Montezuma National Wildlife Refuge
Habitat Management Plan

FINAL – JULY 2008

Submitted by: Tom Jasikoff
Refuge Manager
Date: Aug. 11, 2008

Concurred by: Janith Taylor
Regional Refuge Biologist
Date: Sept. 10, 2008

Concurred by:
Supervisor, Refuges North
Date: 9/15/08

Approved by: Anthony D. Léger
Assistant Regional Director, Refuges
Region 5
Date: 9/16/08

This blue goose, designed by J.N. "Ding" Darling, has become a symbol of the National Wildlife Refuge System.

The U.S. Fish & Wildlife Service is the principal federal agency responsible for conserving, protecting, and enhancing fish and wildlife and their habitats for the continuing benefit of the American people. The Service manages the 93-million acre National Wildlife Refuge System comprised of more than 535 national wildlife refuges and thousands of waterfowl production areas. It also operates 65 national fish hatcheries and 78 ecological services field stations. The agency enforces federal wildlife laws, manages migratory bird populations, restores nationally significant fisheries, and conserves and restores wildlife habitat such as wetlands, administers the Endangered Species Act, and helps foreign governments with their conservation efforts. It also oversees the Federal Aid Program which distributes hundreds of millions of dollars in excise taxes on fishing and hunting equipment to state wildlife agencies.

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Executive Summary

The 9,008-acre Montezuma National Wildlife Refuge (NWR) is part of the 50,000-acre Montezuma Wetlands Complex (MWC) that encompasses public and private lands at the north end of Cayuga Lake in the heart of the Finger Lakes Region of central New York State. More than 1,000,000 waterfowl, as well as a diversity of shore, wading and songbirds, pass through the Complex each year. This Habitat Management Plan (HMP) provides a long-term vision and specific guidance on managing habitat for the resources of concern at Montezuma NWR for the next 15 years.

The HMP formalizes current management at the Montezuma NWR and incorporates many of the habitat goals, objectives, and strategies described in the MWC Management Plan developed by Ducks Unlimited, Inc., the US Fish and Wildlife Service (FWS), and the New York State Department of Conservation. The HMP identifies refuge tracts for management based on habitat goals and objectives. Habitat goals and objectives are based on priority resources of concern, historic conditions, site capability, and current vegetation. High priority habitats are emergent marsh/open water, inland mudflats, and forested wetlands. Moderate priority habitats are upland forest, grassland, and shrublands/early successional habitats. Focal species were identified for each high and moderate priority habitat.

Most habitat goals and objectives will be met by continuing current management. Our highest priority will be to continue to provide high quality mudflat, freshwater emergent marsh, and open water wetland habitat for waterfowl, shorebirds, waterbirds, marshbirds, and bald eagles, primarily through water level management in freshwater impoundments. Changes to current management include the reforestation of selected areas and the creation of potholes in the Dry Marsh portion of the Main Pool. These changes will be made in an effort to restore historic (pre-barge canal) habitat conditions and to provide additional habitat for priority resources of concern. Reforestation will occur in these areas: North and South Spring Pools, the Seneca River Corridor in the Seneca Trail Area, Box Elder Bog, the Clyde River Corridor east of May's Point Pool, the Nash Property between Tyre and Glover Roads, the Smith Property west of VanDyne Spoor Road, and the upland fields on the newly acquired Jackson Property. Reforestation of these areas will increase forest block size and connectivity and reduce habitat fragmentation to support cavity nesting waterfowl (in forested wetlands), songbirds, amphibians, and bats. Potholes will be created in the Dry Marsh to create an interspersion of open water/mudflats and emergent vegetation to provide additional high quality habitat for waterfowl, shorebirds, and marshbirds.

As conditions are likely to change over the next 15 years, the Refuge will use adaptive management to respond to changing conditions that impair our ability to achieve habitat objectives or to refine habitat objectives, as needed.

Chapter 1 Introduction

This Chapter includes the following sections:

- **Scope and Rationale**
- **Legal Mandates**
- **Links to other Plans**

Scope and Rationale

The Montezuma National Wildlife Refuge (NWR) lies at the north end of Cayuga Lake in the heart of the Finger Lakes Region of central New York State and includes 9,008 acres (Map 1-1). The Refuge manages 16 impoundments that provide more than 4,700 acres of freshwater wetlands habitat to more than 200,000 migrating ducks and geese. A diversity of marsh and wading birds breed here, including bitterns, rails, black terns, and grebes, along with several pairs of bald eagles. Montezuma is one of the most significant stopover sites for shorebirds in upstate New York, regularly hosting 1,000 or more individuals of 25 species. The Refuge area supports the second largest population of cerulean warblers in New York. This species of high conservation concern breeds in riparian, forested wetlands, a habitat that was drained or cleared in many other areas. The Refuge is part of a larger 50,000-acre Montezuma Wetlands Complex that encompasses public and private lands. More than 1,000,000 waterfowl, as well as a diversity of shore, wading and songbirds, pass through the Complex each year.

Meeting the wildlife conservation challenges of the 21st century and fulfilling the System mission and vision requires planning and partnerships. The Comprehensive Conservation Plan (CCP) and Habitat Management Plan (HMP) for each Refuge are essential to the System's ability to meet these challenges.

The landmark 1997 National Wildlife Refuge System Improvement Act, prepared 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
- Refuges are national and international leaders in habitat management and wildlife conservation

This Habitat Management Plan provides a long-term vision and specific guidance on managing habitat for the resources of concern at Montezuma NWR. The contributions of this Refuge to ecosystem and landscape scale wildlife and biodiversity conservation are incorporated in the HMP. The HMP sets a direction for the next 15 years (2008-2022) with plan review every 5 years and use of adaptive management to assess and modify management activities as research and monitoring may require.

Map 1-1 Montezuma National Wildlife Refuge Locus Map

Legal Mandates

Statutory Authority

The National Wildlife Refuge Improvement Act of 1997 states that each Refuge shall be managed to fulfill the mission of the Refuge System: *"To administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans."* (Refuge Improvement Act; Public Law 105-57)

Enabling Legislation (Establishing Orders)

The enabling legislation is the legal authority by which the Refuge was initially established and lands acquired within the Refuge.

Montezuma NWR was established on September 12, 1938 with land initially acquired under Executive Order 7971.

Refuge Purposes

The National Wildlife Refuge Improvement Act of 1997 also states that each Refuge *"…shall be managed to fulfill…the specific purposes for which the Refuge was established…"* Purposes of a Refuge are those specified in or derived from the law, proclamation, executive order, agreement, public land order, donation document, or administrative memorandum establishing, authorizing, or expanding a Refuge, Refuge unit, or Refuge sub-unit.

The purpose of the Montezuma NWR acquisition was: "...as a Refuge and breeding ground for migratory birds and other wildlife..." For other lands acquired under the Migratory Bird Conservation Act (16 U.S.C. 715-715r), as amended, the purpose of acquisition was: "...for use as an inviolate sanctuary, or for any other management purpose, for migratory birds."

Links to Other Plans

Refuge Plans

Comprehensive Conservation Plan (CCP)
The 1997 National Wildlife Refuge Improvement Act requires all Refuges to complete Comprehensive Conservation Plans by 2012. A CCP is an all-encompassing document that guides all biological and public use actions on the Refuge for a 15-year period. Montezuma staff will begin preparing the CCP in 2009. The habitat goals and objectives in this HMP provide an important biological foundation for the CCP.

Fire Management Plan
Montezuma NWR completed a Fire Management Plan (FMP) in 1997 to guide all fire program activities on the Refuge (USFWS 1997). The FMP was subject to the National Environmental Policy Act (NEPA) and the National Historic Preservation Act (NHPA) and as such an environmental assessment accompanied the plan. Fish and Wildlife Service policy requires a FMP "for each Refuge that conducts prescribed burning or on which wildfire may occur." The highest priority of the Refuge's FMP is the protection of life, property, and natural resources from fire. Prescribed fire is also used as a habitat management tool to maintain grasslands.

Annual Habitat Work Plan
Each National Wildlife Refuge prepares an Annual Habitat Work Plan (AHWP) that includes a review of the habitat management activities from the previous year, an evaluation of monitoring programs, and recommendations for habitat management strategies and prescriptions for the coming year. The work plan

documents specific habitat and wildlife management strategies for a specific work year. It is an annual tool to implement and fulfill goals and objectives established in this Habitat Management Plan. The annual work plan incorporates adaptive management practices by evaluating success of specific management strategies and prescriptions on a yearly basis.

Grassland, Water, Forest, and Cropland Plans

Montezuma NWR developed individual habitat plans for grassland (1982), water (1987), forest (1987), and cropland (1996). The management goals, objectives, and strategies in these plans were reviewed, updated, and merged into this Habitat Management Plan.

Other Plans

The Refuge has developed several other “step-down” plans that at times have some bearing on habitat management. These include animal control (1982), trapping (1988), fishery management (1958), hunting (2002), fishing (1993), and disease prevention and control (1986).

Regional and State Plans and Partnerships

The Refuge will continue to work in concert with several State and regional partners in the conservation of our trust resources through the participatory development and implementation of the following plans and programs.

U.S. Fish and Wildlife Service Migratory Bird Program 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. Two strategies to achieve these goals are bird population monitoring and habitat management. Refuges provide high quality habitat for many migratory birds and are currently conducting biological surveys and managing habitat. The Montezuma Habitat Management Plan 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.

Montezuma Wetlands Complex and Montezuma Wetlands Research Institute

The Montezuma Wetlands Complex (MWC) Project is an effort by the U.S. Fish and Wildlife Service (USFWS), the New York State Department of Environmental Conservation (NYSDEC), and Ducks Unlimited, Inc. to protect, restore, and enhance wildlife habitat within the MWC. It encompasses approximately 50,000 acres in Seneca, Cayuga, and Wayne Counties and includes the Refuge, the State’s approximately 7,500-acre Northern Montezuma Wildlife Management Area (WMA), and lands owned by conservation groups, farmers, and other private landowners. The three MWC project partners developed a management plan in 2000 to guide their collective efforts (Ducks Unlimited, Inc. 2000).

State and federal agencies, conservation organizations, and academic institutions partnered to form the Montezuma Wetlands Research Institute to facilitate applied research on wetlands, grasslands, habitat restoration, and recreational use in the Montezuma Wetlands Complex.

North American Bird Conservation Initiative (NABCI)

This 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. It is intended to reduce redundancy in the structure, planning and implementation of conservation projects by using a common spatial language and ecological framework to identify priority habitats and sites shared among birds of different taxonomic groups. Bird Conservation Regions (BCRs) are used to guide landscape scale, science-based approaches to conserving birds and their habitats.

Montezuma NWR lies within BCR13, Lower Great Lakes/St. Lawrence Plain (http://www.nabci-us.org/bcr13.html). A draft BCR 13 conservation plan was used by the Refuge, in addition to information in the four individual bird plans listed below, to identify focal species and habitat management goals and objectives for the Refuge.

- Landbirds Lower Great Lakes
- Shorebirds Upper Mississippi Valley/Great Lakes Region
- Waterbirds Upper Mississippi Valley/Great Lakes Region
- Waterfowl UMR/GL JV Implementation Plan

National Audubon Society Important Bird Areas Program and New York Bird Conservation Areas
The Important Bird Areas (IBA) program is an international bird conservation initiative to identify the most important places for birds, and to conserve them. IBAs are identified according to standardized, scientific criteria through a collaborative effort among state, national, and international non-governmental conservation organizations, state and federal government agencies, local conservation groups, academics, grassroots environmentalists, and birders. IBAs link global and continental bird conservation priorities to local sites that provide critical habitat for native bird populations. New York's IBA program began in 1996 and has identified 136 IBAs including the Montezuma Wetlands Complex. This IBA is noted for its diversity of habitats, hosting one of the largest migratory concentrations of waterfowl in the northeast, as one of the most significant stopover and foraging locations for shorebirds in upstate New York, and as a site for many breeding at-risk species (http://ny.audubon.org/IBA_new.htm).

The New York State Department of Environmental Conservation (NYSDEC) established the Bird Conservation Area (BCA) Program in 1997 to safeguard and enhance bird populations and their habitats on State lands and waters. The BCA Program is modeled after the National Audubon Society's Important Bird Areas (IBA) program, which began in New York in 1996. The BCA Program applies criteria developed under the IBA program to state-owned properties. The Montezuma Wetlands Complex is a BCA. The major management recommendations for this BCA include protect existing and potential wildlife habitat, restore and enhance wetlands by restoring hydrology and controlling invasive species, establish grassland habitat, manage lands to support biodiversity, and monitor and protect unique, rare, threatened and endangered species and habitats (see http://www.dec.state.ny.us/website/dfwmr/wildlife/bca/mont_mgs.html#name). Given the juxtaposition of the state and federal lands within the large Montezuma Wetlands Complex, there are opportunities to work on similar management objectives.

New York Comprehensive Wildlife Conservation Strategy
In Fall 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 was charged with developing a Comprehensive Wildlife Conservation Plan or Strategy by October 2005. State fish and wildlife agencies evaluated which species and habitats are in greatest need of conservation (SGNC) while also addressing the full array of wildlife. The New York CWCS is available at http://www.dec.state.ny.us/website/dfwmr/swg/cwcs2005.html.

The NY State Department of Conservation prepared the Plan and organized the conservation recommendations within eleven watershed basins (NYSDEC 2005). New York evaluated their state by watershed basins. Montezuma NWR is within the Southeast Lake Ontario Basin (NYSDEC 2005). This analysis was helpful in the HMP development, particularly for the non-bird taxa, including mammals, fish, reptiles, amphibians, and invertebrates. The CWCS provides pertinent natural resource information on historical and current conditions for the region of the Montezuma NWR. The list of SGNC was included in the Refuge's comprehensive list of resources of concern (see Chapter 3).

Chapter 2 Background

This Chapter includes the following sections:

- **Location and General Description**
- **Landscape Setting**
- **The Historical Picture**
- **Refuge Resources – Current Condition**

Location and General Description

Montezuma National Wildlife Refuge lies at the north end of Cayuga Lake in the heart of the Finger Lakes Region of New York State. The Refuge is 35 miles west of Syracuse, 40 miles north of Ithaca, and 45 miles east of Rochester. The Refuge is 5 miles (8 km) east of Seneca Falls, in Seneca, Cayuga, and Wayne Counties (Map 1-1).

The Refuge headquarters is located on State Route 5 and U.S. Route 20, near the Menard Memorial Bridge over the Cayuga-Seneca Canal. The Refuge is bordered on the south by segments of the New York State Barge Canal system. The western boundary is irregular, following segments of New York State Route 89, Gravel Road, and East Tyre Road. U.S. Routes 5 and 20, NYS Route 89, the New York State Thruway (I-90), and segments of the New York State Barge Canal system pass through the interior of the Refuge.

Although established primarily for migratory waterfowl, the Refuge's mix of wooded wetlands, emergent marsh, and mixed successional stages of upland vegetation provides habitats for a diversity of wildlife species. The Refuge has 16 manageable impoundments totaling over 4,700 acres of freshwater wetland habitat. Impoundment water levels are managed within and between years in an attempt to mimic natural wetland hydroperiods and provide the best possible wildlife habitat for objective wetland species (USFWS 2005).

Most of the upland habitat on Montezuma is currently maintained in an early successional condition (grassland or shrub fields) through active management. These units are maintained through a variety of management techniques including mowing, burning, disking, planting, hydro-axing, and chemical treatment (USFWS 2005).

The National Audubon Society identified the Montezuma Wetlands Complex (see description below), of which the Refuge is a part, as an Important Bird Area (IBA). The Complex was recognized for supporting one of the largest migratory concentrations of waterfowl in the Northeast and as significant stopover site for migrating shorebirds in upstate New York. Many species of conservation concern breed within the Complex, including pied-billed grebe, American bittern, least bittern, black tern, bald eagle, northern harrier, Cooper's hawk, sedge wren, and cerulean warbler. In addition, the site hosts one of the largest Fall swallow concentrations in the State, estimated at 50,000-100,000 individuals. In 2003 and 2004, the

Complex supported the first breeding pair of sandhill cranes in the State (http://iba.audubon.org/iba/viewState.do?state=US-NY).

The Refuge is open daily to visitors and offers several wildlife viewing opportunities along a 4-mile wildlife drive, at several observation towers, and on several nature trails. The Visitor Center is open from April 1 to November 30. More than 150,000 people visit the Refuge each year.

Landscape Setting

Biophysical Region

The physical environment, expressed through climate, geology, topography or landform, and soils, explains much about the patterns and distribution of biological diversity. These patterns describe natural divisions, called biophysical regions or ecoregions, that inform our efforts to understand, conserve, and manage wildlife and other biodiversity. Ecoregions are relatively large geographic areas of land and water defined by common climate, geology and vegetation patterns. The Nature Conservancy (TNC) classified New York into seven ecoregions. Montezuma NWR is in the Great Lakes Plain Ecoregion, a region formed during the last glacial advance and characterized by gently rolling, low level landscapes and flat lake plains (NYSDEC 2005).

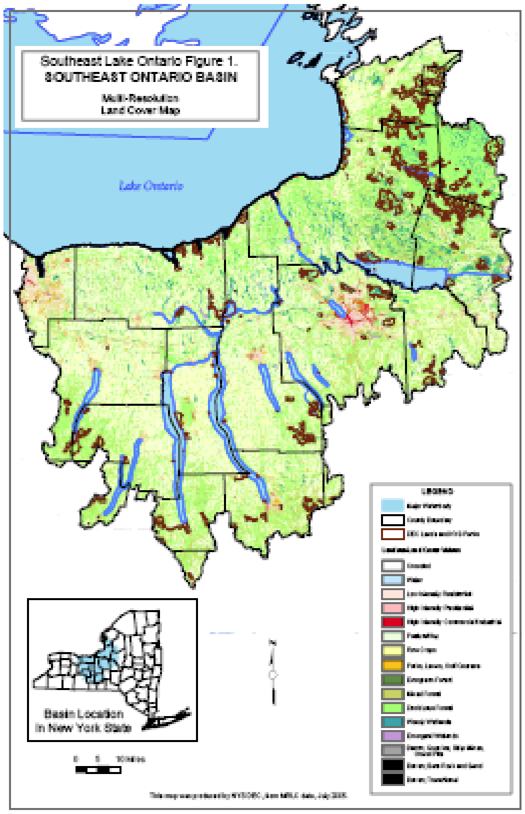
Great Lakes Watershed

Montezuma NWR is in the southeastern corner of the 290,000 square-mile Great Lakes watershed, the largest freshwater ecosystem in the world. The watershed includes all tributary streams and inland lakes that are hydrologically connected to the five Great Lakes: Superior, Michigan, Huron, Erie and Ontario. Together these lakes hold 20% of the world's supply of surface freshwater and 95% of the U.S. supply. The climate and hydrology of the Great Lakes create unique environmental conditions that support a diversity of species and communities. The glacial and cultural history also has greatly influenced the presence and distribution of biodiversity in this region (TNC 2000).

The Nature Conservancy (TNC) identified several pressures on the biodiversity in the Great Lakes ecoregion: development, exotic/invasive species, hydrologic alterations, incompatible forestry and agricultural practices, and resource extraction (TNC 2003). Urban, residential, second home, and road construction are causing loss, degradation, and fragmentation of critical habitat. Purple loosestrife, reed canary grass, common reed, swallow-wort, garlic mustard, buckthorn, and zebra mussel are some of the invasive species negatively impacting the Great Lakes region. Dams, diversions, dikes, groundwater withdrawals, and other changes affect the natural flow regime of aquatic systems (TNC 2000).

Southeast Lake Ontario Basin

The New York State Comprehensive Wildlife Conservation Strategy (CWCS) identified conservation priorities within the major watershed basins of the State (NYSDEC 2005). The watershed basin boundaries are taken from the U.S. Geological Survey (USGS) 4-digit Hydrologic Unit Codes. Montezuma is within the Southeast Lake Ontario Basin (SELO Basin) (Map 2-1). The SELO Basin covers 4.3 million acres (all or part of 19 Counties) in west central New York from Rochester east to the



Map 2-1 Southeast Lake Ontario Basin (NYSDEC 2005).

mouth of Stony Creek and south encompassing the Finger Lakes. The Refuge is within an area of broad, flat wetland basins at the north and south ends of "finger lakes," interspersed with, oval-shaped hills (drumlins) left by the glaciers.

NYSDEC (2005) identified 129 species of greatest conservation need (SGCN) that currently occur in the Basin and another 49 species that historically occurred in the Basin but are now believed to be extirpated. Of the 129 SGCN the State believes that populations of 43 species are decreasing, 11 are increasing, 8 are stable, and 67 are of unknown status. The SELO Basin supports several important habitat types including the emergent marshes, riparian forests, and grasslands on and around Montezuma NWR (NYSDEC 2005).

Montezuma Wetlands Complex

The Montezuma NWR (9,008 acres), Northern Montezuma Wildlife Management Area (~8,000 acres), and other conservation lands and private ownerships comprise the 50,000-acre Montezuma Wetlands Complex (MWC) (Map 2-2). The entire MWC is located in what was historically called the Montezuma Swamp. This vast area extended northward from Cayuga Lake almost to Lake Ontario. In the 19th century, most of this swamp was effectively drained for commerce and transportation by the development of the Erie Canal, the New York State Barge Canal, and the dam at the north end of Cayuga Lake. Draining the area made it possible to clear and farm the rich organic soils that under laid the marsh. Crop farming of potatoes, onions, and other root crops became a major part of the local economy (Montezuma Upland Management Plan, undated).

Prior to the 1970s wetlands were drained and filled as a regular practice across the United States; New York lost 60% of its original wetlands. The Montezuma Wetlands Complex (MWC) was once one of the largest wetland complexes in the Northeast, supporting over 40,000 acres of contiguous wetland habitat. Despite the loss of 70% of its original wetland the MWC still provides habitat for hundreds of wildlife species and is a major migration stop for waterfowl and shorebirds in the Atlantic Flyway. The MWC presents one of the best opportunities in the Northeast to protect, restore, and manage extensive wetlands. The MWC was New York's flagship project in the Atlantic Coast Joint Venture after the adoption of the North American Waterfowl Management Plan (Ducks Unlimted, Inc. 2000).

In 1991, the U. S. Fish and Wildlife Service and the NYS Department of Environmental Conservation completed a final environmental impact statement for a project known as the "Northern Montezuma Wetlands Project" to protect and manage fish and wildlife resources in the Montezuma Wetlands Complex (Wich and Lambertson 1991). The project area is irregularly shaped, roughly following the 390-foot topographic contour and encompassing 50,000 acres with multiple landowners. The project area includes wetlands, former wetlands, and adjacent upland areas north of Cayuga Lake, extending up Black Creek, Crusoe Creek, Butler Creek, Clyde River and Seneca River drainages.

Western Oswego River Watershed

The MWC is a part of the 5,100-square mile Western Oswego River Watershed that largely drains into Lake Ontario. The primary surface-water is the easterly flowing New York State Barge Canal, located mostly within the former natural channels of the Clyde and Seneca Rivers. The MWC encompasses a 17.5-mile segment of the main canal. Other waterways include Black, Crusoe, and White Creeks.

Bird Conservation Region

Montezuma NWR lies within Bird Conservation Region (BCR) 13, the Lower Great Lakes/St. Lawrence Plain (Map 2-3). BCR 13 encompasses the vast, low-lying lake plain region surrounding Lakes Erie and Ontario, the St. Lawrence River valley, low-lying regions between the Adirondack Mountains and the Laurentian Highlands, and upper regions of the Hudson River valley. In addition to important lakeshore habitats and associated wetlands, this region was originally covered with a mixture of oak-hickory, northern hardwood, and mixed-coniferous forests. Although once dominated by forests, the landscape is now dominated by agriculture with interspersed wetlands and remnant forest stands. Today, nearly 95% of the original habitat types have been lost to agriculture and urban development. The BCR plays a critical role in providing important staging and migrating habitat for birds during the spring and fall migration. In addition, over 17% of the global population of bobolinks nests in the St. Lawrence Valley of northern New York (Hartley 2007).

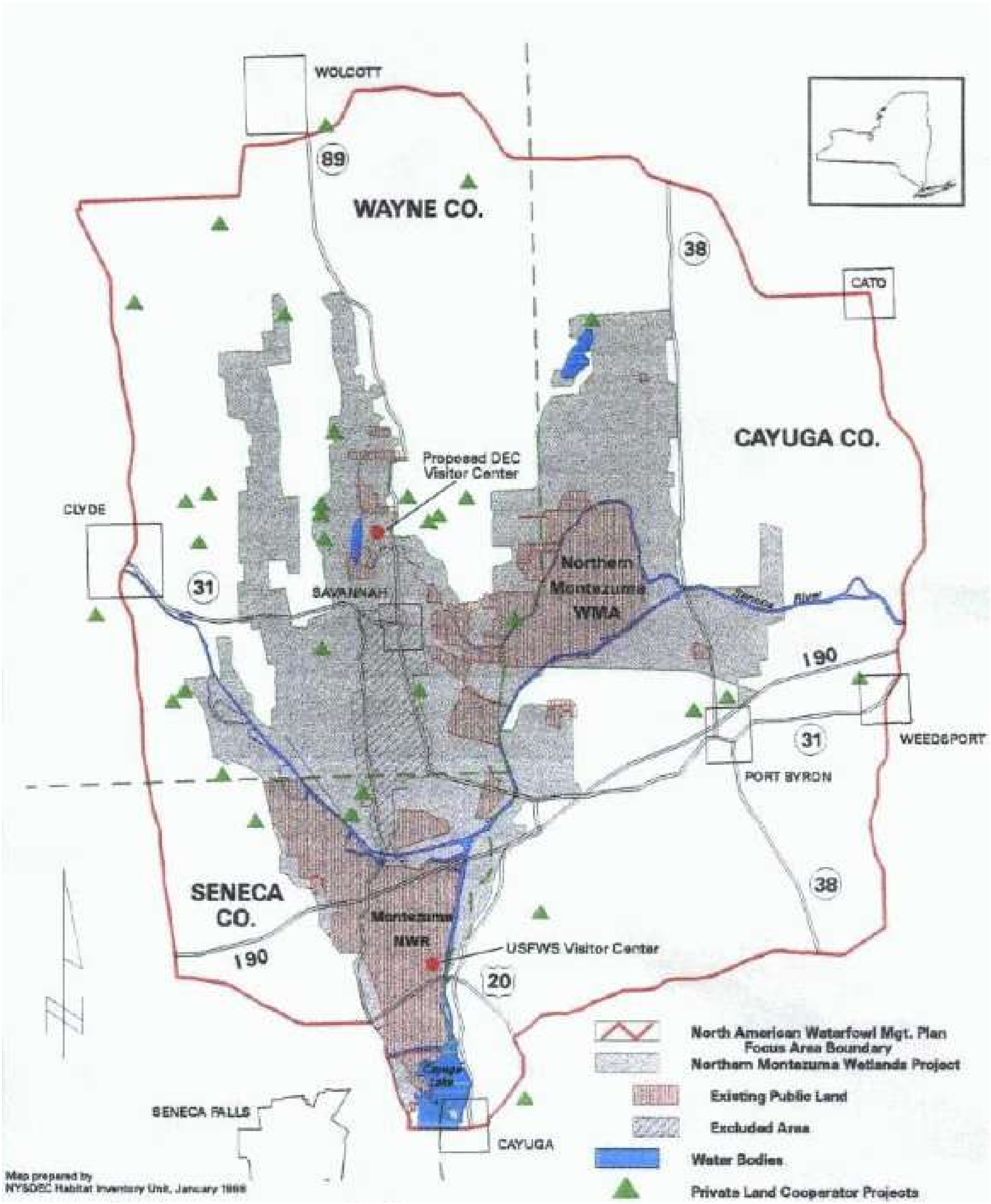
Regional Conservation Lands and Land Use Patterns

The Refuge lies within PIF Area 15, the Lower Great Lakes Plain, which covers the low-lying areas to the south of Lake Ontario in New York and to the north of Lake Erie in southernmost Ontario in Canada. Unlike in most physiographic areas in the Northeast U.S., roughly 74% of the land area in PIF Area 15 is in agricultural production (Dettmers and Rosenberg 2003).

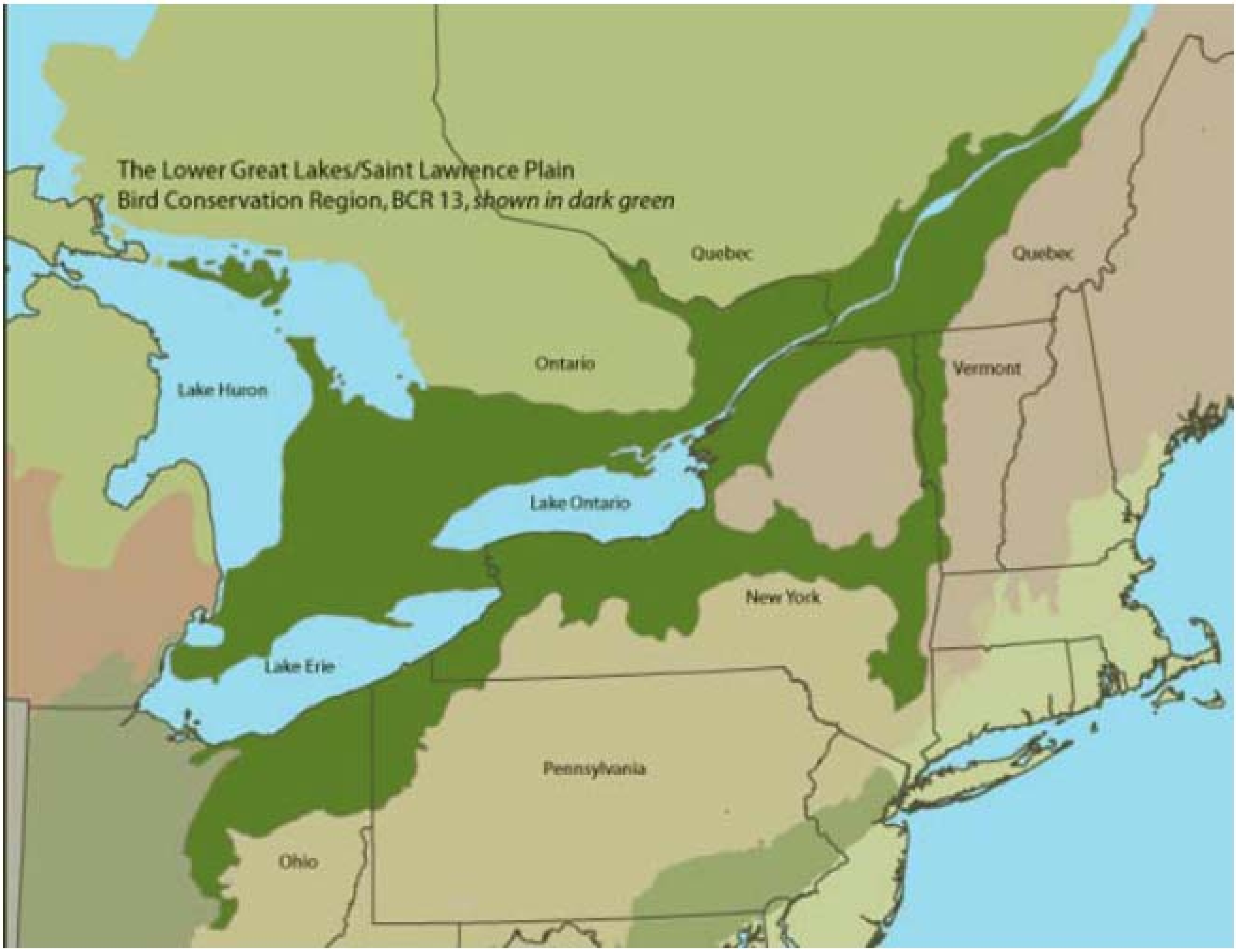
Within PIF Area 15, the Refuge is in the Southeast Lake Ontario (SELO) Basin. According to the U.S. Environmental Protection Agency's land classification, 50% of the Southeast Lake Ontario Basin is forested. The rest of the land area is dominated by agriculture, 24% in row crops and 16% in hay or pasture (Table 2-1). Forty-five percent of the 1.7 million people that live in the SELO Basin are in and around Syracuse. The population of the Basin is expected to continue to decline (NYSDEC 2005).

Table 2-1 Land Cover within the Southeast Lake Ontario Basin of New York (NYSDEC 2005).

Land Cover Classification	**%Cover**
Deciduous Forest	34.17
Row Crops	24.38
Pasture/Hay	15.53
Mixed Forest	11.01
Water	5.01
Wooded Wetlands	3.17
Low Intensity Residential	2.57
Evergreen Forest	1.32
Parks, Lawns, Golf Courses	1.07
High Intensity Commercial/Industrial	0.79
High Intensity Residential	0.60
Emergent Wetlands	0.24
Barren; Quarries, Strip Mines, Gravel Pits	0.11



Map 2-2 Montezuma Wetlands Complex



Map 2-3 BCR 13 (shown in dark green). Adjacent BCRs shown in other colors (Hartley 2007)

Much of the lands in and around the Montezuma Wetlands Complex are in private ownership dominated by muck farms. The major crops are corn, potatoes, onions, beans, wheat, and hay. Muck is the organic soil from drained swamplands, exposed across large areas when the canals were created during the height of agriculture in the 1800-1900s. Muck farming was an important part of farming in New York and other States. Onions, potatoes, celery, and carrots grow especially well on these soils. Maintaining mucklands in agriculture is difficult, requiring constant drainage and wind barriers, as the rich muck soils are extremely susceptible to erosion from wind (as muck becomes wind borne when dry). In addition, oxidation of the rich organic material and subsidence have substantially reduced the topsoil depth and hence lowered the fertility. On much of the muck, corn has become the primary crop because it does not require deep rich soils. Given the nature of past muck farming practices, high levels of pesticide residues are typically found on these sites (Ducks Unlimited, Inc. 2000).

The agricultural land uses surrounding the MWC contribute runoff to the wetlands. However, the function and value of some of these reverted wetlands may have lower wetland quality if invasive plants become established or concentrations of agricultural chemicals are left undetected. The opportunity for restoring abandoned or marginal agricultural lands to high quality wetlands is great in this region (ACJV Focus Area Report).

Wetlands comprise the next largest land cover in the area, after farmland, and forested wetlands are the most common type (ACJV Focus Area Report). Forested wetlands are dominated by red maple (*Acer rubrum*), silver maple (*Acer saccharinum*), green ash (*Fraxinus pennsylvanica*) and swamp white oak (*Quercus bicolor*). Understory vegetation includes spicebush (*Lindera benzoin*), winterberry (*Ilex verticillata*), sensitive fern (*Onoclea sensibilis*), skunk cabbage (*Symplocarpus foetidus*) and arrow arum (*Peltandra virginica*). Non-forested wetlands are dominated by cattail (*Typha* spp.), purple loosestrife (*Lythrum salicaria*), swamp loosestrife (*Decodon verticillatus*) and sedges and rushes (*Cyperus* spp., *Carex* spp., *Eleocharis* spp., *Juncus* spp.). Other less common wetlands include inland salt marshes and non-vegetated mudflats.

Most of the uplands surrounding the Refuge are forested. These forests are characterized primarily by sugar maple (*Acer saccharum*), red maple, basswood (*Tilia americana*) and oak species (*Quercus* spp.), and to a lesser extent, pines (*Pinus* spp.), spruces (*Picea* spp.) and eastern hemlock (*Tsuga canadensis*). Grassland habitats are comprised of cool and warm season grasses and various forbes. Cool season grasslands are dominated by timothy (*Phleum pratense*), brome-grass (*Bromus inermis*), orchard grass (*Dactylis glomerata*), redtop (*Agrostis gigantea*) and birds-foot trefoil (*Lotus corniculatus*). Warm season grasslands typically include switchgrass (*Panicum* spp.), big bluestem (*Andropogaon gerardii*), little bluestem (*A. scoparium*), Sideoats grama (*Bouteloua curtipendula*) and indiangrass (*Sorghastrum nutans*).

Open water surrounding the Refuge consists of lakes, ponds, rivers, canals and streams that do not show emergent vegetation. Floating and submerged aquatic vegetation species may include duckweed (*Lemna trisulca*), *coontail* (*Ceratophyllum demersum*), waterweed (*Elodea canadensis*), water naiad (*Najus flexilis*), and pondweeds (*Potamogeton* spp.).

Climate

The location and size of each lake, air masses from other regions, and the location within a large continental landmass affect the weather in the Great Lakes watershed. Each of the Great Lakes acts as a heat sink, absorbing heat when the air is warm and releasing it when the air is cold. This results in more moderate temperatures at nearshore areas than other locations at similar latitudes. The influence of external air masses varies seasonally. In the summer, the region is influenced mainly by warm humid air from the Gulf of Mexico, whereas in winter the weather is influenced more by Arctic and Pacific air masses (USEPA and Government of Canada 1995).

Lake Ontario provides the source of significant winter precipitation. The lake is very deep and almost never freezes. Cold air flowing over the lake is quickly saturated and produces the cloudiness and "lake effect" snow squalls that are well-known features of winter weather in the vicinity of the Refuge. Snowfall is moderately heavy, with an annual average of approximately 66 inches. Wind velocities are moderate, but during winter months there are numerous days with sufficient winds to cause severe blowing and drifting of snow. The Montezuma area is generally cold and snowy in winter with an average temperature of 27 degrees F and an average low of 19 degrees F. Summers are generally warm with an average temperature of 67 degrees F and an average high of 80 degrees F. Average annual precipitation is 36 inches and is well distributed during the year (Ducks Unlimited, Inc 2000).

Climate Change

There is consensus among the scientific community that global climate change, occurring in part as a result of emissions of carbon dioxide and other greenhouse gases from human activities, will lead to significant impacts across the U.S. This includes sea-level rise, which will add stress to coastal communities and ecosystems (Wigley 2004). The effect of climate change on wildlife and habitats is expected to be variable and species specific, with a predicted general trend of ranges shifting northward. Uncertainty about the future effects of climate change requires Refuge managers to use adaptive management (e.g., adjusting regulations, shifts in active habitat management, or changing management objectives) to maintain healthy ecosystems in light of unpredictability (Inkley et al. 2004). Refuge managers can plan and respond to changing climate conditions. A few recommendations include managing for diverse and extreme weather conditions (e.g., drought and flood); maintaining healthy, connected, genetically diverse wildlife populations; protecting coastal wetlands to accommodate sea level rise (see Inkley et al. 2004 for more recommendations).

The Historical Picture

Glaciation

The Earth has experienced several glacial periods; the last, known as the Pleistocene Ice Age, began about 2 million years ago. Glaciers advanced and retreated over time as temperatures fluctuated. The most recent period to affect portions of New York was the Wisconsin Glaciation. A one-mile thick sheet of ice, known as the Laurentide Ice Sheet, covered the region until its retreat northward, gone from northern New York by about 10,000 years ago (Smith 1985). As the glacier retreated it left behind piles or layers of sediments, rocks, and other debris, known as glacial drift. These surficial deposits over bedrock come in two types: glacial till and glacio-fluvial. Glacial till is a mixture of sand, silt, clay, and rock ground up by the glacier and dropped as it retreated. It covers most of this region. Glacio-fluvial drift develops from the transport, sorting, and deposit of material by flowing glacial meltwater. Larger gravels and stones settle out at higher gradients, while finer silts, sands, and clays settle out at as the waters slow at valley bottoms (Sperduto and Nichols 2004).

In the Finger Lakes Region of New York the receding glacier left behind a series of long finger-like lakes that in time developed into extensive marshes at their shallower northern and southern ends. At the north end of Cayuga Lake, on the old bed of one of these ancient lakes, a large system of marshes developed through which the Seneca and Clyde Rivers meandered. The extensive wetlands covered an area of over 80 square miles in a northerly direction from the head of Cayuga Lake almost to Lake Ontario.

Native People

Native people have lived along the shores of the Great Lakes for over 10,000 years, fishing, raising crops, and using rivers for transportation (EPA 1998). First the Algonquin Indians and later the Cayugas of the Iroquois Nation were the earliest known inhabitants of this area.

European Settlement

The name "Montezuma" was first used in 1806 when Dr. Peter Clark named his hilltop home "Montezuma" after the palace of the Aztec Emperor Montezuma in Mexico City. Eventually the Marsh, the Village, and the Refuge all acquired the name.

Europeans did not extensively settle the New York portion of the Lower Great Lakes Plain until after the American Revolution. Settlers discovered large areas of potentially productive farmland. Clearing of the pre-settlement forests for farming and fuelwood occurred in the early to mid 1800s. By the end of the 19th century, less than 20% of the original forest remained in many of the landscapes within this region (Zipperer et al. 1990). In many portions of southern Ontario and northwestern New York, forest cover remains very low (< 25%) today with agriculture or urban areas dominating the landscape (Dettmers and Rosenberg 2003).

Forest cover began to recover in the early 1900s as farms were abandoned. Also similar to forest cover, wetland cover has increased during the past 100 years in some portions of the planning area where agricultural land uses have declined. Thibault and Zipperer (1994) found that 50% of the wetlands that existed in 1964 were new compared to 1926, and another 32% of wetlands were new in 1988. These increasing amounts of forest and wetland cover in some portions of the Lower Great Lakes Plain are a result of the poorer agricultural value of the land and the resulting farm abandonment. A general shift away from intensive farming to more hobby farming and more urban/suburban land uses also contributed to these changes in land cover (Dettmers and Rosenberg 2003).

The New York State Barge Canal

The New York State Barge Canal that runs along the northern border of Montezuma NWR is a successor to the Erie Canal and other canals within New York. The 525-mile Barge Canal system includes the Erie, Oswego, Cayuga-Seneca, and Champlain Canals. The Cayuga-Seneca Canal connects Seneca and Cayuga Lakes to the Erie Canal and forms the eastern border of the Refuge. The Barge Canal was built as an improvement of the old Erie Canal system, beginning in 1905 and completed in 1918. The canals are used for commercial transport, but they are popular for recreational boating and are of historical interest (Wikipedia 2005).

There were no dramatic changes in the Montezuma marsh complex until the development of the Erie Canal in the 19th century. The Erie Canal, first proposed in 1808 was completed in 1825, linking the Hudson River in the east to Lake Erie in the west. The canal included 83 locks with a rise of 568 feet from the Hudson River to Lake Erie. A 10-foot wide towpath was built along the bank of the canal for horses, mules, oxen and their drivers. The Erie Canal was enlarged between 1836 and 1862 to handle larger boats and more traffic (Whitford 1905).

The original Erie Canal did not greatly affect the marshes because there was no dam at the north end of Cayuga Lake and the Seneca River still flowed directly from the Cayuga Lake into the marshes. Construction of the Seneca-Cayuga Canal began in 1818 and by 1828 boats passed from Geneva to the Erie Canal at Montezuma. In 1910, the reconstruction of the Seneca and Cayuga extension of the New York State Barge Canal altered the marshes. A lock was built at the north end of Cayuga Lake and a dam was constructed at the outlet of the lake. The canal was moved into the Seneca and Clyde Rivers, which were straightened and deepened, thus functioning as huge drainage ditches. These actions effectively lowered the level of the Montezuma marshes by eight to ten feet (about 3 meters) and the waters drained from the marshes. (Montezuma NWR unpublished data).

Refuge Resources – Current Condition

Topography and Hydrology

Post-glacial geologic features dominate the landscape surrounding the Refuge. The topography is represented by formations such as drumlins, eskers, kames, and kettles, and is gently sloping to rolling. The Refuge lies over an old, flat lakebed at the northern end of the Cayuga Lake Basin. The broad, flat basins are interrupted by classic drumlin formations, oblong hills of 60-150 feet high with a north-south orientation resulting from glacial deposits. The flat basins below the 390-foot contours are the location of the existing and historical Montezuma Marshes (Ducks Unlimited, Inc. 2000).

The Refuge receives water from direct precipitation, run-off from the hilly areas bordering the west side of the Refuge, three streams originating to the west of the Refuge, and several springs within Refuge boundaries. Two streams, Black Brook and White Brook, flow directly into Tschache Pool. Black Brook is the major contributor with a drainage area of 12,580 acres (5091 ha). White Brook has a drainage area of 5,760 acres (2331 ha). Esker Brook, with a drainage area of 2,090 acres (846 ha), flows into North Spring Pool (Montezuma Upland Habitat Management Plan, undated)

Surface water concerns include water quality, flood flows generated by the operation of the Barge Canal and surface-water supply for current and future wetland impoundments. Ground water resources in the MWC are located in the consolidated (bedrock) and unconsolidated glacial deposits. Nearly all the ground water in this area is derived from precipitation that is absorbed by the mantle of surficial deposits. Unconsolidated sand and gravel deposits produce the best yield of water for wells in the region. Overall, hydrological data for the MWC is lacking, and more detailed information is needed (Ducks Unlimited, Inc. 2000).

Soils

The Refuge region is generally underlain by a combination of limestone and limestone/shale bedrock. These calcareous rocks result in the highly productive glacial till found throughout the Montezuma wetlands area. Three major soil groups are found within the Montezuma Wetlands Complex. The largest group is comprised of various types of muck (lake bottom and marsh organic materials) occurring at or below the 380-foot contour interval. The Ontario soil association in the drumlin zones and the Odessa-Schoharie Fulton-Lucal association found in the southwestern corner of the MWC characterize the remaining area (Ducks Unlimited, Inc 2000).

A soil profile of the Refuge wetlands would reveal an upper layer of deep Carlisle muck and sedimentary peat over a Chara and shell marl. The subsoil in this area of the old lake basin is compact blue clay. The upland soils are derived from calcareous glacial till. The well-drained sandy loams include pockets of Palmyra gravelly loam, Ontario loam, Poygan silty clay loam, Schoharie silty clay loam, and Wayland silty loam (USDA Soil Conservation Service and Cornell University Agricultural Experiment Station 1972). Table 2-2 includes the typical soils for the Refuge.

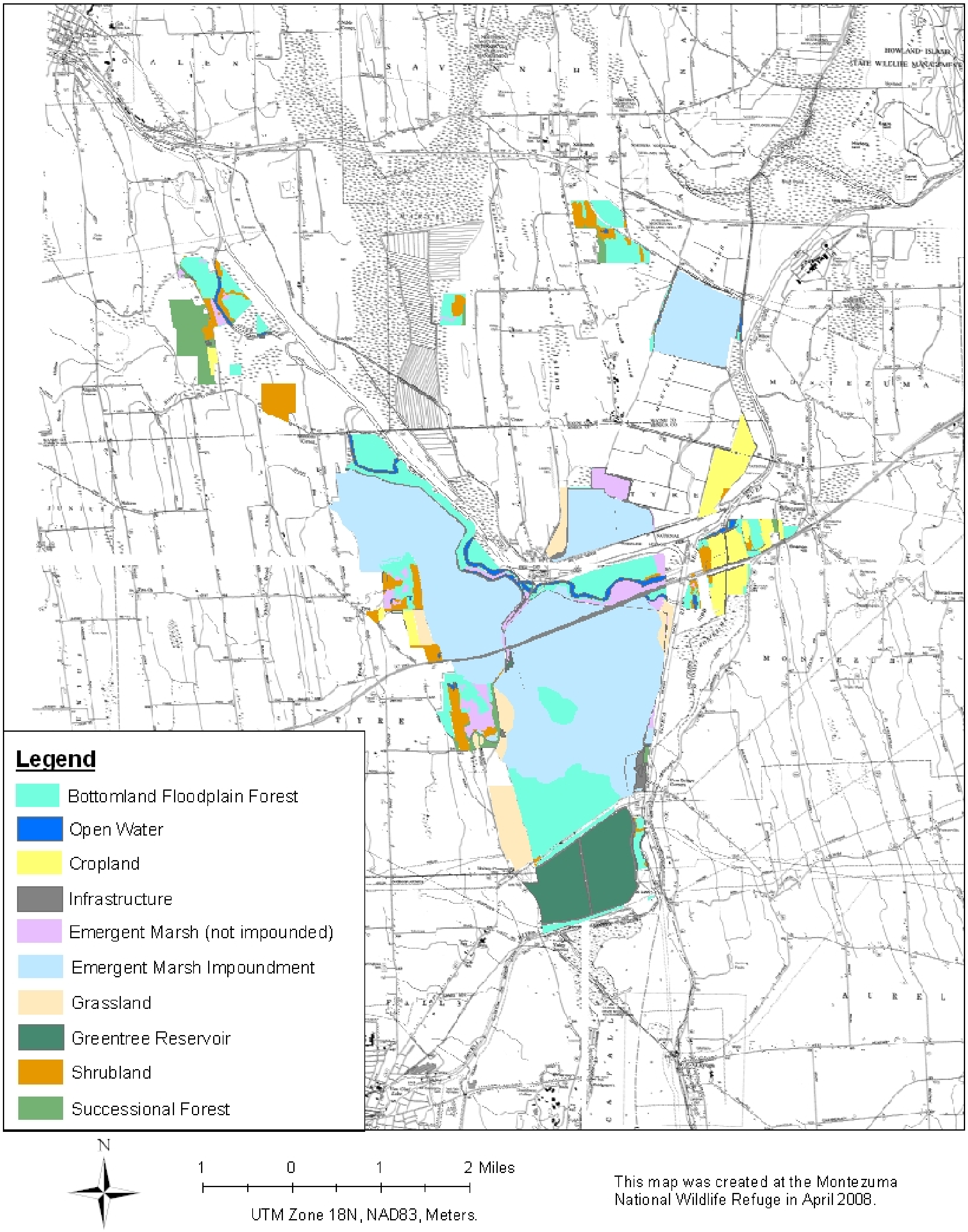
Table 2-2. Soil Types on Montezuma NWR (USDA Soil Conservation Service and Cornell University Agricultural Experiment Station 1972).

Soil Symbol	Soil Name	Description
CeB	Cazenovia silt loam (3 to 8% slopes)	moderately well drained and well drained, medium textured and moderately fine textured soils that formed in glacial till having a high content of clayey shale and in calcareous glacial till in which a deposit of lacustrine clay has been incorporated
CIA	Collamer silt loam (0 to 2% slopes)	moderately well drained, medium textured soils that formed in lacustrine deposits of alkaline or calcareous silt or very fine sand that is high in content of silt
Ed	Edwards muck (level or nearly level)	organic soils that formed in mixed woody, grassy or sedgy material underlain by white to light gray calcareous marl at a depth of 10 to 40 inches
Fn	Fonda mucky silty clay loam (level or depressional)	very poorly drained, moderately fine textured soils that developed in lacustrine deposits of gray, brown, or reddish, calcareous clay containing occasional bands of silt and very fine sand
LcA	Lakemont silty clay loam (0 to 2% slopes)	poorly drained, moderately fine textured soils that formed in calcareous, reddish, lacustrine clay and silty clay
LtB	Lima silt loam (3 to 8% slopes)	deep, moderately well drained soils that formed in strongly calcareous, medium textured glacial till
Ma	Madalin and Odessa silty clay loam (level or depressional)	deep, poorly drained soils that formed in calcareous, gray and brown clay and silty clay in glacial lakes
Md	Made land, tillable	areas in which the original soil has been moved or disturbed, and the original surface layer and subsoil are not evident. Most areas consist of material that was dredged during the straightening and deepening of the Barge Canal
Mr	Muck, deep (0 to 1% slopes)	organic soil formed in a mixture of wood, grass, or sedgy material; strongly acid to alkaline; the organic layer ranges from 40 inches to as much as 17 feet in depth. The organic layer is underlain by mineral soil material or by white, highly calcareous marl.
Ms	Muck, shallow (0 to 2% slopes)	organic soil formed in a mixture of wood, grass, or sedgy material; strongly acid to alkaline; the organic layer ranges from 10 to 40 inches in depth.
OdA	Odessa silt loam (0 to 2%slopes)	deep, somewhat poorly drained soils that formed in calcareous, reddish, lacustrine clay and silt.
OnB	Ontario loam (2 to 8% slopes)	deep, medium textured, well drained soils that formed in strongly calcareous, firm glacial till. The

		glacial till is derived mainly from sandstone, limestone, and some shale, and contains sufficient red sandstone or red shale to impart a reddish hue.
OnC	Ontario loam (8 to 15% slopes, eroded)	commonly occurs in long, narrow strips on the sides or tops of drumlins. 75% of most areas are so eroded that the surface layer consists partly of material from the subsoil
OnD	Ontario loam (15 to 28% slopes, eroded)	typical for the Ontario series but is generally thinner over calcareous till. These soils typically occur on the sides of drumlins. Most of the slopes are single, although a few are hilly and complex.
OvA and OvB	Ovid silt loam (0 to 3% slopes and 3 to 8% slopes)	deep, somewhat poorly drained soils that have a moderately fine textured subsoil. These soils formed in reddish glacial till derived from mixed limestone and red alkaline or calcareous clay shale or from appreciable amounts of reworked red lacustrine clay mixed with limestone and shale.
SeB	Schoharie silt loam (2 to 6% slopes)	deep, moderately well drained and well drained soils derived from calcareous reddish clay and silt. The surface layer is commonly silt loam, but there are a few small areas of very fine sandy loam.
Sn	Sloan silt loam (level or depressional)	deep, poorly drained and very poorly drained, medium textured and moderately fine textured soils that form in slightly acid to mildly alkaline, recent alluvium. These soils typically have little or no structure.

Habitat Types

Map 2-4 shows the habitat types on the Montezuma National Wildlife Refuge. They also are listed in Table 2-3.



Map 2-4 Habitats on Montezuma NWR.

Table 2-3 Habitats on Montezuma NWR.

Habitat Type	Percent
Freshwater Impoundments Open Water/Emergent Marsh/Mudflats (4,131) Greentree (618)	4,749
Bottomland Floodplain Forest	1,646
Early successional (old fields to thickets, includes uplands and wetlands)	444
Cropland	510
Grassland	369
Successional Forest	262
Emergent Marsh/Mudflats (not impounded)	312
Canals/Rivers/Ditches/Ponds	157
Infrastructure (dikes, facilities, trails, etc.)	313

Montezuma NWR is approximately 59% wetland, 39% upland, and 2% open water. Much of the open water is ditches and canals, mostly constructed to drain mucklands and provide recreational boating. These are threaded throughout the Montezuma Wetlands Complex. As the Refuge and other organizations acquire lands, the system of dikes is used to re-flood former farmland to create wetland habitats. Cowardin (1965) compiled an annotated list of vascular plants on the Refuge. He notes in his introduction that the most important plant communities on the Refuge are bottomland hardwood forests and cattail marsh.

Wetlands

New York has approximately 2.4 million acres of wetlands (as of the mid 1990s). The Lake Plains and the Adirondacks are the wettest portions, encompassing 74% of the State. The New York State Department of Conservation estimated the percent wetland type in the Lake Plains region as forested—75.4%, scrub-shrub—14.2%, emergent marsh—7.9%, and open water wetland—3.3% (NYSDEC website: http://www.dec.state.ny.us/website/dfwmr/habitat/fwwprog3.htm).

The three major wetland types at Montezuma NWR, as classified according to Cowardin et al.(1979), are Aquatic Bed, Emergent Wetland, and Forested Wetland. Aquatic Bed refers to wetlands and deepwater habitats dominated by plants that grow principally on or below the water surface including white water lily, coontail, bladderwort, sago pondweed, duckweed, and several additional species of pondweed. Emergent Wetland is characterized by erect rooted herbaceous hydrophytes and typically occurs in calmer more shallow water. Dominant emergent vegetation includes cattail (*Typha* spp.) and *Phragmites*. Bulrush was once a significant component of the emergent plant community but now occurs only as isolated clumps and in small sparse stands (USFWS upland mgmt plan). The ratio of Aquatic Bed to Emergent Wetland on the refuge is dependent on water level management in refuge impoundments.

Impounded Wetlands

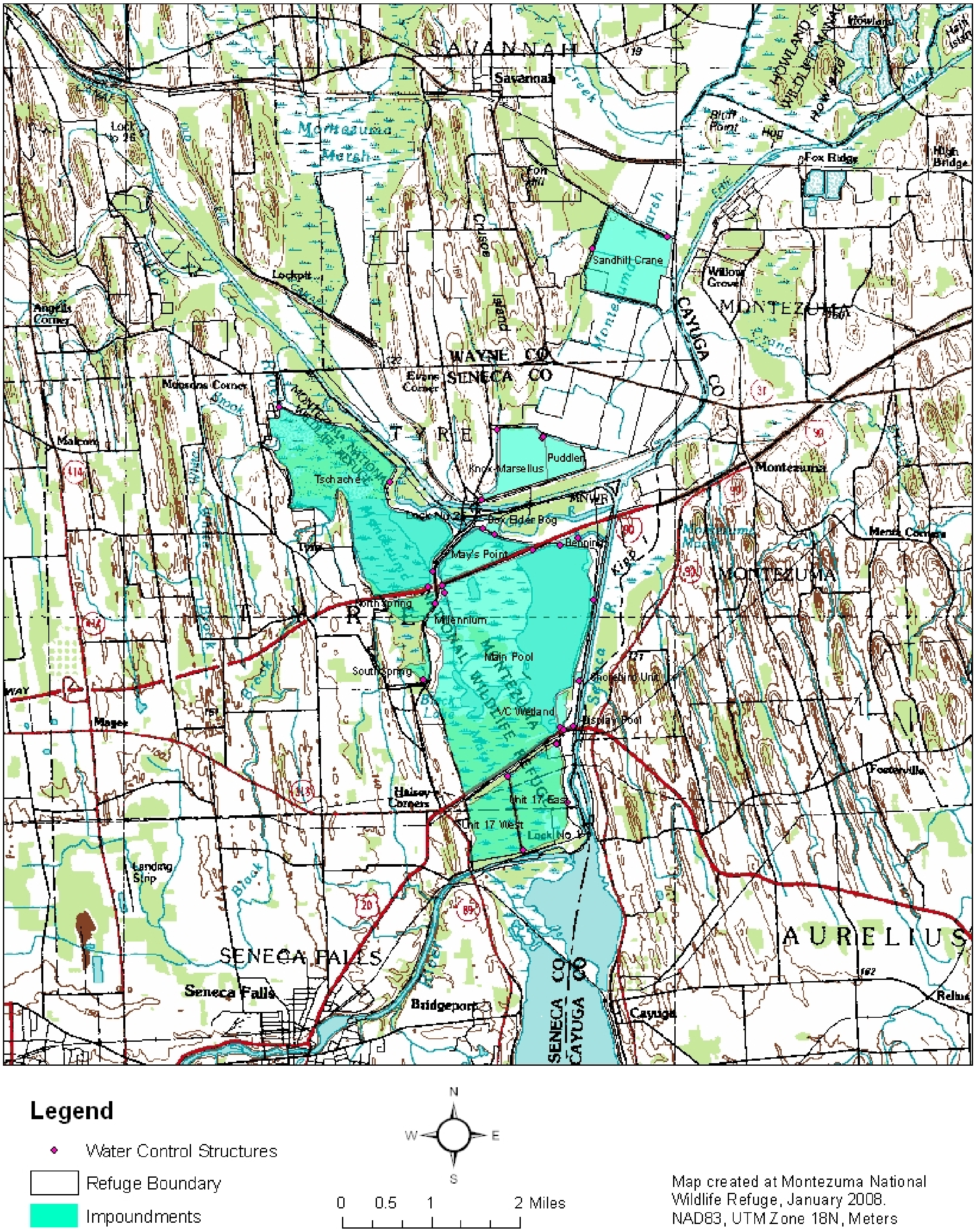
In the 1930s, in an effort to restore wetlands, the U.S. Bureau of Biological Survey (the precursor to the U.S. Fish and Wildlife Service) began acquiring the southern portion of the Montezuma Marsh. Shortly after Montezuma NWR was established in 1938, the Civilian Conservation Corps (CCC) began work on a series of low dikes to reflood the main marsh. Then in 1939, they continued their diking operations to impound the flows of White and Black Brooks, to re-flood a small portion of the former marshes, and to create a water source to refill the main impoundment each fall after farming operations ceased. Today, the Refuge has 16 manageable impoundments totaling more than 4,700 acres of freshwater wetland habitat (Map 2-5 and Table 2-4). Impoundment water levels are manipulated to provide a variety of feeding, nesting, brood rearing, and resting habitats for migratory birds and resident wildlife. Water levels are managed within and between years in an attempt to mimic natural wetland hydroperiods or to provide habitat for priority wildlife species.

Table 2-4 Impoundments on Montezuma NWR**.**

Impoundment Name	Acres
Main Pool	1,659
Tschache Pool	1,270
Sandhill Crane Unit	454
Unit 17 East (forested)	346
Unit 17 West (forested)	268
Knox-Marsellus Marsh	228
May's Point Pool	199
Puddler Marsh	95
North Spring Pool – maybe alkaline, no emergents	90
Millennium Marsh (emergent – 66, forested - 4)	70
South Spring Pool	7
Visitor Center Wetland	26
Benning Marsh	18
Box Elder Bog	10
Shorebird Unit	8
Display Pool	1
TOTAL	**4,749**

Periodically (typically every 5-7 years) these impoundments are drawn down to promote the growth of moist soil annual vegetation, an important food source for migrating waterfowl. Muskrats help maintain the proportion of open water to vegetation by feeding on the dense emergent cattails. At times, the muskrats consume so much emergent vegetation, that the marshes resemble open lakes. The submerged aquatic vegetation (SAV), primarily sago pondweed, provides excellent waterfowl foraging areas.

Situated on the southwestern boundary of the active muck agriculture lands north of the Barge Canal, the Knox-Marsellus wetland was the Refuge's first major attempt at wetland restoration of muck soil agricultural lands in the Montezuma Wetlands Complex. Construction of the perimeter dike and installation of water control structures for the 228-acre unit were completed in late 2000. The unit was



Map 2-5 Impoundments and Water Control Structures on Montezuma NWR

first flooded in the spring of 2001. The impoundment was drawn down during 2004 to encourage growth of moist soil annuals. The vegetation response was excellent. Dense stands of smartweed, sedges, and *Bidens sp.* developed across the bare substrate of the impoundment. Muskrats are beginning to populate the impoundment and open up dense cattail stands that developed along former drainage ditches. Bio-control beetles began feeding on purple loosestrife plants preventing germination.

Forested Wetlands (Bottomland Hardwoods)

Forested wetlands (or bottomland hardwoods) comprise 2,264 acres at Montezuma. Most of the forest on Montezuma is forested wetland. Dominant vegetation includes red maple, American elm, green ash, and swamp white oak. The understory is sparse, and includes common winterberry, northern spicebush, and highbush blueberry. These understory shrubs are largely confined to hummocks. Species common to the transitional zones between hummocks and vernal pools include sensitive fern, marsh fern, skunk cabbage, and false nettle (Ducks Unlimited Inc. 2000).

The largest stand of forested wetland on the Refuge includes two greentree reservoirs, the 344-acre Unit 17 East and the 266-acre Unit 17 West, collectively called Unit17. Unit 17 is south of Rt. 5/20 and separates the northern terminus of Cayuga Lake from the extensive emergent marsh system on the Refuge. This habitat supports high numbers of cerulean warblers (40 singing males), other neotropical migrating songbirds, and cavity-nesting wood ducks. Uncommon invertebrates such as fairy shrimp also are present.

The USFWS created these two “greentree” impoundments in 1965 to benefit nesting, resting, and feeding waterfowl. At the same time the Refuge and its partners (NY Cooperative Wildlife Research Unit) initiated a study of the effects of flooding on the plant and animal communities already present in this unit. The flooding regime included two periods: mid-March until mid-June (east pool) to create nesting and brood-rearing habitat for mallards, black ducks, and wood ducks and a second period from September until mid-November (west pool) to provide resting and feeding habitat for migrating waterfowl. Full pool depth was approximately 11-12 inches, about 4 inches above natural flood level. Dikes surround each tract; the Seneca-Cayuga Canal along the southern edge of the impoundments serves as the water source. A 457-acre area north of Rt. 5/20 served as a natural control area for the study. The Cayuga-Seneca Barge Canal forms the eastern boundary (Golet 1969).

Golet (1969) described the soils here as 10-20 inches of alkaline Carlisle muck, composed of decomposed sedges and woody material, overlying a layer of Chara and shell marl. Beneath the marl lies compact, sticky blue clay. He described the micro-topography of the forest as divided between mounds or hummocks and low areas of standing water including vernal pools (known as “pit and mound” topography). Tree windfall is prevalent with mature trees growing mainly on hummocks. The dominant tree species were mature hardwoods including red maple, American elm, and green ash with some swamp white oak, and ironwood. The artificial flooding in spring extended the period of standing water in vernal pools from May until late June and increased the water level 4 to 6 inches. Fall flooding created deeper standing water in these pools at least two months before it would normally occur (Golet 1969). During the first 3 to 4 years after the initiation of the greentree impoundments, Golet (1969) found a slight reduction in green ash and red maple growth from fall flooding.

The east pool was flooded in the spring from 1965 to 1977. The west pool was flooded in the fall from 1966 to 1969 and in the spring from 1971 to 1977. Flooding was terminated in both pools in 1977 because extended flooding into the growing season caused crown dieback of the overstory (Malecki et al.

1983). In 1996, the east pool was re-flooded from mid-March until mid-July (Deller 1997). Eighteen years after the cessation of flooding in the greentree impoundments, Deller (1997) documented long-term effects on all vegetation layers in the forest, including lower green ash regeneration evidenced by lower density of saplings, and lower density of shrub and herbaceous species. Currently the Refuge maintains water in the ditches surrounding the units and allows the interior water levels to fluctuate according to rainfall, more closely following a natural hydroperiod for a bottomland forest community.

Uplands

Most of the upland habitat on Montezuma NWR is maintained in an early successional state (grassland or scrub/shrub fields) through active management. These areas are maintained through a variety of management techniques including mowing, burning, disking, planting, hydro-axing, and chemical treatment.

Grasslands

The Refuge maintains several fields to support grassland-dependent species (Table 2-5). These fields require long-term maintenance including frequent mowing, herbicide applications, and prescribed burning to control invasive plants and other non-desirable plants including woody shrubs. The more common cool season plant species in grassland fields include timothy (*Phleum pratense*), smooth brome (*Bromis inermis*), birds-foot trefoil (*Lotus corniculatus*), bluegrass (*Poa spp*.), reed canarygrass (*Phalaris arundinacea*), common burdock (*Arctium minus*), thistle (*Cirsium spp*.), field mustard (*Brassica rapa*), and goldenrod (*Solidago spp*.). Warm season grasses include switchgrass, big bluestem, little bluestem, sideoats grama, and indiangrass.

Table 2-5 Grassland Management Units on Montezuma NWR (2006).

Unit Name	Acres	Current Condition
Avery Tract	54	Dense stand of warm season grasses with very few forbs and woody species.
Sub-headquarters Fields	57	Dense stand of warm season grasses with some forbs and woody species.
Lay Road Field	9	
Wildlife Drive-Inside Corner	19	Dense stand of warm season grasses and Phragmites.
Wildlife Drive-Outside Corner	21	Sorghum food plot.
Waugh Tract I	36	Mix of cool season grasses and forbs with some warm season grasses and woody species.
Wilgoose (including Winery Field)	173	Diverse mix of warm and cool season grasses and forbs with very few woody species. Very dense forbs in some areas. Infested with black locust, teasel, and burdock.
TOTAL	**369**	

Cropland

The Refuge generally allows landowners to continue farming through the year of the purchase and one year following our acquisition to provide for a smoother transition both for the farmer and the Refuge. This provides an extra year of income for the farmer and gives the Refuge a year to prepare to restore the farm to native vegetation. The Refuge occasionally allows a farmer to continue farming more than one year after an acquisition to allow more time to plan restoration activities and acquire necessary funding (e.g., for grass seed, dike construction, water control structures, etc.). The Refuge also uses cooperative farming as an interim measure to keep fields open in preparation for conversion to native plants, as a means to properly establish newly converted early successional habitats, and to control invasive plant species on the refuge. Cooperative farmers are not allowed to plant potatoes, as they require large amounts of herbicides, fungicides, and pesticides. With prior approval, farmers are permitted to use certain genetically modified organisms (e.g., roundup ready crops), and apply fertilizers and herbicides. For the past three years, only ammonia sulfate and manure have been used for fertilizer, and only glyphosate products have been used for herbicides. Applications of both are conducted one or two times per year.

In 2006, four cooperative farmers planted corn or soybeans on 663 acres of Refuge lands. In 2007, the Refuge area in the cooperative farming program was reduced to 510 acres. Cooperative farmers provide other in-kind services including:

- Mowing Refuge grasslands to prevent brush encroachment,
- Spraying invasive plants,
- Seeding Refuge fields,
- Plowing, disking, and cultipacking upland fields prior to planting permanent grass cover,
- Purchasing grass seed for planting in Refuge upland fields, and
- Maintaining the tops and slopes of dikes.

Shrubland

The Refuge maintains several tracts as shrubland. Shrublands require long-term maintenance to remove trees and minimize invasive plant density. Shrublands have been created on the Refuge by allowing succession to proceed past the grassland stage but stopping it prior to forest establishment. In 2007, shrubs were planted on two tracts to facilitate shrubland establishment.

Forest

Upland forested sites, including Clark's Ridge and Esker Brook, are dominated by hickory (*Carya spp.*), black walnut, sugar maple, oak sp., and white ash, with some basswood, red maple, white pine, and hemlock. The climax community is a beech-maple association. These sites require little to no maintenance but should be monitored for invasive plants.

Rare Plants and Significant Ecological Communities

The New York Natural Heritage Program (NYNHP) tracks rare species and significant ecological communities in the State. The program provided a list of the rare animals, rare plants, and significant ecological communities known to occur on or near the Refuge (See Appendix A, NYSNHP 2006). In addition to hundreds of relatively more common wildlife species that live on or visit the Refuge, Montezuma supports several state-listed bird species (pied-billed grebe, bald eagle, black tern, short-eared owl), and one of those; the bald eagle is federally listed as threatened.

In addition to the rare bird species, the NYNHP (2006) reported the following species and communities for the Refuge:

- Blue-tipped dancer (damselfly)
- Holly-leaved naiad

- Floodplain forest

Several other rare species and plant communities are documented near the Refuge (see Appendix A).

The Refuge has two designated Research Natural Areas (RNA) and a National Natural Landmark (NNL) (Map 2-4). Beech-Maple Knoll RNA, an 8-acre tract located southwest of Tschache Pool, is a prime example of a mature, northern hardwood beech-maple forest cover type. The beech-maple association provides a unique habitat type not found elsewhere on Montezuma. The identification of these areas on the Refuge was largely a result of a botanical study by Cowardin (1965). In addition to these areas, Cowardin (1965) identified several other areas of botanical significance on the Refuge.

The Swamp Woods RNA is a tract of approximately 100 acres located southwest of the Main Pool. It is an unusual stand in that it is the last remaining undisturbed example of swamp woodland on the Refuge. It was once the common woodland type found on muck soils throughout the historic Montezuma marshes, but has now become rare due to land clearing and draining of muckland for farming. The vegetation of interest includes black ash, American elm, red maple, and white oak.

A 2,100-acre portion of the Refuge was designated as a Montezuma Marshes National Natural Landmark by the National Park Service under the provisions of the Historic Sites Act of 1935. The Refuge was incorporated in the registry because it possesses exceptional value in illustrating the natural history of the United States. A large section of the Main Pool, including Maple Island and Black Lake, is representative of conditions in the original marsh in which broad expanses of cattail marsh were interspersed with old river channels and ponds. This area serves as a resting and feeding area for migrating waterfowl and provides nesting habitat for many species of ducks, herons, other waterbirds, and neotropical migrant songbirds. The Swamp Woods RNA is part of the Montezuma Marshes NNL. The New York State Thruway forms the northern border of the landmark. Water level manipulations, siltation, eutrophication, and invasive species (purple loosestrife, phragmites, carp) are management concerns for this NNL. John Confer (Ithaca College, unpublished report, August 1988) noted a major decline in the number of waterfowl using the Refuge during the last 20 years.

Wildlife

Birds

The bird list for Montezuma NWR lists 320 species that have been identified on the Refuge since its creation in 1938. Of these, 117 species of birds are known to nest on the Refuge. The New York Important Bird Area (IBA) Program recognized the Montezuma Wetlands Complex for harboring a suite of nesting bird species of conservation concern including pied-billed grebe, least bittern, osprey, bald eagle, black tern, sedge wren, and cerulean warbler. Most of the forested wetlands in this region were historically cleared or drained so the bird species that use this habitat are of conservation concern. Montezuma NWR supports this habitat type along with many breeding birds associated with these forests including sharp-shinned hawk, black-billed cuckoo, eastern wood-pewee, wood thrush, cerulean warbler, rose-breasted grosbeak, and Baltimore oriole. The Montezuma Wetlands Complex is also recognized for its importance to migratory birds. Congregations of waterfowl, wading birds, and shorebirds are observed during fall migration (http://iba.audubon.org/iba/viewSiteProfile.do?siteId=1726&navSite=state).

The Refuge was part of a national program called MAPS (Monitoring Avian Productivity and Survivorship) from 1999 through 2004. The major objective of the MAPS program is to contribute to the avian population monitoring system for North American landbird species by providing data necessary to estimate population size, post-fledging productivity, adult survivorship, and recruitment into the adult population. The Montezuma MAPS station was located in early successional habitat (shrubland), and the most common species captured during the breeding season in 1999, 2000, and 2001 were song sparrow, yellow warbler, and gray catbird.

Waterfowl
During 2004, Refuge staff and volunteers recorded more than 100 waterfowl broods, an increase of nearly 20% over the 2003 nesting season. The most common nesting waterfowl are Canada goose, mallard, wood duck, and blue-winged teal. Waterfowl migrate through the Refuge from mid-September to freeze-up. Canada goose numbers peak in mid-November at up to 50,000 birds. Up to 150,000 ducks congregate in late November. Spring waterfowl migration on the Refuge occurs in late February through April depending on the weather and spring thaw. More than 80,000 Canada geese and 100,000 snow geese visit the Refuge in spring. Fewer ducks and geese visit the Refuge on their northward migration.

Shorebirds
The Montezuma Marsh Basin was historically the most significant migratory stopover for shorebirds in upstate New York and is still considered one of the most important inland shorebird sites in the northeast (Ken Rosenberg, Cornell Lab of Ornithology, personal communication). On the Refuge, water levels in some impoundments are managed seasonally to provide exposed mudflats for foraging shorebirds.

Volunteers conducted weekly shorebird surveys on MNWR during fall migration in 1994 and 1995. Species richness (17) and total individuals (641) peaked in August. The most common species were lesser yellowlegs, killdeer, and semipalmated sandpiper.

Sleggs et al. (2000) summarized the results of shorebird surveys conducted at the Main Pool, Benning Marsh, May's Point Pool, Tschache Pool, and North Spring Pool on Montezuma NWR twice per week between sunrise and 1200 hours from March through November in 1997 through 1999. Species richness peaked during May (16 species) and September (23 species). The most common species were semipalmated sandpiper, dunlin, least sandpiper, pectoral sandpiper, killdeer, and greater yellowlegs.

High counts of shorebirds on the MWC reported by birders for the years 2000-2006 were 300 in late August and 137 in the beginning of June for semipalmated sandpiper, 112 in mid-May and 200 in mid-October for dunlin, 65 in mid-May and 150 in late August for least sandpiper, 365 in late August for pectoral sandpiper, and 162 in late September for greater yellowlegs (www.ebird.org).

Marsh and Wading Birds
Both Main and Tschache Pools support a diversity of marsh nesting birds. Surveys conducted during summer 2004 confirmed breeding by black tern, least bittern, pied-billed grebe, American coot, common moorhen, and common tern.

Black terns produced approximately 500 young on the refuge in 1958. By the early 1990s, there were none nesting on the refuge, probably due to the purple loosestrife invasion and declining black tern populations state-wide. By 1998, black terns were nesting on the refuge again in low numbers. In 2006, eight nesting pairs were observed.

A nesting colony of great blue herons has been present on the refuge many years throughout the history of the refuge. Nest colonies move, and the rookeries have been in various locations on the refuge, including Maple Island, Tschache Pool, and Unit 17 East. Black-crowned night-herons also nested on the refuge in the 1980s.

Landbirds
One-day migration counts were conducted by Steven Kahl on the MWC in May from 1994 – 1997. He detected the following species of concern: osprey, bald eagle, northern harrier, peregrine falcon, sharp-shinned hawk, common nighthawk, chimney swift, northern flicker, horned lark, willow flycatcher, wood thrush, brown thrasher, blue-winged warbler, cerulean warbler, prothonotary warbler, scarlet tanager, rose-breasted grosbeak, field sparrow, bobolink, Eastern meadowlark, rusty blackbird, and Baltimore oriole.

Steven Kahl also conducted a breeding bird survey on the refuge in 1995. Fifty points were established across the refuge. The ten most frequently recorded species were song sparrow, American robin, yellow warbler, common yellowthroat, red-winged blackbird, Eastern wood-pewee, brown-headed cowbird, swamp sparrow, veery, and wood thrush.

Breeding bird surveys were conducted in Units 17 East and West in 1995, 1996, and 2006. The following species of concern were detected: Baltimore oriole, Northern flicker, rose-breasted grosbeak, scarlet tanager, song sparrow, willow flycatcher, and wood thrush.

Breeding bird surveys focused on grassland breeding birds were conducted in the Avery and Waugh fields from 2001 – 2003, boblink, Eastern meadowlark, and savannah sparrow were detected.

Cerulean Warbler
The Montezuma Wetlands Complex is one of four sites in New York with exceptional numbers of cerulean warblers recorded during the Cerulean Atlas Project. This warbler is among the highest priority landbirds for conservation in the U.S. based on a small total population size and a significant decline in Breeding Bird Survey (BBS) trend throughout its range (-4.2% per year since 1966) (Rosenberg et al. 2000). On the Montezuma Complex the cerulean warbler occurs in riparian, forested wetlands. Despite the extensive agricultural landscape, the Complex supports the second highest concentration of ceruleans in New York. The largest number of singing males was found at the Howland Island area (87), 77 males were found around and west of Mays Point Pool, and 40 males were found in the Mud Lock area south of Routes 5 and 20. Cerulean warblers also were found on Maple Island, in the Seneca Trail area, and along the Clyde River.

Bald Eagle
Prior to the 1950s more than 70 pairs of bald eagles nested in New York State, by the 1960s only one active nest remained. In the 1970s New York led the national recovery of the bald eagle by “hacking’ young wild birds into new artificial nest sites. Between 1976-1980, 23 young eagles were hacked at Montezuma NWR. After two released birds successfully nested in 1980, the hacking program expanded to three more sites in New York. The first wild pair of eagles nested again on Montezuma NWR in 1987, after a 30-year absence. Two pair nested on the Refuge in 1994. Most of the eagle activity on the Refuge occurs around Tschache Pool, the site of two of the three active nesting territories. However, adult and

immature eagles use the Refuge throughout the year. As the Main Pool was draining to encourage vegetative growth in 2007, 59 bald eagles were counted in one morning in early June.

Sandhill Crane

Sandhill cranes were first observed on the Complex during spring migration in 1999. Since then, a few cranes were observed during migration and the first confirmed breeding occurred in 2003 and a pair with young was observed again in the 2004through 2006 breeding seasons. By the 1930s the sandhill crane population was nearly decimated across its range. Today the population has recovered to 650,000 birds and several states including New York, Pennsylvania, Ohio, and Iowa are part of a range expansion.

Mammals

The most commonly observed mammal species include eastern cottontail, woodchuck, gray squirrel, muskrat, red fox, raccoon, mink, and white-tailed deer.

In 1995, two river otters were released in the Montezuma Wetlands Complex. Otters have been missing from this area for more than 100 years because of habitat loss and overharvesting.

Fish

Foust conducted a baseline inventory of fish on Montezuma NWR in July 2003; most previous fisheries information for the Refuge was anecdotal (Foust 2003). Electrofishing and minnow traps were used to sample fish in portions of the Erie and Cayuga-Seneca canal systems, Seneca River, Old Seneca River, Main Pool, Crusoe Lake, and numerous tributaries and ponds. The fish habitat within the Refuge consists of man-made canal systems with few natural water bodies. The canals supported homogenous habitat that was typically turbid with minimal macrophytes.

Foust captured 37 species, 26 genera, 15 families, and 10 orders of fish. Only one species, brown bullhead, was present in all sample sites. The most commonly encountered species were common carp, golden shiner, bluegill, brown bullhead, and yellow perch. The most abundant fish, common carp, represented 20% of the total catch within the Refuge. The less disturbed areas of the Seneca River provided the most diverse fish assemblage (24 species) with bluegill being the most abundant. Natural in stream habitat, emergent and submerged aquatic vegetation, and overhanging vegetation were more abundant in portions of the Seneca River. The most common species in the Main Pool was golden shiner followed by goldfish. The nutrient rich pool had an organic substrate but the water was relatively clear, providing a nursery ground for golden shiners, goldfish, brown bullhead, and yellow perch. Larger carp are denied access to the Main Pool by a fish deterrent wheel at the outflow. Despite turbid conditions and few macrophytes, the Cayuga-Seneca and Erie Canals had a diverse fish population (Foust 2003).

Reptiles and Amphibians

Sheila Sleggs conducted a baseline inventory of reptiles and amphibians on the Refuge in 1995 and 1996 using various methods including evening audio surveys for frogs and toads, visual encounter surveys, and live-trapping using pitfalls, drift fences, funnel traps, minnow traps, and aquatic hoop traps (Sheila Sleggs 1997, unpublished data). Frogs and toads recorded during this survey included American toad, gray treefrog, spring peeper, western chorus frog, bullfrog, green frog, wood frog, and northern leopard frog. Salamanders included mudpuppy, blue spotted/Jefferson salamander complex, and northern two-lined salamander. Turtles observed during the survey included snapping turtle, common musk turtle, midland and eastern painted turtles. Snakes observed included northern water snake, northern brown snake, and eastern garter snake.

The Refuge has the potential habitat for a number of other reptile and amphibian species. These potential species can be determined by reviewing the maps on the website of the New York Amphibian and Reptile Atlas 1990-1999 at http://www.dec.state.ny.us/website/dfwmr/wildlife/herp/.

Invasive Species

Table 2-6 lists invasive plant species occurring on Montezuma NWR based on observations made by refuge staff and volunteers.

Table 2-6. Invasive Plant Species on Montezuma NWR.

Invasive Plant Species on Montezuma NWR		
Species	**Treatment (Yes/No)**	**Treatment Method**
Velvetleaf (*Abutilon theophrasti*)	No	
Tree of Heaven (*Ailanthus altissima*)	No	
Garlic Mustard (*Alliaria petiolata*)	No	
Burdock (*Arctium sp*)	No	
Japanese Barberry (*Berberis thunbergii*)	No	
Carline Thistle (*Carlina vulgaris*)	No	
Oriental Bittersweet (*Celastrus orbiculatus*)	Yes	Cut stump treatments with glyphosate herbicide
Knapweed (*Centaurea sp*)	No	
Canada Thistle (*Cirsium arvense*)	No	
Bull Thistle (*Cirsium vulgare*)	No	
European (Pale) Swallowwort (*Cynanchum rossicum*)	Yes	Triclopyr and glyphosate herbicides, mowing, seeding natives
Teasel (*Dipsacus sp*)	No	
Autumn Olive (*Elaeagnus umbellate*)	Yes	Cut stump treatments with glyphosate herbicide
Paleyellow Iris (Iris pseudacorus)	No	
Tatarian Honeysuckle (*Lonicera tatarica*)	Yes	Cut stump and foliar treatments with glyphosate herbicide, mowing, planting cover crops
Purple Loosestrife (*Lythrum salicaria*)	Yes	Wetland-approved glyphosate herbicide, Beetles

Invasive Plant Species on Montezuma NWR		
Yellow Sweetclover (*Melilotus officinalis*)	No	
Eurasian Watermilfoil (*Myriophyllum spicatum*)	No	
Reed Canary Grass (*Phalaris arundinacea*)	No	
Common Reed (*Phragmites australis*)	Yes	Wetland-approved glyphosate herbicide, mowing, burning, water level manipulation
Japanese Knotweed (Polygonum cuspidatum)	No	
Curly Pondweed (*Potamogeton crispus*)	No	
Common Buckthorn (*Rhamnus cathartica*)	Yes	Cut stump and foliar treatments with glyphosate herbicide, mowing, seeding natives
Black Locust (*Robinia pseudoacacia*)	Yes	Mowing
Multiflora Rose (*Rosa Multiflora*)	Yes	Cut stump and foliar treatments with glyphosate herbicide

Table 2-7 Invasive Plant Species Surrounding but not on Montezuma NWR.

Species	**Closest Location(s) to Refuge**
Norway Maple (*Acer platanoides*)	Onondaga, Ontario, and Oswego Counties
Nodding Plumeless Thistle (*Carduus nutans*)	Yates and Tompkins Counties
Chinese Catalpa (*Catalpa ovata*)	Montezuma Wetlands Complex
Giant Hogweed (*Heracleum mantegazzianum*)	Cayuga and Wayne Counties
Common (European) Frogbit (*Hydrocharis morsus-ranae*)	Wayne County
Princesstree (*Paulownia tomentosa*)	Tompkins County
Fig Buttercup (*Ranunculus ficaria*)	Cayuga County
Wine Raspberry (*Rubus phoenicolasius*)	Cayuga and Wayne Counties
Water Chestnut (*Trapa natans*)	Northern Montezuma Wildlife Management Area

Purple Loosestrife

Montezuma NWR is a key area for research on the management and control of purple loosestrife. The Refuge has suffered one of the worst infestations of purple loosestrife over the past 45 years. In 1951, loosestrife was found only in sparse stands; by 1980, the plant occupied 1,500 acres of the Refuge's 3,200 acres of managed wetlands. Various control measures were used, including herbicides and water level manipulations with little success in controlling the infestation and at high long-term maintenance costs.

In the summer of 1996, the Biological Control of Non-Indigenous Plant Species Program at Cornell University began a biological control program on the Refuge using several of the plant's natural enemies to control purple loosestrife. The goal of this biological control program is to establish the competitive balance between native plant species and purple loosestrife, not to eradicate purple loosestrife but to reduce its abundance to an acceptable level and reduce the need for herbicide application. Three species of weevils (*Hylobius sp.*) and two species of leaf-beetles (*Galerucella sp.*) that live and feed exclusively on purple loosestrife are approved for introduction and release.

The first release on the Refuge occurred in 1997. This and subsequent releases are monitored. Results from the 2004 season were encouraging. Stands of established purple loosestrife on all Refuge impoundments showed significant signs of stress and decline due to beetle infestations. The number of flowering plants was dramatically reduced on most areas of the Refuge. Of particular note was the almost total lack of loosestrife on the fringes of Main, South Spring, and May's Point Pools during late July and August (USFWS 2005).

Non-Native Fish

The U.S. Fish Commission introduced the carp into the U.S. as a food fish in the 1880s. Carp (*Cyrinus carpio*), native to Asia, have proved detrimental to native fish populations and never became as popular for game or food in North America as they are in Europe and Asia. A typical carp is between 1-2 feet long and weighs between 2 to 10 pounds. Carp are found in many warm, nutrient-rich waterways including the New York State Barge Canal along the Refuge boundary. The Refuge wants to keep carp out of the pools because carp stir up silt, which reduces sunlight penetration and prevents plant growth. Submerged aquatic plants are essential to the marsh community and the thousands of waterfowl that use these wetlands. When water levels subside and water stops flowing from the Main Pool, carp will disperse back into the Canal. Carp occur in low numbers in the Refuge pools. In spring when water levels rise in the Rivers, the Refuge closes the gates to the spillways to prevent carp from entering the pools. Winter drawdowns can be used to remove carp from refuge impoundments.

Environmental Contaminants

A 1995 draft report summarized the existing contaminant information related to Montezuma NWR (USFWS New York Field Office, April 10, 1995). This summary included a list of baseline studies, nearby hazardous waste sites, monitoring sites, and history of pesticide use on the Refuge.

The Fish and Wildlife Service is acquiring mucklands from willing sellers for restoration of wetland and upland habitats in the Montezuma Wetlands Complex. Some surveys of these lands have detected the presence of contaminants. To reduce the potential exposure of trust resources to contaminants, a management strategy was drafted for muckland restoration and acquisition related to contaminant issues (USFWS 2000).

Stoll (1988) sampled water quality, sediments, and wildlife species within Refuge impoundments and adjacent canals and streams to determine the presence and extent of contaminants. DDT, PCBs, and dieldrin were found in turtle and fish tissue samples. Stoll (1988) did not detect these compounds in sediment samples, however these chemicals and other pesticides were found in samples from some tracts (particularly the Sandhill Crane Unit) (USFWS 2000). Stoll (1988) concluded that levels of metals and organics were not a cause for concern, although there is some evidence that adverse effects to ecosystem function are occurring and levels of arsenic, zinc, and copper in agricultural mucklands were above baseline conditions and in some place above the State's "severe effect" level (USFWS 2000). Contaminant uptake by wildlife is dependent on the contaminant, the other contaminants present, the species involved, and the chemistry of the soil and water (NYSDEC 1998). Soils with a high carbon content and large proportions of fines in sediments (such as in the mucklands) can bind a higher amount of contaminants and therefore have a higher capacity of limiting the amount of contaminants available for uptake by wildlife. Thresholds suggested by Long and Morgan (1990) may be more applicable to the mucklands than the statewide thresholds. The cumulative concentrations of arsenic, copper, and zinc show some correlation with a decrease in algae species richness (USFWS 2000).

Chapter 3 Resources of Concern

This Chapter includes the following sections:

- **Introduction**
- **Resources of Concern for Montezuma NWR**
- **Priority Resources of Concern for Montezuma NWR**
- **Adaptive Management**

Introduction

The Service is entrusted by Congress to conserve and protect migratory birds and fish, federally listed threatened and endangered species, inter-jurisdictional fishes, and certain marine mammals. These are known as "trust species." In addition to this Service mandate, 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 diversity, integrity and environmental health at the Refuge, ecosystem, and broader scales (USFWS 1999, 2003).

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 strategies. The following is the process that Montezuma NWR used to identify priority resources of concern and develop habitat goals, objectives, and strategies to benefit these resources.

The Habitat Management Plan policy (620 FW) 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."

Resources of concern are synonymous with "conservation targets" and the terms can be used interchangeably.

Resources of Concern for Montezuma NWR

In collaboration with other Refuges in the Bird Conservation Region 13 (Lower Great Lakes/St. Lawrence Plain) we developed a matrix of resources of concern for the region. To determine the resources of concern that would guide the management priorities at each Refuge we examined a multitude of guiding documents and other information sources. These documents, plans, or policies typically identify focal species, species groups, or habitats. These sources fall into three categories:

- Legal Mandates
- U.S. Fish and Wildlife Service Trust Species
- Biological Integrity, Diversity, and Environmental Health Policy ("Integrity Policy")

Legal Mandates

See pages 1-2 in Chapter 1 Introduction of this HMP.

U.S. Fish and Wildlife Service Trust Species
Although the Refuge purposes are the first obligation, managing for trust species is also a priority for the Refuge. Trust species are further defined as follows:

Migratory Birds: A list of all the 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 are contained in subchapter B of title 50 CFR § 10.13. The Migratory Birds Program also maintains subsets of this list that provide priorities at the national, regional, and ecoregional (bird conservation region) scales.

The primary sources of information that the Refuge used to identify potential migratory birds species of concern included:

- Bird Conservation Region (BCR) 13
- Continental and Regional Plans for landbirds, waterfowl, shorebirds, and marshbirds
  - USFWS Birds of Conservation Concern
  - Federal Threatened and Endangered species
  - Status and Trend Information from Refuge bird surveys
  - Important Bird Area criteria

Interjurisdictional Fish: 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 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:

- USFWS Regional Fisheries Office

***Marine Mammals*:** The Marine Mammal Protection Act of 1972 (16 U.S.C. 13611407) prohibits, with certain exceptions, the take of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S.

Montezuma NWR is not within a marine environment.

Threatened and Endangered Species: The Endangered Species Act (16 U.S.C. §§ 1531-1544, December 28, 1973, as amended 1976-1982, 1984 and 1988) states in Sec. 8A.(a) that "*The Secretary of the Interior (hereinafter in this section referred to as the "Secretary") is designated as the Management Authority and the Scientific Authority for purposes of the Convention and the respective functions of each such Authority shall be carried out through the United States Fish and Wildlife Service.*" The Act also requires all Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of this Act.

To identify Federally threatened or endangered species of relevance to Montezuma NWR we reviewed:
- Federal Threatened and Endangered Species List
- Recovery Plans for Federally listed species in our region

Biological Integrity, Diversity, and Environmental Health
The 1997 National Wildlife Refuge System Improvement Act states that in administering the System the Service shall "*… ensure that the biological integrity, diversity, and environmental health of the System are maintained…*" (601 FW 3; also known as the "Integrity Policy"). The USFWS (2003) defines these terms as:

Biological 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.
Biological Integrity	Biotic composition, structure, and functioning at genetic, organism, and community levels comparable with historic conditions, including 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 the environment.

Where possible management on the Refuge restores or mimics natural ecosystem processes or functions and thereby maintains biological diversity, integrity, and environmental health. Given the continually changing environmental conditions and landscape patterns of the past and present (e.g., rapid development, climate change, sea level rise), relying on natural processes is not always feasible nor always the best management strategy for conserving wildlife resources. Uncertainty about the future requires that the Refuge manage within a natural range of variability rather than emulating an arbitrary point in time. This maintains mechanisms that allow species, genetic strains, and natural communities to evolve with changing conditions, rather than necessarily trying to maintain stability.

As stated by Meretsky et al. (2006), the Integrity Policy directs Refuges to assess their importance across landscape scales and to "forge solutions to problems arising outside Refuge boundaries." Some of these regional land use problems include habitat fragmentation/lack of connectivity, high levels of contaminants, and incompatible development or recreational activities.

To assess the historical condition, site capability, current regional landscape conditions, and biological diversity and environmental health data pertinent to Montezuma NWR we used the following resources:

- Maps and associated data on site capability
  - Soils, topography, and hydrology
  - History of natural disturbance patterns
- Map of current landscape condition showing conserved lands network, connectivity, land use patterns, and management/ownership trends surrounding the Refuge
- Map of existing vegetation on the Refuge
- Regional/Global Environmental Trends
  - Climate Change
  - Air and water quality
- New York Natural Areas Program information on rare plants and animals and significant ecological communities
- New York State Comprehensive Wildlife Conservation Strategy
- Status and Trend Information from Refuge surveys and other research

Summary Table

Table 3-1 is the comprehensive list of resources of concern for Montezuma NWR based on the information compiled and analyzed in this section as described under legal mandates, trust species, and integrity policy.

Table 3-1 Comprehensive List of Resources of Concern for Montezuma NWR.

Species*	Seasons on Refuge[1]	Federal T&E[2]	New York T&E[3]	NY Comprehensive Wildlife Conservation Strategy Priorities[4]	USFWS Birds of Management Concern[5]	BCR 13[6]	Partners in Flight[7]	Shorebird Plan-Atlantic Flyway[8]	Waterbird Plan[9]	Waterfowl Plan[10]
WATERBIRDS										
American bittern	B-U, M-O			X		H			H	
Black-crowned night heron	B-U, M-U			X		M			H	
Black tern	B-U, M-U		E	X		M			H	
Common tern	B-O, M-O		T	X	X	H			H	
Horned grebe	M-U			X						
King rail	B-R, M-R		T	X		H	IB		HI	
Least bittern	B-O, M-0		T	X		M			M	
Pied-billed grebe	B-C, M-C		T	X		M			M	
Sandhill crane	B-R, M-O									

Virginia rail	B-C, M-C, W-R					M			L	
WATERFOWL										
American black duck	B-C, M-A, W-C			X	X	HH	IB			H (H)
Blue-winged teal	B-C, M-C					M				MH (ML)
Canada goose Atl/SJBP	??			X	X	HH				(H)
Canvasback	B-R, M-C, W-R			X	X	H				
Common goldeneye	M-U					HH				
Common merganser	M-C,W-U					M				L (L)
Greater scaup	M-C			X	X	H				(H)
Greater snow goose	M-C, W-O					M				
Green-winged teal	M-C, B-O									ML (ML)
Hooded merganser	M-C, B-U, W-O									H (L)
Lesser scaup	M-C			X	X	HH				(H)
Long-tailed duck	M-R			X		HH				
Mallard	M-A, B-C, W-C			X	X	M				H (M)
Northern pintail	M-C, B-O			X	X	H				M (M)
Redhead	M-C, B-O					M				
Ruddy duck	M-C, B-O			X						
Tundra swan	M-C,W-C					H				(H)
Wood duck	M-C, B-C			X	X	H				H (H)
SHOREBIRDS										
American golden plover	M-U			X	X	H		MC		
American woodcock	M-C, B-C			X	X	H	IA	HC		
Black-bellied plover	M-U			X		M		MC		
Buff-breasted sandpiper	M-O			X	X	H				
Dunlin	M-C			X		M		MC		
Greater yellowlegs	M-C			X		M		HC		
Hudsonian godwit	M-R			X	X	M		MC		
Least sandpiper	M-C					M		MC		
Pectoral sandpiper	M-C					M		LC		
Red knot	M-U			X	X	M				
Sanderling	M-U			X		M		MC		
Semipalmated sandpiper	M-C			X		M		MC		
Short-billed dowitcher	M-C			X	X	H		HC		
Solitary sandpiper	M-U					H		MC		
Upland Sandpiper	M-R, B-R		T	X	X	M	IB	HC		
Wilson’s phalarope	M-U					M				
Wilson’s snipe	M-U, B-U					M		MC		
LANDBIRDS										
Bald eagle	B-C, M-C, W-C	T		X	X					

Baltimore oriole	M-C, B-C					M	IIA			
Black-billed cuckoo	M-O, B-O			X	X	H	IIA			
Blue-winged warbler	M-U			X		H	IB			
Bobolink	M-U, B-U			X		M	IIA			
Brown thrasher	M-O, B-O			X		H				
Canada warbler	M-U			X	X	M	IB			
Cerulean warbler	M-C, B-C			X	X	HH	IB			
Chimney swift	M-U, B-U					M				
Common nighthawk	M-O			X						
Cooper's hawk	M-U, B-U, W-U			X						
Eastern meadowlark	M-U, B-R, W-R			X		M				
Field sparrow	M-U, B-U, W-R					H	IIA			
Golden-winged warbler	M-O			X	X	HH	IB			
Grasshopper sparrow	M-R, B-R			X		M	IIC			
Henslow's sparrow	M-R, B-R		T	X	X	HH	IB			
Horned lark	M-O, B-O, W-O			X						
Long-eared owl	M-R,W-R			X						
Northern flicker	M-C, B-C, W-U					M				
Northern goshawk	M-R,W-R			X						
Northern harrier	M-C, B-U, W-U		T	X	X	M				
Osprey	M-C, B-C			X						
Peregrine falcon	M-O		E	X	X					
Prothonotary warbler	M-R, B-R			X		M	IB			
Red-headed woodpecker	M-O			X	X	M	IB			
Red-shouldered hawk	M-O			X						
Rose-breasted grosbeak	M-C, B-C					M	IIB			
Rusty blackbird	M-U			X		M				
Scarlet tanager	M-C, B-C			X		M	IIA			
Sedge wren	M-R, B-R		T	X	X		IIC			
Sharp-shinned hawk	M-U, B-U, W-U			X						
Short-eared owl	M-R,W-R		E	X	X	M	IB			
Song sparrow	M-C, B-C, W-O					M				
Whip-poor-will	M-R			X	X					
Willow flycatcher	M-C, B-C			X		M	IA			
Wood thrush	M-C, B-C			X	X	H	IA			
Yellow-breasted chat	M-R			X						
MAMMALS										
Eastern red bat				X						
Eastern small-footed bat				X						
Hoary bat				X						

Indiana bat				X						
River otter				X						
Silver-haired bat				X						
AMPHIBIANS[11]										
Blue-spotted salamander				X						
Common mudpuppy				X						
Jefferson salamander				X						
Western chorus frog				X						

KEY

[1]Seasons on the Refuge: B=Breeding, W=Wintering, M=Migration, A=Abundant, C=Common, U=Uncommon, O=Occasional, R=Rare

[2]Federal T&E = Federal Endangered Species List: T=Threatened, E=Endangered, C=Candidate

[3]State T&E= State of New York Threatened and Endangered Species List: T=Threatened, E=Endangered, CR=Candidate rare, PE=Proposed endangered, PT=Proposed threatened

[4]New York State Comprehensive Wildlife Conservation Strategy. X=Species of greatest conservation concern

[5]U.S. Fish and Wildlife Service Birds of Management Concern for Region 5 (Northeast) 21 September 2005

[6] BCR 13 = Bird Conservation Region 13: Lower Great Lakes/St. Lawrence Plain. HH=Highest Priority, H=High Priority, M=Medium Priority. Hartley 2007

[7] Partners in Flight Landbird Priorities for the Lower Great Lakes Plain (Dettmers and Rosenberg 2003). IA=High continental concern and high regional responsibility; IB=High continental concern and low regional responsibility; IIA=High regional concern; IIB=high regional responsibility; IIC=High regional threats

[8]Upper Mississippi Valley/Great Lakes Regional Shorebird Conservation Plan (Szalay et al. 2000). HI=highly imperiled species; HC=species of high concern; MC=species of moderate concern; LC=species of low concern

[9]Upper Mississippi Valley/Great Lakes Watershed Conservation Plan. Priorities: HI=Highly Imperiled; H=High; M=Moderate; L=Low; NR=Not at Risk; TD=To be Determined

[10]North American Waterfowl Management Plan: Atlantic Coast Joint Venture Waterfowl Implementation Plan Revision, June 2005 Priorities: H=High; MH=Moderately High; M=Moderate; ML=Moderately Low; L=Low. Example: H(H) = Breeding (Non-Breeding).

[11]Presence on Refuge based on information from the New York State Amphibian and Reptile Atlas Project 1990-1999. www.dec.state.ny.us/website/dfwmr/wildlife/herp/index.html

Priority Resources of Concern

The resources of concern table (Table 3-1) contains a large number of species with a broad array of habitat needs. The Refuge needs to prioritize these species and their associated habitats to determine what the Refuge is best suited to focus on in its management strategies. To guide us in prioritizing this list, we considered the following concepts:

- 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 USFWS trust resources such as migratory birds.

- 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 focal species that were ranked High or Moderate in Continental concern with a High to Moderate BCR Responsibility. If there were too many or too few birds with these rankings for a given habitat type then species with the highest then high then medium final BCR ranking were chosen. (See www.abcbirds.org/nabci for BCR rules used to rank birds.)

- Habitat conditions on or surrounding the Refuge may limit the Refuge's capability to support or manage for a potential species of concern. The following site-specific factors were evaluated:
    - Patch size requirements
    - Habitat connectivity
    - Compatibility of surrounding land uses
    - Environmental conditions: soils, hydrology, disturbance patterns, contaminants, predation, invasive species
    - Specific life history needs

- The likelihood that a potential species of concern would have a positive reaction to management strategies.

High and Moderate Priority Habitat Types

Refuge management is most often focused on restoring, managing, or maintaining habitats or certain habitat conditions to benefit a suite of focal species or a suite of plants and animals associated with a particular habitat. Montezuma NWR identified the high and moderate priority habitats on the Refuge based on information compiled (e.g., site capability, historic condition, current vegetation, conservation needs of wildlife associates). As part of this process we identified any limiting factors that affect the Refuge's ability to maintain these habitats (see Table 3-2).

Table 3-2 High and Moderate Priority Habitats on Montezuma NWR in Priority Order

High Priority Habitat Types	Reason for Selecting as a High Priority	Limiting Factors for Maintaining this Habitat
Freshwater Impoundments: emergent marsh-open water	Refuge has over 4,000 acres of this habitat within 12 manageable impoundments; More than 600,000 migrating ducks and geese use these areas annually; American and least bitterns, black tern, pied-billed grebe, Virginia rail, priority species in BCR 13 nest here; foraging areas for nesting bald eagles; foraging areas for migrating shorebirds. Emergent wetland is the habitat type containing the most species listed as a priority in the BCR 13 plan.	Requires water level manipulation; controlling dense monotypic stands of cattails; affected by weather; requires maintenance of dikes and water control structures; inflow of water and undesirable species from canal system and contaminants are of concern.
Freshwater Impoundments: inland mudflats	One of the most significant inland areas for shorebird migration including many BCR 13 priority species; ability to create mudflats within impoundments	Contaminants are a concern, controlling invasive species, affected by weather; requires maintenance of dikes and water control structures
Forested Wetland: bottomland hardwoods and riparian forest corridors	Supports native forest community and associated species including wood duck, cerulean warbler (highest number in New York), and priorities within BCR 13. Historically, was dominant habitat type in BCR 13. Nearly 95% of the original habitat types in the BCR have been lost.	Hydrology has been altered and water levels cannot be controlled; controlling invasive species; water quality is a concern.
Moderate Priority Habitat Types	**Reason for Selecting as a Moderate Priority**	**Limiting Factors for Maintaining this Habitat**
Upland Forest	Supports several BCR 13 priority bird species	Fragmentation, invasive species
Grasslands	Supports several BCR 13 priority bird species	Requires intensive management to maintain in grassland condition; size of fields determines presence of breeding birds; invasive species
Shrublands/Early Successional Habitats	Supports several BCR 13 priority bird species	Wetlands: water level fluctuations; invasive species; contaminants; may require restoration. Uplands: requires periodic management to maintain in shrub condition; succession, invasive species

Based on the criteria listed above and the habitat types identified on the Refuge as described in Table 3-2, we then developed a table of the priority species of concern with their associated habitat types (Table 3-3). This table also describes the habitat structure required by each priority or **"focal species"** and identifies other species that would benefit from the same or similar habitat conditions.

Table 3-3 Priority Resources of Concern, Habitat Structure, and Other Benefiting Species of Concern on Montezuma NWR

Habitat Type	Focal Species	Habitat Structure	Other Benefiting Species of Concern[1]
Freshwater Emergent Wetlands	American bittern	Tall, dense emergent vegetation, such as cattail, burreed, and bulrush, with water depth < 4 in. and a vegetation - open water ratio of 70:30. Inhabits wetlands <2.5 to 62.5 acres, but is more abundant in larger wetlands. Feeds on insects, amphibians, small fish and mammals, crayfish in vegetation fringes and shorelines (Gibbs et al. 1992, Lor 2000). Present on the refuge during migration and breeding seasons.	Virginia rail, black-crowned night heron, Canada goose Atl/SJBP, blue-winged teal, green-winged teal, common goldeneye, common merganser, hooded merganser, northern pintail, long-tailed duck, mallard, greater scaup, redhead, ruddy duck, tundra swan, common tern, osprey, short-eared owl, Wilson's phalarope, Wilson's snipe, wood duck, turtles, river otters
	Black tern[2]	Nest semi-colonially in large, shallow, emergent wetlands >50 acres and feed their young both insects and fish. Nests built of sticks and reeds on floating mats of dead vegetation or small mud flats. Flooding and predation on eggs and chicks, not habitat availability, may be the limiting factor (McCollough et al. 2003). Present on the refuge during migration and breeding seasons.	
	Least bittern	Freshwater wetlands with tall, dense emergent vegetation, such as cattail, burreed and bulrush, interspered with clumps of woody vegetation and open water with water depth > 18 in. and a vegetation/open water ratio of 50:50. Inhabits wetlands <24 acres. Feeds on small fish and insects in tall dense stands of emergent plants along deep, open water (Gibbs et al. 1992, Lor 2000). Present on the refuge during migration and breeding seasons.	
	Pied-billed grebe	Freshwater wetlands greater than 12.5 acres, with emergent vegetation separated by channels or patches of deep, open water (>17 in deep) and a 50:50 vegetation - open water ratio. Nest site is a floating platform among tall emergents and near deep, open water (Muller and Storer 1999, Lor 2000). Present on the refuge during migration and breeding seasons.	
	American black duck	Shallow, emergent wetlands of reeds, sedges, pondweed, floating-leaved plants, that are rich in invertebrates (Longcore et al. 2000). Breeding habitat is diverse and includes meadows, marshes, wooded wetlands, and upland forests (Longcore et al. 2000). Present on refuge year-round.	
	Canvasback	Variety of coastal marine and freshwater habitats, including estuaries, saltwater lagoons, brack-ish marshes, large slow-moving rivers, lakes, open marshes, ponds, sewage lagoons, and occasionally flooded fields; prefers larger water bodies that provide ample food (Mowbray 2002).	

Habitat Type	Focal Species	Habitat Structure	Other Benefiting Species of Concern[1]
	Lesser Scaup	During migration, variety of habitats, typically larger semipermanent and permanent wetlands and lakes and large impounded portions of rivers (>3,000 ha). Important migration habitats tend to have abundant foods (aquatic invertebrates) and shallow water (<3 m). Flocks tend to use smaller wetlands and marshes during spring migration (Austin et al. 1998).	
	Bald eagle[3]	Nests atop large, older trees (often the largest tree) near large lakes, rivers, and reservoirs that support abundant fish populations, although are opportunistic feeders. During the day perch on tall trees along the shore, usually away from human disturbance (Buehler 2000). Defend territories including active and alternate nests from other eagles; nest sites typically have at least one perch with a clear view of the water where they forage; exhibit high nest site fidelity.	
Inland Mudflats	Short-billed dowitcher	During migration most common on tidal flats, beaches, salt marshes, sewage ponds, and flooded agricultural fields. Feeds by rapid, vertical probing in soft mud and water. Most commonly probes around itself with pivoting movements of the body, then makes a step or 2 and repeats process. Feeds in water up to belly depth, sometimes while swimming (Jehl et al. 2001). At Montezuma, migrates through in April/May with a peek in the last two weeks of May, also migrates through in low numbers in July, and from Aug-Sept with a peek in the last week of August (ebird.org).	Other shorebirds, especially buff-breasted sandpiper and solitary sandpiper
	American golden-plover	During migration, birds use variety of inland and coastal habitats, both natural and human-made: native prairie, pastures, tilled farmland, burned fields, golf courses, airports, mudflats, shorelines, estuaries, and beaches (Johnson and Connors 1996). At Montezuma, migrates through in low numbers in April and May and from August into November with a peek during the last week of September (ebird.org).	

<table>
<tr><th>Habitat Type</th><th>Focal Species</th><th>Habitat Structure</th><th>Other Benefiting Species of Concern[1]</th></tr>
<tr><td rowspan="3">Bottomland Hardwood Forest and Riparian Forest Corridors</td><td>Cerulean warbler</td><td>More often in riparian or bottomland hardwood forest but also in dry slopes and ridgetops. Requires large tracts of mature forest (> 500 acres) with sparse understories and closed or semiclosed canopies; stays in the canopy (DeGraaf and Yamasaki 2001, Rosenberg et al. 2000). Present on the refuge during migration and breeding seasons.</td><td rowspan="3">American black duck, black-crowned night-heron, common goldeneye, wood duck, Cooper's hawk, red-shouldered hawk, rusty blackbird, prothonotary warbler, Canada warbler, Baltimore oriole, black-billed cuckoo, northern flicker, hooded merganser, scarlet tanager, willow flycatcher, Indiana bat, amphibians, river otter</td></tr>
<tr><td>Rose-breasted grosbeak</td><td>Exhibits a preference for mesic woodlands, swamp forests, riparian corridors; avoids dry oak (Quercus spp.) woodlands (Peterjohn and Rice 1991, Veit and Petersen 1993).</td></tr>
<tr><td>Wood thrush</td><td>Nests in interior and edge of mature, deciduous or mixed forests, particularly damp woodlands near swamps or water. Primary habitat features include trees taller than 53 feet, a shrub-subcanopy layer, shade, moist soil, and leaf litter (DeGraaf and Yamasaki 2001).</td></tr>
<tr><td rowspan="3">Upland Forest</td><td>Black-billed cuckoo</td><td>Young deciduous and mixed forest or shrubland with a dense understory of shrubs and vines. May be susceptible to habitat fragmentation and avoid forest patches less than 10 acres (DeGraaf and Yamasaki 2001, Hughes 2001). Only sporadically present on the refuge during migration and breeding seasons.</td><td rowspan="3">Baltimore oriole, brown thrasher, Canada warbler, red-shouldered hawk, Cooper's hawk, sharp-shinned hawk, rose-breasted grosbeak, cerulean warbler, Indiana bat</td></tr>
<tr><td>Scarlet tanager</td><td>Prefers mature forest, especially where oaks (Quercus spp.) are common, but may occur in young successional woodlands. In ne. U.S., occurs in a wide variety of forest types ranging from pine (Pinus)-oak woodland and eastern hemlock (Tsuga canadensis)–northern hardwoods to dry oak-hickory (Carya) woodland. Prefers to nest in large trees (Mowbray 1999)</td></tr>
<tr><td>Wood thrush</td><td>See above.</td></tr>
</table>

Habitat Type	Focal Species	Habitat Structure	Other Benefiting Species of Concern[1]
Grasslands	Bobolink	Fields at least 25 acres in size with medium to low vegetation density, a 50:50 mix of grasses and forbs, very few shrubs (< 1%), overall vegetation height of 30 – 40cm, and leaf litter 3-4cm (Morgan and Burger 2008). Present on the refuge during migration and breeding seasons.	Grassland obligates especially Henslow's sparrow, grasshopper sparrow, horned lark, upland sandpiper, northern harrier, sedge wren, short-eared owl. Also rusty blackbird, song sparrow.
	Eastern meadowlark	Accepts a wide variety of habitat conditions but requires fields >37 acres. Prefers densely vegetated fields with overall vegetation height of 20 – 40cm, 2-3% shrub cover, 20-30% forb component, and a litter depth of 2-6cm. Perches are important (Morgan and Burger 2008). Rare on the refuge.	
Shrubland/Early Successional Habitat	Field sparrow	Breeds in old fields in early stages of succession with scattered woody vegetation such as lightly overgrown pastures, abandoned hayfields, powerline corridors, woodland edges (DeGraaf and Yamasaki 2001). Present on the refuge during migration and breeding seasons.	Baltimore oriole, golden-winged warbler, northern flicker, red-headed woodpecker, song sparrow, willow flycatcher, black-billed cuckoo, Canada warbler, rose-breasted grosbeak, yellow-breasted chat
	Blue-winged warbler	A mix of vegetation including dense herbaceous growth, shrubs, and young forest (<20 feet tall); often near wetland edges or damp areas but also in dry uplands (Gill et al. 2001). Present on the refuge during migration and breeding seasons.	
	Brown thrasher	Uses a wide variety of habitats, but reaches highest densities in shrub or midsuccessional stages of forests. Present on the refuge in very low numbers during migration and breeding seasons.	
	American woodcock	During the breeding season woodcock use several habitat conditions in close proximity to one another: forest openings, ~1/2 acre or more in size, as singing grounds; shrubby areas, particularly alders and dense young hardwoods on moist soils as feeding/daytime cover; young to mid-aged forest (15-30 years old) as brood and nesting habitat; and clearings of 2-3 acres as roost sites during migration (Keppie and Whiting 1994, Sepik et al. 1981). Present on the refuge during migration and breeding seasons.	

[1]Many "other benefiting species of concern" have slightly different habitat requirements than the focal species. Management will primarily be directed at focal species, but other benefiting species will be considered as time, habitat conditions, and resources allow.
[2]Black tern is ranked low in BCR Responsibility but is a NY State endangered species and historically bred in large numbers on the refuge.
[3]Bald eagle is not ranked in the BCR but is a federally threatened species.

Adaptive Management

The priority resources of concern and their respective habitat attributes were used to develop specific habitat objectives. Refuge habitat management objectives must be achievable. Many factors, such as lack of resources, existing habitat conditions, species response to habitat manipulations, climatic changes, contaminants or invasive species, may reduce or eliminate the ability of the Refuge to achieve objectives. Although these limiting factors were considered during the development of Refuge objectives, conditions may and are likely to change over the next 15 years and beyond.

The Refuge will use adaptive management to respond to changing conditions that impair our ability to measure and achieve the habitat objectives. This requires that we establish and maintain a monitoring program to ensure that we can detect and respond to changing conditions.

Chapter 4 Habitat Goals and Objectives

The goals listed in this chapter and the objectives listed under each goal are in priority order. Habitat management goals and objectives will be met as time and resources allow, starting with the highest priority where practical.

Goal 1 Provide high quality mudflat and freshwater emergent marsh and open water wetland habitats dominated by native plants for migrating and breeding waterfowl, shorebirds, waterbirds, marshbirds, and bald eagles provided through water level control.

Discussion

The Montezuma National Wildlife Refuge is part of the 50,000-acre Montezuma Wetland Complex. The creation of the Barge Canal System, beginning in the early 1800s, and the draining of wetlands for agriculture and other uses dramatically changed the hydrology of the Montezuma wetlands. The wetlands continued to flood each spring creating thousands of acres of shallow wetlands, but the spring waters would recede quickly, and only the lowest areas remained wet through the summer. Once the Refuge was established, farm ditches were plugged and several impoundments were created to allow managers to control water levels and provide wetland habitat throughout the year, and restore some variability to the hydrology of the region.

The managed emergent wetland impoundments on the Refuge are diverse and varied, covering more than 4,700 acres. Because of the slight water level differences within individual impoundments, often a single impoundment will help meet multiple objectives within the same year. Water levels are adjusted within and between years to mimic natural hydroperiods associated with unaltered wetlands or to provide optimal habitat conditions for wetland-dependent wildlife species.

Primary objectives for managing open water areas are to maintain and improve native submergent aquatic vegetation communities, to increase habitat diversity within a wetland and to provide open water for resting and courtship activities of migratory and resident waterfowl. The submergent plant community provides a rich environment for aquatic macroinvertebrates, which in turn provides an important food source for wildlife especially breeding waterfowl and waterfowl broods. Native submergent plant species in central New York that have been found to have a high food value and/or support large concentrations of macroinvertebrates include duckweed, coontail, waterweed, water naiad and pondweeds.

Emergent wetlands can be managed in a number of different ways using a variety of techniques depending on the hydrology and the capacity for water level manipulation at a particular wetland. For example, some wetlands may be managed for a greater amount of open water, while others will be best suited for a greater percentage of native vegetation cover or subject to moist soil and mud flat management to benefit a host of species from waterfowl to wading birds to shorebirds. The expansive marshes on the Montezuma Refuge and potential marshes on large muck fields are ideal for supporting a slightly greater open water component for the large numbers of migratory waterfowl during the spring and fall. Wading birds will also benefit from open water management. Conversely, the numerous smaller wetlands interrupted by drumlin uplands found in the northern part of the Montezuma Wetlands Complex may be best suited to support more vegetation cover interspersed with open water for waterfowl pairing and brood-rearing and amphibian reproduction. Management for dense emergent vegetation cover and shallow water will benefit rails and songbirds while mudflat management will benefit migrating shorebirds (Ducks Unlimited, Inc. 2000).

For the most part, each impoundment is drawn down every four to seven years, with only a few pools scheduled each year to provide a diversity of habitats among the impoundments. This draw down mimics a drought in a natural marsh and allows the re-growth of natural vegetation. In year one of the cycle, the water is drained off the pool soon after the peak of waterfowl migration. The relatively cool soils in April and early May favor the germination of annuals such as Bidens *spp*., smartweed, and wild millet, among others. The seeds of these plants provide waterfowl food when the pool is re-flooded in the fall.

Organic material from several years of dead marsh vegetation is exposed to oxygen during the drawdown and thus oxidizes (breaks down) and becomes nutrients for the growth of new marsh plants. As more of the water evaporates the bottom "firms up" and provides a rich bed for the new plant roots. Some perennials, such as cattail and bur-reed, germinate and grow. These plants usually will remain in the understory but play an important role in future years of the cycle. If the water is drained off later when the soil is warmer (mid to late May) it is likely that purple loosestrife will germinate. That was formerly a problem, but the expanding population of *Galerucella* beetles seems to be capable of controlling loosestrife when it does germinate.

The second year of the cycle is a growth and re-colonization year. Residual seeds from the annuals provide a rich carbohydrate food source for the northward migrating waterfowl. The dead, and now partially decomposing, stalks of those plants become a food source for many kinds of invertebrates that, in turn, provide a critical protein source for the northbound birds, particularly for female ducks that will soon lay eggs. The cattails and bur-reed grow vigorously, and soon become colonized by muskrats which utilize the perennials as both a food source and a material for construction of their houses. The cover from the perennials, interspersed with openings newly created by the muskrat's activities, provides ideal conditions for waterfowl broods and migrating waterfowl.

In subsequent years of the cycle, as the perennials are used by muskrats and are stressed by higher, more constant water levels, the interspersion of emergent vegetation and small irregular water areas results in habitat conditions suitable to marsh-nesting birds. Initially, the dense vegetation is ideal for rails. As it becomes more open, it becomes ideal for least bitterns and as the pool becomes slightly more open nesting black terns may use it. The terns seem to favor old, sunken muskrat houses as nesting platforms. Eventually conditions become too open and the habitat value is greatly reduced for waterfowl and most marsh nesting species. The drawdown cycle starts over when Refuge managers determine that habitat value is relatively low. A "typical" cycle may last 4 to 7 years.

Objective 1.1 Emergent (Hemi-) Marsh – Migrating Waterfowl
Each year, provide a minimum of 1,000 acres of spring (March-April) and fall (Oct-Nov) waterfowl migration and staging habitat consisting of shallow flooded wetlands (≤12") with a mix of vegetation and open water (hemi-marsh) dominated by native emergent vegetation such as millet, barnyard grass, sedges, beggarticks, spike rushes, water plantain, and smartweeds.

Rationale
This will benefit several waterfowl species listed as priorities (highest, high, or medium) in the BCR 13 Plan including American black duck, Canada goose (Atl/SJB), common goldeneye, long-tailed duck, and lesser scaup (highest), greater scaup, northern pintail canvasback, and tundra swan (high), blue-winged teal, common merganser, mallard, and redhead (medium), among other waterfowl species that comprise the tens of thousands of ducks that pass through the Refuge during migration. The black duck, mallard, and northern pintail are species of management concern for the USFWS in the northeast region and are also listed in the New York Wildlife Action Plan as species of greatest conservation concern. The New York Important Bird Area program listed the large concentration of migrating waterfowl as important criteria in designating Montezuma as an IBA. Cowardin (1965) identified the most important plant communities on the Refuge as cattail marsh and bottomland hardwood forests.

Objective 1.2 Shallow Water Mudflats
Provide a minimum of 100 acres of shallow water (<3") mudflats with sparse (<25%) vegetation and high invertebrate biomass in at least two patches twice annually during spring and again during late summer and early fall to benefit migrating shorebirds including semipalmated sandpipers, greater yellowlegs, and short-billed dowitcher, among other shorebirds.

Rationale
Many shorebirds are of conservation concern in the Upper Mississippi Valley/Great Lakes (UMVGL) shorebird plan. The populations of these species are known or believed to be small and/or declining, and they are experiencing other known or potential threats (de Szalay et al. 2000). Most shorebirds using the Great Lakes region are long-distance migrants that require stopover sites to replenish their fat reserves and meet their high energetic demands of migration. These "staging" areas require shallow water and/or mud flat habitats with sparse vegetation, undisturbed roosting areas, and abundant invertebrate food resources. In this region these conditions can occur in various habitats including natural and managed wetlands, lake shorelines, sand and gravel bars, reservoirs, and flooded agricultural fields.

Researchers are just beginning to understand the importance of habitats in the interior U.S. to shorebirds. However, variable climatic conditions common to inland areas make shorebird habitat unpredictable compared to coastal regions. Precipitation and hydrology patterns from year to year and in different locations are highly variable. In addition, loss of wetlands from urban development, dikes and ditches, and agriculture has reduced the amount of habitat in the region. With the ability to manage water levels, Montezuma NWR can contribute to providing habitat for migrating shorebirds.

Objective 1.3 Open Water
Each year, provide open water on a minimum of 1,000 acres, consisting of at least 2 patches ≥100 acres from March through November. This will provide feeding habitat for bald eagles, particularly important during their fledging in mid to late summer, and migratory habitat for diving ducks.

Rationale
The bald eagle is a state threatened species and a bird of management concern for the USFWS as well as a species of greatest conservation concern in New York. The presence of breeding pairs contributed to the designation of Montezuma as an Important Bird Area. This also will benefit other species listed as priorities in the BCR 13 Plan including common goldeneye, lesser scaup, and long-tailed duck (highest), canvasback and greater scaup (high), and common merganser and redhead (medium).

Objective 1.4 Emergent Marsh – Breeding Marshbirds
Each year, provide a minimum of 800 acres of habitat for breeding marshbirds (especially black tern, pied-billed grebe, least bittern, and American bittern) consisting of an average mix of 50 - 70% vegetation and 30 – 50% open water (hemi-marsh) with an average water depth of 10-20" and at least 5 muskrat lodges per acre. Additionally, this habitat should be provided in a minimum of 3 patches >100 acres each.

Rationale
Black tern, pied-billed grebe, and least bittern are listed as medium priorities in the BCR 13 Plan and are species of greatest conservation concern in the New York Wildlife Action Plan. The black tern is listed as an endangered species and pied-billed grebe and least bittern are listed as threatened in New York. The abundance of these three breeding species was included as an important criterion in designating the Montezuma Wetlands Complex as an Important Bird Area in New York.

The American bittern is a high priority species in the BCR 13 Plan, the New York Wildlife Action Plan, and the North American Waterfowl Management Plan. American bitterns breed mainly in freshwater wetlands with tall, emergent vegetation of native species and avoid even-aged stands of older, dense or dry vegetation. Some of the regional threats to bitterns include habitat loss and degradation due to drainage, filling, and conversion to agriculture; vulnerability to habitat fragmentation and pesticides and contaminants; and non-native invasive plants (Mid-Atlantic/New England/Maritimes Waterbird Working Group 2006).

Goal 2 Restore and maintain bottomland hardwood forests (forested wetland), the riparian forests along the Seneca and Clyde Rivers, and upland forests to increase block size and connectivity and reduce fragmentation to support nesting waterfowl and songbirds, breeding amphibians, and uncommon plant communities.

Objective 2.1 Bottomland Floodplain Forest

Maintain and restore, as necessary, a minimum of 1,000 acres of mature bottomland floodplain forest dominated by red maple, American elm, green ash, and swamp white oak, by allowing natural processes and controlling non-native invasive species to provide breeding habitat for cavity nesting waterfowl (primarily wood duck), migratory songbirds (especially cerulean warbler), and breeding amphibians. The New York Natural Heritage Program identified the Montezuma floodplain forest as a significant ecological community.

Rationale

Cowardin (1965) identified the most important plant communities on the Refuge as bottomland hardwood forests and cattail marsh. This habitat supports high numbers of cerulean warblers as well as other high priority birds in BCR 13 including black-billed cuckoo, prothonotary warbler, Baltimore oriole, rusty blackbird, northern flicker, wood duck, and American black duck (highest priority). Many bat species listed by the New York Wildlife Action Plan as species of greatest conservation concern, including the federally endangered Indiana bat, roost and feed in floodplain forests.

Objective 2.2 Riparian Forest Corridor

Where practical, maintain and restore, as necessary, at least a 150m-wide (Fischer 2000) corridor of riparian forest along the Seneca and Clyde Rivers dominated by native species to maintain connectivity of bottomland hardwood forest and the riverine habitat and to protect the water quality of the river, and provide nesting habitat for wood duck, cerulean warbler, bald eagle, and other species of conservation concern.

Rationale

Although riparian habitats generally occupy small areas on the landscape, they are often more diverse and have more plants and animals than adjacent upland areas. Riparian areas help control nonpoint source pollution by holding and using nutrients and reducing sedimentation, supply food, cover, and water for many species, and serve as migration routes and stopping points between habitats for a variety of wildlife. Riparian vegetation shades streams to optimize light and temperature conditions for aquatic plants, fish, and other animals.

Through the land acquisition process, Montezuma NWR has an opportunity to restore riparian habitats in areas where such habitats are currently altered or degraded. For example, newly acquired agricultural lands adjacent to watercourses should be evaluated for restoration to shrub or forest riparian habitat. The river otter is recognized as a species of greatest conservation concern in the New York Wildlife Action Plan and will benefit from habitat restoration as will Baltimore oriole, cerulean warbler, and other species associated with mature bottomland forests.

Objective 2.3 Mature Upland Forest
Provide 300 acres of mature-late successional upland forest (>150 years old) dominated by native species, especially sugar maple, oaks, hickories, and white ash to benefit migratory breeding birds including wood thrush, cerulean warbler, and black-billed cuckoo. Focus forest management and restoration on parcels within 500-acre blocks of forest or more, if possible, with an emphasis on those parcels with minimal edge, and maintain forests in close proximity to one another.

Rationale
Although once dominated by a mix of oak-hickory, northern hardwood, and hemlock-northern hardwood forests, the upland areas around Montezuma are now dominated by agricultural land interspersed with wetlands and remnant forest stands. Currently, the mature forest habitats on the Refuge are not actively managed. Although in small patch sizes, the upland forests are relatively intact with a diversity of canopy tree species and some midstory and understory plant associates and light impact from invasive species. These forests support BCR 13 priority bird species including wood thrush and cerulean warbler (highest), and black-billed cuckoo (high). These three species are also birds of management concern for the USFWS in the northeast region and are noted as species of greatest conservation concern in the New York Wildlife Action Plan. The federally endangered Indiana bat roosts and feeds in upland forests (Luensmann 2005).

Goal 3 Provide a diverse mix of grasslands and shrublands within the Montezuma Wetlands Complex juxtaposed to reduce fragmentation and edge effect and to enhance habitat quality for priority species of conservation concern.

Objective 3.1 Grasslands
Maintain a minimum of 350 acres of grassland habitat dominated by native species with a mix of cool and warm season grasses, < 20% forbs and < 3% shrub cover to provide habitat diversity, nesting cover for waterfowl and other grassland nesting birds (especially bobolink), habitat for pollinators, and improved wildlife viewing opportunities for the visiting public. Focus grassland management on large (> 20 acres) fields, with an emphasis on those fields with minimal edge, less surrounding forest, and more surrounding open habitats (old fields, emergent wetlands), and where possible maintain grasslands in close proximity to one another.

Rationale
Mowing and prescribed fire are used to retard woody growth and maintain grassy conditions for nesting waterfowl and songbirds. Many grassland-nesting songbirds are area-sensitive and each species prefers a slightly different grass and forb structure and bare ground. Grasslands of 100 acres or more will provide habitat for a larger suite of grassland bird species, rather than small (<10 acres), isolated grassland patches. The bobolink is a priority (medium) in the BCR 13 Plan.

Populations of grassland birds are declining as their habitats are converted to agricultural, residential, and other urban uses. Norment (2002) provides an eloquent commentary on the need to approach grassland bird conservation in the northeast with “particular wisdom and care.” He notes that despite the relatively recent (last 200 years) rise and fall of grassland habitats and associated birds in the northeast, the region may still be important for these species given their continental decline and habitat loss in the core of their ranges in the midwest.

Objective 3.2 Shrubland/Early Successional Habitats
Provide 100 acres of shrubland habitat dominated by native species with a mix of shrubs and herbaceous vegetation throughout the Refuge to provide breeding habitat for shrubland-dependent birds, especially

brown thrasher, field sparrow, and blue-winged warbler and to provide food sources for migrating songbirds.

Rationale
A range of habitat types are included under shrubland/early successional habitat (collectively called "thicket" habitat) ranging from brushy old field conditions to regenerating forests to more naturally maintained, relatively stable shrublands associated with wetlands. Shrublands and early successional habitat support many species of high priority in the BCR 13 Plan including blue- and golden-winged warblers and field sparrow. Managing small patches (< 20 acres) as shrubland habitat can be more effective for many of the shrubland birds than managing such relatively small patches for other habitat types such as grassland or forest because of the relatively low patch size sensitivity exhibited by many shrubland birds compared to some of the grassland and forest birds. Consolidating and clustering patches and maintaining some large patches of shrubland habitat will provide habitat for a range of wildlife associated with these habitats.

Chapter 5 Habitat Management Units and Strategies

This Chapter includes the following sections:

- **Introduction**
- **Habitat Management Units**
- **Habitat Management Strategies**

Introduction

This chapter sets out specific management strategies 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. A comprehensive literature review was conducted to identify all potential strategies for each habitat objective. In consultation with other Refuge biologists, managers, and experts, we then selected the most effective strategies for accomplishing the habitat objectives. Since environmental factors, such as wildlife population changes, 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, strategies are discussed conceptually. The full list of potential management strategies is in Appendix B.

Habitat Management Units

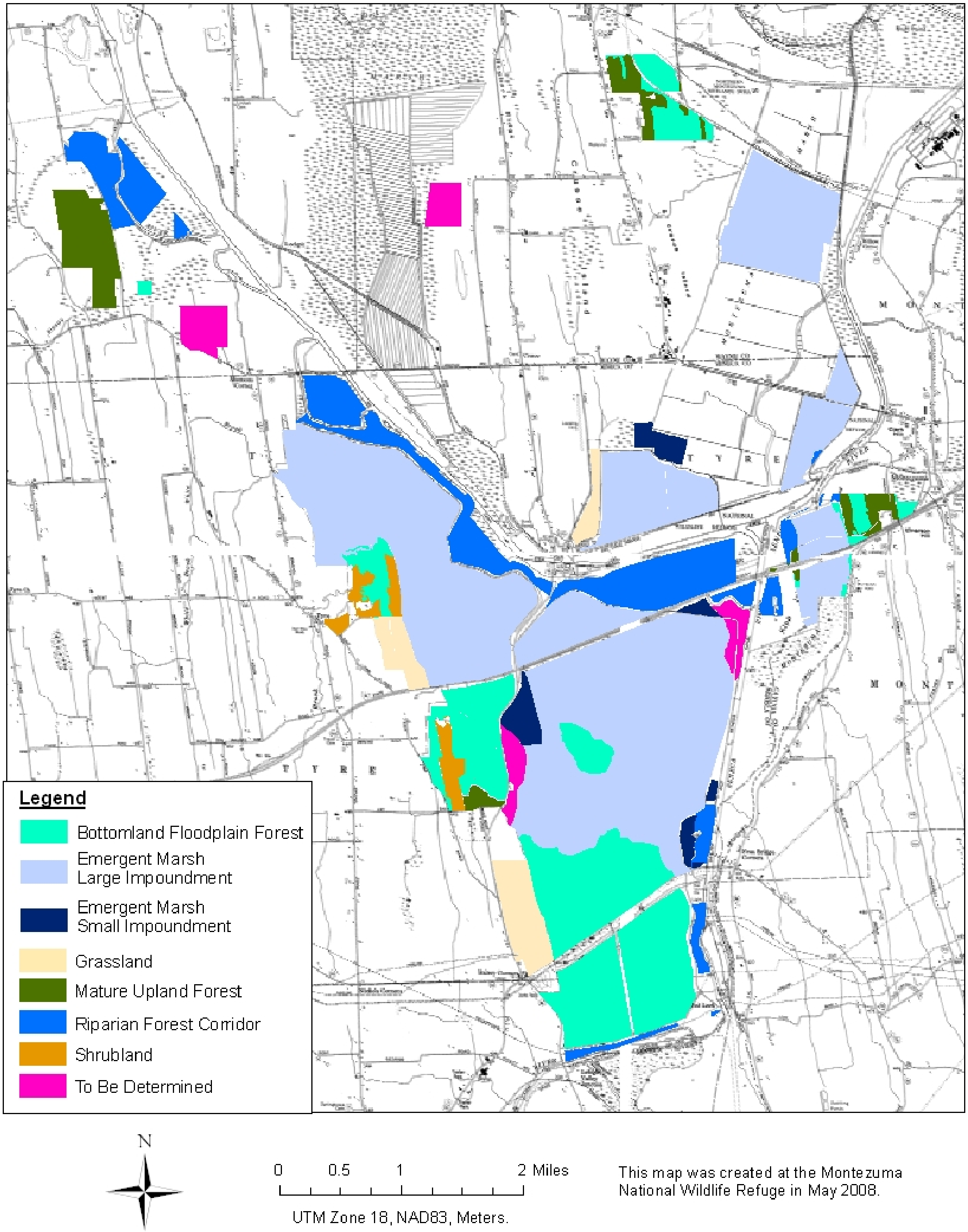
For the purpose of meeting habitat management objectives, Montezuma NWR is divided into Management Units (Map 5-1). Management Unit boundaries were delineated based on a clear ecological feature such as a transition from wetland to upland forest or based on a physical feature such as a road. Table 5-1 summarizes the management units at Montezuma NWR, the habitats objectives, and acreages.

Table 5.1 Habitat Management Units at Montezuma NWR

Habitat Management Units	Current Habitat Type	Treatment Areas	Habitat Objective	Acres
Emergent Marsh Large Impoundment	Cropland	Furman Tract North	1.1, 1.2, 1.3, 1.4	45
	" "	Furman Tract South		137
	" "	Jackson Muck		183
	Emergent Marsh	Knox Marsellus Marsh		228
	" "	Main Pool		1,663
	" "	May’s Point Pool		199
	" "	Puddler Marsh		95
	" "	Sandhill Crane Unit		448
	" "	Tschache Pool		1,270
Emergent Marsh Small Impoundment	" "	Benning Marsh	1.1, 1.2	18
		Display Pool		2

	" "	Millennium Marsh		70
	" "	Shorebird Unit		8
	" "	Stowell		63
	" "	Visitor Center Wetland		26
Bottomland Floodplain Forest	Bottomland Floodplain Forest	Cerulean Forest East	2.1	45
		Cerulean Forest West		85
		Clark's Ridge Forest		75
	Early Successional Forested Wetland	Esker Brook Forest East		118
		Esker Brook Forest West		48
	Bottomland Floodplain Forest	Jackson Floodplain Forest		53
	" "	Knox Marsellus Forest		3
	" "	Maple Island		73
	Pond	North Spring Pool		91
	" "	South Spring Pool		37
	Bottomland Floodplain Forest	Stowell Forest		2
	" "	Swamp Woods Natural Area		457
	" "	Unit 17 East		344
	" "	Unit 17 West		266
	" "	Wright Property		10
Riparian Forest Corridor	Riparian Forest Corridor	Benning Seneca River Forest Corridor	2.2	24
		Eagle Island		101
		Furman Seneca River Forest Corridor		2
	Riparian Forest Corridor	Jackson Riparian Forest		56
	Riparian Forest Corridor and Emergent Wetland	May's Clyde River Forest Corridor (including Box Elder Bog)		296
	Riparian Forest Corridor	Mud Lock Area		1
	Thicket	Seneca Trail Area		39
	Early Successional Forest	Syron's Island		98
	Mostly Riparian Forest Corridor	Syron West		116
	Riparian Forest Corridor	Tschache Clyde River Forest Corridor		205
	Riparian Forest Corridor	Unit 17 Cayuga and Seneca Canal Forest Corridor		26
	Riparian Forest Corridor	Unit 17 Seneca River Forest Corridor		32
Mature Upland Forest	Successional Forest	Cerulean Forest East	2.1, 2.3	1
	" "	Cerulean Forest West		81

	" "	Esker Brook Forest West		48
	Cropland and Successional Forest	Jackson Uplands		59
	Shrubland	Lay Road Forest		24
	Successional Forest and Shrubland	Nash Forest	2.3	211
Grassland	Grassland	Avery Tract	3.1	54
	" "	Sub-headquarters Fields		57
	Grassland and Cropland	Waugh I, II, and South		90
	Grassland	Wilgoose (including Winery Field)		173
Shrubland	Shrubland	Clark's Ridge Old Field and Wet Meadow	3.2	64
	" "	Esker Brook Thicket		61
	Cropland and Shrubland	Waugh III		14
To Be Determined	Shrubland	Noble Property	2.1, 2.3, or 3.2	91
		Russell Property	2.1, 2.3, 3.1, or 3.2	65
	Grassland	Wildlife Drive Inside Corner Field	3.1 or 3.2	19
	Cover Crop	Wildlife Drive Outside Corner Field	2.2, 3.1, or 3.2	37



Map 5-1 Habitat Management Units on Montezuma National Wildlife Refuge.

Habitat Management Strategies

The following management strategies apply to all management units.

- Continue to work with interested landowners and conservation partners to protect through acquisitions, conservation easements, donations, and management agreements high priority lowlands (e.g., large parcels adjacent to public lands that contain wetland, restorable wetland and upland habitat, parcels with high-quality, unique and/or endangered species habitats that are currently threatened by development, and parcels with large, contiguous areas of wildlife habitat or those that would provide continuity or a corridor with existing habitat, reducing fragmentation). Protection is the highest priority for existing wetland habitat in the MWC (Ducks Unlimited, Inc. 2000).
- Continue the cooperative farming agreements on newly acquired lands and degraded lands until an alternative habitat objective and management prescription is developed and funded to avoid growth of invasive plants into abandoned farm fields.
- Continue to work with conservation partners to assess the hydrology and biogeochemistry of soils and waters in the Montezuma Wetlands Complex to address four major hydrological issues: (1) surface water flows and groundwater conditions, particularly outflows to the Seneca River and inflows from Cayuga Lake; (2) how much of the former Montezuma Wetlands are no longer hydrologically connected to the Seneca River, and what effect will present and future impounded areas within the MWC have on these relationships; (3) soil and water chemistry of the MWC, particularly in relation to pesticide and fertilizer residues in abandoned muck soils; and (4) the effect of up-gradient sources of chemicals such as those from the Seneca Meadows landfill and smaller waste-disposal sites on the overall quality of MWC wetlands.
- Develop a comprehensive GIS-based database for the Montezuma Refuge and the surrounding landscape to map and analyze habitat types and conditions, rare species populations, other ecological features, land use issues, locations of dikes, water control structures, bathymetry of impoundments, and canals, and other relevant information for long-term planning and monitoring of resources.
- Research native seed sources and germination techniques for all restoration efforts; consider a nursery.
- Control invasive plants to maintain the biological integrity and diversity of all habitats and management units. The potential management strategies for controlling invasive plants are described in Appendix B.
- As time permits, conduct baseline surveys of birds, amphibians, reptiles, mammals, plants, invertebrates, fish, and other species. Within five years of the initiation of a survey or inventory, evaluate the data to determine what additional baseline surveys are needed to determine presence/absence in respective habitat types and to determine what additional surveys are needed to address management questions.
- Evaluate results of wildlife and vegetation surveys every five years.
- Monitor trends of focal bird species during the targeted time in their life cycle (e.g., waterfowl and shorebirds during spring and fall migration, waterbirds and cerulean warblers during the breeding season), correlate bird use with management actions, and encourage partners to enter data in www.ebird.org.
- Monitor vegetative responses to management actions.
- Monitor and manage the Research Natural Areas and National Natural Landmark to maintain the ecological functions and associated rare and unique plants and animals.

Emergent Marsh Large Impoundment Management Unit

Objectives:
- 1.1 Emergent (Hemi-) Marsh – Migrating Waterfowl
- 1.2 Shallow Water Mudflats - Shorebirds
- 1.3 Open Water – Bald Eagles
- 1.4 Emergent Marsh – Breeding Marshbirds

Table 5-2 Emergent Marsh Large Impoundment Treatment Areas

Treatment Area	**Acres**
Main Pool	1,663
Sandhill Crane Unit	448
Tschache Pool	1,270
May's Point Pool	199
Knox-Marsellus Marsh	228
Puddler Marsh	95
Furman North	45
Furman South	137
Jackson Muck	183
TOTAL	**4,268**

Management Strategies
- Restore muckland areas as they become available to the Fish and Wildlife Service to functioning wetland systems. For most parcels, use diked impoundments as a preferred method of restoration because the original hydrology of the MWC was essentially lost with the construction of the Barge Canal in the early 1900's. Artificial management of water levels is currently the only means to provide abundant quality wetland habitat in most of the MWC. Diked impoundments also offer the greatest benefit to the greatest number of wildlife species by allowing a diversity of management options. A disadvantage of this restoration method is that diked impoundments require persistent and costly maintenance. Newly acquired mucklands should remain in the cooperative farming program until restoration is feasible. It may be desirable to postpone restoration until adjacent parcels are purchased to increase impoundment size to decrease habitat fragmentation and maintenance costs. When possible, restoration will focus on re-establishing a natural hydrological regime engineered to minimize maintenance costs.
- Continue to implement the 4-7 year drawdown cycle through water level controls.
- Continue to record and maintain logs of the proposed and actual water levels for each impoundment (e.g., 2005 proposed, 2005 actual, 2006 proposed).
- Continue to monitor the response of annual moist soil vegetation after each drawdown.
- Continue to monitor the response of purple loosestrife to herbivory by the *Galerucella* beetles.
- Monitor and control non-native carp to limit their damage to submergent vegetation.
- Continue to monitor the resident Canada goose population on the refuge and implement a control program (e.g., open portion of refuge to the Canada Goose September Hunt Season) as needed.
- Monitor and regulate muskrat populations as needed to provide an appropriate mix of vegetation and open water, to ensure adequate muskrat houses for marshbird nest sites, and to minimize muskrat damage to dikes.
- Continue mapping the bathymetry of each impoundment to correlate water gauge readings with actual water depths.
- Monitor and regulate beaver populations as needed to minimize damage to structures and ditches.

- Restore up to 250 acres of the Dry Marsh in the northern portion of the Main Pool by excavating muck and constructing a series of inter-connected depressions to re-connect the hydrology between the Dry Marsh and the Main Pool (Appendix C).
- Consider creating openings in cattail monocultures in dry marsh portions of other impoundments using the same methods as in the Main Pool Dry Marsh.
- Consider keeping Furman Tracts North and South in the Cooperative Farming Program until adjacent parcels are acquired to create a large impoundment and eliminate the need for an interior dike on the Main Muck.
- Restore the Sandhill Crane Unit by shaping and reinforcing the dikes, installing water control structures and water level gauges, and seeding emergent wetland plants to promote desirable vegetation and inhibit the establishment of invasive plants.
- Avoid summer drawdowns (June-July), as much as possible, in impoundments with nesting black terns so nests are not stranded on dry ground, leading to nest desertion and possible increased predation (John Confer, personal communication, August 1988).

Emergent Marsh Small Impoundment Management Unit

Objectives:
- 1.1 Emergent (Hemi-) Marsh – Migrating Waterfowl
- 1.2 Shallow Water Mudflats - Shorebirds

Table 5-3 Emergent Marsh Small Impoundment Treatment Areas

Treatment Area	**Acres**
Display Pool	2
Millennium Marsh	70
Benning Marsh	18
Shorebird Unit	8
Stowell	64
Visitor Center Wetland	26
TOTAL	**120**

Management Strategies
- Restore muckland areas as described for Emergent Marsh Large Impoundments.
- Continue to record and maintain logs of the proposed and actual water levels for each impoundment (e.g., 2005 proposed, 2005 actual, 2006 proposed).
- Continue to monitor trends of focal bird species during the targeted time in their life cycle (e.g., waterfowl and shorebirds during spring and fall migration), correlate bird use of impoundments with management actions, and encourage partners to enter data in www.ebird.org.
- Continue to monitor the response of purple loosestrife to herbivory by the *Galerucella* beetles.
- Monitor and control non-native carp to limit their damage to submergent vegetation.
- Continue to monitor the resident Canada goose population on the refuge and implement a control program (e.g., open portion of refuge to the Canada Goose September Hunt Season) as needed.
- Monitor and regulate muskrat populations as needed to provide an appropriate mix of vegetation and open water and to minimize muskrat damage to dikes.
- Continue mapping the bathymetry of each impoundment to correlate water gauge readings with actual water depths.
- Monitor and regulate beaver populations as needed to minimize damage to structures and ditches.
- Install water level gauges at the Display Pool, Millennium Marsh, and the Shorebird Unit.
- Grade the Display Pool and the Shorebird Unit to improve water level control.

- For spring and fall shorebird migration: Continue to conduct slow spring drawdowns to expose mudflats through spring shorebird migration. This also will allow the growth of moist soil vegetation, which should be disked during the summer to break up organic root matter, which will encourage decomposition, which increases invertebrate populations. After disking, flood slightly (approximately 3 inches) to provide mudflats for fall-migrating shorebirds.
- For fall shorebird migration: Maintain high water levels through mid-summer and then slowly lower water levels to expose mudflats.

Bottomland Floodplain Forest Management Unit

Objective 2.1 Bottomland Floodplain Forest

Table 5-4 Bottomland Floodplain Forest Treatment Areas

Treatment Area	**Acres**
Cerulean Forest East	45
Cerulean Forest West	85
Clark's Ridge Forest	75
South Spring Pool	37
Unit 17 West	266
Unit 17 East	344
North Spring Pool	91
Maple Island	73
Swamp Woods Area	457
Esker Brook Forest East	118
Esker Brook Forest West	48
Jackson Floodplain Forest	53
Wright Property	10
TOTAL	**1,701**

Management Strategies:

- Evaluate the opportunity to restore newly acquired mucklands outside the Main Muck to bottomland hardwood forest to enhance the block size and connectivity of forest habitats.
- Secure funding to remove and/or reforest the mowed-grass mid-dike separating Units 17 East and West. This dike, along with the ditches on either side of it, creates a 50m wide forest-dividing corridor. Rich et al. (1992) found that relative abundances of forest-interior neotropical migrants were reduced significantly along 16m and 23m wide forest-dividing corridors compared to forest interiors in New Jersey. They also found that brown-headed cowbirds exhibited significantly elevated abundances associated with the presence of mowed grass in the corridors.
- Allow natural seasonal flooding to occur within the Unit 17 East and West "greentree" impoundments.
- Do not flood the interior of Units 17 East and West to avoid damaging trees.
- Keep the ditches surrounding Units 17 East and West flooded to provide habitat for nesting waterfowl such as wood ducks as well as fairy shrimp.
- Continue to limit visitor access into wooded wetland areas during the breeding season.
- Evaluate opportunities to restore other contiguous areas to floodplain forests and to link these lowland forests with mature upland forests to increase forest block size and connectivity and reduce fragmentation.
- Rely on natural tree cavities for nest sites for wood ducks and other cavity nesters.
- Identify and map vernal pools within floodplain forests.

- Drain and reforest North and South Spring Pools. Both of these pools have been held at constant, high water levels for many years killing the standing timber in the impoundments. High mineral content precludes the development of much aquatic vegetation and the high water regime has not allowed the development of moist soil vegetation.
- Repair the water control structure at South Spring Pool so it can be drained and reforested.
- Compare the results of breeding bird surveys in greentree reservoirs and control areas.
- Conduct forest assessments to determine if silvicultural prescriptions are needed.
- Promote the reforestation of artificial forest openings, areas surrounding forest peninsulas, gaps between isolated forest tracks, and riparian corridors to create more forest interior for area-sensitive species.

Riparian Forest Corridor Management Unit

Objective 2.2 Riparian Forest Corridor

Table 5-5 Riparian Forest Corridor Treatment Areas

Treatment Area	**Acres**
Seneca Trail Area	39
Syron's Island	98
Syron West	116
Eagle Island	101
Jackson Riparian Forest	56
Tschache Clyde River Forest Corridor	205
May’s Clyde River Forest Corridor	296
Benning Seneca River Forest Corridor	24
Furman Seneca River Forest Corridor	2
Mud Lock Area	1
Unit 17 Seneca River Forest Corridor	32
Unit 17 Cayuga and Seneca Canal Forest Corridor	26
TOTAL	**996**

Management Strategies:

- Continue reforesting the Seneca Trail Area by planting native tree and shrub saplings and seedlings and by direct seeding native plants, including woody and herbaceous species.
- Allow Box Elder Bog to succeed to forest and include it in the May’s Clyde River Forest Corridor Treatment Area. Box Elder Bog is surrounded on three sides by forest. Allow water levels to fluctuate with the natural hydroperiod.
- Control the reed canary grass in the eastern portion of the May’s Clyde River Forest Corridor Treatment Area and then plant native trees, shrubs, and herbs.
- Rely on natural tree cavities for nest sites for wood ducks and other cavity nesters.
- Conduct forest assessments to determine if silvicultural prescriptions are needed.
- Limit visitor access near bald eagle nesting and foraging areas to minimize disturbance.
- Monitor all restoration efforts to determine the most efficient method.

Mature Upland Forest Management Unit

Objective 2.3 Mature Upland Forest

Table 5-6 Mature Upland Forest Treatment Areas

Treatment Area	Acres
Cerulean Forest East	1
Cerulean Forest West	81
Lay Road Forest	24
Nash Forest	211
Jackson Uplands	59
TOTAL	**376**

Management Strategies:

- Evaluate opportunities to reforest areas to link these upland forests with mature wetland forests to increase forest block size and connectivity and reduce fragmentation.
- Rely on natural tree cavities for nest sites for cavity nesters.
- Conduct forest assessments to determine if silvicultural prescriptions are needed.
- Rely on natural tree fall gaps within mature forests to create a multi-layered forest structure with a diversity of dead and down woody debris.
- Promote the reforestation of artificial forest openings, areas surrounding forest peninsulas, gaps between isolated forest tracks, and riparian corridors to create more forest interior for area-sensitive species.
- Reforest the portions of the Nash property that are currently enrolled in the cooperative farming program. These fields are adjacent to a riparian forest corridor.
- Allow the field on the Smith property to succeed naturally to forest and include it in the Cerulean Forest West Treatment Area. Allow the forest surrounding this field to succeed from early successional to mature forest.

Grassland Management Unit

Objective 3.1 Grasslands

Table 5-7 Grassland Treatment Areas

Treatment Area	Acres
Avery	54
Sub-headquarters Fields	57
Waugh I	36
Waugh II	30
Waugh South	24
Wilgoose	173
TOTAL	**374**

Management Strategies:

- Evaluate growing season management options such as mowing, haying, or burning for the Avery Grassland to reduce warm season grass cover and increase species and structural diversity. This 54-acre field is surrounded by open habitats (emergent marsh and cropland) and could support grassland birds, but it is currently dominated by a dense stand of warm season grasses.

- Remove the hedgerow on the eastern border of the Avery Grassland and the small trees and shrubs along ditch that bisects southern end of the Unit.
- Evaluate growing season management options such as mowing, haying, or burning for the Sub-headquarters Fields to reduce warm season grass cover and increase species and structural diversity. Norment (1999) found low grassland bird numbers in these fields and suggested that the configuration of these fields does not warrant intensive management. However, they are adjacent to open habitat in the Main Pool so they may be productive grasslands if dominated by more desirable vegetation.
- Remove the trees and shrubs growing on the eastern edge of the field near the Main Pool.
- Continue to use mowing as a tool to discourage shrub invasion and to promote growth of low, dense grasses and forbs in the Waugh I, II, and South Treatment Areas. Between 1995 and 1998, grassland bird abundances were higher on the Waugh tract than in other fields surveyed at Montezuma. Northern harrier, savannah sparrow, bobolink, and eastern meadowlark nested in this field during the survey period.
- Remove the willow trees along the drainage ditch near the eastern boundary of Waugh I.
- Remove the hedgerow along the western boundary of Waugh II.
- Monitor the recently restored Wilgoose field for vegetative response and response by grassland breeding birds.
- Remove the hedgerow separating the Wilgoose Grassland from the Montezuma Winery Field and prepare and seed the Winery Field to create 173 acres of contiguous grassland.
- Maintain grassland areas by mowing between July 15th (preferably August 15th) and October 15th depending on the desired vegetation structure (the latter date will benefit pollinators), every 1 to 3 years. Mowing may be conducted within a different block in each field annually on a rotational basis.
- Use prescribed fire in the spring to encourage the growth of warm season grasses where they are sparse and to prevent encroachment of woody vegetation and invasive species. Do not conduct spring burns in dense warm season grass stands as spring burning will encourage warm season grass growth and decrease habitat quality.
- Remove hedgerows and small patches of trees to increase connectivity of open habitats.

Shrubland Management Unit

Objective 3.2 Shrubland/Early Successional Habitats

Table 5-8 Shrubland/Early Successional Treatment Areas

Treatment Area	Acres
Clark's Ridge Old Field	40
Waugh III	14
Clark's Ridge Wet Meadow	24
Esker Brook Thicket	61
TOTAL	**139**

Management Strategies:

- If possible, use selective herbicide application to maintain shrubland habitats with vegetative cover that has about equal abundance of herbs and patches of shrubs (Confer and Pascoe 2003).
- Work with partners to develop cost-effective methods for managing and maintaining shrublands dominated by native shrub species and few or no invasive species.

- Develop a shrubland monitoring and management strategy including a comparison of the avian and vegetative response to mechanically vs. chemically maintained shrublands.
- Remove Waugh III from the cooperative farming program, and plant shrubs to facilitate conversion to a thicket dominated by native species.
- Put the Clark's Ridge old field into a 5-year mowing rotation to set back succession.
- Shift the management of the Esker Brook Fields (south, central, and north) from grassland to shrubland. Norment (1999) found low grassland bird numbers in these fields and suggested that the configuration of these fields does not warrant intensive management.

To Be Determined Management Unit

Objectives to be determined.

Table 5-9 To Be Determined Treatment Areas

Treatment Area	**Acres**
Wildlife Drive Inside Corner Field	19
Wildlife Drive Outside Corner Field	37
Russell Property	65
Noble Property	91
TOTAL	**212**

Management Strategies:

- Continue to prevent and control invasive plants in the Wildlife Drive Inside Corner Field while evaluating it for conversion to grassland or shrubland.
- Continue to prevent and control invasive plants in the Wildlife Drive Outside Corner Field while evaluating it for conversion to grassland, shrubland, or riparian forest.
- Evaluate the habitat within and surrounding the Russell Property to determine if this parcel should be restored to shrubland or forest.
- Evaluate the habitat within and surrounding the Noble Property to determine if this parcel should be restored to grassland, shrubland, or forest. Consider including the Noble Property in the Cooperative Farming Program to inhibit invasive plant growth.

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New York Natural Heritage Report
on Rare Animals, Rare Plants, and Significant Ecological Communities

of MONTEZUMA NATIONAL WILDLIFE REFUGE

Prepared February, 2006 from the Biodiversity Databases of the New York Natural Heritage Program, NYS DEC, 625 Broadway, Albany, NY, 12233-4757.

COMMON NAME	SCIENTIFIC NAME	NY STATE LISTING	NY STATE RANK*
<u>Montezuma National Wildlife Refuge</u>			
Documented on the Refuge <u>since</u> 1985			
Birds			
Pied-billed Grebe	*Podilymbus podiceps*	Threatened	S3
Bald Eagle	*Haliaeetus leucocephalus*	Threatened**	S2S3
Black Tern	*Chlidonias niger*	Endangered	S2
Short-eared Owl	*Asio flammeus*	Endangered	S2
Dragonflies and Damselflies			
Blue-tipped Dancer	*Argia tibialis*		S1
Plants			
Holly-leaved Naiad	*Najas marina*	Endangered	S1
Ecological Communities			
Floodplain Forest			S2S3
Other Species and Community Types Documented near the Refuge <u>since</u> 1985			
Birds			
Sedge Wren	*Cistothorus platensis*	Threatened	S3
Great Blue Heron	*Ardea herodias*		S5
Moths			
Imperial Moth	*Eacles imperialis imperialis*		SU
Plants			
Kentucky Coffee Tree	*Gymnocladus dioica*	Endangered	S1
Big Shellbark Hickory	*Carya laciniosa*	Threatened	S2
Seaside Bulrush	*Bolboschoenus maritimus* ssp. *paludosus*	Endangered	S2
Salt-meadow Grass	*Leptochloa fusca* ssp. *fascicularis*	Endangered	S1
Ecological Communities			
Inland Salt Pond			S1
Inland Salt Marsh			S1
Shrub Swamp			S5

COMMON NAME	SCIENTIFIC NAME	NY STATE LISTING	NY STATE RANK*
Documented on or near the Refuge (precise locations unknown) before 1940.			
Plants			
Golden Dock	*Rumex maritimus*	Endangered	S1
Log Fern	*Dryopteris celsa*	Endangered	S1
Communities			
Inland Salt Marsh			S1
Documented near the Refuge before 1970; current status unknown.			
Birds			
Northern Harrier	*Circus cyaneus*	Threatened	S3
Plants			
Button-bush Dodder	*Cuscuta cephalanthi*	Endangered	S1
Seaside Crowfoot	*Ranunculus cymbalaria*	Endangered	S1
Marsh Valerian	*Valeriana uliginosa*	Endangered	S1S2
Pink Wintergreen	*Pyrola asarifolia* ssp. *asarifolia*	Threatened	S2
Sartwell's Sedge	*Carex sartwellii* var. *sartwellii*	Threatened	S1S2
Documented near the Refuge at one time, but now extirpated from those locations.			
Plants			
Seaside Crowfoot	*Ranunculus cymbalaria*	Endangered	S1
Marsh Arrow-grass	*Triglochin palustre*	Threatened	S2
Marsh Valerian	*Valeriana uliginosa*	Endangered	S1S2

* Rarity in NYS as ranked by NY Natural Heritage Program on a 1 to 5 scale:
S1 = Critically imperiled; S2 = Imperiled; S3 = Rare or uncommon;
S4 = Abundant and apparently secure; S5 = Demonstrably abundant and secure;
SH = Historical records only; no recent information available;
SU = Not yet ranked.

** Also Federally Listed.

Natural community occurrences in this report are all ranked as being of excellent quality, and therefore are considered significant from a statewide perspective. By meeting specific, documented significance criteria, the NY Natural Heritage Program considers this occurrence to have high ecological and conservation value.

Potential Habitat Management Strategies

This section identifies potential management tools or strategies that are available to land managers to achieve desired habitat objectives. These strategies were identified through successful refuge application, literature review and in consultation with other land managers**.**

Invasive Species Management

Controlling and managing invasive species is a strategy for maintaining the biological integrity and diversity of all habitats. The *Fulfilling the Promise* National Invasive Species Management Strategy Team developed a national strategy for management of invasive species for the National Wildlife Refuge System in 2002. The strategy recommends the following priority order of action for invasive species management:

1. Prevent invasion of potential invaders.
2. Eradicate new and/or small infestations.
3. Control and/or contain large established infestations.

Potential management strategies for preventing invasive species, prioritizing control efforts for established invasive species, and controlling invasive species are described in detail below. Prior to the initiation of invasive species control efforts, the refuge manager must understand the biology of the species to be controlled. A number of resources are available on the internet to assist refuge managers with invasive species management. This is a partial list of helpful websites.

- National Invasive Species Information Center: http://invasivespeciesinfo.gov/index.shtml
- National Biological Information Infrastructure Invasive Species Information Node: http://invasivespecies.nbii.gov/
- The Global Invasive Species Initiative: http://tncweeds.ucdavis.edu/control.html
- USGS Invasive Species Program: http://biology.usgs.gov/invasive/
- Invasive Plant Atlas of New England (IPANE): http://nbii-nin.ciesin.columbia.edu/ipane/
- Weeds Gone Wild: http://www.nps.gov/plants/alien/index.htm

Refuge managers should conduct appropriate and applicable pest detection, environmental surveillance, and monitoring before, during, and after any management activity to determine whether pest management goals are achieved and whether the activity caused any significant unanticipated effects. The lowest risk, most targeted approach for managing invasive species should always be utilized (Department of Interior 2007).

Work with Partners

Working with partners is the most effective way to manage invasive species on a refuge. Control efforts on the refuge will have little long-term impact if the surrounding lands and waters are infested with invasives. In New York State, Partnerships for Regional Invasive Species Management (PRISMs) have formed to reduce the spread and impact of invasive species through coordinated prevention, detection, and control measures. Montezuma NWR should work with the Finger Lakes PRISM to stay informed regarding invasive species issues surrounding the refuge.

Incorporate Invasive Species Prevention in All Facilities and Construction Projects

Minimize ground disturbance and restore disturbed areas. Require mulch, sand, gravel, dirt, and other construction materials to be certified as free of noxious weed seeds. Avoid stockpiles of weed-infested materials.

To prevent the spread of invasives along transportation corridors, maintain invasive species-free zones along trails, around parking lots and boat launches, and at other related facilities. Inspect these areas often and control new infestations immediately. Minimize the number and size of roads on the refuge.

Remove all mud, dirt, and plant parts from all equipment between projects or when equipment is moved from one location to another.

Incorporate Invasive Species Prevention in Impoundment Design and Management

Minimize infrastructure development in managed wetland units to reduce unnecessary dikes, waterways, and access roads. These often are sources of infestation and pathways of spread.

Plant a native cool season grass mix that will establish quickly to stabilize banks and dikes and to prevent the establishment of invasive species. Consider one of the following mixes recommended by the Natural Resources Conservation Service for New York State:

1. Canada wildrye (*Elymus canadensis*) (5 lb./acre), riverbank wildrye (*E. riparius*) (3 lb./acre), and Eastern bottlebrush grass (*E. hystrix*) (2 lb./acre); or
2. Canada wildrye (4 lb./acre), riverbank wildrye (4 lb./acre), Virginia wildrye (*E. virginicus*) (4 lb./acre), and rough bentgrass (*Agrostis scabra*) (1 lb./acre)

For either mix, consider adding annual ryegrass (*Lolium perenne*) so bare soil is not exposed to erosion or to invasive plant seeds and rhizomes. This non-native plant will establish quickly and then drop out of the mix after one or two years.

Time water manipulation activities, such as flooding and drawdowns, to minimize the germination and spread of invasive plant seeds and to encourage the growth of native species. Flooding can also be used to stunt the growth of some invasive species as described below under water level management.

Early Detection and Rapid Response

Where prevention is not possible, early detection and rapid response is the next best strategy. Success will depend, in part, on participation by all refuge staff, contractors, volunteers, and visitors in efforts to report and respond to invasions. The refuge manager must have access to up-to-date reliable scientific and management information on species that are likely to invade. The Invasive Plant Council of New York State has developed an Early Detection list for each of the eight PRISM regions in the state (http://www.ipcnys.org/). This list, along with identification information for each species, should be distributed amongst refuge staff and volunteers and posted in refuge facilities. The Finger Lakes PRISM addresses all invasive species and will be adding organisms other than plants to the list. Additionally, a list of experts should be maintained by the refuge manager to facilitate rapid and accurate species identification for species that are particularly difficult to identify. The refuge manager should communicate with the Finger Lakes PRISM regarding the status of early detection species in the region.

For some species, an active monitoring protocol may be established to facilitate early detection. For example, artificial substrates may be suspended in water bodies and checked regularly for the early detection of zebra mussels on the refuge.

When small infestations are spotted, they should be eradicated as soon as possible. The site must then be monitored for several years to ensure the control was effective.

Prioritizing Invasive Species Control Efforts

The first step in prioritizing invasive species control efforts is to determine the abundance and distribution of invasive species on the refuge or management unit. However, control efforts should not be delayed to collect statistically rigorous survey data. Baseline data regarding the location of many invasives on the refuge already may be available via observations of staff, volunteers, contractors, and refuge visitors. These observations should be documented and mapped. If a more formalized mapping procedure is desired the North American Weed Management Association (http://www.nawma.org) has information on mapping procedures.

There are a number of ranking tools to assist land managers with the daunting task of prioritizing their invasive plant control efforts. The *Fulfilling the Promise* National Invasive Species Management Strategy Team recommends using the following order of priority to determine appropriate actions:

1. Smallest scale of infestation
2. Poses greatest threat to land management objectives
3. Greatest ease of control.

When limited resources prevent the treatment of entire populations, the following order of priority is recommended:

1. Treat the smallest infestations (satellite populations).
2. Treat infestations on pathways of spread.
3. Treat the perimeter and advancing front of large infestations.

The following ranking systems are available for prioritizing invasive plant species control:

- Morse, L.E., J.M. Randall, N. Benton, R. Hiebert, and S. Lu. 2004. An Invasive Species Assessment Protocol: Evaluating Non-Native Plants for Their Impact on Biodiversity. Version 1. NatureServe, Arlington, Virginia. *Website:* http://www.natureserve.org/getData/plantData.jsp
- R. D. Hiebert and J. Stubbendieck, *Handbook for Ranking Exotic Plants for Management and Control* (Natural Resources Report NPS/NRMWRO/NRR-93/08), U.S. National Park Service, Midwest Regional Office, Omaha, Nebraska, 1993.
- APRS Implementation Team. 2000. Alien plants ranking system version 5.1. Jamestown, ND: Northern Prairie Wildlife Research Center Online. (Version 30SEP2002). *Website*: http://www.npwrc.usgs.gov/resource/literatr/aprs

Restore Altered Habitats and Reintroduce Native Plants

Restoration is critically important because the conditions responsible for the initial invasion will expose the site to a resurgence of the invasive species, as well as a secondary invasion of one or more different species. Furthermore, restoration of a disturbed area *before* the initial invasion may preclude the need for further control efforts. The goal is to conserve and promote natural processes that will inherently suppress potential pest populations (Department of the Interior 2007).

If funding or personnel are not available to restore highly disturbed areas in a timely manner, consider planting a cover crop for several years to stabilize the site prior to reintroducing native plants. This will prevent more invasive seeds from entering the environment until the site can be restored. Native plants can then be established by direct seeding or planting with less competition from invasives in the seed bank. When practical, local genotypes of native species should be used.

Biological Control

Biological control is the use of animals or disease organisms that feed upon or parasitize the invasive species target. Usually, the control agent is imported from the invasive species' home country, and artificially high numbers of the control agent are fostered and maintained. There are also "conservation" or "augmentation" biological control methods where populations of biological agents already in the environment (usually native) are maintained or enhanced to target an invasive species. The advantages of this method are that it avoids the use of chemicals and can provide relatively inexpensive and permanent control over large areas. Appropriate control agents do not exist for all invasive species. Petitions must be submitted to, and approved by, the USDA Technical Advisory Group on weed biological control before any proposed biological control agent can be released in the United States.

Manual and Mechanical Control

Mechanical removal of invasive organisms can be effective against some herbaceous plants, shrubs and saplings, and aquatic organisms. This is particularly effective for plants that are annuals or have a taproot. Care should be taken to minimize soil disturbance to prevent creating conditions ideal for weed seed germination. Repeated cutting over a growing period is needed for effective control of many invasive plant species. Care should be taken to properly remove and dispose of any plant parts that can re-sprout. Treatments should be timed to prevent seed set and re-sprouting. The following methods are available: hand-pulling, pulling with hand tools (weed wrench, etc.), mowing, brush-hogging, weed-eating, stabbing (cutting roots while leaving in place), girdling (removing cambium layer), mulching, tilling, smothering (black plastic or other), and flooding.

The advantages of mechanical treatment are low cost for equipment and supplies and minimal damage to neighboring plants and the environment. The disadvantages are higher costs for labor and inability to control large areas. For many invasive species, mechanical treatments alone are not effective, especially for mature plants or well-established plants. **For some invasive plants, mechanical treatments alone exacerbate the problem by causing vigorous suckering.** Mechanical treatments are most effective when combined with herbicide treatments (e.g. girdle and herbicide treatment).

Water Level Management in Impoundments

Water level management is also used to control invasive and promote desirable plants. Robust plants such as Phragmites require air pockets (carbon dioxide) to survive. Flooding the impoundment through all or part of a growing season, particularly after mowing or chemical application, stymies vegetative growth of robust vegetation. Subsequent drawdown will allow for germination of moist-soil plants preferred by waterfowl. Timing and speed of drawdown affects species diversity, density, and seed production. Slow drawdown (4-8 weeks) early in the season creates greater species diversity, while fast drawdown (a few to less than 2 weeks) results in lush extensive stands of similar vegetation. Late in the season, however, slow drawdown promotes greater diversity and density, whereas fast drawdown promotes undesirable plant composition (Lane and Jensen 1999). Flooding also promotes robust perennial control by muskrats.

Winter drawdowns are also possible, but should be avoided as they have detrimental effects on species over-wintering in the impoundments such as invertebrates, reptiles, amphibians, and muskrats. Winter drawdowns have been shown to help control undesirable overpopulations of white water lily and carp, but managers should weigh this benefit with the potential costs before undertaking a winter drawdown.

Prescribed Fire

Fire can either suppress or encourage any given plant species, so great care must be taken to understand the ecosystem and the life histories of the native and invasive plants before using this tool. This tool is most successful when it is used to mimic natural fire regimes. Proper timing of prescribed burns is essential for controlling target invasive species. The most effective fires for invasive plant control occur just prior to flower or seed set, or at the young sapling/seedling stage. Invasive plants are well adapted to disturbance, often surviving fire and rapidly spreading through a disturbed landscape. Studies in northeastern successional habitats have generally shown that fire alone *will not* remove invasive shrubs. Additional herbicide and/or cutting treatments are necessary (Patterson 2003).

This tool requires a good deal of pre-planning (including permitting) and requires a trained crew available on short notice during the burn window. Spot burning using a propane torch can be a good method to control small infestations of invasive plants. It can be advantageous where it is too wet or where there is too little fuel to carry a prescribed fire.

There are several principles that should be considered when employing prescribed fire to control woody plants:

1. Plant mortality is strongly tied to death of “growth points” (i.e. meristems/buds), which are more sensitive to heat damage when actively growing, and when tissue moisture is high (Miller 2000). Therefore, applying fire during spring, when target plants are mobilizing water/nutrients and breaking dormancy of leaf/flower buds, or during fall cold-acclimation periods, is more likely to kill growth points than prescribed fire during dormant periods.

2. Concentrations of metabolic compounds, i.e. sugars, salts, lignins, vary seasonally, and have been shown to relate to seasonal effects on shrubs. Consequently, timing of treatments may be more important than the type (cutting versus burning) in controlling invasive plants. To maximally reduce biomass, fires should be applied during periods of low below-ground

carbohydrate storage (i.e. immediately after spring flushing and growth) and should be followed with a second growing season treatment (such as mowing, herbicide, or more prescribed fire) before total non-structural carbohydrate (TNC) levels are replenished. Repeated burning (several consecutive years) during the low point of a plant's TNC cycle can amplify the negative effects of the treatment (Richburg and Patterson 2003, 2004).

Deer Control

Invasive plant problems often are exacerbated by white-tailed deer over browsing native species, and when deer numbers rise above the carrying capacity, biodiversity declines (NY State Department of Environmental Conservation 2007). Public hunting should be used to reduce the deer population wherever necessary and logistically feasible. Hunting must be regulated (e.g., hunting methods, timing of seasons, hunting pressure) and harvests monitored to prevent negative impact to long-term survival of deer populations. Deer control must be conducted in combination with other invasive plant control measures as deer control alone will not be effective if the invasive plants are already established.

Deer exclosures should be considered only in small highly sensitive areas (e.g., where invasive plants are out-competing rare plants and the rare plants will be extirpated without intervention). This method is labor intensive and costly to employ and should only be used on a very limited basis until the native community is firmly established and the invasive species are controlled.

Herbicides

There are a wide variety of chemicals that are toxic to plant and animal species. They may work in different ways and be very target specific, or affect a wide range of species. Herbicides may be "pre-emergent," that is, applied prior to germination to prevent germination or kill the seedling, or "post-emergent" and may have various modes of action (auxin mimic, amino acid inhibitor, mitosis inhibitor, photosynthesis inhibitor, lipid biosynthesis inhibitor). Products may come in granular, pelleted, dust or liquid forms. Liquid herbicides are commonly diluted to an appropriate formula and mixed with other chemicals that facilitate mixing, application, or efficacy. Common application methods include foliar spray, basal bark, hack and squirt, injection, and cut stump. The timing of applications is critical to achieve good control, as the growth stage at which an organism will be most effectively controlled varies with different species.

The advantages are that the right chemicals, applied correctly, can produce desired results over a large area for a reasonable cost. The disadvantages are that the chemicals may affect non-target species at the site (including the applicator) and/or contaminate surface or groundwater. Proper planning includes using the most target-specific, least hazardous (humans and the environment), and most effective chemical for the job. Additionally, one should research minimum effective dosage, as the chemical labels often give higher than necessary concentrations. Herbicides often are most effective when used in combination with mechanical methods described above.

Attention to protective gear, licensing requirements and other regulations is essential. In the U.S. Fish and Wildlife Service, all pesticide and other chemical applications (including adjuvants designed to enhance effectiveness) are covered by Service and departmental regulations, and a Pesticide Use Proposal (PUP) is required for all pesticide applications.

Control of Over-abundant or non-native Waterfowl Populations

Controlling invasive or over-abundant waterfowl, such as mute swans, snow geese, and resident population Canada geese is a strategy used to protect native water birds and fisheries, and prevent the destruction of wetland habitats on refuges. Control methods include: harassment, egg shaking, sterilization, and removal.

The Atlantic Flyway Council's (2003), "*Atlantic Flyway Mute Swan Management Plan 2003-2013* (http://www.dnr.state.md.us/wildlife/afcmuteplan.html)" outlines the coordination of state (lead) and federal wildlife agencies "to reduce mute swan populations in the Atlantic Flyway to levels that will minimize negative ecological impacts to wetland habitats and native migratory waterfowl and to prevent further range expansion into unoccupied areas." Target populations of mute swans vary by state and range from 0 to 500 free-flying birds.

In the fall of 2006, the US Fish and Wildlife Service completed an Environmental Impact Statement that included a multi-faceted approach for managing resident Canada geese (http://migratorybirds.fws.gov/issues/cangeese/deis.html). At the recommendation of the Atlantic Flyway Council, the Service approved the use of special regulations beginning in 2007 to help curb the growth of these geese in the eastern US. Included in this approach was the expansion of hunting methods during September seasons. The refuge manager should consider implementing hunting seasons targeting this population.

Protecting Nesting Birds

The seasonal closure of nesting and foraging areas may be necessary to protect sensitive nesting bird species and habitats on the refuge. Posting "no disturbance" or "area closed" signs near bird nesting areas, nesting islands, or individual nest locations, is one way to help prevent disturbance caused by humans and boats. Signs are placed in the appropriate areas as soon as possible in the spring and are maintained throughout the nesting season. If disturbance is noted by refuge staff, additional areas may be posted as well.

Artificial Nesting Platforms for Osprey

Artificial nesting platforms have played a vital role in the comeback of osprey populations. Different types of nesting platforms have been erected; the tripod or quadropod platform is designed to be placed directly in the water, while the single-poled structure is designed for use on land (http://www.cumauriceriver.org/pages/npmats.html; http://www.ospreys.com/Platform.htm; http://www.lrconline.com/Extension_Notes_English/pdf/ospry.pdf). To be effective, osprey nesting platforms should mimic ideal natural nesting conditions as much as possible. Platforms should be 20-40 feet in height (exceeding the height of nearby trees), near or in water, and placed to have an unobstructed view of the surrounding sky.

Land (raccoons, skunks) and airborne (eagles, owls) predators can pose a threat to both adult ospreys and chicks. A platform needs to be an adequate distance off of the ground and have a clear view of the surrounding sky, in order to help protect osprey nests from predators. In addition, bands of sheet metal, acting as predator guards, should be placed around platform poles to minimize the approach of predators from nearby trees and/or the ground.

Since osprey populations have increased dramatically over the last two decades, no new artificial nesting platforms have been erected on the refuge. Older platforms that are starting to show signs of wear are being torn down instead of being repaired or replaced. Today, most ospreys are using trees or snags, instead of artificial structures, for nesting on the refuge. Any time a new osprey nest is located on the refuge, a predator-guard is placed around the tree or snag in which the nest occurs.

Impoundment Management

Water Level Manipulation

Water level management (drawdown and flooding) is a strategy used to mimic the dynamic water regime of some natural wetlands, and is typically timed to benefit shorebirds, wading birds, and/or waterfowl. During a draw down, mudflats and shallow waters areas are created to provide foraging habitat for shorebirds, while at the same time concentrating food for wading birds. Some waterfowl (e.g., teal) will also take advantage of the concentrated and more accessible food resources. Eventually, the soils in these mudflat areas begin to oxidize and warm up. This in turn causes moist-soil vegetation to germinate. If the water is removed early in the growing season, moist-soil vegetation will out compete most perennial emergent vegetation, which requires warmer soil temperatures for germination. When water is removed later in the growing season, perennial emergent vegetation usually dominates. This is often an undesirable outcome of a drawdown and is usually avoided. As moist-soil annual vegetation grows, shallow (not to exceed 1/3 plant height) flooding can be used to irrigate growing vegetation, create shallow water foraging habitat for waterfowl or discourage growth of perennial or invasive plants. Water levels are usually returned to the desired management level prior to fall migration, or the following spring migration if water is not available in the fall. Generally, slow (over several weeks) drawdowns will provide a greater diversity of moist-soil plants than faster (over a few days) drawdowns (Frederickson and Taylor 1982).

Alternatively, drawdowns may occur in fall to provide foraging habitat for fall migrating shorebirds and some waterfowl. Winter drawdowns are also possible, but should be avoided as they have detrimental effects on species over-wintering in the impoundments such as invertebrates, reptiles and amphibians and muskrats. Winter drawdowns have been shown to help control undesirable overpopulations of white water lily, but managers should weigh this benefit with the potential costs before undertaking a winter drawdown.

Water may also be held in an impoundment over the growing season, or several growing seasons, to provide breeding habitat for waterfowl and marsh birds. This is usually done in areas where a healthy perennial emergent component exists in the wetland. Over time, water stress and/or muskrat activity will often reduce the amount of emergent vegetation until it is no longer a significant component of the impoundment. At this point the impoundment has little value to breeding waterfowl and marsh birds and another drawdown should be considered.

Vegetation Management

Plants that occur in an impoundment can be either desirable or undesirable based on their value to wildlife. Generally, plants that provide cover, energy, or nutritional value for objective wildlife are desirable. Plants that quickly develop monocultures and impede foraging by wildlife are undesirable. Whether a plant is desirable or not also depends on why the impoundment is being managed. For example, cattail is undesirable to shorebirds and waterfowl because it forms dense monotypic stands, and reduces foraging habitat (mudflats and moist-soil vegetation) of shorebirds and waterfowl. In contrast, it provides cover and breeding habitat for marsh birds, and therefore is desirable if managing for those species. The challenge of impoundment management is balancing the needs of various wildlife guilds. In addition to the water level manipulation techniques listed in the previous paragraphs, below are available strategies for promoting desirable vegetation and controlling undesirable or invasive plants.

Muskrat Population Management

Muskrats are efficient at reducing the cover of robust perennial vegetation. The impoundment should be held high for at least one year, and muskrat trapping in the impoundment interior should be prohibited when the cover of robust perennial vegetation needs to be decreased. However, if perennial vegetative cover is lower than desired, muskrat control should be conducted. Muskrat trapping also should be employed when muskrat numbers are high enough to damage impoundment dikes or water control structures. Trapping of muskrats takes place during the fall and winter, during state-established trapping seasons. Muskrat trapping follows state regulations and refuge-specific regulations and is issued through a special use permit. See the refuge trapping plan for more information.

Mowing

Mowing can be used to reduce plant height and deplete energy reserves of invasive and robust plants. Repeated mowing within a growing season is often necessary to successfully control invasive plants. This can be logistically difficult in a habitat that is managed for various resources of concern. However, mowing can be effective when combined with other strategies, such as chemical treatment, spring flooding, and disking. Timing of mowing should be scheduled to occur when the undesirable plants are at maximum above ground energy reserve and have little potential for seed dispersal. This is usually the point between flowering and seed setting. Mowing may also increase plant diversity by creating space (light) for other species to germinate.

Disking/Tilling

Disking (turning over of top soil) is often used in combination with mowing to set back succession and promote seed germination and increased invertebrate populations. Disking breaks up dense root matter, killing perennial plants and encouraging decomposition, which increases invertebrate populations. This reduction in perennial vegetation in combination with freshly exposed soil encourages germination of annual seed producing plants. Tilling (turning over a deeper layer of soil) can also be used to set back succession and control robust vegetation but this technique is generally more costly than disking or mowing.

Some research indicates that soil disturbances (disking or tilling) can promote invasive plants by cutting rhizomes into numerous segments that may eventually grow into adult plants (Frederickson and Taylor 1982). To avoid promoting expansion of invasive species such as *Phragmites*, disking should only be implemented where there are existing dense stands of invasives, or where invasive species monitoring and control can ensure that these species do not expand their area of coverage (Lane and Jenson 1999).

Disking can also be used to provide habitat for shorebirds. As described above under water level manipulation, slow spring drawdowns not only promote the growth of moist-soil vegetation but also create mudflats and shallow water areas for spring migrating shorebirds. Disking during summer will break up organic root matter, which encourages decomposition, and therefore increases invertebrate populations. After disking, the impoundment can be flooded slightly (approximately 3 inches) to provide mudflats and shallow water for fall-migrating shorebirds.

Herbicide

The most commonly used herbicide for controlling invasive and robust vegetation in impoundments is glyphosate. Methods of application include spot-treatment using backpack or ATV mounted sprayer, or aerial application. Spot-treatment is more targeted (avoiding neighboring plants), but can be very labor intensive when treating large areas. Aerial application is less labor-intensive, but is not as target-specific, and requires extensive planning to execute. Herbicides are applied during flowering and prior to seed set to maximize effectiveness.

Prescribed Burning

Prescribed burning in impoundments has been used to control undesirable vegetation and may promote growth of desirable plants (Baldassarre and Bolen 1994). Burning can kill perennial plants and reduce excessive litter accumulation, allowing moist soil vegetation to germinate. However, successful control of species such as cattail requires root burns, which rarely occur since rhizomes are usually covered by a layer of soil, mud and/or water. Prescribed fire will often remove accumulated leaf litter and dead standing material, giving seeds of other species an opportunity to germinate. Removing litter may also increase shoot germination of undesirable plants by increasing light availability to the ground.

Currently, the USFWS and USGS are collaborating on a study to compare the effects of growing and dormant season burns on cattail stands on several refuges in Regions 3 and 5. The results of this study should help to guide future wetland management through the use of fire and subsequent flooding regimes. It is generally believed that growing season burns are more effective at controlling cattail than are dormant season burns. There remains some question as to the efficacy and safety of burning cattail in the summer and this study should help to address this question.

Seeding/Planting

Most impoundments contain abundant stock of moist-soil plant seeds native to a locality, therefore making seeding and planting unnecessary (Frederickson and Taylor 1982). These seeds may remain viable in the soil for many years, and germinate under suitable environmental conditions (Lane and Jensen 1999). In extreme circumstances, past human activities (such as extensive herbicide use, prolonged flooding, and promoting monotypic plants for many years) may have altered site conditions such that the soil seed bank is inadequate or nonexistent (Weller 1990). In these situations, the seed bank may need to be augmented through planting of seeds, rhizomes, or seedlings to ensure growth of desirable plants. Only native species should be used for seeding and planting. Whenever possible, seeds and other plant material should be obtained from a local reference site, either through direct seed harvest or transplant, or from a nursery that procured their stock locally.

Beaver Control

Because beavers are part of the natural landscape, and can be beneficial in terms of creating wetland habitats, harvest of nuisance beavers will only be conducted when negative impacts are determined to be excessive. Beavers interfere with impoundment management by damaging or clogging water control structures and altering water levels on surrounding lands so impoundments either cannot be filled or cannot be drained. Whenever possible, water control structures and drainage pipes should be fitted with guards to prevent beavers from clogging the pipes or damaging the structures. Trapping is the most effective method of removing problem beavers and may be conducted either during fur season or by nuisance trappers during other times of the year.

Wetland Restoration through Impoundment Creation

Many natural wetland types are relatively stable and are driven by natural processes such as soil type, surface water runoff, and ground water and precipitation collecting in depressions or slopes. Seasonal changes in hydrology create a fluctuating water table, resulting in wetland vegetation development. When these systems are functioning naturally, are devoid of invasive plants, and are not heavily impacted by human development, they do not require active management. However, in altered systems where the hydrology has been modified and cannot be restored due to surrounding land uses, active management is essential. It may be necessary to create impoundments to mimic natural wetland hydroperiods or to provide the best possible wildlife habitat for objective wetland species. This management action should only be conducted when there is no other practical way to restore the natural hydrology of a system.

The Montezuma Refuge is located in what was historically called the Montezuma Swamp. This vast area extended northward from Cayuga Lake almost to Lake Ontario. In the 19th century, most of this swamp was drained for commerce and transportation by the development of the Erie Canal, the New York State Barge Canal, and the dam at the north end of Cayuga Lake, all of which lowered the water table up to ten feet. The dam and canals are still in place, and the water levels are managed by the NY State Canal Corporation. These artificial manipulations of the water table make it necessary for the refuge to create impoundments to restore the historic wetlands.

When creating an impoundment, the first step is to inventory the existing hydrogeologic, hydrologic, soil, and biological characteristics to determine that the target condition can be established. The cost of maintaining the new impoundment over a long period of time also must be considered prior to construction. Construction should be planned for the dry season when moving earth is the least problematic and excess water and erosion control is minimal (Lowry 1990).

Impoundment depths will vary depending on the target species. Most geese and dabbling ducks prefer an average water depth no greater than 18”; whereas most shorebirds prefer mudflats or 4” or less of water. Impoundment dikes should be formed by material excavated from the interior of the new impoundment. The borrow area should not be adjacent to the dike to minimize damage caused by burrowing animals (e.g., muskrats). Vegetative material that might lead to leaking and loss of water at a later date should be cleared. A minimum of 50% of the dike side slope area should be at a grade of 6:1 (6 horizontal to 1 vertical) or flatter. The remaining side slope area should have a grade of 3:1 or flatter. After drying and settling, the dike should be graded to uniformity along its entire length. The surface of the dike should be graded to leave a slight rise in the middle to allow rainfall to run off without damage to the surface. After settling and grading, the dike top and sides should be seeded to grasses for erosion control (USDA-NRCS 1999, Williams 1995). Recommended seed mixes are listed above under "Incorporate Invasive Species Prevention in Impoundment Design and Management" in the Invasive Species Management Section.

Various types of water control structures are available. It is important to have a structure designed to accommodate the physical features of the area and the objectives of the management plan (Williams 1995).

Impoundment Improvement through Depression Creation

As stated above, impoundments are created when an ecological system has been altered and the hydrology has been modified and cannot be restored by other means due to surrounding land uses. Impoundments are managed to mimic natural hydroperiods or to provide the best possible habitat for high-priority wildlife species. Impoundments that do not provide high quality habitat, should be modified to achieve the refuge's highest priority habitat goals and objectives.

If part of an impoundment is elevated above the surrounding area and cannot be flooded, a "dry marsh" may form. At Montezuma, this often results in a cattail (*Typha* sp.) monoculture. These areas tend to lack biological diversity relative to the remainder of the impoundment. Due to the degree of habitat degradation and the lack of wildlife use, it is beneficial to create depressions to restore these areas to high-quality wetland habitat. Depressions will create a mix of emergent marsh and open water habitat that will improve biological diversity and productivity.

Depressions should be created by physically removing material. Other methods that leave the material onsite create temporary openings that fill in as the displaced muck slumps back in and cattails re-invade. Material should be removed to create open water areas and channels in an irregular pattern. The irregular pattern visually attracts wildlife and creates more edge/interspersion between open water and emergent vegetation. The finished bottom of all excavations should be 6 to 36 inches lower than the managed water level of the rest of the impoundment. A meandering channel should connect the newly created depressions to the rest of the impoundment, thus permitting water flow and water level management by the same structures used to control water levels in the surrounding impoundment. A minimum of 50% of the side slopes of the depressions should be at a grade of 6:1 (6 horizontal to 1 vertical) or flatter. Slopes as flat as 10:1 are preferable if possible. The remaining side slope area should have a grade of 3:1 or flatter. The connecting ditches should have side slopes of 2:1 or flatter. Excavated muck should be spread over a nearby upland area on the Refuge (Sheila Hess, personal communication, October 2005, USDA-NRCS 2005).

Construction should be planned for the winter when the ground is frozen or the summer following a spring drawdown when earth moving equipment is least likely to sink in the muck. It may continue through the year as long as logistically possible.

Greentree Reservoir Management

Greentree reservoirs (GTRs) are impounded tracts of bottomland hardwood forests usually created to provide habitat for migrating and wintering waterfowl. Typically, GTRs are flooded earlier, longer, and at depths greater than would normally occur under natural flooding from fall or winter rainfall. These modifications in hydrology cause changes in the diverse flora and fauna that are adapted to normal seasonal and long-term fluctuating water regimes, and a number of problems are associated with GTR management. Generally after ten years, waterfowl use, acorn production, and plant diversity decline. Regeneration of mast producing over-story species is inhibited by typical GTR management. New green-tree reservoirs should not be created on refuges, and if possible, existing GTRs should be managed by the natural hydrology of the area rather than by artificially raising water levels.

If the refuge manager chooses to hold water in GTRs, (s)he must monitor water levels closely to prevent undesirable changes in species composition and retardation of tree growth and vigor. Fall flooding should not commence until trees are dormant. Drawdowns must be initiated early enough to ensure complete water removal by the time trees break dormancy. Thorough drainage is essential as only a few inches of water during the growing season can cause permanent tree damage. Even dormant season flooding should not occur annually as this regime may cause decreased tree growth, regeneration, and plant diversity (Baldassarre and Bolen 1994, Frederickson and Batema, Mitchell and Newling 1986).

Similar to other types of forest stands, timber management may be necessary to improve habitat quality. See “Forest Management” below.

Forest Management

Silvicultural Prescriptions

Active management generally is not necessary to maintain forest communities in BCR 13. However, if a forested tract is degraded and not meeting habitat objectives, then a silvicultural prescription may be needed. A silvicultural prescription is a detailed set of written instructions for the treatment of a forested property and should be developed prior to the treatment of forested tracts other than invasive species treatments (http://www.sref.info/courses/mtf2/mtf2-2-1.pdf). A forester should be consulted to develop a prescription based on the site conditions and habitat objectives identified in the Habitat Management Plan.

Forest Establishment/Reforestation

Patch size and distribution on the landscape are important considerations in planning and managing habitats. Forest restoration should only occur on parcels within large forested blocks (at least 500 acres, if possible) to reduce fragmentation of the landscape and because many forest-dependent species are area sensitive. Forest restoration also is appropriate along rivers as riparian forest corridors are often more diverse than adjacent upland areas despite occupying a small area. These areas should be chosen based on their juxtaposition in relation to currently existing forested tracts. Riparian corridors that connect existing forested tracts should be prioritized for reforestation.

In former agricultural fields, forests may be established by allowing the area to succeed naturally, by seeding herbaceous, shrub, and tree species, by planting shrub and tree seedlings or saplings, or by a combination of these methods. Shade-tolerant herbaceous species may need to be seeded or planted after a canopy is established as they may not survive full sun conditions. The plants in the surrounding landscape should be surveyed to determine the seed stock. If desirable species are in the surrounding landscape and the invasive species load is low, then natural succession should be allowed to proceed. Invasive or other undesirable species can be selected out with herbicides. It may be desirable to plant only those species that are not already present in the surrounding landscape.

If the area is surrounded by invasives, then allowing natural succession without seeding or planting natives likely will not be successful. Planting seeds of native species is less expensive than planting seedlings or saplings, but it will take longer for these to become established. A combination of seeding and planting may be the best strategy to "flood" the site with natives to out-compete surrounding invasives. The seedlings and saplings will produce seed and provide shade more quickly, and the planted seeds will provide competition for invasive seeds already present in the soil. The site must be monitored, and invasive species must be controlled before they become well-established. The invasives in the surrounding landscape also should be controlled as resources permit.

Whenever nursery shrubs and trees are planted, they should be protected from deer and other herbivores. Selection of species and ecotypes is a critical step in seeding and restoration. Using local seed and plant materials is important in restoration as plants have wide genetic diversity across geographic space.

Shrubland Management

Nearly all upland shrublands in BCR 13 need to be periodically disturbed to maintain their shrubland character. Shrublands left undisturbed will eventually succeed to young forests and will no longer provide habitat for shrubland dependent wildlife. The number of years between disturbances depends on how quickly a particular shrubland matures and also at what stage the shrubland is being managed. As an example, a very young shrubland that is dominated by herbaceous vegetation with only a few scattered shrubs may provide excellent habitat for singing woodcock and nesting field sparrows, but poor habitat for golden-winged and chestnut-sided warblers. If your goal is to manage for singing woodcock, then you would likely disturb the area more regularly than if you were managing for golden-winged warblers. Managing several different shrubland units will allow a refuge to disturb a few units every year or every few years and still provide all shrubland stages from very young to very mature.
The seasonal timing of disturbance can alter the vegetative character of the shrubland. Resprouting of both trees and shrubs will be greater if cut after the growing season (Sepik et al. 1981). Cutting encroaching trees during the growing season will often result in better control of trees the following year whereas cutting during the dormant season will often stimulate more robust tree resprouting the following year. If managing during the growing season, care should be taken to time the disturbance after most bird species have fledged.

Listed below are several techniques available for the management of shrubland vegetation.

Mechanized Equipment

Several pieces of equipment are available for use in cutting shrubs and small trees (see bullets below). All of these tools can be used with varying degrees of effectiveness, depending on what is being cut. Special consideration needs to be given to ground disturbance when using heavy equipment. Soils may be compacted and rutted which could cause a change in the vegetation component of the area. Disturbed soils are also more likely to promote germination of invasive species, an undesirable outcome of any shrubland management program.

Examples of shrub and tree cutting equipment:

- Drum mowers for removal of small trees
- Hydro-Axe – this piece of equipment consists of an articulated tractor with a mower mounted on the front. It is generally able to cut trees up to approximately 6-8” dbh. Woody material is reduced to fine chips, often finer then those resulting from a roller mower.
- Roller Chopper Mower – used to knock down and chop up shrubs and trees. This technique causes significant disturbance to the soil and should probably be reserved for situations where the area is going to be seeded after treatment.
- Mowing and brush hogging – mowing is an appropriate treatment for grass, forbs and small shrubs and saplings. Vegetation > 4 inches often needs a higher powered machine.
- Girdling – Girdling can be appropriate to kill single trees to create snags and open up the canopy. It can also cause stump sprouting.
- Chainsaw – Saw work can be appropriate to remove single trees or groups of trees to open up the canopy. Stump sprouting may occur.

Chemical Treatment

Chemical treatment in shrublands usually involves the selective spraying of individual or small groups of trees or undesirable shrubs (e.g., invasive species or post mature plants) to maintain the shrub component of the vegetation and prevent trees from shading out the shrubs. This technique can be very labor intensive over a large area if there is a significant tree component to the shrubland. If trees are sprayed on a regular basis (e.g., every few years) then it can be a relatively easy process, assuming the shrubland acreage is small. Over time, shrub density is likely to increase which in turn decreases encroachment of trees. In the best of situations, this scenario will result in a climax shrub community (Niering and Goodwin 1974). This technique could be very useful when managing for mature shrublands, such as providing foraging areas for migrating and wintering songbirds.

Prescribed Fire

Prescribed fire is very difficult to use effectively in BCR 13 as a shrubland maintenance tool in itself. This region is generally too moist and the shrubs too sparse to produce a good burn. However, prescribed fire can be used in conjunction with another management technique, such as after mowing, to help return nutrients to the soil and stimulate regrowth of treated shrubs.

Invasive Species Control

Any disturbance to a shrubland has the potential to stimulate the germination or continued growth of invasive species. Care should be taken to reduce this potential by disturbing the soil as little as possible. Additionally, within one or two years after disturbing a shrubland the area should be surveyed for the presence of invasive species and where possible these plants should be treated with one or more of the strategies described in the invasive species control section earlier in this document.

Shrubland Establishment

Patch size and distribution on the landscape are important considerations in planning and managing habitats. Small patches of habitat (<25 acres) or habitat patches with a lot of edge (e.g., powerline rights-of-way) may be suitable for shrubland establishment as shrubland-dependent species tend to be less area-sensitive than grassland and forest species.

In former agricultural fields, shrublands may be established by allowing the area to succeed naturally, by seeding herbaceous and shrub species, by planting shrub seedlings or saplings, or by a combination of these methods. The plants in the surrounding landscape should be surveyed to determine the seed stock. If desirable shrubs are in the surrounding landscape, the invasive species load is low, and there is not an immediate need for shrubland habitat, then natural succession should be allowed to proceed. Invasive or other undesirable species can be selected out with herbicides. It may be desirable to plant only those species that are not already present in the surrounding landscape.

If the area is surrounded by invasives, then allowing natural succession without seeding or planting natives likely will not be successful. Planting seeds of native species is less expensive than planting seedlings or saplings, but it will take longer for these to become established. A combination of seeding and planting may be the best strategy to “flood” the site with natives to out-compete surrounding invasives. The seedlings and saplings will produce seed and provide shade more quickly, and the planted seeds will provide competition for invasive seeds already present in the soil. The site must be monitored, and invasive species must be controlled before they become well-established. The invasives in the surrounding landscape also should be controlled as resources permit.

Whenever nursery shrubs are planted, they should be protected from deer and other herbivores. Selection of species and ecotypes is a critical step in seeding and restoration. Using local seed and plant materials is important in restoration as plants have wide genetic diversity across geographic space.

Grassland Management

Currently, some BCR13 refuges support healthy populations of grassland nesting birds, such as Savannah sparrow, bobolink, eastern meadowlark, sedge wren, Henslow’s sparrow, grasshopper sparrow, vesper sparrow, northern harrier, short-eared owl and upland sandpiper. Additionally several duck species including mallard, black duck, gadwall, northern shoveler, blue-winged teal, green-winged teal, American wigeon and northern pintail use BCR13 refuge grasslands for nesting. During migration and winter refuge grasslands serve as resting and feeding areas for several bird species.

BCR 13 refuge grasslands consist of both cool season and warm season grasses. Cool season grasses start growing in spring as soon as the snow melts and the days start to warm up. They grow best in spring and fall and tend to stop growing during the hot dry days of summer. They are usually relatively short and do not grow as dense as many warm season grasses. Conversely, warm season grasses do not start growing until late spring and grow best during the hot dry summer months. They generally grow taller and denser than cool season grasses.

Currently, most cool season grasses on BCR 13 refuges are exotic species brought over from Europe as forage for livestock. Most warm season grasses are native to the U.S. prairies and some varieties are native to the Northeast as well. Exotic cool season and native warm season grasses are readily availably from seed companies across the country. Some seed companies are beginning to propagate native cool season grasses making them more available for planting, but still at a relatively high price.

Many species of grassland birds require relatively large blocks of habitat for nesting areas. Some species, such as upland sandpiper and Henslow's sparrow are not likely to be found in grassland patches of less than 75 acres. Other species patch size requirements are smaller, but grasslands of less than 25 acres generally do not meet the requirements for most grassland nesting birds and may be better suited to a different habitat type (e.g., shrubland) (Mitchell et al. 2000).

Refuges should consider providing a variety of different grassland stages within close proximity to one another. Short sparse grasslands with little litter accumulation benefit a different group of grassland birds than do tall rank grasslands with a large litter layer. Managing adjacent grassland units in different stages will help to provide multiple grassland types in the same general area. This effect can also be achieved by managing smaller sections of larger contiguous grassland fields in different stages.

Historically, most of the Northeast was forested, except for a period following European settlement when much of the region was cleared for agriculture and subsequently grasslands and open fields became abundant. In pre-settlement times, permanent, large openings were uncommon, except for selected coastal areas. Scattered openings occurred along large river floodplains, around beaver flowages, in coastal heathlands and in other areas of regular disturbance. Large grasslands are now in decline and the region is becoming more forested (Rothbart and Capel 2006).

Populations of grassland birds are declining as grassland habitats and other agricultural conditions diminish. Norment (2002) notes that despite the relatively recent (last 200 years) rise and fall of grassland habitats and associated birds in New England, the region may still be important for these species given their continental decline and habitat loss in the core of their ranges in the Midwest.

As grasslands succeed into shrublands and then forestlands the amount of available habitat for grassland nesting species declines. Without periodic treatment most refuge grasslands quickly revert to brush and forests. Listed below are several management techniques designed to maintain grasslands on BCR13 refuges.

Mowing/Haying

Mowing and haying (collectively, cutting) are very effective at controlling broad leaf forbs and woody species, provided it occurs during the growing season of these plants. Cutting should be delayed until after the nesting season of most grassland birds (usually mid-July) but should be done as soon as possible after this date to allow for maximum stress on invading forbs and shrubs. Depending on the amount of forb and shrub invasion, some grassland fields may require repeated cutting during any one season. Cutting should be done often enough to keep the grassland in the intended state. This may require annual haying to provide habitat for species that prefer short sparse grasslands such as grasshopper sparrow, or mowing every third year (or more) for species that prefer tall rank grasslands such as Henslow's sparrow. Mowing tends to accumulate thatch whereas haying removes this thatch and keeps the grassland in a more open condition. Occasionally it is possible to selectively mow small sections of forb and tree encroachment within larger grassland fields, thus saving the refuge resources and reducing disturbance to the grassland as a whole.

Cooperative haying can be used in lieu of refuge staff mowing the grasslands, thus saving the refuge significant resources while still accomplishing mission related goals. The hay crop has value to the farmer as forage for his livestock or as a cash crop. Haying is generally restricted to fields already dominated by grass species, as forbs and shrubs are unsuitable as a hay crop. Refuge staff should work closely with the farmer to ensure haying is conducted to refuge specifications (e.g., after grassland bird nesting season) and also to guard against introduction of invasive plant species.

Prescribed Fire

If used properly, fire can be a useful tool for maintaining grasslands in BCR13. Generally, prescribed fire is suitable for controlling woody species and to a lesser extent broad leaf forbs in warm season grasslands. Cool season grasslands are difficult to maintain with prescribed fire. To achieve effective control of woody species, fire must be applied late enough in the growing season to allow these species to leaf out, but early enough to ensure that sprouting warm season grasses are not damaged. Due to the early season growth habits of cool season grasses, they are often too green to allow a fire during the time when woody plants have leafed out.

Most prescribed fires will result in only a top-killing of woody plants. Therefore, resprouting is likely to occur later in the season. This top-killing is usually sufficient to maintain the woody species as only a small portion of the vegetative community provided fire is applied on a regular schedule (e.g., once every four years). Broad leaf forbs are often less susceptible to damage from fire and may not be controlled at all. It may be necessary to use other management techniques (mowing, herbicide) to effectively control broad leaf forbs within a grassland unit.

Fire removes thatch from a grassland unit. This result is often desirable, but can also be detrimental to species that perfer a thatch component for nesting (e.g., Henslow's sparrow) (Zimmerman 1988). The conversion of thatch into nutrients by fire results in an immediate return of nutrients to the soil, stimulating the growth of new plants during the growing season immediately following the fire.

Herbicides

Woody plants or broadleaf forbs can be sprayed with herbicide during the growing season to control their spread within a grassland. Herbicides can either be specific to a certain type of plant (e.g., dicamba for broad leaf plants) or general (e.g., glyphosate). Herbicides can also be sprayed on individual plants, such as from a backpack sprayer, or broadcast across the grassland, such as from a boom sprayer. The species being controlled and the amount of invasion into the grassland will determine which herbicide is used and how it is applied.

The sensitive nature of many refuge habitats and species dictate that herbicides are used with extreme care. It is illegal to use a herbicide in a manner inconsistent with the label, but refuges should strive to be even more restrictive with their use. Non-chemical management techniques should be considered before deciding to use herbicides. Unfortunately, chemical control is often the only effective control technique available for certain plants, particularly many invasive species.

Refuges should select the most benign chemical available to effectively do the job and apply it at the minimum necessary rate.

Barrier Removal

As mentioned earlier, patch size is very important in determining the suitability of a grassland as nesting habitat. As a general rule, the bigger a grassland is the more attractive it is to grassland nesting birds (Sample and Mossman 1997). Often a few or several smaller grassland units are located in close proximity to one another with only small shrub or tree hedgerows separating them. When faced with this situation, refuges should decide if it is better to let the small unproductive grasslands revert to shrublands, or remove the hedgerows to create a larger more productive grassland. Additionally, even if a grassland is already large enough to meet breeding grassland bird requirements, it may be possible to further improve the habitat by removing a barrier between this grassland and an adjacent grassland unit.

Shrub dominated hedgerows can be removed by mowing with a brush hog, Hydro-ax, or similar equipment. Tree dominated hedgerows will often need to be cut with a chainsaw or a tree felling piece of heavy equipment (e.g., Hydro-ax with a feller buncher attachment). Cutting can be done by refuge staff or contracted out. To save money, trees within hedgerows can be offered to the public as part of a timber or firewood cutting program.

Disking

Fall and winter disking can be used to decrease warm season grass cover and increase forb cover in established warm season grasslands (Gruchy and Harper 2006). This technique should not be used if there are invasive plants in or surrounding the grassland as the soil disturbance likely will provide ideal conditions for invasives.

Grassland Establishment

As stated above, patch size and distribution on the landscape are important considerations in planning and managing habitats. Grasslands should not be established in fields that are 25 acres or less as most grassland-dependent species are area sensitive. Field shape also is important; edge should be minimized so round or square fields are preferable to linear fields. Grasslands may be established in former agricultural fields, old fields, or large thickets, but habitat conversion is generally not recommended for forested areas.

Seeding and planting desirable plants can be used to enhance existing grasslands, in restoration of degraded grasslands, or in conversion of croplands. Selection of species and ecotypes is a critical step in seeding and restoration. While many species are commercially available for grassland restoration, few are native to the Northeast. Using local seed and plant materials is important in restoration as plants have wide genetic diversity across geographic space.

Initial seedbed preparation to decrease the weed seed bank is critical to successful grassland establishment. Former agricultural fields are ideal sites for grassland establishment if weed problems are already under control. The field should only need to be disked or sprayed with herbicide in spring prior to seeding as soon as the soil is dry enough.

In fallow fields, a controlled burn the summer or fall prior to seeding decreases surface weed seeds and litter. By the following March or April, spring disking or tilling will reduce the number of winter-growing weeds which set seed. The area should be left fallow during summer and tilled or sprayed with herbicide (glyphosate or pre-emergent herbicide), as necessary, to eliminate late-germinating weeds. One advantage of this spring-summer fallow technique is that deep soil moisture is conserved for the following fall planting. Finally, seedbed preparation may require smoothing with a land plane or scraper and roller if soil clods are large. Rolling with a ring roller provides compaction that will maintain good soil moisture following the first rains.

Broadcast seeding followed by shallow harrowing and cultipacking is very effective, especially on well-prepared soil. A small flexible tine harrow (Fuerst) can be pulled by a standard ATV to easily and rapidly harrow soil to cover the broadcast seed. In small or inaccessible areas, four pronged cultivator rakes can be used to agitate the soil and cover the seed. The preferred method of seeding warm season grasses is with a no-till drill. When using a drill in recently tilled seedbeds, it is best to culti-pack the tilled soil before seeding. Whether drilling or broadcasting on tilled soil, it is essential to culti-pack after seeding. It is further recommended to culti-pack twice after broadcasting, with the second culti-packing 90 ° to the first (NRCS-USDA 2006).

Because warm season grasses are slow to germinate and have less seedling vigor than cool season grasses, weed/sod control — both before and after planting — is much more critical than when establishing cool season grasses. For establishing warm season grasses, weed control throughout the growing season is just as critical as it is before planting. It usually takes at least two growing seasons to establish a warm season grass stand which makes weed control during the first growing season critical. Because warm season grasses are not shade tolerant, weed canopies will reduce seedling vigor. Moisture competition from weeds and cool season grasses may also further reduce seedling vigor (NRCS-USDA 2006).

To establish warm season grasses, weeds are usually controlled by clipping with a sicklebar mower set at a height where only the leaf tips of the warm season grass seedlings are cut, and the growing point is not damaged. This will reduce the shading competition but not hurt the emerging seedlings. Mowing weeds before flowering will prevent seed production. Mowing 2-3 times may be necessary during the establishment year; however, if clipped too frequently, weeds may “stool out” (grow out instead of up) (NRCS-USDA 2006).

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Dry Marsh Restoration Project

Introduction

The Montezuma Refuge is located in what was historically called the Montezuma Swamp. This vast area extended northward from Cayuga Lake almost to Lake Ontario. In the 19th century, most of this swamp was drained for commerce and transportation by the development of the Erie Canal, the New York State Barge Canal, and the dam at the north end of Cayuga Lake, all of which lowered the water table up to ten feet. The Civilian Conservation Corps constructed a dike around the Main Impoundment in 1938 to hold water and restore part of the marsh habitat that had once existed. A portion of this impoundment was higher than the rest of the area, and due to these hydrological changes, a “dry” marsh consisting of more than 900 acres and almost entirely of cattails (*Typha* sp.) formed.

The Main Impoundment was bisected by the New York State Thruway in 1953 forming two “dry” marshes – one in the northern portion of the Main Pool and the other in the southern portion of the newly formed May’s Point Pool. The Dry Marsh in the Main Pool was further degraded through ditching and farming. It was last farmed in 1979 and has since reverted to a contiguous stand of cattails and Phragmites. Researchers from the Rochester Institute of Technology conducted biological surveys in the Dry Marsh of the Main Pool from 2000 – 2002 and found a lack of avian, amphibian, and plant species diversity compared to the remainder of the Main Pool.

It has long been recognized that the Dry Marsh portion of the Main Pool requires restoration to increase productivity. Explosives (ammonium nitrate) were used to create a pond in 1959. Years later, a large Bucyrus dragline was used for thousands of hours to open up the habitat to no avail. Both these methods created temporary openings that filled in as the displaced muck slumped back in and cattails re-invaded.

In 2000, the Refuge restored a small portion of the Dry Marsh in order to address this issue. This 70-acre impoundment, known as the Millennium Marsh, was created through the construction of a dike to hold water to a higher level, resulting in a mix of more open water to emergent marsh. Waterfowl and wading birds have used this area regularly ever since. This method of building a dike to create deeper water habitat is not possible in the rest of the Dry Marsh due to the elevation of the Wildlife Drive and the Thruway. In addition, constructing a dike in the project area would result in filling of a portion of the dry marsh wetland and cutting off surface water flow from the rest of the Main Pool.

Methods

Due to the degree of habitat degradation in the Dry Marsh, it is necessary to create depressions to restore this area to high-quality wetland habitat, thereby creating a mix of emergent marsh and open water habitat that will improve biological diversity and productivity. Soils in the dry marsh consist of deep muck (Mr) with a depth range between 40” to 17’ (United State Department of Agriculture Soil Conservation Service 1972).

This project involves the creation of depressions in the northern 240-acre portion of the Dry Marsh immediately adjacent to the Refuge's Wildlife Drive and the NYS Thruway. These depressions will be created in an irregular pattern through the excavation of muck using tracked excavators and other earth moving equipment. The irregular pattern visually attracts wildlife and creates more edge/interspersion between open water and emergent vegetation (Map 1).

The finished bottom of all excavations would be approximately 6 to 36 inches lower than the managed water level of the Main Pool. A meandering channel would connect the newly created depressions to the rest of the Main Pool thus permitting water flow and water level management.

A minimum of 50% of the side slopes of the depressions would be at a grade of 6:1 (6 horizontal to 1 vertical) or flatter. Slopes as flat as 10:1 are preferable if possible. The remaining side slope area would have a grade of 3:1 or flatter. The connecting ditches would have side slopes of 2:1 or flatter. Excavated muck would be spread over two nearby fields (Wildlife Drive Inside and Outside Corner Fields, Map 2).

The project has been divided into two phases. Phase I involves the creation of three depressions and will provide approximately 26 acres of manageable habitat with the excavation and removal of approximately 188,760 cubic yards of material. Phase I will be evaluated to determine success of the project. Researchers from the Rochester Institute of Technology will conduct biological surveys to determine avian, amphibian, and plant species diversity and compare their results to the remainder of the Main Pool well as the Dry Marsh, pre-restoration.

If Phase I is deemed successful, Phase II will be implemented. Phase II involves the creation of five depressions and will provide approximately 48 acres of manageable habitat with the excavation and removal of approximately 464,640 cubic yards of material.

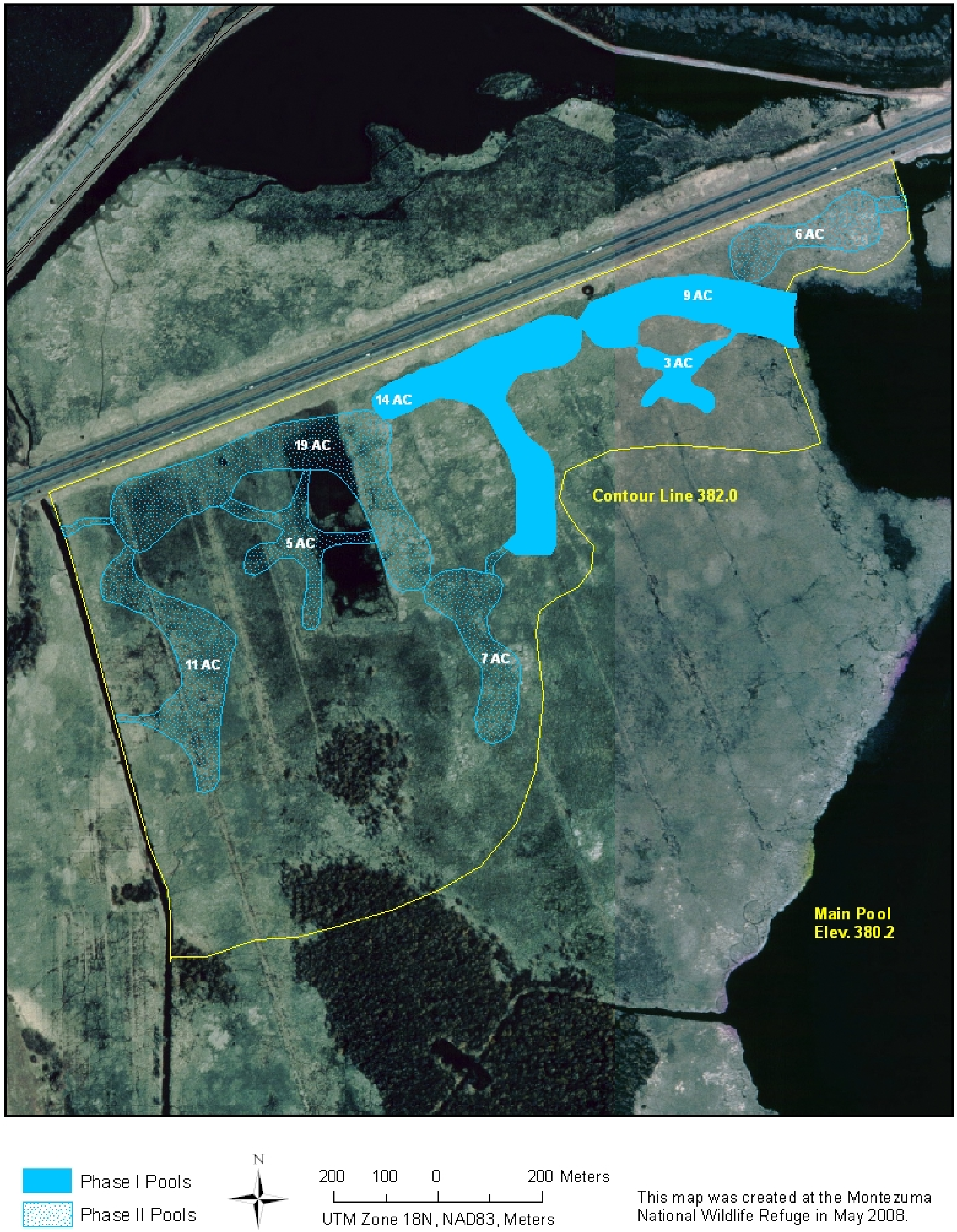
Construction will occur in the winter when the ground is frozen or in the summer following a spring drawdown when conditions are most favorable. It may continue through the year as long as logistically possible.

Conclusions

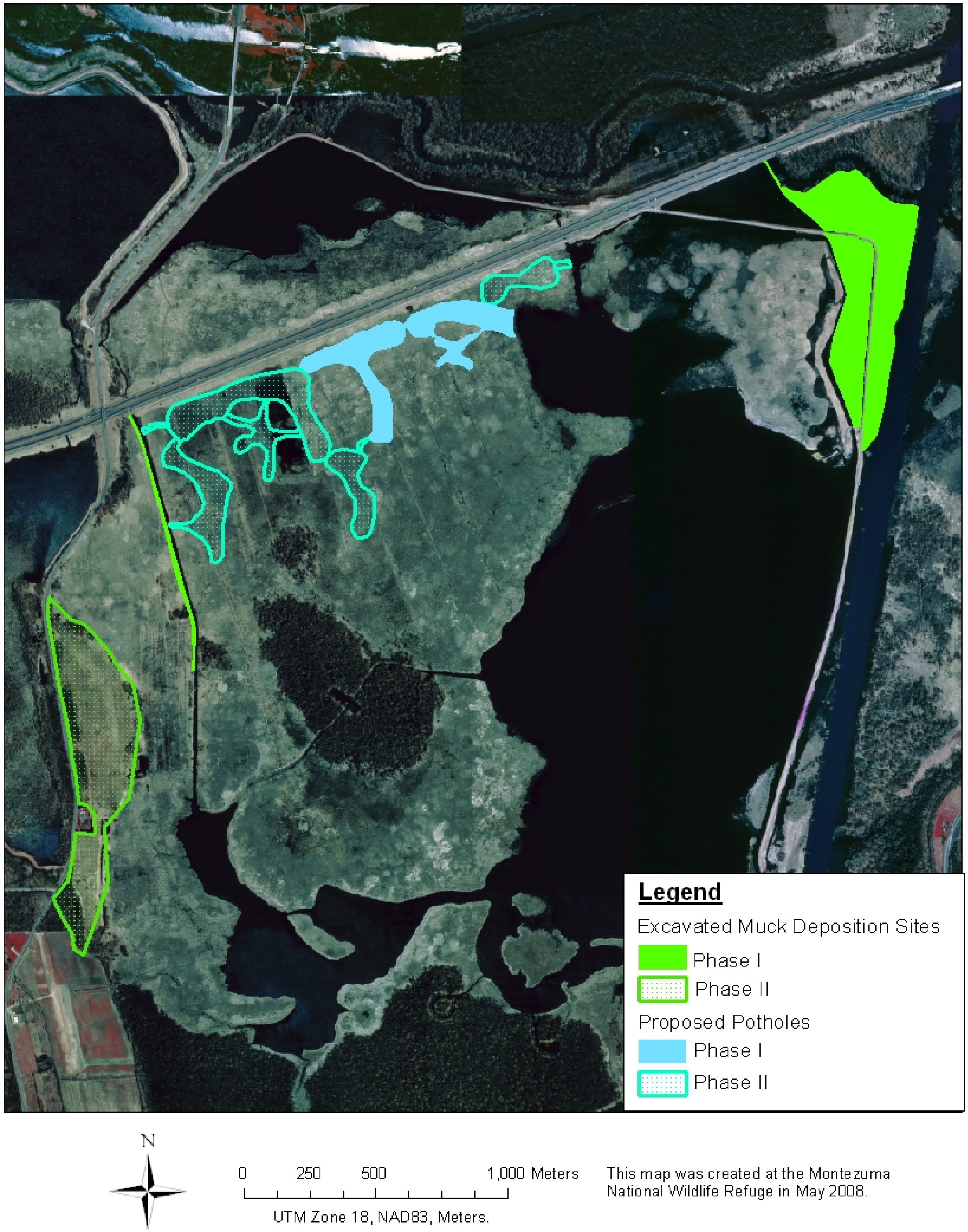
This project is being implemented to achieve the refuge's top priority habitat goal identified in the habitat management plan:

> Provide high quality mudflat and freshwater emergent marsh and open water wetland habitats dominated by native plants for migrating and breeding waterfowl, shorebirds, waterbirds, marshbirds, and bald eagles provided through water level control.

Specifically, restoring the dry marsh will address habitat management objectives 1.1, 1.2, and 1.4.



Map 1 Locations of proposed potholes in the Dry Marsh portion of the Main Pool.



Map 2 Location of the proposed potholes in the Dry Marsh portion of the Main Pool and the upland fields where the excavated muck will be placed.

Objective 1.1 Emergent (Hemi-) Marsh – Migrating Waterfowl - Each year, provide a minimum of 1,000 acres of spring (March-April) and fall (Oct-Nov) waterfowl migration and staging habitat consisting of shallow flooded wetlands ($\leq$12”) with a mix of vegetation and open water (hemi-marsh) dominated by native emergent vegetation such as millet, barnyard grass, sedges, beggarticks, spike rushes, water plantain, and smartweeds.

Objective 1.2 Shallow Water Mudflats - Provide a minimum of 100 acres of shallow water (<3") mudflats with sparse (<25%) vegetation and high invertebrate biomass in at least two patches twice annually during spring and again during late summer and early fall to benefit migrating shorebirds including semipalmated sandpipers, greater yellowlegs, and short-billed dowitcher, among other shorebirds.

Objective 1.4 Emergent Marsh – Breeding Marshbirds - Each year, provide a minimum of 800 acres of habitat for breeding marshbirds (especially black tern, pied-billed grebe, least bittern, and American bittern) consisting of an average mix of 50 - 70% vegetation and 30 – 50% open water (hemi-marsh) with an average water depth of 10-20" and at least 5 muskrat lodges per acre. Additionally, this habitat should be provided in a minimum of 3 patches >100 acres each.

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Public Comments and Refuge Responses

Summary

The Montezuma National Wildlife Refuge held an open house on May 20, 2008 at the Refuge Visitor Center to gather public input on the Draft Habitat Management Plan. Refuge staff provided a brief presentation highlighting the main components of the Draft Plan, followed by a question and answer period. A press release inviting the public was issued to area newspapers on May 5, 2008. The Draft Plan was available to the public at the Refuge Office and Visitor Center, on the Refuge Website, and on the Friends of the Montezuma Wetlands Complex Website. The Draft Plan and an invitation to the open house also were sent to the Director of Conservation and Science, the Director of Bird Conservation, and the Wildlife Ecologist, Audubon New York; the Center Director, Montezuma Audubon Center; the President and the Vice-President, Friends of the Montezuma Wetlands Complex; the Coordinator, Montezuma Wetlands Complex; the Biologist, Region 8 NY State Department of Environmental Conservation; the Nature Conservancy; Ducks Unlimited, Inc.; and two former Refuge Managers and a former Wildlife Biologist, Montezuma National Wildlife Refuge.

The Refuge received 11 positive comments and no negative comments. Public comments and refuge responses are detailed below.

Comments Received at the Public Meeting

Frank Moses, Director Montezuma Audubon Center, Savannah, NY

- Read a very supportive letter reflecting the opinions of the entire staff from the Audubon New York Office at the Cornell Lab of Ornithology Conservation and Science Program.
- Overriding Message: The Montezuma Wetlands Complex is globally significant; conservation agencies are identifying a sense of urgency to move forward with conservation efforts.

Tom Hicks, Junius, NY

- It is interesting how the Refuge is tinkering over time and the progression from historic to current conditions.
- The Great Lakes Commission also is trying to promote natural water levels and increase diversity.
- Inquired about bald eagles, land acquisition procedures, Savannah Dhu, volunteers, and adding additional trails.
- Commented about the Armitage Road Bald Eagle nest.
- Commented on the original digging of the Erie Canal and the human death toll.

Nancy Bates, Throope, NY

- The Refuge is really on top of everything and very aware.
- Commented on places for birds to stop over.
- Inquired about the Seneca Trail, osprey, and a bald eagle observation.
- Inquired about pollution from the NYS Thruway and the newly passed truck law (regarding truck traffic through small towns).

Other Verbal Comments

Bob Lamoy, Former Deputy Refuge Manager, Vice-president, Friends of the Montezuma Wetlands Complex, Waterloo, NY, May 20, 2008

- HMP looks good; no real controversy.
- Concern for funding Dry Marsh restoration project with Refuge money as other stations are being closed. Dry Marsh project itself looks good with minimal issues (golden nematode and deposition areas have been covered).

Wilhelmina Pusmuscans, Seneca Falls, NY, May 21, 2008

- "It's very boring when you drive right along there [where Wildlife Drive parallels the Thruway]. You should do something there with that area."
- Comment on the Dry Marsh plans: "Yes, that looks beautiful."

Jim Eckler, Biologist, Region 8 NY State Department of Environmental Conservation, Savannah, NY, June 2, 2008

- I agree with Dave Odell's written comments on the Plan.

Written Comments and Refuge Responses

- Dave Odell, Coordinator, Montezuma Wetlands Complex – See attached.
- Michael F. Burger, Director of Conservation and Science, Audubon New York – See attached.
- Larry Nogaj, Refuge Hunter – See attached.
- Chuck Gibson, Refuge, State, and Audubon Volunteer – See attached.
- Pat Sanderson, Refuge Volunteer – See attached.