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 available 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).

References

Anonymous, Montana Weed Mapping Handbook: Montana Noxious Weed Survey and Mapping System (Version 2.0), undated.

Baldassarre, G. A. and E. G. Bolen. 1994. Waterfowl Ecology and Management. John Wiley and Sons, Inc., New York, NY.

Department of the Interior. 2007. Departmental Manual; Environmental Quality Programs; Part 517: Pesticides: Chapter 1: Integrated Pest Management Policy. Office of Environmental Policy and Compliance, Washington D.C.

Frederickson, L. H. and D. L. Batema. Greentree Reservoir Management Handbook. Gaylord Memorial Laboratory, The School of Natural Resources, University of Missouri-Columbia, Puxico, MO.

Fredrickson, L. H. and T. S. Taylor. 1982. Management of seasonally flooded impoundments for wildlife. U.S. Fish and Wildlife Service Resource Publication.

Fulfilling the Promise National Invasive Species Management Strategy Team. 2002. The National strategy for management of invasive species. National Wildlife Refuge System.

Gruchy, J. P. and C. A. Harper. 2006. When is the best time to disk native warm-season grasses for wildlife? *In* Proceedings of the Fifth Eastern Native Grass Symposium (Matt Sanderson ed.) Omnipress, Madison, WI.

Lane, J. J. and K. C. Jensen. 1999. Moist-soil impoundments for wetland wildlife. U.S. Army Corps of Engineers Technical Report EL-99-11.

Lowry, D. J. 1990. Restoration and creation of palustrine wetlands associated with riverine systems of the glaciated northeast. *In* Wetland Creation and Restoration: The Status of Science (J. A. Kusler and M. E. Kentula, eds.). Island Press, Washington, D.C.

Mitchell, L. R., C.R. Smith, and R. A. Malecki. 2000. Ecology of Grassland Breeding Birds in the Northeastern United States-A Literature Review with Recommendations for Management. US Geological Survey, New York Cooperative Research Unit, Department of Natural Resources, Cornell University.

Mitchell, W. A. and C. J. Newling. 1986. Greentree Reservoirs: Section 5.5.3, US Army corps of Engineers Wildlife Resources Management Manual. Department of the Army, Vicksburg, MS.

Niering, W.A. and R. H. Goodwin. 1974. Creation of Relatively stable shrublands with herbicides: arresting "succession" on rights-of-way and pastureland. Ecology 55:784-795.

Norment, C. J. 2002. On grassland bird conservation in the Northeast. Auk 119:271–279.

NY State Department of Environmental Conservation. 2007. New York hunting and trapping 2007-08 official regulations guide. NY State Department of Environmental Conservation, Albany, NY.

Rothbart, P. and S. Capel. 2006. Maintaining and Restoring Grasslands. *In* Managing grasslands, shrublands, and young forest habitats for wildlife. A guide for the northeast (J. D. Ohler, D. F. Covell, S. Capel, and B. Long, eds.). The Northeast Upland Habitat Technical Committee. Massachusetts Division of Fisheries and Wildlife

Sample, D. W. and M. J. Mossman. 1997. Managing habitat for grassland birds: a guide for Wisconsin. Wisconsin Department of Natural Resources Publication No. SS-925-97.

Sepik, G. F., R. B. Owen, and M. W. Coulter. 1981. A Landowner's Guide to Woodcock Management in the Northeast. Misc. Report No. 253. University of Maine, Orono, ME.

USDA-NRCS. 1999. Natural Resources Conservation Service Conservation Practice Standard: Pothole. New York.

USDA-NRCS. 2006. Natural Resources Conservation Service Wetland Restoration – 774 Pothole. New York.

USDA-NRCS. 2006. Warm Season Grasses in Pennsylvania. Harrisburg, PA.

Weller, M. W. 1990. Waterfowl management techniques for wetland enhancement, restoration and creation useful in mitigation procedures. *In* Wetland creation and restoration: The status of the science. (J. A. Kusler and M. E. Kentula, eds.). Island Press, Washington, D.C.

Williams, R. K. Construction, maintenance, and water control structures of tidal impoundments. *In* Waterfowl Habitat Restoration Enhancement and Management in the Atlantic Flyway (W. R. Whitman, T. Strange, L. Widjeskog, R. Whittemore, P. Kehoe, and L. Roberts eds.). Delaware Department of Natural Resources and Environmental Control, Dover, DE.

Zimmerman, J. L. 1988. Breeding season habitat selection by the Henslow's sparrow in Kansas. Wilson Bull. 100(1):17-24