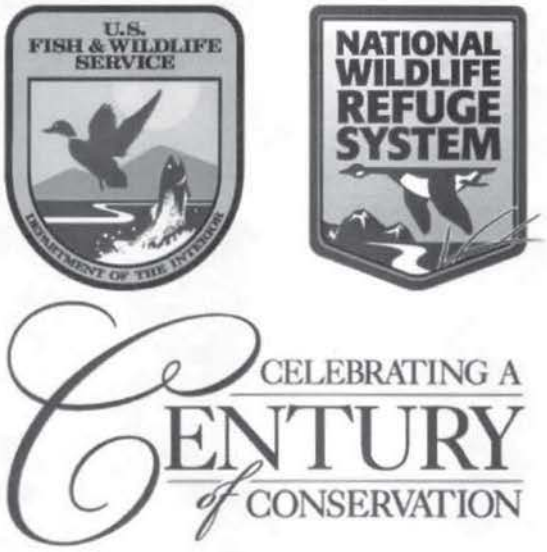
Prime Hook National Wildlife Refuge

11978 Turkle Pond Road
Milton, DE 19968



ANNUAL MARSH AND WATER LEVEL MANAGEMENT PROGRAM

2003

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Annual Marsh and Water Management Program CY 2003
PRIME HOOK NATIONAL WILDLIFE REFUGE

SECTION I. INTRODUCTION

This program describes the results of 2002's marsh and water level management actions and summarizes the planned strategies for calender year (CY) 2003. Moist-soil management techniques as developed by Fredrickson and Taylor (1982) are the foundation for developing the refuge's marsh and annual water level management planning and performance evaluations. The most effective application of moist-soil management involves an interplay of several impounded areas, each with the capability of independent operation. Strategies for integrating habitat and wildlife management on Prime Hook's mosaic of freshwater impoundments, which are nestled between salt marsh habitats, are used to attract and feed waterfowl, shorebirds, and other wetland dependent birds very successfully.

Refuge personnel use water level manipulations and moist-soil management techniques that produce diverse habitat conditions annually. The fundamental goal of this program is to increase the foraging carrying capacity of the refuge's wetland habitats. Prime Hook's Annual Marsh and Water Management Program has two specific operating goals: 1.) to produce reliable plant and animal food resources each year and 2.) to make areas that contain these food resources **available** to wetland migratory birds. These goals are accomplished by manipulating water levels within the refuge's impounded management units at critical times throughout the year.

Annual food resources produced on the refuge each year consist mainly of moist-soil vegetation like wild millet, beggar's ticks, sprangletop, panic grasses, smartweeds, and chufa. "Naturally occurring annual seed production provide excellent waterfowl foods and have higher nutritive qualities than farmed cereal grains. The total energy in moist-soil foods often is as high as or higher than corn, milo, or soybeans." (Fredrickson-1982)

In addition to annual plant foods, short-cycle invertebrates like chironomids, corixids, plus reptiles and amphibians regularly occur in freshwater and brackish impoundment management units. These animals are also very important components of migratory bird management areas and serve as key prey species supplying critical protein sources for waterfowl, shorebirds, wading birds and raptors. In contrast, invertebrates and cold-blooded vertebrates are non-existent in intensively farmed areas. The presence of high invertebrate densities provide superior habitats for diverse populations of waterfowl and shorebirds. Prioritized bird guilds targeted by marsh management actions include migrating and wintering waterfowl, breeding and migrating shorebirds and wading birds, as suggested by refuge enabling legislature and strategic regional resource planning studies. Other wetland dependent bird species and wildlife also benefit.

Water is the chief driver for annual production of food resources within the refuge's wetland complex. Water levels govern the timing, seasonal growth and annual succession of wetland plants and associated invertebrate communities. Marsh management by means of dynamic water level manipulations provide annual dependability and availability of wetland resources (food & cover) for migratory bird exploitation that best serves their breeding, migrating and wintering life cycle needs.

Asynchronous drawdowns between marsh management units are conducted each year to maximize habitat heterogeneity and increase wetland foraging carrying capacity. Slow draw-down rates are most often used because they create environmental conditions that improve root development of annual wetland plants and maximize annual seed production and invertebrate availablilty for shorebird and waterfowl consumption. Dynamic drawdown and reflooding schedules are used to manage 4,200 acres of impounded marshes that include: Unit II - 1,500 acres; Unit III - 2,500 acres; and Unit IV - 200 acres. (See Figure I - Refuge Water Level Management Map in appendix). Contrasting hydrological regimes are timed to vary from impoundment to impoundment and from year to year, generating dynamic water regimes, in an effort to create diverse biological and habitat conditions.

HIGHLIGHTS

Marsh Habitat Conditions. Estimates of seed production are used to assess annual carrying capacity of waterfowl forage and evaluation of wetland management actions. Good to excellent moist-soil habitat conditions were measured this year, resulting in a high percentage of desirable annual vegetation with excellent seed yields recorded. Chief moist-soil crops produced in CY 2002 included barnyard grass (*Echinochloa walteri)*, giant foxtail (*Setaria magna)*, and chufa (*Cyperus esculentus)*. Average seed yields in each of the management units included 1,673 lbs/acre in Unit II; 1,629 lbs/acre in Unit III; and 977 lbs/acre of annual seed production in Unit IV. These food resources translated into excellent waterfowl use of the refuge's marshes summarized as follows:

Month	Peak Duck Populations	Snow Geese	Canada Geese
Oct	67,483	30,710	5,296
Nov	36,414	94,240	6,995
Dec	16,990	13,760	12,976
Jan	3,842	28,210	13,695

Region 5 Shorebird Study Project. Prime Hook NWR participated in this regional project by collecting year three data during CY 2002, using standardized protocols for the **"Shorebird Use of Impounded Wetlands within USFWS Region 5 Study."** The purpose of this endeavor was to identify refuge specific contributions and management potential within the regional landscape for spring migrating shorebirds. Results from this study will determine 1.) if there are geographic differences in shorebird use of managed wetlands at NWRs within Region 5, and 2.) if specific NWR management actions can influence the use of impoundments by shorebirds. Results will be used to establish strategic regional planning objectives for shorebird management. Data collected during the 2002 field season included shorebird census and activity surveys, water column and benthic invertebrate sampling, vegetation surveys and water depth topography at two study site locations in Units III and IV. Collection of 2002 data concluded the refuge's participation in this shorebird regional study which only examined aspects of the spring migration.

Regional Open Marsh and Water Management (OMWM) Study. Prime Hook also participated in a comprehensive regional OMWM study. The objective of this study is to evaluate salt

marshes that have undergone OMWM construction and establish the fundamentals of a consistent and standardized long-term salt marsh monitoring program for refuges in Region 5. Data collection during 2002 included physical parameters to monitor hydrology (biweekly water table levels), and ecological factors to evaluate vegetation (species composition, density, and soil salinity), bird use (of waterbirds and salt marsh passerines), nekton (species composition and density of fish and decapods), and mosquito production (larval counts). This study is essential to support and update a regional guidance document on **"Marsh Management for Mosquito Control"** that has been recently adopted by Region 5 (Taylor 1998). Standardized, quantitative data are needed to confirm if OMWM effectively restores marsh hydrology, significantly enhances fish and wildlife functions, and controls salt marsh mosquito production. Based on the final results of this study, the practice of OMWM may be unconditionally supported or other more appropriate marsh management alternatives may be recommended.

Integrated Wetland Management Study for Shorebirds and Wintering Waterfowl on R5 NWRs. The refuge also participated in this regional study during the fall and winter of 2000 and 2001 seasons. The objectives of the study were 1.) to evaluate the impacts of drawdowns on vegetative composition, seed production, invertebrates, and waterbird use and 2.) develop management recommendations for wetlands that will maximize benefits for nonbreeding waterbirds. Researchers (Anderson & Osbourne 2002) analyzed field data collected from 17 NWRs and they concluded that shorebird management is compatible with wintering waterfowl management. They verified that **slow drawdowns**, when properly conducted, provide a greater capacity for increasing potential carrying capacity than **fast drawdowns**. Wintering waterfowl use was shown to be enhanced through slow drawdowns timed specifically for spring migrating shorebirds. Based on field-data analysis it was recommended that R5 refuges should **emphasize** targeting nonbreeding waterfowl over breeding waterfowl based on food resource production estimates.

Study results also showed that seed production was 1.5 times greater and benthic invertebrate biomass 5 times higher in areas sustaining slow drawdown rates, supplying further evidence that shorebird management is compatible with wintering waterbird management and that slow drawdowns timed specifically for spring migrating shorebirds have no adverse impacts on wintering waterbird carry capacity and may actually increase it. Additional results concerning vegetation responses to water management, concluded that plant composition may be influenced by salinity but over-all carrying capacity was not affected by salinity, as several annual moist-soil seed producers are relatively salt tolerant. Anderson and Osborne (2002) empirically showed that water regimes directly influences the seed bank and is a much greater influence on carrying capacity than salinity. Over-all researchers concluded that water management practices targeting spring migrating shorebirds had no short-term detrimental effects and generally are beneficial to wintering waterbirds. It was also concluded that if the appropriate monitoring is conducted and an adaptive management approach is used, both spring migrating shorebirds and wintering waterfowl can be managed simultaneously. However, it was also recommended that an impoundment should only be subjected to a slow drawdown during shorebird migration every other year. (Anderson & Osborne 2002)

Refining Water Level Management in Units III and IV. FY 2001 funding of $64K was used for the rehabilitation of two water control structures in Unit IV and replacing two dysfunctional culverts and a gut plug that connected Management Units III and IV underneath Broadkill Beach Road. The funds were transferred to Ducks Unlimited to plan, design and execute repairs. Replacement culverts will be constructed with screw gates and stoplog bays to refine water level management between PMH3D and PMH4A. The project was not completed during 2002 and hopefully will be finished in 2003. Currently, leaking water control structures do not allow us to hold water levels in the Unit IV impoundment during drier weather conditions.

A. BRIEF HISTORY OF REFUGE MARSH AND WATER LEVEL MANAGEMENT

Prime Hook National Wildlife Refuge was established under the authority of the Migratory Bird Conservation Act in 1963 to preserve marsh habitat for migrating and wintering waterfowl in the Atlantic Flyway. It was also set aside to preserve coastal wetlands along the Delaware Bay that were historically of high value to waterfowl by protecting them from commercial and urban development. Since its formal establishment in 1963, the refuge has never undergone any master planning process to date. Subsequently, there is no refuge master plan or any other comprehensive management plan in place. As of this writing, the refuge is scheduled for a CCP start in 2003.

A long history of acquisition problems dating from 1963 led to approximately 16 % of refuge lands (1,456 acres) being acquired via "condemnation." To this date a series of isolated access problems and unresolved "Rights of Way" issues have hampered management capabilities in many areas of the refuge. The establishment of water management capability at Prime Hook was a slow and painful process due to public misconceptions and opposition. (See Refuge Narrative Reports from 1963 to 1980) This era can be defined as a period of "NO MANAGEMENT" for the refuge. Prior to its establishment, Prime Hook's marshes were extremely manipulated and disturbed, as the result of several anthropocentric activities which included massive grid-ditching for mosquito control, flooding and draining wetlands by multiple land owners, intensive farming and grazing of salt hay (*Spartina patens*) by cattle.

The consequence of "No Management" actions from 1963 to 1980 on Prime Hook's wetland complex, was the enhancement of a severe *Phragmites* expansion problem. Cumulative encroachment resulted in monotypic stands covering 4,000 acres of refuge habitats. Major marsh restoration planning and implementing actions started in 1980. Prime Hook's water-level control infrastructure (dikes, water control structures, etc.) that today provides water level management capability on 4,200 acres of marsh, was initiated in 1980 and completed in 1987.

Unit IV was the first management unit completed on February, 1981 with two small structures impounding 200 acres. Unit III was completed next in 1984, with two large water control structures (one at Petersfield containing 9 bays and one at Prime Hook Creek with 5 bays) plus a mile long dike which impounds 2,500 acres of marsh. Unit II was on line in 1987, with one large

water control structure containing 11 bays built across Slaughter Canal that provides water level management capability on 1,500 acres of wetlands. Interim water management plans were written for Management Units II and III as part of respective Environmental Assessments. Later, a refuge-wide marsh and water plan was written in 1986. However, it must be noted that this current marsh and water management program report for CY 2003 does not invoke its management goals and operating objectives due to the fact that the 1986 plan is very outdated and espouses the concept of maintaining **"stable"** water levels, as a "modus operandi" to manage Prime Hook's marshes.

Wetland management practices that stabilize water depths and fluctuations across wetland complexes generate poor food resources and do not make natural food items available for waterfowl and shorebird exploitation. Since 1993 the refuge has also incorporated integrated wetland management practices by proactively managing for both spring migrant shorebirds and wintering waterfowl each season. Shorebird management strategies for spring migrants consists of creating mudflats or shallow water depths (mud to 10 cm) and concentrating invertebrates by conducting slow drawdowns during the periods in which shorebirds are most abundant (last 2 weeks of May). These created mudflat areas for shorebirds also promote excellent germination of annual moist-soil plants that are made available to wintering waterfowl, by reflooding at the appropriate water levels for exploitation by ducks and geese.

Upon completion of a CCP, an updated Marsh and Water Level Management Plan rewrite, as part of a subsequent "step-down" Habitat Management Plan for the refuge, will be used to develop an Annual Habitat Management Work Plans. The current annual water level and marsh management program incorporates the latest conservation biology principles, Service biological integrity, diversity, and environmental health guidelines, and moist-soil management science and techniques as per Fredrickson (1991) and Hamiliton and Laubhan (1997).

B. CURRENT MARSH AND WATER LEVEL MANAGEMENT PRACTICES

As previously stated the primary purpose of the refuge's annual marsh and water level management program is to increase the foraging carrying capacity of Prime Hook's marshes, in an effort to provide reliable resting habitat and high quality food resources for migratory birds. The concept of wetland foraging carrying capacity usually incorporates the quantity and quality of annual plant production in the form of seed yields of moist-soil vegetation and aquatic invertebrate densities for animal foods, that are produced each year in response to water level manipulations. (Reinecke et al 1989 and Anderson and Smith - 1998)

Moist-soil management science has been described by Fredrickson and Taylor (1982). Water level management is practiced each year with the goal of maximizing annual moist-soil vegetation. This is primarily accomplished by lowering water levels in the spring and summer to expose the natural marsh seed bank to stimulate germination, and set back succession with soil disturbances thereby increasing plant productivity and diversity. Moist-soil management techniques have several advantages: 1.) the consistent production of foods across the years with

varying water availability, 2.) low management input costs, 3.) high tolerance to extreme environmental conditions and weather variances, and 4.) very low deterioration rates of moist-soil plant seeds after flooding. (Lauban and Fredrickson-J. Wildl. Manage. 1992)

Specifically timed water level manipulations are used to enhance the annual production of diverse plant and animal resources by scheduling dynamic hydrological regimes between all 3 impounded marshes. Annually produced resources include the following predominant plant and animal food types: seeds, tubers, browse, chironomid larvae, corixids, and hydrophilids that are consumed by migrating and wintering waterfowl, migrating and breeding shorebirds and wading birds each year. These food resources would not be produced if stable water levels were maintained from year to year.

An integrated wetland management approach is also used to treat several subunits of impounded marsh as a cluster of smaller and varied microhabitat types to create greater habitat heterogeneity. Diverse and assorted clusters of smaller marsh areas instead of one large homogenous wetland is more efficient in preserving bird species and maximizes migratory bird use (Brown & Dinsmore 1986). The annual creation of mutable habitat heterogeneity is accomplished by staggering slow drawdowns between management units and then timing reflooding events asynchronously within and between impoundments.

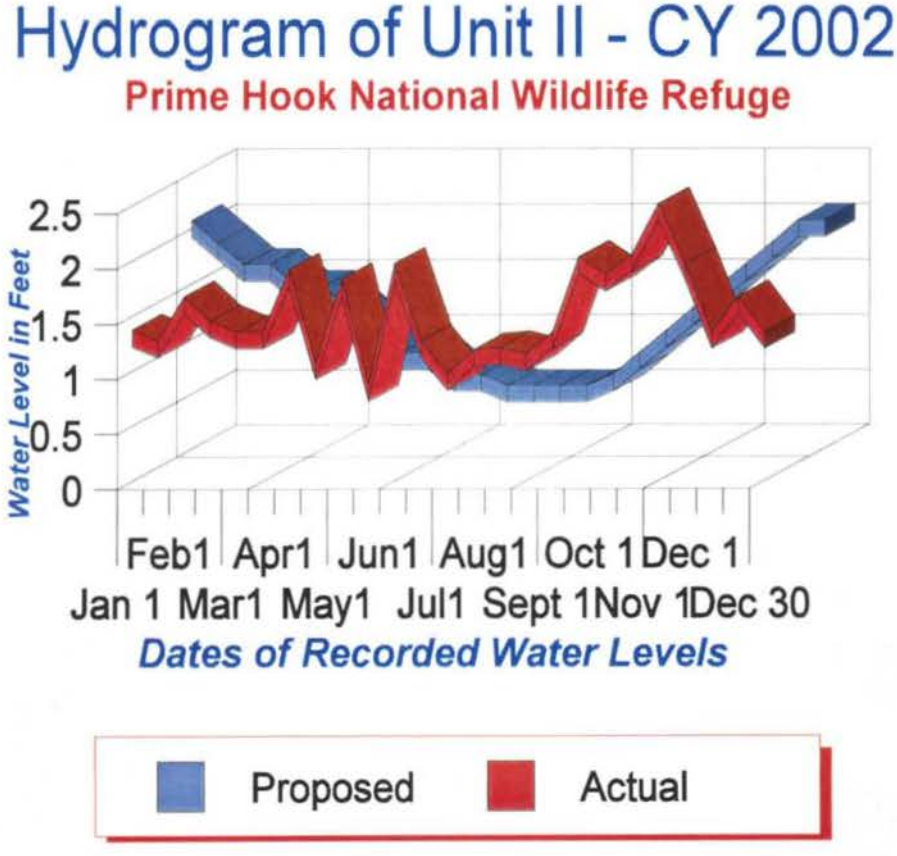
The wetland management science and techniques used to achieve habitat heterogeneity and maximize forage carrying capacity on refuge are the moist-soil science principles as developed by Leigh H. Fredrickson, University of Missouri (1991) and Fredrickson and Taylor (1982). Annual marsh management program practices are premised on the idea that dynamic water depths and fluctuations across Prime Hook's wetland complex will enhance natural food production and optimize migrating and wintering migratory bird use. Foremost in the refuge's water level management scheme is the avoidance of maintaining **stable water levels** across the marsh.

Prescription water levels are defined each year to help achieve the key operational goals of the annual marsh management program. Seasonally targeted water levels are designed each year to maintain and enhance freshwater wetland ecosystems, set back plant succession to earlier seral stages, and reduce rank emergent perennial vegetation by increasing interspersion with water to emulate hemimarsh conditions. At the start of each calender year the refuge's water management program is designed as a flexible annual work plan and is not to be taken as an unalterable and absolute commitment of proposed water levels projected for that year. An adaptive management philosophy is incorporated in the implementation of the annual work plan, designed to support "mid-course corrections" as new information (weather extremes, biological needs, maintenance or repairs requirements, wildlife responses, mosquito control activities) becomes available. Once the annual program is written and approved, the adaptive management process includes: 1.) acting to maintain proposed water levels, 2.) reacting to weather patterns, monitoring biological responses and evaluating actions on a weekly, monthly, seasonally, and annual basis and making adjustments as needed.

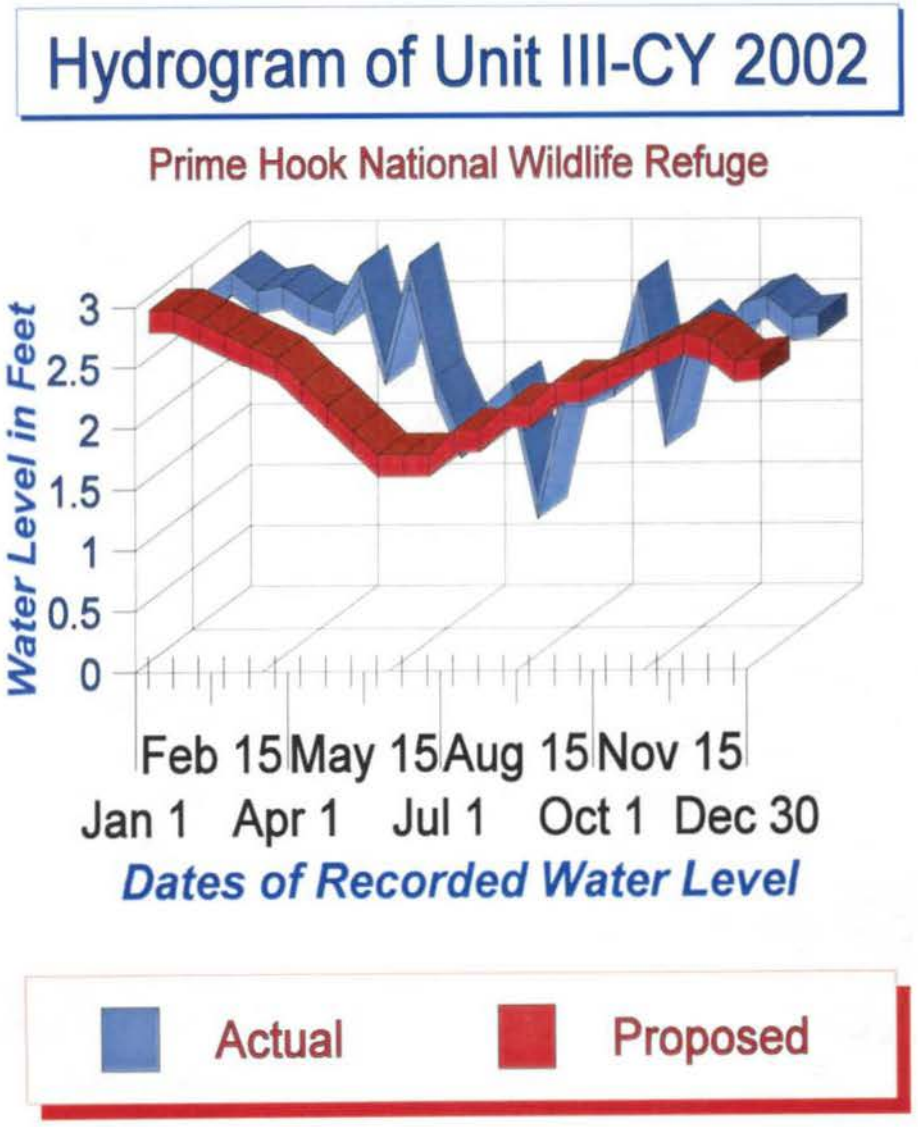
The next section of this report is a summary of the water levels experienced by each impounded management unit. A description of the hydrology created following 2002's drawdown/reflood schedules plus rainfall inputs are all depicted in respective water level management unit hydrograms. Remaining sections report on the resulting vegetative responses to this year's water regimes and subsequent wildlife use of created moist-soil habitats and salt marsh conditions.

SECTION II. Hydrological Regimes and Water Salinities Recorded During 2002 and Planned Water Levels for Program Year 2003.

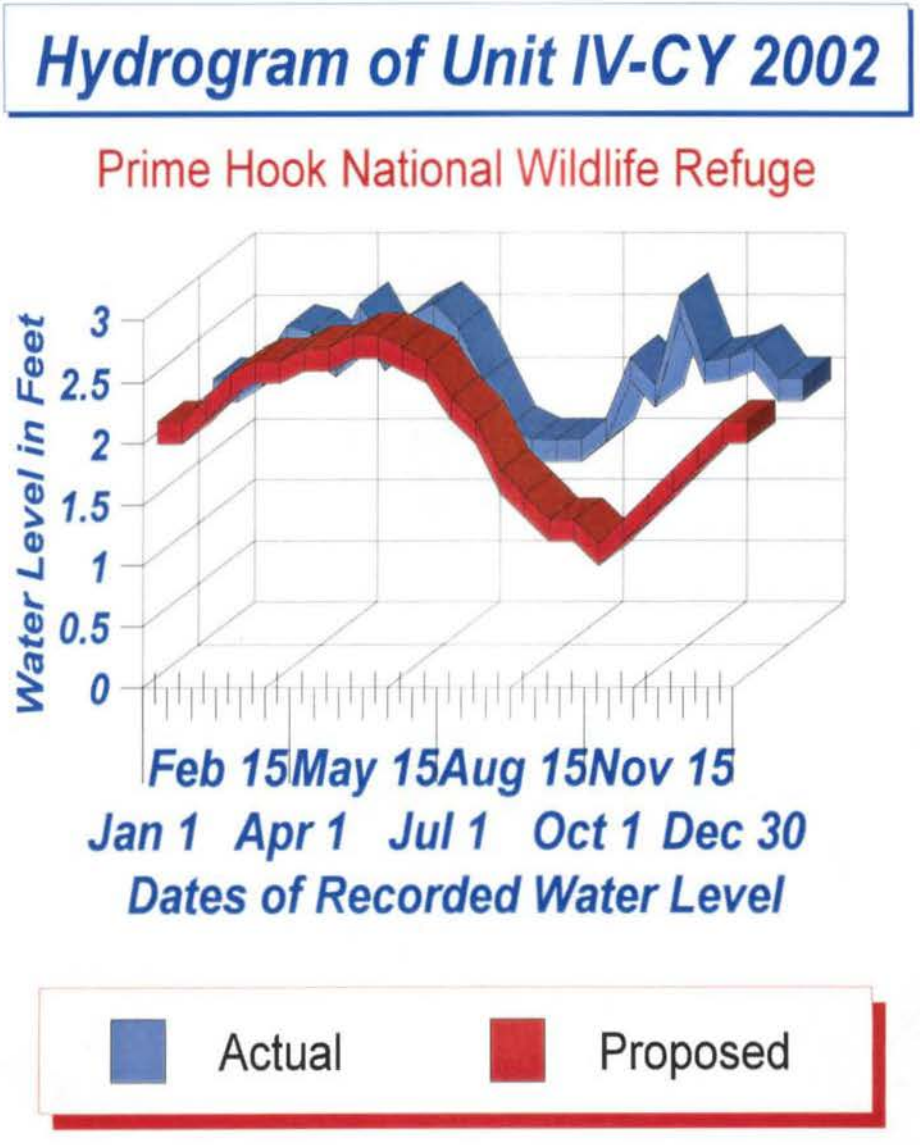
Unit II. Above normal precipitation and several untimely rain events made it difficult to manage proposed water levels. A slow drawdown was initiated on 02/01/02 and moist soil conditions were achieved on 05/15/02 in PMH2A and on 06/15/02 in PMH2B and PMH2C. (See Figure 1.) The hydrogram of Unit II shows the three sharp peaks in early spring and two peaks in late fall which reflect heavy rain events that demanded daily stop-log adjustments to draw off excessive water from the marsh. Water salinities ranged from 0 to 26 ppt. Higher salinities were recorded during the late summer and early fall when draught weather conditions and below normal rainfall during June, July and August increased water salinity readings. Reflooding was initiated on 09/01/02. (See the Unit-II Hydrogram below and Table (1.) in Section III Part B of this report for water level and salinity data recorded in 2002 plus proposed water levels for CY 2003.)



Unit III. High water levels were supposed to be maintained until 04/01/02 when a slow drawdown was initiated. However two heavy rain events in the 1st and 3rd weeks of April made it difficult to maintain prescription levels. Several log adjustments were made to compensate for above normal spring rainfall. Moist-soil conditions were achieved by 07/15/02 in part of the unit and completed by 08/01/02. Salinities ranged from 0 to 18 ppt throughtout the year. Reflooding was started on 10/15/02 and 3/4 full pool levels were achieved by 12/30/02. (See the Unit III Hydrogram below and Table (2.) for salinity data and proposed water levels for CY 2003.)



Unit IV. High water levels were planned to be maintained until 06/15/02. The Project Leader wanted water levels lowered for culvert repairs, contrary to proposed levels. Water levels were lowered for 2 weeks in March (3/01/02 to 03/15/02) and again in April (04/01/02 to 04/15/02) for culvert work. However, culvert work never occurred. Water levels were then restored to planned levels by May 10th. A rapid drawdown on 06/15/02 and moist soil conditions were achieved 30 days later. Water salinities ranged from 0 to 22 ppt. Reflooding was initiated on 11/01/02. (See Unit IV Hydrogram below and Table (3.) - Section III, Part B of this report for tabulated water level and salinity data for CY 2002 and proposed levels for 2003.)



SECTION III. Effects of past Year's Water Levels (CY2002) on the Ecology of the Refuge's Wetland Management Units

Annual rainfall ultimately determines marsh water conditions and actual surface water levels within the impoundments during the year and when moist-soil conditions are achieved. Rainfall patterns coupled with drawdown schedules influence the spring and summer growing conditions that determine annual vegetation responses. Plant food resources produced each year represent either pure stands of annuals, a mix of annuals and perennials, or predominantly perennial stands.

Vegetation Monitoring. Plant composition (% cover) and frequency of occurrence of various plant species within impounded wetlands were measured and analyzed using the regional VEG-DATA computer program. Management Units have been subdivided into smaller subunits for monitoring purposes since 1993. The subsequent subunit designations are as follows: Unit II - PMH2A (223 acres), PMH2B (523 acres), PMH2C (530 acres); Unit III - PMH3A (291 acres), PMH3B (479 acres), PMH3C (500 acres), PMH3D (620 acres); Unit IV - PMH4A (168 acres). (See Figure 1) Above-ground biomass was also estimated for dominant annual moist-soil plants produced this year. These seed yield estimates serve as a means of estimating the level of annual seed food production within impounded subunits and the rate of succession. Measuring annual moist-soil plants and calculating seed yields also provides a method of monitoring the response of wetland plants to water level manipulations, and assessing the potential plant food base available for wildlife. Phytomorphological measurements and multiple regression techniques incorporated in a seed yield database program developed by Laubhan and Fredrickson (USFWS-1992) make these estimates possible with minimal time during the course of routine annual plant surveys of marsh vegetation.

Water Level Management Results: Moist-Soil Vegetation Seed Production Estimates & Drawdown Schedules - Data in pounds/acres.

SUBUNIT	1993	1999	2002
PMH2A	491	962	1643
PMH2C	1166	483	1703
PMH3A	930	1159	1798
PMH3B	891	667	1273
PMH3D	987	596	1817
PMH4A	431	448	977
UNIT II	Mid-March	Mid-April	Mid-February
UNIT III	Mid-April	Mid-July	Early- April
UNIT IV	Early-April	Mid-May	Mid-June

A. REPORT OF EFFORTS ON CONTROLLED WATER MANAGEMENT, ANNUAL BIOLOGICAL CONDITIONS CREATED AND WILDLIFE USE

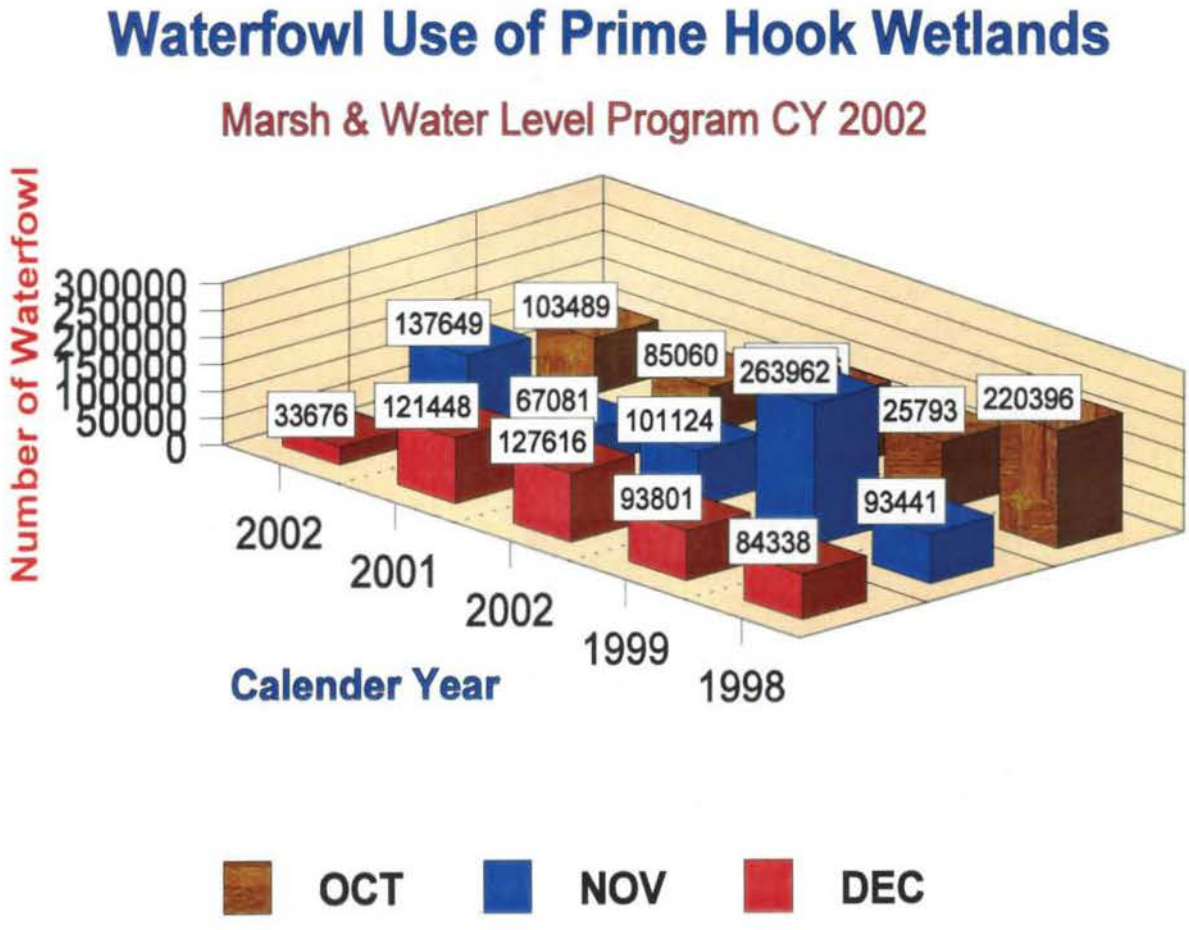
1.) **WEATHER.** Extremes defined the rainfall patterns experienced during 2002. Over-all a very wet spring and very wet fall resulted in doubling the work and efforts in manipulating stop logs and screw gates to maintain water depths at prescription levels. The year started out with below normal precipitation during the first three months of the year. A total 1.5 inches of snow was recorded in Jan/Feb., one of the lowest totals in recent years. Then, in March, April and May, several Northeaster rain events resulted in above average rainfall which delayed corn planting, followed by high winds and 55 % below normal precipitation for June, July and August, which created severe drying conditions of the marsh. From September until December, above normal rainfall finally accounted for an over-all wet year with an annual rainfall of 49.59 inches. (See weather data table below)

Weather Data at Prime Hook NWR CY 2002 Monthly and Cumulative Rainfall (Data Collection began 1965 to present) Temp = °F & Rain = inches.						
Month	**1965-Pres**	**Hist/CUM**	**CY 2002**	**2002Cum**	**Temp-Hi**	**Tem-Low**
JAN	2.88	2.88	3.02	3.02	75.2	17.6
FEB	3.52	6.40	0.84	3.86	76.5	20.7
MAR	3.57	9.97	5.23	9.09	76.8	18.0
APR	2.70	12.67	4.04	13.13	90.5	33.3
MAY	2.91	15.58	3.42	16.55	88.0	38.7
JUN	2.90	18.48	1.99	18.54	96.3	52.0
JUL	4.40	22.88	2.20	20.74	97.0	55.2
AUG	6.91	29.79	2.28	23.02	98.4	59.9
SEPT	1.97	31.76	7.95	30.97	90.0	55.9
OCT	3.09	34.85	8.18	39.15	87.8	45.9
NOV	2.62	37.47	6.76	45.91	76.5	31.8
DEC	4.51	41.98	3.68	49.59	64.8	17.6
TOTAL	41.98	XXX	49.59	XXX	XXX	XXX

2.) **REFUGE-WIDE WILDLIFE USE.**

Waterfowl. Aerial waterfowl survey data indicated that peak waterfowl use occurred in November (137,649). These included 94,240 snow geese, 6995 Canada geese, 15,944 green-winged teal, 9,972 Northern pintails, 2,455 American black ducks, and 7,993 (other duck species). Peak duck-use of the refuge marsh complex occurred during the month of October. The highest waterfowl numbers (103,489) recorded for October included 34,622 Northern pintails, 29,440 green-winged teal, 1,375 American black ducks, 2006 (other duck species), 30,710 snow geese and 5,296 Canadas.

Migratory waterfowl were responding to excellent natural food production where average moist-soil seed yields included Unit II-1,673 lb/acre; Unit III-1,629 lb/acre; and Unit IV-977 lb/acre. Waterfowl use in general increased, compared to last year, despite a reduction in the fall flight numbers for ducks and snow geese during 2002. Breeding habitat conditions and waterfowl production significantly decreased during the 2002 breeding season reflected in reduced continental duck abundance. (Waterfowl Population Status Report - 2002 USFWS)



Continental breeding reports and habitat surveys described below average winter and spring precipitation in the prairies and parklands plus cold spring temperatures in the East resulted in poorer habitat conditions for breeding waterfowl compared to 2001. Dry conditions were reflected in the number of ponds counted in 2002. May Pond Surveys were 41% below 2001's estimate and 45 % below the long term average (survey data since 1961).

Winter-like conditions were recorded in the entire pond-survey area in May, when snowstorms and cold temperatures caused birds to halt migration for several weeks. Prolonged, unseasonally cold weather had negative impacts on early nesting species like mallards, Northern pintails, and green-winged teal.

Data from July Production Survey also showed that the number of ponds in Prairie Canada and the north-central US was 36 % below last year's estimate and 33 % below last year's long-term average resulting in very poor brood-rearing conditions. As a result, total duck population estimates were 14 % below last year's estimate and 6 % below the 1955-2001 long-term average. Over-all, gadwalls (-17 %), shovelers (-30 %), and pintails (-46 %) were below 2001 estimates, green-winged teal, redheads, canvasbacks and scaups were unchanged from 2001 estimates.

Pintails were the lowest on record (-58 %) below long-term averages while the mallard fall-flight index was the same as last year. However, the number one duck species using refuge wetland habitats this year were pintails, due to excellent foraging habitat conditions created in CY 2002. (Note Oct., Nov., and Dec., 5-year comparative tables for predominant waterfowl use and species composition of Prime Hook's marsh complex.)

Five Year Comparison of October Waterfowl Use - Species Composition Refuge-wide for Prime Hook National Wildlife Refuge

OCTOBER	2002	2001	2000	1999	1998
Snow geese	30,701	53,500	60,750	82,500	132,500
Canada	5,296	2,223	1,894	2,910	6,684
Pintails	34,662	16,169	21,835	9,263	21,061
GWTE	29,440	8,484	47,995	29,206	53,822
ABDU	1,375	774	1,063	1,095	2,913
Wigeon	421	3,000	234	20	1,365
Other	1,585	9,394	485	799	2,051
TOTALS	103,489	85,060	134,256	125,793	220,396

Five Year Comparison of November Waterfowl Use - Species Composition Refuge-wide for Prime Hook National Wildlife Refuge					
November	**2002**	**2001**	**2000**	**1999**	**1998**
Snow Geese	94,240	47,000	54,500	143,692	70,230
Canada	6,995	7,385	6,247	5,589	8,130
Pintails	9,972	4,160	4,811	6,970	1,669
GWTE	15,994	5,219	30,861	96,592	9,491
ABDU	2,455	1,159	1,272	1,765	2,035
WIGE	37	1,380	1,130	3,510	192
Other	7,956	778	2,303	5,844	1,694
TOTALS	137,649	67,081	101,124	263,962	93,441

Five Year Comparison of November Waterfowl Use - Species Composition Refuge-wide for Prime Hook National Wildlife Refuge					
December	**2002**	**2001**	**2000**	**1999**	**1998**
Snow Geese	13,760	76,840	104,312	63,800	65,900
Canadas	12,926	18,400	8,107	9,293	7,892
Pintails	853	7,650	4,711	960	1,594
GWTE	341	10,334	2,973	11,059	3,326
ABDU	3,062	3,494	2,942	3,243	3,241
WIGE	50	30	504	155	76
Other	2,684	4,700	4,067	5,291	2,309
TOTAL	33,676	121,448	127,616	93,801	84,338

2. <u>REFUGE-WIDE USE: SHOREBIRDS</u>. Refuge marshes provided stopover habitat for a total of 27 species of shorebirds during the year. Shorebird population declines continent-wide emphasize the importance in providing alternative stop-over food and habitat resources within refuge impoundments in addition to the staging areas along the Delaware Bay. Specific

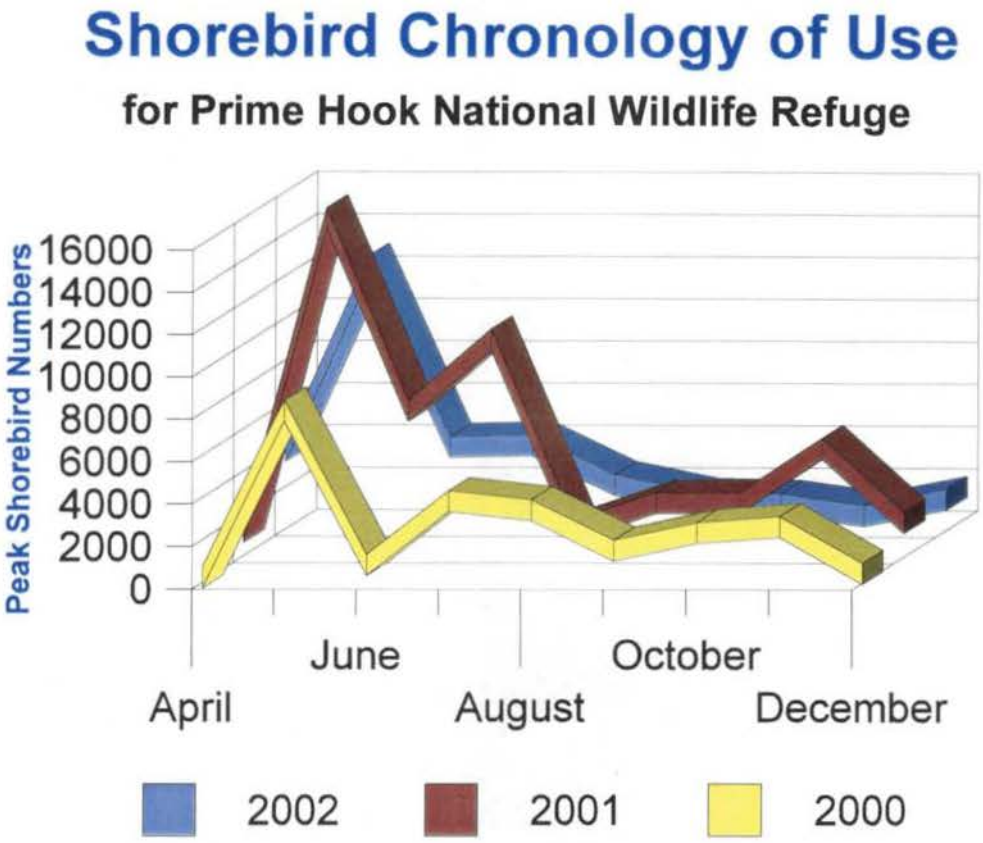
shorebird species using refuge marsh habitats have been divided into four guilds and are listed in the appendix. The table also includes information on what shorebird species bred, migrated through or wintered on the refuge during CY 2002.

Active management practices for shorebirds include manipulating water depths in early spring to increase benthic invertebrate biomass (mainly *Chironomidae)* and target areas that have been heavily browsed by snow geese during the winter months. These eat-out areas provide vegetation-free mudflats during the spring, that are favored by shorebirds due to optimal predator detection.

Spring migrants start to arrive by mid-April and peak by the 3rd week of May. Peak numbers of birds and dominant species migrating through the refuge in April were dunlin (2,094), long-billed dowitchers (300) and semipalmated plovers (225). Peak shorebird species using refuge impoundments in May included semipalmated sandpipers (5,179), dunlin (1,640), semipalmated plovers (1,189) and short-billed dowitchers (1,028).

Refuge-wide Shorebird Use of Prime Hook NWR's Marshes (Ground Survey Data-Three Year Comparison)			
Month	**2002**	**2001**	**2000**
April	3,698	1,122	229
May	12,439	15,978	8,099
June	3,894	6,849	827
July	3,982	10,232	3,844
August	2,114	1,188	3,422
September	1,329	2,518	1,527
October	1,245	2,509	2,361
November	686	5,102	2,645
December	1,458	1,613	450

Fall migrants start coming through by the first week of July on to early November. No large pronounced peaks occur during the fall as the birds trickle through in steady small groups, in contrast to the large, sharp peaks which is evident during the spring migration. (See line graph below, depicting three year comparison of shorebird chronology of use for the refuge.) A steady stream of shorebirds returning to the wintering grounds were recorded during the fall migration this year, while the following species wintered on the refuge: greater yellowlegs (481), dunlin (966), sanderlings, killdeer and common snipe. (See Shorebird Use based on monthly species composition summarized in Pie Charts located in the appendix)



3. VEGETATION RESPONSES AND WILDLIFE USE WITHIN PROGRAM UNITS

Unit II. The Unit II management unit is bounded on the north by Fowler's Beach Road, barrier dunes on the east facing the Delaware Bay, Prime Hook Beach Road on the south, and an upland interface on the west. Tidal ranges along the Delaware Bay are from 2.5 to 4.0 feet except during spring tides (± 5.5 ft). Tidal flow enters the Slaughter Canal from Delaware Bay through the Mispillion Inlet. Water salinity readings at Slaughter Canal (which bisects the entire Unit I salt marsh management area) ranged from 5.0 to 28.0 ppt. Salt water intrusion into Unit II is held in check at the Fowler's Beach Road water control structure located on the northern refuge boundary. Water salinities within the Unit II impoundment ranged from 0 to 15 ppt.

PMH2A (223 acres)-Habitat Management Objectives. Create 150 acres of mudflats for spring migrant shorebirds and produce 200 acres of dense annual vegetation production by the end of the summer (> 75% of water surface). Then flood to a depth of less than 25 cm from Oct - Jan to

maximize seed production availability for foraging fall (Sept-Nov) migrant dabbling ducks (especially pintails, teak and black ducks) and wintering geese.

PMH2A-Vegetation Responses to Water Level Management. Drawdown was initiated on 02/21/02 and completed 95 days later. Organic soils' average salinity was 8.0 ppt, ranging from 5 - 12 ppt. Vegetation responses to this year's water conditions resulted in the following covertypes: 68% - Walter's millet, 12% sprangletop, 9% *Phragmites,* 6 % Panicum grasses with the remaining cover-types in Chufa and beggarticks Relatively little change in covertypes was noted compared to last year, however, seed production for surveyed moist-soil plants was much higher than prior years' estimates, with average yields of 1,643 lb/acre calculated for PMH2A.

Wildlife Responses (PMH2A). Weekly ground survey data showed good use by shorebirds during the spring migration, peaking by the second week of May. Predominant species included semipalmated sandpipers (1550), dowitchers (55), dunlin (270), semipalmated plovers (375) and red knot (75). Excellent waterfowl use was recorded from September through December, most notably for blue and green-winged teal, pintails and snow geese. (See Peak Monthly Wildlife Populations Census Summary Report for PMH2A in appendix).

PMH2B (530 acres). This subunit is located in the northeastern corner of Unit II with Fowler's Beach Road as its northern boundary, dunes along its entire eastern boundary and Slaughter creek marks its western boundary. Drawdown was started on 02/01/02 and completed on 05/21/02. Soil salinity grab samples ranged from 0 to 10 ppt. The area is predominantly covered with dense stands of *Phragmites* (95%) and received heavy herbicidal control treatments in September 2002.

PMH2C (500 acres)-Habitat Management Objectives. This subunit is delineated by Slaughter Creek on its northern and eastern boundaries, Prime Hook Beach Road on its southern end with upland habitats on the western fringe. Management objectives during 2002 included the creation of 250 acres of mudflats for migrant and breeding shorebirds (especially black-necked stilts) and produce 500 acres of dense annual vegetation as forage for migrating and wintering waterfowl.

PMH2C-Vegetation Responses to Water Level Manipulations. A late winter drawdown was initiated on 02/01/02 and completed on 05/15/02. Grab samples of organic marsh soils revealed soil salinities ranging from 0 to 8 ppt. Good to excellent moist-soil plant responses were noted. Vegetation surveys (n = 120) yielded very desirable annual plant responses with the following cover-types recorded: Walter's millet (69 %), Panicum grass (15 %), sprangletop, (4%), Chufa (3%), salt marsh fleabane (2 %). (See Impoundment Vegetation Frequency and Cover Report for PMH2C in appendix). Seed production yields from dense annual vegetative stands recorded for PMH2C was also excellent with average seed estimates calculated at 1,703 lb/acre.

Wildlife Responses. (PMH2C). Weekly ground surveys showed fair shorebird use during the spring migration predominantly by dunlin (500), semipalmated sandpipers (600), semipalmated plovers (250), and short-billed dowitchers (150). Peak waterfowl numbers during the fall. migration included pintails (2700), green-winged teal (890), snow geese (8500), Canada geese (541) and Northern shovelers (210).

UNIT III IMPOUNDMENT DESCRIPTION. This management unit is bordered by Prime Hook Beach Road on the north, the Prime Hook Beach and Broadkill Beach communities on the east, Route 16 on the southern border and upland habitats along the western boundary.

PMH3A. Habitat Management Objectives. Manage at least 50 % of perennial vegetation to create hemi-marsh conditions with 20 to 35 cm water depths during the summer for breeding American and least bitterns within the core of the subunit, and also produce 150 acres of annual vegetation along the edges of the area to generate good seed production for fall migrating and wintering waterfowl.

PMH3A (290 acres). Vegetation Responses. This subunit is located within the northwest corner of Unit III (See Refuge Impoundment Map in appendix). A slow drawdown was initiated on 04/01/02 and completed 90 days later. Random grab samples of organic marsh soils indicated zero soil salinities. Predominant vegetation included Walter's millet (51%),Phragmites (25 %), cattails (23%), curled dock (2%), bareground (10 %), rose mallow (4 %), Panicum grass (3 %), and a remaining mix of foxtail, Chufa, smartweeds, and hempweed. Measured moist-soil plants (n = 45) also yielded excellent seed production of 1,789 lb/acre around the peripheral boundary of the subunit..

PMH3A Wildlife Use. Slow drawdowns created good habitat conditions for great egrets, great blue herons, American bitterns, green-backed herons and snowy egrets within the perennial vegetation component of this subunit. Peak numbers of waterfowl use occurred during the month of November which included green-winged teal (1,100), American wigeon (479), Northern pintails (532), American black ducks (227), Northern shovelers (220), snow geese (550), Canada Geese (120), ruddy ducks (150) and ring-necked ducks (120).

PMH3B (479 acres). Habitat Management Objectives. The perennial vegetation component in the northeast corner of the subunit will be managed for rails and bitterns in the late spring and summer, and for resting and feeding wading birds coming off Pea Patch Island Rookery in late summer, by holding water levels between 10 - 45 cm deep, and also produce annual vegetation around the edges of the subunit (120 acres) to maximize seed production for foraging fall migrating and wintering waterfowl.

PMH3B (479 acres)/Vegetation Response. Located in the northeast corner of Unit III, this subunit also experienced a slow drawdown rate initiated on 04/01/02 and completed on 08/01/02. Soil salinities measured at the start of the growing season were zero. Vegetation surveys (n = 120) revealed the following cover types: Walter's millet (37 %), Phragmites (33 %), cattail(8%), rose mallow (8%), Panicum grass (3%), curled dock (2%), salt marsh fleabane (2%), and 1% of soft stem bulrush, smartweeds, and foxtail.

Wildlife Use - PMH3B . Peaking wading bird use occurred during the month of June, and peak waterfowl us occurred during the month of October which included the following species: Northern pintail (1790), green-winged teal (1334), Canada geese (254), Norther shoverlers (239),

mallard (150), American black ducks (110).

PMH3D (620 acres). Located in the southern portion of Unit III, two water control structures for the unit are located here, as the drainage for Unit III flows north to south. The smaller structure with 5 bays (1 screw gate, 2 flapgates, and 1 fish weir) is located on the lower reaches of the Prime Hook Creek along the eastern boundary of the Unit III impoundment which feeds into the Broadkill Sound. The larger structure with 8 bays (2 screwgates, 4 flap gates, and 1 fish weir) is located on Petersfield Ditch which bisects PMH3D and flows out into the Broadkill River.

PMH3D Habitat Management Objectives. Manage 300 acres to target spring migrant shorebirds by conducting a slow drawdown 4 to 6 weeks prior to arrival of shorebirds. Lowering water levels slowly allows the water temperature to increase and stimulate invertebrate development. Timing will be critical to ensure that a maximum amount of wet and moist mud-flats and shallow water depths (2 to 10 cm) by the last 2 weeks of May. Produce 500 acres of dense annual vegetation to maximize seed production for foraging fall migrating and wintering waterfowl.

Vegetative Response. A slow drawdown was experienced in PMH3D. Dewatering was started on 04/01/02 and completed in 70 days. Excellent moist-soil plant response was recorded this year (n = 125) with the following cover-types surveyed: Walter's millet (64 %), Phragmites (18 %), Panicum grass (7%), beggarticks (6%), Northen Wild Rice (4 %), softstem bulrush (3 %), and salt marsh fleabane (1 %). Seed production of measured moist-soil vegetation was the highest in PMH3D with 1,817 lb/acre recorded.

PMH3D Wildlife Use. Peak shorebird numbers occurred during May, predominantly by dunlin, semipalmated sandpipers, least sandpipers, semipalmated plover, short-billed dowitchers, black-necked stilts and yellowlegs. Peak duck use occurred during October with 1300 pintails, 1450 green-winged teal, 450 Northern shovelers. Peak snow gees use occurred during December with 20,000 birds recorded during weekly ground surveys.

DESCRIPTION OF UNIT IV. The Unit IV water management impoundment is bordered by Route 16 on the north, the Broadkill Beach community on the east, the Broadkill River on the south, and upland habitats on the west. Tidal range along the Broadkill River is from 2.1 to 5.5 feet and salinity values range from 10 to 30 ppt. Two small water control structures impound about 200 acres of marsh area and also block the direct tidal influence of the Broadkill River from entering PMH4A.

PMH4A Habitat Objectives. Within the impounded portion of Unit IV (PMH4A-200 acres) water levels will be maintained at high levels during the spring shorebird migration with a small portion of shorebird habitat available around the periphery of the impoundment. Water depths were kept at higher levels (15 to 30 cm) from May 10 to mid-June. Then a fast drawdown was initiated to provide maximum amount of mudflat habitats by the second week of July, to target fall migrant shorebird use. These shorebird management strategies would also help stimulate sea purslane (*Sesuvium maritimum*) seed bank germination as a major forage plant component for exploitation by fall migrating and wintering waterfowl.

Vegetation Responses. A mid-summer drawdown was experienced in PMH4A, initiated on 06/15/02 and completed 30 days later. Soil salinities averaged 10 ppt. Desirable moist-soil vegetation included sea purslane (Sesuvium maritimum) (45 %), Walter's millet (24 %), bareground (20 %), Chufa (3 %), fathen (*Atriplex patula)* (3 %), salt marsh fleabane (2 %), and sprangletop (1 %). Seed yield measurements of moist-soil plants taken within veg-plots generated excellent seed production of 977 lb/acre for PMH4A.

PMH4A Wildlife Use. Once again this small impoundment yielded the heaviest bird use of any area on the refuge during CY 2002. Ground survey data showed excellent shorebird use during the spring migration (April-May) which included the following shorebird species: semipalmated sandpiper (957), dunlin (540), short-billed dowitchers (269), least sandpipers (66), semipalmated plover (50), black-bellied plovers (11) and yellowlegs (31). Fall migrant shorebirds also made good use of PMH4A with July surveys peaking with 1052 short-billed dowitchers, 744 semipalmated sandpipers, 252 greater yellowlegs, 88 lesser yellowlegs and 4 ruddy turnstones. Aerial survey data revealed peak waterfowl use occurred during the month of November which included 44,659 birds, mostly snow geese (43,000), green-winged-teal (1371), Canada geese (135), American black dusks (89), Northern pintails (21), American wigeon (21), Northern shovelers (10), gadwalls (10), mallards (10) and wood ducks (11).

4.) PHRAGMITES CONTROL. Annual herbicidal treatments has been the main method of *Phragmites* control used on the refuge for the past ten years. Annual treatments have become an integral part of the refuge's marsh and water level management program in order to achieve the maintenance of biological integrity, diversity, and environmental health within Prime Hook's wetland complex. It is recognized that water level management practices favor competitive strategies of *Phragmites* plants and have resulted in the cumulative expansion of large blocks of monotypic stands within the refuge's impounded marsh areas.

However, for the past ten years the only *Phragmites* spraying that has occurred on refuge has been the result of fire funding obtained through the Regional FMO for fire breaks. This has not been adequate to maintain any significant control of *Phragmites* within the refuge's impounded freshwater wetland areas. Significant annual *Phragmites* expansion does occur as a result some water level management practices that far exceeds any herbicide treatments that the refuge gets funded for on an annual basis. However, a large WUI (Wildland Urban Interface) Project has provided the refuge with extra funding for the next three years which will afford staff to aggressively treat large blocks of areas that contain dense stands of *Phragmites.* Therefore, in addition to the regularly cost-share spray program, WUI funding provided that a total of 4,198 acres were treated at a two quart per acre rate during FY 2002. (See the table below summarizing the total acres treated between the two programs and the Figure 2 map at the end of this report showing areas sprayed during the 2002 field season.)

Phragmites Control Program Cy 2002 - Total Acres Treated with Herbicide			
Management Area	**WUI SprayProgram**	**StateCost Share Prg**	**Total Acres Sprayed**
Unit I	1,053.3	None	1,053.3
Unit II	1,447.7	155	1,602.7
Unit III	1,217,2	92	1,309.2
Unit IV	221.5	12	233.5
TOTALS	3,939.7	259	4,198.7

5.) PESTICIDE USE ON WETLAND HABITATS A total of 4,079.25 acres were treated with mosquito chemicals during CY 2002. Chemical applications to control mosquitoes over refuge marsh habitats were initiated on 05/10/2002 and the last spray event occurred on 09/18/2002. See the table below for information on the chemicals used and areas sprayed by the State of Delaware Mosquito Control Section.

PRIME HOOK NATIONAL WILDLIFE REFUGE CY 2002 (Acres Treated)Dibrom				
Management Unit	**ALTOSID (Methoprene)**	**VECTOBAC (Bti)**	**TEKNAR (Bti)**	**TRUMPET (Naled)***
Unit I	63	None	None	150
Unit II	1007	None	None	100
Unit III	2015	None	120	212
Unit IV	31.25	21	160	200
TOTALS	**3116.25**	**21**	**280**	**662**

* Naled, the active ingredient in **Trumpet** by weight (78.0%) is a very toxic organophosphate with serious environmental hazards listed on the label. "This pesticide is toxic to fish, invertebrates and wildlife." Washington Office approval (By Michael Higgins for Elaine Snyder-Conn {Approval of PUP R5-02-51560-17 and -18 for Use of Trumpet EC and Dibrom Concentrate at Prime Hook NWR for CY 2002}) was conditionally made only if the following steps were taken:

1.) action thresholds were considered in advance of pesticide applications, based on human health threats or extreme nuisance;

2.) adult mosquito monitoring is conducted on or near the refuge by the Mosquito Control Section in accordance with standard IPM practices to include count data (fromlight traps or landing rate counts) before and after spraying naled and that these data are to be provided to the refuge within 2 weeks following application to justify spray events and demonstrate efficacy;

3.) *Bacillus* products are utilized as the preferred (primary) method of mosquito control;
4.) If *Bacillus* products fail to control the mosquitoes within the expected time frame, then liquid methoprene products should be used next;
5.) If both *Bacillus* and methoprene products fail to control mosquitoes, only then could adulticides Trumpet or Dibrom be applied;

It was further recommended that "if they have not done so in the past, the Mosquito Control Section, State of Delaware, should provide all available data and publications to Prime Hook NWR on the following:"

* Mosquito species composition and abundance pattern in Odessa, Smyrna, Leipzig, Bombay Hook NWR, and other local communities used for systematic trapping efforts or landing counts;
* Any other quantitative sampling data collected by the State of Delaware related to source identification for mosquitoes in any of these communities;
* Any viral titer data or data on public health threats within 5 km of the refuge;
* Any efficacy, resistance, and nontarget effects data gathered in quantitative, scientifically designed studies;

None of this information was made available to the refuge during CY 2002.

B. PLANNED WATER LEVELS FOR COMING YEAR

Water level management strategies for the first three months of CY 2003 will be dictated by the Wildland Urban Interface (WUI) Prescribed Fire Program. A late winter drawdown is planned for Unit II an early spring drawdown for Unit III and an early summer drawdown for Unit IV. Water level management strategies will include the following: Reduce water levels during January, February, and March in Management Units II and IV to facilitate burn plans within designated burn blocks in these impoundments. The targeted window for burning activities will be from 02/15/03 to 04/30/03. Water levels will then be stabilized (logs returned to flap gate structures) in Unit II but a slow drawdown will continue in Unit IV.

Once logs are in place in Unit II precipitation inputs will raise levels quickly during the spring. High water levels will be desirable to stress any new *Phragmites* growth within treatment blocks. This strategy will be used in Management Unit II because the highest acreage and densest stands of *Phragmites* are located here. Water levels will be maintained high until mid to late June, at which time a rapid drawdown will be initiated. By the commencement of fall shorebird migration (July 1), Unit II will be from 30 to 50% drained, providing some mudflat habitats available to fall migrants and creating new microhabitats throughout the fall migration period, while also stimulating annual vegetation seed banks to produce good forage later in the summer for migrating and wintering waterfowl.

In Unit III, the largest impoundment (2,500 acres), a slow drawdown is scheduled to start in mid-February and should be completed within 60 to 90 days. A slow and gradual drawdown will allow water temperatures to increase and stimulate invertebrate development providing good foraging resources for both spring and fall migrating shorebirds and generate good annual seed production for ducks and geese in the winter.

TABLE 1. UNIT II PMH2A, PMH2B, PMH2C, PMH12
ANNUAL WATER MANAGEMENT PROGRAM - CY2002

Date	Actual Water Level 2002	Salinity (PPT)	Proposed Water Level 2002	Proposed Water Level 2003
Jan 1	1.30	0	2.00	2.20
15	1.20	5	1.80	1.00
Feb 1	1.60	7	1.60	0.90
15	1.38	2	1.60	0.50
Mar 1	1.28	5	1.40	1.00
15	1.28	3	1.40	1.50
Apr 1	1.85	5	1.20	2.00
15	1.00	5	1.00	2.00
May 1	1.76	3	0.80	2.00
15	0.80	0	0.80	2.00
Jun 1	0.90	5	0.60	1.90
15	1.20	15	0.60	1.50
Jul 1	0.90	15	0.50	1.30
15	1.12	24	0.50	1.10
Aug 1	1.14	21	0.50	1.00
15	1.08	26	0.50	0.90
Sept 1	1.28	18	0.60	0.90
15	1.96	5	0.80	0.90
Oct 1	1.80	22	1.00	1.00
15	1.98	10	1.20	1.20
Nov 1	2.44	5	1.40	1.30
15	1.90	4	1.60	1.40
Dec 1	1.28	4	1.60	1.60
15	1.60	4	1.80	1.80
30	1.38	4	1.80	2.00

Refuge Prime Hook NWR Water Management Unit Name or Number II
Maximum w.s. elevation permissible 4.0 NGVD Unit II is revised NGVD.

TABLE 2. UNIT III (PMH3A, PMH3B, PMH3C, PMHD3D)
ANNUAL WATER MANAGEMENT PROGRAM - CY2002

Date	Actual Water Level CY 2002	Salinity (PPT) CY 2002	Proposed Water Level 2002	Proposed Water Level 2003
Jan 1	2.60	0	2.80	2.60
15	2.76	5	2.80	2.40
Feb 1	2.60	15	2.70	2.00
15	2.64	7	2.60	1.80
Mar 1	2.50	3	2.50	1.80
15	2.42	2	2.40	2.00
Apr 1	2.80	0	2.20	2.00
15	2.00	1	2.00	2.00
May 1	2.82	2	1.80	1.80
15	1.88	0	1.60	1.60
Jun 1	1.40	1	1.60	1.50
15	1.66	10	1.60	1.50
Jul 1	1.85	0	1.80	1.50
15	0.90	9	1.80	1.50
Aug 1	1.82	6	2.00	1.50
15	1.82	15	2.00	1.40
Sept 1	1.90	18	2.20	1.40
15	2.66	3	2.20	1.50
Oct 1	1.48	0	2.30	1.60
15	2.34	3	2.40	1.80
Nov 1	2.14	2	2.50	2.00
15	2.48	4	2.60	2.00
Dec 1	2.54	4	2.70	2.00
15	2.36	4	2.80	2.20
30	2.40	5	2.80	2.40

Refuge Prime Hook NWR Water Management Unit Name or Number III
Maximum w.s. elevation permissible is 2.8 feet msl.

TABLE 3. UNIT IV (PMH4A)
ANNUAL WATER MANAGEMENT PROGRAM - CY2002

Date	Actual Water Level CY 2002	Salinity (PPT) CY 2002	Proposed Water Level 2002	Proposed Water Level 2003
Jan 1	2.00	0	2.00	2.20
15	2.00	8	2.00	2.00
Feb 1	2.12	17	2.20	1.80
15	2.42	7	2.40	1.60
Mar 1	2.37	7	2.50	1.60
15	2.20	5	2.50	1.60
Apr 1	2.60	2	2.60	1.80
15	2.25	3	2.60	1.80
May 1	2.50	8	2.70	1.80
15	2.60	15	2.70	1.70
Jun 1	2.40	8	2.60	1.60
15	2.00	15	2.50	1.60
Jul 1	1.60	18	2.20	1.60
15	1.50	20	2.00	1.60
Aug 1	1.50	16	1.60	1.50
15	1.50	22	1.40	1.50
Sept 1	1.67	12	1.20	1.60
15	2.17	9	1.20	1.60
Oct 1	1.95	8	1.00	1.80
15	2.67	10	1.20	2.00
Nov 1	2.14	6	1.40	2.20
15	2.17	5	1.60	2.20
Dec 1	2.25	5	1.80	2.40
15	2.00	4	2.00	2.40
30	2.00	5	2.00	2.60

SECTION IV. MARSH AREAS WHERE WATER CAPABILITY DOES NOT EXIST

Unit I Description. This management unit comprises the northern most end of the refuge and is delineated by Slaughter Beach Road on the northern boundary, barrier dunes and a portion of the Slaughter Beach community homes on the east, Fowler's Beach Road on the south, and an upland fringe of croplands and scrub-bush areas on the western boundary. Currently, there is no water level management capability within Unit I which contains about 1,400 acres of salt marsh. Tidal salt water is the primary source of water for this unit, entering through Slaughter Canal, which flows southward from the Mispillion River inlet, at the mouth of the Delaware Bay.

Tidal flow provided by Slaughter Canal bisects Unit I and receives its afflux from the ditches and creeks within the Unit I salt marsh area. The Draper-Bennett Tax Ditch drains the southwest portion of this unit, which ultimately feeds into Slaughter Canal. Daily tidal action has a 4.4 foot range at the Mispillion Inlet. Salinities ranged from 0 to 32 ppt in the canal portions of the refuge. Rainfall, new and full moon tides, plus spring and neap tides maintain the salt marsh habitats in this area.

Unit I is the major salt marsh component of the refuge's wetland complex, with Unit IV also containing about 800 acres of salt marsh areas. The eastern half of the unit is characterized by the following dominant vegetation cover types: 55% Phragmites, 20 % Spartina patens, 15 % S. alterniflora, 10 % Distichlis spicata, 20 % ponded areas (SG eatouts), and 2 % Salicornia. The upland fringe is surrounded by shrub thicket edges primarily of bayberry (*Myrica pennslyvanica*) and high-tide bush (*Iva frutescens)* mixed with *Phragmites* along the upland border and in all OMWM areas.

Current management practices consists of prescribed burning, herbicide applications (primarily glyphosate to treat *Phragmites*), bird, vegetation and salinity monitoring, and mosquito control activities. Mosquito control actions within refuge salt marsh areas have involved two principal activities: 1.) the physical alteration of saltmarsh habitats (SOURCE REDUCTION TECHNIQUE) to make it less for mosquito breeding = OMWM (Open Marsh and Water Management); and 2.) the use of chemical agents to directly kill adult and larval mosquitoes over OMWM sites.

Irreversible habitat alterations utilizing OMWM techniques have generated growing concerns about negative impacts on salt marsh habitats. Increasingly, the continued observations of excessively drying out the refuge's coastal salt marsh habitats through time, has resulted in the conversion of *Spartina alterniflora* and *S. patens* areas to *Phragmites* and high-tide bush *(Iva frutescens)*. Such negative vegetation changes are very undesirable.

Negative vegetation changes have been prevalent where soils have been poorly dispersed from new pond and ditch excavations from OMWM constructions. Prior to OMWM construction, most sites of low marsh areas were dominated by smooth cordgrass (*Spartina alterniflora)* and black grass *(Juncus gerardi)*. While high marsh areas were dominated bt salt grass (*Distichlis spicata)* and salt meadow hay (*S. patens)* with occassionally scattered shrubs (typically *Iva frutescens* and/or *Baccharis hamilifolia*).

Post OMWM construction sites from the past 15 years have had large portions of *alteriniflora* areas converted to high marsh with heavy encroachment of *Phragmites* . In addition, high marsh areas dominated by *S. patens* have been taken over and dominated by shrubs (most *Iva frutescens)*. (Pers

comm G. O'Shea and refuge photographic record).

Unit I - Salt Marsh Habitats and Migratory Bird Use. Peak shorebird use occurred during the spring migration (May) where shorebirds utilized snow-goose eat-out areas directly parallel to the Delaware Bay, just beyond the dune-line. Peak numbers of dominant shorebird species included the following: semiplamated sandpipers (2,500), dunlin (500), semipalmated plovers (550), short-billed dowitchers (405), and red knots (355). Peak fall-migrant shorebird use occurred in August. Dominant species stopping over in August included semipalmated sandpipers (1,110), and western sandpipers (300), and in September 350 short-billed dowitchers, 190 yellowlegs, 195 semiplamated sandpipers, and 187 semiplamated plovers.

Good waterfowl use within the same areas were also noted. Ground surveys revealed peak duck use in October, most notably blue-winged teal (2450), Northern pintail (1150), green-winged teal 9895) and American black ducks (600). Aerial survey data showed good waterfowl use of salt marsh habitats during the month of November: 21,000 snow geese, 1,070 green winged-teal, 800 Northern pintails, 211 American black ducks, and 262 Canada geese.

As part of the second year plan for the Regional OMWM study on refuge, CY 2002 marked the year that several ditches were plugged by the Mosquito Control Section within designated salt marsh treatment sites. In early March, the Section plugged four ditches within the Petersfield 's treatment site (Unit IV), using spoil generated from 2 new dug ditches in the same area. These treatments were designed by The Section in an attempt to restore a higher water table and correct negative vegetation responses from prior OMWM work. At Unit I, Slaughter Beach Treatment site, two ditches were also plugged using material scraped from a *Spartina alterniflora* area adjacent to near Pond 11. Because insufficient fill was not available, the use of sand bags was required to plug these ditches. By mid-July and into August of 2002 several ponds within the Slaughter Beach treatment site had dried up completely causing several fish kills in these ponds due to only mud, water missing conditions. This occurred in study ponds #8, #9, #10, and # 11 of the PHST site.

OMWM Study Bird Surveys conducted during the spring and late summer of CY 2002 have shown that the seaside sparrow and clapper rails have the highest densities within the low marsh areas, while salt marsh sharp-tailed sparrows, marsh wrens, coastal plain swamp sparrows, and willets utilized the high marsh areas in both Units I and IV. During the fall and winter, American black ducks, common snipe, wading birds, and coastal-plain swamp sparrows were the dominant birds using the salt marsh habitats in 2002.

Discussion Notes and Management Implications. In December of 2002 the USFWS - Division of Migratory Bird Management Office published a "BIRDS OF CONSERVATION CONCERN" document (BCC-2002) which is a comprehensive list of non-ESA listed bird species deemed to have the greatest need of proactive and protective conservation actions. The BCC list is the most recent effort by the USFWS to carry out its proactive bird conservation mandate by accurately identifying bird species in greatest need of conservation action at different geographic scales.

The BCC-2002 uses current ecological risk assessment scores from three national bird conservation plans: Partners in Flight (Pashley et al 2000), The United States Shorebird Conservation Plan (Brown et al - 2002) and the North American Waterbird Conservation Bird (NAWCP-2001). The methods and criteria used to develop these priority lists are more quantitative and comprehensive than any previous lists and represents the best available information for identifying avian communities for

CCP and other refuge habitat and wildlife management actions and annual work plans.

The Region 5 - BCC 2002 list identifies 36 priority conservation bird species. Two of these species use refuge marsh habitats extensively during two critical life cycle activities: breeding and migrating. These two birds species are sharp-tailed and seaside sparrows. The most important requirement for the proactive management of these obligate salt marsh passerines will be to protect salt marsh breeding habitats that are used by these birds on refuge.

Nests of sharp-tailed sparrows (*Ammodramus caudacutus*) have been mostly found in high marsh (*Spartina patens & Juncus gerardi)* patches and a few noted in low marsh areas; whereas all seaside sparrows *(A. maritimus)* have only been found in low marsh (*S. alterniflora)* areas. As salt marsh specialists these two bird species also represent potential valuable "indicators" of ecological and biological integrity as they are very sensitive to any habitat modifications that occur within their breeding habitats.

Management Implications. Invasion of breeding habitats with large patches of alien *Phragmites* in high marsh areas (residual negative impact of OMWM construction in such areas) will result in the loss of breeding habitat for seaside sparrows. These birds are also heavily dependent on the previous growing season's dried grasses for nesting so that annually repetitive prescribed burning would eliminate local breeding populations. Successful proactive management for sharp-tailed sparrows will require controlling the spread of *Phragmites* by eliminating any new OMWM construction within these habitats and by carefully planning any prescribed fire activities in order to protect breeding habitats located on refuge.

Successful proactive management for seaside sparrows will entail protecting low marsh (*Spartina alterniflora)* breeding areas. Optimum habitat for these birds contains both feeding and nesting microhabitats in close proximity to minimize the commute between nest-centered territories and feeding zones (implies maintaining large "alterniflora" patches). High marsh areas provide suboptimal breeding habitat and marginal feeding habitat for seasides. Also since adult local populations are highly philopatric, any management actions that create long-term irreversible negative changes to "alterniflora" areas will be detrimental to breeding populations.

Status and Management of Greater Snow Geese. Greater snow geese (GSG) nest principally on Bylot, Ellesmere and Baffin Island. They winter along the Atlanic coast from New Jersey to North Carolina. Spring 2002 photographic surveys conducted in the staging area of the St. Lawrence Valley was 639,300 birds, 24% below last year's estimate (837,400). (USFWS - 2002 Waterfowl Status Report). Nesting phenology was 3-4 days later than average and over-all nesting effort was greatly reduced from the 2001 season. Average clutch size was 3.4, but nest predation rates were very high. This coupled with a two week period of extreme cold and snow in the beginning of the breeding season translated into poor to moderate production for 2002, and a reduced fall flight compared to 2001. Evidence of poor recruitment was noted from September to December, where most flocks seemed to contain no juveniles, refuge hunter harvest consisted mostly adult birds, and during January, less than 10% juvenile birds were noted in flocks wintering on the refuge.
Despite poor recruitment in the last four years, over the long term (30 years) the flyway population of GSG has followed a 9 % increase trend. Based on this accelerated growth rate of snow geese, perceived threats to arctic habitats and local farmers in the form of growing crop depredations, greater snow goose management on refuge has become a more pressing political issue in recent years. Current flyway population estimates of 650,000 birds and the refuge winters from 10 to 15

percent of the birds mostly in marsh habitats.

To fine tune biological and habitat management objectives, it is necessary to develop population wintering goals. To accomplish this, R5 needs to develop a standardized method to measure wintering carrying capacity for GSG to define the maximum number of individuals the refuge can reasonably support based on annual vegetation production to help establish GSG wintering population goals for the refuge. This goals should also mesh with R5 strategic planning assessments and flyway habitat carrying capacity goals (Masse et al - 2001).

Habitat carrying capacity estimates based on annual habitat condtions for wintering GSG could be calculated using techniques developed by Reinecki et al (1989), Masse et al (2001) and/or duck use day calculations (Anderson et al - 2002) modified for GSG food requirements instead of mallard figures. Numerical GSG estimates for foraging carrying capacity would better define the total food availability that results from annual water level manipulations and would also help to quantitatively define "SMART GSG BIOLOGICAL OBJECTIVES" for future CCP efforts. These numerical estimates could also articulate how much forage foods produced in refuge wetland areas each year help relieve crop depredation off-refuge.

Improving Water Level Management Capabilities. Regional biological peer review of the current marsh and water level management program has resulted in several excellent recommendations which identified specific information needs to improve impoundment management by acquiring certain hydrological data. This information can then be used to establish "SMART" criteria to develop improved marsh management objectives to be used for refuge CCP planning process and incorporated in the HMP.

Impoundment management Units II and III, which are both larger than 1,000 acres, present several water level management problems. Information is lacking on the actual surface water level depths within the various subunit locations and their relationships to established staff gauge depth readings at all the water control structures. This data is needed to better predict and fine tune the timing of drawdowns that can create the best marsh conditions for specific migration chronology of species being managed for.

The science of site-specific water level management for refuge environmental conditions could be advanced with the pursuit of the development of a hydrological model for both large impoundments (Units II and III) as per Biological Peer Review Team suggestion. Such a model would include groundwater and surface water inputs and discharges, marsh topography, substrate characteristics soil permeability rates, evapotranspiration rates, external water influences (upgradient, off-refuge water uses) and surface flow analysis.

Surface flow analysis in each unit (II and III) would be conducted to qualify how surface flow patterns are altered at different water levels by determining the quantities and direction of water flow and relating surface water levels to specific water control structure staff gauge water depths by creating water level contour maps. This could easily be accomplished as a cooperative refuge research project with the USGS water division office. Data would be incorporated into a working GIS analytical model that would serve to fine tune future water level management planning and decision-making processes that would be identified in the CCP and incorporated in the refuge HMP.

REFERENCES

Anderson, J. T. and L. M. Smith. 1998. Protein and energy productions in Playas: Implications for Migratory Birds. WETLANDS 18(3): 437- 446.

_____ and J. D. Osbourne. 2002. Integrated wetland management for shorebirds and wintering waterfowl on Region 5 National Wildlife Refuges. FINAL REPORT submitted to Migratory Bird Office and Region5 USFWS, West Virginia University, Dec. 23, 2002.

Brown, M, and J. J. Dinsmore. 1986. Implications of marsh size and isolation for marsh bird management. J. WILDLIFE MANAGEMENT 50(3): 392-397.

Fredrickson, L. H. 1991. WATERFOWL MANAGEMENT HANDBOOK. 13.4. Habitat management Chapter 13.3.6 - Strategies for Water Level Manipulations in Moist-soil systems. DOI - USFWS Leaflet 13, Washington, D. C.

_____ and M. K. Laubhan. 1994. Intensive Wetland Management: A Key to Biodiversity. TRANS. NORTH AMERICAN WILDLIFE. AND NATURAL RESOURCE CONFERENCE, 59.

_____ and T. S. Taylor. 1982. Management of seasonally flooded impoundments for wildlife. USFWS - Resource Publication 148, Washington, D. C. 29 pp.

Hamilton, D. B., and M. K. Laubhan. 1997. Moist-soil managemeent advisor program. USGS - Mid-continent Ecological Science Center, Fort Collins, CO., 130 pp.

Laubhan, M. K. and L. H. Fredrickson. 1992. Estimating seed production of common plants in seasonally flooded wetlands. J. WILDL. MANAGE. 56(2): 329-337.

_____ 1992. A technique for estimating seed production of common moist-soil plants. DOI - USFWS, Fish and Wildlife Leaflet 13.4.5., in WATERFOWL MANAGEMENT HANDBOOK, Washington, D. C.

Masse H., L. Rochefort and G. Gauthier. 2001 Carrying Capacity of Wetland Habitats used by breeding Greater Snow Geese. JOURN. WILDLIFE MANAGEMENT 65(2) - 271 - 281.

Pashley, D. N. et al. 2000. Partners in Flight: Conservation of the Land Birds of the United States. American Bird Conservancy, Virginia, 92 pp.

Reinecke, K. J. et al. 1989. Habitat Management for migrating and wintering waterfowl in North America: Mississippi Alluvial Valley, Texas Tech University Press, Lubbock, Texas, pp 203 - 247.

United States NABCI Committee. 2000. North American Bird Conservation Initiative: bringing it all together. USFWS, Arlington, Va.

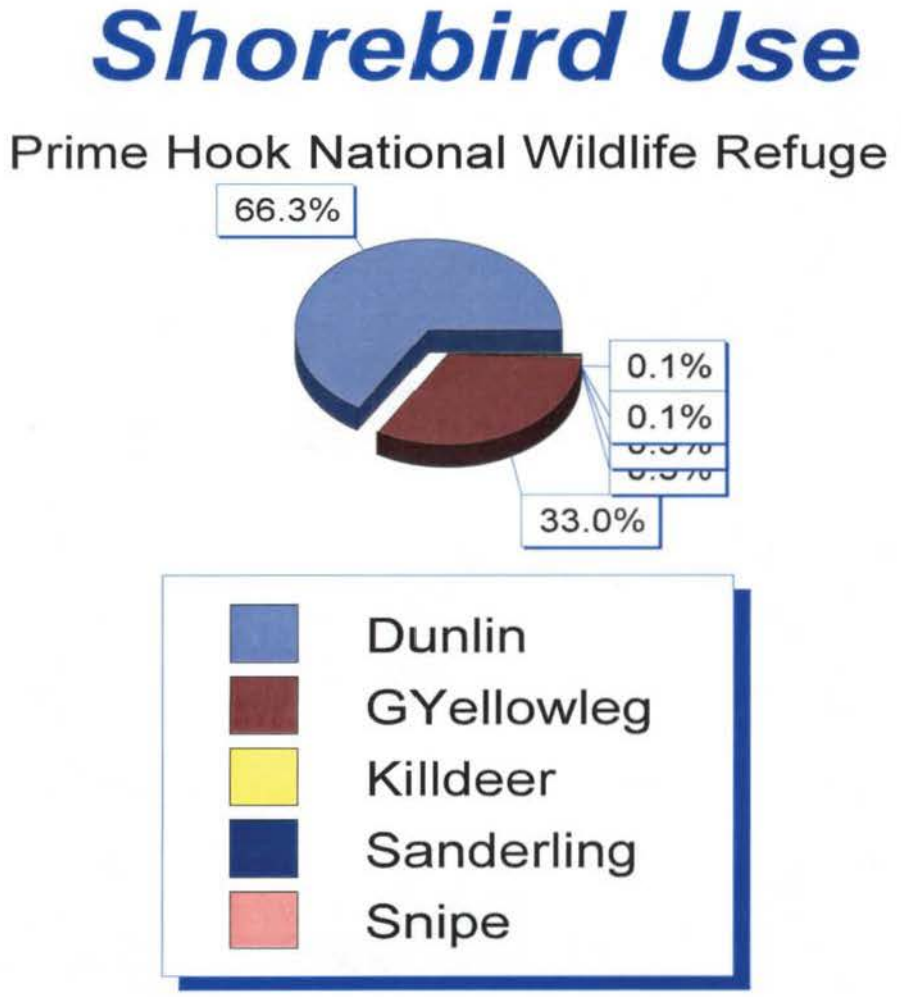
USFWS. 2002. Birds of Conservation Concern (BCC-2002) - Prepared by U. S. Fish and Wildlife Service - Division of Migratory Bird Management, Arlington, Va., December 2002.

USFWS. 2002. Waterfowl Population Status. US DOI - Washington, D. C.

Shorebirds that Bred, Migrated and Wintered on Prime Hook NWR during 2002			
GUILD/SPECIES	**BREEDING**	**MIGRATING**	**WINTERING**
BAY/IMPD			
Red Knot		X	
Sanderling		X	X
Ruddy Turnstone		X	
UPLAND			
Killdeer	X	X	X
Baird's sandpiper		X	
American woodcock	X	X	X
MUDFLATS			
Black-bellied plover		X	
Semipalmated plover		X	
Spotted sandpiper	X	X	
Semipalmated sdpr		X	
White-rumped sdpr		X	
Least sandpiper		X	
Willet	X	X	X
WADING			
Black-necked stilt	X	X	
American avocet		X	
Greater Yellowlegs		X	X
Lesser Yellowlegs		X	X
Solitary sandpiper		X	
Western Sandpiper		X	X
Stilt Sandpiper		X	
Pectoral Sandpiper		X	
Dunlin		X	X

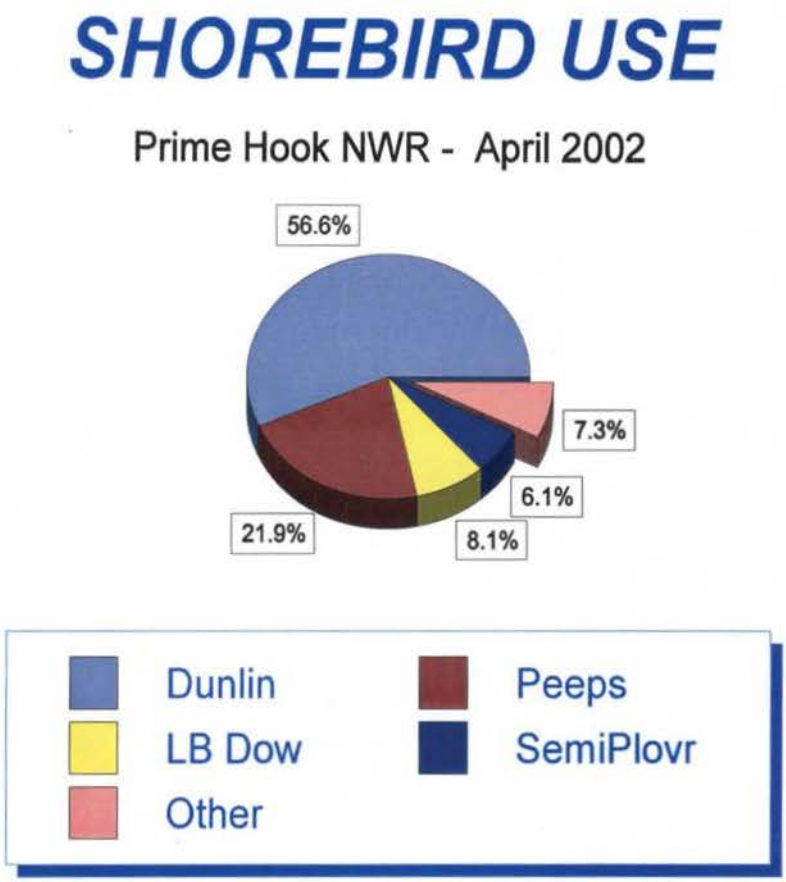
Shorebirds that Bred, Migrated and Wintered on Prime Hook NWR during 2002			
Short-billed Dow		X	
Long-billed Dow		X	
Common Snipe		X	X
Ruff		X	
Wilson's Phalarope		X	

Shorebird Use - Species Composition (December 2002)
Peak Population Estimates from Weekly Ground Surveys



TOTAL SHOREBIRDS = 1,458

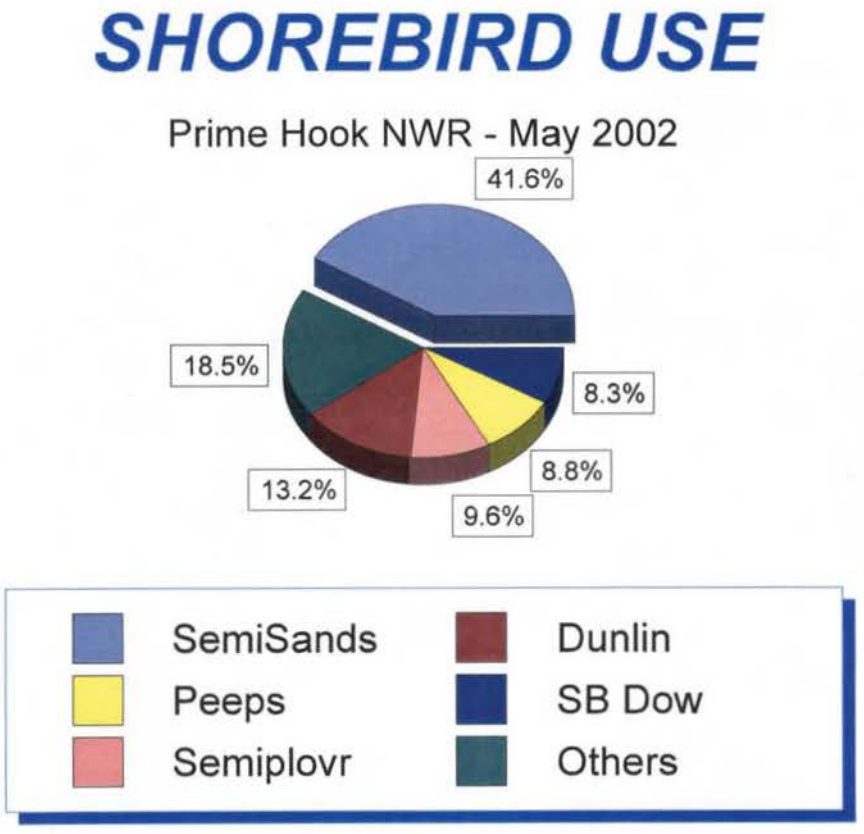
Shorebird Use - Species Composition (April 2002)
Peak Population Estimates from Weekly Ground Surveys



TOTAL SHOREBIRDS = 3,698

Other includes sanderling, black-bellied Plover, willet, killdeer, black-necked stilt, solitary sandpiper, greater & lesser yellowlegs, common snipe, A. woodcock, A. avocet.

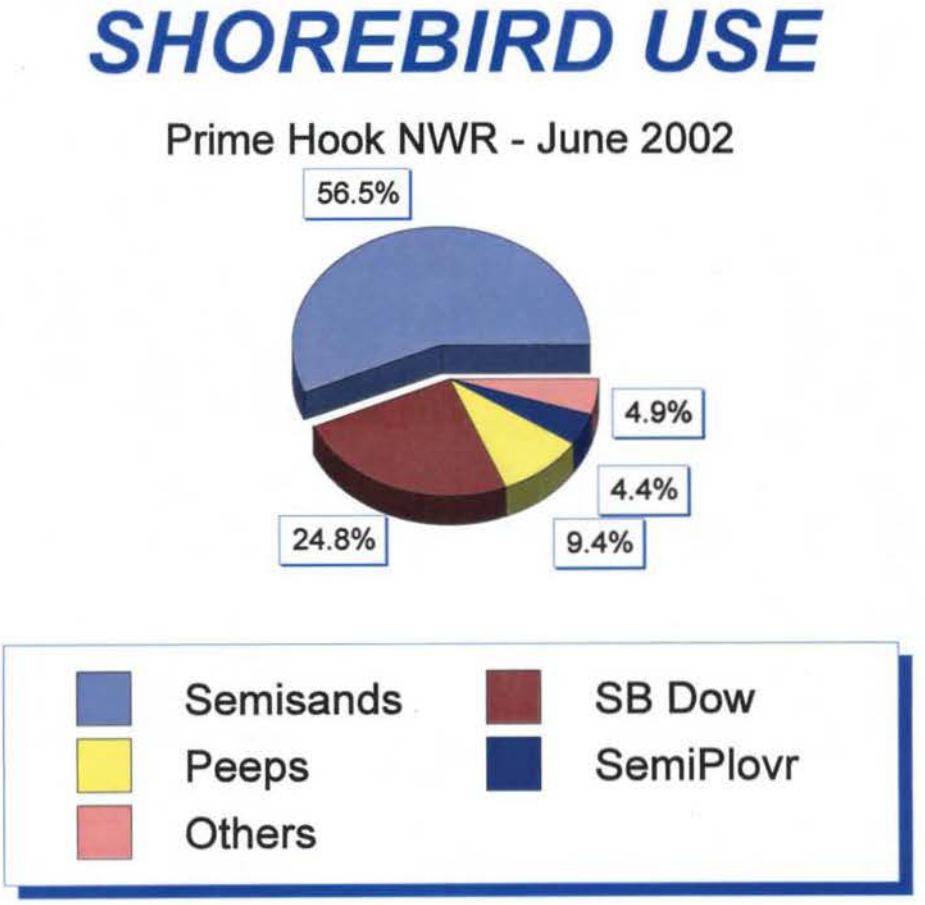
Shorebird Use - Species Composition (May 2002)
Peak Population Estimates from Weekly Ground Surveys



TOTAL SHOREBIRDS = 12,439

Others includes ruddy turnstone, spotted sandpiper, willet, black-bellied plover, greater & lesser yellowlegs, solitary sandpipers, Baird's sandpiper, red knot, western sandpiper, pectoral sandpiper, least sandpiper, med-dowitchers, and black-necked stilt.

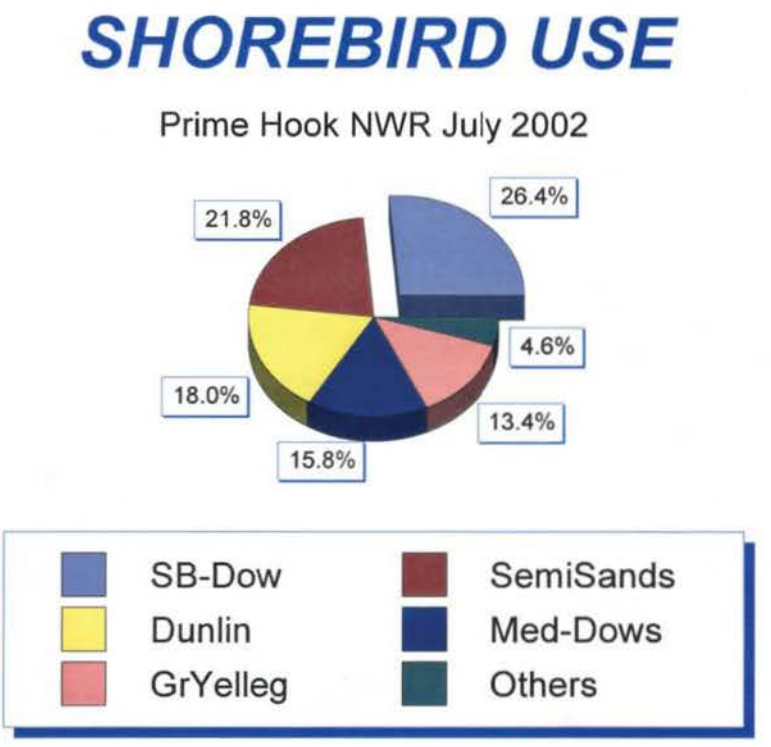
Shorebird Use - Species Composition (June 2002)
Peak Population Estimates from Weekly Ground Surveys



TOTAL SHOREBIRDS =3,894

Other species included ruddy turnstone, long-billed dowitcher, black-bellied plover, American avocet, black skimmer, greater and lesser yellowlegs, willet, killdeer, black-necked stilt and common snipe.

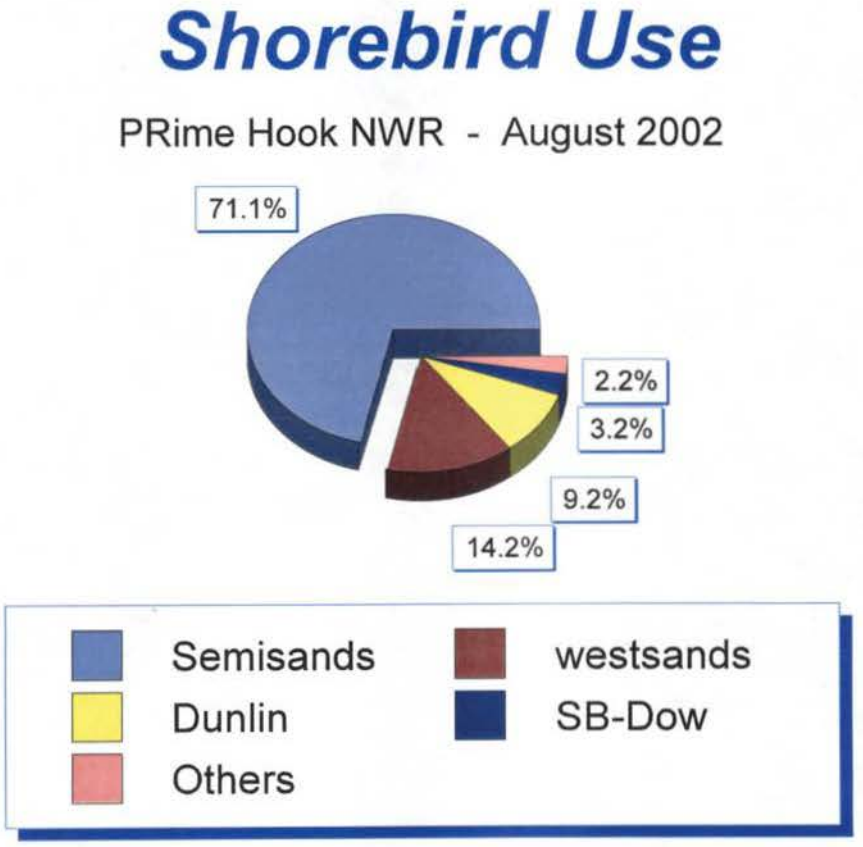
Shorebird Use - Species Composition (July 2002)
Peak Population Estimates from Weekly Ground Surveys



TOTAL SHOREBIRDS = 3,982

Other species include ruddy turnstone, ruff, little brown beeps, black skimmer, lesser yellowlegs, red knot, stilt sandpiper, white-rumped sandpiper, willet, semipalmated plover, willet, killdeer, and black-necked stilt.

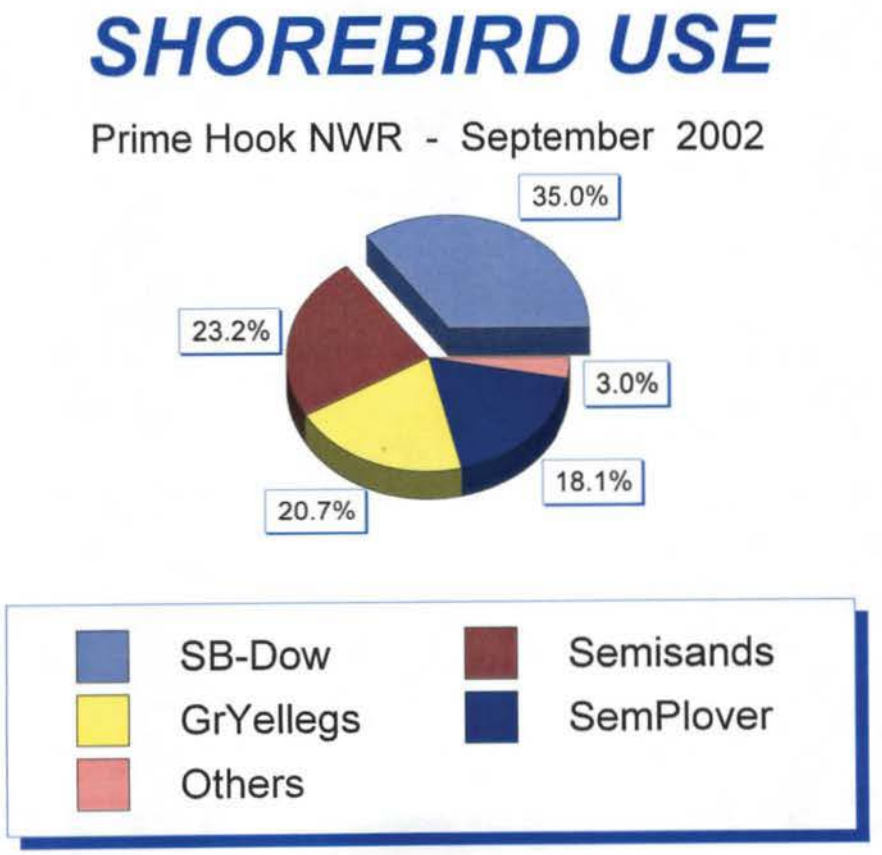
Shorebird Use - Species Composition (August 2002)
Peak Population Estimates from Weekly Ground Surveys



TOTAL SHOREBIRDS = 2,114

Other species included greater & lesser yellowlegs, stilt sandpiper, pectoral sandpiper, little brown peeps, semipalmated plovers, killdeer, and black-necked stilt.

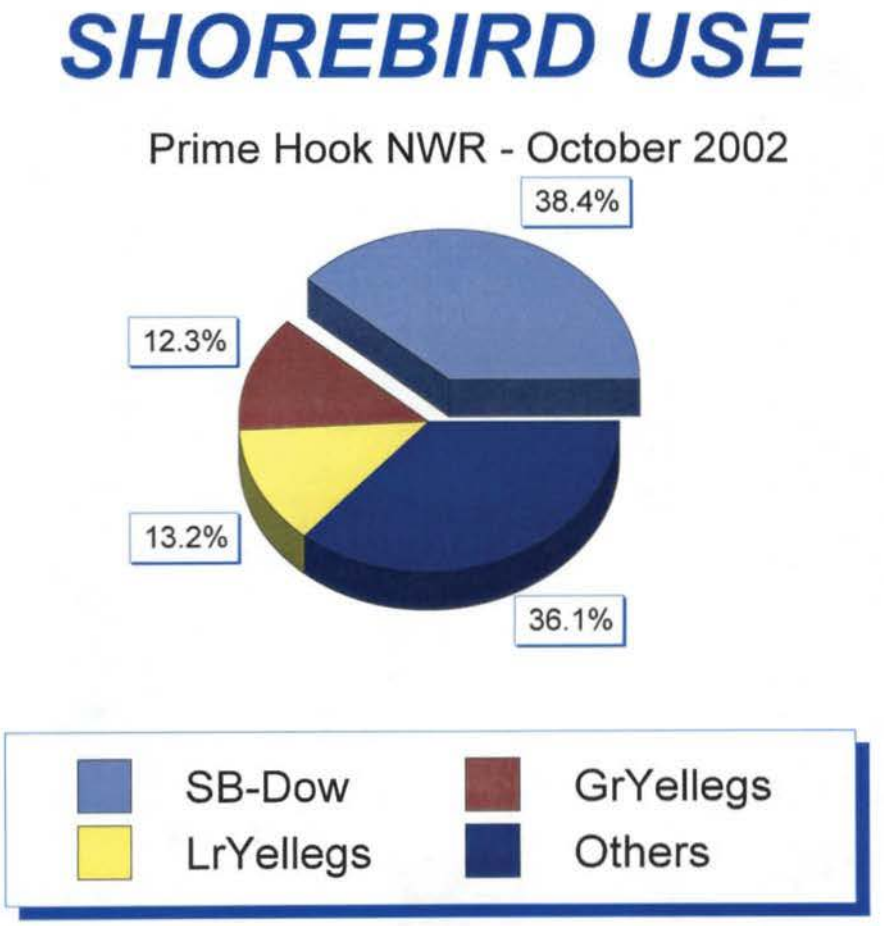
Shorebird Use - Species Composition (September 2002)
Peak Population Estimates from Weekly Ground Surveys



TOTAL SHOREBIRDS = 1,329

Other species included lesser yellowlegs, killdeer, sora, and black-necked stilt.

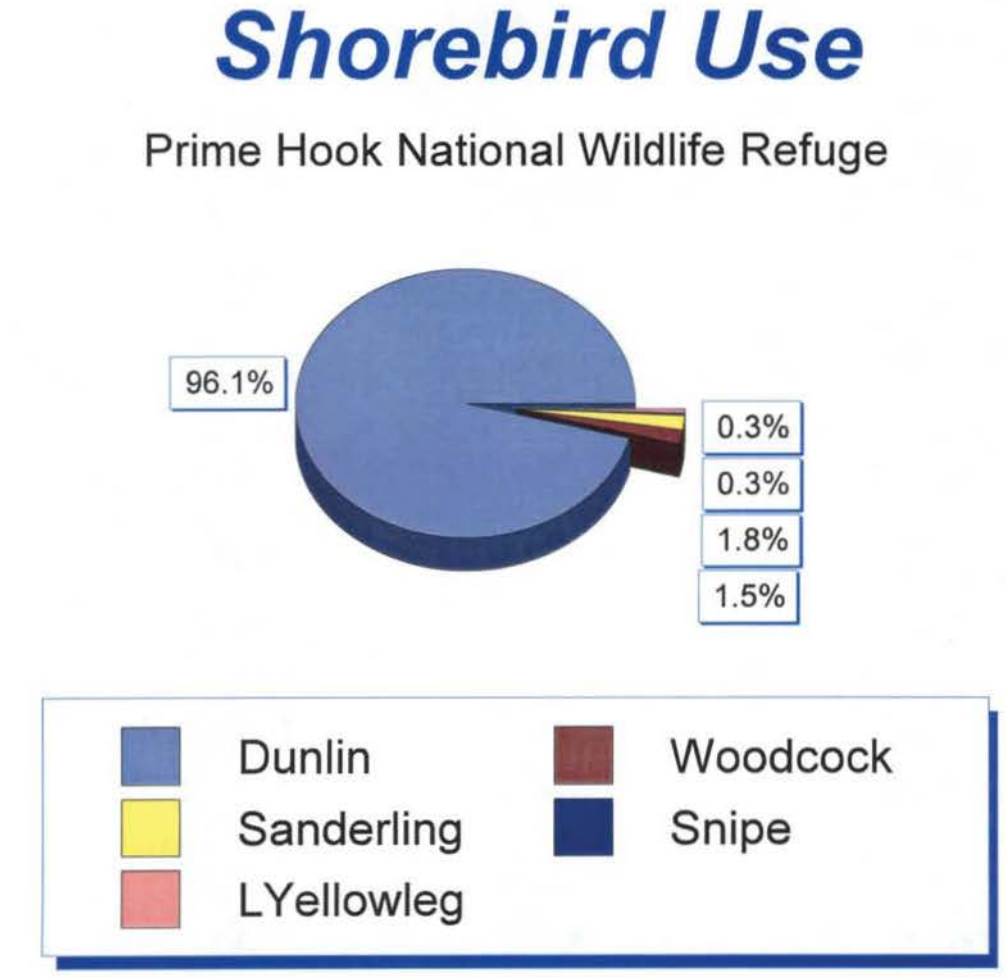
Shorebird Use - Species Composition (October 2002)



TOTAL SHOREBIRDS = 1,245

Other species included American woodcock, Dowitchers(med), Western snadpipers, little brown peeps.

Shorebird Use - Species Composition (November 2002)
Peak Population Estimates from Weekly Ground Surveys



TOTAL SHOREBIRDS = 686

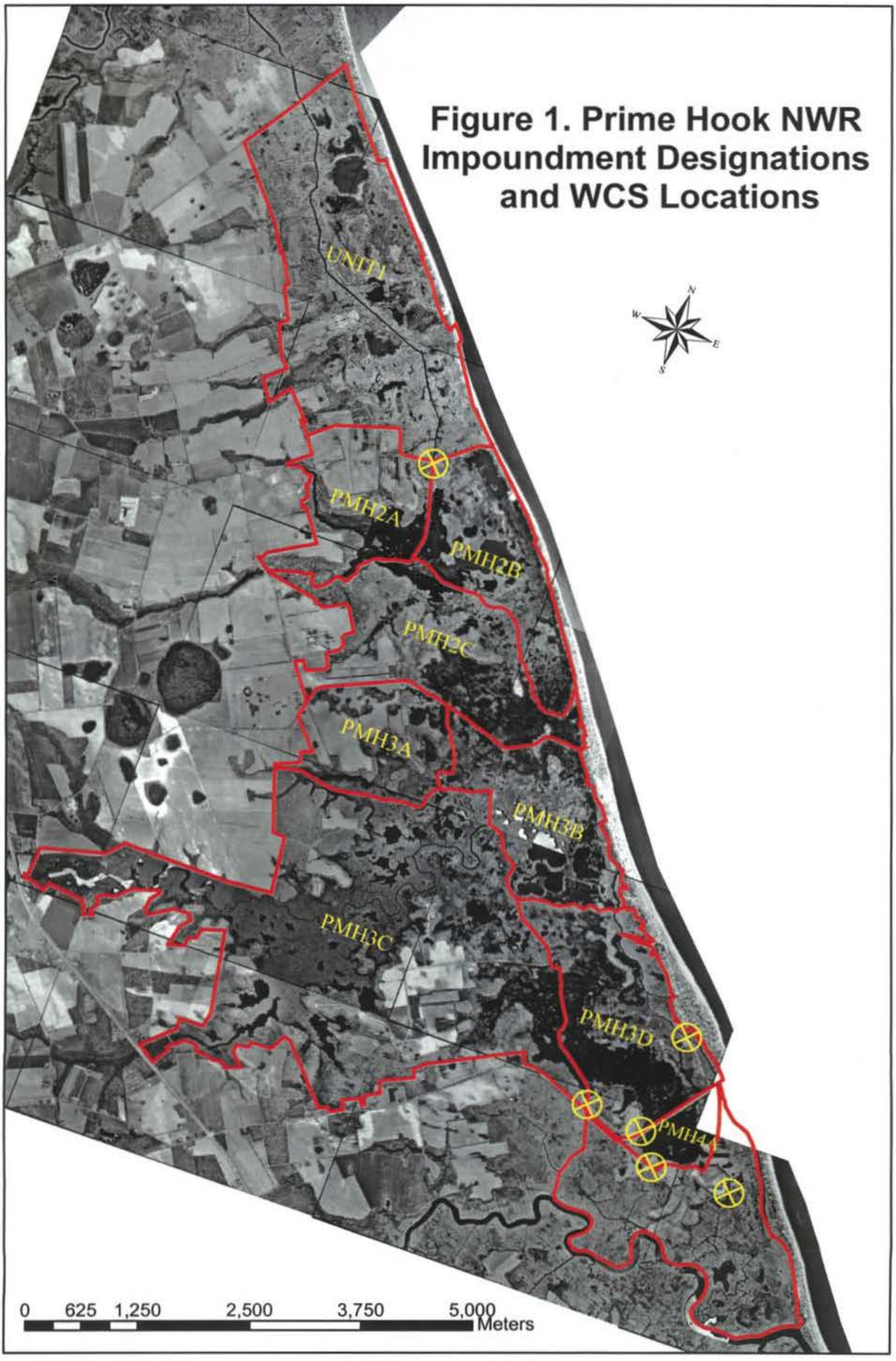


Figure 1. Prime Hook NWR
Impoundment Designations
and WCS Locations
UNIT1
PMH2A
PMH2B
PMH2C
PMH3A
PMH3B
PMH3C
PMH3D
PMH4
N
W
E
S
0
625
1,250
2,500
3,750
5,000
Meters

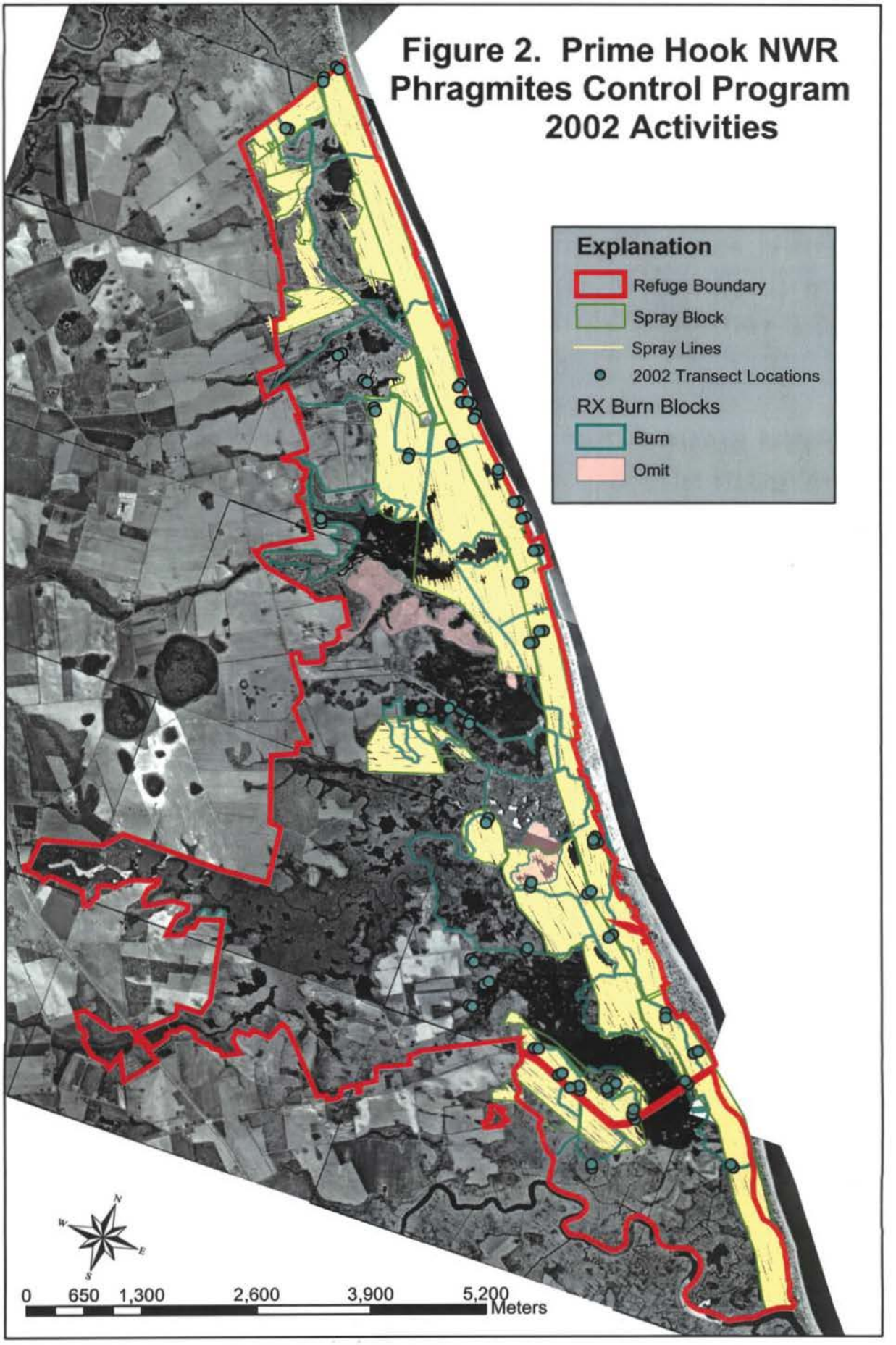


Figure 2. Prime Hook NWR
Phragmites Control Program
2002 Activities
Explanation
Refuge Boundary
Spray Block
Spray Lines
2002 Transect Locations
RX Burn Blocks
Burn
Omit
N
W
E
S
0
650
1,300
2,600
3,900
5,200
Meters