Dear Reader,

Over the past decade, we have employed various habitat management techniques on the refuge mostly related to the grasslands. During this time, surveys and studies along with observed responses of the vegetation raised a number of questions about whether our goals and techniques were improving the habitat and providing increase benefits for wildlife.

We decided that the best way to evaluate our habitat management and current knowledge of the refuge was through the process of developing a Habitat Management Plan (HMP). We requested the assistance of Service wildlife biologist Laura Mitchell who is also a fire ecologist and has been involved in a number of projects on other refuges related to grassland restoration. Laura, in turn, brought in several professionals from outside the Service. We approached this effort with no pre-conceived objectives and no constraints. Simply put, our goal was to look at the refuge and based on habitat (type, size, and configuration), soils, moisture/wetness, and wildlife determine what areas were most suitable for specific types of habitat that would best support a diversity of species while targeting species of concern.

This HMP is a step down plan, providing more detailed objectives and strategies for habitat objectives identified in the Comprehensive Conservation Plan (CCP). It expands on these objectives and provides for some new habitat regimes such as shrub/scrub and management of the tidal marsh along with restoration of some grassland units and expansion of the upland hardwoods. It provides habitat components for a broader range of targeted species and greater overall species diversity. Some actions will take longer to implement than others due to the resources needed to achieve those objectives. We view this plan as being dynamic and will modify techniques, strategies, and objectives based on results and changing conditions. As written by the Regional Director when he signed the CCP "It is explicit in the plan that management of all resources will be adjusted to consider new and better information, ensuring that refuge activities best serve the intended purposes of the refuge".

This is a lengthy plan exceeding more than 60 pages with another 60 pages of appendices. The first three sections discuss the history, related plans, current conditions and the process of cross walking refuge habitat types and wildlife with those listed as priorities in various plans to arrive at prioritized listing of habitat types and species. Section 4 discusses new objectives for habitat management while section 5 discusses specific management actions to achieve those objectives.

We encourage you to read the plan and would appreciate it if you would notify anyone who may be interested that the plan is available for review. We welcome your comments which can be sent to the refuge office at 14344 Jefferson Davis Hwy, Woodbridge, VA 22191 or emailed to greg_weiler@fws.gov. Please provide your comments on the objectives of this plan by November 30, 2009.

Greg Weiler
Project Leader
Potomac River NWR Complex

Occoquan Bay National Wildlife Refuge
Habitat Management Plan

April 2010

I. Introduction

1.1 Scope and Rationale

Occoquan Bay National Wildlife Refuge (NWR) is a small Refuge unit (644 acres) located at the confluence of the Potomac and Occoquan Rivers in the Chesapeake Bay watershed. The Refuge is located in Prince William County, one of the fastest growing counties in the Commonwealth of Virginia, with more than 357,000 residents (U.S. Census Bureau, 2006). Despite its small size, the Refuge contains a unique and diverse mix of tidal and nontidal freshwater wetlands, upland forest, and upland successional fields, including native, warm-season grasslands.

The Refuge is located approximately 25 miles south of Washington, D.C.; therefore, this isolated, but biologically rich unit, is located in one most densely populated and developed portions of the mid-Atlantic. The mix of habitats, its location along major rivers and, hence, major migratory waterbird routes, and its proximity to northern Virginia, creates an extraordinary opportunity for significant numbers of the visiting public to experience a diversity of habitats and associated wildlife during a remarkably short site visit.

Occoquan Bay NWR and the Potomac River NWR Complex are managed by the U.S. Fish and Wildlife Service as part of the National Wildlife Refuge System (NWRS). The mission of the NWRS is to *administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans*.

In 1997, Congress passed the landmark National Wildlife Refuge System Improvement Act, preparing the way for a renewed vision for the future of the refuge system where:

- Wildlife comes first
- Refuges are anchors for biodiversity and ecosystem-level conservation
- Lands and waters of the System are biologically healthy
- Refuge lands reflect national and international leadership in habitat management and wildlife conservation

Meeting the wildlife conservation challenges of the 21st century, such as climate change, and fulfilling the System mission and vision will require planning and partnerships. The Service's Comprehensive Conservation Plan (CCP) Policy (620 FW3) and Habitat Management Plan (HMP) Policy (620 FW1), together, provide a process for each refuge to prepare for these challenges. The purpose of this HMP is to guide habitat management actions on Occoquan Bay National Wildlife Refuge (NWR),

1.2 Legal Mandates

Occoquan Bay NWR was authorized in 1994, by Section 128, Public Law 103-307 and the Military Construction Appropriations Act of 1995 – H.R. 4453 (32) Sec. 12. While the lands transfer was authorized in 1994, the property was actually conveyed to the National Wildlife Refuge System in 1998. A portion of the lands comprising Occoquan Bay NWR once served as an Army research site, the "Woodbridge Research Facility" (closed in 1994 under the Base Realignment and Closure Act). A second portion was formerly known as Marumsco NWR, a

small freshwater marsh on Marumsco Creek which had been transferred from the Department of Defense to the U.S. Fish and Wildlife Service (Service) in 1973.

The Woodbridge Legislation (H.R. 4453) authorizing the Woodbridge Research Facility lands transfer from the Department of Defense to the Service, established Occoquan Bay NWR and stated general purposes for the Refuge:

"(b) The Secretary of the Interior shall use appropriate parts of this real property for (1) incorporation into the Mason Neck NWR and (2) work with the local government and the Woodbridge Reuse Committee to plan any additional usage of the property, including an environmental education center: Provided, that the Secretary of the Interior provide appropriate public access to the property."

In addition, the purpose of Marumsco NWR was for the "particular value in carrying out the national migratory bird management program" (16 U.S.C. §667b: An act authorizing the transfer of certain real property for wildlife, or other purposes).

The Refuge CCP (1997) considered and combined the founding legislation for Marumsco NWR, and H.R. 4453, and interpreted and defined the purposes of Occoquan Bay NWR as follows:

1. As a refuge and breeding area for migratory birds, interjurisdictional fisheries, and endangered species;
2. As an outdoor classroom to provide the public with educational opportunities relating to fish and wildlife resources; and
3. For other compatible recreational uses including: fishing, wildlife observation, interpretation, and wildlife photography.

Other pertinent authorities and legal mandates to the management of the Refuge include:

The Refuge Recreation Act of 1962 (16 U.S.C. 460K) authorizes the Secretary of the Interior to administer such areas for public recreation as an appropriate incidental or secondary use only to the extent that it is practicable and not inconsistent with the primary objectives for which the area was established. The USFWS has recently published redefined guidance on these appropriate/secondary uses. The new compatibility use policy states that a use may be determined to be compatible, if it will not materially interfere with or detract from the purpose(s) for which the Service lands unit was established, goals of the National Wildlife Refuge System, and the objective of the Service lands unit.

The National Wildlife Refuge System Administration Act of October 15, 1966, (16 U.S.C. 668 dd-ee; 80 Stat. 927), as amended by the National Wildlife System Improvement Act of 1997, which consolidated the various categories of land administered by the Secretary of the Interior through the Service into a single National Wildlife Refuge System. The Act establishes a unifying mission for the Refuge System, a process for determining compatible uses of refuges, and a requirement for preparing comprehensive conservation plans. This Act states first and foremost that the mission of the System is focused singularly on wildlife conservation. This Act identifies six priority wildlife-dependent recreation uses (hunting, fishing, wildlife observation and photography, and environmental education and interpretation); and reinforces and expands the "compatibility standard" of the Refuge Recreation Act. In 1997, Congress passed the National Wildlife Refuge System Improvement Act, establishing a unifying mission and a wildlife-first mandate for the Refuge System. The Refuge Improvement Act declares that all existing and

proposed public uses must be compatible with each Refuge's purposes, and highlights six priority public uses that each refuge should evaluate for compatibility. These include wildlife observation, photography, interpretation, environmental education, hunting and fishing. The new act also required that all refuges prepare a Comprehensive Conservation Plan by 2012.

The National Wildlife Refuge System Centennial Act (Public Law 106-408, November 21, 2000. The purpose of the legislation was to: (1) to establish a commission to promote awareness by the public; (2) to develop a long-term plan to meet the priority needs; (3) to require an annual report on the needs of the System; and (4) to improve public use programs and facilities.

1.3 Relationship to Other Refuge Plans

A. Comprehensive Conservation Plan (CCP)

In December, 1997, the U.S. Fish and Wildlife Service (Service) published the final Comprehensive Conservation Plan (CCP) for Occoquan Bay NWR. This HMP is a step-down plan, providing refuge objectives and strategies, and implementation schedules, for meeting goals identified in the CCP. This HMP provides a long-term vision for managing habitat for resources of concern at Occoquan Bay NWR, and addresses the contribution of this Refuge to ecosystem- and landscape- scale wildlife and biodiversity conservation. This Plan is intended to set the direction for Refuge habitat management for the next 15 years (2007-2022), with reviews and updates made to the Plan every 5 years. Refuge staffs will exercise principles of adaptive management in determining if habitat management practices are meeting this Plan's objectives. Staff may modify management activities, and/or Plan objectives, as a result of habitat monitoring and assessment, or significant changes in biological priorities.

B. Fire Management Plan (FMP)

A FMP (and accompanying Environmental Assessment) was written and approved in 2001 and revised in 2009, as mandated by the U.S. Fish and Wildlife Service (Service) policy for any refuges that have "vegetation capable of sustaining fire". The fire plan addresses wildland and prescribed fire events and activities with guidelines on the level of protection needed to ensure safety, protect facilities and resources, and restore and perpetuate natural processes.

C. Deer Management Plan (DMP)

The U.S. Fish and Wildlife Service plans to regulate the growth of the white-tailed deer population on the Refuge through implementation of a deer management plan. The plan strives to protect and maintain the unique biota, species diversity, and biological communities dependant upon the Refuge grasslands and wetland habitats by managing the deer herd within the carry capacity of the Refuge. An environmental assessment (EA) examined potential strategies, benefits, and programs to manage the deer herd on the Refuge as defined in the Comprehensive Conservation Plan (CCP) within a relative index of approximately 50-75 deer. A sound deer management program will help achieve resource management objectives of the CCP and Environmental Assessment for the Occoquan Bay National Wildlife Refuge (December 1997). White-tailed deer management on Occoquan Bay NWR was begun in 2001; the plan was amended in 2007 to include cumulative impacts in response to the 2003 lawsuit by Fund for Animals.

D. Annual Habitat Management Plan (AHMP)

An AHMP is a brief plan, which identifies the previous year management action accomplishments

and results and their contribution to the HMP. It also outlines the specific management treatments and actions that are being planned for the upcoming year. The AHWP is a step-down plan from the HMP. An AHMP will be written pursuant to this HMP.

1.4 Relevant State and Regional Plans

A. USFWS Migratory Bird Program (MBP) Strategic Plan

The Migratory Bird Program completed a 10-year strategic plan in January 2004 (USFWS 2004). The strategic plan seeks to conserve and manage migratory bird populations and their habitats, and refuges can provide high quality habitat for many migratory birds. Two strategies to achieve these goals are bird population monitoring and habitat management. Refuges contribute to these strategies by conducting biological surveys and managing habitat on a local scale. The Occoquan Bay NWR HMP will use, to the maximum extent practicable, standardized monitoring protocols and habitat assessments, thus contributing to region-wide assessments of population trends and effects of habitat management on migratory birds.

B. North American Bird Conservation Initiative (NABCI)

The Initiative brings together the landbird, shorebird, waterbird, and waterfowl plans into a coordinated effort to protect and restore all native bird populations and their habitats in North America. Conservation partnerships reduce redundancy in the structure, planning and implementation of conservation projects. The Initiative utilizes Bird Conservation Regions (BCRs) to guide landscape scale, science-based approaches to conserving birds and their habitats. Conservation planning within BCR 30 was initiated in winter of 2005; a draft **"**Mid-Atlantic/southern New England Bird Conservation Region (BCR 30) Implementation Plan" was issued in the fall of 2006. This HMP addresses draft bird conservation priorities set forth in this preliminary BCR30 planning document.

C. Partners in Flight Landbird Conservation Plan for Physiographic Area 44, Mid-Atlantic Coastal Plain

The Occoquan Bay NWR Habitat Management Plan also addresses priorities set forth in the Partners in Flight (PIF) Physiographic Area 44 Plan, as it provides a more local, less generalized, physiographic perspective than the BCR30 plan.

D. Recovery Plans

Occoquan Bay NWR follows recovery plan guidelines for the management of the federally threatened Bald Eagle (USFWS 1982, rev. 1990). The Refuge Complex actively manages three active and two historic sites for Bald Eagles and works with partners to manage three off-Refuge sites.

E. State Comprehensive Wildlife Conservation Plan

In 2001, Congress established a new "State Wildlife Grants" (SWG) program that provided funds to state wildlife agencies for the conservation of fish and wildlife and their habitats. Each state is charged with developing a Comprehensive Wildlife Conservation Plan by October 2005. The Virginia Department of Game and Inland Fisheries recently completed their State Comprehensive Wildlife Conservation Plan. Through this process the State identified which species and habitats are in greatest need of conservation; the plan provides a comprehensive guide to wildlife and habitat conservation and management. This HMP considers conservation priorities set forth in this comprehensive document.

1.5 Chesapeake Bay/Susquehanna River Ecosystem Priorities

The Refuge lies within the Chesapeake Bay/Susquehanna River watershed; the Occoquan and Potomac Rivers are significant tributaries of the Chesapeake Bay. The Chesapeake Bay watershed covers 64,000 square miles, encompassing portions of DE, MD, PA, NY, VA, and WV. The primary challenge to all Chesapeake Bay stewards is to support bay water quality, and conserve, protect and enhance the fish and wildlife and their habitats within the watershed. The following priorities establish the framework for Service efforts and management in the Chesapeake/Susquehanna watershed:

- Wetlands Resource Priority – Protect or restore vegetated palustrine and riverine wetlands with emphasis on the seven areas identified in Recent Wetlands Status and Trends in the Chesapeake Bay Watershed (Tiner 1994)
- Non-Game Birds Resource Priority – Reverse the decline of migratory bird populations identified in Migratory Non-game Birds of Management Concern in the Northeast (Schneider and Pence 1992) including grassland species and other migrant Neotropical birds
- Waterfowl and other Migratory Game Birds Resource Priority – Restore waterfowl populations to 1970s levels by the year 2000 as identified in the North American Waterfowl Conservation plan and the Chesapeake Bay Waterfowl Policy & Conservation plan

- Interjurisdictional fisheries – Restore and maintain self-sustaining populations of anadromous species (American shad, hickory shad, river herring, striped bass, and Atlantic sturgeon), coastal migratory fishes identified in the Atlantic Coastal Fisheries Cooperative Management Act of 1993, and those species for which the Fisheries Management Workgroup of the Chesapeake Bay Program has developed fishery conservation plans.

- Endangered Species Resource Priority – protect, monitor, and restore threatened endangered, and candidate species facing immediate or serious decline

II. Background

2.1 Refuge Location and General Description

The Occoquan Bay National Wildlife Refuge (OBNWR) is approximately 265 hectares (644 acres) in size, and is located in Prince William County, Virginia (Figure 1). The Refuge is positioned on the Coastal Plain Geological Province and is bordered by the sandy, river shoreline of Belmont Bay and Occoquan Bay of the Potomac River and the marshy tidal flats of Marumsco Creek. A relatively recent aerial photograph of the Refuge is found in Figure 2 (September 2005, Source: USGS, http://seamless.usgs.gov/index.php). A map of the refuge, including current facilities, roads, trails, and parking areas is found in Figure 3.

Figure 1. Refuge vicinity

Figure 2.

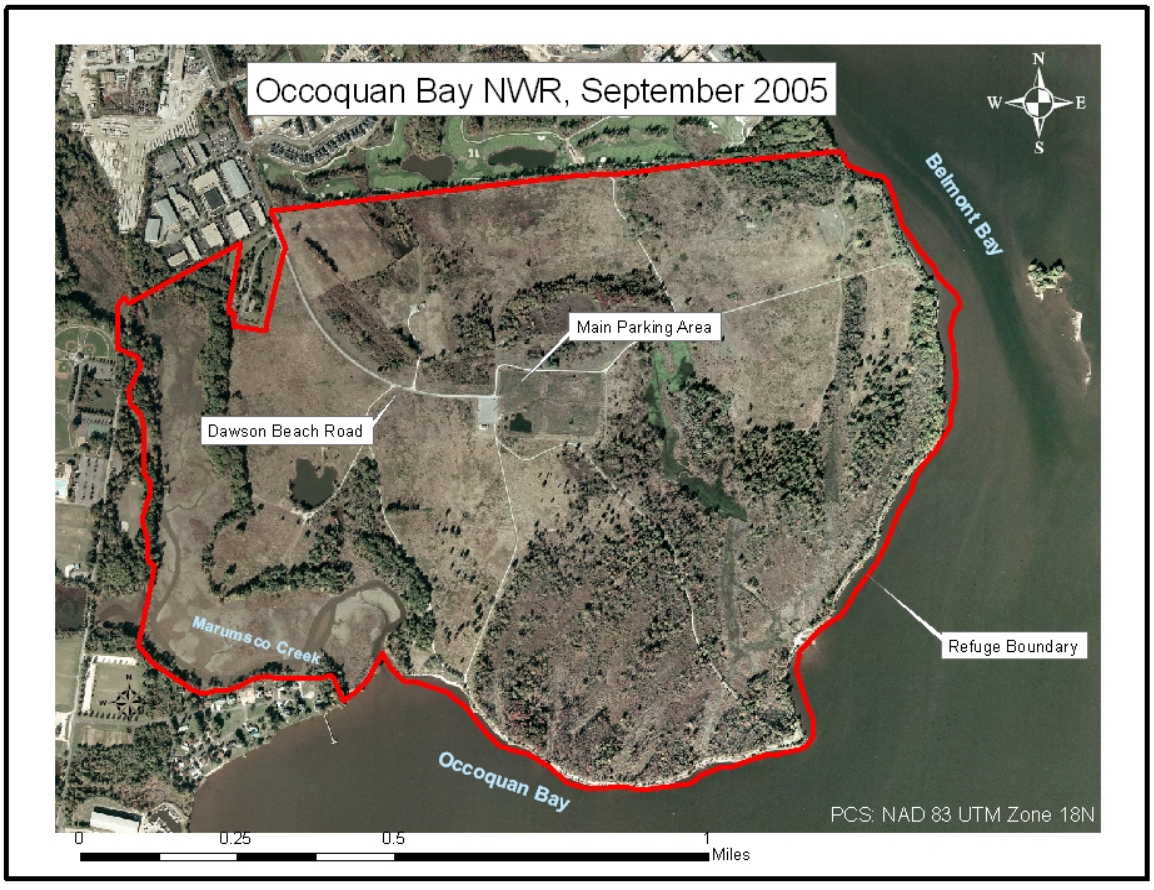


Figure 3. Occoquan Bay NWR facilities map.

According to a somewhat outdated, jurisdictional wetlands delineation of the site (1991), wetlands cover about 43% of the Refuge. These habitats are primarily shrub-scrub and emergent, tidal wetlands, and hydrologically linked to either Belmont or Occoquan Bay. A single, 107 hectare (265 acre) wetland complex was delineated, extending to the southeast from the Refuge entrance to the shoreline, containing nontidal, emergent, wet meadow and scrub-shrub habitats in its upper reaches, small streams, and shrubby and emergent tidal wetlands in the central and southeastern portions of the complex. Islands of tidally influenced, young bottomland hardwood forest were also described for the southernmost reaches of this system.

The western edge of the Refuge contains a 25.9 hectare (64 acre) tidal marsh along Marumsco Creek, bordered by about 10 hectares (24.7 acres) of dry, oak-hickory-beech forests. Upland successional meadows comprise almost half of the Refuge, including grasslands dominated by native warm-season grasses and forbs, as well as scrub-shrub areas dominated by invading tree saplings. The remaining vegetated areas consist largely of young, streamside forest, or shrublands (see Figure 4 for an approximate map of current land cover types on the Refuge).

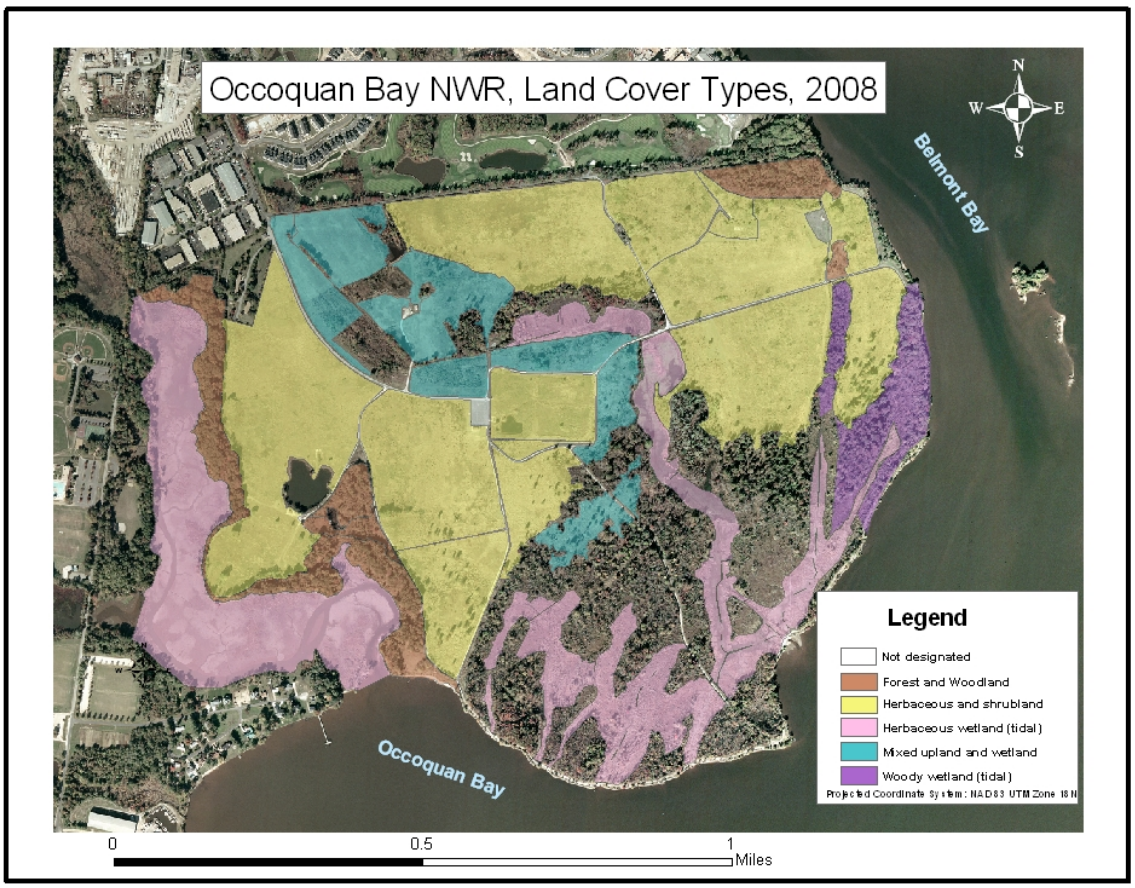
Noted for its grassland nesting birds, neo-tropical migrants and raptors, the Refuge also hosts wildlife common to Virginia. Over 220 species of birds, over 600 species of plants, and 65 species of butterflies have been documented on the Refuge. Many of the bird species are uncommon or rare in the region.

2.2 Geographical Setting

A. Geology

The Refuge is located on unconsolidated sands, clays, and silts of the Atlantic Coastal Plain Physiographic Province. The sediment is composed primarily of terrace and alluvial deposits from the current and ancestral Potomac River. Cobbles and gravels derive originally from the ancestral Potomac River and include a variety of cherts, rhyolite, silicified sand stone, and quartz. Tributary streams such as the Occoquan River and Marumsco Creek also carry this material as they cut through the adjacent cobble deposits and quartz float and veins of the Piedmont Plateau and Coastal Plain Physiographic Provinces. The sediments are underlain by undifferentiated Paleozoic.

Figure 4. Current land cover types



meta-sedimentary and meta-igneous rocks. Locally, the unconsolidated sediments include the Potomac Group of the Cretaceous age, which are overlain by terrace and alluvial deposits of Pleistocene and Holocene age.

The general soil types found on the Refuge are the Dumfries-Lunt-Marr soil association (Prince William County USDA Soil Survey 1989). Six soil types have been identified on the Refuge during on-site surveys, and are described in Chapter 2.5.

B. Biophysical Ecoregion

The Nature Conservancy has delineated the continental United States into 63 ecoregions—large geographic areas that share similar geologic, topographic, ecological, and climatic characteristics. These ecoregions are a modification of the U.S. Forest Service "Bailey System." Occoquan Bay NWR is in Ecoregion 58, the Chesapeake Bay Lowlands (Figure 5). This ecoregion includes most of Delaware, all of the coastal plain in Maryland, Washington, D.C., and coastal Virginia south to the James River. The landscape of the ecoregion to the west of the Bay, which encompasses Occoquan Bay NWR, is characterized by a broad plain with generally low slopes and gentle drainage divides, dissected by a series of major rivers – the Patuxent, the Potomac, the Rappahannock, the York and the James – that form a series of large, parallel peninsulas running into the Bay. The western shore in Maryland and Northern Virginia is dominated by urban/suburban development around and between Washington, D.C., Baltimore and Annapolis. Hundreds of years of land clearing, agriculture, and widespread development has fragmented the landscape and eliminated large areas of forest (The Nature Conservancy 2002).

The Draft Chesapeake Bay Lowlands (CBY) Ecoregional Plan identifies 113 terrestrial, natural community types in the ecoregion (TNC 2002). Terrestrial community targets were set at the *association* level of the National Vegetation Classification (NVC; Grossman et al., 1998); however, every association was further lumped into a coarser scale vegetation system or group, of which 18 were identified. The plan identifies *all* of these communities as conservation targets; the goal is to conserve viable, high-quality examples of all communities at their appropriate scales, and in numbers relative to their importance, in terms of their abundance and distribution within the ecoregion and throughout their range. The plan then identifies minimum numerical conservation goals of each of these communities in the ecoregion, that is, target numbers of viable, healthy examples of each natural community.

Current progress towards meeting these conservation goals is found in Table 2-1. At present, 14 of the 18 vegetation groups have not exceeded 30% of numerical goals for the ecoregion. Terrestrial communities representing at least 6 of these community groups occur at Occoquan Bay NWR: Dry-Mesic Oak Forests, Alluvial Forests and Shrublands, Freshwater Nontidal Marshes, Tidal Swamp Forests, Tidal Shrublands, and Tidal Marshes. Unfortunately, their current size and degraded conditions - small, linear, and/or fragmented, historically impacted by clearing and/or hydrologic alteration – may prevent some of these Refuge communities from contributing significantly towards the CBY Ecoregional Plan community goals. Future restoration activities on the Refuge may help the Refuge make more meaningful contributions.

Figure 5.

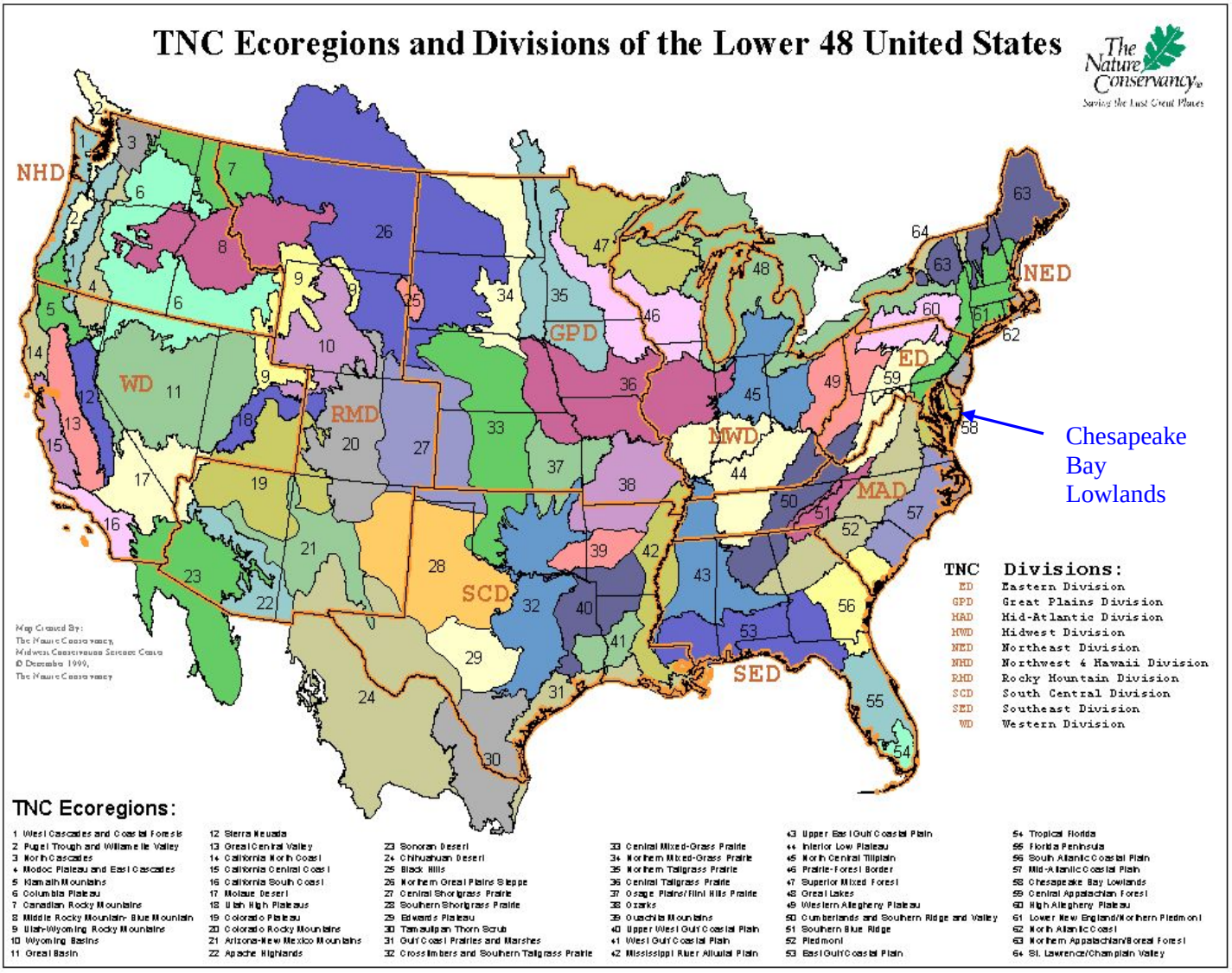

TNC Ecoregions and Divisions of the Lower 48 United States
The Nature Conservancy
Saving the Last Great Places
NHD
NED
GPD
ED
WD
RMD
MWD
MAD
SCD
SED
Chesapeake Bay Lowlands
TNC Divisions:
ED Eastern Division
GPD Great Plains Division
MAD Mid-Atlantic Division
MWD Midwest Division
NED Northeast Division
NHD Northwest & Hawaii Division
RMD Rocky Mountain Division
SCD South Central Division
SED Southeast Division
WD Western Division
TNC Ecoregions:
1 West Cascades and Coastal Forests
2 Puget Trough and Willamette Valley
3 North Cascades
4 Modoc Plateau and East Cascades
5 Klamath Mountains
6 Columbia Plateau
7 Canadian Rocky Mountains
8 Middle Rocky Mountain- Blue Mountain
9 Utah-Wyoming Rocky Mountains
10 Wyoming Basins
11 Great Basin
12 Sierra Nevada
13 Great Central Valley
14 California North Coast
15 California Central Coast
16 California South Coast
17 Mojave Desert
18 Utah High Plateaus
19 Colorado Plateau
20 Colorado Rocky Mountains
21 Arizona-New Mexico Mountains
22 Apache Highlands
23 Sonoran Desert
24 Chihuahuan Desert
25 Black Hills
26 Northern Great Plains Steppe
27 Central Shortgrass Prairie
28 Southern Shortgrass Prairie
29 Edwards Plateau
30 Tamaulipan Thorn Scrub
31 Gulf Coast Prairies and Marshes
32 Cross Timbers and Southern Tallgrass Prairie
33 Central Mixed-Grass Prairie
34 Northern Mixed-Grass Prairie
35 Northern Tallgrass Prairie
36 Central Tallgrass Prairie
37 Osage Plains/Flint Hills Prairie
38 Ozarks
39 Ouachita Mountains
40 Upper West Gulf Coastal Plain
41 West Gulf Coastal Plain
42 Mississippi River Alluvial Plain
43 Upper East Gulf Coastal Plain
44 Interior Low Plateau
45 North Central Tillplain
46 Prairie-Forest Border
47 Superior Mixed Forest
48 Great Lakes
49 Western Allegheny Plateau
50 Cumberlands and Southern Ridge and Valley
51 Southern Blue Ridge
52 Piedmont
53 East Gulf Coastal Plain
54 Tropical Florida
55 Florida Peninsula
56 South Atlantic Coastal Plain
57 Mid-Atlantic Coastal Plain
58 Chesapeake Bay Lowlands
59 Central Appalachian Forest
60 High Allegheny Plateau
61 Lower New England/Northern Piedmont
62 North Atlantic Coast
63 Northern Appalachian/Boreal Forest
64 St. Lawrence/Champlain Valley
Map Created By:
The Nature Conservancy,
Midwest Conservation Science Center
© December 1999,
The Nature Conservancy

Table 2-1. Assessment of success towards identifying viable examples of each natural community target (TNC 2002).

No.	Group Name	NVC Assoc. in CBY	w/EOR's	Total Occurrences All	Viable	Success by Group Goal	%
1	Dry-Mesic Oak Forests	5	3	3	2	20	10
2	Mesic Hardwood Forests	6	5	27	15	50	30
3	Evergreen or Mixed Coastal Plain Forests	6	6	42	34	39	87
4	Alluvial Forests and Shrublands	6	2	2	2	65+	3
5	Cypress-Gum Swamps	2	1	6	2	20	10
6	Nonalluvial Wetland Forests	10	8	43	25	115	22
7	Woody Vegetation of Coastal Plain Ponds	4	3	32	21	55	21
8	Herbaceous Coastal Plain Ponds	10	7	32	22	95	38
9	Sea-level Fens	1	1	9	8	10	80
10	Freshwater Nontidal Marshes	5	0	6	3	23	13
11	Tidal Swamp Forests	2	2	7	5	24	21
12	Tidal Shrublands	2	1	2	1	8	13
13	Tidal Marshes	27	15	59	41	156	26
14	Submerged Saline Tidal	3	0	0	0	25	0
15	Maritime Shrub	7	3	5	4	67	6
16	Interdunal Wetlands	9	7	34	31	82	38
17	Dune Grasslands/Beaches	4	2	10	8	33	24
18	Dune Woodlands	4	2	17	9	42	21
Totals for Ecoregion		113	68	336	233	929	25

C. Bird Conservation Region (BCR)

Migratory bird conservation has had a long history of cooperative regional and national-level conservation efforts. The latest initiatives include Partners in Flight, which seeks to conserve landbirds on biologically based regions called Physiographic Areas; and North American Bird Conservation Initiative (NABCI), which strives to unite all bird conservation initiatives to conserve all birds on regionally-based scale. The conservation planning units for NABCI are called Bird Conservation Regions, and are generally larger than the PIF Physiographic Areas. Occoquan Bay NWR is in Bird Conservation Region 30 (Figure 6), the New England/Mid-Atlantic Coast region. BCR 30 supports some of the highest human population densities in the United States. Nearly 95% of the original habitat types have been lost to agriculture and urban development (Dettmers and Rosenburg 2000). The draft BCR30 Implementation Plan (Steinkamp 2006) lists **coastal marsh** and **mature forested habitats** as the highest priority habitats within the BCR due to development pressures, rate of loss, or lack of information on rate of loss and present spatial distribution.

D. Partners in Flight (PIF) Physiographic Area

Occoquan Bay NWR is located in PIF Physiographic Area 44 (Figure 7), the Mid-Atlantic Coastal Plain region. PIF 44 covers 5,621,877 ha (13,891,658 ac) across Virginia, Delaware, Pennsylvania, Maryland, and New Jersey. The mid-Atlantic Coastal Plain landscape has been altered by European culture for nearly four centuries. Currently, the urban crescent from Baltimore south to Richmond and east to Norfolk is one of the fastest growing regions in North America, home to tens of millions of people. Growth is expected to continue into the foreseeable future, placing increasing demands on the regions natural resources (Watts 1999). Regional PIF Plans identify the highest priority habitats by sorting species in the PIF priority pool by habitat. These habitats are considered either in need of critical conservation attention or critical for long term planning to conserve regionally important bird populations. In PIF 44, highest priority habitats, *ranked in order of importance*, are: pine savannah, barrier and bay islands, salt marsh, forested wetland, mixed upland forest, early successional, pine plantation, and fresh/brackish

emergent wetland (Watts 1999).

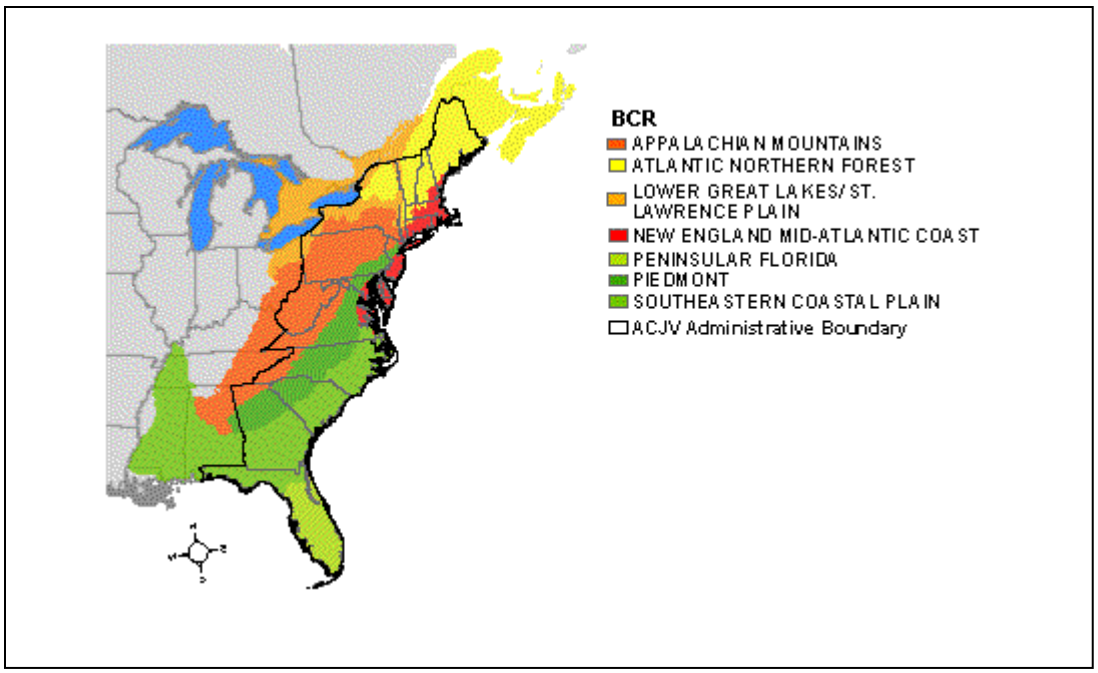


Figure 6. Bird Conservation Regions of the eastern U.S. (Source: Atlantic Coast Joint Venture).

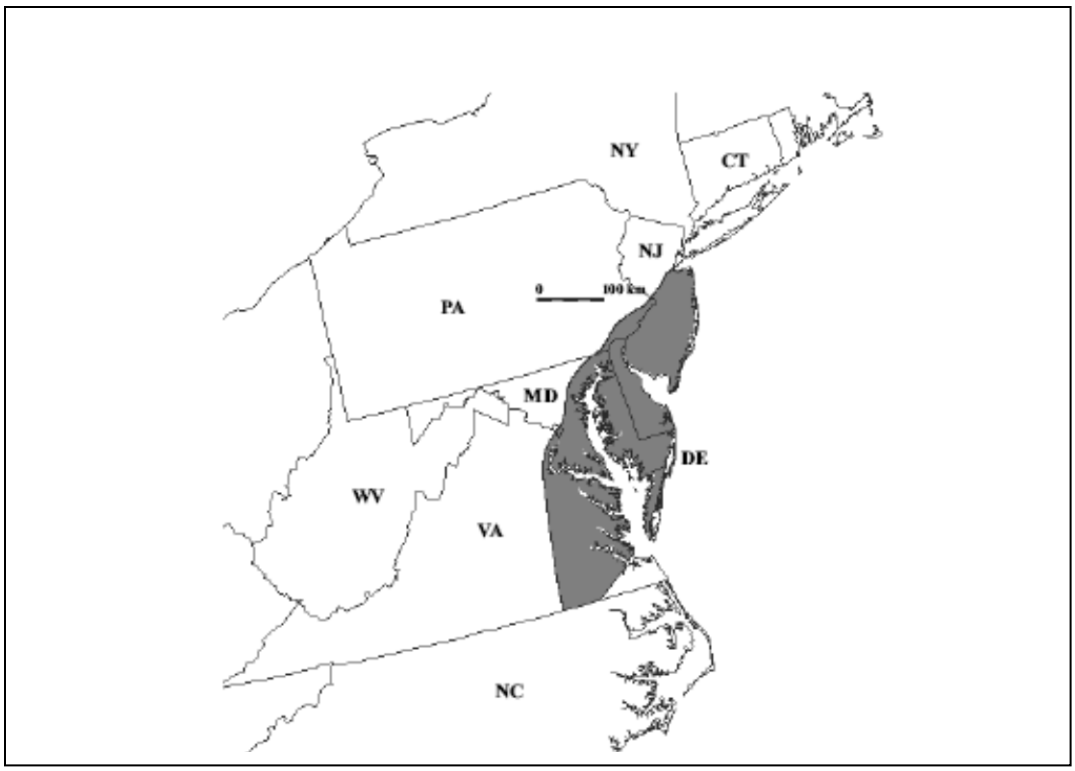


Figure 7. PIF Region 44, the Mid-Atlantic Coastal Plain Region (Source: Partners in Flight).

E. Broad Vegetation Zones

Land cover maps and data usually describe a habitat condition at a specific point in time, but not potential vegetation or successional trajectories. Maps by Kuchler (1964) depict broad *potential* vegetation zones for the conterminous U.S. Whereas cover type is a classification of existing vegetation, Potential Natural Vegetation (PNV) is a site classification based on climax vegetation. PNV is defined as the vegetation that will occupy a site without disturbance or climatic change, and is an expression of environmental factors such as topography, soils and climate across an area. Occoquan Bay NWR lies within the Oak-Hickory-Pine forest Potential Natural Vegetation Group of the southeastern U.S. (Kuchler 1964, Schmidt et al. 2002). That is, according to Kuchler, the natural successional trajectory of this region leads to dominance by forest species such as Hickory (*Carya* spp.), Shortleaf pine (*Pinus echinata*), Loblolly pine (*Pinus taeda*), White oak (*Quercus alba*) and Post oak (*Quercus stellata*).

F. Regional Conservation Context

The Refuge is one of three refuges in the Potomac River NWR Complex, which also includes Featherstone NWR and Mason Neck NWR. Together, the three Potomac River NWR refuge units protect about 3,256 acres in the mid-Potomac River, about 20 miles south of Arlington, VA/Washington D.C. Other significant conservation areas adjacent to the Potomac River NWR Complex include Mason Neck State Park (1,804 acres), Leesylvania State Park (508 acres), Gunston Hall Plantation (550 acres), Pohick Bay Regional Park (1002 acres), and BLM property (800 acres). Together, these state and Federal partners protect over 7900 acres of nearshore wildlife habitat, much of it forested, and greater than 8 miles of the Potomac River shoreline, from Pohick Bay south to Neabsco Creek.

Two incorporated cities are located near the Occoquan Bay NWR, Dumfries and Manassas, with the Refuge being located in an unincorporated city of Woodbridge. Much of the Woodbridge landscape immediately to the west of Occoquan Bay and Featherstone NWRs has been heavily developed. The I-95 corridor comes less than a mile from the Potomac River at Belmont Bay, just north of the two Refuges; consequently, much of the previously forested habitats in the Potomac River watershed in this region are becoming or have been converted to urban cover types.

Much of the remaining shoreline in the vicinity of the Potomac River NWR Complex, is either cleared for private use, or has been historically developed for Federal government/Department of Defense installations. Stations such as the Naval Surface Warfare Center at Indian Head, and U.S. Naval Ordinance Stations, across the Potomac from the Refuge, and the Quantico Marine Corps Base, consist largely of cleared, industrial/urban cover, with highly developed shorelines. An exception is the Fort Belvoir Military Reservation to the north of the Complex, which protects a significant portion of the Pohick Bay and Accontick Bay shorelines. Residential development has consumed much of the Potomac River watershed adjacent to these federal installations.

2.3 Historical Conditions, Habitat Changes over Time

A. Pre-European Settlement

Fire has reportedly played a major historic role in shaping the ecosystems of the mid-Atlantic, particularly oak-hickory-pine dominated forests, drought-prone barrens, and coastal marsh habitats, including the coastal plain (Tyndall 1992, 1994; Orwig and Abrams 1994, Kirwan and

Shugart 2000, Frost 1998, Frost 2005). Runkle (1990) indicates in a generalized scheme for the Eastern U.S., that the historic, major disturbance factors for the deciduous forest of the western shore of the Chesapeake Bay were first"gaps"(mainly single tree death), then fire and large wind events.

Some naturalists believe that prior to European contact, the landscape of much of the East contained open stands of trees and some grasslands (savannahs). Large, historic grasslands have been reported for Ohio, Pennsylvania, Maryland, western North Carolina and Virginia, as a result of human-set or naturally-occurring, low-intensity fires (Brown 2000, Tyndall 1994, Delcourt and Delcourt 1996, Latham et al. 1996). While many authors agree grasslands existed in the East, some also argue that Native American set fires (Delcourt and Delcourt 1996) in combination with wildfires, resulted in a "shifting mosaic" of open land habitat within a forested landscape in the region.

American Indians reportedly entered Virginia around 11,500 years ago (Brown 2000), coincident with a rapid post-glacial spread of oaks in the temperate forests of the region (Davis 1981). According to Kneller and Peteet (1993) and Maxwell and Davis (1972), oak and pine forest had come to dominate much of the Virginia landscape by 8,000 years ago. Fire intolerant species, such as beech and maple (Davis 1981) spread more slowly into the region. Since fire is an important factor in oak and pine regeneration (Sutherland and Hutchinson 2002), and in suppressing beech and maple (Kirwan and Shugart 2000), some authors believe that Indian fire use during the Holocene helped shape the oak-pine forests that existed at that time (Brown 2000).

The historic forest composition/structure of Virginia was likely very different from current conditions. Early colonial accounts describe larger trees (Beverley 1705), forests with an open, easily traversable understory (Smith 1624) and a mixed landscape of open forest and meadow (Percy 1607), all possibly influenced by frequent fire (Brown 2000). In addition, early explorers rarely listed fire-intolerant species such as American beech in their species accounts, but often cited disturbance-tolerant species such as oaks and pines. Jamestown colonists found enough pine, an early successional species, to support a pitch and tar industry (Brown 2000); fire dependent forests of pitch pine and Table Mountain pine were more common, at least in western Virginia, prior to European contact (Williams 1998).

Frost (1998) estimates that fire frequency in presettlement, coastal Virginia flatlands was about every 4-6 years, due to the effects of lightning and anthropogenic burning. It is likely that such fires, especially in coniferous forests, were low intensity ground fires every 1-10 years, and of stand-replacement intensity every 100-1000 years (Bond and van Wilgen 1996). Grasslands dominated by native warm season grasses and pine-oak forests are found on Occoquan Bay NWR today, and likely represent different successional stages for Kuchler's Oak-Hickory-Pine forest Potential Natural Vegetation Group.

B. European Settlement

After European settlement along the east coast land management practices changed. The intentional burning by Native Americans ceased as native peoples were decimated and most wildfires were suppressed. Suppression has had profound ecological effects on forests and grasslands in the eastern U.S. (Tyndall 1992; 1994, Abrams 1996, Latham et al. 1996, Askins 1997). In the absence of periodic fire, many eastern habitats changed rapidly from grasslands to shrublands and dense forests (Brown 2000). Fire intolerant species, such as American beech

(*Fagus grandifolia*), red maple (*Acer rubrum*), dogwood (*Cornus florida*) and blackgum (Nyssa sylvatica) have increased in distribution and abundance (Orwig and Abrams 1993, Brown 2000, Kirwan and Shugart 2000), and the absence of fires has likely fostered dense forest undergrowth. Fire-tolerant natural communities, such as oak pine forests, shortleaf or pitch-pine barrens, and eastern prairies dominated by native warm-season grasses, have undergone major changes in vegetation structure, and likely decreased (Tyndall 1992:1994).

European colonists introduced permanent settlements and political boundaries to coastal Virginia, and shifted land use from primarily subsistence farming and gathering to harvesting and export of natural resources. "Occoquan" is derived from a Dogue Indian word meaning "at the end of the water." The location of the Occoquan River, at the head of the tidewater, made the area natural site for water-borne commerce, from the earliest days of the settlement of Virginia. A tobacco warehouse was built on the river as early as 1736, and an industrial complex begun in 1750. Before the turn of the century, Occoquan had forges, water grist mills, tolling mills, a bake house, saw mills, storehouses and dwellings. By the late 1700s, much of the forests of the coastal region had been largely cleared for agriculture, especially tobacco farming (from the town of Occoquan website: http://www.occoquan.com/History/HistoryFrm.asp).

Historical records of the Refuge property date back to the late 17th century when Martin Scarlet purchased approximately 700 acres (including the Refuge) from Captain Edward Streator. The land (referred to as Deep Hole Point) was used primarily for tobacco farming for nearly a century. In 1765 the land was transferred to Colonel John Taylor in whose name the property remained until the Civil War. During the Civil War, Confederate artillery batteries were constructed in the vicinity of the Refuge. When the war ended, the Refuge land returned to farming, and farm residences and outbuildings were present on the site. Fishing ports were also located along the southern shoreline. In 1908, J. Lindsay Dawson purchased the farmland for raising cattle.

Raising cattle and commercial fishing ended in 1950 when the Army acquired title to approximately 648 acres of land for use as a military radio station (CCP Occoquan Bay NWR). The Army constructed compounds, parking lots, radio towers, recreational facilities, roads, etc. on the site, and maintained extensive open areas with frequent mowing. As noted above, the Army and/or previous land managers ditched (channelized) intermittent streams, partially or entirely obstructed tidal flows in natural drainages with culverts and water control structures, and, most notably, constructed a service road along much of the Refuge shoreline along Occoquan and Belmont Bays.

2.4 Refuge Current Conditions

A. Climate

The climate at the Refuge is influenced by the Chesapeake Bay and the Atlantic Ocean to the east and the Appalachian Mountains to the west. The weather in the Refuge area is characterized by cold, dry, continental-polar winds from the west and northwest during the winter and maritime-tropical winds from the south and southwest during the spring and summer, which brings warm, often humid air to the region. During the summer, occasional air pollution episodes are created when high-pressure systems stagnate over the area.

Rainfall averages about 39 inches per year, and is evenly distributed throughout the year. January, February, and April are the only months with less than three inches of precipitation. Snowfall averages less than 10 inches per year. The maximum recorded snowfall of 25 inches fell

in January 1922 (NRMP, 1991). The annual mean daily temperature for the area is 57°F. The monthly mean temperature ranges from 29°F in January to 90°F in July. The growing season, based on average first and last killing frosts, is from April 15 to October 15 (ESE, 1981). Prevailing winds are generally from the south in the summer months and the north to northwest in the winter months. The average wind speed is 7.1 miles per hour (mph). The Refuge is infrequently subject to strong coastal storms - hurricanes or tropical storms in the late summer, and northeasters in the colder months.

B. Soils

The Refuge was not included in the *Soil Survey of Prince William County, VA* (USDA, 1989), likely for reasons of restricted access to the property when it was in use by Department of Defense. As of 2007, there was no soil survey of the Refuge. In May, 2007, Louis W. Heidel, Soils Resource Specialist from the USDA, Natural Resources Conservation Service, Harrisonburg Area Office, generously volunteered to conduct a general soil survey of the Refuge. Mr. Heidel evaluated 24 borings across the Refuge (or approximately one boring per 27 acres), focusing primarily in non-forested or upland areas, and describing approximate depths to seasonal high water tables (see soil drainage features, Figure 8).

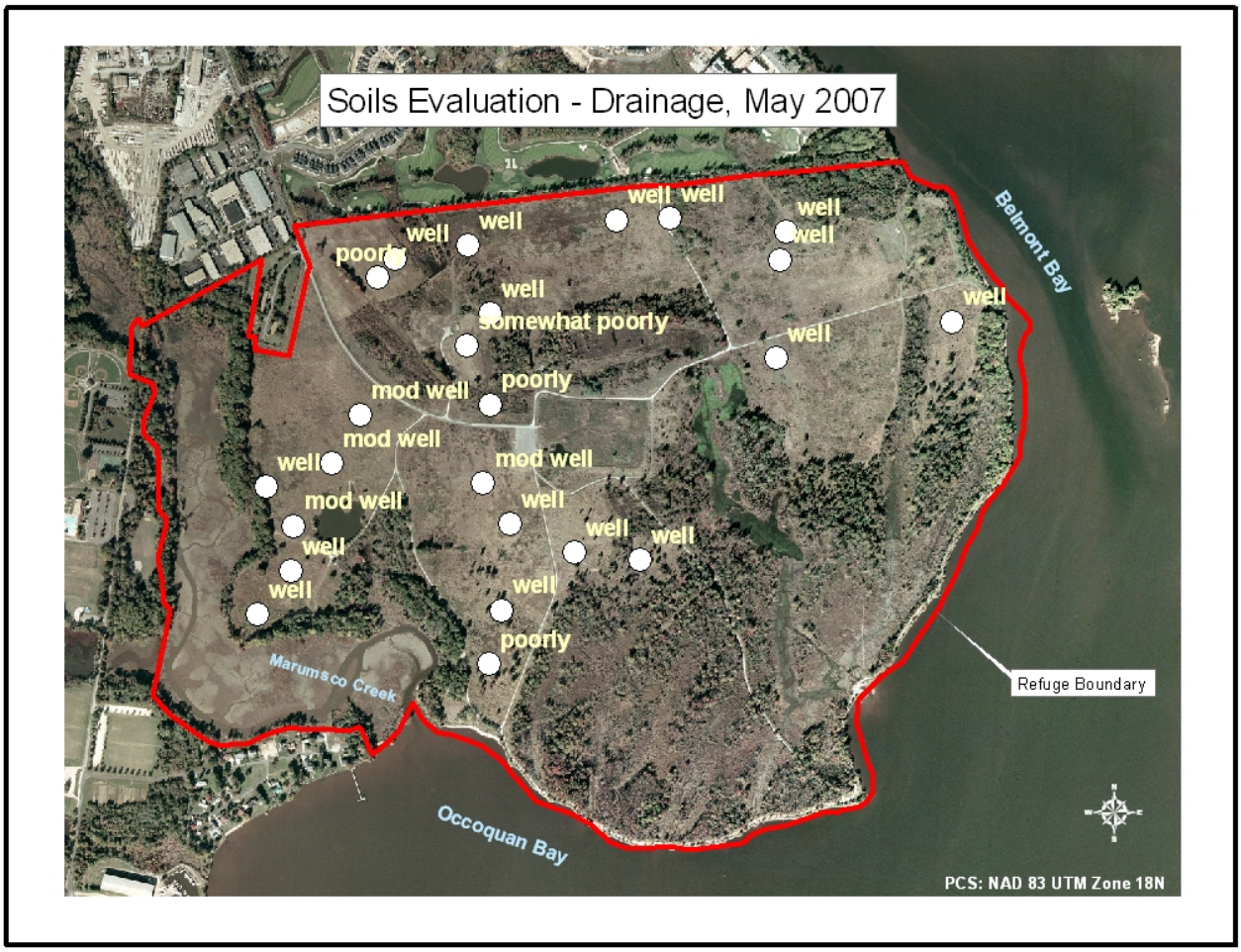


Figure 8. Soil borings at Occoquan Bay NWR, evaluated by NRCS, 2007.

Mr. Heidel constructed a generalized soils map of the Refuge (Figure 9). The soil Map Units assigned to Occoquan Bay NWR by USDA NRCS during the 2007 site visit can be cross-referenced with their physical descriptions in Appendix A. Additionally, a table describing the dominant soil types, per habitat management unit of the Refuge, is found in Section 2.6 (Habitat Management Units).

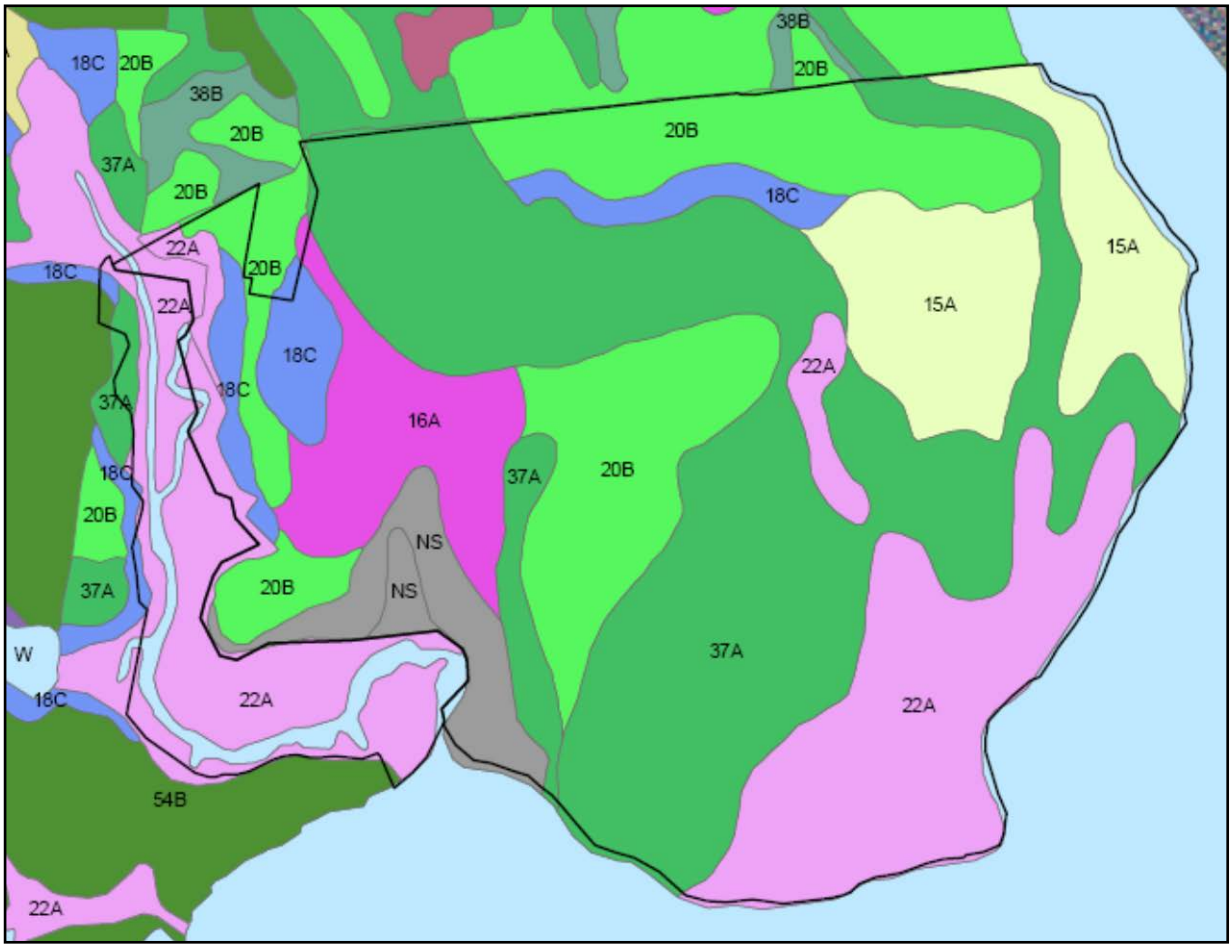


Figure 9. A generalized soils map of Occoquan Bay NWR, as constructed by Louis Heidel, USDA, and digitized by Rick Schauffler of Region 5 USFWS.

C. Hydrology – Wetlands

A comprehensive jurisdictional wetlands delineation of the site was conducted during November/December 1991 (CH2M Hill), using the procedure outlined in the 1987 Corps of Engineers Wetlands Delineation Manual. All delineated wetlands were mapped (Appendix B) and major wetland complexes were described. The Refuge was described as containing 2 major

wetlands complexes/drainages. One area is the 64-acre Marmusco Creek tidal mashland, vegetated with shrubby and emergent tidal freshwater communities, such as areas of swamp rose (*Rosa palustris*), button bush (*Cephalanthus occidentalis*), silky dogwood (*Cornus amomum*), and black willow (*Salix nigra*), and emergent areas of marsh mallow (*Hibiscus moscheutos*), pickerelweed (*Pontedaria cordata*), and wild rice (*Zizania aquatica*). The other is the large wetland complex encompassing much of the southeastern quarter of the Refuge. This system is primarily nontidal emergent in its upper reaches, and contains an unnamed stream, becoming tidal and shrubby as it nears Occoquan Bay, with islands of young green ash (*Fraxinus pennsylvanica*), sycamore (*Platanus occidentalis*), red maple (*Acer rubrum*), and black willow (*Salix nigra*).

The Refuge biological program does not manage wetland hydrologic processes on the site; unlike many east coast refuges, the Refuge does not contain constructed waterbird management impoundments. Nevertheless, certain tidal and nontidal stream channels have been altered and hydrologic processes restricted, through road construction, culvert placement, and filling activities that likely took place during the time interval between the 1950's and transfer of the property to FWS in 1998. Recent beaver activity has amplified these alterations.

D. Environmental Contaminants

According to Fred Pinkney of the FWS Chesapeake Bay Field Office, following the closure of U.S. Army operations at the Refuge in the early 1990s, cleanup was conducted with the guidance of a Base Realignment and Closure Act (BRAC) Cleanup Team, beginning in 1993. Four operable units (OUs) were originally established on the site, and these included a total of 49 Areas Requiring Environmental Evaluation (AREEs). "No further action" decisions were reached at 39 of the 49 AREEs and the remaining ten were included in Operable Unit 1 (24-acres near Lake Drive, Marumsco Creek, and Occoquan Bay) and Operable Unit 3 (Main Drainage Ditch). Decision documents were signed in 1997 and remedial actions were conducted in OUs 1 and 3, beginning in 1998. In OU1, the most serious contamination occurred in AREE 1. PCB-contaminated soil was removed, a cap was constructed and the soil was stabilized. Other activities in the remainder of OU1 included the removal of surface debris and PCB-contaminated soils. In OU3, sediments from the ditch were removed to a cleanup level of 1 ppm total PCBs. A long-term monitoring program was started for both OU1 and OU3. It involved groundwater, surface water, and biota evaluations.

In 2003, the first five year review was conducted. For OU1, the conclusions were that additional groundwater monitoring at AREEs 2,3,5,6A, and 6B should be discontinued. Continued groundwater monitoring for cobalt at AREE 4 was recommended. At AREE 1 continued groundwater, surface water, runoff, and sediment monitoring was recommended as well as biota sampling of the pond. For OU3, it was recommended that the frequency of groundwater monitoring be reduced to annual and that monitoring of surface water, sediment, and biota continue.

A second 5-year review was conducted in 2008. At this point, the major issue is the continued detection of PCBs in soil samples at AREE1 in excess of the 1 ppm wetland cleanup level (range of about 2 to 12 ppm). Additional sampling has been conducted to estimate whether contaminant concentrations below the surface layer are of concern. It does not appear that there will be substantive concerns about OU3.

E. Vegetative communities

As mandated for all Department of Interior Agencies, the National Wildlife Refuge System has adopted the National Vegetation Classification System (NVCS) developed by The Nature Conservancy and the Natural Heritage Network as its standard system for classifying vegetation communities. This classification system is based on hierarchical levels so that it can be used on the finest or coarsest level as needed. The finest level of classification is "Association", defined as "a plant community of definite floristic composition, uniform habitat conditions, and uniform physiognomy." Some refuges in Region 5 are currently grouping Associations into higher-level (and not necessarily NVCS) "Habitat Types", which are more structural in nature, to guide management objectives and prescriptions.

To date, the Service has not yet developed NVCS vegetation maps, using the vegetation types of the Chesapeake Bay Lowlands Ecoregion, for Occoquan Bay NWR. The most recent plant community characterizations were conducted by Todd Waltemeyer (DOD), and Elaine Haug and Nicky Staunton of the Virginia Native Plant Society, as part of the Environmental Assessment for the Woodbridge Research Facility Disposal, August 1995 (USACOE 1995). The authors divided the Refuge into 20 different "Areas" and described the vegetative community for each area in narrative descriptions, including: community size, generalized hydrologic regime (e.g. upland, seasonally wet, tidal), and commonly observed species (Appendix B).

Ecological Systems represent recurring groups of biological communities that are found in similar physical environments and are influenced by similar, dynamic ecological processes, such as fire or flooding (NatureServ). Ecological Systems may also be combined into higher level, structural habitat categories (e.g. "Land Cover Class") that can be used to guide management objectives and prescriptions. These approximate NVCS ecological systems are used in the development of habitat objectives in Chapter 4. Table 2-2 shows the crosswalk between the 1995 "Area" designations, NVCS Ecological Systems, and NVCS Land Cover Classes. Table 2-3 summarizes this information (as surveyed in 1995), for the Refuge. As will be seen in Section 2.5, Refuge biological staff roughly incorporated these areas into geographically-referenced habitat management units, with some inconsistencies in acreages. The inconsistencies stem from the fact that some wooded portions of the Refuge (primarily wet shrublands or islands of tidal swamp) remain relatively undescribed and have not been ascribed habitat management units (see Section 2.5).

F. Altered Habitats

The ecological processes (e.g., tidal cycles, wildfires) of both the wetland and upland communities on the Refuge have been highly disturbed. Following European settlement, uplands at Occoquan Bay NWR were converted from mainly oak-hickory-pine forest to agricultural lands, used for grazing and tobacco production. In the past century, previous land managers have ditched (channelized) intermittent streams, likely reducing the extent and duration of flooding or saturation in adjacent, non-tidal wetland areas. Previous managers also partially or entirely obstructed tidal flows with culverts and water control structures (e.g. when constructing roads), and converted tidal wetlands into nontidal systems (e.g. converting tidal emergent or woody wetlands to nontidal ponds). As a result, fish passage has certainly been restricted, and reduced sediment transport may have affected the tidal marshes on the Refuge. Also, culverts made it easier for beavers (who have recently staged a comeback in the region) to restrict or block tidal flows in tidal wetlands.

Table 2-2. "Area" types for Occoquan Bay NWR, crosswalked with current NVCS Ecological Systems, and NVCS Land Cover Classes.

Area	Acres	Approximate NVCS Ecological System	Land Cover Class	Brief description
1	30	Northern Atlantic Coastal Plain Stream and River	Mixed Upland and Wetland	Small gradient stream and river, floodplain development, mosaic of forests, shrublands, and herbaceous communities
2	7	Unclassified early successional wetland	Herbaceous Wetland	(Artificial – mowed wet meadow)
3	103	Unclassified early successional upland	Herbaceous and Shrubland	(Artificial – cleared and mowed)
4	7	Northern Atlantic Coastal Plain Stream and River	Mixed Upland and Wetland	Small gradient stream and river, floodplain development, mosaic of forests, shrublands, and herbaceous communities
5	7	Unclassified early successional wetland	Herbaceous wetland	(Artificial – mowed wet meadow)
6	21	Northern Atlantic Coastal Plain Tidal Swamp	Woody wetland	Tidally flooded deciduous forests and shrublands; along upper reaches of inner coastal plain rivers; salinity levels below 0.5 ppt
7	11	Unclassified early successional upland	Herbaceous and Shrubland	(Artificial – cleared and mowed)
8	120	Northern Atlantic Coastal Plain Fresh and Oligohaline Tidal Marsh; also inclusions of Northern Atlantic Coastal Plain Tidal Swamp	Herbaceous Wetland; also inclusions of Woody wetland	Freshwater tidal vegetation; includes tall marshes dominated by grasses such as *Zizania aquatica*, and characteristic forbs such as *Amaranthus cannabinus*, *Hibiscus moscheutos*, and rooted aquatics such as *Peltandra virginica*
9	17	Unclassified early successional upland	Herbaceous and Shrubland	(Artificial – cleared and mowed)
10	38	Unclassified early successional upland	Herbaceous and Shrubland	(Artificial – cleared and mowed)
11	15	Northern Atlantic Coastal Plain Stream and River	Mixed Upland and Wetland	Small gradient stream and river, floodplain development, mosaic of forests, shrublands, and herbaceous communities
12	14	Unclassified early successional upland	Herbaceous and Shrubland	(Artificial – cleared and mowed)
13	153	Unclassified early successional upland	Herbaceous and Shrubland	(Artificial – cleared and mowed)
14	4.5	Northern Atlantic Coastal Plain Dry Hardwood Forest	Forest and Woodland	Dry hardwood forest, dominated by oaks, acidic, sandy or gravelly soils, thick duff layer
15	9	Northern Atlantic Coastal Plain Tidal Swamp	Woody Wetland	Tidally flooded deciduous forests and shrublands; along upper reaches of inner coastal plain rivers; salinity levels below 0.5 ppt
16	2	Northern Atlantic Coastal Plain Tidal Swamp	Woody Wetland	Tidally flooded deciduous forests and shrublands; along upper reaches of inner coastal plain rivers; salinity levels below 0.5 ppt
17	4	OPEN WATER - POND		
18	10	Northern Atlantic Coastal Plain Dry Hardwood Forest	Forest and Woodland	Dry hardwood forest, dominated by oaks, acidic, sandy or gravelly soils, thick duff layer
19	3	Northern Atlantic Coastal Plain Stream and River	Mixed Upland and Wetlands forest	Small gradient stream and river, floodplain development, mosaic of forests, shrublands, and herbaceous communities

20	74	Northern Atlantic Coastal Plain Fresh and Oligohaline Tidal Marsh	Herbaceous wetland	Freshwater tidal vegetation; includes tall marshes dominated by grasses such as *Zizania aquatica*, and characteristic forbs such as *Amaranthus cannabinus*, *Hibiscus moscheutos*, and rooted aquatics such as *Peltandra virginica*

Table 2-3. Habitat types summarized from Table 2-2, for Occoquan Bay NWR.

Approximate NVCS Ecological System	**Land Cover Class**	**Approximate acreage**
Northern Atlantic Coastal Plain Stream and River	Mixed Upland and Wetland	22.26 hectares (55 acres)
Unclassified early successional wetland	Herbaceous Wetland	5. 67 hectares (14 acres)
Unclassified early successional upland	Herbaceous and Shrubland	135.9 hectares (336 acres)
Northern Atlantic Coastal Plain Tidal Swamp	Woody Wetland [1]	12.9 hectares (32 acres)
Northern Atlantic Coastal Plain Fresh and Oligohaline Tidal Marsh	Herbaceous Wetland [2]	78.5 hectares (194 acres)
Northern Atlantic Coastal Plain Dry Hardwood Forest	Forest and Woodland	5.87 hectares (14.5 acres)

In addition, previous land owners constructed a service road ("Deephole Point Road"), along much of the Refuge shoreline adjacent to Occoquan and Belmont Bays, disrupting tidal influence in bottomland hardwood and shrub-scrub wetlands along the shore, and reducing the habitat quality for shoreline wildlife (e.g. nesting terrapins). Upland forests that had been historically cleared for agricultural purposes, were, until recently, heavily mowed, to provide recreational facilities, lawns, and other open compounds. Some of these areas have succeeded to native warm season grasses or upland shrub-scrub communities; many open fields are becoming invaded by upland, exotic, invasive plants, such as Canada thistle (*Cirsium arvense*), Nepalese browntop (*Microstegium vimineum*), mile-a-minute weed (*Polygonum perfoliatum*), Bradford pear (*Pyrus calleryana)*, as well as native, early successional woody plants such as sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*) or Eastern red cedar (*Juniperus Virginiana*).

In the spirit of the NWRS Policy regarding Biological Diversity, Integrity and Environmental Health (601 FW 3), over time, the Refuge will work to restore ecological integrity of these natural communities, where possible.

G. Rare Plants and Exemplary Natural Communities

Although no comprehensive rare plant/plant community inventories have been conducted on the Refuge, the Virginia Native plant society has been compiling a floral inventory of the Refuge since 1993, and has documented over 600 plant species to date for Occoquan NWR (Appendix C). We cross-referenced these lists with lists found in *Natural Heritage Resources of Virginia: Rare Plants* (Townsend, 2006). We found that none of the plants listed for the Refuge were on the list of Federally Endangered and Threatened Plants of Virginia; nor were any state-listed as Endangered or Threatened. Joe Witt, a former biologist at Occoquan Bay NWR, reports two state-listed, S2 plants (see Appendix I for state rarity definitions) for the tidal freshwater marshes at the Refuge (Hoary skullcap and A Field Chickweed); these plants are listed in Appendix C.

[1] Note that hereafter in the document we will refer to this as "Woody Wetland (Tidal)"

[2] Note that hereafter in the document we will refer to this as "Herbaceous Wetland (Tidal)"

H. Wildlife

Occoquan Bay NWR was established primarily to provide feeding, resting, and nesting habitat for migratory birds, and to provide outdoor educational opportunities. The Refuge's diverse upland and wetland habitats support varied and abundant populations of resident and migratory wildlife including more than 220 species of birds and 73 species of butterflies (Waggener, 2006).

Birds

The Refuge is a popular birding spot, especially because of its grassland-nesting and grassland-wintering birds, neo-tropical migrants, and raptors, many of whom are uncommon in the heavily developed Washington D.C./Northern Virginia region. The Refuge has over 200 species of breeding, wintering, or migrating birds, and more than 20 species found using the adjacent river and bays. Grassland breeding birds arrive at the end of April to set up territories. Raptors migrate through the Refuge in April and May. Waves of migrating songbirds, especially warblers, vireos, thrushes, and flycatchers pass through in May and again in late summer and early fall. In October and November, and into the winter months, dabbling ducks are found in shallow habitats adjacent to Refuge tidal marshes; diving ducks congregate in deeper waters adjacent to the Refuge in Occoquan and Belmont Bays. Wintering loons, grebes, red-breasted mergansers, and diving ducks are found along the bay sides of the Refuge.

The grassland/open-country breeding avian community at the Refuge is dominated by the Eastern Meadowlark (*Sturnella magna*) Common Yellowthroat (*Geothlypis trichas*), Red-winged Blackbird (*Ageliaius phoeniceus*), Indigo Bunting (*Passerina cyanea*), American Goldfinch (*Carduelis tristis*), Field Sparrow (*Spizella pusilla*), and Yellow Warbler (*Denroica petechia*). The most frequently observed birds migrating thorough the Refuge in the spring, based on mist netting along the Marumsco Creek, were the White-throated Sparrow (*Zonotrichia albicollis*), Common Yellowthroat *(Geothlypis trichas),* Yellow-rumped Warbler (*Dendroica coronata*), and the Gray Catbird (*Dumetella carolinensi*s).

A list of birds of Occoquan Bay NWR, assembled by The Friends of the Potomac River Refuges and The Audubon Society of Northern Virginia, is found in Appendix D, including the seasonal period the species is found on the Refuge, and in which general habitat type(s).

Other Resources Surveys

The Refuge has hosted several long-term citizen monitoring projects, sponsored by the Audubon Society of Northern Virginia (ASNV), to survey for the occurrence of birds and other wildlife in exemplary regional habitats. Volunteers are drawn from ASNV, the Northern Virginia Bird Club, Audubon Naturalist Society, and other local conservation organizations. Data gathered from the site surveys are made available to resource managers of the respective public properties and to the interested general public. The project includes bi-monthly, "General Surveys", during which species and numbers of birds and other identifiable fauna are recorded. In addition, the project involves "Butterfly-Dragonfly" surveys, conducted weekly, between April and October. Species and numbers of Lepid and Odonate species are recorded. To date, 75 species of Lepidopterans (Appendix E), 40 species of Dragonflies and 24 species of Damselflies (Appendix F) have been documented at Occoquan Bay NWR (Waggener, 2009).

We cross-referenced these lists with lists found in Natural Heritage Resources of Virginia: Rare Animal Species (Roble, 2006). We found that none of the butterflies were on the list of Federally

Endangered and Threatened Invertebrates of Virginia; none were on the Natural Heritage Invertebrate Watch List. We found that 7 species of Dragonflies and Damselflies are on the Natural Heritage Invertebrate Watch List (State-listed 1- S2, 6-S3, very rare and rare in the state). These species are highlighted in Appendix F.

These informal surveys have also yielded a preliminary checklist of other wildlife observed on the Refuge, including amphibians, reptiles, and mammals. A checklist of these species is found in Appendix G. We cross-referenced these lists with lists found in Natural Heritage Resources of Virginia: Rare Animal Species (Roble, 2006) and found none to be on the list of Federally Endangered and Threatened Vertebrates of Virginia, nor were any state-listed as Endangered or Threatened, nor on the Natural Heritage Vertebrate Watch List (State-listed S3, or rare in the state)

Other Research and Monitoring

Small Mammals

A small mammal survey was conducted by Dr. Larry Underwood from 1998 to 2002. five species of small mammals were documented on the refuge. These include: white-footed mouse (Peromyscus leucopus), house mouse (Mus musculus), meadow vole (Microtus pennsylvanicus), marsh rice rat (Oryzomys palustris), and short-tailed shrews (Blarina brevicauda). Also found were two species of mole: the star-nosed mole (Condylura cristata) and the eastern mole (Scalopus aquaticus).

Frogs

Annuran surveys were conducted by E. Carson from 2000 to 2004. Fifteen species were documented on the refuge.

Northern Cricket Frog	Acris crepitans
Southern Cricket Frog	Acris gryllus
American Toad	Bufo americanus
Fowler's Toad	Bufo fowleri
Green Treefrog	Hyla cinerea
Gray Treefrog	Hyla versicolor
Spring Peeper	Pseudacris crucifer
Upland Chorus Frog	Pseudacris feriarum
Bull Frog	Rana catesbiana
Green Frog	Rana clamitans
Pickerel Frog	Rana palustris
Southern Leopard Frog	Rana sphenocephala
Wood Frog	Rana sylvatica

Hyla crysoscelis was heard but grouped with H. versicolor as they are identical and must be separated by chromosome count.

Abnormal Frog Surveys

From 1999 to 2003, Dr. Fred Pinkey (FWS) conducted sampling on the refuge as part of a nationwide study of the prevalence of abnormal frogs on U.S. National Wildlife Refuges. Unsuccessful attempts were made from 1999-2002 to collect a sample of metamorphs at this refuge. In 2003, 56 bullfrogs were collected at the pond near the parking lot and 23 pickerel frogs collected in the irrigation ditch. No abnormalities were observed.

2.5 Habitat Management Units – Purpose, Utility

The HMP guides the *type* and the *configuration* of management actions on the Refuge. An ArcGIS map project of 30 habitat management units (HMUs), with corresponding habitat attributes, has been developed to support this HMP. A map, showing the location of the HMUs for this Plan, is found in Figure 10.

A table describing the size, dominant plant community, and dominant soil type, per HMU, and summary information, is found in Table 2-4. Many of the HMUs roughly correspond to the original "Areas", or separate vegetation communities, delineated in the CCP (USACOE 1995) and previously described in Section 2.5. Note, however, that the correspondence is not exact. The total land area for HMUs is approximately 200 hectares, or about 494 acres. This is short of the 654 acres reported for Refuge, because the large, broken, wooded wetland complex in the southeastern quarter of the Refuge is not incorporated into an HMU. This area (see Figure 10) is currently unmanaged, and somewhat undescribed, and had not been designated for management by the former station Biologist (Joseph Witt). This area could be added as (a) future Habitat Management Unit(s). Portions of it may be either Woody Wetland (Tidal) or Mixed Upland and Wetland NVCS Land Cover Class.

A map, showing the current HMUs, designated as NVCS Land Cover Classes, is found in Figure 11. This map differs slightly from Figure 4 (Land Cover Types), since it includes a potential forest restoration area in HMU 30.

Figure 10. Habitat Management Units.

Table 2-4. Size estimates, dominant plant community, and soil type, per HMU, for Occoquan Bay National Wildlife Refuge, as of 2008.

Management Unit	Approximate NVCS Ecological System	Land Cover Class	Hectares (acres)	Soil Type
0	Northern Atlantic Coastal Plain Tidal Swamp	Woody Wetland (Tidal)	7.3 ha (18.08)	37A/22A
1	Unclassified early successional upland	Herbaceous and Shrubland (grass-dominated)	13.5 ha (33.3)	20B
2	Unclassified early successional upland	Herbaceous and Shrubland (grass-dominated)	5.1 ha (12.5)	20B
3	Unclassified early successional upland	Herbaceous and Shrubland (shrub/forb dominated)	2.0 ha (5.0)	15A
4	Unclassified early successional upland	Herbaceous and Shrubland (grass-dominated)	8.9 ha (22.0)	15A
5	Unclassified early successional upland	Herbaceous and Shrubland (grass-dominated)	12.6 ha (31.1)	15A
6	Unclassified early successional upland	Herbaceous and Shrubland (shrub/forb dominated)	4.9 ha (12.1)	15A
7	Northern Atlantic Coastal Plain Stream and River	Mixed Upland and Wetland	2.4 ha (6.0)	37A
8	Northern Atlantic Coastal Plain Stream	Mixed Upland and Wetland	2.7 ha (6.6)	37A

	and River			
9	Northern Atlantic Coastal Plain Stream and River	Mixed Upland and Wetland	1.9 ha (4.8)	37A
10	Northern Atlantic Coastal Plain Stream and River	Mixed Upland and Wetland	3.0 ha (7.3)	37A
11	Northern Atlantic Coastal Plain Stream and River	Mixed Upland and Wetland	3.8 ha (9.4)	37A
12	Northern Atlantic Coastal Plain Stream and River	Mixed Upland and Wetland	6.0 ha (14.8)	37A
13	Unclassified early successional upland	Herbaceous and Shrubland (shrub/forb dominated)	4.0 ha (9.9)	20B
14	Unclassified early successional upland	Herbaceous and Shrubland (shrub/forb dominated)	0.6 ha (1.5)	20B
15	Unclassified early successional upland	Herbaceous and Shrubland (grass-dominated)	11.8 ha (29.2)	16A/20B
16	Northern Atlantic Coastal Plain Dry Hardwood Forest	Forest and Woodland	1.3 ha (3.4)	18C
17	Northern Atlantic Coastal Plain Tidal Swamp	Woody Wetland (Tidal)	1.4 ha (3.6)	37A/22A
18	Unclassified early successional upland	Herbaceous and Shrubland (grass-dominated)	14.9 ha (36.7)	16A/18C
19	Unclassified early successional upland	Herbaceous and Shrubland (grass-dominated)	4.9 ha (12.0)	20B
20	Unclassified early successional upland	Herbaceous and Shrubland (shrub/forb dominated)	6.3 ha (15.5)	37A
21	No information – unknown forest type		0.45 ha (1.13)	37A
22	Northern Atlantic Coastal Plain Dry Hardwood Forest	Forest and Woodland	1.0 ha (2.4)	18C
23	Unclassified early successional upland	Herbaceous and Shrubland (shrub/forb dominated)	1.3 ha (3.3)	20B
24	Northern Atlantic Coastal Plain Stream and River	Mixed Upland and Wetland	2.2 ha (5.3)	37A
25	Northern Atlantic Coastal Plain Stream and River	Mixed Upland and Wetland	0.60 ha (1.5)	37A
26	Northern Atlantic Coastal Plain Dry Hardwood Forest	Forest and Woodland	13.6 ha (33.7)	18C
27	Northern Atlantic Coastal Plain Fresh and Oligohaline Tidal Marsh	Herbaceous Wetland (Tidal)	26.5 ha (65.4)	22A
28	Northern Atlantic Coastal Plain Tidal Swamp	Woody Wetland (Tidal)	7.3 ha (18.1)	37A/22A
29	Northern Atlantic Coastal Plain Fresh and Oligohaline Tidal Marsh	Herbaceous Wetland (Tidal)	26.0 ha (65.0)	22A
30	Northern Atlantic Coastal Plain Dry Hardwood Forest (restoration area)	Forest and Woodland	5.6 ha (13.7)	20B

Summary Information for Habitat Management Units

Approximate NVCS Ecological System	**Land Cover Class**	**Hectares (acres)**
Unclassified early successional upland	Herbaceous and Shrubland (Grass-dominated, early seral stage)	71.6 hectares (176.9)
Unclassified early successional upland	Herbaceous and Shrubland (Shrub/Forb dominated)	19.1 hectares (47.3)
Northern Atlantic Coastal Plain Stream and River	Mixed Upland and Wetland	22.4 hectares (55.5)
Northern Atlantic Coastal Plain Dry Hardwood Forest	Forest and Woodland	15.9 hectares (39.4)
Northern Atlantic Coastal Plain Dry Hardwood Forest **(Restoration Area)**	Forest and Woodland	15.9 hectares (39.4)
North Atlantic Coastal Plain Tidal Swamp	Woody Wetland (Tidal)	8.7 hectares (21.6)
Northern Atlantic Coastal Plain Fresh and Oligohaline Tidal Marsh	Herbaceous Wetland (Tidal)	52.7 hectares (130.3)

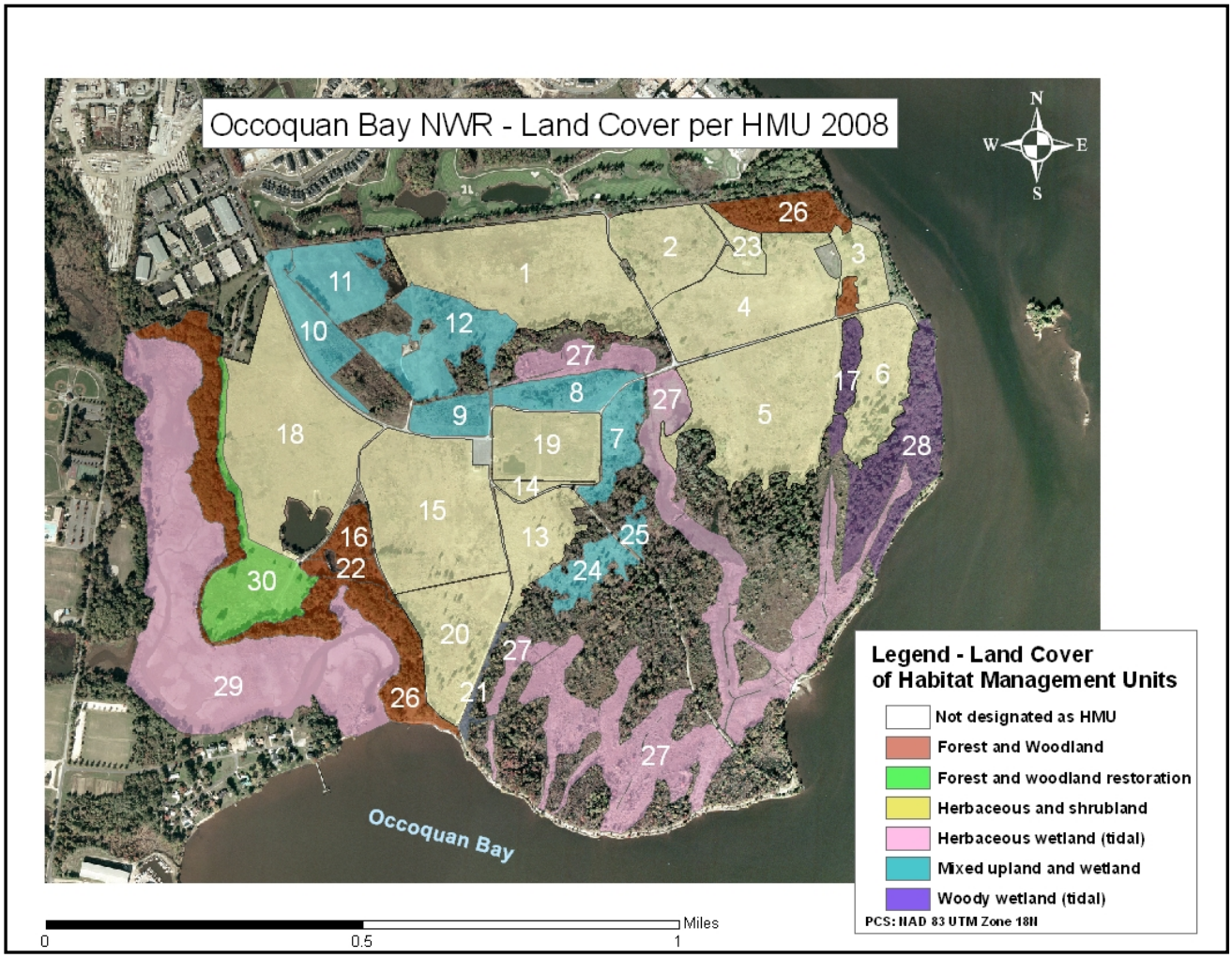


Figure 11. Current land cover types described per HMU.

Habitat management units will be used by Refuge staff to implement restoration and/or management actions on the ground. Over time, the boundaries of certain habitat management units may change, e.g. some units may be combined with others, with their original boundaries dissolving, or some may be split. It will be important to document and geo-reference such management unit changes (e.g. update GIS maps).

Habitat management prescriptions will likely include mowing, burning, disking, invasive plant removal and control, tidal flow restoration, and native vegetation establishment. Once this habitat management plan has begun to be implemented, it will be critical to plan habitat management actions, per unit, annually, and track the management history of each unit (area). This information will be contained in an Annual Work Plan (citation), and will assist the Refuge in assessing the results of management actions, and in determining if objectives are being met (adaptive management).

III. Resources of Concern

3.1 Introduction

Resources of Concern are the primary focus of this Habitat Management Plan. The Service is entrusted by Congress to conserve and protect migratory birds, federally listed threatened and endangered species, inter-jurisdictional fishes, and certain marine mammals (i.e., "trust species"). In addition to this Service mission, each refuge has one or more purposes for which it was established that guide its management goals and objectives. Further, refuges support other elements of biological diversity including invertebrates, rare plants, unique natural communities, and ecological processes that contribute to biological integrity and environmental health at the refuge, ecosystem, and broader scales (USFWS 1999, 2003).

The Habitat Management Plan policy (620 FW 1) defines "Resources of Concern" as

"All plant and/or animal **species, species groups, or communities** specifically identified in refuge purpose(s), System mission, or international, national, regional, State, or ecosystem conservation plans or acts. For example, waterfowl and shorebirds are a resource of concern on a refuge whose purpose is to protect 'migrating waterfowl and shorebirds.' Federal or State threatened and endangered species on that same refuge are also a resource of concern under terms of the respective endangered species acts."

Given the multitude of purposes, mandates, policies, regional and national plans that can apply to a refuge, there is a need to identify the Resources of Concern and then prioritize those resources that the Refuge is best suited to focus on in its management objectives. The following is the process that Potomac Rivers NWR Complex used to identify priority Resources of Concern for Occoquan Bay NWR, and develop habitat goals, objectives, and strategies to benefit these resources. (Note: priority Resources of Concern are synonymous with "conservation targets" and the terms can be used interchangeably).

3.2 Potential Resources of Concern

We developed a matrix of potential priority wildlife species, federally and state- listed plants, and plants of concern in the region (Appendix H), and other state-rare plants and natural communities (Appendix I), of potential concern to Occoquan Bay NWR. These species are of local, state, regional, or national conservation concern based on numerous legal mandates, trust resource documents, the biological integrity policy, and other information sources. These documents, plans, or policies typically identify focal species, species groups, or habitats. To determine the Resources of Concern that would guide management priorities at Occoquan Bay NWR, we used a "filtering" approach to develop a subset of *priority* Rresources of Concern., using regional priorities, which resources historically or currently occur on the Refuge, and existing and potential habitat at the Refuge, as "filters" (see Section 3.4).

Resources in the Matrix

<u>USFWS Trust Resources</u>

Although the Refuge purposes are the first obligation, managing for trust resources (defined above) is also a priority for refuges. Trust resources are further defined as follows:

Migratory Birds

A list of all species of migratory birds protected by the Migratory Bird Treaty Act (16 U.S.C. 703–711) and subject to the regulations on migratory birds is contained in subchapter B of title 50 CFR § 10.13. The Migratory Bird Program also maintains subsets of this list that provide priorities at the national, regional, and ecoregional (bird conservation region) scales. Since the list of all migratory birds that occur at Occoquan Bay NWR is over 200 bird species, we used a set of existing plans and documents to develop a subset of potential migratory birds that Occoquan Bay NWR would be best able to manage for, paying particular attention to the highest priority species for which FWS has regional responsibility. These sources of information included:

- Mid-Atlantic/Southern New England Bird Conservation Region (BCR 30) Draft Implementation Plan (Steinkamp, 2006)
- Partners in Flight Plan for the Mid-Atlantic Coastal Plain (Watts 1999)
- USFWS Birds of Conservation Concern (2002)
- Continental and Regional Plans for landbirds, waterfowl, shorebirds, and marshbirds
- Status and Trend Information from Refuge bird surveys

Interjurisdictional Fish

The U.S. Fish and Wildlife Service has a responsibility to manage interjurisdictional fish, defined as those "*…populations that two or more States, nations, or Native American tribal governments manage because of their geographic distribution or migratory patterns (710 FW 1.5H).*" Examples include anadromous species of salmon, American eel, and free-roaming species endemic to large river systems, such as paddlefish and sturgeon (FWS Director's Order No. 132, Section 6[c]).

A standard set of information resources is not currently available for fish. However, we used the best available information from the following sources:

- US Fish and Wildlife Service Threatened and Endangered Species System (TESS)
- Virginia Comprehensive Wildlife Conservation Strategy (2005)
- Federal Trust Fish Species, USFWS Population Trend Data

Wetlands

Wetlands are vital for sustaining populations of fish and wildlife and are one of the Service's conservation priorities for accomplishing its mission. Wetlands provide habitat for approximately one third of federally listed plants and animals, and nesting, migratory and wintering areas for more than 50 percent of the Nation's migratory bird species (USFWS 1996). The Emergency Wetlands Resources Act of 1986, Public Law 99-645 (100 Stat. 3582), authorized the purchase of wetlands using the Land and Water Conservation Fund. It required the Secretary to establish a National Wetlands Priority Conservation Plan and required the States to include wetlands in their Comprehensive Outdoor Recreation Plans. Marshes at Occoquan Bay are included in the list of wetlands that warrant protection (USFWS Regional Wetlands Concept Plan, Emergency Wetlands Resources Act, October 1990).

Threatened and Endangered Species

The Endangered Species Act (16 U.S.C. §§ 1531-1544, December 28, 1973, as amended 1976-1982, 1984 and 1988) designates the U.S. Fish and Wildlife Service as the responsible agency through which the Authority of the ESA will be carried out. Section 7(a)(1) of the Act further requires all Federal agencies and departments to use their authority in furtherance of the purposes

of this Act by carrying out conservation programs for the benefit of endangered and threatened species.

To identify federally threatened or endangered species of relevance to Occoquan Bay NWR we reviewed:

- USFWS Threatened and Endangered Species System (TESS), Report for the State of Virginia

Other Resources of Concern

In addition to trust resources, the Service is charged by Congress to conserve other resources, such as anadromous fish, and rare plants/animals/communities. The NWRS Policy on Habitat Management Plans (620 FW 1) defines Resources of Concern as including "State threatened and endangered species." The 1997 Refuge Improvement Act also mandates refuges to manage lands to

"…ensure that the biological integrity, diversity, and environmental health of the System are maintained."

Habitats or plant communities can be Resources of Concern when they are specifically identified in refuge purposes, support species or species groups identified in refuge purposes, support FWS trust resources, and/or when they are important in the maintenance or restoration of biological integrity, diversity, and environmental health (601 FW 3).

In addition to identifying state-listed threatened or endangered species, we also consulted the Chesapeake Bay Lowlands Ecoregional Plan (TNC, 2002) for "primary species conservation targets" for the Region. Species targets in CBY were categorized as "Primary" or "Secondary" conservation targets, based largely on their global rarity and the degree to which their viability within the ecoregion was considered to be secure. Primary species targets were globally rare (G1-G3) species with occurrences in the ecoregion.

In summary, to identify state-listed threatened or endangered species, or "primary species conservation targets" (based upon global rarity), of potential relevance to Occoquan Bay NWR, we reviewed:

- Natural Heritage Resources of Virginia: Rare Plants (2006)
- Natural Heritage Resources of Virginia: Rare Animals (2006)
- Chesapeake Bay Lowlands Ecoregional Plan

In addition, the Virginia Natural Heritage Program (VANHP) tracks information on over 1600 rare plants, animals and exemplary natural communities in Virginia. We used the VANHP's online searchable database to generate a list of rare plants and exemplary natural communities potentially occurring in Prince William County, Virginia, as resources of potential interest at Occoquan Bay NWR (VANHP, 2007). Results of this search are listed in Appendix I.

3.3 Biological Integrity, Diversity, and Environmental Health

The 1997 National Wildlife Refuge System Improvement Act states that in administering the System the USFWS shall "… ensure that the biological integrity, diversity, and environmental health of the System are maintained…" (USFWS 2003). The Service defines these terms as:

Diversity – The variety of life and its processes, including the variety of living organisms, the genetic differences between them, and the communities and ecosystems in which they occur.

Integrity – The biotic composition, structure, and functioning at genetic, organism, and community levels that are comparable with historic conditions, which included the natural biological processes that shape genomes, organisms, and communities.

Environmental Health – Composition, structure, and functioning of soil, water, air, and other abiotic features comparable with historic conditions, including the natural abiotic processes that shape and direct the environment.

In addition to providing habitat for trust species, refuges support other elements of biodiversity including invertebrates, rare plants, unique natural communities, and ecological processes (USFWS 1999). The HMP documents the process used by the Refuge to identify and prioritize trust resources and other elements of biodiversity for conservation action.

Where possible, management on the Refuge will restore or mimic natural ecosystem processes or functions and thereby maintain biological diversity and integrity and environmental health. Specific management actions are guided both by Refuge-specific goals and by landscape-scale conservation goals (e.g., BCR priorities). Given the continually changing environmental conditions and ecosystem patterns of the past and uncertainty about the future, management strategies support mechanisms that allow species, genetic strains, and natural communities to evolve, rather than trying to maintain stability. As noted by many theoretical and field ecologists, the appropriate recommendation is managing within a natural range of variability (such as a range of successional states) rather than emulating an arbitrary point in time (such as a single successional state).

To manage the Refuge within a natural range of variability, we investigated the potential of the Occoquan Bay NWR to support the prioritized habitats by examining the following resources:

- Maps and associated data on site capability
- Kuchler's (1964) potential natural vegetation maps
- Soils, topography, wetlands, and hydrology maps
- History of natural disturbance patterns: e.g., storms, fire
- Maps of current landscape condition showing conserved lands network, connectivity, land use patterns, and management/ownership trends surrounding the Refuge
- General descriptions of existing vegetation on the Refuge
- Virginia Department of Natural Heritage and Endangered Species Program information on rare, declining, or unique natural communities and plant populations for Prince William County
- Status and Trend Information from Refuge surveys and studies grassland breeding birds.

3.4 Priority Resources of Concern

The potential Resources of Concern tables (Appendices H and I) contain a large number of species with a broad array of habitat needs. The Refuge has attempted to "filter" these species and

their associated habitats to determine where the Refuge can make the greatest contribution to conservation efforts within the context of the NWR System, the surrounding landscape, and national priorities. To help determine the Resources of Concern that will guide management priorities at Occoquan Bay NWR, we first developed a "subset of focal species" based on regional plan priorities (Appendix J).

In developing this subset, we considered the following concepts (or "rules"):

1. Achieving Refuge purposes, and managing for trust resources as well as biological diversity, integrity, and environmental health can be addressed through the habitat requirements of "focal species" or species that may represent guilds that are highly associated with important attributes or conditions within habitat types. The use of focal species is particularly valuable when addressing Fish and Wildlife Service trust resources such as migratory birds.

2. The Bird Conservation Region (BCR) plans are increasing their effectiveness at ranking and prioritizing those migratory birds most in need of management or conservation focus. Although all species that make it to a ranked BCR priority list are in need of conservation attention, we selected species that were ranked "HH" as potential focal species; we also selected species that were ranked as "H", and also ranked as "Tier 1A, 2A, or 2B species"[1], in the PIF plan for the Mid-Atlantic Coastal Plain or "I" in the State Comprehensive Wildlife Conservation Plan. Definitions of codes are listed after the table in Appendix D.

3. Non-bird wildlife species (vertebrates: mammals, amphibians, fish, reptiles) were selected as potential focal species because they are currently listed as Federally Endangered or Threatened; we also selected species that were state-listed Endangered or Threatened, and also ranked "I" in the State Comprehensive Wildlife Conservation Plan.

4. We considered all invertebrate species as potential focal species that were either: currently listed as Federally Endangered or Threatened; or state-listed Endangered or Threatened; we then selected from that list those invertebrate species known to occur in Prince William County Virginia, as potential focal species

5. We considered all plant species as potential focal species that were either: currently listed as Federally Endangered or Threatened; state-listed Endangered or Threatened, or listed as a primary species conservation target in the Chesapeake Bay Lowlands Plan (TNC, Draft, 2006); we then selected from that list those plant species known to occur in Prince William County, Virginia, as potential focal species. We also listed two state-ranked rare plant species reported for the Refuge by Joseph Witt, former Occoquan Bay NWR wildlife biologist. We selected all rare communities that were currently State-Ranked, and known to occur in Prince William County Virginia, as potential focal resources

We then evaluated each species in the "subset of focal species" (Appendix J), using current and historic inventories of the Refuge, to determine whether that species had ever been documented on the Refuge, or on the former Woodbridge Research Facility or Marumsco NWR (for vertebrate species), or in Prince William County (for invertebrates, plants, or plant communities). We used

this information to create a **second subset** of focal species, after filtering out those wildlife species who have not historically (to the best of our knowledge), occurred on the Refuge, and those invertebrates, plants, or plant communities that have not been recorded for Prince William County (Appendix K). The list also includes information on the primary habitat types in which these potential priority resources occur (in the mid-Atlantic), their reported season of occurrence on the Refuge (if known), and potential quantity of refuge habitat for each, based upon the Refuge habitat management unit information described, previously, in Table 2.4.

We then considered the Refuge site capabilities. Physical conditions and processes on or around the Refuge may limit its ability to support certain Resources of Concern. The following site-specific factors were considered:

- Patch size requirements of priority species
- Habitat connectivity
- Incompatibility of surrounding land uses (refuge is largely surrounded by urban landcover, although there are other conservation lands along the Potomac River in the vicinity)
- Environmental conditions: soils, hydrology, disturbance patterns, contaminants, predation, invasive species
- Specific life history needs of species
- The likelihood that a species of concern would have a positive reaction to management strategies.
- The ability to rely on natural processes to maintain habitat conditions within a natural range of variability suitable to the focal species

Table 3-1 is the final list of refuge priority Resources of Concern, after considering the capability of the Refuge to support each resource, and removing potential resources for which the Refuge has limited to no habitat potential. The list includes focal species, related habitat requirements, plus other "associated" priority species – species that are likely to benefit from managing for each focal species at Occoquan Bay NWR, and which are also listed as higher-tiered species in any of the following plans: 1) Mid-Atlantic/Southern New England Bird Conservation Region (BCR 30) Draft Implementation Plan (Steinkamp, 2006); 2) Partners in Flight Plan for the Mid-Atlantic Coastal Plain (Watts 1999); 3) USFWS Birds of Conservation Concern (2002); or 4) Continental and Regional Plans for landbirds, waterfowl, shorebirds, and marshbirds.

Table 3-1. Resources of concern selected as focal species, associated habitat requirements, and other species likely to benefit at Occoquan Bay NWR

Habitat Type	Priority Resources of Concern	Habitat requirements[3]	Other Priority Benefiting Migratory Species [4]
Forest and Woodland (Northern Atlantic Coastal Plain Dry Hardwood Forest)	Oak-Hickory Woodland/Savanna	Dry woodland on well-drained soils, well-spaced trees, open understory, mature oak and hickory overstory	Breeding: Eastern towhee, Broad-winged hawk, Northern flicker, Worm eating warbler, Black and white warbler, Whip-poor-will Migration: Whip-poor-will, Black and white warbler
	Scarlet tanager (breeding and migration)	Breeds in mature forest, especially where oaks (*Quercus* spp.) are common, occurs in a variety of forests ranging from pine (*Pinus*)-oak woodland to dry oak-hickory (*Carya*); estimated minimum forest area needed to sustain a viable population 10–12 ha; needs high density of tall trees (dbh >22.4 cm) for breeding, migration habitat	

~16 hectares	Wood thrush (breeding and migration)	Breeds in cool mature, lowland, mixed or more typically, deciduous forests; somewhat tolerant of forest fragmentation; may be found in habitat patches of 1 to 5 ha for breeding, migration habitat poorly documented, perhaps similar to breeding habitat for spring migration and second growth forest edge with fruit for fall	
	Chimney swift (breeding and migration)	Habitat little quantified, appears focused in urban areas with concentrations of chimneys for nest sites and communal roosts; may still nest in hollow trees, tree cavities, or caves; during migration is aerial forager in flocks over forests and open areas	
	Yellow-throated vireo (breeding and migration)	Breeds in variety of edge habitats in bottomland and upland mature deciduous and mixed deciduous-coniferous forests; forest types used include: oak-hickory, maple-oak; in md-Atlantic states, relative abundance is positively related to mean canopy height, tree basal area, percent forest cover within 2 km, and foliage density between 0.3 and 1.0 m; negatively related to percent canopy cover of coniferous trees and number of snags; migration habitat similar	
	Small whorled pogonia	Open, dry deciduous woods with acid soil	
Woody Wetland (Tidal) (Northern Atlantic Coastal Plain Tidal Swamp) ~9 ha	Prothonotary warbler[2] (breeding and migration)	Area-sensitive; avoids waterways with wooded borders <30 m wide; nests over or near standing or slow-moving water, common overstory trees in nesting habitat include willows, maples, sweet gum,; canopy height 12–40 m, canopy cover usually 50–75%; ground vegetation sparse	Breeding: Mallard, Acadian Flycatcher, Bald Eagle, Baltimore Oriole, Broad winged Hawk, Great Crested Flycatcher, Northern Parula, Worm-eating Warbler , American Redstart Migration: critical importance to adult, fall migrating landbirds as stopover habitat/food sources, including: Kentucky warbler, Louisiana waterthrush, Blackburnian warbler, Black-and-white warbler, Canada warbler, Great crested flycatcher and many other migrants Wintering: Rusty Blackbird
	Scarlet tanager (breeding and migration)	Breeds in mature forest, especially where oaks (*Quercus* spp.) are common, occurs in a variety of forests ranging from pine (*Pinus*)-oak woodland to dry oak-hickory (*Carya*); estimated minimum forest area needed to sustain a viable population 10–12 ha; needs high density of tall trees (dbh >22.4 cm); migration habitat similar	
	Wood thrush (breeding and migration)	Prefers cool mature, lowland, mixed or more typically, deciduous forests; somewhat tolerant of forest fragmentation; may be found in habitat patches of 1 to 5 ha for breeding, migration habitat poorly documented, perhaps similar to breeding habitat for spring migration and second growth forest edge with fruit for fall	
	Yellow-throated vireo (breeding and migration)	Breeds in variety of edge habitats in bottomland and upland mature deciduous and mixed deciduous-coniferous forests; forest types used include: oak-hickory, maple-oak; in md-Atlantic states, relative abundance is related to mean canopy height, tree basal area, percent forest cover within 2 km, and foliage density between 0.3 and 1.0 m; negatively related to percent canopy cover of coniferous trees and number of snags; migration habitat similar	
	American woodcock (wintering)	Sporadic wintering in mid-Atlantic; uses a wide variety of forests diurnally, including bottomland hardwoods; proximity to openings, soil pH, accessibility to substrate are important	
Mixed Upland and Wetland	American woodcock (breeding)	Breeding habitat is a forest with openings; abandoned farmland mixed with forest is ideal; forest openings, meadows and old fields provide display area for males as grasses, herbaceous cover, and low shrubs transition to young trees; adjacent young hardwoods and mixed woods with shrubs, particularly alder , provide moist ground for daytime feeding	Breeding: Gray catbird, Brown thrasher (in shrubby edges), Sora rail (in sedge/rush meadows) Migration: Rails (King, Sora, Virginia,) in sedge/rush

(Northern Atlantic Coastal Plain Stream and River) ~23 hectares	Willow flycatcher (breeding and migration)	Breeds in moist, shrubby areas, often with standing or running water , often in thickets of willows or alders; migration habitat similar	meadows; critical migration habitat for a variety of fall migrating landbirds in dense, multi-layer, young thickets of maple and sweetgum (e.g. Kentucky warbler, Louisiana waterthrush, Blackburnian warbler, Black-and-white warbler, Canada warbler, Great crested flycatcher and others) Winter: Common snipe (in sedge/rush meadows); Rusty blackbird, Sora/Virginia rails, also concentrations of short-distance migrants
	Coastal plain swamp sparrow (breeding)	Breeds in high marsh, dominated by a mix of tall and short graminoid vegetation with a few shrubs intermingled; often patches of High Tide Bush (*Iva frutescens*) with an understory of marsh grasses	
Herrbaceous and Shrubland (Unclassified early successional upland) ~90 hectares	Blue-winged warbler (migration); also may use Mixed Upland and Wetland during migration	Migration habitat is similar to breeding habitat: open forest, dense, brushy areas, pitch pine-scrub oak forests, utility rights-of-way; old fields, shrubby riparian areas	Breeding: Eastern kingbird, Eastern meadowlark, Grasshopper sparrow Migration: Henslow's sparrow, Northern Harrier, Sedge wren, Short eared owl, American woodcock Wintering: Short-eared owl, probably sporadic concentrations of short-distance migrants
	Field sparrow (year round)	Breeds in old fields in early stages of succession—open grassy areas with scattered low shrubs or trees; scattered woody vegetation with elevated perches in the territory; as thickets of trees increase, numbers decline; migration and wintering habitat is similar	
	Northern bobwhite (resident)	Resident in old fields in early stages of succession; requires a mixture of grasses and forbs, with some woody vegetation interspersed: old fields, wide, weedy field borders and hedgerows.	
	Prairie warbler (breeding and migration)	Breeds in various shrubby associations lacking closed canopies, Typical habitats are southern pine (*Pinus*) forests (trees scattered, therefore shrub layer present); abandoned fields or pastures with shrubby growth, pitch pine-scrub oak woodlands, scattered early growth of pine and red cedars; migration habitat is similar	
	Eastern towhee (year round)	Edge-associated generalist that breeds in varied mesic and xeric habitats characterized by dense shrub/small tree cover near ground and well-developed litter layer,; overstory trees may or may not be present, and if present, open-canopy (woodland) situations are favored; occupies mid- to late stages of secondary succession with greatest densities in old fields thickets and later stages of second growth; migration and winter habitat similar	
	Hoary skullcap (Scutellaria incana), A field chichweed	Open woods, rocky slops, upland meadows, savannas clearings	
	Earleaf foxglove[1]	mesic to wet prairie, disturbed prairies, shrubby prairies, old fields and red cedar-oak barrens	
Herbaceous Wetland (Tidal) (Northern Atlantic Coastal Plain Fresh and Oligohaline Tidal Marsh) ~ 53 hectares, Herbaceous Wetland	Forster's tern (year round)	Breeds primarily in fresh, brackish, and saltwater marshes, often in open, deeper portions of marshes, in wetlands with considerable open water and large stands of island-like vegetation and/or large mats of floating vegetation; migration and wintering habitat similar	Breeding: Black-crowned night heron, King rail, Least bittern, Mallard Migration: Sora rail, King rail, Virginia rail, American bittern, Least bittern, Blue-winged teal, Green-winged teal, Gadwall, Mallard
	American black duck (migration/wintering)	Important migration and wintering habitat; spring migrants are abundant along Atlantic Coast in salt marsh bays before ice-out; in mid-Atlantic, uses tidal habitats heavily in winter and used especially at night and when ice forms.	

(Nontidal) (Unclassified early successional wetland) ~ 53 ha	Canada goose (wintering)	In coastal areas, inhabits mudflats, shallow tidal waters, and salt-water marshes, with extensive beds of bulrush and cord grass near or adjacent to agricultural fields of grain or cover crops	Wintering: Greater yellowlegs, Gadwall, Green-winged teal, King rail, Sora rail, American bittern, Least bittern, Gadwall, Green-winged teal, Mallard
	Marsh wren (year round)	Breeds in salt or brackish marshes, especially in tidal creeks dominated by tall plants such as cordgrasses (Spartina spp.) and/or cattails (Typha spp.); migration and wintering habitat Resembles breeding habitat, but greater variety, such as adjacent , nontidal sedge meadows and brushy areas	
	Seaside Sparrow (migration)	Transients concentrate in tall stands of cordgrass, usually in sheltered areas along waterways; local movements made between feeding areas and roost sites on marsh islands, where vegetation less flooded (*Baccharis, Iva, Phragmites, Typha* and *Borrichia*)	
	Coastal plain swamp sparrow[5]	Breeds in high marsh, dominated by a mix of tall and short grasslike vegetation with a few shrubs intermingled; often patches of High Tide Bush (*Iva frutescens*) with an understory of grasses	

[1] Plant not currently found on Refuge, but Refuge has suitable habitat. Potential for reintroduction.
[2] Historical record, last seen in the 1980s.
[3] Information taken largely from "The Birds of North America Online" (http://bna.birds.cornell.edu/BNA/)
[4]Documented on the Refuge; listed as higher-tiered species in any of the following: 1) Mid-Atlantic/Southern New England Bird Conservation Region (BCR 30) Draft Implementation Plan (Steinkamp, 2006); 2) Partners in Flight Plan for the Mid-Atlantic Coastal Plain (Watts 1999); 3) USFWS Birds of Conservation Concern (2002); 4) Continental and Regional Plans for landbirds, waterfowl, shorebirds, and marshbirds
[5]Not documented on refuge; surveys needed

3.5 Prioritizing Habitat Management

Refuge management is most often used to restore, manage, or maintain habitats or certain habitat conditions to benefit a suite of focal species or a suite of plants and animals associated with a particular habitat. As described in the previous section, Potomac River NWR Complex identified focal species and associated habitats in concert with each other (Table 3-1). We then identified any limiting factors that affect the ability of the Refuge to restore, manage, or maintain these habitats (e.g., site capability, historic condition, current vegetation, conservation needs of wildlife associates). Since all management activities cannot be undertaken at the same time, we used this information to prioritize the habitats (Table 3-2) based on the following ranking factors:

Highest Priority

- Can be managed to provide the greatest conservation benefit to priority species, especially those species specifically identified in refuge purpose
- Offer the greatest contribution to native habitats not well represented within the landscape (including the broader ecoregion of with the Refuge is a part)
- Habitat condition or other factors suggest an urgent need for active management

Medium Priority

- Can be managed to provide a lesser, but substantial, benefit to priority species, especially those species specifically identified in refuge purpose
- Habitat condition or other factors suggest a moderate need for active management

Low Priority

- Too limited in extent to make a meaningful conservation contribution
- May consist of important communities that do not require active management
- Outside the management authority or jurisdiction of the Refuge

Although a habitat may be ranked as "moderate" priority, this should not be interpreted to mean that this habitat type does not provide valuable habitat to a variety of species and contribute to the overall diversity of the Refuge. In many cases, these habitats do not require active management by the Refuge or represent an area where we have little management capability.

Table 3-2. Priority habitats and potential limiting factors for maintaining these habitats on Occoquan Bay National Wildlife Refuge.

Habitat Type	Reasons for Ranking	Limiting Factors/Threats	Management Needs
Highest Priority Habitats			
Herbaceous Wetland (Tidal) (Northern Atlantic Coastal Plain Fresh and Oligohaline Tidal Marsh)	Tidal marsh habitat is limited globally; high potential for Refuge contribution; supports several highest priority birds in BCR 30 (Seaside sparrow, Marsh wren and Black duck); important year round to a variety of priority migratory birds; at about 53 hectares, it is about one fourth of the Refuge and a significant resource in the Chesapeake Bay estuary(high priority UFWS ecosystem)	Altered hydrology (e.g. culverts, beaveractivity, historic ditching or filling); invasive species (e.g. non-native *Phragmites australis*); sea level rise; human disturbance; pollution	Removal of tidal restrictions (culverts, beaver); restoration of hydrology in any historically impacted areas; surveys for invasive species and appropriate control measures. Note: the Refuge is not likely to be able to remove all tidal restrictions, since this would require removal of portions of road and replacement of culverts with bridges. Some culverts may be removed, or re-fitted
Herbaceous and Shrubland (Shrub/ Forb Dominated)	Supports many high priority breeding and migrating landbirds in BCR 30, including two highest priority birds (Blue-winged warbler, Prairie warbler); well-suited to meet refuge purpose for outreach and education regarding habitat management	Requires disturbance; invasive plants will be a chronic problem requires brush-hog, Geo-boy brush cutter, Davco mower or other specialized thicket-mower necessary to maintain scrub-shrub habitats; requires occasional cutting of larger diameter trees	Periodic disturbance: mowing/burning shrubs and forbs about every 5-10 years, plus removal of saplings entering the canopy (<20'); survey for invasive plants and take control measures
Mixed Upland and Wetland (Northern Atlantic Coastal Plain Stream and River)	Many high priority bird species in BCR 30 breeding in this habitat; important for fall migrating songbirds in wooded thickets; importance of sedge meadows for breeding/migrating/wintering rails; relatively manageable acreage.	Requires disturbance; succession is ongoing; bush-hogging or disking sedge meadows using Geo-boy brush cutter, Davco mower or other specialized thicket-mower is necessary to maintain shrub and sapling thickets; mowing windows restricted by soil wetness	Periodic disturbance: Infrequent mowingor disking of sedge meadows important (every 3-4 years); brush-hogging grass Or forb openings around shrubs every 5 years to maintain interspersion; mow sweetgum/maple thickets every 10-15 years; survey for invasive plants and take control measures

Medium Priority Habitats			
Forest and woodland (Northern Atlantic Coastal Plain Dry Hardwood Forest)	Rare forest community type, also supports high priority forest interior breeding bird species, but the Refuge contains only limited, linear examples of this community type	Limited patch size, linear patchshape, lack of natural understory disturbance (fire); deer impacts to understory	Restoration of additional oak/hickory forest, adjacent to core forest areas abutting Marumsco Creek
Herbaceous and Shrubland (Grass Dominated)	Cultural habitat type that supports nesting grassland birds of moderate concern in BCR 30, monarchs, other butterflies, foraging raptors; may be important to short-distance migrants (e.g. Savannah sparrow), native WSG community may harbor rare, disturbance dependent plants	Requires frequent disturbance and maintenance; invasive plants will be a chronic problem current state of grasslands dominated by Eastern Gamma grass is limiting habitat use by grassland breeding birds, and also discouraging other early succesional species (e.g. Eastern kingbird, field sparrow, Indigo bunting)	Restoration of dense, tall grasslands to shorter, sparser cover type in largest grasslands; periodic disturbance (mowing/burning every 2-3 years); survey for invasive plants and take control measures
Low Priority Habitat Types			
Woody Wetland (Tidal) (Northern Atlantic Coastal Plain Tidal Swamp)	Supports many high priority breeding and migrating land birds in BCR 30 including two highest priority birds (American woodcock and Wood thrush), but requires little management	Limited patch size on refuge (~ 30 acres, plus discontinuous swamp islands) limits use for area sensitive FIB's; much of this is young forest, not very diverse (red maple dominated)	Passive management - allow succession of wet areas adjacent to current bottomland forest to succeed to forest and increase core forest size
Occoquan Bay - open water/adjacent waters	State has primary jurisdiction and lack of management capability	Contaminants; commercial and recreational fishing and other uses	No management (oil spill response, debris and trash cleanup.

3.6 Conflicting Habitat Needs

Given the diversity of goals, purposes, and mandates for the NWRS, it is not uncommon to have conflicts over management priorities on a Refuge. Balancing the types and proportions of habitat conditions on the Refuge requires a thoughtful and documented process for determining the best course of action. Occoquan Bay NWR is taking a deliberate, transparent approach to resolving at least 4 types of habitat management conflicts associated with this HMP:

A. Open habitats versus wooded habitats in uplands

Three types of upland habitats are priority habitats for the Refuge (Table 3-2): Herbaceous and Shrubland (Shrub/Forb Dominated), Forest and Woodland, and Herbaceous and Shrubland (Grass Dominated). While shrublands are a high management priority, Forest and Woodland, and grasslands are a medium management priority. The original Refuge CCP directs the Refuge to "maintain approximately 290 acres [117 hectares] in grassland habitat in a variety of successional stages." Occoquan Bay NWR currently manages about 90 hectares (about 222 acres) of early successional habitat, comprised of about 72 ha of grasslands and about 19 ha of shrublands (see Table 2-3, Figure 10). These fields are abandoned farm fields (some may have been originally cleared at the time of European settlement) and/or areas that were cleared and maintained as lawn

for recreational or security purposes by the military.

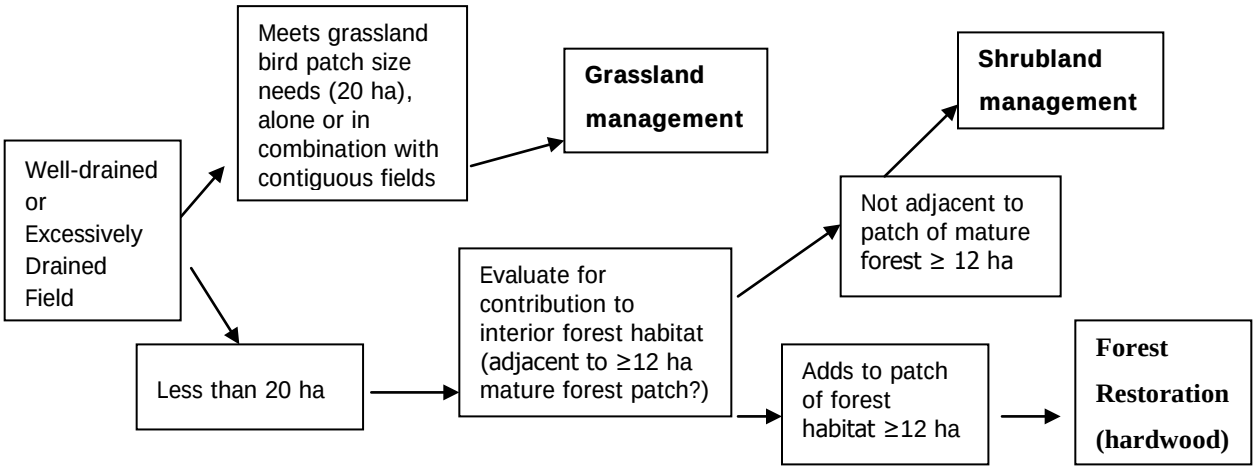
Many of the units currently in grassland cover are too small and isolated (e.g. surrounded by wooded or urban cover) to support obligate grassland breeding birds of regional concern. For example, the high priority grassland species in BCR 30 and PIF Plans, Upland sandpiper and Henslow's sparrow, require contiguous grassland blocks >50 ha, while several of the grassland units at Occoquan are on the scale of 1-5 ha. Some of the largest grassland units at the Refuge (e.g. HMUs 1, 4, 5 and 18, which are each >20 ha) have the potential to provide breeding habitat for Eastern Meadowlark and Grasshopper Sparrow, species of moderate concern in some plans, who will breed in grasslands of about 20 ha. These larger units also are also likely to provide important migratory habitats for priority grassland birds (e.g. Song sparrow, Savannah sparrow), forage areas for grassland raptors (e.g. Northern Harrier, Short-eared owl), and habitat for pollinating insects.

In contrast to the grasslands , most of the upland, early successional shrublands on the Refuge (2-13 ha in size) (see Table 2-3, Figure 10), are likely to provide adequate nesting, foraging, and migration habitats for high priority shrubland species for BCR 30, such as Field Sparrow, Blue-winged Warbler, Northern Bobwhite, Prairie Warbler, and Eastern Towhee, as well as other associated old field species such as Yellow-breasted chat and American Woodcock. This is because shrubland bird species, in general, can successfully reproduce in smaller habitat patches than grassland breeding birds. In general, authors recommend that shrubland patches be maintained on the order of 2-10 ha, to ensure the reproduction and survival of landbirds (Tefft 2006).

Ultimately, if any of the early successional HMUs, adjacent to unbroken forest patches of size >10-12 ha, are allowed to revert to closed-canopy forest, these areas would eventually contribute to breeding and migratory habitats for high-priority forest interior birds of BCR 30, such as Scarlet tanager, Wood thrush, Yellow-throated vireo, and Prothonotary warbler, and American Woodcock.

The Refuge used the above information to assemble a decision process, which was used to choose habitat management objectives for upland HMUs, from among three habitat types: Herbaceous and Shrubland (Shrub/Forb Dominated), Forest and woodland, and Herbaceous and Shrubland (Grass Dominated) (Figure 12):

Figure 12. Flowchart depicting decision analysis for developing upland habitat management recommendations at Occoquan Bay NWR, based on soil characteristics, field size, and surrounding landscape context.



As previously mentioned, in 2007, the Refuge completed brief soils evaluations of all early successional units, with the assistance of a soil scientist from USDA NRCS (Mr. Louis Heidel) (See Section 2.4). Using this information, the Refuge selected all HMUs classified as well-drained, followed the flowchart in Figure 12, and determined which upland HMUs would be managed for grassland objectives, shrubland objectives, or forest restoration objectives (see Section 4.2 for specific habitat objectives, per HMU).

B. Open vs. Wooded cover in Mixed Uplands and Wetlands

Mixed Upland and Wetlands are of medium priority for the Refuge (Table 3-2). The original Refuge CCP does not address these streamside/riparian habitats. Occoquan Bay NWR currently manages about 22.4 hectares (about 55 acres) of early successional Mixed Upland and Wetlands, mainly adjacent to upper Catamount Creek, and a few low-lying areas adjacent to tidal forests (see Table 2-3, Figure 11). These are mostly abandoned farm fields.

These wet, former agricultural fields, and stream valleys, form a complex of shrub-early successional vegetation types (e.g. moist thickets, sedge meadows, scrub-shrub habitats), which can provide feeding, breeding, migrating and wintering habitat for several priority migratory birds. Areas that are frequently disturbed (e.g. disked, root-raked, hydro-axed) are generally dominated by herbaceous wetland vegetation (e.g. sedge meadows), while areas not recently disturbed turn into wooded thickets (e.g. sweetgum or red maple sapling thickets), or a patchwork of native shrubs, such as elderberry (*Sambucus* spp.), or arrowwood (*Viburnum* spp.).

The Refuge has a management choice of disturbing (mowing or plowing) Mixed Uplands and Wetlands periodically to maintain sedge meadows, or to allow HMUs to grow up into shrub or sapling thickets. In general, if these areas develop into dense young forests and moist shrubby areas, they may benefit migrating and breeding American woodcock, Willow flycatcher, and possibly Coastal plain swamp sparrow, all priority BCR 30 species. In addition, dense shrub and sapling thickets serve as critical stopover habitats for east coast fall migrants (e.g. Kentucky warbler, Lousiana Waterthrush, Canada Warbler, Great Crested Flycatcher). However, the sedge meadows are likely to benefit priority wintering secretive marsh birds such as Sora, King and Virginia rails (of moderate concern in Partners in Flight Plan 9, and BCR 30 Plan), and other migrating and wintering birds of moderate management concern (e.g. Common Snipe, Song Sparrow, Savannah Sparrow, Rusty Blackbird) (B. Watts, personal communication, 2007).

The Refuge consulted directly with avian ecologist from the College of William and Mary, Center for Conservation Biology, Dr. Bryan Watts, regarding setting management objectives and strategies for the Mixed Uplands and Wetlands HMUs on the Refuge – where to expend refuge resources in maintaining sedge meadows (frequent disturbance), where to maintain or encourage shrubland patches (infrequent mowing), and where to maintain or encourage sapling thickets (infrequent cutting). Dr. Watts examined HMU configuration, hydrology, landscape context, age/density of woody plant cover, and made unit-by-unit management recommendations, based on his avian expertise, and best professional judgement concerning site capability.

In general, Dr. Watts recommended that the refuge maintain current sedge meadows (with mowing and/or light disking), as this is an uncommon habitat, of importance to migrating and wintering rails and short-distance, migrating sparrows. He recommended that the refuge engage in infrequent bush hogging or disking in small, wet shrublands and wet meadows, located adjacent to wet woods, as these areas may serve as breeding and foraging sites for American

Woodcock. And finally, he recommended that certain wet thickets (currently recently hydro-axed), already heavily populated by tree saplings and rootstocks (e.g. red maple, sweet gum), be allowed to succeed to dense woody cover (sapling thickets), to serve as important fall migrant landbird stopover habitat (see Appendix L for site visit notes). The Refuge translated these recommendations into habitat objectives for Mixed Uplands and Wetlands in Chapter 4, and to habitat management prescriptions in Chapter 5.

C. Tidal vs. Nontidal Marsh

The Refuge contains about 53 ha (130 acres) of Herbaceous Wetland (Tidal), the highest priority habitat on the Refuge. This habitat can support several of the highest priority birds in BCR 30 that occur on the Refuge, such as Seaside Sparrow, Marsh Wren, and Black Duck. Tidal marshes also support many other species of moderate priority in BCR 30, such as breeding, migrating, and wintering Sora, King and Virginia Rails, breeding Black-crowned Night Heron and Least Bittern; and migrating and wintering Greater Yellowlegs, Gadwall, Green-winged Teal, American bittern, Least bittern, Gadwall, Green-winged teal, and Mallard. Coastal wetlands have been recognized widely as resources of global importance, as important habitats for a diversity of waterbirds as well as other specialized and endemic wildlife species, and as critical links between uplands and esturaries (Greenberg 2006). Tidal marshes are key to estuarine productivity, and they help to stabilize sediments to protect shoreline areas from erosion. The east and Gulf coasts contain the majority of the tidal marshes of North America; these marshes are under threat of losses due to the effects of sea level rise.

As mentioned above, previous land managers altered tidal flows on the Refuge by constructing culverts and water control structures when building roads. In some cases, this has converted tidal emergent (or woody) wetlands into ponded, nontidal systems. Beavers have further restricted tidal flows, and compounded the flooding effects. As a result, fish passage has certainly been restricted, net acreage of tidal marshes has been reduced on the Refuge, and obstructions may also be depriving downstream tidal marshes of sediment transport, reducing the ability of extant marshes to cope with the effects of sea level rise in the Potomac Basin.

Due to the global importance of tidal wetlands, the Refuge has determined that it will explore management actions to remove or ameliorate the effects of tidal obstructions, wherever possible, on the Refuge. The Refuge will make a concerted effort to reverse the effects of blocked or improperly placed culverts and beaver dams, wherever practical.

D. Biological Integrity vs. Shrubland Bird Habitat Needs

The Biological Diversity and Environmental Health Policy requires refuges to detect and control populations of invasive species. In most instances, such management also benefits our trust resources. Occasionally, this directive may conflict with wildlife needs. An example of this is the need to provide optimal habitat for breeding and migratory landbirds while maintaining the long-term ecological integrity of shrubland habitats. Landbirds have a higher survival rate in thick shrub habitat, as it provides escape cover from potential predators (Randy Dettmers, personal communication, USFWS 2006). In addition, some landbirds seem to have adapted to breeding in areas invaded by non-native shrubs, such as multiflora rose, Asian honeysuckles, etc. (Dr. Chris Norment, SUNY Brockport, personal communication 2008). Currently, invasive shrubs and trees on the Refuge, such as Bradford pear and glossy buckthorn, provide the dense structure preferred by landbird species of conservation concern, such as Field sparrow and Prairie warbler. While the

Refuge will strive to reduce cover by invasive shrubs, since their presence may be degrading various ecological processes, the Refuge will proceed carefully, with sensitivity regarding effects to migratory species. The Refuge will monitor bird response, where possible, when invasive plant control measures are taken.

3.7 Adaptive Management, Inventory and Monitoring

The Refuge will use adaptive management when responding to changing conditions that impair our ability to measure and achieve the habitat objectives. The Refuge will need to establish and maintain a monitoring program to ensure detection and response to changing habitat conditions.

IV. Goals and Objectives

4.1 Habitat Goals and Objectives - Defined

According to the NWRS Goals and Objectives Handbook, these elements are the unifying ingredients of successful refuge management. It is critical that goals and objectives be understandable and deal directly with priority Resources of Concern, and the habitats that support these resources. Habitat Management Goals should "describe the desired future habitat conditions of a refuge in broad but succinct statements." Goals are not measurable, but each one generates one or more objectives that specify conditions in measurable terms" (Identifying Refuge Resources of Concern and Management Priorities: A Handbook, 2007 [draft]). An example is: *"Perpetuate the biological integrity and diversity of **coastal habitats** to sustain native wildlife and plant communities, including species of conservation concern."*

Habitat objectives, in contrast to goals, must be *measurable*. As stated in the Goals and Objectives Handbook, objectives must meet SMART criteria: specific, measurable, achievable, resource-oriented, and time-fixed. Habitat objectives describe future conditions, in quantitative terms, and will be supported by specific strategies and tasks. An example is: *"by 2015, create and maintain 40 acres of mid-successional shrublands in areas previously maintained as mowed grasslands, dominated by native shrubs such as sumac (Rhus spp.), arrowwood (Viburnum spp.), dogwood (Cornus spp.), raspberries (Rubus spp.) and young saplings such as cherry (Prunus spp.), Easter red Juniperus virginiana) cedar, Sassafras (Sassafras albidum). Woody invasive plants such as Bradford pear (Pyrus calleryana) and Glossy buckthrorn (Frangula alnus) will be controlled to compose less than 20% of woody plant cover. The shrublands will be managed to benefit migrating and breeding landbirds such as Prairie warbler, Northern bobwhite, Blue-winged warbler, Eastern Towhee, and Field Sparrow."*

The goals and objectives identified in this chapter were developed by citing, and then expanding on, the original goals and objectives from the Occoquan Bay NWR CCP (1997) that pertain directly to refuge habitat management. The original goals and objectives were written broadly, without references to specific habitats/plant communities, other than "grasslands" or "wetlands", and without guidance on supporting specific wildlife species or other priority Resources of Concern, other than "breeding and migratory birds." The objectives for this plan are more specific.

4.2 Original CCP Goals and Objectives

The following, original, goals and objectives from the Occoquan Bay NWR CCP NWR (1997)

pertain to refuge habitat management:

GOAL 1: MAINTAIN, RESTORE, AND ENHANCE GRASSLAND AND WETLAND HABITATS TO SUPPORT A DIVERSITY OF PLANTS AND ANIMALS.

> **Objective 1: The Refuge will maintain approximately 290 acres in grassland habitat in a variety of successional stages to maximize the potential habitat for the greatest diversity of breeding and migratory bird species.**
>
> **Objective 2: The Refuge will maintain approximately 180 acres in wetland habitat in the current mix of wetland types for migratory bird species.**

GOAL II: PREVENT AND CONTROL INVASIVE SPECIES THAT IMPACT NATIVE PLANT AND ANIMAL COMMUNITIES

> **Objective 5: The Refuge will maintain desired wetland diversity by evaluating the impact of beaver activity on wetland structure, composition, and water flow through the Refuge and by identifying and implementing potential methods for managing the population.**
>
> **Objective 6: The Refuge will identify and inventory invasive plant species and will begin controls on these species by FY 2000.**

GOAL III: PROVIDE HABITAT AND PROTECTION FOR FEDERALLY LISTED THREATENED OR ENDANGERED SPECIES.

> **Objective 8: Provide habitat that supports State-listed rare species, species of Service management concern, and globally rare species.**

4.3 Habitat Objectives for this HMP

The goals from the 1997 CCP seem relevant, and certainly meet the standards of describing "the desired future habitat conditions of a refuge in broad but succinct statements." These ten-year old objectives that pertain to refuge habitat management represent a starting place for this HMP. They: 1) provide refuge management with a target acreage for early successional habitats and wetland habitats to maintain on the Refuge; 2) identify the need to restore or protect tidal wetlands impacted by a combination of culvert placement and beaver activity; 3) identify the ongoing need to address invasive plant species in all refuge habitats; and 4) emphasize the need to provide habitat for rare, threatened or endangered species.

To further refine the original habitat objectives for the Refuge, we investigated habitat requirements for priority Resources of Concern (Table 3-1). We prioritized habitats, and described limiting factors and threats for each (Table 3-2). Using the SMART criteria, we have refined (and revised) the original habitat objectives from the CCP to provide the desired habitat conditions required by the priority Resources of Concern for the Refuge. In other words, statements from the original objectives, such as "variety of successional stages" and "wetland habitat", were made more specific in terms of plant community composition and structure, or physical attributes of habitats – to ensure support for Resources of Concern, and associated priority species.

The following section is a summary of the original Goals for the refuge, and the updated habitat

objectives, for this HMP. Table 4-1 summarizes the management units at Occoquan Bay NWR (as described in Section 2.6), the applicable habitats objectives described in this section, and the acreages of the relevant HMUs. It is important to note that habitat objectives 2.1 (addressing tidal restrictions) and 2.2 (addressing invasive species) apply refuge-wide.

Table 4-1. Management Units at Occoquan Bay NWR, see Figure 10 for HMU locations.

HMU	Land Cover Class	Hectares (acres)
TIDAL HERBACEOUS MARSH HMUs - OBJECTIVE 1.1		
27	Herbaceous Wetland (Tidal)	26.5 ha (65.4)
29	Herbaceous Wetland (Tidal)	26.0 ha (65.0)
SHRUBLAND HMUs - OBJECTIVE 1.2		
3	Herbaceous and Shrubland (shrub/forb dominated)	2.0 ha (5.0)
6	Herbaceous and Shrubland (shrub/forb dominated)	4.9 ha (12.1)
13	Herbaceous and Shrubland (shrub/forb dominated)	4.0 ha (9.9)
14	Herbaceous and Shrubland (shrub/forb dominated)	0.6 ha (1.5)
15	Herbaceous and Shrubland (grass-dominated)	11.8 ha (29.2)
20	Herbaceous and Shrubland (shrub/forb dominated)	6.3 ha (15.5)
23	Herbaceous and Shrubland (shrub/forb dominated)	1.3 ha (3.3)
GRASSLAND HMUs - OBJECTIVE 1.2		
1	Herbaceous and Shrubland (grass-dominated)	13.5 ha (33.3)
2	Herbaceous and Shrubland (grass-dominated)	5.1 ha (12.5)
4	Herbaceous and Shrubland (grass-dominated)	8.9 ha (22.0)
5	Herbaceous and Shrubland (grass-dominated)	12.6 ha (31.1)
18	Herbaceous and Shrubland (grass-dominated)	14.9 ha (36.7)
19	Herbaceous and Shrubland (grass-dominated)	4.9 ha (12.0)
MIXED UPLAND AND WETLAND HMUs - OBJECTIVE 1.3		
7	Mixed Upland and Wetland (sapling thicket and wet shrubland)	2.4 ha (6.0)
8	Mixed Upland and Wetland (sapling thicket and wet shrubland)	2.7 ha (6.6)
9	Mixed Upland and Wetland (sapling thicket and wet shrubland)	1.9 ha (4.8)
10	Mixed Upland and Wetland (sedge/wet meadow)	3.0 ha (7.3)
11	Mixed Upland and Wetland (sedge/wet meadow)	3.8 ha (9.4)
12	Mixed Upland and Wetland (sapling thicket)	6.0 ha (14.8)
24	Mixed Upland and Wetland (sedge/wet meadow)	2.2 ha (5.3)
25	Mixed Upland and Wetland (sedge/wet meadow)	0.60 ha (1.5)
BOTTOMLAND FOREST HMUs - OBJECTIVE 1.4		
17	Woody Wetland (Tidal)	1.4 ha (3.6)
28	Woody Wetland (Tidal)	7.3 ha (18.1)
NORTHERN ATLANTIC COASTAL PLAIN-DRY HARDWOOD FOREST HMUs - OBJECTIVE 1.5		
16	Forest and Woodland	1.3 ha (3.4)
22	Forest and Woodland	1.0 ha (2.4)
26	Forest and Woodland	13.6 ha (33.7)
30	Forest and Woodland	5.6 ha (13.7)
NO MANAGEMENT - NO OBJECTIVE		
21	Unknown forest type	0.45 ha (1.13)

GOAL 1: MAINTAIN, RESTORE, AND ENHANCE UPLAND AND WETLAND HABITATS TO SUPPORT A DIVERSITY OF PLANTS AND ANIMALS.

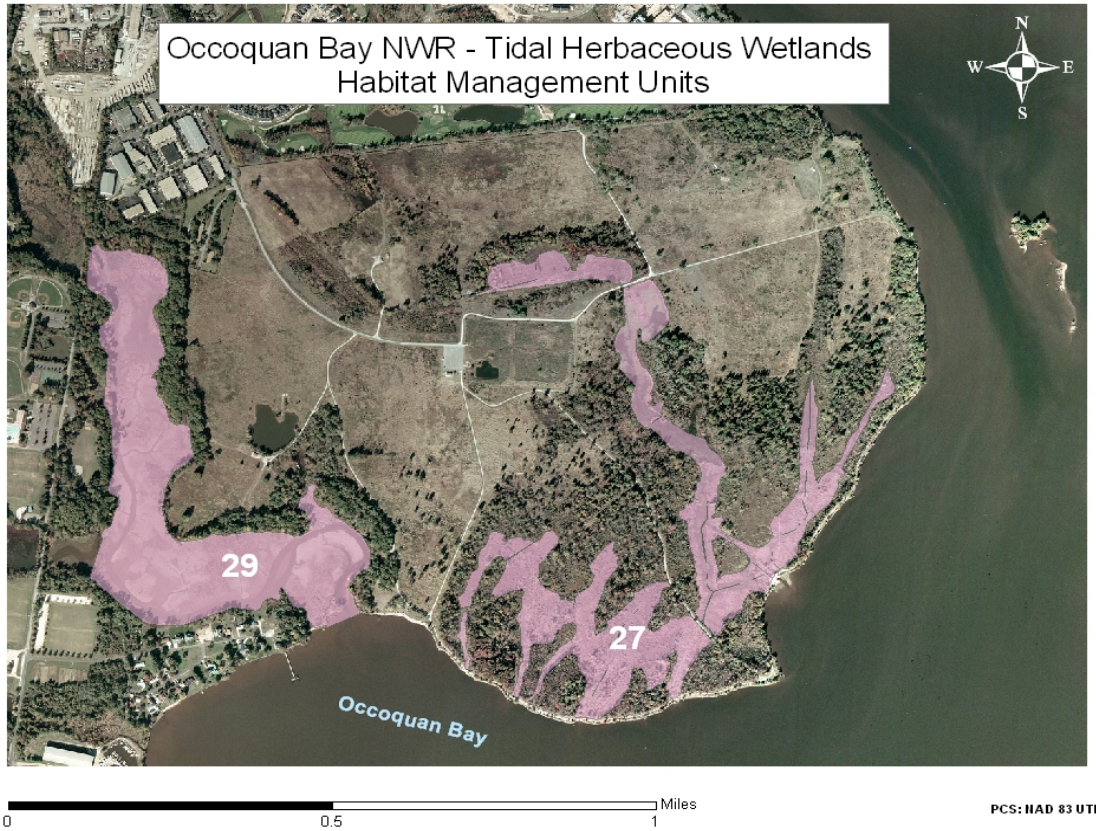
Revised Objective 1.1

Annually, maintain a minimum of approximately 53 ha (132 acres) of Herbaceous Wetlands (Tidal) (Northern Atlantic Coastal Plain Fresh and Oligohaline Tidal Marsh), with a plant community composition consistent with high-quality, local reference sites, and comprised of less than 5% overall cover of invasive plants. By 2010, control beaver populations, and restore tidal flows and tidal marsh habitat, in at least 2 previously, tidally-influenced areas on the Refuge, if practicable, to ensure that the quality and natural function of the tidal marshes on the Refuge are sustained or enhanced.

The Tidal Herbaceous Wetlands on the Refuge will be managed to provide: 1) breeding habitat for Forster's tern and Marsh wren, 2) migration/wintering habitat for American black duck, Canada goose, and Seaside sparrow, and 3) migration/wintering habitat for other priority species such as rails, other secretive marsh birds, and dabbling ducks. Management will focus on the following tidal marsh HMUs: 27 (27.2 ha) (marshes in the SE quarter of the Refuge) and 29 (26.29 ha) (Marumsco Creek marshes) (Figure 13).

The refuge will investigate the practicality of reversing the effects of beaver activity along Deephole Point Road, which is currently impounding tidal marshes, reducing tidal flows, and creating permanent ponds in this area. Similarly, the refuge will evaluate the utility of the beaver exclusion device installed on Catamount Creek, adjacent to Easy Road, and investigate the practicality of restoring tidal influence to this segment of the Creek.

Figure 13.



Revised Objective 1.2

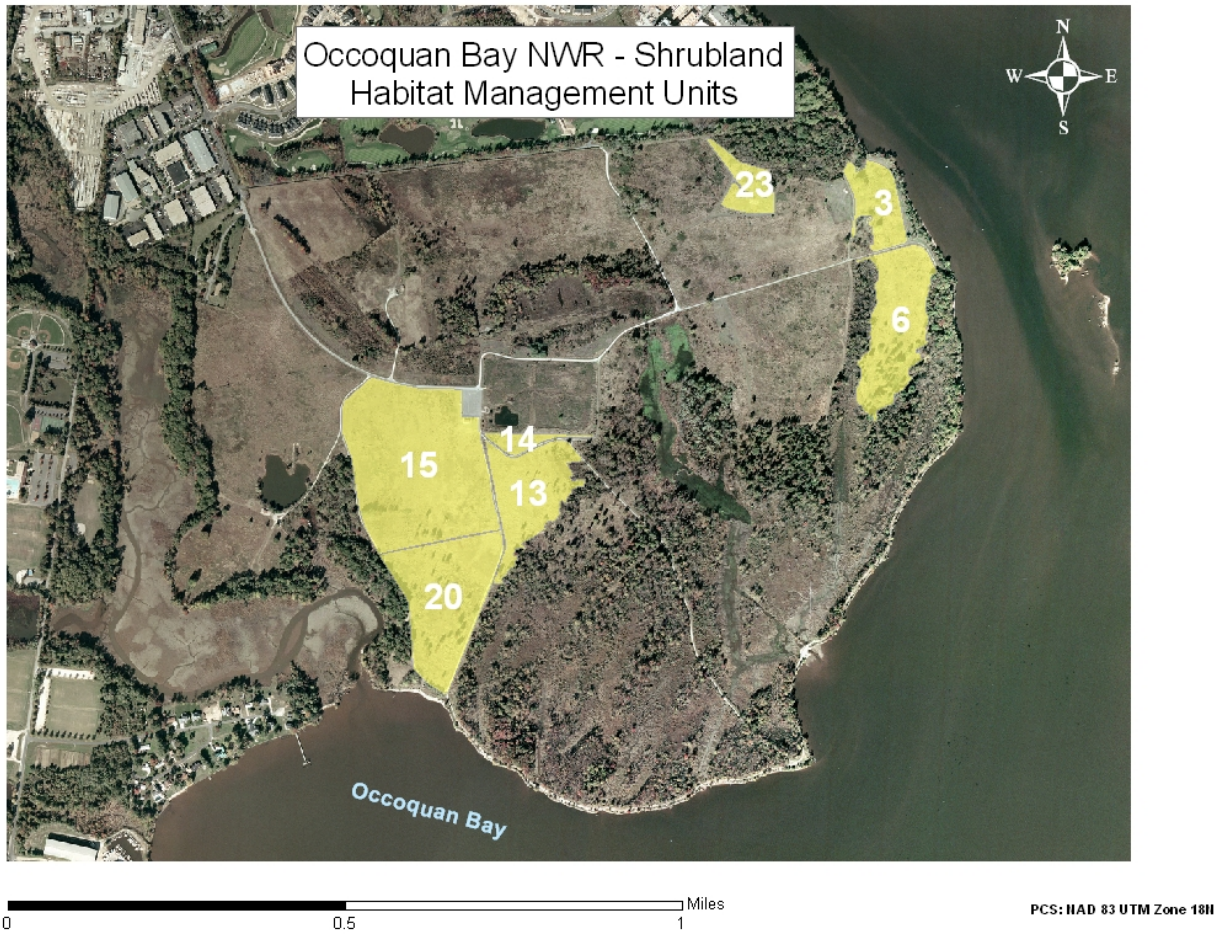
By 2015, the Refuge will: a) create and/or maintain 30 hectares of forb dominated, shrubby, mid-seral stage habitat in refuge uplands (Land Cover Class = Herbaceous and Shrubland (Shrub/Forb Dominated)), and b) maintain 64 hectares of grass-dominated, early seral stage habitat in refuge uplands (Land Cover Class = Herbaceous and Shrubland (Grass Dominated)).

Shrub/Forbe Dominated:
Current shrub-scrub habitat will be conserved, and some areas previously maintained as mowed grasslands will be converted to shrub-scrub, esp. in the smaller fields. Habitat will be composed of a mosaic of native shrubs such as sumac (*Rhus* spp.), arrowwood (*Viburnum* spp.), dogwood (*Cornus* spp.), raspberries (*Rubus* spp.); young saplings such as cherry (*Prunus* spp.), Eastern red cedar (*Juniperus virginiana*), Sassafras (*Sassafras albidum*); and patches of both native and non-native/naturalized grasses and forbs. Woody invasive plants such as Bradford pear (*Pyrus calleryana*) and Glossy buckthrorn (*Frangula alnus*) will be controlled to compose less than 20% of woody plant cover. All saplings will be cut after they exceed 20' tall (see example optimal habitat structure in Photograph 1).

The shrublands will be managed to benefit migrating and breeding Prairie warbler, Northern bobwhite, Blue-winged warbler, Eastern Towhee, and Field Sparrow, and associated priority species such as Eastern kingbird and Short-eared owl**.** Shrubland management will focus on the following HMUs: 3 (2.0 ha), 6 (4.8 ha), 13 (4.02 ha), 14 (0.62 ha), 15 (11.8 ha), 20 (6.2 ha), 23 (1.34 ha) (Figure 14).

Photograph 1. Example of target upland habitat structure for Herbaceous and Shrubland (Shrub/Forb Dominated) HMUs (Occoquan Bay NWR, 2006, L. Mitchell).

Figure 14



Grass Dominated:

Habitats will be maintained on the largest, most well-drained, contiguous fields on the Refuge, dominated by both native and non-native/naturalized graminoids and forbs. Woody plants such as non-native Bradford pear (*Pyrus calleryana*) and Glossy buckthrorn (*Frangula alnus*), and native shrubs and saplings, will be controlled to compose less than 2 % of plant community cover. Much of the current grassland units are dominated by Eastern gamma grass (*Tripsacum dactyloides*) (see Photograph 2) – a tall, dense, grass that while providing migration and wintering habitat is relatively unused by breeding grassland birds. Several grassland units, sufficient to meet minimum acreages desired by grassland breeding birds, will be converted to being dominated by shorter, sparser native grasses used by obligate grassland species (e.g. broomsedge [*Andropogon virginicus*], purpletop [*Tridens flavus*], little bluestem [*Schizachyrium scoparium*], deer tongue [*Dichanthelium clandestinum*], wild rye [*Elymus* spp.] etc.) (see example optimal habitat structure in Photograph 3). On these units the following plant community characteristics will be maintained: 80% or greater grass cover; 1% or less cover of aggressive, invasive plants; community structure with shallow litter and thatch layers and an average height-density of < 1m

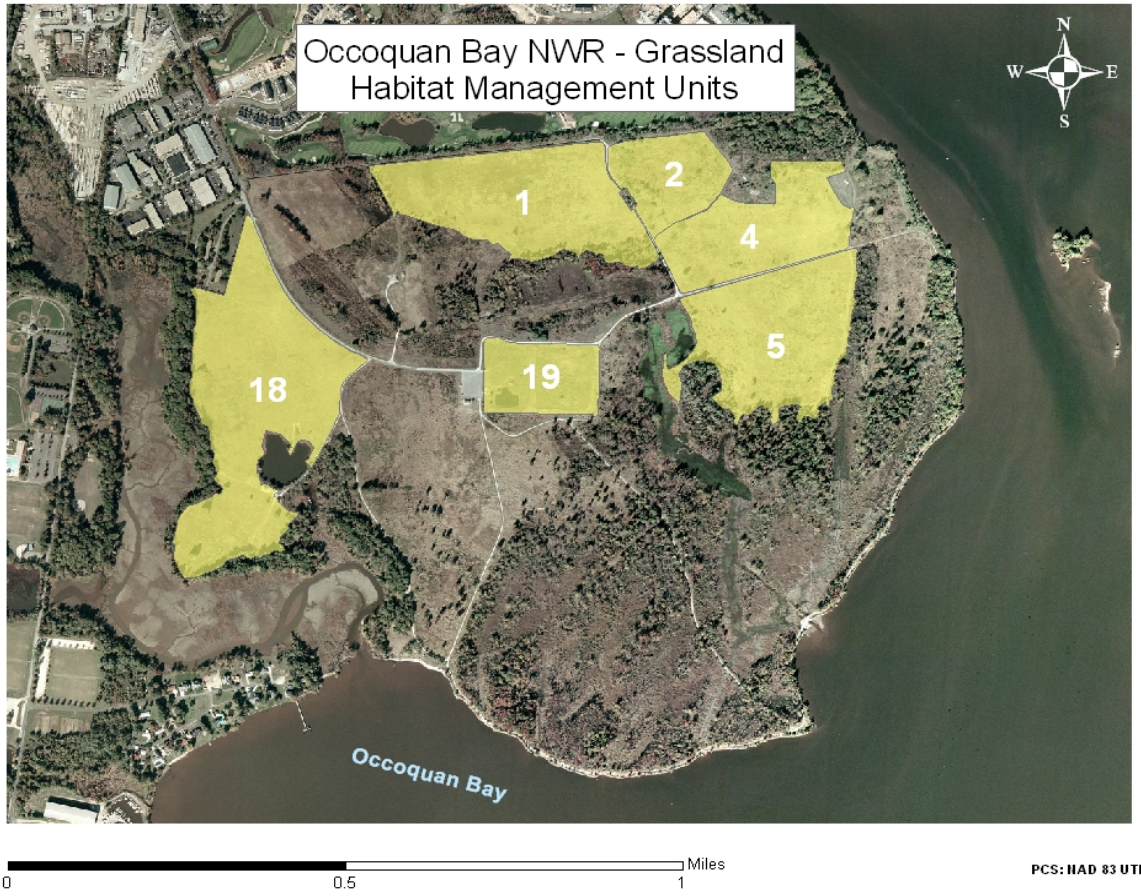
(as measured with a Robel pole). The remaining units will be maintained in their current state.

The mix of grasslands will be managed to benefit migrating and breeding grassland birds of moderate concern, such as Eastern Meadowlark and Grasshopper Sparrow, foraging raptors such as Northern Harrier, and wintering migrants such as Song Sparrow and Savannah Sparrow. Grassland management will focus on the following habitat units: 1 (13.4 ha), 2 (5.05 ha), 4 (8.9 ha), 5 (12.57 ha), 18 (15.4 ha), and 19 (4.85 ha) (Figure 15). Note: Unit 18 will eventually be partly converted to Forest and Woodland Habitat.

Photograph 2. Current state of Occoquan NWR fields – dominated by Eastern gammagrass; they are overly tall and too dense to provide habitat for grassland breeding birds (Occoquan Bay NWR, 2007, L. Mitchell).

Photograph 3. Example of target grassland structure for Herbaceous and Shrubland (Grass Dominated) HMUs. Note that average height density of the vegetation in this field is significantly less than 1 meter (1meter is indicated by "10" on the Robel pole) (Bombay Hook NWR, 2003, L. Mitchell).

Figure 15



Objective 1.3

Annually, maintain and/or restore 22 hectares (43 acres) of Mixed Upland and Wetland (Northern Atlantic Coastal Stream and River), in the somewhat poorly drained, and poorly drained HMUs along the upper reaches of Catamount Creek.

Specific details for Mixed Upland and Wetland:

Current Mixed Upland and Wetland habitat will be conserved. Some areas previously maintained as frequently hydro-axed openings will be converted to shrublands or sapling thickets, while sedge meadows will be mowed or plowed periodically to maintain dominance by graminoids.

Mixed Upland and Wetland HMUs (Figure 16) will be composed of a mosaic of: 1) **moist shrub patches (**~3-5 ha) of alder (*Alnus* spp.), arrowwood (*Viburnum* spp.), willow (*Salix* spp.) and similar native species; 2) patches (~3-5 ha) of **thickets of young** (<15 years), **native saplings** such as red maple and sweetgum; and 3) **patches** (~3-5 ha) **of native wetland graminoid plants** (e.g. sedge meadows). Woody invasive plants such as multiflora rose (*Rosa multiflora*) will be controlled to compose less than 20% of woody plant cover. See Photograph 4 for and example of optimal structure for a shrub patch; see Photograph 5 for an example of optimal structure for a thicket of young saplings; see Photograph 6 for an example of optimal structure for a sedge meadow).

The mixture of young forest, moist shrubby areas and wet meadows will be managed to benefit migrating and breeding American Woodcock, Willow Flycatcher, and possibly Coastal Plain Swamp Sparrow. The shrub and sapling thickets will benefit associated priority species such as migrating landbirds and the sedge meadows will benefit priority wintering secretive marsh birds such as rails and also wintering sparrows of moderate management concern**.**

Mixed Upland and Wetland management will be focused as follows:

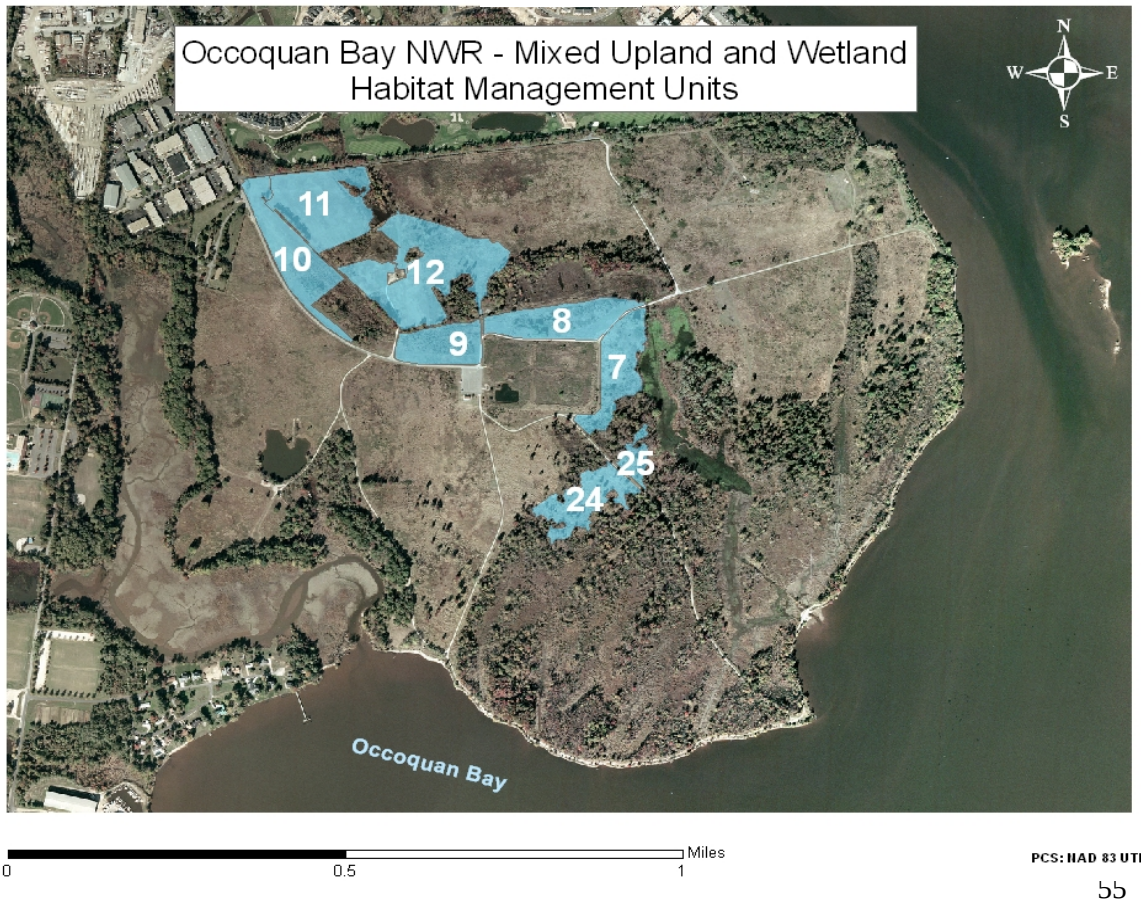
- Existing sedge meadows and sapling thickets in HMU 10 and HMU 11 will be maintained
- HMUs 9, 8, and 7 will be managed as a mixture of sapling thickets and moist shrublands
- HMU 12 will be allowed to succeed to a sapling thicket, and managed as such in the future
- HMUs 24 and 25 will be managed as wet meadows, with patches of moist shrublands

Photograph 4. Example of shrub patches and wet meadows to be maintained in Mixed Upland and Wetland HMUs (Occoquan Bay NWR, 2007, L. Mitchell).

Photograph 5. Example of native sapling thicket to be maintained in Mixed Upland and Wetland HMUs (in the background) (Occoquan Bay NWR, 2007, L. Mitchell).

Photograph 6.. Example of native sedge meadow to be maintained in Mixed Upland and Wetland HMUs (in the foreground) (Occoquan Bay NWR, 2007, L. Mitchell).

Figure 16

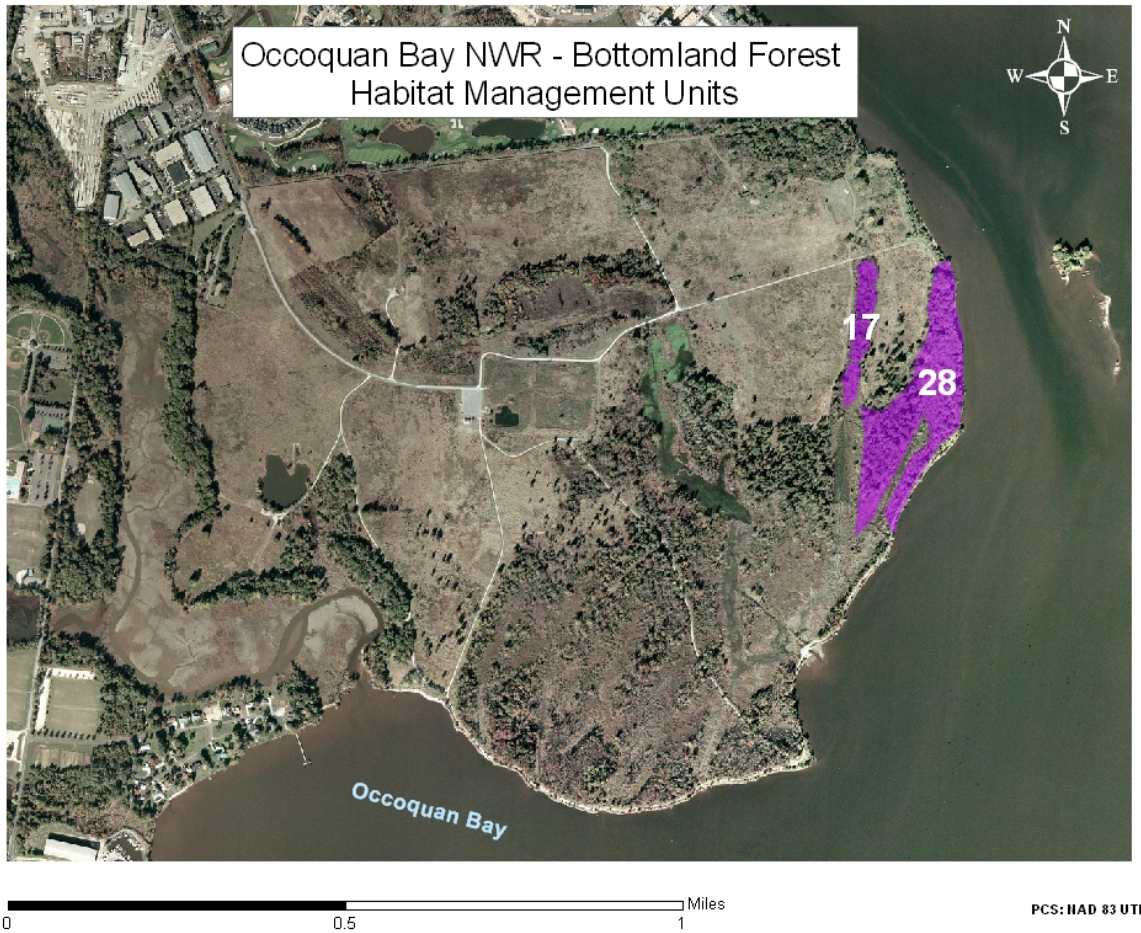


Objective 1.4

Annually, provide a minimum of 10 hectares (25.5 acres) of Woody Wetland (Tidal) (Northern Atlantic Coastal Plain Tidal Swamp), in a closed canopy condition, comprised of less than 5% overall cover of invasive plants, and with a forest community composition consistent with high-quality, local reference sites.

Woody Wetland (Tidal):
Management will be mainly passive, allowing the bottomland forests on the refuge (which are mainly rather young), to continue to age. Some limited, active management actions may be necessary in the future to control insect or disease outbreaks, or to control invasive plants. Over time, the Refuge also may allow wet fields or shrublands adjacent to current bottomland forest to succeed to closed canopy forest, to increase the total bottomland forest area on the Refuge. The tidal swamps will be managed to provide: 1) breeding and migratory habitat for forest interior birds of wetland habitats, including Prothonotary Warbler, Scarlet Tanager, Wood Thrush, Yellow-throated Warbler, and American Woodcock, and associated priority migratory species such as Mallard, Acadian flycatcher, Bald eagle, Baltimore Oriole, Broad winged hawk, Great crested flycatcher, Northern Parula, Worm-eating Warbler , and American Redstart; and 2) spring and fall migration habitat for migrating landbirds, including: Kentucky warbler, Louisiana waterthrush, Blackburnian warbler, Black-and-white warbler, Canada warbler, and Great crested flycatcher. Management will focus on the following habitat management units: 28 and 17, plus other areas within the wetland complex in the southeastern quarter of the Refuge, as they are identified and described (Figure 17).

Figure 17



Objective 1.5

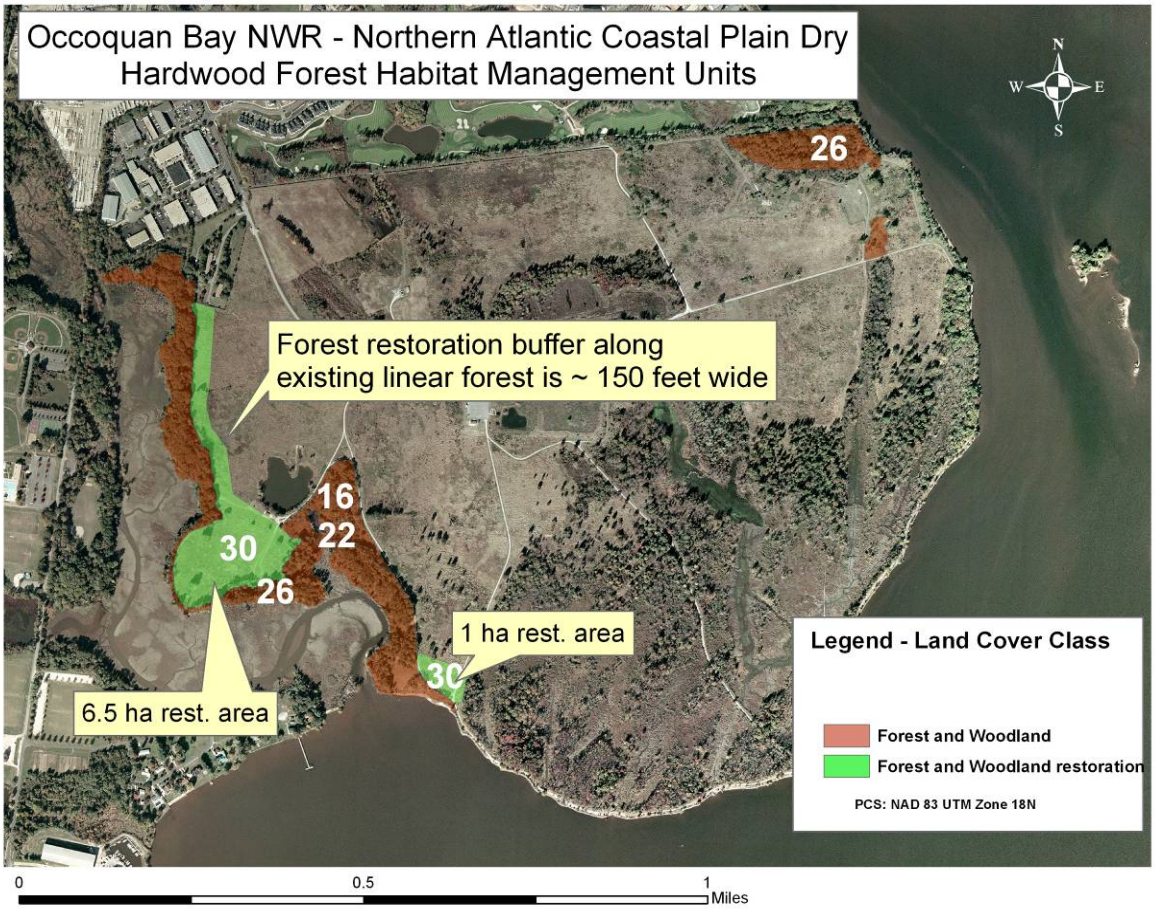
(Although it does not fit in neatly as a step-down objective from the original goals of the CCP, the following Forest Restoration Objective is also included in this HMP. Northern Atlantic Coastal Plain Dry Hardwood forest is a natural community that is listed as critically imperiled in Virginia because of extreme rarity. The refuge contains a small amount of this rare ecosystem, and has the well-drained soils that could foster restoration of more of this forest.)

The Refuge will maintain 15 acres of rare, Northern Atlantic Coastal Plain Dry Hardwood Forest. In addition, by 2015, the Refuge will plant/begin restoration of 7.5 additional hectares of this forest type.

Specific details for Northern Atlantic Coastal Plain Dry Hardwood Forest (Forest and Woodland):

The native and restored forest will be comprised of less than 5% overall cover of invasive plants, and forest community composition consistent with high-quality, local reference sites, such as the current conditions in the existing dry forest adjacent to Marumsco Creek (HMU 26). Management will focus on the following HMUs: 16 (1.3 ha), 22 (.9 ha), 26 (13 ha) and 30 (7.5 ha total, in 2 disjunct restoration areas, adjacent to HMUs 18 and 20) (Figure 18).

Figure 18



V. Management

5.1 Introduction

This chapter sets out specific management strategies and prescription for meeting habitat management objectives identified in Chapter 4. Management strategies identify how (e.g. burning, water-level manipulation, mowing, etc.) we will achieve the habitat objectives. Management prescriptions further identify the specific means by which the strategies will be implemented (e.g. location, timing, frequency, intensity). A comprehensive literature review was conducted to identify all potential strategies and prescriptions for each habitat objective. In consultation with other Refuge biologists, managers, and experts, we then selected the most effective strategies and prescriptions for accomplishing the habitat objectives. Since environmental factors, such as wildlife population, weather, and habitat conditions affect what prescriptions we select to achieve objectives from year to year, the details of prescriptions will be identified in the Annual Habitat Work Plan. Under this chapter, prescriptions are discussed conceptually.

The natural world, and particularly coastal habitats, is a vastly complex and dynamic system. As stewards of this ever-changing ecosystem, we can never completely understand every aspect of the system, but must be ready to react to its ever-changing geophysical, ecological, social, and political factors that influence status of biodiversity and its conservation. We can't always know or predict which management strategies or prescriptions will be needed in five years or in ten years and not all strategies listed may be used at Occoquan Bay NWR. Some management strategies identify inventory and monitoring of certain communities or populations. Specific details concerning implementation of the inventory and monitoring prescriptions will be identified in the Inventory and Monitoring Plan, to be drafted in the future.

5.2 Management Units

As described in Section 2.6, for the purpose of implementing these prescriptions, Occoquan Bay is divided into 30 Management Units (Table 2-4 and 4-1, Figures 9 and 10). Several habitat types, such as grasslands and shrublands, require more intensive management, and thus have multiple management units, whereas other habitats, such as Forest and Woodland, or Herbaceous Tidal Marsh, do not require constant management, and are treated as one unit.

5.3 Management Strategies and Prescriptions by Habitat Objective

Objective 1.1 Tidal Herbaceous Marsh HMUs 27 and 29

Annually, maintain a minimum of approximately 53 ha (132 acres) of Herbaceous Wetlands (Tidal) (Northern Atlantic Coastal Plain Fresh and Oligohaline Tidal Marsh), with a plant community composition consistent with high-quality, local reference sites, and comprised of less than 5% overall cover of invasive plants. By 2010, control beaver populations, and restore tidal flows, and tidal marsh habitat, in at least 3 previously, tidally-influenced areas on the Refuge, to ensure that the quality and natural function of the tidal marshes on the Refuge are sustained or enhanced. The refuge will use any means available to control the beaver population and maintain the health of tidal marsh habitat.

Management Strategies and Prescriptions:

- The refuge will work with fisheries, Ecological Services, and other partners, to control beaver populations on the refuge, and reverse the effects of beaver activity along Deephole Point Road, which is currently impounding tidal marshes, reducing tidal flows, and creating permanent ponds in this area.
- Similarly, the refuge will evaluate the utility of the beaver exclusion device installed on Catamount Creek, adjacent to Easy Road, and investigate the practicality of restoring tidal influence to this segment of the Creek.
- Visit all stream/culverts monthly and determine if actions are required to remove or reduce restrictions to tidal flows.
- Continue to maintain a native shrub or forest buffer next to the tidal marshes.
- Control any populations of invasive plant species (e.g. *Phragmites*, mile-a-minute) in the marsh through cutting, hand pulling, stem injection, and herbicide application.
- Work with volunteers and partners to inventory and GPS invasive plant infestations to guide refuge control actions.

Monitoring Elements:
Conduct appropriate monitoring and survey programs as funding and staffing permits to measure our success with respect to our objectives. The results may trigger adjustments to management strategies and may trigger a reevaluation or refinement of our objectives. Examples of monitoring or surveys that we may implement include:

- Annually survey streams, culverts, and outlets to determine if beaver activity is impeding tidal influence or drainage.
- Develop and implement a survey protocol to monitor population trend and densities, and possibly productivity of, breeding saltmarsh sparrows (seaside) at various tidal marsh units on the Refuge.
- Work with partners (e.g. Center for Conservation Biology, Audubon) to develop and implement a survey protocol for breeding and wintering rails on the refuge, including tidal marsh habitats.
- Work with partners (e.g. Center for Conservation Biology, Audubon) to develop and implement a survey protocol for coastal plain swamp sparrow on the refuge, including shrubby edges of tidal marsh habitats.
- List all invasive plants known to exist on the refuge; prioritize invasive plants for control actions, placing those presenting the highest threats to ecological integrity first (consult state invasive plant control programs)
- Evaluate success of invasive species control efforts and prioritization in order to focus control efforts and adjust management strategies as necessary to maintain effectiveness.
- To maintain desired quality and characteristics of marsh habitats, annually conduct scouting for invasive species. We will afford zero tolerance to highly invasive or stand replacing species. Occurrences of stands or more stable patches of invasive plants may be tolerated in the short term as long as fundamental objectives are not compromised.

Objective 1.2 Shrubland Component HMUs 3, 6, 13, 14, 15, 20, and 23

By 2015, the Refuge will: a) create and/or maintain 30 hectares of forb dominated, shrubby, mid-seral stage habitat in refuge uplands

Management Strategies and Prescriptions:

- Conduct selective management to control small trees or invasive woody plants that invade the area (e.g. every five years); conduct intermittent mowing or burning to maintain interspersion of shrubs and herbaceous vegetation.
- Strategy 1. Selective cutting and herbicides - **s**table shrub communities can be created and maintained by selectively cutting overstory trees (and undesired exotic plants), followed by selective herbicide application (e.g. stump application), while leaving desired shrubs.
- Dense, clonal shrubs (e.g. Cornus spp. and Viburnum spp.) may be encouraged to resprout and increase stem density through mowing, or prescribed fire (e.g. every 5-10 years).
- Strategy 2. Mowing - mowing can be used to create an interspersion of desired patches of shrubs and/or saplings, and herbaceous vegetation. It is preferable to mow woody vegetation at the small diameter stem stage, minimizing ground disturbance, allowing the most selective mowing work. Units will be mowed on a rotational basis determined by the growth or woody vegetation.
- Strategy 3. Prescribed fire- fire might be used as an alternative to mowing, to alter plant species composition and reduce woody cover. Intermittent (e.g. every few years) application of dormant season burns will promote shrub cover, by increasing shrub stem density, and promote warm season grass growth.
- Patches dominated by regenerating trees will require aggressive management; this may include stumping and mowing every one to three years, perhaps coupled with an herbicide application to control trees attempting to resprout.
- Once upland shrublands become well established they may require only periodic management (every five to ten years or longer).
- Invasive species control will likely require annual inspection and application of control measures to keep old fields and shrublands free of aggressive invaders, such as autumn olive, multiflora rose, and Canada thistle.
- To control invading tree species, mowing should take place during the growing season to minimize resprouting.

Monitoring Elements:
Conduct appropriate monitoring and survey programs as funding and staffing permits to measure our success with respect to our objectives. The results may trigger adjustments to management strategies, such as burning and selective removal to achieve structural and species diversity of native shrub species. Results may trigger a reevaluation or refinement of our objectives. Examples of monitoring or surveys that we may implement include:

- To evaluate quality of shrubland habitat conduct periodic vegetation surveys for species composition, community structure and berry production every one to five years.
- List all invasive plants known to exist on the refuge; prioritize invasive plants for control actions, placing those presenting the highest threats to ecological integrity first (consult state invasive plant control programs)
- To maintain desired quality and characteristics of shrublands, annually conduct scouting for invasive species. We will afford zero tolerance to species that are highly invasive and stand replacing. Occurrences or stands of more stable patches of invasive species may be tolerated in the short term as long as their cumulative coverage is no more than 5% percent, and

objectives are not compromised.
- Incorporate this habitat type into biological surveys, such as habitat-based landbird point count surveys, migration and winter bird surveys, and anuran call counts. Landbird point count habitat classifications in shrublands would be updated to track changes in habitat relative to bird use.

Objective 1.2 Grassland HMUs 1, 2, 4, 5, 18, 19

The Refuge will maintain 64 hectares of grass-dominated, early seral stage habitat in refuge uplands

Management Strategies and Prescriptions for Upland Grasslands

- Conduct selective management to control small trees or invasive woody plants that invade the area (every year); conduct aggressive mowing or burning to maintain herbaceous vegetation (e.g every 2-3 years).
- Strategy 1. Mowing - mowing will be the primary tool to control woody vegetation and weeds; mid-summer mowing maintains forbs and cool-season grasses and is most effective at controlling woody plants; mowing in late winter to early spring favors warm-season grasses vs. cool-season grasses, and leaves protective cover on the ground during the winter months for wintering species; mowing will be used on a rotating basis in sub-compartments of the larger (>5 ha) grassland fields, likely on a 2-3 year basis.
- Strategy 2. Prescribed fire -prescribed fire should be used alternately with mowing, to alter plant species composition and reduce woody cover; dormant season burns suppress cool-season grasses and promote warm-season grasses and late season forbs (e.g. goldenrods, asters); but fail to reduce shrub cover; mid- to late-summer burns reduce warm season grasses and forbs, but are more effective at reducing shrub cover; dormant season burns might be particularly effective in increasing native warm season grass cover, and increasing cover of late season forbs for summer/fall lepidopterans, such as migrating monarchs.
- Strategy 3. Haying - Haying may be used to maintain grass cover, and to control woody vegetation and weeds; haying may occur on any of the grassland fields, after the peak of breeding bird activity.
- Prescribed fire should be used in concert with other techniques to control woody plants (e.g. mowing, herbicide), since fire alone will not control these plants, particularly woody shrubs and vines.

Monitoring Elements:
Conduct appropriate monitoring and survey programs as funding and staffing permits to measure our success with respect to our objectives. The results may trigger adjustments to management strategies, such as burning and selective removal to achieve structural and species diversity of native shrub species. Results may trigger a reevaluation or refinement of our objectives. Examples of monitoring or surveys that we may implement include:
- To measure abundance, relative abundance, and density of obligate grassland birds (where appropriate), survey during the breeding season (late May through early July?) on selected fields annually throughout the life of the CCP.

- To evaluate quality of grassland habitats conduct periodic vegetation surveys during the grassland bird breeding season at bird points for height, grass-forb ratio, and bare ground. If grassland bird density or percent occupancy falls, and grass height, grass-forb ratio and percent bare ground are suggestive as being the cause, then this would be a trigger point for evaluating the management regime of the grassland.
- List all invasive plants known to exist on the refuge; prioritize invasive plants for control actions, placing those presenting the highest threats to ecological integrity first (consult state invasive plant control programs)
- To maintain desired quality and characteristics of grasslands, annually conduct scouting for invasive species. We will afford zero tolerance to species that are highly invasive and stand replacing. Occurrences or stands of more stable patches of invasive species may be tolerated in the short term as long as their cumulative coverage is no more than 25%, and objectives are not compromised.

Objective 1.3 Mixed Upland and Wetland HMUs 7, 8, 9, 10, 11, 12, 24, 25

Annually, maintain and/or restore 22 hectares (43 acres) of Mixed Upland and Wetland (Northern Atlantic Coastal Stream and River), in the somewhat poorly drained, and poorly drained HMUs along the upper reaches of the small, unnamed stream that bisects the Refuge.

- Conduct management to control small trees or invasive woody plants that invade the area (every year); conduct aggressive mowing or disking to maintain herbaceous vegetation (e.g every 3-4 years).
- Strategy 1. Moist Shrublands (portions of HMUs 7, 8, 9) – create and maintain by selectively cutting overstory trees (and undesired exotic plants), followed by selective herbicide application; brush-hogging grass or forb openings around shrubs; to maintain shrub cover mow or apply dormant season prescribed fire (e.g. every 5—10 years); to increase herbaceous cover, brush hog openings during the growing season.
- Strategy 2. Sapling Thickets (portions of HMUs 7, 8, 9, 12) - Cut with heavy equipment; cut patches dominated by late-successional tree species on a 10-15 year rotation, with large-diameter mowing equipment.
- Strategy 3. Sedge/Wet meadows (HMUs 10, 11, 24, 25) – Mow, disk, or plow (with advanced woody invasion) every 3-4 years.

Monitoring Elements:
Conduct appropriate monitoring and survey programs as funding and staffing permits to measure our success with respect to our objectives. The results may trigger adjustments to management strategies, such as burning and selective removal to achieve structural and species diversity of native shrub species. Results may trigger a reevaluation or refinement of our objectives. Examples of monitoring or surveys that we may implement include:
- To evaluate quality of sedge/wet meadow habitat conduct periodic vegetation surveys for species composition and community structure every one to five years.
- List all invasive plants known to exist on the refuge; prioritize invasive plants for control actions, placing those presenting the highest threats to ecological integrity first (consult state invasive plant control programs)
- To maintain desired quality and characteristics of mixed uplands and wetlands, annually

conduct scouting for invasive species. We will afford zero tolerance to species that are highly invasive and stand replacing. Occurrences or stands of more stable patches of invasive species may be tolerated in the short term as long as their cumulative coverage is no more than 5%, and objectives are not compromised.
- Incorporate this habitat type into ongoing biological surveys, such as habitat-based landbird point count surveys, migration and winter bird surveys, and anuran call counts. Landbird point count habitat classifications in mixed uplands and wetlands would be updated to track changes in habitat relative to bird use.

Objective 1.4 Bottomland Forest HMUs 17 and 28

Annually, provide a minimum of 10 hectares (25.5 acres) of bottomland forest (Northern Atlantic Coastal Plain Tidal Swamp), in a closed canopy condition, comprised of less than 5% overall cover of invasive plants, and with a forest community composition consistent with high-quality, local reference sites.

Management Strategies and Prescriptions

- Work with partners (e.g. Center for Conservation Biology, Audubon) to develop and implement a survey protocol for forest interior breeding and migrating landbirds in tidal swamps on the Refuge.
- Control any populations of invasive plant species (e.g. *Phragmites*, mile-a-minute) in the tidal forestes through cutting, hand pulling, stem injection, and herbicide application.

Monitoring Elements:
Conduct appropriate monitoring and survey programs as funding and staffing permits to measure our success with respect to our objectives. The results may trigger adjustments to management strategies, such as burning and selective removal to achieve structural and species diversity of native shrub species. Results may trigger a reevaluation or refinement of our objectives. Examples of monitoring or surveys that we may implement include:
- To evaluate forest interior breeding and migrating landbird use of tidal swamps conduct surveys during breeding season and peak migration to determine bird abundance, density and diversity every 5 years.
- List all invasive plants known to exist on the refuge; prioritize invasive plants for control actions, placing those presenting the highest threats to ecological integrity first (consult state invasive plant control programs)
- To maintain desired quality and characteristics of mixed uplands and wetlands, annually conduct scouting for invasive species. We will afford zero tolerance to species that are highly invasive and stand replacing. Occurrences or stands of more stable patches of invasive species may be tolerated in the short term as long as their cumulative coverage is no more than 5%, and objectives are not compromised.
- Incorporate this habitat type into ongoing biological surveys, such as habitat-based landbird point count surveys, migration and winter bird surveys, and anuran call counts. Landbird point count habitat classifications in bottomland forests would be updated to track changes in habitat relative to bird use.

Objective 1.5 Northern Atlantic Coastal Plain-Dry Hardwood Forest HMUs (16, 22, and 30)

The Refuge will maintain 15 acres of rare, Northern Atlantic Coastal Plain Dry Hardwood Forest. In addition, by 2015, the Refuge will plant/begin restoration of 7.5 additional hectares of this forest type.

Management Strategies and Prescriptions:

- Conduct inventories of existing upland forest HMUs; use this to guide plant list and proportions for forest restoration actions and to develop a comprehensive plan for invasive plant management for these habitats, if invasives are found.
- Plant saplings (up to 5 feet), spaced 20 to 30 feet apart. Check commercially available plants to ensure that parent stock are obtained from the mid-Atlantic coastal plain or piedmont
- Water seedlings and saplings as recommended and protect from deer herbivory.
- Initiate volunteer weed management program on refuge, using volunteers to inventory and GPS invasive plant infestations, to guide refuge control actions
- Annually treat new invasive plants within restoration site with backpack sprayer as needed.

Monitoring Elements:
Conduct appropriate monitoring and survey programs as funding and staffing permits to measure our success with respect to our objectives. The results may trigger adjustments to management strategies, such as burning and selective removal to achieve structural and species diversity of native shrub species. Results may trigger a reevaluation or refinement of our objectives. Examples of monitoring or surveys that we may implement include:

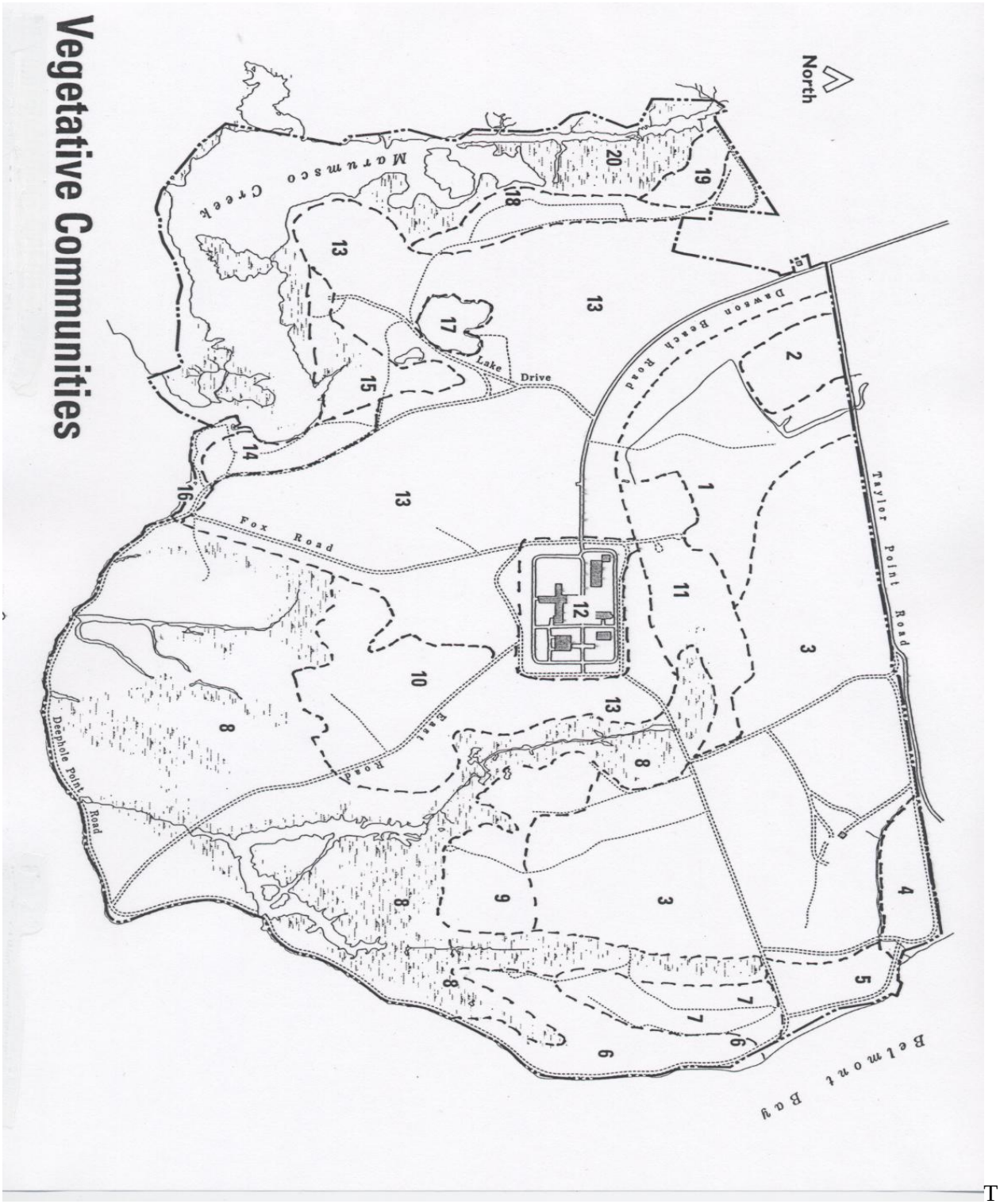
- List all invasive plants known to exist on the refuge; prioritize invasive plants for control actions, placing those presenting the highest threats to ecological integrity first (consult state invasive plant control programs)
- To maintain desired quality and characteristics of Northern Atlantic Coastal Plain Dry Hardwood Forests, annually conduct scouting for invasive species. We will afford zero tolerance to species that are highly invasive and stand replacing. Occurrences or stands of more stable patches of invasive species may be tolerated in the short term as long as their cumulative coverage is no more than 5%, and objectives are not compromised.
- Incorporate this habitat type into ongoing biological surveys, such as habitat-based landbird point count surveys, migration and winter bird surveys, and anuran call counts. Landbird point count habitat classifications in upland forests would be updated to track changes in habitat relative to bird use.

Appendix A.

Map unit descriptions for soils mapped for Occoquan Bay NWR during 2007 site visit.

Map symbol	Map Unit Name	Description
15A	Comus loam, 2-2 % slopes	Nearly level to gently sloping, well drained soil. Seasonal high water table depth >6 feet. Surface has moderate OM content.
16A	Delanco fine sandy loam, 0-4% slopes	Nearly level to moderately sloping, very deep, moderately well drained soil. Top of seasonal high water table is 21 inches. Surface has moderate OM content.
18C	Dumfries sandy loam, 7-15% slopes	Strongly sloping, moderately steep, very deep, well drained soil. Seasonal high water table depth > 6 feet. Surface has low OM content.
20B	Elsinboro sandy loam, 2-7% slopes	Gently sloping to moderately sloping, very deep, well drained soil. Seasonal high water table depth > 6 feet. Surface has moderate OM content.
22A	Featherstone mucky silt loam, 0-1% slopes	Nearly level, very deep, very poorly drained soil. Top of seasonal high water table is at the surface. Surface layer has a very high OM content.
37A	Marumsco loam, 0-4 % slopes	Nearly level to moderately sloping, very deep, moderately well drained soil. Top of seasonal high water table is at 15 inches. The surface has moderately low OM content.

Appendix B



There are 20 vegetative communities at the refuge, with wetlands habitats covering about 50 percent of the site (Comprehensive Conservation Plan 1997). Transitions between vegetative communities on the refuge are largely the result of differing hydrologic regimes. Tidal influences are signficant because most of the refuge lies below the 100-year flood plain elevation.

Area 1 30 Acres 4.3% of refuge

Area 1 is composed of two intermittent channels draining south from the east side of Dawson Beach Road. Except for the forested band along each channel, the area was traditionally mowed several times during the spring and summer. Common observed woody species include black gum (*Nyssa sylvatica*), northern arrowwood (*Viburnum recognitum*), sweetgum (*Liquidambar styraciflus*~~a~~**),** and red maple (*Acer rubrum*). Herbaceous species found in this habitat include soft rush (*Juncus effusus*), orchard grass (*Dactylis glomerata*), Virginia creeper (*Parthenocissus quinquefolia*), tichseed sunflower (*Bidens spp.*), and umbrella sedge (*Cyperus spp.*).

Area 2 7 Acres 1.1% of Refuge

Area 2 is a grassy area between two stream channels north of Area 1. This area was mowed regularly. Herbaceous vegetation include white-top sedge (*Dichromena colorata*), soft rush, tickseed sunflower, senstive fern (*Onoclea sensibilis*), and barnyard grass (*Echinocloa crusgalli*).

Area 3 103 Acres 15.7% of Refuge

Area 3 is an open field covering much of the area adjacent to the northern boundary of the refuge. Historically (prior to 1996), the area was mowed once annually. Dominant species include sweetgum saplings, eastern gamma grass (*Tripsacum dactyloides*), jointgrass (*Manisuris cylindrica*),dropseed grass (*Muhlenbergia expansa*), and bush clover (*Lespedeza capitata*)**.**

Area 4 30 Acres 4.3% of Refuge

Area 4 is a forested tract in the northeast corner of the refuge. The dominant woody species include persimmon (*Diospyros virginiana*), sweetgum, and northern arrowwood. Herbaceous species along the stream channel include jointgrass, dropseed grass, barnyard grass, and Christmas fern (*Polystichum acrostichoides*).

Area 5 7 Acres 0.5% of Refuge

Historically, Area 5 was a picnic and recreation area for the base, and contained both a softball diamond and picnic facilities. Vegetative cover was predominantly mowed turfgrass.

Area 6 21 Acres 1.1% of Refuge

Area 6 is a forested tract on the east side of the refuge. The dominant tree species is silver maple (*Acer saccharinum*). Also common are green ash (*Fraxinus pennsylvanica*) and black gum. Herbaceous understory species include nimble-well (*Muhlenbergia schreberi*), terell grass (*Elymus virginicus*), and ground ivy (*Glecoma hederacea*).

Area 7 11 Acres 1.7% of Refuge

Area 7 is a frequently mowed area west of Area 6 that is bounded by an intermittent stream channel hydrologically connected to a large tidal marsh community (Area 8)on the west. Dominant herbaceous species include jointgrass, dropseed grass, thistle (*Cirsium spp.*), and soft rush.

Area 8 120 Acres 18.3% of Refuge

Area 8 is dominated by shrubby and emergent growth with occasional interspersion of tree species on islands, that is tidally influenced covering most of the shorelind of Belmont and Occoquan Bays. Dominant species include marsh mallow (*Hibiscus moscheutos*), swamp rose (*Rosa palustris*), button bush (*Cephalanthus occidentalis*), spatterdock (*Nuphar luteum*), pickerelweed (*Pontederia cordata*), silky dogwood (*Cornus amomum*), and black willow (*Salix nigra*). The islands are dominated by green ash, sycamore (*Plantanus occidentalis*), black willow, and silver maple.

Area 9 17 Acres 2.6% of Refuge

Area 9 is a transitional area between a tidal community (Area 8) and an open field community (Area 3). This transitional community is sparsely covered with persimmon, red maple, and sweetgum. Herbaceous cover include jointgrass, raspberry (*Rubus* spp.), poison ivy, Japanese honeysuckle (*Lonicera japonica*), soft rush, tickseed sunflower, and nimble-well.

Area 10 **38 Acres** **5.8% of Refuge**

Area 10 is a transitional area between a tidal community (Area 8) and an open field community in the main compound (Area 12). The community contains a mixture of trees, shrubs, and herbaceous species. The most common species is the persimmon. Other common species include sweetgum, silky dogwood, black willow, jointgrass, and yellow foxtail (*Seteria glauca*).

Area 11 **15 Acres** **2.3% of Refuge**

Area 11 is a forested tract north of the main tributary and the main compound (Area 12). Tidal influences are minimal at this point, and the vegetation is predominantly woody. Common species include persimmon, black gum, red maple, sweetgum, northern arrowwood, nimble-well, and soft rush. Remediation activities to clean up a portion ofthe area were completed (under contract with the Army) during the winter of 1999.

Area 12 **14 Acres** **2.1% of Refuge**

Area 12 is the 14-acre compound and contains expanses of mowed turfgrass and a few ornamental plantings.

Area 13 **153 Acres** **23.4% of Refuge**

Area 13 is a drier grassland that is upslope of the floodplain and historically mowed annually. Dominant vegetation consists of various herbaceous species, including broomsedge (*Andropogon virginicus*),yellow foxtail, and bush clover.

Area 14 **4.5 Acres** **0.7% of Refuge**

Area 14 is a narrow, steep forested tract near the mouth of Marumsco Creek. The community contains northern red oak (*Quercus rubra*), pin oak (*Quercus palustris*), white oak (*Quercus alba*), sweetgum, willow oak (*Quercus phellos*), and black locust (*Robinia pseudoacacia*).

Area 15 **9 Acres** **1.4% of Refuge**

Area 15 is a wet swale that runs southeast from the pond to Marumsco Creek. Common woody species include green ash, red maple, willow oak, black locust, silky dogwood, smooth alder (*Alnus serrulata*), northern arrowwood, and black willow. Herbaceous species include clearweed (*Pilea pumila*), nimble-well, sensitive fern (*Onoclea sensibilis*), wool grass (*Scirpus cyperinus*), small-flower agrimony (*Agrimonia parviflora*), Japanese honeysuckle, and Virginia creeper.

Area 16 **2 Acres** **0.3% of Refuge**

Area 16 is a small tidal area downslope from Area 14. Commom species include silky dogwood, black haw (*Viburnum prunifolium*), northern arrowwood, yellow iris (*Iris pseudacorus*), green ash, and cattail (*Typha angustifolia*).

Area 17 **4 Acres** **0.6% of Refuge**

Area 17 is a small pond. Above the District of periodic inundation is a narrow band of woody vegetation dominated by red maple, black locust, black willow, and pin oak.

Area 18 **10 Acres** **1.5% of Refuge**

Area 18 is a forested ridge along Marumsco Creek and just south of the Fort Belvoir Woodbridge Housing Site. The elevation of this community is the highest on the installation and it is dominated by ~~oat~~ oak trees. Common species include northern red oak, white oak, chestnut oak (*Quercus prinus*), Virginia pine (*Pinus virginiana*), mockernut hickory, American beech (*Fagus grandifolia*), black locust, and eastern red cedar.

Area 19 **3 Acres** **0.5% of Refuge**

Area 19 is a low area downslope from Area 18 and adjacent to Marumsco Creek. Portions of the area have been disturbed by machinery. The undisturbed portions are dominated by red maple. Other woody species include black cherry and pin oak. Herbaceous cover includes cattail, soft rush, wool grass, barnyard grass, and tickseed sunflower.

Area 20 **74 Acres** **11.3% of Refuge**

Area 20 is the 74-acre Marumsco Creek tidal marshland containing open marsh plants.

Appendix C. Plants on Occoquan Bay NWR

GENUS	SPECIES	FAMILY	COMMON NAME
Acer	negundo	Aceraceae	Box Elder, Ash Leaf Maple
Acer	rubrum	Aceraceae	Red Maple
Achillea	millefoliuum	Asteraceae	Yarrow
Acorus	calamus	Araceae	Sweet Flags
Agastache	nepetoides	Lamiaceae	Yellow Giant Hyssop
Agrimonia	gryposepala	Rosaceae	Tall Agrimony
Agrimonia	parviflora	Rosaceae	Small-Flowered Agrimony
Agrostis	giganitea (stolonifera)	Poaceae	Creeping Bent Grass
Ailanthus	altissima	Simaroubaceae	Tree of Heaven
Albizia	julibrissin	Fabaceae	Mimosa
Alisma	subcordatum	Alismataceae	Small Water Plantain
Allium	canadense	Liliaceae	Wild Garlic, Wild Onion
Allium	vineale	Liliaceae	Field Garlic
Alnus	serrulata	Betulaceae	Tag Alder
Ambrosia	artemisiifolia	Asteraceae	Common Ragweed
Amelanchier	sp.	Rosaceae	Shadbush
Amorpha	fruticosa	Fabaceae	Wild Indigo Bush
Amphicarpa	bracteata	Fabaceae	Hog Peanut
Anagallis	arvensis	Primulaceae	Scarlet Pimpernel
Andropogon	virginicus	Poaceae	Broomsedge
Antennaria	neglecta	Asteraceae	Field Pussytoes
Antennaria	plantaginifolia	Asteraceae	Plantain Pussytoes
Anthemis	cotula	Asteraceae	Mayweed
Apios	americana	Fabaceae	Groundnut
Apocynum	cannabinum	Apocynaceae	Indian Hemp, Hemp Dogbane
Arisaema	triphyllum	Araceae	Jack-in-the-Pulpit
Arisaema	dracontium	Araceae	Green Dragon
Aristida	dichotoma	Poaceae	Three-Awn Grass
Aristida	oligantha	Poaceae	Prairie Three-Awn Grass
Artemisia	annua	Asteraceae	Annual Wormwood
Artemisia	vulgaris	Asteraceae	Wormwood
Asarum	canadense	Aristolochiaceae	Wild Ginger
Asclepias	incarnata	Asclepiadaceae	Swamp Milkweed
Asclepias	syriaca	Asclepiadaceae	Common Milkweed
Asclepias (Acerates)	viridiflora	Asclepiadaceae	Green Flowered Milkweed
Asimina	triloba	Annonaceae	Paw Paw
Aster	dumosus	Asteraceae	Bushy Aster
Aster	lateriflorus	Asteraceae	Calico Aster
Betula	nigra	Betulaceae	River Birch
Bidens	aristosa	Asteraceae	Tickseed Sunflower
Bidens	bipinnata	Asteraceae	Spanish Nettles
Bidens	frondosa	Asteraceae	Beggar-Ticks
Bidens	laevis	Asteraceae	Large Bur Marigold
Bidens	tripartita	Asteraceae	European Tickseed
Boehmeria	cylindrica	Urticaceae	False Nettle
Botrychium	dissectum var. obliqu	Ophioglossaceae	Cut-Leaf Grapefern
Bromus	racemosus (commutatus)	Poaceae	Spiked Bromegrass, Upright Chess

Campsis	radicans	Bignoniaceae	Trumpet Vine
Carex	crinita	Cyperaceae	Drooping Sedge
Carex	frankii	Cyperaceae	Frank's Sedge
Carex	grayi	Cyperaceae	Gray's Sedge
Carex	intumescens	Cyperaceae	Swollen Sedge
Carex	lurida	Cyperaceae	Yellow-Green Sedge
Carex	scoparia	Cyperaceae	Broom-Like Sedge
Carex	squarrosa	Cyperaceae	Wide Spreading Sedge
Carex	stipata	Cyperaceae	Crowded Sedge
Carex	tribuloides (projecta)	Cyperaceae	Tribulus Sedge
Carya	cordiformia	Juglandaceae	Bitternut Hickory
Carya	glabra	Juglandaceae	Pignut Hickory
Carya	tomentosa	Juglandaceae	Mockernut Hickory
Cassia (Chamaecrista)	nictitans	Fabaceae	Wild Sensitive Plant
Celtis	occidentalis	Ulmaceae	American Hackberry
Centaurea	maculosa	Asteraceae	Spotted Knapweed
Cephalanthus	occidentalis	Rubiaceae	Button Bush
Cercis	canadensis	Fabaceae	Redbud
Chelone	glabra	Scrophulariaceae	Turtlehead
Chrysanthemum	leucanthemum	Asteraceae	Oxeye Daisy
Cichorium	intybus	Asteraceae	Chicory
Cinna	arundinacea	Poaceae	Wood Reed Grass
Circaea	lutetiana (quadrisulcata)	Onagraceae	Enchanter's Nightshade
Cirsium	discolor	Asteraceae	Field Thistle
Clematis	terniflora (dioscoreifolia)	Ranunculaceae	Japanese Clematis
Commelina	communis	Commelinaceae	Asiatic Dayflower
Commelina	virginica	Commelinaceae	Virginia Dayflower
Conoclinium (Eupatorium)	coelestinum	Asteraceae	Mistflower
Cornus	amomum	Cornaceae	Bush Dogwood
Cornus	florida	Cornaceae	Flowering Dogwood
Cornus	foemina (stricta)	Cornaceae	Swamp Dogwood
Cuscuta	gronovii	Convolvulaceae	Dodder
Cyperus	echinatus (ovularis)	Cyperaceae	Egg Sedge, Hedge-hog Club Rush
Cyperus	esculentus	Cyperaceae	Edible Nut Sedge
Cyperus	strigosus	Cyperaceae	Umbrella Sedge, Gaingale
Danthonia	spicata	Poaceae	Poverty Grass
Daucus	carota	Apiaceae	Queen Anne's Lace
Decodon	verticillatus	Lythraceae	Swamp Loose Strife
Desmodium	nudiflorum	Fabaceae	Naked-Flower Tick-Trefoil
Dianthus	armeria	Caryophyllaceae	Deptford Pink
Dichanthelium (Panicum)	clandestinum	Poaceae	Deertongue Grass
Dichanthelium (Panicum)	ravenellii	Poaceae	Ravenell's Panic Grass
Dichanthelium (Panicum)	dichotomum (tenue)	Poaceae	Bushy Panic Grass
Digitaria	ischaemum	Poaceae	Smooth Crabgrass
Diodia	teres	Rubiaceae	Annual Buttonweed
Dioscorea	villosa (quaternata)	Dioscoreaceae	Wild Yam
Diospyros	virginiana	Ebenaceae	Persimmon

Echinochloa	crusgalli	Poaceae	Barnyard Grass
Eclipta	alba (prostrata)	Asteraceae	Yerba de Tajo
Eleocharis	obtusa	Cyperaceae	Blunt Spikerush
Elephantopus	carolinianus	Asteraceae	Elephant's Foot
Elodea	canadensis	Hydrocharitaceae	Common Elodea
Elodea	nuttallii	Hydrocharitaceae	Western Water Weed
Elymus	virginicus	Poaceae	Virginia Wild Rye
Epilobium	coloratum	Onagraceae	Purple-Leaved Willow Herb
Eragrostis	spectabilis	Poaceae	Purple Love Grass
Erigeron	strigosus	Asteraceae	Lesser Daisy Fleabane
Eryngium	aquaticum	Apiaceae	Rattlesnake Master
Eupatoriadelphus (Eupatorium)	fistulosus	Asteraceae	Hollow Joe-Pye Weed
Eupatoriadelphus (Eupatorium)	maculata	Asteraceae	Spotted Joe-Pye Weed
Eupatorium	hyssopifolium	Asteraceae	Hyssop-Leaved Boneset
Eupatorium	perfoliatum	Asteraceae	Common Boneset
Eupatorium	serotinum	Asteraceae	Late Flowering Boneset
Fagus	grandifolia	Fagaceae	American Beech
Festuca (Vulpia)	myuros	Poaceae	Mouse Tail Fescue
Fimbristylis	autumnalis	Cyperaceae	Slender Fimbry
Fraxinus	americana	Oleaceae	White Ash
Fraxinus	pennsylvanica	Oleaceae	Green Ash
Fraxinus	profunda	Oleaceae	Pumpkin Ash
Galium	obtusum	Rubiaceae	Stiff Marsh Bedstraw
Galium	tinctorium	Rubiaceae	Clayton's Bedstraw
Geranium	maculatum	Geraniaceae	Wild Geranium
Agalinis (Gerardia)	tenuifolia	Scrophulariaceae	Slender Gerardia
Geum	canadense	Rosaceae	White Avens
Glecoma	hederacea	Lamiaceae	Ground Ivy
Gleditsia	triacanthos	Fabaceae	Honey Locust
Gnaphalium	obtusifolium	Asteraceae	Sweet Everlasting
Gratiola	negelecta	Scrophulariaceae	Clammy Hedge Hyssop
Hamamelis	virginiana	Hamameliadaceae	Witch Hazel
Hedeoma	pulegioides	Lamiaceae	American Pennyroyal
Helenium	autumnale	Asteraceae	Autumn Sneezeweed
Helianthus	decapetalus	Asteraceae	Thin-Leaved Sunflower
Helianthus	microcephalus	Asteraceae	Small-Headed Sunflower
Helianthus	tuberosus	Asteraceae	Jerusalem Artichoke
Heliopsis	helianthoides	Asteraceae	Oxeye Daisy
Hibiscus	moscheutos (palustris)	Malvaceae	Swamp Rose Mallow
Hibiscus	syriacus	Malvaceae	Rose-of-Sharon
Hieracium	paniculatum	Asteraceae	Paniculed Hawkweed
Hydrocotyle	americana	Apiaceae	Water Pennywort
Hypericum (Ascyrum)	hypericoides (stragal	Hypericaceae	St. Andrew's Cross
Hypericum	mutilum	Hypericaceae	Dwarf St. Johnswort
Hypericum	punctatum	Hypericaceae	Spotted St. Johnswort
Hypericum (Triadenum)	virginicum	Hypericaceae	Marsh St. Johnswort
Ilex	opaca	Aquifoliaceae	American Holly
Ilex	verticilata	Aquifoliaceae	Winterberry

Impatiens	capensis	Balsaminaceae	Spotted Jewelweed
Ipomoea	pandurata	Convolvulaceae	Wild Potato Vine
Ipomoea	purpurea	Convolvulaceae	Common Morning Glory
Iris	pseudacorus	Iridaceae	Yellow Iris
Iris	virginica	Iridaceae	Virginia Blue Iris
Itea	virginica	Saxifragaceae	Virginia Willow
Juncus	acuminatus	Juncaceae	Tapered Rush
Juncus	dichotomus	Juncaceae	Forked Rush
Juncus	effusus	Juncaceae	Common Rush
Juniperus	virginiana	Cupressaceae	Red Cedar
Justicia	americana	Acanthaceae	Water Willow
Kalmia	latifolia	Ericaceae	Mountain Laurel
Krigia	virginica	Asteraceae	Dwarf Dandelion
Lactuca	canadensis	Asteraceae	Wild Lettuce
Lactuca	floridana	Asteraceae	Florida Blue Lettuce
Laportea	canadensis	Urticaceae	Wood Nettle
Lechea	racemulosa	Cistaceae	Spreading Pinweed
Leersia	oryzoides	Poaceae	Rice Cutgrass
Leersia	virginica	Poaceae	White Grass
Lespedeza	cuneata	Fabaceae	Silky Lespedeza
Lespedeza	intermedia	Fabaceae	Wand Like Bush Clover
Lespedeza	virginica	Fabaceae	Slender Bush Clover
Lindera	benzoin	Lauraceae	Spicebush
Lindernia	dubia	Scrophulariaceae	False Pinpernel
Liquidambar	styraciflua	Hamameliadaceae	Sweetgum
Liriodendron	tulipifera	Magnoliaceae	Tulip Poplar
Lobelia	cardinalis	Campanulaceae	Cardinal Flower
Lobelia	sphilitica	Campanulaceae	Great Blue Lobelia
Lobelia	spicata	Campanulaceae	Pale Spiked Lobelia
Lonicera	japonica	Caprifoliaceae	Japanese Honeysuckle
Lorinseria	areolata	Polypodiaceae	Netted Chain Fern
Ludwigia	alternifolia	Onagraceae	Seedbox
Ludwigia	leptocarpa	Onagraceae	Narrow-Fruited Primrose Willow
Ludwigia	palustris	Onagraceae	Water Purslane
Lycopus	americanus	Lamiaceae	Water Horehound
Lycopus	virginicus	Lamiaceae	Virginia Bugleweed
Lysimachia	ciliata	Primulaceae	Fringed Loosestrife
Maclura	pomifera	Moraceae	Osage Orange
Medicago	lupulina	Fabaceae	Black Medic
Melilotus	alba	Fabaceae	White Sweet Clover
Melilotus	officinalis	Fabaceae	Yellow Sweet Clover
Mentha	arvensis	Lamiaceae	Wild Mint
Microstegium	vimineum	Poaceae	Napal Eulalia
Mikania	scandens	Asteraceae	Climbing Hempweed
Mimulus	ringens	Scrophulariaceae	Monkey Flower
Miscanthus	sinensis	Poaceae	Eulalia, Silver Grass
Morus	rubra	Moraceae	Red Mulberry
Myosotis	laxa	Boraginaceae	Small Forget-Me-Not
Myriophyllum	aquatica (brasiliense)	Haloragaceae	Parrot Feather
Nuphar	luteum	Nymphaeaceae	Spatterdock, Yellow Pond Lily
Nyssa	sylvatica	Nyssaceae	Black Gum
Oenothera	fruticosa	Onagraceae	Sundrops

Oenothera	laciniata	Onagraceae	Cut Leaved Evening Primrose
Onoclea	sensibilis	Polypodiaceae	Sensitive Fern
Ophioglossum	vulgatum	Ophioglossaceae	Adder's Tongue Fern
Osmunda	regalis	Osmundaceae	Royal Fern
Oxalis	stricta	Oxalidaceae	Erect Yellow Wood Sorrel
Oxalis	violacea	Oxalidaceae	Purple Wood Oxalis
Oxypolis	rigidior	Apiaceae	Cowbane
Dichanthelium (Panicum)	rigidulum	Poaceae	Redtop Panic Grass
Dichanthelium (Panicum)	virgatum	Poaceae	Switch Grass
Parthenocissus	quinquefolia	Vitaceae	Virginia Creeper
Paspalum	laeve	Poaceae	Panic Grass
Paulownia	tomentosa	Bignoniaceae	Princess Tree
Peltandra	virginica	Araceae	Arrow Arum
Penstemon	laevigatus	Scrophulariaceae	Smooth Beardtongue
Phleum	pratense	Poaceae	Timothy
Phragmites	australis	Poaceae	Common Reed
Phytolacca	americana	Phytolaccaceae	Pokeweed
Pilea	pumila	Urticaceae	Clearweed
Pinus	strobus	Pinaceae	White Pine
Pinus	virginiana	Pinaceae	Virginia Scrub Pine
Plantago	aristata	Plantaginaceae	Bracted Plantain
Plantago	lanceolata	Plantaginaceae	English Plantain
Plantago	rugelii	Plantaginaceae	Red-Stemmed Plantain
Platanus	occidentalis	Platanaceae	Sycamore
Podophyllum	peltatum	Berberidaceae	Mayapple
Polygala	sanguinea	Polygalaceae	Rose Milkwort
Polygonum	arifolium	Polygonaceae	Halberd-Leaved Tearthumb
Polygonum	pensylvanicum	Polygonaceae	Pinkweed
Polygonum	perisicaria	Polygonaceae	Lady's Tearthumb
Polygonum	punctatum	Polygonaceae	Water Smartweed
Polygonum	sagittatum	Polygonaceae	Arrow Vine
Polygonum (Tovara)	virginianum	Polygonaceae	Jumpseed
Polymnia	uvedalia	Asteraceae	Yellow Leaf Cup
Polystichum	acrostichoides	Polypodiaceae	Christmas Fern
Pontederia	cordata	Pontederiaceae	Pickerel Weed
Populus	deltoides	Salicaceae	Common Cottonwood
Potentilla	canadensis	Rosaceae	Rough-Fruited Cinquefoil
Potentilla	simplex	Rosaceae	Common Cinquefoil, Five-finger
Prunella	vulgaris	Lamiaceae	Self Heal
Prunus	serotina	Rosaceae	Wild Cherry
*Pycnanthemum	virginianum	Lamiaceae	Virginia Mountain Mint
Quercus	alba	Fagaceae	White Oak
Quercus	coccinea	Fagaceae	Scarlet Oak
Quercus	falcata	Fagaceae	Spanish Oak, Southern Oak
Quercus	palustris	Fagaceae	Pin Oak
Quercus	phellos	Fagaceae	Willow Oak
Quercus	prinus	Fagaceae	Chestnut Oak
Quercus	stellata	Fagaceae	Post Oak
Quercus	velutina	Fagaceae	Black Oak
Rhexia	virginica	Melastomataceae	Virginia Meadow Beauty

Rhus	copallina	Anacardiaceae	Winged Sumac
Rhus	glabra	Anacardiaceae	Smooth Sumac
Rhus	radicans	Anacardiaceae	Poison Ivy
Rhus	typhina	Anacardiaceae	Staghorn Sumac
Rhynchospora	macrostachya	Cyperaceae	Large Spike Beakrush
Robinia	pseudo-acacia	Fabaceae	Black Locust
Rosa	carolina	Rosaceae	Carolina Rose
Rosa	multiflora	Rosaceae	Wild Rose
Rosa	palustris	Rosaceae	Swamp Rose
*Rubus	pubescens	Rosaceae	Dwarf Raspberry
Rudbeckia	hirta	Asteraceae	Black Eyed Susan
Rumex	acetosella	Polygonaceae	Sheep Sorrel
Rumex	crispus	Polygonaceae	Curled Dock
Sagittaria	latifolia	Alismataceae	Duck Potato, Arrowhead
Salix	nigra	Salicaceae	Black Willow
Salvia	lyrata	Lamiaceae	Lyre-Leaf Sage
Sambucus	canadensis	Caprifoliaceae	Common Elderberry
Samolus	parviflorus (floribundus)	Primulaceae	Water Pimpernel
Saponaria	officinalis	Caryophyllaceae	Bouncing Bet, Soapwort
Sassafras	albidum	Lauraceae	Sassafrass Tree
Satureja	vulgaris	Lamiaceae	Wild Basil
Saururus	cernuus	Saururaceae	Lizard's Tail
Schoenoplectus (Scirpus)	americanus	Cyperaceae	Three Square
Schoenoplectus (Scirpus)	validus	Cyperaceae	Great Bulrush
Scirpus	cyperinus	Cyperaceae	Woolgrass
Scirpus	polyphyllus	Cyperaceae	Many Leaved Bulrush
Scrophularia	marilandica	Scrophulariaceae	Carpenter's Square
Scutellaria	integrifolia	Lamiaceae	Narrow-Leaved Skullcap
Scrophularia	lanceolata	Scrophulariaceae	Hare Figwort
Setaria	glauca	Poaceae	Yellow Foxtail
Sicyos	angulatus	Cucurbitaceae	Bur Cucumber
Silphium	trifoliatum	Asteraceae	Whorled Rosinweed
Sisyrinchium	angustifolium	Iridaceae	Stout Blue-Eyed Grass
Smilacina	racemosa	Liliaceae	False Solomon Seal
Smilax	herbacea (pulverulenta)	Liliaceae	Carrion Weed
Smilax	rotundifolia	Liliaceae	Round Leaf Catbriar
Solanum	carolinense	Solanaceae	Horse Nettle
Solidago	canadensis (altissima)	Asteraceae	Tall Goldenrod
Solidago	gigantea	Asteraceae	Great Goldenrod
Solidago (Euthamia)	graminifolia	Asteraceae	Grass-Leaved Goldenrod
Solidago	juncea	Asteraceae	Early Goldenrod
Sparganium	americanum	Sparganiaceae	American Burreed
Sparganium	eurycarpum	Sparganiaceae	Large Burreed
Strophostyles	helvola	Fabaceae	Trailing Wild Bean
Symphoricarpos	orbiculatus	Caprifoliaceae	Coralberry
Symplocarpus	foetidus	Araceae	Skunk Cabbage
Teucrium	canadense	Lamiaceae	Germander
Thelypteris	palustris (thelypterioides)	Polypodiaceae	Marsh Fern
Trichostema	dichotomum	Lamiaceae	Bluecurls
Tridens	flavus	Poaceae	Purple Top

Trifolium	arvense	Fabaceae	Rabbit's Foot Clover
Trifolium	pratense	Fabaceae	Red Clover
Trifolium	repens	Fabaceae	White Clover
Triodanis (Specularia)	perfoliata (perfoliata)	Campanulaceae	Venus Looking Glass
Tripsacum	dactyloides	Poaceae	Eastern Gama Grass
Typha	angustifolia	Typhaceae	Narrow Leaf Cattail
Typha	domingensis	Typhaceae	Pale Cattail
Typha	latifolia	Typhaceae	Broad Leaf Cattail
Ulmus	americana	Ulmaceae	American Elm
Ulmus	rubra	Ulmaceae	Slippery Elm
Urtica	dioica	Urticaceae	Stinging Nettle
Vaccinium	pallidum (vacillans)	Ericaceae	Low Bush Blueberry
Verbascum	blattaria	Scrophulariaceae	Moth Mullein
Verbascum	thapsus	Scrophulariaceae	Woolly Mullein
Verbena	hastata	Verbenaceae	Blue Vervain
Verbena	simplex	Verbenaceae	Narrow-Leaf Vervain
Verbena	urticifolia	Verbenaceae	White Vervain
Verbesina (Actinomeris)	alternifolia	Asteraceae	Yellow Ironweed, Wingstem
Vernonia	noveboracensis	Asteraceae	New York Ironweed
Viburnum	acerifolium	Caprifoliaceae	Maple Leaf Viburnum
Viburnum	dentatum	Caprifoliaceae	Southern Arrowwood
Viburnum	prunifolium	Caprifoliaceae	Black Haw
Vitis	aestivalis	Vitaceae	Summer Grape
Vitis	labusca	Vitaceae	Fox Grape
Vitis	riparia	Vitaceae	Riverbank Grape
Vitis	rupestris	Vitaceae	Sand Grape
Zizania	aquatica	Poaceae	Wild Rice
Saxifraga	virginiensis	Saxifragaceae	Early Saxifrage
*Veronica	hederaefolia	Scrophulariaceae	Ivy Leaf Speedwell
Lamium	purpureum	Lamiaceae	Purple Dead Nettles
Lamium	amplexicaule	Lamiaceae	Henbit
Houstonia (Hedyotis)	caerulea	Rubiaceae	Bluet, Quaker Ladies or Bonnets
Dentaria (Cardimine)	laciniata (concatenata)	Brassicaceae	Cut-Leaf Toothwort
Viola	rafinesquii (kitaibeliana)	Violaceae	Field Pansey
Viola	affinis	Violaceae	Pale Violet
*Vaccinium	corymbosum(atrococcum)	Ericaceae	High Bush Blueberry
Taxus	canadensis	Taxaceae	American Yew
Taraxacum	officinale	Asteraceae	Dandelion
Ranunculus	abortivus	Ranunculaceae	Kidney Leaf Buttercup
Epigaea	repens	Ericaceae	Trailing Arbutus
Malus	coronaria	Rosaceae	Wild Sweet Crabapple
Viburnum	nudum	Caprifoliaceae	Possum Haw
Mitchella	repens	Rubiaceae	Partridge Berry
Chimaphila	maculata	Ericaceae	Striped Pipsissewa
Stellaria	pubera	Caryophyllaceae	Star Chickweed
Arabis	laevigata	Brassicaceae	Smooth Rock Cress
Alliaria	petiolata (officinalis)	Brassicaceae	Garlic Mustard
Barbarea	verna	Brassicaceae	Early Winter Cress
Barbarea	vulgaris	Brassicaceae	Yellow Rocket

Cardamine	pensylvanica	Brassicaceae	Pennsylvania Bittercress
Draba (Erophila)	verna	Brassicaceae	Whitlow Grass
Muscari	atlanticum (racemosum)	Liliaceae	Wild Hyacinth
*Andropogon	gerardii	Poaceae	Big Bluestem Grass
Arthraxon	hispidus	Poaceae	Arthraxon
*Baccharis	halimifolia	Asteraceae	Groundsel Tree
Carex	vulpinoidea (annectens)	Cyperaceae	Foxtail Like Sedge
*Carex	lupulina (lupuliformis)	Cyperaceae	Hop-Like Grass
Ceratophyllum	demersum	Ceratophyllaceae	Coontail
*Diodia	virginiana	Rubiaceae	Large Buttonweed
*Dulichium	arundinaceum	Cyperaceae	Three-Way Sedge
*Echinochloa	walteri	Poaceae	Walter's Millet
*Galium	asprellum	Rubiaceae	Rough Bedstraw
*Hibiscus	militaris (laevis)	Malvaceae	Halberd Leaved Mallow
*Juncus	canadensis	Juncaceae	Canadian Rush
*Lemna	minor	Lemnaceae	Lesser Duckweed
*Mentha	spicata	Lamiaceae	Spearmint
*Murdannia (Aneilema)	keisak	Commelinaceae	Marsh Dayflower
*Polygonum	amphibium (coccineum)	Polygonaceae	Water Smartweed
*Potamogeton	crispus	Potamogetonaceae	Curly Pondweed
*Rubus	allegheniensis	Rosaceae	Blackberry
*Rubus	laciniatus	Rosaceae	Cut Leaved Blackberry
*Rumex	verticillatus	Polygonaceae	Swamp Dock
*Schoenoplectus (Scirpus)	novae-angliae	Cyperaceae	Bulrush
*Scirpus	fluviatilis	Cyperaceae	River Bulrush
*Scirpus	georgianus?	Cyperaceae	Bulrush
*Solidago	odorata	Asteraceae	Fragrant Goldenrod
*Spirodela	polyrhiza	Lemnaceae	Duckweed
*Sporobolus	vaginiflorus	Poaceae	Annual Dropseed
*Utricularia	gibba	Lentibulariaceae	Humped Bladderwort
*Valisneria	americana	Hydrocharitaceae	Eelgrass
Hedera	helix	Arailiaceae	Ivy
*Passiflora	lutea	Passifloraceae	Yellow Passion Flower
Amelanchier	arborea	Rosaceae	Downy Shadbush
Cardamine	rhomboidea (bulbosa)	Brassicaceae	Spring Cress
Chaerophyllum	tainturieri	Apiaceae	Wild Chervil
Corydalis	flavula	Fumariaceae	Yellow Corydalis
Crataegus	flabellata	Rosaceae	Hawthorne
Ranunculus	hispidus	Ranunculaceae	Hairy Buttercup
Viola	sagittata (fimbriatula)	Violaceae	Arrow Leaved Violet
Erodium	cicutarium	Geraniaceae	Heron's Bill Geranium
Lysimachia	nummularia	Primulaceae	Moneywort
Malus	pumila	Rosaceae	Apple Tree
Perilla	frutescens	Lamiaceae	Beefsteak Plant
*Veronica	persica	Scrophulariaceae	Bird's Eye Speedwell
Ranunculus	pusillus	Ranunculaceae	Low Spearwort
Cerastium	arvense	Caryophyllaceae	Field Chickweed
*Berteroa	incana	Brassicaceae	Hoary Alyssum
Leucothoe	racemosa	Ericaceae	Fetterbush
Polygonatum	biflorum	Liliaceae	Smooth Solomon Seal

Galium	aparine	Rubiaceae	Cleavers
Valerianella	olitoria (locusta)	Valerianaceae	Blue Cornsalad
Valerianella	chenopodifolia	Valerianaceae	White Cornsalad
Ranunculus	septentrionalis	Ranunculaceae	Swamp Buttercup
Ranunculus	recurvatus	Ranunculaceae	Hooked Crowfoot
Lithospermum	arvense	Boraginaceae	Corn Gromwell
Duchesnea	indica	Rosaceae	Indian Strawberry
Ranunculus	bulbosus	Ranunculaceae	Bulbous Buttercup
Botrychium	virginianum	Ophioglossaceae	Rattlesnake Fern
Viola	primulifolia	Violaceae	Primrose Leaved Violet
Myriophyllum	spicatum (exalbescens)	Haloragaceae	Eurasian Watermilfoil
Vicia	tetrasperma	Fabaceae	Slender Vetch
Salix	sericea	Salicaceae	Silky Willow
Dactylis	glomerata	Poaceae	Orchard Grass
Festuca	elatior (arundinacea)	Poaceae	Tall Fescue
Anthoxanthum	odoratum	Poaceae	Sweet Vernal Grass
Poa	pratensis	Poaceae	Kentucky Blue Grass
Poa	compressa	Poaceae	Canadian Blue Grass, Wire Grass
Lysimachia	quadrifolia	Primulaceae	Whorled Loosestrife
Equisetum	arvense	Equisetaceae	Field Horsetail
Juncus	tenuis	Juncaceae	Path Rush
Lepidium	campestre	Brassicaceae	Field Peppergrass
Lepidium	virginicum	Brassicaceae	Wild Peppergrass
Luzula	echinata	Juncaceae	Sea Urchin Like Woodrush
*Magnolia	grandiflora	Magnoliaceae	Magnolia
Myosotis	macrosperma	Boraginaceae	White Forget-me-not
Asparagus	officinalis	Liliaceae	Garden Asparagus
Lysimachia	terrestris	Primulaceae	Swamp Candles
Silene	antirrhina	Caryophyllaceae	Sleepy Catchfly
Plantago	virginica	Plantaginaceae	Dwarf Plantain
Holcus	lanatus	Poaceae	Velvet Grass
Coronilla	varia	Fabaceae	Crown Vetch
*Eleocharis	palustris (macrostachya)	Cyperaceae	Marsh Spikerush
Eleocharis	engelmannii	Cyperaceae	Engelmann's Spikerush
Carex	rosea	Cyperaceae	Rose Like Sedge
*Carex	bromoides	Cyperaceae	Bromus Like Sedge
Carex	stricta (walteriana)	Cyperaceae	Erect Sedge, Tussock Grass
Glyceria	striata	Poaceae	Fowl Mana Grass
Hydrocotyle	ranunculoides	Apiaceae	Floating Water Pennywort
Lyonia	ligustrina	Ericaceae	Maleberry
Convolvulus	arvensis	Convolvulaceae	Field Bindweed
Calystegia	sepium	Convolvulaceae	Hedge Bindweed
Asclepias	tuberosa	Asclepiadaceae	Butterfly Weed
Acer	saccharinum	Aceraceae	Silver Maple
*Scutellaria	galericulata (epilobiifolia)	Lamiaceae	Marsh Skullcap
Penstemon	digitalis	Scrophulariaceae	White Beardtongue
Euphorbia	maculata (supina)	Euphorbiaceae	Spotted Spurge
*Senecio	pauperculus	Asteraceae	Balsam Ragwort
Thalictrum	pubescens (polygamum)	Ranunculaceae	Tall Meadow Rue
Erigeron (Conyza)	canadensis	Asteraceae	Horseweed
Houstonia	purpurea	Rubiaceae	Large Leaf Houstonia

(Hedyotis)			
Lespedeza	hirta	Fabaceae	Hairy Bush Clover
Galium	palustre	Rubiaceae	Marsh Bedstraw
Pycnanthemum	tenuifolium	Lamiaceae	Narrow Leaf Mountain Mint
Scutellaria	incana	Lamiaceae	Downy Skullcap
Gnaphalium	purpureum	Asteraceae	Cudweed
Alisma	trivale(brevipes,plantago-aqua	Alismataceae	Water Plantain
*Hordeum	jubatum	Poaceae	Squirreltail Grass
Hordeum	pusillum	Poaceae	Little Barley
Setaria	geniculata	Poaceae	Bent Foxtail
Sorghum	halepense	Poaceae	Johnson Grass
Setaria	viridis	Poaceae	Green Foxtail
Lolium	perenne	Poaceae	Italian Rye Grass
Elytrigia (Agropyron)	repens	Poaceae	Quack Grass
Eleusine	indica	Poaceae	Goose Grass, Crab Grass
*Eragrostis	pectinacea	Poaceae	Carolina Love Grass
Poa	annua	Poaceae	Annual Blue Grass
Rudbeckia	laciniata	Asteraceae	Tall Coneflower
Ruellia	caroliniensis	Acanthaceae	Hairy Ruellia
Tragopogon	dubius	Asteraceae	Yellow Goatsbeard
Cynodon	dactylon	Poaceae	Bermuda Grass
Sabatia	angularis	Gentianaceae	Rose Pink
Sabatia	dodecandra	Gentianaceae	Large Marsh Pink
Helenium	flexuosum (nudiflorum)	Asteraceae	Purple Headed Sneezeweed
Cicuta	maculata	Apiaceae	Water Hemlock
Polygonum	cuspidatum	Polygonaceae	Japanese Knotweed
*Najas	minor	Najadaceae	Small Naiad
Penthorum	sedoides	Crassulaceae	Ditch Stonecrop
Mimulus	alatus	Scrophulariaceae	Winged Monkey Flower
Xanthium	strumarium	Asteraceae	Cocklebur
Amaranthus (Acnida)	cannabinus (a)	Amaranthaceae	Water Hemp
Cassia	hebecarpa	Fabaceae	Wild Senna
Scutellaria	lateriflora	Lamiaceae	Mad_Dog Skullcap
Lespedeza	procumbens	Fabaceae	Trailing Bush Clover
Lobelia	inflata	Campanulaceae	Indian Tobacco
Hieracium	gronovii	Asteraceae	Hairy Hawkweed
Euphorbia	corollata	Euphorbiaceae	Flowering Spurge
Solidago	nemoralis	Asteraceae	Gray Goldenrod
*Linum	intercursum	Linaceae	Flax
Lobelia	puberula	Campanulaceae	Downy Lobelia
Quercus	marilandica	Fagaceae	Blackjack Oak
Clematis	virginiana	Ranunculaceae	Virgin's Bower
Strophostyles	umbellata	Fabaceae	Pink Wild Bean
Ageratina (Eupatorium)	altissima (rugosum)	Asteraceae	White Snakeroot
Asplenium	platyneuron	Polypodiaceae	Ebony Spleenwort
Thelypteris	noveboracensis	Polypodiaceae	New York Fern
Lespedeza	bicolor	Fabaceae	Bicolor Bushclover
Gaura	biennis	Onagraceae	Biennial Gaura
Desmodium	paniculatum	Fabaceae	Lance Leaf Tick Trefoil

Cerastium	fontanum (vulgatum)	Caryophyllaceae	Mouse Ear Chickweed
*Proserpinaca	palustris	Haloragaceae	Mermaid Weed
Fragaria	virginiana	Rosaceae	Wild Strawberry
Hemerocallis	fulva	Liliaceae	Orange Daylily
Menispermum	canadensis	Menispermaceae	Canadian Moonseed
Vicia	sativa (angustifolia)	Fabaceae	Narrow Leaved Vetch
Monarda	punctata	Lamiaceae	Common Horse Mint
Polygonum	scandens	Polygonaceae	Climbing False Buckwheat
Bidens	polylepis	Asteraceae	Many Bract Tickseed Sunflower
*Hydrocotyle	verticillata	Apiaceae	Whorled Water Pennywort
Erchtites	hieracifolia	Asteraceae	Pilewort, Fireweed
Acalypha	rhomboidea	Euphorbiaceae	Three Seeded Mercury
Polygonum	convolvulus	Polygonaceae	Black Bindweed
Solanum	ptycanthum(nigrum)(americanum)	Solanaceae	Black Nightshade
Datura	stramonium	Solanaceae	Jimsonweed
Chenopodium	album	Chenopodiaceae	Pigweed
*Physalis	pubescens	Solanaceae	Low Hairy Ground Cherry
***Bidens	mitis	Asteraceae	Narrow Leaf Tickseed Sunflower
Kickxia	elatine	Scrophulariaceae	Canker Root
*Cyperus	bipartitus	Cyperaceae	Shinning Cyperus
*Cyperus	brevifolius	Cyperaceae	Short Leaved Cyperus
*Cyperus	retrofractus	Cyperaceae	Turned Back Cyperus
*Cyperus	lancastriensis	Cyperaceae	Lancaster's Cyperus
Juncus	marginatus	Juncaceae	Margined Rush
*Eleocharis	parvula	Cyperaceae	Small Spikerush
*Cyperus	retrorsus	Cyperaceae	Slender Sedge
Cuphea	viscosissima (petiolata)	Lythraceae	Clammy Cuphea
*Limnobium	spongia	Hydrocharitaceae	American Frog Bits
*Heteranthera	reniformis	Pontederiaceae	Mud Plantain
Rhododendron	peridymenoides	Ericaceae	Pixter Azalea
Vaccinium	stamineum	Ericaceae	Deerberry
Chaerophyllum	procumbens	Apiaceae	Spreading Chervil
Athyrium	asplenioides	Polypodiaceae	Southern Lady Fern
Geranium	dissectum	Geraniaceae	Cut Leaf Cranesbill
Krigia	dandelion	Asteraceae	Potato Dandelion
Anthemis	arvensis	Asteraceae	Field Chamomile
Camelina	microcarpa	Brassicaceae	Small Fruited False Flax
Hieracium	caespitosum (pratense)	Asteraceae	Field Hawkweed
Hieracium	venosum	Asteraceae	Rattlesnake Hawkweed
*Rumex	hastatulus	Polygonaceae	Wild Sorrel
Senecio	anonymus (smallii)	Asteraceae	Small's Ragwort
Rosa	sp.	Rosaceae	White Rose?
*Rosa	wichuraiana	Rosaceae	Memorial Rose
*Chondrilla	juncea	Asteraceae	Skeleton Weed, Gum Succory
Pyrus	communis	Rosaceae	Common Pear
Cardamine	hirsuta	Brassicaceae	Hairy Bitter Cress
*Narcissus	tazetta x poeticus	Amaryllidaceae	Pheasant's Eye x Paper Narcissus
*Narcissus	incomparabilis	Amaryllidaceae	Daffodil
Viola	papillionacea (sororia)	Violaceae	Common Blue Violet
*Crateagus	phaenopyrum	Rosaceae	Washington Thorn

Arabidopsis	thaliana	Brassicaceae	Mouse Ear Cress
Prunus	americana	Rosaceae	American Wild Plum
Luzula	multiflora \ bulbosa	Juncaceae	Woodrush
Callictriche	heterophylla	Callitrichaceae	Large Water Starwort
*Hydrocotyle	umbellata	Apiaceae	Umbellate Water Pennywort
Erigeron	annuus	Asteraceae	Daisy Fleabane
*Hypochoeris	radicata	Asteraceae	Cat's Ear
Viburnum	recognitum	Caprifoliaceae	Northern Arrowwood
Eleocharis	tenuis	Cyperaceae	Dog Hair
Carex	uberior	Cyperaceae	Big Headed Crowded Sedge
Trifolium	hybridum	Fabaceae	Alsike Clover
Sisyrinchium	mucronatum	Iridaceae	Slender Blue Eyed Grass
Oenothera	biennis	Onagraceae	Common Evening Primrose
Oxalis	grandis	Oxaldaceae	Great Wood Sorrel
*Rumex	altissimus	Polygonaceae	Water Dock
Athyrium	filix-femina	Polypodiaceae	Lady Fern
**Philadelphus	coronarius	Saxifragaceae	Mock Orange
Veronica	arvensis	Scrophulariaceae	Corn Speedwell
Veronica	serphyllifolia	Scrophulariaceae	Thyme Leaf Speedwell
Cornus	florida (rubra)	Cornaceae	Pink Dogwood
*Scleranthus	annuus	Caryophyllaceae	Knawel
**Nemophila	menzenseis	Hydrophyllaceae	Baby Blue Eyes
Tusuga	canadensis	Pinaceae	Canadian Hemlock
Claytonia	virginica	Portulaceae	Spring Beauty
Potentilla	recta	Rosaceae	Dwarf Cinquefoil
*Scirpus	maritimus	Cyperaceae	Alkali Bulrush
*Cerastium	semidecandrum	Caryophyllaceae	Pubescent Mouse Eared Chickweed
*Scutellaria	nervosa	Lamiaceae	Veined Skullcap
Prunus	cerasus	Rosaceae	Sour Cherry
Rubus	flagellaris	Rosaceae	Northern Dewberry
Rubus	trivialis	Rosaceae	Coastal Plain Dewberry
*Polygonum	hydropiperoides	Polygonaceae	False Water Peper
Carduus	nutans	Asteraceae	Musk Thistle
Taraxacum	erythrospermum (laevigatum)	Asteraceae	Red Seeded Dandelion
Cyperus	lupulina	Cyperaceae	Hop Sedge
Quercus	rubra	Fagaceae	Red Oak
Hypericum	perforatum	Hypericaceae	Common St. Johnswort
Utricularia	vulgariis	Lentibulariaceae	Common Bladderwort
*Floerkea	proserpinacoides	Limnanthaceae	False Mermaid
Passiflora	incarnata	Passifloraceae	Passion Flower
Prunus	virginiana	Rosaceae	Choke Cherry
Ribus	rotundifolium	Saxifragaceae	Gooseberry
*Hedeoma	hispidum	Lamiaceae	Rough Pennyroyal
*Habenaria	lacera	Orchidaceae	Green Ragged Fringed Orchid
*Catalpa	bignonioides	Bignoniaceae	Common Catalpa
Bulbostylis	capillaris	Cyperaceae	Hair Like Sedge
Cynanchum (Ampelamus)	laeve (albidus)	Asclepiadaceae	Sandvine
Habernaria	clavellata	Orchidaceae	Club Spur Orchid
Asclepias	amplexicaulis	Asclepiadaceae	Blunt Leaf Milkweed
Cirsium	pumilium	Asteraceae	Pasture Thistle

*Gaillardia	pulchella	Asteraceae	Gaillardia, Fire Wheel
*Coreopsis	basilis	Asteraceae	Red eye Coreopsis
Arctium	lappa	Asteraceae	Great Burdock
**Cosmos	sp.	Asteraceae	Cosmos
**Delphinium	tricore	Ranunculaceae	Double Larkspur
Hypericum	gentianoides	Hypericaceae	Orange Grass
Spiranthes	gracilis	Orchidaceae	Slender Ladies Tresses
Juglans	nigra	Juglandaceae	Black Walnut
*Commelina	erecta	Commelinaceae	Dayflower
Linum	virgnanum	Linaceae	Wild Yellow Flax
*Nymphaea	odorata	Nymphaeaceae	Fragrant Waterlily
Lycium	halimifolium	Solanaceae	Matrimony Vine
Erianthus	contortus	Poaceae	Contorted Plume Grass
Phlox	paniculata	Polemoniaceae	Summer Phlox
Hypericum	prolificum (spatulatum)	Hypericaceae	Shrubby St. Johnswort
Acer	rubrum var. triloba	Aceraceae	Three Lobed Red Maple
Myrica	cerifera	Myricaceae	Southern Bayberry
Andropogon	gyrans (elliottii)	Poaceae	Elliott's Broomsedge
Andropogon	ternarius	Poaceae	Splitbeard Broomsedge
Echinocystis	lobata	Cucurbitaceae	Wild Cucumber, Balsam Apple
Smilax	glauca	Liliaceae	Glaucous Leaf Greenbriar
Morus	alba	Moraceae	White Mulberry
Polygonum	hydropiper	Polygonaceae	Water Pepper
*Quercus	ilicifolia	Fagaceae	Bear Oak
Quercus	lyrata	Fagaceae	Overcup Oak
*Quercus	nigra	Fagaceae	Water Oak
*Nymphoides	cordata	Menyanthaceae	Little Floating Heart
*Chasmanthium (Uniola)	laxum (laxa)	Poaceae	Tuffted Wild Oats
Ornithogalum	umbellatum	Liliaceae	Star of Bethlehem
Ranunculus	sceleratus	Ranunculaceae	Cursed Crowfoot
Mollugo	verticillata	Aizoaceae	Carpet Weed
*Wolffia	gradista	Lemnaceae	Water Meal
Riccia	fluitans	Ricciaceae	Riccia
Spiranthes	vernalis	Orchidaceae	Grass Leaf Ladies Tresses
Abutilon	theohrasti	Malvaceae	Velvet Leaf, Indian Mallow
Malva	neglecta	Malvaceae	Common Mallow, Cheeses
Osmunda	cinnamomea	Osmundaceae	Cinnamon Fern
Sorghastrum	nutans	Poaceae	Indian Grass
Schizachyrium (Andropogon)	scoparium	Poaceae	Little Bluestem
*Pluchea	foetida	Asteraceae	Saltmarsh Fleabane
*Pluchea	camphorata	Asteraceae	Stinking Fleabane
**Ratibida	columnifera	Asteraceae	Mexican Hat
Elaeagnus	sp.	Elaeagnaceae	Autumn Olive
Lechea	pulchella	Cistaceae	Leggett's Pinweed
Ligustrum	sinense	Oleaceae	Privet
Linaria	canadensis	Scrophulariaceae	Old Field Toadflax
*Habenaria	flava	Orchidaceae	Tubercled Orchid
Coreopsis	lanceolata	Asteraceae	Lance Leaf Tickseed
Ambrosia	trifida	Asteraceae	Giant Ragweed
Desmodium	pauciflorum	Fabaceae	Few Flowered Tick Trefoil

Triadenum	walteri	Clusiaceae	Stemmed Marsh St. John's Wort
*Spiranthes	cernua	Orchidaceae	Nodding Laidies Tresses
Carex	blanda	Cyperaceae	Charming Sedge
Carex	cephalophora	Cyperaceae	Bear Headed Sedge
Carex	debillis	Cyperaceae	Weak Sedge
Carex	granularis	Cyperaceae	Grandular Sedge
Carex	swanii	Cyperaceae	Swan's Sedge
Carex	amphibola	Cyperaceae	Ambiguous Sedge
Carex	complanata	Cyperaceae	Flattened Sedge
Carex	flaccosperma	Cyperaceae	Gray-green Sedge
*Carex	normalis	Cyperaceae	Normal Sedge
Rhychospora	capitellata	Cyperaceae	Small Headed Beak Rush
Croton	grandulosus var. septentrionalis	Euphorbiaceae	Croton
Bidens	discoidea	Asteraceae	Few Bracted Beggar Ticks
Paspalum	dilatatum	Poaceae	Dallis Grass, Golden Crown Grass
Muhlenbergia	schreberi	Poaceae	Nimble Will
Setaria	faberi	Poaceae	Nodding Foxtail
Agrostis	elliottiana	Poaceae	
Agrostis	perennans	Poaceae	Autumn Bent Grass
Arrhenatherum	elatius	Poaceae	Tall Oat Grass
Carex	laevivaginata	Cyperaceae	Smooth Seathed Sedge
Digitaria	sanguinalis	Poaceae	Crabgrass
Ipomea	coccinea	Convolvulaceae	Small Red Morning Glory
Senecio	aureus	Asteraceae	Golden Ragwort
*Solidago	sempervirens	Asteraceae	Sea Side Goldenrod
Cassia	marilandrica	Fabaceae	Southern Senna
Mollugo	verticillata	Mollunginaceae	Carpetweed
Lindernia	anagallidea	Scrophulariaceae	Long Stalked False Pimpernel
Vitis	vulpina	Vitaceae	Frost Grape
Catalpa	speciosa	Bignoniaceae	Norther Catalpa

Appendix D

Birds of the Occoquan Bay NWR-area

A Checklist of Species Documented (1989-2009)at Occoquan Bay National Wildlife Refuge

Legend: Accidental (A); Rare (R); Irregular Visitor (V); *Non-native species(italics)*

Loon, Common
Grebe, Pied-billed
– Horned
– Red-necked (R)
Pelican, Am White (A)
Cormorant, Double-crested
Bittern, American
– Least
Heron, Great Blue
Egret, Great
– Snowy (R)
Heron, Little Blue
Egret, Cattle
Heron, Green
Night-Heron, Black-crowned
– Yellow-crowned
Ibis, White (A)
– Glossy (R)
Vulture, Black
– Turkey
Swan, Tundra
Goose, Snow (R)
– Canada
Duck, Muscovy
– Wood
Teal, Green-winged
Duck, American Black
Mallard
Pintail, Northern
Teal, Blue-winged
Shoveler, Northern
Gadwall
Wigeon, American
Canvasback
Redhead
Duck, Ring-necked
Scaup, Greater
– Lesser
Duck, Long-tailed (R)
Goldeneye, Common
Bufflehead
Merganser, Hooded
– Common
– Red-breasted
Duck, Ruddy

Osprey
Kite, Mississippi (R)
Eagle, Bald
Harrier, Northern
Hawk, Sharp-shinned
– Cooper's
Goshawk, Northern (R)
Hawk, Red-shouldered
– Broad-winged
– Red-tailed
– Rough-legged (V)
Eagle, Golden (A)
Kestrel, American
Merlin
Falcon, Peregrine (R)
Pheasant, Ring-necked
Turkey, Wild
Bobwhite, Northern
Rail, King (R)
– Virginia (R)
Sora (R)
Coot, American
Crane, Sandhill (A)
Plover, Semipalmated (R)
Killdeer
Stilt, Black-necked (A)
Yellowlegs, Greater
– Lesser
Sandpiper, Solitary
– Spotted
– Semipalmated
– Western (R)
– Least
– Baird's (R)
– Pectoral (R)
Dunlin (R)
Dowitcher, Short-billed (R)
Snipe, Wilson's
Woodcock, American
Gull, Laughing
– Bonaparte's
– Ring-billed
– Herring
– Greater Black-backed
Tern, Caspian
– Common (R)
Tern, Royal (R)
_ Forster's
– Least (R)
– Black (R)
Pigeon, Rock
Dove, Mourning
Cuckoo, Black-billed (R)
– Yellow-billed
Owl, Great Horned
– Barred
– Short-eared (R)
Nighthawk, Common
Swift, Chimney
Hummingbird, Ruby-throated
Kingfisher, Belted
Woodpecker, Red-headed (R)
– Red-bellied
Sapsucker, Yellow-bellied
Woodpecker, Downy
– Hairy
Flicker, Northern
Woodpecker, Pileated
Wood-Pewee, Eastern
Flycatcher, Yellow-bellied (R)
Flycatcher, Acadian
– Alder (R)
– Willow
Phoebe, Eastern
Flycatcher, Vermilion (A)
– Great Crested
– Ash-throated (A)
Kingbird, Eastern
Shrike, Loggerhead (V)
Vireo, White-eyed
– Yellow-throated
– Blue-headed (R)
– Warbling (R)
– Philadelphia (R)
– Red-eyed
Jay,Blue

Crow, American
– Fish
Lark, Horned (R)

Martin, Purple
Swallow, Tree
– Northern Rough-winged
– Bank
– Cliff (R)
– Barn
Chickadee, Carolina
– Black-capped (V)
Titmouse, Tufted
Nuthatch, Red-breasted (R)
– White-breasted
Creeper, Brown
Wren, Carolina
– House
– Winter
– Sedge (R)
– Marsh (R)
Kinglet, Golden-crowned
– Ruby-crowned
Gnatcatcher, Blue-gray
Bluebird, Eastern
Veery
Thrush, Gray-cheeked (R)
– Swainson's
– Hermit
– Wood
Robin, American
Catbird, Gray
Mockingbird, Northern
Thrasher, Brown
Starling, European
Pipit, American
Waxwing, Cedar
Warbler, Blue-winged (R)
– Tennessee
– Nashville (R)
Parula, Northern
Warbler, Yellow
– Chestnut-sided
– Magnolia
– Cape May (R)
– Black-throated Blue
– Yellow-rumped
– Black-throated Green
– Blackburnian (R)
– Yellow-throated
Warbler, Pine
– Prairie
– Palm
– Bay-breasted
– Blackpoll
– Black-and-white
_ Prothonotary
_ Worm-eating
Ovenbird
Redstart, American

Waterthrush, Northern
– Louisiana
Warbler, Kentucky
– Connecticut (R)
– Mourning
Yellowthroat, Common
Warbler, Hooded
– Wilson's (R)
– Canada (R)
Chat, Yellow-breasted
Tanager, Summer
Tanager, Scarlet
Towhee, Eastern
Sparrow, American Tree
– Chipping
– Clay-colored (A)
– Field
– Vesper
– Lark (A)
– Savannah
– Grasshopper
– Henslow's (A)
– LeConte’s (A)
– Seaside (A)
– Fox
– Song
– Lincoln's (R)
– Swamp
– White-throated
– White-crowned
Junco, Dark-eyed
Bunting, Snow (V)
Cardinal, Northern
Grosbeak, Rose-breasted (R)
– Blue
Bunting, Indigo

Dickcissel (R)
Bobolink (R)
Blackbird, Red-winged
Meadowlark, Eastern
Blackbird, Rusty
Grackle, Common
Cowbird, Brown-headed
Oriole, Orchard
– Baltimore
Finch, Purple
– *House*
Redpoll, Common (V)
Siskin, Pine (V)
Goldfinch, American
Sparrow, House

Total Species: 241

Compiler: J. Waggener (Jan 2010)
Audubon Society of Northern Virginia

Appendix E. Butterflies of Occoquan Bay

Swallowtails (Papilionidae)
Pipevine
Zebra
Black
Eastern Tiger
Spicebush

Whites and Sulphurs (Pieridae)
White, Checkered
Cabbage
Orangetip, Falcate
Sulphur, Clouded
Orange
Little Yellow
Sleepy Orange

Gossamer Wings (Lycanidae)
Copper, Bronze
Hairstreak, Coral
Banded
White "M"
Gray
Red-banded
Tailed-Blue, Eastern
Azure, Spring
Summer

Brush-footed Butterflies (Nymphalidae)
Snout, American
Fritillary, Variegated
Great Spangled
Meadow
Checkerspot, Silvery
Crescent, Pearl
Question Mark
Comma, Eastern
Mourning Cloak
Lady, American
Painted
Red Admiral
Common Buckeye
Red-spotted Purple
Viceroy
Emperor, Hackberry

Tawny Hackberry
Pearly-Eye, Northern
Brown Appalachian
Sartyr, Carolina
Little Wood
Wood-Nymph, Common
Monarch

Skippers (Hesperiidae)
Skipper, Silver-spotted
Long-tailed
Cloudywing, Southern
Northern
Scallopwing, Hayhurst's
Duskywing, Dreamy
Sleepy
Juvenal's
Horace's
Wild Indigo
Checkered Skippered, Common
Sootywing, Common
Skipper, Swarthy
Clouded
Least
Fiery
Peck's
Tawny-edged
Crossline
Broken-Dash, Southern
Northern
Glassywing, Little
Sachem
Skipper, Delaware
Skipper, Zabulon
Broad-winged
Dion
Dun
Skipper,Ocol

Appendix F

Dragonflies

Petaltails
Gray Petaltail (Tachopteryx thoreyi)

Darners
Common Green (Anax junius)
Swamp (Epiaeschna heros)
Cyrano (Nasiaeschna pentacantha)

Clubtails
Unicorn (Arigomphus villosipes)
Black-shouldered Spinyleg (Dromogomphus pinosus)
Lancet (Gomphus exilis)
Dragonhunter (Hagenius brevistylus)
Russet-tipped Clubtail (Stylurus plagiatus)

Emeralds
Prince Baskettail (Epitheca costalis)
Clamp-tipped Emerald (Somatochlora tenebrosa)
Mocha Emerald (S. linearis)
Fine-lined Emerald (S. filosa)*

Skimmers
Bar-winged Skimmer (Libellula axilena)
- Widow (L. luctuosa)
- Common Whitetail (L. Lydia)
- Twelve-spotted (L. pulchella)
- Painted (L. semifasciata)
- Blue Corporal (L.deplanata)
- Spangled (L. cyanea)
- Golden-winged (L. auripennis)
- Needham's (L. needhami)
- Great Blue (L. vibrans)
- Slaty (L. incesta)

Blue-faced Meadowhawk (Sympetrum ambiguum)
- Ruby (S. rubicundulum)
- Autumn (S. vicinum)

Little Blue Dragonlet (Erythodiplax minuscule)
Easter Amberwing (Perithemis tenera)
Blue Dasher (Pachydiplax longipennis)

Common Pondhawk (Erythemis simplicicollis)
Wandering Glider (Pantala lavescens)
- Spot-winged (P. hymenaea)

Black Saddlebags (Tramea lacerate)
Carolina (T. Carolina)
Four-spotted Pennant (Brachymesia gravida)
Halloween Pennant (Celithemis eponina)
- Calico (C. elisa)

Banded Pennant (C. fasciata)
Dot-tailed Whiteface (leucorrhinia intacta)

Damselflies

Broad-winged
Smoky Rubyspot (Hetaerina titla)

Spreadwings
Common (Lestes disjunctus)
Slender (L. rectangularis)
Swamp (L. vigilax)
Great (Archilestes grandis)

Pond Damsels
Blue-fronted Dancer (Argia apicalis)
Variable Dancer (Amphiagrion saucium)
- Powdered (A. moesta)
- Blue-ringed (A. sedula)
- Blue-tipped (A. tibialis)

Familiar Bluet (Enallagma civile)
- Torquoise (E. divagens)
- Atlantic (E. doubleday)
- Big (E. durum)
- Stream (E. traviatum)
- Skimming (E. geminatum)
- Orange (E. signatum)
- Slender (E. traviatum)

Citrine Forktail (Ischnura hastate)
- Fragile (I. posita)
- Furtive (I. prognata)
- Rambur's (I. ramburii)
- Eastern (I. verticalus)

Sedge Sprite (Nehalennia Irene)

Red indicates State listed S3 (rare in the State),

* indicates State listed S2 (very rare in State)

Natural Heritage Invertabrate Watch List

Appendix G Other Fauna reported at Occoquan Bay NWR, other than migratory birds

Spotted Salamander
Slimy Salamander
Eastern Snapping turtle
Eastern Mud turtle
Eastern Painted turtle
Northern Red-bellied turtle
Spotted turtle
Eastern Box turtle
Red-eared Slider
Five-lined skink
Northern Black Racer
Northern Rat snake
Mole King snake
Northern water snake
Rough Green snake
Eastern Ribbon snake
Eastern Garter snake
Star-nosed mole
Little brown bat
Eastern cottontail
Eastern chipmunk
Woodchuck
Gray squirrel
Beaver
Muskrat
Marsh Rice Rat
Coyote
Red fox
Northern River otter
White-tailed deer

Appendix H . Potential Resources of Concern and Consideration for Occoquan Bay NWR

Species	Seasons on Refuge[1]	Federal T&E for VA[2]	State T&E[3,4]	BCR 30[5]	PIF 9[6]	State Comprehensive Wildlife Conservation Plan Priorities[7]	CBY Plan[8]	USFWS Birds of Conservation Concern[9]	Federal Trust Fish Species (USFWS Trend Data)[10]	Shorebird Plan-Atlantic Flyway[11]	Waterbird Plan[12]	Waterfowl Plan[13]
WATERBIRDS												
American bittern	Sp, F			M		II					-	
Arctic tern											H	
Audubon's shearwater				H							HI	
Black rail				HH	1a	I		X			-	
Black skimmer				M	1a	II		X			H	
Black tern	Sp										M	
Black-headed gull											M	
Black-crowned night heron	Sp, S, W			M		III					M	
Bridled tern				H							H	
Caspian tern	Sp, S, F										L	
Clapper rail				H	2b	IV					-	
Common tern	F			M		III		X			L	
Cory's shearwater				M							M	
Forster's tern	YR			H	2b	IV					M	
Glossy ibis	S			H		III					L	
Greater shearwater				H							H	
Green heron						IV					L	
Gull-billed tern			T	HH		I					H	
Herring gull	YR										L	
Horned grebe	Sp, F, W			H		IV					-	
King rail	YR			M	1b	II					-	
Least bittern	Sp, F			M		III					-	
Least tern	Sp, F			H	1a	II		X			H	

Species	Seasons on Refuge[1]	Federal T&E for VA[2]	State T&E[3,4]	BCR 30[5]	PIF 9[6]	State Comprehensive Wildlife Conservation Plan Priorities[7]	CBY Plan[8]	USFWS Birds of Conservation Concern[9]	Federal Trust Fish Species (USFWS Trend Data)[10]	Shorebird Plan-Atlantic Flyway[11]	Waterbird Plan[12]	Waterfowl Plan[13]
	(H)											
Little blue heron	Sp, F			M		II					H	
Manx shearwater				M							M	
Northern gannet				H							N	
Razorbill				M				X			M	
Red-throated loon				HH							-	
Roseate tern		E	E	HH		IV					H	
Royal tern	Sp			M		II					M	
Snowy egret	Sp, F			M							H	
Sora	Sp, S, F			M							-	
Tricolored heron				M		III					H	
Virginia rail	Sp, F				2a	IV						
Yellow rail						IV						
Yellow-crowned night heron	Su, F (H)			M		II					M	
WATERFOWL												
American black duck	Sp, F, W			HH	1a	II						D
American wigeon	Sp, W			M								S
Atlantic brant				HH		III						S
Black scoter				H								D
Blue-winged teal	Sp, F, W											S
Bufflehead	Sp, F, W			H								I
Canada goose –	YR			HH								I

Species	Seasons on Refuge[1]	Federal T&E for VA[2]	State T&E[3,4]	BCR 30[5]	PIF 9[6]	State Comprehensive Wildlife Conservation Plan Priorities[7]	CBY Plan[8]	USFWS Birds of Conservation Concern[9]	Federal Trust Fish Species (USFWS Trend Data)[10]	Shorebird Plan-Atlantic Flyway[11]	Waterbird Plan[12]	Waterfowl Plan[13]
Atlantic Population												
Canada goose – North Atlantic				H								U
Canvasback	Sp, F, W			H								S
Common eider				H								D
Common goldeneye	Sp, W			M								S
Gadwall	Sp, F, W			M								I
Greater scaup	Sp, W			H		IV						S
Green-winged teal	Sp, F, W			M								I
Harlequin duck				M								S
Hooded merganser	Sp, F, W			M								I
King eider												D
Lesser scaup	YR			H								D
Long-tailed duck	Sp			H								D
Mallard	YR			H								S
Northern pintail	Sp, F, W			M								D
Red-breasted merganser	Sp, F, W			M								I
Redhead						III						
Ruddy duck	YR			M								I
Surf scoter				H								D
Tundra swan – Eastern				H								I
White-winged scoter				H								D
Wood duck – Eastern	YR			M								I

Species	Seasons on Refuge[1]	Federal T&E for VA[2]	State T&E[3,4]	BCR 30[5]	PIF 9[6]	State Comprehensive Wildlife Conservation Plan Priorities[7]	CBY Plan[8]	USFWS Birds of Conservation Concern[9]	Federal Trust Fish Species (USFWS Trend Data)[10]	Shorebird Plan-Atlantic Flyway[11]	Waterbird Plan[12]	Waterfowl Plan[13]
SHOREBIRDS												
American avocet				M						3		
American golden plover				H						4		
American oystercatcher				HH		II		X		5		
American woodcock	Sp, S, W			HH	1a	IV				5		
Baird's sandpiper										2		
Black-bellied plover				H		IV				3		
Buff-breasted sandpiper				H				X		4		
Common snipe	Sp, S, W			M						3		
Dunlin	Sp, F			H		IV				3		
Eskimo curlew		E								5		
Greater yellowlegs	YR			H						4		
Hudsonian godwit				H		IV		X		4		
Killdeer	YR			M						2		
Least sandpiper	Sp, F			M						3		
Lesser yellowlegs	YR			M						2		
Long-billed dowitcher										2		
Marbled godwit				H		IV		X		4		
Pectoral sandpiper	F									2		
Piping plover		T	T	HH		I	G3			5		
Purple sandpiper				H		IV		X		3		
Red knot		C		HH		IV		X		5		
Red phalarope				M						3		
Red-necked phalarope				M						3		
Ruddy turnstone				HH						4		
Sanderling				HH						4		

Species	Seasons on Refuge[1]	Federal T&E for VA[2]	State T&E[3,4]	BCR 30[5]	PIF 9[6]	State Comprehensive Wildlife Conservation Plan Priorities[7]	CBY Plan[8]	USFWS Birds of Conservation Concern[9]	Federal Trust Fish Species (USFWS Trend Data)[10]	Shorebird Plan-Atlantic Flyway[11]	Waterbird Plan[12]	Waterfowl Plan[13]
Semipalmated plover	Sp			M						2		
Semipalmated sandpiper	Sp, S			H						4		
Short-billed dowitcher				H		IV				3		
Solitary sandpiper				H						3		
Spotted sandpiper				M						3		
Stilt sandpiper										3		
Upland sandpiper			T	M	1b	I		X		4		
Western sandpiper				M						2		
Whimbrel				HH		IV		X		5		
White-rumped sandpiper				H						3		
Willet				H	2b					4		
Wilson's phalarope				H						3		
Wilson's plover			E	H	1b	I		X		4		
LANDBIRDS												
Acadian flycatcher	Sp, S, F				2b							
Appalachian Bewick's wren			E			I						
Appalachian winter wren						II						
Appalachian yellow-bellied sapsucker						I						
Bachman's sparrow			T	M	1b	I	G3					
Bald eagle	YR	T	T	M		II						
Baltimore oriole	Sp, S, F			H				X				

Species	Seasons on Refuge[1]	Federal T&E for VA[2]	State T&E[3,4]	BCR 30[5]	PIF 9[6]	State Comprehensive Wildlife Conservation Plan Priorities[7]	CBY Plan[8]	USFWS Birds of Conservation Concern[9]	Federal Trust Fish Species (USFWS Trend Data)[10]	Shorebird Plan-Atlantic Flyway[11]	Waterbird Plan[12]	Waterfowl Plan[13]
Barn owl						III						
Bay-breasted warbler	Sp			H								
Bicknell's thrush				H		IV						
Black-and-white warbler	Sp, F			H		IV						
Blackburnian warbler	Sp, F			M								
Blue-winged warbler	Sp			HH	1b			X				
Broad-winged hawk	Sp, F, W			H								
Brown creeper	Sp, F, W					IV						
Brown thrasher	YR			H	2a	IV						
Brown-headed nuthatch				M	1b	IV						
Canada warbler	Sp, F			M		IV		X				
Cerulean warbler				M	1b	II		X				
Chimney swift	Sp, S, F			H	2a	IV						
Chuck-will's-widow						IV						
Coastal plain swamp sparrow	Sp, S, F(?)			M			G5T3					
Eastern kingbird	YR			H		IV						
Eastern meadowlark	YR					IV						
Eastern towhee	YR			H	2a	IV						
Eastern wood-pewee					2a	IV						
Field sparrow	YR			H	2a	IV						
Golden-winged warbler				M		I		X				
Grasshopper sparrow	Sp, S, F			M	2c	IV						
Gray catbird	YR			M	2a	IV						

Species	Seasons on Refuge[1]	Federal T&E for VA[2]	State T&E[3,4]	BCR 30[5]	PIF 9[6]	State Comprehensive Wildlife Conservation Plan Priorities[7]	CBY Plan[8]	USFWS Birds of Conservation Concern[9]	Federal Trust Fish Species (USFWS Trend Data)[10]	Shorebird Plan-Atlantic Flyway[11]	Waterbird Plan[12]	Waterfowl Plan[13]
Great crested flycatcher	Sp, S, F			H								
Henslow's sparrow	S, F (H)		T	M	1b	I		X				
Ipswich savannah sparrow				M								
Kentucky warbler	Sp, F			H	1a	IV		X				
Kirtland's warbler						IV						
Loggerhead shrike	W (H)		T	M		I						
Louisiana waterthrush	Sp			H	2c	IV						
Marsh wren	Sp, F			H	2a	IV		X				
Nelson's sharp-tailed sparrow				M		III						
Northern bobwhite	YR			H	2a	IV						
Northern flicker	YR			H								
Northern harrier	Sp, F, W					III						
Northern parula	Sp, S, F					IV						
Northern rough-winged swallow	Sp, S, F					IV						
Northern saw-whet owl						II						
Ovenbird	Sp, F					IV						
Peregrine falcon			T			I		X				
Prairie warbler	Sp, S, F			HH	1a	IV		X				
Prothonotary warbler	(H)			H	1a	IV						
Red crossbill						I						
Red-cockaded		E	E	M	1b	I	G3					

Species	Seasons on Refuge[1]	Federal T&E for VA[2]	State T&E[3,4]	BCR 30[5]	PIF 9[6]	State Comprehensive Wildlife Conservation Plan Priorities[7]	CBY Plan[8]	USFWS Birds of Conservation Concern[9]	Federal Trust Fish Species (USFWS Trend Data)[10]	Shorebird Plan-Atlantic Flyway[11]	Waterbird Plan[12]	Waterfowl Plan[13]
woodpecker												
Red-headed woodpecker	Sp, F, W			M	1b			X				
Rose-breasted grosbeak						IV						
Rusty blackbird	Sp, F, W			H		IV						
Saltmarsh sharp-tailed sparrow				HH	1a	II		X				
Scarlet tanager	Sp, S, F			H	2a	IV						
Seaside Sparrow	Sp (H)			HH	1a	IV		X				
Sedge wren	F			M	2c	III		X				
Short-eared owl	Sp, F				1b			X				
Swainson's warbler				M	1b	II						
Wayne's black-throated green warbler						I						
Whip-poor-will				H	2a	IV		X				
Willow flycatcher	Sp, S			H	1b	IV						
Wood thrush	Sp, F			HH	1a	IV		X				
Worm-eating warbler	Sp			H	1a	IV		X				
Yellow warbler	Sp, S, F					IV						
Yellow-billed cuckoo	Sp, S, F					IV						
Yellow-breasted chat	Sp, S, F					IV						
Yellow-throated vireo	Sp, S			H	2a	IV						

MAMMALS

Species	Seasons on Refuge[1]	Federal T&E for VA[2]	State T&E[3,4]	BCR 30[5]	PIF 9[6]	State Comprehensive Wildlife Conservation Plan Priorities[7]	CBY Plan[8]	USFWS Birds of Conservation Concern[9]	Federal Trust Fish Species (USFWS Trend Data)[10]	Shorebird Plan-Atlantic Flyway[11]	Waterbird Plan[12]	Waterfowl Plan[13]
Allegheny woodrat						IV						
American water shrew						II						
Appalachian cottontail						IV						
Carolina Northern flying squirrel			E			I						
Cotton mouse						IV						
Delmarva fox squirrel		E	E			II	G5T3					
Dismal Swamp/Southeastern shrew			T			IV						
Eastern big-eared bat			E			I						
Eastern puma		E										
Eastern small-footed bat						III						
Eastern spotted skunk						IV						
Fisher						II						
Gray myotis		E	E			II						
Gray wolf		E										
Indiana bat		E	E			I						
Least weasel						IV						
Long-tailed or rock shrew						IV						
Marsh rabbit						IV						
Pungo white-footed mouse						III						
Rafinesque's big-eared bat							G3G4					
Right whale		E										
Snowshoe hare			E			I						

Species	Seasons on Refuge[1]	Federal T&E for VA[2]	State T&E[3,4]	BCR 30[5]	PIF 9[6]	State Comprehensive Wildlife Conservation Plan Priorities[7]	CBY Plan[8]	USFWS Birds of Conservation Concern[9]	Federal Trust Fish Species (USFWS Trend Data)[10]	Shorebird Plan-Atlantic Flyway[11]	Waterbird Plan[12]	Waterfowl Plan[13]
Southeastern myotis						IV						
Southern bog lemming						IV						
Southern fox squirrel						II						
Southern rock vole			E			II						
Virginia big-eared bat		E	E			II						
Virginia/WV northern flying squirrel		E	E			I						
AMPHIBIANS												
Barking treefrog			T			II						
Blue ridge dusky salamander						IV						
Blue ridge two-lined salamander						III						
Carpenter fog						III						
Common mudpuppy						III						
Cow knob salamander						II						
Cumberland plateau salamander						IV						
Dwarf waterdog						III						
Eastern hellbender						II						
Eastern mud salamander						IV						
Eastern spadefoot toad						IV						
Eastern/Tiger salamander			E			II						
Greater siren						IV						
Green salamander						II						
Jefferson salamander						IV						
Lesser siren						III						

Species	Seasons on Refuge[1]	Federal T&E for VA[2]	State T&E[3,4]	BCR 30[5]	PIF 9[6]	State Comprehensive Wildlife Conservation Plan Priorities[7]	CBY Plan[8]	USFWS Birds of Conservation Concern[9]	Federal Trust Fish Species (USFWS Trend Data)[10]	Shorebird Plan-Atlantic Flyway[11]	Waterbird Plan[12]	Waterfowl Plan[13]
Little grass frog						IV						
Mabee's salamander			T			II						
Many-lined salamander						IV						
Mole salamander						II						
Mountain chorus frog						II						
New Jersey chorus frog						IV						
Oak toad						II						
Peaks of otter salamander						II						
Pygmy salamander						III						
Shenandoah mountain salamander						III						
Shenandoah salamander		E	E			I						
Shovel-nosed salamander						III						
Southern zigzag salamander						II						
Striped southern chorus frog						IV						
Weller's salamander						II						
Yonahlossees salamander						IV						
REPTILES												
Atlantic loggerhead turtle		T	T			I	G3					
Bog turtle		T	E			I	G3					
Chicken turtle			E			I						
Cumberland slider						III						

Species	Seasons on Refuge[1]	Federal T&E for VA[2]	State T&E[3,4]	BCR 30[5]	PIF 9[6]	State Comprehensive Wildlife Conservation Plan Priorities[7]	CBY Plan[8]	USFWS Birds of Conservation Concern[9]	Federal Trust Fish Species (USFWS Trend Data)[10]	Shorebird Plan-Atlantic Flyway[11]	Waterbird Plan[12]	Waterfowl Plan[13]
Eastern black kingsnake						III						
Eastern box turtle	X					III						
Eastern glass lizard			T			II						
Eastern hognose snake						IV						
Eastern ribbon snake						IV						
Eastern scarletsnake						IV						
Eastern slender glass lizard						IV						
Eastern spiny softshell						IV						
Finback whale		E										
Glossy crayfish snake						III						
Green sea turtle		T										
Hawksbill sea turtle		E										
Humpback whale		E										
Kemp's ridley sea turtle		E										
Leatherback sea turtle		E										
Loggerhead sea turtle		T										
Mountain earthsnake						II						
Mudsnake						IV						
Northern diamondback terrapin						II						
Northern map turtle						IV						
Northern pine snake						I						
Queen snake						IV						
Rainbow snake						IV						
Smooth green snake						III						
Southeastern crowned snake						IV						

Species	Seasons on Refuge[1]	Federal T&E for VA[2]	State T&E[3,4]	BCR 30[5]	PIF 9[6]	State Comprehensive Wildlife Conservation Plan Priorities[7]	CBY Plan[8]	USFWS Birds of Conservation Concern[9]	Federal Trust Fish Species (USFWS Trend Data)[10]	Shorebird Plan-Atlantic Flyway[11]	Waterbird Plan[12]	Waterfowl Plan[13]
Spotted turtle	X					III						
Striped-necked musk turtle						IV						
Timber/Canebrake rattlesnake			T			IV						
Wood turtle			T			I						
Yellow-bellied slider						IV						
FISH												
Alewife						IV			D			
American eel						IV			D			
American shad						IV			D			
Atlantic sturgeon							G3					
Blackbanded sunfish			E			I						
Carolina darter			T			II						
Duskytail darter		E	E			I						
Emerald shiner			T			III						
Greenfin darter			T			II						
Longhead darter			T			II						
Orangefin madtom			T			II						
Paddlefish			T			II						
Roanoke logperch		E	E			I						
Sharphead darter			E			I						
Shortnose sturgeon		E	E			I	G3					
Slender chub		T	T			I						
Spotfin chub		T	T			I						
Steelcolor shiner			T			III						
Tennessee dace			E			I						
Tippecanoe darter			T			III						

Species	Seasons on Refuge[1]	Federal T&E for VA[2]	State T&E[3,4]	BCR 30[5]	PIF 9[6]	State Comprehensive Wildlife Conservation Plan Priorities[7]	CBY Plan[8]	USFWS Birds of Conservation Concern[9]	Federal Trust Fish Species (USFWS Trend Data)[10]	Shorebird Plan-Atlantic Flyway[11]	Waterbird Plan[12]	Waterfowl Plan[13]
Variegate darter			E			II						
Western sand darter			T			II						
Whitemouth shiner			T			IV						
Yellowfin madtom		T	T			I						
INVERTEBRATES												
American burying beetle		E				I						
Appalachian/Southern grizzled skipper			T			I						
Buffalo mountain mealybug			T			I						
Ellet valley pseudotremia millipede			T			II						
Frosted elfin							G3					
Holsinger's cave beetle			E			II						
A Lampyrid firefly							G1?					
Laurel creek xystodesmid millipede			T			I						
Lee county cave isopod		E	E			I						
Madison cave amphipod			T			I						
Madison cave isopod		T	T			II						
Mitchell's satyr		E	E			I						
Northeastern beach tiger beetle		T	T			II	G4T2					
Northern Virginia well amphipod							G2G3					
Powell valley terrestrial			T			II						

Species	Seasons on Refuge[1]	Federal T&E for VA [2]	State T&E[3,4]	BCR 30[5]	PIF 9[6]	State Comprehensive Wildlife Conservation Plan Priorities[7]	CBY Plan[8]	USFWS Birds of Conservation Concern[9]	Federal Trust Fish Species (USFWS Trend Data)[10]	Shorebird Plan-Atlantic Flyway[11]	Waterbird Plan[12]	Waterfowl Plan[13]
cave isopod												
Puritan tiger beetle							G1G2					
Rare skipper							G2G3					
Seth Forest water scavenger beetle							G1					
Tidewater amphipod							G2G3					
Tidewater interstitial amphipod							G2G3					
Virginia piedmont water boatman			E			I						
FRESHWATER MUSSELS												
Appalachian monkeyface		E	E			I						
Appalachian springsnail			E			II						
Atlantic pigtoe			T			II						
Birdwing pearlymussel		E	E			I						
Black sandshell			T			III						
Brook floater	PWC		E			II						
Brown supercoil			T			I						
Cracking pearlymussel		E	E			I						
Cumberland bean		E	E			I						
Cumberland combshell		E	E			I						
Cumberland monkeyface		E	E			I						
Deertoe			E			IV						
Dromedary pearlymussel		E	E			I						
Dwarf wedgemussel		E	E			II	G1G2					

Species	Seasons on Refuge[1]	Federal T&E for VA[2]	State T&E[3,4]	BCR 30[5]	PIF 9[6]	State Comprehensive Wildlife Conservation Plan Priorities[7]	CBY Plan[8]	USFWS Birds of Conservation Concern[9]	Federal Trust Fish Species (USFWS Trend Data)[10]	Shorebird Plan-Atlantic Flyway[11]	Waterbird Plan[12]	Waterfowl Plan[13]
Elephant ear			E			IV						
Fanshell		E	E			I						
Fine-rayed pigtoe		E	E			I						
Fragile papershell			T			IV						
Green blossom pearlymussel		E	E			I						
Green floater			T			II						
James spinymussel		E	E			I						
Little-winged pearlymussel		E	E			I						
Ohio pigtoe			E			III						
Oyster mussel		E	E			I						
Pimpleback			T			IV						
Pink mucket		E	E			I						
Purple bean		E	E			I						
Purple liliput			E			II						
Pyramid pigtoe			E			II						
Rough pigtoe		E	E			I						
Rough rabbits foot		E	E			I						
Rubble coil			E			I						
Shaggy coil			E			I						
Sheepnose			T			II						
Shiny pigtoe		E	E			I						
Slapside pearlymussel			T			II						
Slippershell mussel			E			II						
Snuffbox			E			II						
Spectaclecase			E			II						
Spider elimia			E			II						
Spiny riversnail			T			III						

Species	Seasons on Refuge[1]	Federal T&E for VA[2]	State T&E[3,4]	BCR 30[5]	PIF 9[6]	State Comprehensive Wildlife Conservation Plan Priorities[7]	CBY Plan[8]	USFWS Birds of Conservation Concern[9]	Federal Trust Fish Species (USFWS Trend Data)[10]	Shorebird Plan-Atlantic Flyway[11]	Waterbird Plan[12]	Waterfowl Plan[13]
Spirit supercoil			E			I						
Tan riffleshell		E	E			I						
Tennessee heelsplitter			E			II						
Unthanks cave snail			E			I						
Virginia fringed mountain snail			E			I						
Virginia springsnail			E			I						
PLANTS												
Awned meadowbeauty							G3					
Bentley's coralroot			E									
Canby's dropwort							G2					
Chaffseed		E										
Curly-grass fern							G3					
Cuthbert turtlehead							G3?					
Creamflower tick-trefoil							G2G3					
Creeping St. John's-wort							G2G3					
Cypress-knee sedge							G3					
Earleaf foxglove	PWC						G3					
Eastern prairie fringed orchid		T	T									
Gaylussacia brachycera							G2G3					
Glade spurge							G3					
Harperella		E	E									
Harper's fimbristylis							G2					
Hirst's panicgrass							G1					
Juniper sedge			E									
Long-stalked holly			E									

Species	Seasons on Refuge[1]	Federal T&E for VA[2]	State T&E[3,4]	BCR 30[5]	PIF 9[6]	State Comprehensive Wildlife Conservation Plan Priorities[7]	CBY Plan[8]	USFWS Birds of Conservation Concern[9]	Federal Trust Fish Species (USFWS Trend Data)[10]	Shorebird Plan-Atlantic Flyway[11]	Waterbird Plan[12]	Waterfowl Plan[13]
Michaux's sumac		E	T									
Narrow-leaved spatterdock			T									
Nestronia			E									
New Jersey rush			T				G2					
Northeastern bulrush		E	E									
Northern prostrate clubmoss			T									
Pale false foxglove							G3					
Peter's mountain mallow		T	E									
Piratebush			E									
Pondspice							G3					
Reclining bulrush			T									
Running glade clover			E									
Sandplain gerardia							G1					
Seabeach amaranth		T	T				G2					
Sea-beach knotweed							G3?					
Sensitive joint-vetch		T	T				G2					
Shale barren rock-cress		E	T									
Small whorled pogonia	PWC	T	E				G2G3					
Small-anthered bittercress		E	E									
Smooth coneflower		E	T									
Southern Lady's-Slipper							G3					
Swamp pink		T	E				G3					
Sweet pinesap							G3					
Torrey's dropseed							G3					

Species	Seasons on Refuge[1]	Federal T&E for VA[2]	State T&E[3,4]	BCR 30[5]	PIF 9[6]	State Comprehensive Wildlife Conservation Plan Priorities[7]	CBY Plan[8]	USFWS Birds of Conservation Concern[9]	Federal Trust Fish Species (USFWS Trend Data)[10]	Shorebird Plan-Atlantic Flyway[11]	Waterbird Plan[12]	Waterfowl Plan[13]
Torrey's mountain mint							G2					
Tropical water-hyssop			E									
Variable sedge			E									
Virginia least trillium							G3T2					
Virginia round-leaf birch		T	E									
Virginia sneezeweed		T	E									
Virginia spiraea		T	E									

*Species highlighted in yellow are potential focal species of concern

[1]Seasons on the Refuge: Sp = Spring; S = Summer; F = Fall; W = Winter; YR = Year-Round; (H) = historic, (?) = unknown but possible (for birds); for other species (amphibians, reptiles, invertebrates, plants) if known to occur in Prince William County, denoted with "PWC", if known to occur on Occoquan Bay NWR, denoted with an "X"

[2] US Fish and Wildlife Service. Threatened and Endangered Species System (TESS). Report for the state of Virginia.
T = threatened; E = endangered

[3]Virginia Comprehensive Wildlife Conservation Strategy. 2005. Data from the Excel file developed by the Federal Aid office of US Fish and Wildlife Service, Hadley, MA. Sept. 2006.
E = endangered; T = threatened
Does not include state listed plants.

[4]Natural Heritage Resources of Virginia: Rare Animals. 2006. Compiled by Steven M. Roble, Zoologist; also, Natural Heritage Resources of Virginia: Rare Plants. 2006. Compiled by John F. Townsend, Staff Botanist. Virginia Department of Conservation and Recreation, Division of Natural Heritage.
T = threatened; E = endangered

[5]BCR 30 Mid-Atlantic/Southern New England Bird Conservation Region. Draft Implementation Plan, 19 July 2006. Melanie Steinkamp, Atlantic Coast Joint Venture, Laurel, MD.

HH=highest priority: H = high priority; M = medium priority

[6]PIF 9 = Partners in Flight Physiographic Area 44; Mid-Atlantic Coastal Plain (Watts 1999)
Tier I = *High overall (global) priority* - species scoring 22 or higher in the PIF prioritization system. Indicates high vulnerability of populations throughout the species range.
Tier II = *High physiographic area priority* -species scoring 19-21 in the PIF system, with AI +PT of 8 or higher. Indicates species of moderately high global vulnerability, and with relatively high abundance as well as declining or uncertain population trend in the physiographic area.
Tier 1A, 2A and 2B species are either: 1) species for which conservation in this region is critical to the overall health of this species, 2) species that are experiencing declines in the core of their range and that require immediate conservation action to reverse or stabilize trends, or 3) species for which this region has substantial responsibility for long-term conservation, even if they are not currently declining or threatened.

[7]Virginia Comprehensive Wildlife Conservation Strategy. 2005. Data from the Excel file developed by the Federal Aid office of US Fish and Wildlife Service, Hadley, MA. Sept. 2006.

I = Tier 1: critical conservation need

II = Tier 2: very high conservation need

III = Tier 3: high conservation need

IV = Tier 4: moderate conservation need

Listed all birds, mammals, reptiles and amphibians. For fish (96 species), non-arthropod invertebrates (157 species) and arthropod invertebrates (489 species), only the federal and state listed endangered and threatened species are listed.

[8]Chesapeake Bay Lowlands Ecoregional Plan (TNC, Draft, 2006). Primary species conservation targets with global ranks. G1 = extremely rare; usually 5 or fewer occurrences in the overall range or very few remaining individuals; or because of some factor(s) making it especially vulnerable to extinction; G2 = very rare; usually between 5 and 20 occurrences in the overall range or with many individuals in fewer occurrences; or because of some factor(s) making it vulnerable to extinction; G3 = Rare to uncommon; usually between 20 and 100 occurrences; may have fewer occurrences, but with a large number of individuals in some populations; may be susceptible to large-scale disturbances; T = Denotes that the rank applies to a subspecies or variety

[9]US Fish and Wildlife Service. 2002. Birds of conservation concern 2002. Division of Migratory Bird Management, Arlington, Virginia. 99pp. (Online version available at http://migratorybirds.fws.gov/reports/bbc2002.pdf)

[10]Federal Trust Fish Species US Fish and Wildlife Service Population Trend Data.

I = increasing; D = decreasing

[11]North Atlantic Regional Shorebird Plan. Clark and Niles 2000.

5 = highly imperiled – all species listed as threatened or endangered nationally, plus all species with significant population declines and either low populations or some other high risk factor.

4 = species of high concern – populations of these species are known or thought to be declining and have some other known or potential threat as well.

3 = species of moderate concern – populations of these species are either a) declining with moderate threats or distributions; b) increasing but with known or potential threats and moderate to restricted distributions; or c) of moderate size.

2 = species of low concern – populations of these species are either a) stable with moderate threats and distributions; b) increasing but with known or potential threats and moderate to restricted distributions; or c) of moderate size.

1 = species not at risk – all other species where there is apparently no current risk of population decline.

[12]Waterbird Plan: James A. Kushlan, Melanie J. Steinkamp, Katharine C. Parsons, Jack Capp, Martin Acosta Cruz, Malcolm Coulter, Ian Davidson, Loney Dickson, Naomi Edelson, Richard Elliot, R. Michael Erwin, Scott Hatch, Stephen Kress, Robert Milko, Steve Miller, Kyra Mills, Richard Paul, Roberto Phillips, Jorge E. Saliva, Bill Sydeman, John Trapp, Jennifer Wheeler, and Kent Wohl. 2002. Waterbird Conservation for the Americas: The North American Waterbird Conservation Plan, Version 1. Waterbird Conservation for the Americas. Washington, DC, U.S A.

HI = highly imperiled; H = high risk; M = moderate risk; L = low risk; NR = not currently at risk; - = species to be assessed in Version 2 of the North American Waterbird Conservation Plan

[13]North American Waterfowl Management Plan, Plan Committee. 2004. North American Waterfowl Management Plan 2004. Implementation Framework: Strengthening the Biological Foundation. Canadian Wildlife Service, U.S. Fish and Wildlife Service, Secretaria de Medio Ambiente y Recursos Naturales, 106 pp.

Population trend 1970 – 2003:

I = increasing; S = stable; D = decreasing; U = unknown

Appendix I

Rare Plants and Exemplary Natural Communities Potentially Occurring in Prince William County, Virginia*				
Species		**State Status[1]**	**Srank[2]**	**Grank[3]**
Agalinis auriculata	Earleaf Foxglove	S1		G3
Asclepias purpurascens	Purple Milkweed	S2		G5?
Asclepias rubra	Red Milkweed	S2		G4G5
Buchnera americana	Blue-hearts	S1S2		G5?
Cabomba caroliniana	Carolina Fanwort	S1		G3G5
Carex buxbaumii	Brown Bog Sedge	S2		G5
Carex vestita	A Sedge	S2		G5
Cerastium arvense (ssp. Velutinum?)	A field chickweed	S2?		G5
Crataegus calpodendron	Pear Hawthorn	S1		G5
Isoetes appalachiana	Engelmann's Quillwort	S2?		G4
Isotria medeoloides	Small Whorled Pogonia	S2	E	G2
Lycopodiella inundata	Northern Bog Clubmoss	S1		G5
Oligoneuron rigidum var. rigidum	Stiff Goldenrod	S2		G5T5
Orthilia secunda	One-sided Wintergreen	SH		G5
Pycnanthemum torrei	Torrey's Mountain-mint	S2?		G2
Pyrola elliptica	Shinleaf	S2		G5
Ranunculus aquatilis var. diffusus	White Water Crow-foot	S1		G5T5
Rosa setigera	Prairie Rose	S1		G5
Schoenoplectus acutus var. acutus	Hardstemmed Bulrush	S1		G5T5
Scutellaria incana	Hoary skullcap	S2[4]		
Sphenopholis filiformis	Long-leaf Wedgescale	S1		G4?
Spiranthes ochroleuca	Yellow Nodding Ladies'-tresses	S1		G4?
Stachys pilosa var. arenicola	Marsh Hedgenettle	S1		G5T4?
Stellaria alsine	Trailing Stitchwort	SNR		G5
Thelypteris simulata	Bog Fern	S1S2		G4G5
Trifolium reflexum	Buffalo Clover	S1		G3G4
NATURAL COMMUNITIES				
Oak-Hickory Woodland/Savanna			S1	Not

			Ranked

* We used the VANHP's online searchable database to generate a list of potential state-listed natural heritage resources for Prince William County, Virginia.

[1]State Status=State of Virginia Threatened and Endangered Species List: T=Threatened, E=Endangered, SC=Special Concern

[2]Srank=State Rarity Ranks

S1 Critically imperiled in VA because of extreme rarity (five or fewer occurrences or very few remaining individuals or acres) or because some aspect of its biology makes it especially vulnerable to extirpation from the State of VA.

S2 Imperiled in VA because of rarity (6-20 occurrences or few remaining individuals or acres) or because of other factors making it vulnerable to further decline.

S3 Rare in VA (on the order of 20-100 occurrences).

S4 Apparently secure in VA.

S5 Demonstrably secure in VA.

SH Occurred historically in VA, and could be rediscovered; not known to have been extirpated.

SU Possibly in peril in VA, but status uncertain; need more information.

SX Apparently extirpated in VA (historically occurring species for which habitat no longer exists in Maine).
Note: State Ranks determined by the VA Natural Areas Program.

[3]Grank=Global Rarity Ranks

G1 Critically imperiled globally because of extreme rarity (five or fewer occurrences or very few remaining individuals or acres) or because some aspect of its biology makes it especially vulnerable to extirpation from the State of VA.

G2 Globally imperiled because of rarity (6-20 occurrences or few remaining individuals or acres) or because of other factors making it vulnerable to further decline.

G3 Globally rare (on the order of 20-100 occurrences).

G4 Apparently secure globally.

G5 Demonstrably secure globally.

Note: Global Ranks are determined by The Nature Conservancy. T indicates subspecies rank, Q indicates questionable rank, HYB indicates hybrid species.

[4]Documented for Occoquan NWR by Joe Witt

Appendix J

A “subset of focal species” for Occoquan Bay NWR – all potential species based upon prioritization criteria.

Species	Seasons Reported on Refuge[1]
BIRDS	
Black rail	
Forster’s tern	YR
Gull-billed tern	
Least tern	Sp, F (H)
Roseate tern	
American black duck	Sp, F, W
Atlantic brant	
Black scoter	
Canada goose – Atlantic Population	W
American oystercatcher	
American woodcock	Sp, S, W
Piping plover	
Red knot	
Ruddy turnstone	
Sanderling	
Whimbrel	
Willet	
Wilson’s plover	
Blue-winged warbler	Sp
Chimney swift	Sp, S, F
Eastern towhee	YR
Field sparrow	YR
Marsh wren	Sp, F
Northern bobwhite	YR
Prairie warbler	Sp, S, F
Prothonotary warbler	Sp, S (H)
Saltmarsh sharp-tailed sparrow	
Scarlet tanager	Sp, S, F

Seaside Sparrow	Sp (H)
Whip-poor-will	
Willow flycatcher	Sp, S
Wood thrush	Sp, F
Yellow-throated vireo	Sp, S
Coastal plain swamp sparrow	?
MAMMALS	
Carolina Northern flying squirrel	
Delmarva fox squirrel	
Eastern big-eared bat	
Eastern puma	
Fisher	
Gray myotis	
Gray wolf	
Indiana bat	
Right whale	
Snowshoe hare	
Virginia big-eared bat	
Virginia/WV northern flying squirrel	
AMPHIBIANS	
Shenandoah salamander	
REPTILES	
Atlantic loggerhead turtle	
Bog turtle	
Finback whale	
Green sea turtle	
Hawksbill sea turtle	
Humpback whale	
Kemp's ridley sea turtle	
Leatherback sea turtle	
Loggerhead sea turtle	
Wood turtle	
FISH	
Blackbanded sunfish	
Duskytail darter	
Roanoke logperch	

Shortnose sturgeon	
Slender chub	
Spotfin chub	
Tennessee dace	
Yellowfin madtom	
INVERTEBRATES	
Brook floater	PWC
PLANTS, PLANT COMMUNITIES	
Earleaf foxglove (S1, G3)	PWC
Small whorled pogonia (S2, G2)	PWC
Hoary skullcap (S2, G5)	Occurs at Occoquan NWR
A field chickweed (S2, G5)	Occurs at Occoquan NWR
Oak-Hickory Woodland/Savanna	PWC

[1]Seasons on the Refuge: Sp = Spring; S = Summer; F = Fall; W = Winter; YR = Year-Round; (H) = historic, (?) = unknown (for birds); for other species (amphibians, reptiles, invertebrates, plants) if known to occur in Prince William County, denoted with "PWC"

Appendix K

Potential priority Resources of Concern for Occoquan Bay NWR – historically or currently present at the Refuge (for wildlife), or occurring in Prince William County (for invertebrates and plants).

Primary Habitat	**Species or Community**	**Seasons documented on Refuge[3]**	**Potential Habitat at Occoquan Bay NWR?**
High relief streams (boulders and sand)	Brook floater	PWC	No
Sandy beach	Least tern (breeding); also forages in shallow nearshore waters during migration	Sp, F (H)	No significant breeding habitat, unquantified foraging/migration habitat
Forest and woodland (Northern Atlantic Coastal Plain Dry Hardwood Forest)	Oak-Hickory Woodland/Savanna	X	Yes (~20 hectares)
	Yellow-throated vireo	Sp, S	Yes, breeding/migration (~20 hectares
	Chimney swift (breeding/ migration)	Sp, S, F	Yes, breeding/migration (~20 hectares
	Scarlet tanager (breeding/migrating)	Sp, S, F	Yes, breeding, migrating (~20 hectares)
	Wood thrush	Sp, F	Yes, breeding, migrating, (~20 hectares)
Bottomland forest (Northern Atlantic Coastal Plain Tidal Swamp)	Prothonotary warbler	Sp, S (H)	Yes breeding/migration (~19 hectares, likely more)
	Scarlet tanager	Sp, S, F	Yes breeding/migration (~19 hectares, likely more)
	Wood thrush	Sp, F	Yes breeding/migration (~19 hectares, likely more)

[3] Seasons on the Refuge: Sp = Spring; S = Summer; F = Fall; W = Winter; YR = Year-Round; (H) = historic (for birds); for other species (amphibians, reptiles, invertebrates, plants) if known to occur in Prince William County, denoted with "PWC"

	Yellow-throated vireo	Sp, S	Yes breeding/migration (~19 hectares, likely more)
	Small whorled pogonia (S2, G2)	PWC	Yes breeding/migration (~19 hectares, likely more), not recorded for refuge
Mixed Upland and Wetland (Northern Atlantic Coastal Plain Stream and River and small inclusions of Unclassified early successional wetland)	American woodcock (breeding); also breeds in Bottomland forest during winter	Sp, S, W	Yes, breeding/wintering (~17.4 hectares)
	Willow flycatcher (breeding/migration)	Sp, S	Yes,breeding/migration (~17.4 hectares)
	Coastal plain swamp sparrow	?	Yes, possibly breeding (~17.4 hectares)
Scrub/early successional (Unclassified early successional upland)	Blue-winged warbler; also may use Mixed Upland and Wetland during migration	Sp	Yes, migration (~95.02 hectares potential habitat[4])
	Field sparrow	YR	Yes, year round (~95.02 hectares potential habitat[5])
	Northern bobwhite	YR	Yes,year round (~95.02 hectares potential habitat[6])
	Prairie warbler	Sp, S, F	Yes, (~95.02 hectares potential habitat[7])
	Eastern towhee	YR	Yes, year round (~95.02 hectares potential habitat[8])
	Earleaf foxglove (S1, G3)	PWC	Yes (~95.02 hectares potential habitat[9]); not recorded for Refuge
Tidal herbaceous wetland (Northern	Forster's tern	YR	Yes, year round (~53+

[4] Proportions of grassland and shrub-scrub vary in the open fields of the refuge

[5] Proportions of grassland and shrub-scrub vary in the open fields of the refuge

[6] Proportions of grassland and shrub-scrub vary in the open fields of the refuge

[7] Proportions of grassland and shrub-scrub vary in the open fields of the refuge

[8] Proportions of grassland and shrub-scrub vary in the open fields of the refuge

[9] Proportions of grassland and shrub-scrub vary in the open fields of the refuge

Atlantic Coastal Plain Fresh and			hectares)
Oligohaline Tidal Marsh), Nontidal herbaceous wetland (Unclassified early successional wetland)	American black duck	Sp, F, W	Yes, year round (~53+ hectares)
	Canada goose	W	Yes , wintering, (~53+ hectares)
	Marsh wren	Sp, F	Yes, migrating, possibly breeding and wintering (~53+ hectares)
	Seaside Sparrow (Tidal herbaceous wetland only)	Sp	Yes, migrating (~53+ hectares)
	Coastal plain swamp sparrow	?	Yes, possibly breeding (limited acres, marsh/shrubland interface)
	Hoary skullcap (S2, G5), A field chickweed (S2 G5)		Yes, occurs on Refuge

Appendix L

Site visit notes with Dr. Bryan Watts, as taken by Laura Mitchell, Region 5 Fire Wildlife Biologist

General thoughts:

- the refuge should maintain current sedge meadows (with mowing and/or light disking), as this is an uncommon habitat, of importance to migrating and wintering rails and short-distance, migrating sparrows
- the refuge should engage in infrequent bush hogging or disking in small, wet shrublands and wet meadows, located adjacent to wet woods, as these areas may serve as breeding and foraging sites for American Woodcock
- certain wet thickets (currently recently hydro-axed), already heavily populated by tree saplings and rootstocks (e.g. red maple, sweet gum), be allowed to succeed to dense woody cover (sapling thickets), to serve as important fall migrant landbird stopover habitat
- grassland management recommendations – should leave grass cover during the fall in the fields, likely important for fall migrating landbirds; leave fields alone in winter to provide winter cover for sparrows; mowing activities should take place in April, later in the season (May), will impact grassland breeding bird activity; prescribed fire might be employed cautiously in the fall, but rotationally, in order to maintain some fall migration habitat
- grassland management recommendations – need to reduce cover/density of eastern gammagrass; may disk it, apply herbicides, replant to shorter grassland vegetation
- young woody thickets and deciduous forests of the refuge – should be maintained or increased – they provide important fall migrant landbird habitat – adults migrants concentrate movements along the outer coastal plain, especially in hardwood forests, with dense understory vegetation (better food sources)
- the refuge should conduct coastal plain swamp sparrow surveys in the SE portion of the refuge, stream corridor/shrub areas

Specific Comments While Visiting Refuge Habitat Management Units

HMU	Habitat Comments	Recommendations
10 & 11	Several rail species likely use soft rush meadows during migration (Virginia, king,	Mowing/light disking in soft rush meadows;

	sora); rush meadows are winter habitats for swamp sparrows, song sparrows; adjacent 10 yr old sweetgum thickets are good fall migrant habitat; breeding habitat for common yellowthroat, indigo bunting	occasional disturbance in sweetgum thickets to maintain them
12	Recently-mowed, moderately well drained area; open areas good winter song sparrow habitat, but low diversity bird habitat right now; if allowed to grow to "head high" would increase value for migrant landbirds; difficult to restore to closed canopy forest, other than red maple/sweetgum (dense vine and maple/gum rootstocks); not good American woodcock habitat	Manage as sapling thicket – allow dense cover of saplings and intermittently disturb; also, control mile-a-minute weed
1 & 2	Currently poor obligate grassland breeding bird habitat; eastern gammagrass is too dense and tall for eastern meadowlark or grasshopper sparrow); too many inclusions of shrubs; provides winter song sparrow habitat, possible LeConte's sparrow habitat; spring and fall raptor foraging habitat	Possibly strip-plow the fields, or strip-apply herbicide; or disk and herbicide entire field and replant to shorter native grasses, or plant clover
4 & 5	Open fields - same description as fields 1 & 2, except fields are slightly less dense; brambles and goldenrod add vegetation diversity; breeding habitat for tree swallow, king bird, red winged blackbird	Reduce density of eastern gammagrass
3 & 6	Old fields succeeding to shrubland/early woody successional habitat; breeding habitat for: brown thrasher, common yellowthroat, yellow breasted chat, song sparrow, eastern towhee, indigo bunting, orchard oriole	Occasionally hydro-ax or bush hog; also remove saplings as they reach 20' height; alternate mowing field 3 with field 6, this will maintain shrubland habitat (e.g. for kingbirds) in one field, and early sapling habitat (e.g. for yellow breasted chat) in the other field

River treeline, Deephole Point Road	Woodcock breeding habitat; wet meadows along the river serve as important king rail habitat; beaver activity is impounding tidal marshes, increasing shrub cover, decreasing tidal marsh herbaceous cover, increasing OW, causing loss of king rail habitat; reducing fish passage	Control beaver populations; exclude beaver from tidal marsh areas
Easy Road	Good fall migrant habitat; dense vegetation, vines, good structure	none
13	Dry early successional shrubland; good prairie warbler habitat; invasive shrubs such as Bradford pear and buckthorn still provide good shrubland bird habitat structure; breeding habitat for common yellowthroat, white eyed vireo, catbird, orchard oriole, bobwhite quail, indigo bunting, eastern towhee	Cut tallest trees, when they reach >20'; mow serpentine paths to keep shrubs from closing canopy; disturb approximately every 5 years
15	Similar to HMU 1, 2; tree spacing is ok;	Need to reduce eastern gammagrass component to increase grassland bird use; needs more blackberry cover for diversity
24	Good American woodcock habitat; good context (meadow surrounded by forest); likely spring and fall woodcock use	Plow, strip-mow, create patches of bare ground
20	Similar to HMU 13; good field sparrow and prairie warbler breeding habitat	Same as HMU 13; mowing in the fall would increase fall and winter use by meadowlarks, barn owls, kestrels, other raptors
Forest strip/Marumsco Creek	Provides breeding habitat for whip poor will, eastern towhee, summer and scarlet tanager, red eyed vireo, woodthrush, ovenbird, cuckoo	Increase forest width

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