2.00 or greater will be sought from January to mid-March since this level floods the upper reaches of the pool's coves which traditionally grow some of the best emergent vegetation. As the northward shorebird migration begins in late April or early May we will begin a very gradual drawdown or allow evaporation to expose some mudflats around the perimeter of the pool. Each week during May we will ideally drop the water levels approximately 2 inches. This will expose new mudflats around the perimeter. We will continue dropping water levels about 2 inches a week until the migration is finished (early June). During the middle of June the water control structure will be closed off to begin catching and holding any water from summer rainstorms or any excess water from Shearneck. If water levels are sufficient a gradual drawdown of the pool during late July-August would occur similar to the spring drawdown. The key is to constantly expose the new mudflats during the migration, and have the majority of the water average less than 4" deep. This regime should also favor spikerush growth which is eagerly sought by early arriving teal.

E. Moist Soil Units BMH 5-222

These units will be managed primarily to provide alternative wetland habitats for migratory water birds during the winter and spring period. Units BMH 7, 14, and 15 are the only small units containing water control structures which have shown the capability of holding significant amounts of water through the growing season during a normal year. Further, these units contain soils which are adequate to hold water once reflooded. In an effort to provide more annual seed producing plants around the pool fringes we will attempt partial drawdowns on these units during the spring. Water levels in BMH7 and BMH 14 will be lowered enough to expose approximately 50% of the pool bottom beginning in mid June. BMH 15 will be de-watered beginning in early April. Each area should be attractive to wading birds during the drawdown and the resultant emergent fringe of annuals should be

Planned Water Elevations : 1999

Refuge : BOMBAY HOOK NWR
 Impoundment:BMH4 Raymond Pool

Max. Pool Elev.: 4.0
 WCS Drain Elev : -3.0
 Ave. Pool Bottom: 1.0

Past Year 1998			Program Year 1999	
Water Elev.		Salinity	Planned Elev.	
<hr/>				
01/01/98	1.0	3.0	01/01/99	1.4
01/15/98	1.2		01/15/99	1.5
02/01/98	1.7	10.0	02/01/99	1.6
02/15/98	1.6		02/15/99	1.6
03/01/98	1.8		03/01/99	1.5
03/15/98	1.9		03/15/99	1.4
04/01/98	1.2		04/01/99	1.4
04/15/98	1.2		04/15/99	1.3
05/01/98	0.9		05/01/99	1.2
05/15/98	1.7		05/15/99	1.0
06/01/98	1.0		06/01/99	1.0
06/15/98	1.2		06/15/99	1.0
07/01/98	1.0	6.0	07/01/99	1.1
07/15/98	0.9		07/15/99	1.1
08/01/98	0.7		08/01/99	1.0
08/15/98		1.0	08/15/99	1.0
09/01/98	1.0		09/01/99	1.1
09/15/98	0.8		09/15/99	1.2
10/01/98	0.3	9.0	10/01/99	1.2
10/15/98	0.6		10/15/99	1.4
11/01/98	0.3		11/01/99	1.4
11/15/98	0.4		11/15/99	1.4
12/01/98	0.2		12/01/99	1.5
12/15/98	0.8		12/15/99	1.6
01/01/99		4.0	01/01/00	1.7
01/15/99	0.8			
02/01/99				
02/15/99				
03/01/99				
03/15/99				

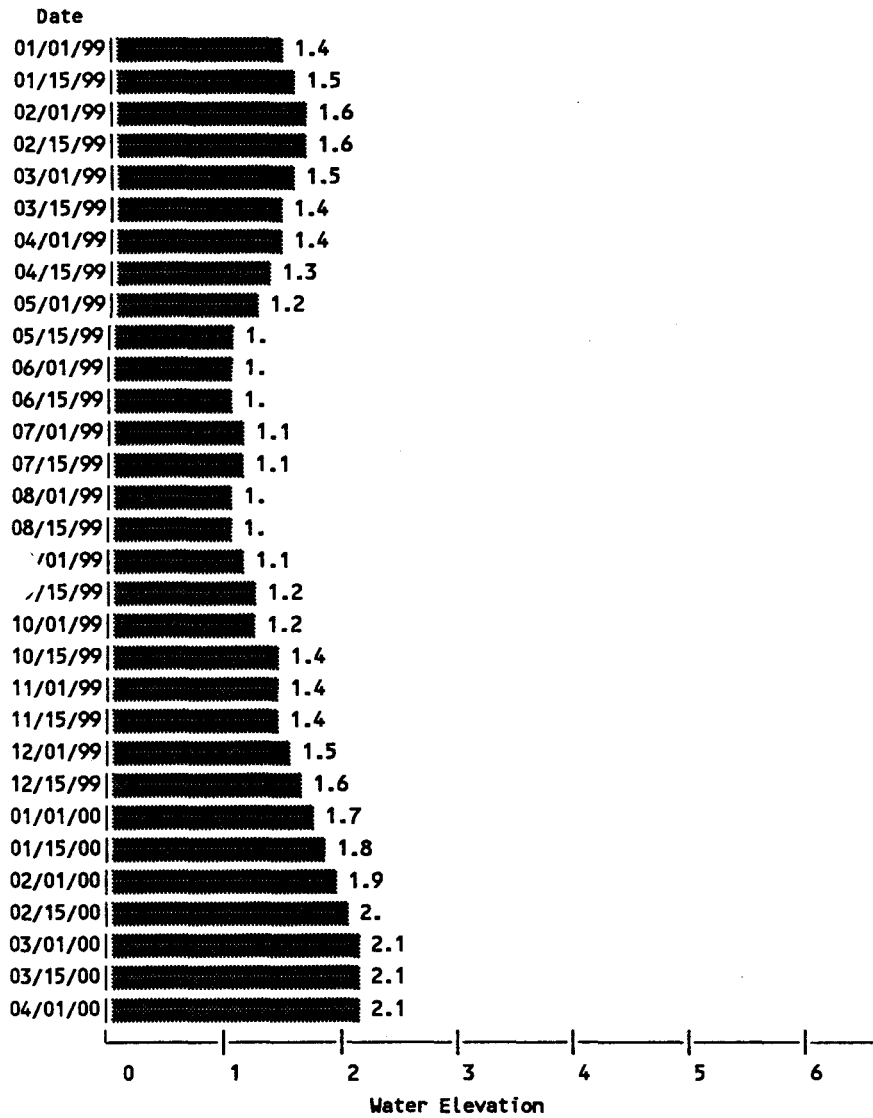
Projected Annual Water Levels : Raymond Pool

Refuge: BOMBAY HOOK NWR

Growing Year: 1999

Impound Bottom Elev. 1.0

WCS Invert Elev. -3.0



excellent food for wintering waterfowl. Water levels will be raised during the fall as water becomes available. All other units will be monitored and if needed will be disced during the summer to promote annuals. The portable and submersible pumps will be used if necessary to achieve desirable water levels in BMH5 & 6.

F. Tidal Marsh

No active management other than snow goose hunting and prescribed burning will be conducted within the saltmarsh.

Monitoring of passerine birds via point counts within the saltmarsh will be continued.