Agassiz National Wildlife Refuge

U.S. Fish and Wildlife Service

HABITAT MANAGEMENT PLAN

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AGASSIZ NATIONAL WILDLIFE REFUGE

Habitat Management Plan

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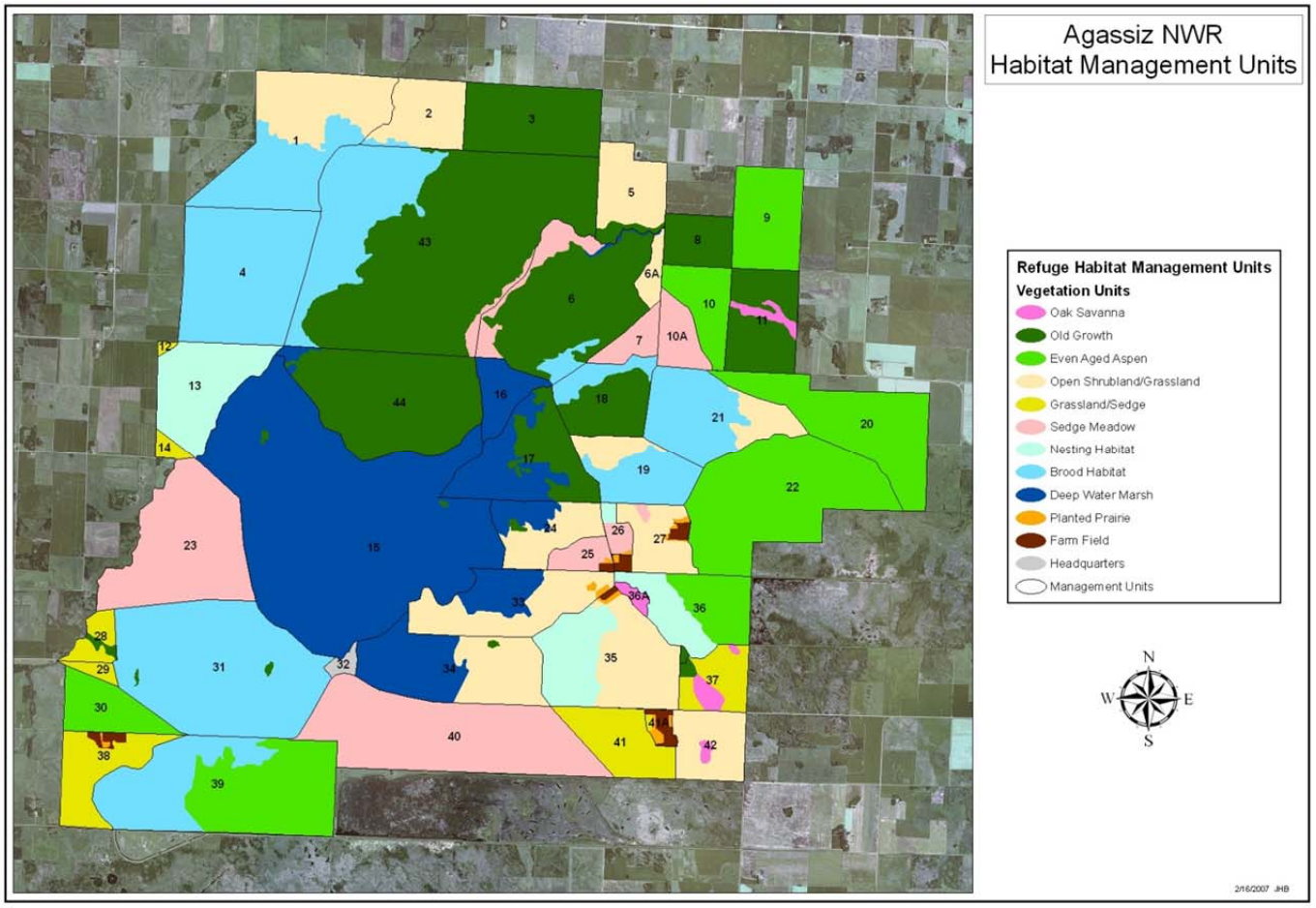


Grassland/Sedge Prescription. The objective is to eliminate trees in these habitat management units (HMU) and to reduce willow (*Salix* spp.) and other shrubs to acceptable limits for Wet Prairie and Wet Meadow plant communities. The HMUs designated for this prescription have complex mosaics of soil and vegetation and will always have a vegetation mosaic that includes areas where trees and tall shrubs will be dominant; however, the application of management tools in the designated units will be to favor open grasslands and sedge meadows. During the conversion stage prescribed burning should be conducted every other year. When conversion has been achieved and the objective becomes to maintain the grasslands, the burning frequency should be reduced to every three or four years to allow more available nesting cover. These burns will be late summer burns (15 July to 31 August) when possible and fall burns (1 September to 30 November) when a summer burn cannot be completed.

Herbicide can be used only on a limited scale due to its expense and the amount of woody debris and growth. The most effective application will be with a wick applicator

the second year after mowing, since only new willow and tree growth will be high enough to receive the herbicide. Herbicide applications will be in early summer and followed by burning later in the summer, after the woody vegetation has died. In areas that herbicide is not used, mowing should take place during the winter following a burn. Willows will then re-sprout and are subject to burning two years later. Summer burns may reverse the trend of invasion by common reed. Herbicide application with a wick applicator can also be used on common reed (*Phragmites australis*) the summer after a burn when only the new growth of common reed will be tall enough to receive the herbicide.

Within the Open Landscape Management Area (OLMA), HMUs 37 and 41 are under this prescription. Additional HMUs outside of the OLMA that should be managed with these strategies are 12, 14, 28, 29 and 38. Three small areas will be burned annually for a five-year period to evaluate any differences in increasing sedge (*Carex* spp.) and grassland between annual spring, annual summer, and annual fall burning. The west half of HMU 37 (South Shop) will be an annual summer burn unit. HMU 14 will be an annual fall burn and HMU 12 will be an annual spring burn (1 April to 5 May). Air photo analysis will be used to evaluate the effectiveness of these treatments.

Sedge Meadow Prescription. This prescription is similar to the Grassland/Sedge prescription under Objective 2.1, but this prescription is applied to sedge meadows which are under the influence of impoundments where drawdowns can be applied. These treatments should benefit marshbirds, such as yellow rails (*Coturnicops noveboracensis*), American bitterns (*Botaurus lentiginosus*), and nesting dabbling ducks. The objective is to reduce or keep the amount of willow cover below 25% (Minnesota Department of Natural Resources [MNDNR] 2005 Sedge Meadow/Carr-Sedge Meadow), reduce common reed, and have sedge meadow expand into areas presently occupied by cattail (*Typha* spp.). The basic prescription will be a May drawdown, followed by a summer burn on a two-year rotation. Fall burns would be a second choice when summer burns cannot be accomplished. In the alternate year the impoundments will be set for shallow flooding of the sedge meadow zone with a gradual lowering of water level in the late summer or early fall. Of those impoundments in the one- to two-year cycle, only four or five will be placed in drawdown each year.

Herbicide can be used to reduce the amount of willow on a limited scale due to its expense. The most effective application will be with a wick applicator the second year after mowing or a burn, since only new willow and tree growth will be high enough to receive the herbicide. Herbicide applications will be in early summer and followed by burning later in the summer, after the woody vegetation has died. In areas that herbicide is not used, mowing should take place during the winter following a burn. Willows will then re-sprout and be subject to burning two years later.

Summer burns may reverse the trend for invasion by common reed, but herbicide application can also be used on re-sprouted common reed later in the summer after burns (Cross and Fleming 1989). Herbicide can also be applied with a wick applicator the summer following the burn, when only the new growth of common reed will be tall

enough to receive the herbicide. HMUs 7, 10a, 23 (Madsen Pool; management aimed at the sedge meadows on the north half of the unit), 25, 26, and 40 are under this prescription. Webster Creek Pool in HMU 6 (under the Natural Watercourse prescription), is also shown on the map (Figure 10) as part of this prescription.

Impoundments in this prescription may periodically present opportunities for mechanical manipulation in the cattail zones, which can be taken advantage of if time and budget allow. This manipulation should be aimed at the fringe of the existing sedge meadow zone to open the cattail root mat for sedge establishment. Grazing may also be an alternative for opening up the cattail root mat and could be tried on an experimental basis.

Natural Watercourse Prescription. This prescription applies to three impoundments that will be allowed to stay in drawdown in an attempt to create sedge meadows along the watercourse through the impoundment. The treatment for Webster Pool will be a mid-August drawdown in 2007. The target area for sedge in this pool is the exposed open water areas. Stoplogs will remain out of the water control structure (WCS) for the next five years. Evaluation of sedge establishment and the amount of invasives (e.g., >40% reed canary grass (*Phalaris arundinacea*) with an increasing trend) will determine if the stoplogs will remain out after this time or if the HMU will return to a Brood Habitat Prescription. Leigh Fredrickson, Wetland Management and Education Services, Inc., Puxico, MO, is attempting to organize a study to intensively evaluate this effort.

Kelly Pool and Upper Mud River Pool were placed in drawdown in the spring of 2005. Rain events kept water on these areas into August. The pools were burned on 30 August, 2005. The stoplogs will remain out of the water control structures for the next five years. Evaluation of sedge establishment and the amount of invasives will determine if the stop logs will remain out after this time or if the units will return to a Nesting Habitat Prescription.

Nesting Habitat Prescription (Semi-permanent Cattail Marsh). This prescription is aimed at providing quality nesting habitat for overwater-nesting ducks and marshbirds, such as rails and American Bitterns. The impoundments in this category are characterized as semi-permanent wetlands with large expansive stands of cattail and little open water. These are marshes that cannot be shifted to hemi-marsh by deep water flooding. In these impoundments we are accepting the large areas of cattail for its value as nesting cover and trying for the best management of cattail for nesting waterfowl and marsh birds. The basic prescription is a drawdown on a three- to four-year cycle with a fall or spring burn after the drawdown. In the three- to four-year cycle prescription only one impoundment will be in drawdown each year. In the three- to four-year cycle units the first choice will be a fall burn during the drawdown year with the following spring as second burn choice. Summer burns during the drawdown year can be used if other higher priority burns have been accomplished.

Herbicides, such as glyphosate, can be utilized in the impoundments listed in the three- to four-year cycle to create small openings for waterfowl to access nesting cover. Transects can be flown with the herbicide applied in short bursts to create small openings. This

treatment was used in Kelly Pool and East Pool during the 1990s and followed with high water levels. The treatment effects persisted for six to seven years.

Brood Habitat Prescription (Semi-permanent Hemi-marsh). The emphasis of this prescription is to provide ideal conditions for diving duck production and marshbirds, such as least bitterns (*Ixobrychus exilis*) and grebes. These impoundments are semi-permanent wetlands with a hemi-marsh appearance. These areas need to be managed to keep cattail coverage less than 70% to preserve open water/emergent vegetation interspersion. They will be in a five- to six-year drawdown cycle. Drawdowns will be initiated in early May to discourage nesting and to expose mudflats in late May for shorebirds. During the drawdown year the marsh vegetation will be burned in the summer as first choice or during the fall, if not accomplished during the summer. Water levels the following year will be shallow to keep the ephemeral emergent vegetation (i.e., softstem bulrush [*Scirpus validus*]) available. Years three to five would be at full normal pool, or nearly so, to drown out encroaching cattail. Water levels in years three to five will depend on the character of the individual pool. If the aerial photo history from the late 1990s indicates that more areas can be open water than the current situation, then all three years may need to be at full pool. Conversely it the aerial photo record shows that the current situation is the same as that obtained in the late 1990s, then one or two of the years can be less than full pool.

Only two of these impoundments will be in drawdown in any given year. There will be some years when either very wet conditions or very dry conditions will modify the number of impoundments in drawdown. Drawdown effectiveness will vary with the annual variation in summer precipitation events. Refuge staff cannot hold out for the perfect drawdown and should not repeatedly try in subsequent years. This creates a roll up effect that has too many ramifications on the full pool or drawdown of other pools that scheduling is dependant on. Nor should they try to hold water in an impoundment scheduled for drawdown in a dry year because other pools are low on water. Take advantage of getting it “dry”.

Deep Water Marsh Prescription. This prescription is to provide habitat for waterfowl migration, diving duck production, and colonial waterbirds. The two impoundments in this category will be in a 10-year drawdown cycle and will not be in drawdown during the same year. Water levels the year following drawdown will be shallow to keep the ephemeral emergent vegetation (such as softstem bulrush) available. To stimulate submergent vegetation and invertebrates during the 10-year interim, a shallow water year will be scheduled in year five or six of the cycle. Water levels during other years should be at normal pool levels.

Headquarters Pool will be burned every five years with summer as first choice. Every other burn will be in conjunction with the drawdown. The Agassiz Pool perimeter will be burned in conjunction with the priorities for the adjoining upland management prescriptions.

Open Shrubland/Grassland Prescription. Application of this prescription should create a mosaic of shrubland, brush prairie, grassland, and sedge meadow. Trees should be reduced to an occasional stand near the edge of the open landscape adjoining other woody areas. Within the OLMA, HMUs 24, 27, 33, 35 and 42 should be managed with these strategies. In Figure 8 the areas labeled as FDW44A & B, Northwestern Wet-Mesic Aspen Woodland are the primary target of this prescription. Stands of large aspen should be commercially harvested and the non-commercial class sizes mowed. Herbicide application with a wick applicator should follow approximately two years after cutting. Most stands of trees in these HMUs should be cut. Entire HMUs will be burned on a three-year rotation during the conversion phase and then on a three- to five-year rotation for maintenance. Burns will be in the summer whenever possible, or in the fall when necessary.

Outside of the OLMA, HMUs 1, 2, 5, 6A, 19, 21 and 34 should be managed with similar prescriptions. These HMUs should be burned in the summer or fall on a three- to five-year cycle. Woody vegetation should be mowed or harvested and followed two years later by prescribed fire. When time and money allow, herbicide application with a wick applicator can also be utilized.

Oak Savanna Prescription. At this time the Dahl Woodlot (36A) is in the only HMU in the maintenance category of this prescription. Maintenance of oak savannas and oak woodlands will require burns under dry conditions in May or summer on an approximate four- to five-year rotation, where crown killing of aspen (*Populus* spp.) saplings will occur.

Restoration efforts will be concentrated on Argiborolls soils such as Reiner fine sandy loams in the Maintenance Center Unit 37, east half of Johns Field (HMU 42), and on the Garnes and Kittson Soils in Ditch 2 Upland (HMU 11). On these soils the aspen should be girdled in May after aspen have leaved out, allowed to die (two years), and then be harvested. After the harvest the units should be burned every two to three years for two or three cycles, depending on the results. First choice for these burns will be late May or summer. Second choice would be a fall burn. At least one of these burns must be under conditions identified for potentially crown killing young aspen saplings. The late May burns will be after aspen leaf-out and prior to bur oak (*Quercus marcrocarpa*) leaf-out.

Even-Aged Aspen Prescription. The HMUs in this prescription are not solid stands of aspen, nor are they intended to be. The HMUs will always consist of a mosaic of woodland, shrubland, and grassland/sedge. This prescription characterizes management that is favorable to wildlife, such as white-tailed deer (*Odocoileus virginianus*) and ruffed grouse (*Bonasa umbellus*), which benefit from woody vegetation. All trees in these HMUs will be subject to a stand altering, catastrophic clearcut on a 42-year rotation. The preferred method of harvest will be short wood logging, where limbing, topping and cut to length is at the stump, leaving the nutrients on site and not creating slash piles which need to be burned (potentially creating weed invasion sites). As much of the shrub areas as possible will be mowed in the unit the same winter as the clearcut. An exchange of service contract would be an excellent way to accomplish the mowing. There are seven

HMUs in this prescription, so only one HMU is cut every six years. HMUs 9, 10, 20, 22, 30, 36 and 39 are in this prescription. Based on current growth and proximity to each other, the suggested clear cut rotation for these HMUs is: HMU 20 in 2007/08, HMU 9 in 2013/14, HMU 30 in 2019/20, HMU 22 in 2025/26, HMU 10 in 2031/32, HMU 39 in 2037/38, and HMU 36 in 2043/44. Prescribed burns should be conducted in the spring on these HMUs at about five-year intervals to keep browse plants healthy and available for big game and snowshoe hares (*Lepus americanus*) and to help maintain the grasslands and sedge meadows.

Old Growth Prescription. These HMUs are not solid stands of aspen, nor are they intended to be. The HMUs will always consist of a mosaic of woodland, shrubland, and grassland/sedge. This prescription characterizes how the woody vegetation in these HMUs will be managed and should be favorable to deer, ruffed grouse, woodpeckers, tree cavity nesters, and black bears (*Ursus americanus*). The HMUs are 3, 6, 8, 11, 17, 18, 43 and 44. Burn the units on a 10-year rotation with cool, spring burns that will not kill mature trees. No mowing of shrubs and trees is needed. Evaluate stands over time to see if gap cutting or clearcutting is necessary or desirable. If deemed appropriate, the guidelines discussed above can be used. In HMUs 43 and 44, south of the Wilderness Area boundary, no cutting will take place in accordance with Wilderness Area regulations.

Islands designated for old growth management are marked on the Habitat Management Prescription Map (Figure 11). Three to six cottonwood saplings should be planted on each of these islands with the aid of tree shelters to increase the chances of cottonwoods being replaced.

Maakstad Grove, the Office Complex Grove, and the Shop Complex Grove are also designated as old growth management sites for wind protection, aesthetics, and environmental education opportunities for these sites. The north side of Webster Creek in HMU 6 and along the Parker Pool spillway outlet channel are also designated old growth to add riparian diversity.

Old Growth Prescription also covers conifer swamps located within HMUs 3, 6, 18, 43 and 44. These areas will not be subjected to any harvesting or mowing. The stands in HMUs 3, 6, and 18 will be subjected to a cool, spring burn treatment on a 10-year cycle in conjunction with the old growth aspen management for that HMU. These HMUs have all had prescription burns in the past with only a few trees near the edge of the stand occasionally being killed by fire. HMU 43 and most of HMU 44 are in the designated Wilderness Area and no cutting or mowing will be done there. Prescribed burns could be considered in HMUs 43 and 44 on a >50-year interval.

Thief Bay Spillway will be lowered to 1143.7' to prevent sustained water levels from negatively affecting the conifer swamp on the west side of the Wilderness Area.

The Wilderness Area has an east west dike excluded from wilderness designation that divides the area into north and south units. Herbicide application should be considered a

priority for invasive plant management on this dike to keep invasives from gaining a foothold in the Wilderness Area.

It should be noted that the following anticipated habitat management schedules for this Habitat Management Plan (HMP) are subject to, and will undoubtedly undergo, multiple changes. Changes in management schedules may be unavoidable due to necessary construction projects, climatic extremes (i.e., periods of drought and deluge), among other things. Additionally, this HMP was developed under an adaptive management framework which allows for changes (scheduling and otherwise) to be made to the HMP if habitat and/or wildlife monitoring results suggest a need for change.

Appendix 1 of this HMP will consist of "addendums" that are added throughout its lifespan. Addendums may consist of little more than short notes or documentations that through systematic monitoring, research, or simple 'trial and error', Refuge staff have decided to deviate from the plan as it was originally written.

Table 1. Drawdown Schedule Under New Prescription.

POOL	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Agassiz Pool (15)				X								
Dahl (36)	X				X				X			
East (35)		X				X				X		
East 80 (27)		X		X		X		X		X		
Farmes (39)	X					X					X	
Golden Valley (25)	X		X		X		X		X		X	
Goose Pen (26)		X		X		X		X		X		X
Headquarters (34)							X					
Kelly (10A)	X	X	X	X	X	?	?	?	X	X	X	X
Lower CCC (19)				X					X			
Madsen (23)	X	X		X		X		X		X		X
Middle CCC (18)			X					X				
Mud River (6)		X					X					X
Northwest (4)			X					X				
Parker (31)		X					X					X
Pool 8 (13)	X				X				X			
Pool 21 (21)	X					X					X	
South (40)	X		X		X		X		X		X	
Tamarac (1)	X					X					X	
Thief Bay (43)					X					X		
Upper CCC (18)					X					X		
Upper Mud (7)	X	X	X	X	X	?	?	?	X	?	?	?
Webster (6)		X	X	X	X	X	?	?	?	?	X	?

Table 2. Burn Schedule Under New Prescription.

HMU	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Tamarac (1)	su/f					su/f					su/f	
West Berg (2)					su/f					su/f		
East Berg (3)								sp				
Northwest (4)			su/f					su/f				
Webster Lake (5)				su					su			
Mud River (6)							sp					
Webster (6)												
Kilen's Corral (6A)		s/f										su/f
Upper Mud (7)	su		su		su		su		su		su	
Webster Creek Upland (8)		sp										sp
Ditch 1 Uplands (9)	sp					sp					sp	
Kelly (10)					sp					sp		
Kelly Pool (10A)	su/f		su		sp		su		su	sp		su
Ditch 2 Uplands (11)							sp					
Pool 8 Triangle (12)	sp	sp	sp	sp	sp							
Pool 8 (13)					f *or…*	sp			f *or…*	sp		
Davidson Triangle (14)	f	f	f	f	f							
Agassiz Pool (15)										su/f		
Agassiz NE Uplands (16)				su/f						su/f		
Tower Road Uplands (17)			sp									
Middle CCC (18)								sp				
Upper CCC (18)												
Lower CCC (19)				su		sp			su/f			
N. Hinterlands (20)				sp					sp			
Pool 21 (21)		su				f					su	
S. Hinterlands (22)			sp					sp				
Madsen (23)	su			su		su		su		su		Su
Johnson Island (24)				f					su			

Golden Valley (25)	su		su		su		su		su		su	
Goose Pen (26)		su		su		su		su	su	su		su
East 80 (27)		su				su				su		
Parker West (28)	su		su		su				su			
Nelson Triangle (29)		su		su		su				su		
Rodahl Triangle (30)						sp					su	
Parker (31)		su					su					su
Office Area Woods (32)					f (10 yr. freq.)							
Moose Pasture (33)				su					f			
Headquarters (34)			f				f					
East (35)		f (if mow)				f				f		
Dahl (36)		sp				sp (36A late May)				sp		
Maintenence Center (37)	su	sw corner - su	sw corner - su	sw corner - su	su				su			
Silo (38)				su				su/f			su/f	
Farmes (39)	f					f					f	
South (40)	su (west side f)		su		su		su		su		su	
John's Field (41)		su		su		su		su				su
CHZ (42)					sp/su if spray			f				su
Thief Bay (43)												

SP = spring burn
SU = summer burn
F = fall burn

Table 3. Willow Mowing Schedule Under New Prescription.

HMU	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Tamarac (1)			X	X				X	X	
West Berg (2)	X	X								
Webster Lake (5)		X					X			
Kilen's Corral (6A)				X						X
Lower CCC (19)	X	X				X				
Pool 21 (21)								X		
P21 Uplands (21)			X							
Johnson Island (24)		X					X			
East 80 (27)			X				X			
Parker West (28)			X							
Nelson Triangle (29)				X						
Moose Pasture (33)		X					X			
Headquarters (34)				X						
East Pool (35)		X	X				X	X		
Maintenance Ctr. (East Side) (37)			X			X				
Silo (38)		X				X				X
CHZ (42)			X							

Table 4. Aspen Cut Schedule Under New Prescription.

HMU	2007/08	2008/09	2009/10	2013/14	2019/20	2025/26	2031/32	2037/38	2043/44
Kelly Pool Uplands (10)							Com.		
Hinterlands N. (20, + any commercial in HMU 21)	Com. clear cut								
Hinterlands S. (22)						Com.			
Nelson Triangle (29)	Firewood cutters	Hydroaxe or Com. w/ HMU 38							
Rodahl Triangle (30)					Com.				
East Pool (35)	Hydroaxe								
Dahl Pool (36)									Com.
Maintenance Center (37; SE corner)	Com.								
Silo (38)		Com.?							
Farmes Pool (39)								Com.	
CHZ (42)			Com.						
Webster Lake (5)		Firewood cutters		Com.					
Ditch 1 Uplands (9)				Com.					

Com. = Commercial logging

Plan the drawdowns and the burns and take your best shot at them. Mother Nature will have the last word on how they turn out. No matter how they turn out some critters will benefit and some critters will not. The HMUs on Agassiz National Wildlife Refuge (NWR) are numerous and large enough that overall, diversity will be enhanced and the program successful as long as the long-term trend is pushed in the desired direction.

I. Introduction

A. Scope and Rationale Based on CCP, July 2005.

This HMP articulates the management direction for Agassiz NWR and its Refuge Management District (RMD) for the next 15 years, based on goals and objectives developed in the Comprehensive Conservation Plan (CCP) that was approved in July 2005. The CCP describes how the Refuge and District contribute to the overall mission of the National Wildlife Refuge System (NWRS). Several legislative mandates within the NWRS Improvement Act of 1997, and principles identified in "Fulfilling the Promise" (a strategic vision document for the NWRS) have guided the development of the CCP. These mandates and principles include:

1.) Wildlife has first priority in the management of refuges.
2.) Wildlife-dependent recreation activities, namely hunting, fishing, wildlife observation, wildlife photography, environmental education and interpretation are priority public uses of refuges.
3.) We will facilitate these activities when they do not interfere with our ability to fulfill the Refuge's purpose or the mission of the NWRS.
4.) Other uses of the Refuge will only be allowed when determined appropriate and compatible with Refuge purposes and mission of the NWRS.

The CCP will guide the management of Agassiz NWR and the RMD by:

1.) Providing a clear statement of direction for the future management of the Refuge and the District.
2.) Making a strong connection between Refuge activities and those activities that occur off-Refuge in the District.
3.) Providing Refuge and District neighbors, users, and the general public with an understanding of the Service's land acquisition and management actions on and around the Refuge.
4.) Ensuring the Refuge and District management actions and programs are consistent with the mandates of the NWRS.
5.) Ensuring that Refuge and District management considers federal, state, and county plans.
6.) Establishing long-term continuity in Refuge and District management.
7.) Providing a basis for the development of budget requests on the Refuge's and District's operational, maintenance, and capital improvement needs.

With this guidance the HMP will strive to use management tools that mimic natural processes to develop and maintain biological integrity in Agassiz NWR habitats to the extent possible within the political and biological reality of today. Biological integrity is defined by the U.S. Fish and Wildlife Service as "maintaining 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" (U.S. Fish and Wildlife Service Manual, Part 601 FW 3, April 19, 2001). Agassiz NWR has an impoundment infrastructure which although it may conflict with the integrity mandate, is aligned with its establishment purpose of "a refuge and breeding ground for migratory birds and other wildlife". As Meretsky et al. (2006) point out: "Much active management on refuges that might be seen to conflict with the integrity mandate is required by land-use history and surrounding land uses. Dikes prevent water from flooding neighboring drained fields; pumps flood areas that were once drained; prescribed burning substitutes for natural fires; wetland drawdowns, fire, and herbicides are used to control invasive plant species. ….. most cases of potential conflict are improving as refuges seek ways to accomplish establishment purposes within the integrity mandate."

The CCP's Goal 2 for Habitat is to restore and enhance a natural landscape within the Refuge and its seven-county RMD to emulate naturally functioning watersheds and habitats within the tallgrass prairie, prairie pothole, aspen parkland, and northern coniferous forest, including habitat corridors for wildlife. The Refuge has both inherited and further constructed a radically altered landscape and vegetation communities from those that existed during the pre-settlement era. The habitat goal seeks to restore natural landscapes and processes, to the extent feasible, within the constraints imposed by the Refuge's establishment purposes, the altered landscape outside the Refuge, responsibility to the surrounding community, and wildlife aims.

B. Legal Mandates

President Franklin D. Roosevelt established the Refuge by Executive Order 7583 on March 23, 1937. Its primary purpose was to be "a refuge and breeding ground for migratory birds and other wildlife." Although its original focus was waterfowl (ducks and geese), over the years other migratory birds and year-round resident wildlife, including mammals such as moose (*Alces alces*), deer, and gray wolves (*Canis lupus*), have received an increasing management emphasis.

As a result of the 1985 Food Security Act, Agassiz NWR assumed additional responsibilities for a seven-county RMD. Staff duties expanded to include working with the National Resources Conservation Service (NRCS) and Farm Service Agency (FSA) on wetland determinations, Swamp Buster Act provisions, and the Conservation Reserve Program (CRP). The Refuge actively collaborates on habitat restoration projects for both uplands and wetlands on private and CRP lands throughout its RMD.

C. Relationship to Other Plans

This HMP is a step down plan of Agassiz NWR's CCP (July 2005). This HMP replaces the Marsh and Water Management Plan of 1987. The Wildlife Inventory and Monitoring Plan Appendix to this HMP replaces the Wildlife Inventory Plan of 1989, as revised in 1991. This is the first HMP for the uplands since the 1960 Land Use Plan. This HMP

has been developed synchronously with the revised Fire Management Plan for the Refuge and both will be used to develop burn plans for the HMUs.

D. Time Period

This plan is intended to guide management of the Refuge from 2007 to 2022.

II. Background

A. Location

Located in Mud Lake, East Valley, Eckvoll, Whiteford, Cedar, and Agder townships of Marshall County, Agassiz NWR located is 23 miles northeast of Thief River Falls. The northern boundary of Agassiz NWR is within 40 miles of the Canadian province of Manitoba and Lake of the Woods, which straddles the U.S.-Canadian border. The nearest city is Grand Forks, North Dakota, 75 highway miles to the southwest. Although 'off the beaten track', Agassiz NWR offers wildlife-related experiences to thousands of visitors every year, including wildlife viewing, photography, hunting, environmental education, and interpretation.

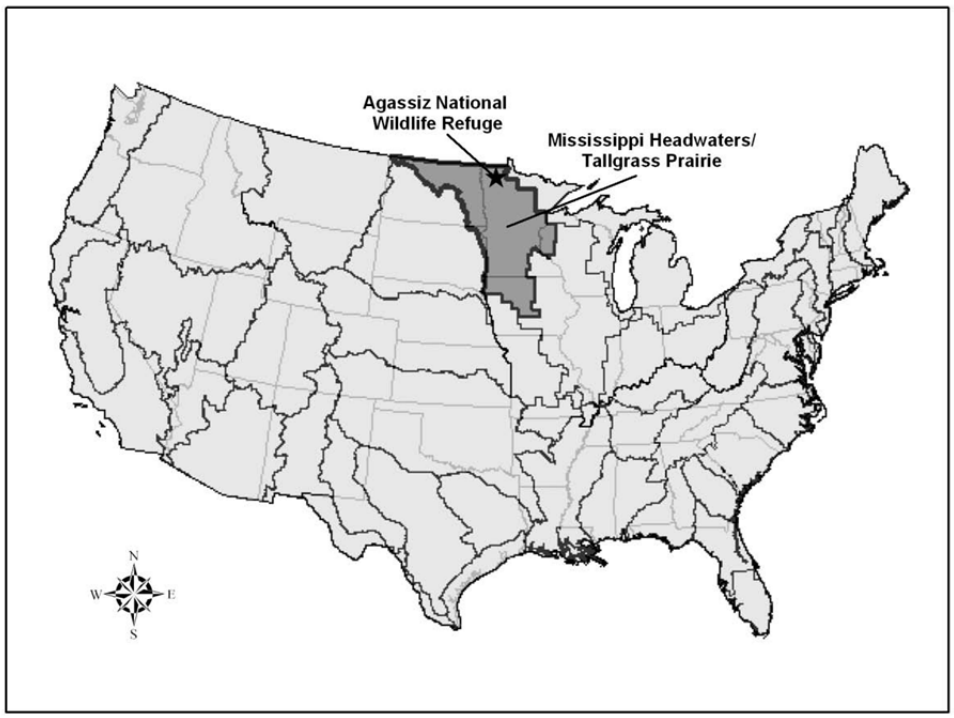
B. Physical and Geographical Setting, Watershed, Ecoregion

(1) Ecosystem

The Service has adopted an ecosystem approach to conservation because we cannot look just at an individual animal, species, or fragment of land in isolation from all that surrounds it. We recognize that we cannot achieve conservation within the boundaries of a NWR, or restore aquatic resources with a national fish hatchery, and that listing an endangered species is not going to conserve the system on which it depends. Therefore, the ecosystem approach strives to be comprehensive. It is based on all of the biological resources within a watershed (the total land area from which water drains into a single stream, lake, or ocean) and it considers the economic health of communities within that watershed landscape. An ecosystem approach to fish and wildlife conservation means protecting or restoring the function, structure, and species composition of an ecosystem, while providing for its sustainable socio-economic use.

Agassiz NWR and its RMD are located in the Mississippi Headwaters/Tallgrass Prairie Ecosystem as currently defined by the Service (Figure 1). This ecosystem is primarily located in Minnesota and North Dakota, with small portions extending into Wisconsin and Iowa. It falls within the prairie pothole region (PPR) of North America. The PPR produces greater than 50 percent of the continental duck populations during wet years (Batt et al. 1989). This portion of North America was subject to periodic glaciation and consequently, glacial melt-waters were instrumental in forming the five major river systems located or partly located within this ecosystem. These river systems are the Mississippi River, St. Croix River, Red River of the North, Missouri River, and the Minnesota River. Likewise, glacial moraines and other deposits resulted in a myriad of lakes and wetlands which are common throughout this area. Significant variation in the topography and soils of the area attests to its dynamic glacial history.

Figure 1. Mississippi Headwaters/Tallgrass Prairie Ecosystem, U.S. Fish and Wildlife Service.



The three major ecological communities within this ecosystem are the tallgrass prairie (which includes oak savanna and barrens), the northern boreal forest, and the eastern deciduous forest. Grasses common to the tallgrass prairie include big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), Indian grass (*Sorghastrum mutans*), and sideoats grama (*Bouteloua curtipendula*). Native prairie also supports numerous ecologically important forbs such as prairie coneflower (*Echinacea pallida*), purple prairie clover (*Dalea purpurea*), and blazing star (*Liatris* spp.). The northern boreal forest is dominated by a variety of coniferous species, such as jack pine (*Pinus banksiana*), balsam fir (*Abies balsamea*), and black spruce (*Picea mariana*). Common tree species in the eastern deciduous forest include maple (*Acer* spp.), basswood (*Tilia americana*), red oak (*Quercus rubra*), white oak (*Quercus alba*), and green ash (*Fraxinus pennsylvanica*). Current land uses range from tourism, timber harvest, and mineral extraction in the northern forests, to intensive agriculture in the tallgrass prairie. Of the three major ecological communities, the tallgrass prairie is by far the most threatened, with more than 99 percent of it having been converted to agricultural uses.

Because of its ecological and vegetative diversity, the Refuge supports 137 nesting species of birds, the vast majority of which are migratory. It provides breeding and migration habitat for significant populations of waterfowl, as well as a variety of other waterbirds. The **ecosystem** supports several species of candidate and federally-listed threatened and endangered species including the Piping Plover (*Charadrius melodus*), Higgins eye pearly mussel (*Lampsilis higginsii*), Karner blue butterfly (*Lycaeides melissa samuelis*), prairie bush clover (*Lespedeza leptostachya*), Leedy's roseroot (*Sedum integrifolium leedyi*), dwarf trout lily (*Erythronium propullans*), and the western prairie

fringed orchid (*Platanthera leucophaea*). The increasingly rare paddlefish (*Polyodon spathula*) and lake sturgeon (*Acipenser fulvescens)* are also found in portions of this ecosystem. Presently, the gray wolf (threatened) is the only Threatened and Endangered species found on the Refuge.

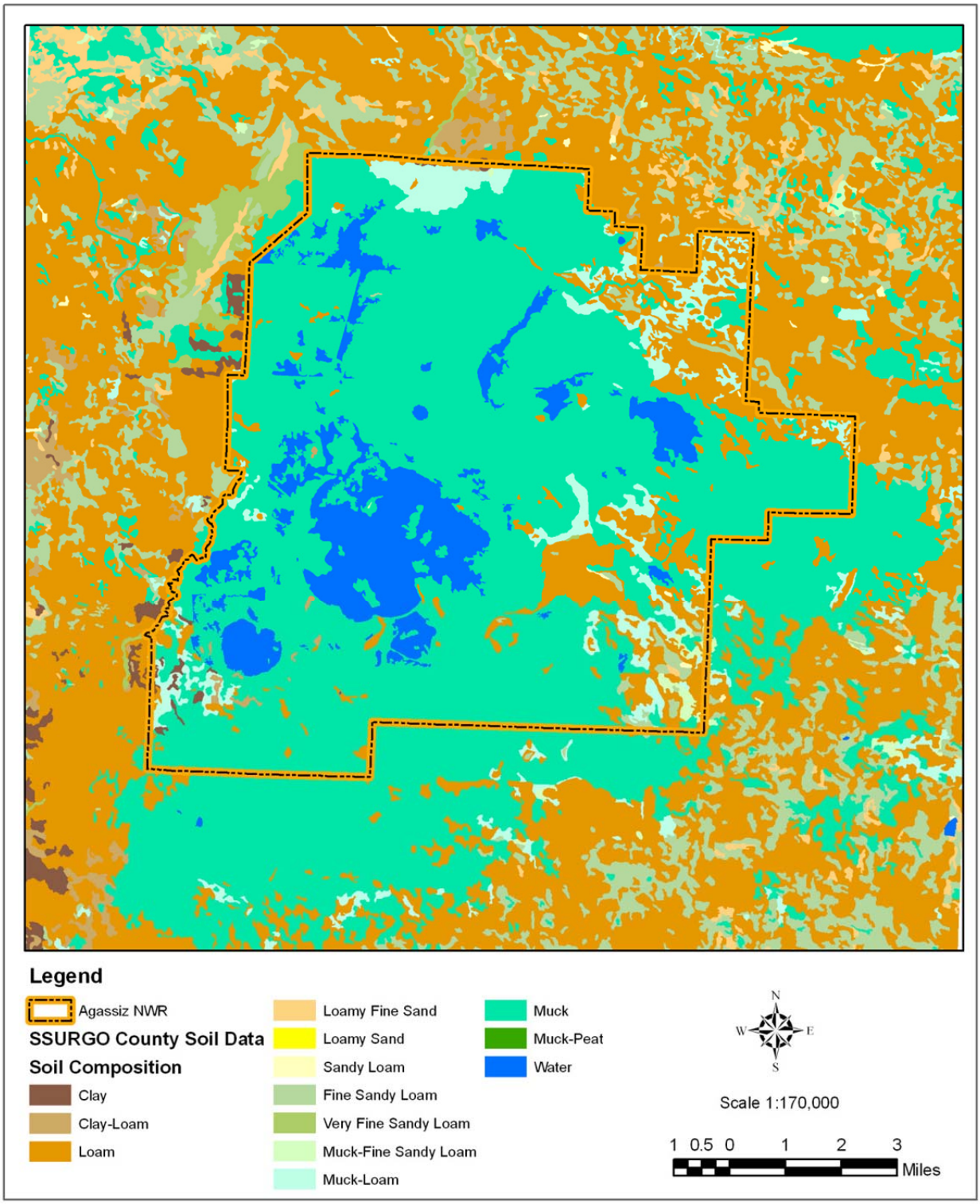
Like all parts of the Nation, the Mississippi Headwaters/Tallgrass Prairie Ecosystem is confronted with an invasion of non-native and nuisance species. Most of these "exotic" species are plants, but animals are counted among the invaders as well. Some were brought to the region or country deliberately, and then escaped their confines or intended environment. Others arrived by accident. They can cause extensive and expensive ecological and economic damage throughout the region and nation as their infestations spread. The primary nuisance species the Service has identified in the Mississippi Headwaters/Tallgrass Prairie Ecosystem are purple loosestrife (*Lythrum salicaria)*, Eurasian watermilfoil (*Myriophyllum spicatum*), spotted knapweed (*Centaurea biebersteinii*), leafy spurge (*Euphorbia esula*), and the zebra mussel (*Dreissena polymorpha*). Reed canary grass, Canada thistle (*Cirsium arvense*), and hybrid cattail (*Typha x glauca*) are particularly invasive at Agassiz NWR.

(2) Topography and Soils

Agassiz NWR is located in the eastern Red River Valley, in what was once the lakebed of ancient Glacial Lake Agassiz. The terrain is relatively flat, with a gentle gradient averaging 1.5 feet/mile, sloping from east to west across the Refuge. Underlying rocks in the area are Precambrian in origin, overlain by sedimentary rock (sandstones, limestones, and shales) dating to the Paleozoic and Mesozoic eras. Overlying all of these strata are thick deposits of glacial till and lake sediments from the Pleistocene Epoch. The layer of till and lake sediments on Agassiz NWR is estimated to exceed 200 feet in depth (U.S. Dept.of the Interior 1967).

The Refuge's surface soils are typical of lakebed deposits, consisting of mostly peat or silty loams and clays (Figure 2). Peat occurs at depths of one to two feet but is thicker in some areas. Clay-dominated glacial drifts with pockets and lenses of sand are found beneath the surface soils. Except for the peat, these soils have generally lent themselves well to dike construction. However, they are vulnerable to erosion because fine-grained silts and clays predominate. Also, dike slopes need to be protected from wave action by encouraging heavy vegetative cover. Peat soils may be used to dress the dike slopes (U.S. Dept. of the Interior 1978).

Figure 2. Soil Types on Agassiz NWR (http://soils.usda.gov/survey).



The glacial lake sediments and drift deposits of sand and gravel contain groundwater in quantities sufficient for domestic and stock use. Local groundwater is of good quality but is relatively hard and high in iron. Over much of the Refuge the depth to the water table is only one to four feet. This proximity to the surface has been favorable for pothole development, but conversely, makes building construction difficult and subsurface waste disposal impractical. The relative impermeability of the Refuge's surface soils impedes recharge of even its more permeable aquifers.

The soil survey is available on line at **http://soils.usda.gov/survey** and basic delineations and acreage calculations can be made in the Web Soil Survey section of this web site.

(3) Historic Condition

Some 10,000 years ago, the last Ice Age was nearly over. As the frigid grip of the Pleistocene Epoch weakened, the great continental glaciers that had blanketed the northern expanses of North America under thousands of feet of ice for the better part of two million years melted and receded. One of these glaciers spanned an area greater than that of the present-day five Great Lakes, and melt-water poured from it to form an enormous inland sea. One hundred centuries later, that prehistoric, glacial lake would be named in honor of the Swiss-American naturalist and geologist, Jean Louis Rodolphe Agassiz.

Prior to the settlement of northwestern Minnesota by Euro-Americans and the vast ecological changes these pioneers wrought, what is now Agassiz NWR consisted largely of marshes, wetlands, and the Mud Lake basin. American Indians of the Eastern Dakota and Anishinaabe tribes inhabited the greater region. Like many natural areas, the Mud Lake basin was subject to considerable climatic variation and corresponding ecological changes on the ground. During dry years, the surface flow of the Thief River would dwindle to almost nothing, or stop altogether, while Mud Lake would shrink in area. Wildland fires swept periodically through vegetation communities, altering plant structure and composition and sometimes causing peat fires, which could create potholes.

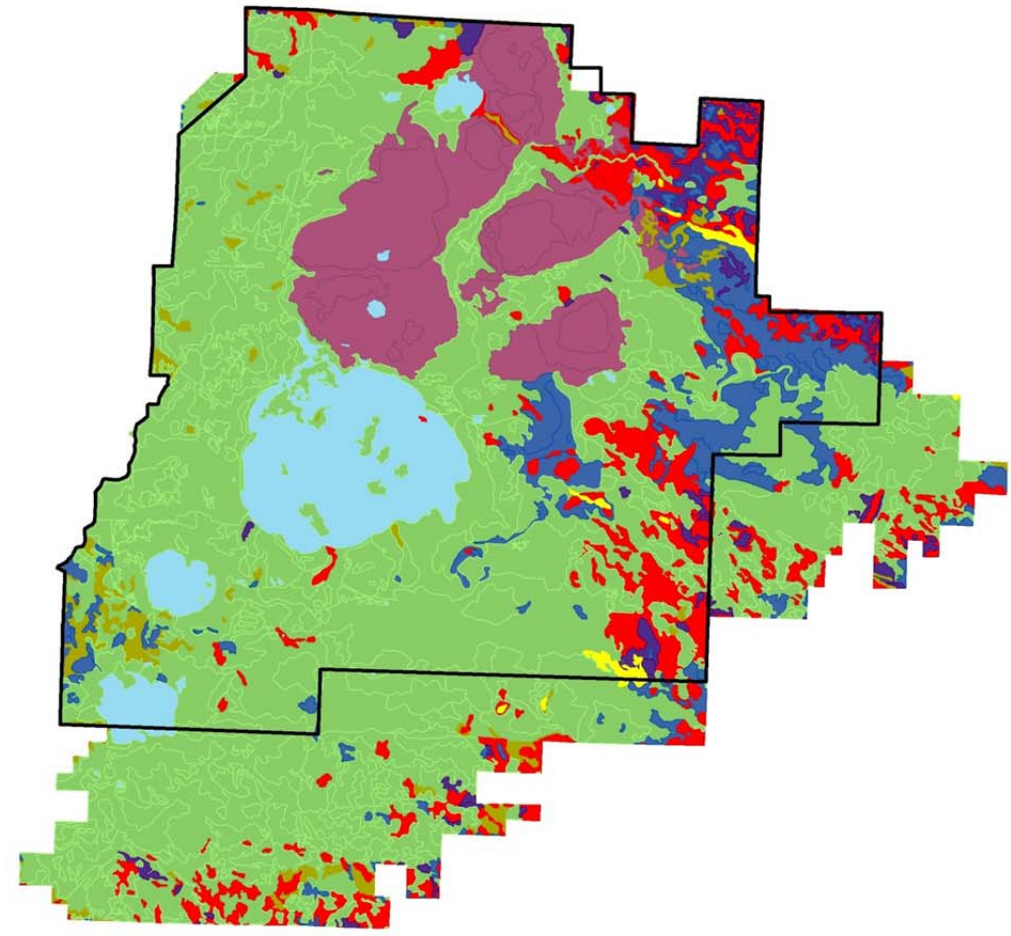
Flooding from the Thief River also occurred regularly. The swamps and marshes surrounding Mud Lake provided habitat for a rich array of wildlife, including ducks, geese, songbirds, black bear, elk (*Cervus canadensis*), moose, wolves, muskrats (*Ondatra zibethica*), minks (*Mustela vison*), bobcats (*Lynx rufus*), coyotes (*Canis latrans*), weasels (*Mustela* spp.), and fish. The Mud Lake area was the last part of Marshall County to be settled by Euro-Americans, who began homesteading there in the 1890s. Settlers were lured by farming promoters into what was then a boggy wilderness, checkered with wetlands and ponds, hoping to convert it to farmland. It was called the Mud Lake area. In 1909, in an effort to make farming more feasible and productive, state, local and private interests, supported by loans from the federal government, undertook a large, expensive drainage project. This drainage system eventually became one of the largest public drainage projects ever undertaken in the United States.

Initially, the area's abundant wildlife was a crucial food source for these newcomers. By 1915, approximately 150-200 homesteads had sprung up in the area. In 1909, the massive, federally-supported land drainage project described earlier began, with the goal of converting the soggy swamps and marshes into productive, well-drained farmland. However, agricultural productivity never met expectations, and both drainage and drought continued to plague agriculture in the area. Thus, most of the farmers in the basin were unable to make payments on their drainage assessments, forcing Marshall County's bond payment into default. The county was reportedly on the verge of bankruptcy. The deteriorating financial circumstances of the county and the farmers were no doubt aggravated by the regional drought and nationwide economic depression of the late 1920s and early 1930s. By 1933, approximately $1 million had been spent on Judicial Ditch 11. The State Legislature appropriated $750,000 to pay for delinquent drainage taxes on 90 percent of the area.

In the meantime, the Izaak Walton League and other sport hunters had begun to urge the creation of a national migratory bird sanctuary in the vicinity. As a result of the State Legislature's rescue of Marshall County from bankruptcy, the Minnesota Conservation Department had the right to use lands in the drainage district for conservation purposes. Eventually, this agency, with funds provided by the U.S. Resettlement Administration, acquired properties totaling 55,170 acres by condemnation, and in 1937 transferred them to the federal Bureau of Sport Fisheries and Wildlife (presently the U.S. Fish & Wildlife Service) for the establishment of Mud Lake NWR. In the six and a half decades since, Agassiz NWR has expanded to 61,500 acres.

Agassiz NWR is situated within an ecotone, the aspen parkland transitional zone between the coniferous or boreal forest to the north and east and the tallgrass prairie and prairie pothole zone to the west and south. A map of the pre-settlement vegetation was constructed by Jessie Adams, St. Cloud State University, 2006, based on the original survey notes, current soil survey, and MNDNR Ecological Classification (MNDNR 2005). Ecological classification contract work by Scott Zager, Wildlands Ecological Services, Maplewood, MN, in the OLMA (located in the southeast corner of the Refuge) was used to fine tune the Pre-settlement Vegetation Map (Zager 2007; Figure 3). Mapping the pre-settlement vegetation has limitations due to the accuracy of the soil survey and general descriptive terms used by early surveyors.

Figure 3. Pre-settlement Vegetation Map (prepared by Jessie Adams, St. Cloud State University).



Legend

- Northern Poor Conifer Swamp: Northern Poor Fen
- Northwestern- Dry Mesic Oak Woodland: Mesic Aspen- Oak Woodland: Wet Mesic Aspen
- Northern Rich Conifer Swamp
- Northern- Dry Prairie: Dry Savanna: Mesic Prairie: Mesic Savanna
- Water
- Northwestern Wet Aspen Forest
- Southern Wet Meadow Carr
- Northern Wet Prairie
- Refuge boundary

(4) Current Condition

Once established as a unit of the NWRS, the Refuge's wildlife benefited greatly from active habitat management conducted by Refuge staff. Wetlands were restored through an extensive system of dikes and water control structures. Twenty-six pools (impoundments) were developed, ranging in size from 30 to 9,000 acres. Today, water levels and flows are manipulated to create a variety of wetland types with a mix of emergent and submerged vegetation communities. This management of water is a vital tool used to benefit waterfowl and other water-dependent bird species at Agassiz NWR. In addition, prescribed fire and mowing are widely employed to manage habitats such as grasslands, shrublands, and sedge meadows, in order to benefit nesting waterfowl, white-tailed deer, moose, songbirds, and other native wildlife. Farming has been used to attract migrating waterfowl and to benefit resident wildlife. A variety of small grains have been planted including barley, oats, and wheat.

The Refuge lies in the aspen parkland transitional zone between the coniferous or boreal forest to the north and east and the tallgrass prairie and PPR to the west and south. This diversity of habitats in turn supports a wide diversity of resident and migratory wildlife, including 298 species of birds, 49 species of mammals, 12 species of amphibians, and nine species of reptiles. The Refuge's 61,500 acres are a key breeding ground for 17 species of ducks and the Refuge is an important migration rest stop for waterfowl. The Refuge is also noted for two resident packs of gray wolves, moose, and nesting bald eagles (*Haliaeetus leucocephalus*).

Figure 4, based on the 1997 infrared photography and vegetation delineation, illustrates the major vegetation types at the Refuge in these approximate acreages:

37,400 acres of wetland and shallow open water (pools)

11,650 acres of shrubland

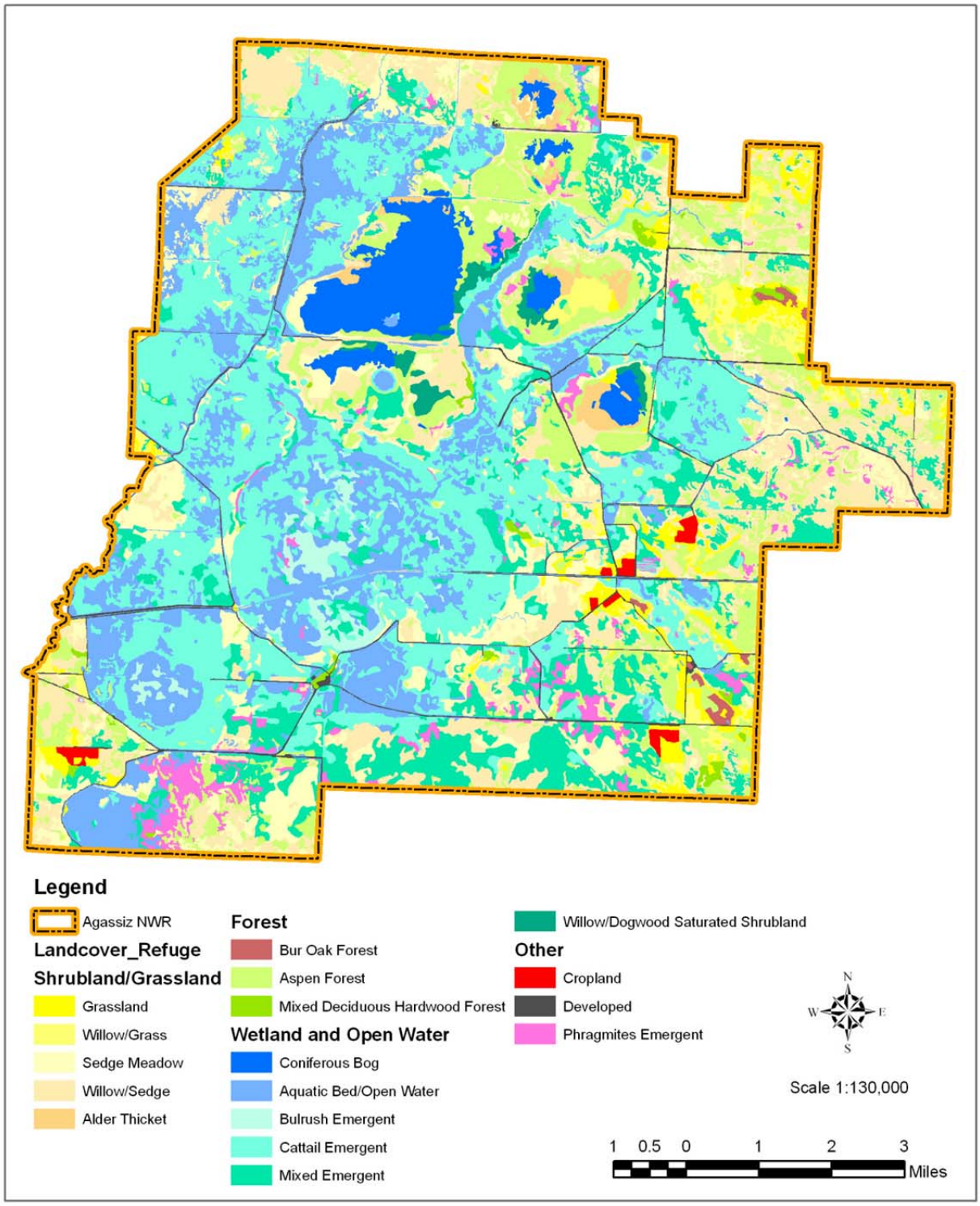
9,900 acres of woodland

1,710 acres of grassland

170 acres of cropland (managed for the benefit of wildlife)

670 acres of developed land (e.g., roads, parking lots)

Figure 4. Major Vegetation Types on Agassiz NWR Based on 1997 Aerial Infrared Photos.



Agassiz NWR issued a contract with ecologist Scott Zager to identify and delineate the ecological classification of the native plant communities within the OLMA, identified in the CCP, to set a bench mark for future monitoring and to aid management decisions. This assessment of the current vegetation, how it relates to the historic plant communities, and potential native plant communities will be used to tailor the management prescriptions in this area and will be useful as a monitoring tool to evaluate the changes that take place. The report is presented in the Habitat Inventory and Monitoring Plan (Appendix).

(a) Wetlands and open water

Wetlands and open water comprise approximately 37,400 acres (61%) of Agassiz NWR's 61,500 acres. Included are the Marsh System and Wet Meadow/Carr System plant communities described by MNDNR (MDNR 2005).

The Marsh System communities are tall forb and graminoid-dominated wetland communities that have standing or slow-moving water through all or most of the growing season. The Prairie Mixed Cattail Marsh community is dominated by dense stands of cattails with usually more than 50% cover and interspersed with areas of water. The cattail community is dominated by non-native species of narrow-leaved cattail (*Typha angustifolia*) and hybrid cattail. There are pockets of the native broad-leaved cattail (*Typha latifolia*) scattered throughout the Refuge. The Northern Bulrush Marsh on the Refuge is dominated by hardstem bulrush (*Scirpus acutus*) and is mostly found in the deeper areas of Agassiz Pool. The open water pools on the Refuge have submerged aquatic plants dominated by sago pondweed (*Potamogeton pectinatus*), coontail (*Ceratophyllum demersum*), common bladderwort (*Utricularia vulgaris*), and whorled water milfoil (*Myriophyllum verticillatum*). During drawdown these areas become mudflats and may become vegetated with moist soil annuals such as goosefoots (*Chenopodium* spp.) and docks (*Rumex* spp.). Marshes and open water habitats are important or indispensable to many of the migratory birds found on the Refuge, either during nesting season or in transit during migration. Ducks, geese, shorebirds, wading birds, and certain songbirds and raptors are all heavily dependent on various kinds of wetlands. Emergent marsh habitat is important to Franklin's gulls (*Larus pipixcan*), red-winged blackbirds (*Agelaius phoeniceus*), yellow-headed blackbirds (*Xanthocephalus xanthocephalus*), marsh wrens (*Cistothorus palustris*), black-crowned night-herons (*Nycticorax nycticorax*), and least bitterns. Submerged aquatic vegetation and associated invertebrates provide essential food for waterbirds. Submergents are present throughout the marsh but reach their greatest densities in open bays free of emergents. They also provide nesting material for five grebe species. A number of mammals, especially furbearers, utilize or depend on these habitats as well. The majority of these habitat acres on the Refuge are managed by adjusting water levels in the impoundments. Management of the wetlands has been guided by the 1987 Marsh and Water Management Plan.

Wet Meadow/Carr System plant communities are graminoid- or shrub-dominated wetlands that are subjected to moderate inundation during spring floods and heavy rains

and to periodic drawdowns during the summer. Sedge meadows with less than 25% willow cover are included in the wetland category in the above list and were mapped as sedge meadows in the 1997 Refuge Vegetation Map. Sedge meadows with greater than 25% willow cover are included in the shrubland category listed below. The Wet Meadow/Carr System includes both of these plant communities as the Sedge Meadow which is included here and the Willow-Dogwood Shrub Swamp community which is included in the Shrubland category below.

These open landscape communities are found along a moisture gradient from wet to dry following the MNDNR native plant communities of Northern Mixed Cattail Marsh, Northern Wet Meadow Carr and Southern Basin Wet Meadow Carr, Prairie Wet Meadow Carr and Northern Wet Prairie. Northern Mesic Upland Prairie was most likely very limited in its distribution throughout the Refuge (Zager 2007).

The sedge meadows are dominated by several species. Lake sedge (*Carex lacustris*) and slough sedge (*C. atherodes*) can form dense monotypic stands, but usually include cattail, bluejoint (*Calamagrostis canadensis*), narrow reedgrass (*Calamagrosti stricta*), and whitetop (*Scolochloa festucacea*). Common forbs in this community include marsh cinquefoil (*Potentilla palustris*), swamp milkweed (*Asclepias incarnata*), red-stemmed aster (*Aster puniceus*), marsh bellflower (*Campanula aparinoides*), spotted joe-pye weed (*Eupatorium maculatum*), sweet flag (*Acorus calamus*), and small bedstraw (*Galium trifidum*). Sedge meadows are a rare and declining habitat type in Minnesota, and several species prefer to breed or nest in this community. These include the American bittern, mallard (*Anas platyrhynchos*), northern harrier (*Circus cyaneus*), sandhill crane (*Grus canadensis*), sora (*Porzana Carolina*), Wilson's snipe (*Gallinago gallinago*), yellow rail, sedge wren (*Cistothorus platensis*), Le Conte's sparrow (*Ammodramus leconteii*) and swamp sparrow (*Melospiza georgianna*). Each of these species have been recorded nesting at Agassiz NWR.

(b) Shrubland

Lowland shrub extends across approximately 11,650 acres (19%) of the Refuge. Most of the area in this vegetation type is in the Willow – Dogwood Shrub Swamp community of the Wet Meadow/Carr System. This plant community is dominated by greater than 25% cover of willows and red osier dogwood (*Cornus stolonifera*) and occasionally speckled alder (*Alnus incana*) and bog birch (*Betula pumila*). The most common willows are slender willow (*Salix petiolaris*), pussy willow (*Salix discolor*), and Bebb's willow (*Salix bebbiana*). The most common graminoids are lake sedge, bluejoint, and tussock sedge (*Carex stricta*).

Northern Rich Alder Swamps dominated by speckled alder are found in water discharge areas of the bogs and some wetland edges. Speckled alder is frequently in association with other shrub species such as willows and bog birch. The ground layer tends to be sparse because of the dense shrub canopy.

Among the species that commonly utilize shrubland habitats are the moose, white-tailed deer, Le Conte's sparrow, yellow warbler (*Dendroica petechia*), common yellowthroat (*Geothlypis trichas*), and black-billed cuckoo (*Coccyzus erythropthalmus*). The use of this habitat by moose and deer means that it indirectly benefits the gray wolf, which preys on these two ungulates. Other migratory birds and waterfowl also use this habitat for nesting and cover.

(c) Woodland

Upland woodlands on the Refuge consist of about 9,900 acres (16%). The 1960 Land Use Plan listed the acres of woodland at 1,800 acres of which only 846 acres were in aspen. The remaining acres were small woodlots of mixed hardwoods and the black spruce (*Picea mariana*)/tamarack (*Larix laricina*) in bogs. According to the Land Use Plan the tamarack and black spruce were intensively harvested from 1900 to 1910, as there were one or two saw mills operating in the area at this time.

The mixed hardwood woodlands on the Refuge can be placed on a moisture gradient from wet to dry following the MNDNR native plant communities of Northwestern Wet Aspen Forest – Northwestern Wet-Mesic Hardwood Forest – Northwestern Wet-Mesic Aspen Woodland – Northwestern Mesic Aspen-Oak Woodland – Northwestern Dry-Mesic Oak Woodland (Zager 2007). The two wettest communities are fairly rare and limited to pockets and wetland edges.

Most of the aspen woodlands are the Northwestern Wet-Mesic Aspen Woodland (MNDNR 2005). The canopy is dominated by quaking aspen (*Populus tremuloides*), but balsam poplar (*Populus balsamifera*) can be abundant when present. Bur oak, green ash (*Fraxinus pennsylvanica*), American elm (*Ulmus americana*), and white spruce (*Picea glauca*) may be present. Bluejoint and Pennsylvania sedge (*Carex pensylvanica*) are the dominant graminoids. American hazelnut (*Corylus Americana*), beaked hazelnut (*Corylus cornuta*), and gray dogwood (*Cornus reacemosa*), and red osier dogwood are common shrubs. MNDNR (2005) states that Public Land Survey records indicate the rotation of stand replacing catastrophic fires was about 100 years and the frequency of surface fires was about 15 years. The rotation for catastrophic windthrow was estimated at 230 years. The Mesic Aspen-Oak Woodland grades into the driest community, Dry-Mesic Oak Woodland, which is found on the top of beach ridges and should have a patchy to interrupted canopy of 25% to 75% cover. Pennsylvania sedge is abundant. Big bluestem appears to have not been a component of this community in the Refuge area and has been replaced by bluejoint. Snowberry (*Symphoricarpos albus*), juneberry (*Amelanchier alnifolia*), American and beaked hazelnut, and gray dogwood can be found in the shrub layer. The Refuge's aspen/mixed hardwood and bur oak habitats are utilized by a wide variety of bird species, including the bufflehead (*Bucephala albeola*), hooded merganser (*Lophodytes cucullatus*), ovenbird (*Seiurus aurocapillus*), whip-poor-will (*Caprimulgus vociferous*), northern flicker (*Colaptes auratus*), downy woopecker (*Picoides pubescens*), hairy woodpecker (*Picoides villosus*), and pileated woodpecker (*Dryocopus pileatus*), eastern bluebird (*Sialia sialis*), great horned owl (*Bubo*

virginianus), red-tailed hawk (*Buteo jamaicensis*), Cooper's hawk (*Accipiter cooperii*), northern goshawk (*Accipiter gentillis*) and ruffed grouse. A variety of mammals also utilize woodlands at Agassiz NWR, including shrews, bats, squirrels, voles, mice, red fox (*Vulpes fulva*), porcupine (*Erithzon dorsatum*), raccoon (*Procyon lotor*), fisher (*Martes pennanti*), black bear, skunk (*Mephitis mephitis*), bobcat, white-tailed deer, moose, and gray wolf.

Coniferous Swamp occurs primarily within Agassiz NWR's designated Wilderness Area in the northern part of the Refuge and in three other locations in the northeast part of the Refuge. These areas are a mix of the Forested Rich Peatland Systems and the Acid Peatland Systems described by MNDNR (2005). The most common is Tamarack - Black Spruce Swamp (Aspen Parkland) in the higher areas and the Northern Poor Conifer Swamp in the wetter parts. Adjacent to Whiskey Lake there is poor Tamarack-Black Spruce Swamp. Portions of the edge of the conifer swamp and southern part of the Wilderness Area are open floating mat areas that are Northern Poor Fen. Some of the areas along the old ditches such as the excluded dike between the north and south Wilderness Area have become Northwestern Wet Aspen Forest due to the drainage effects. Beaver impacts to these areas have also flooded out the aspen and created willow swamps.

The Tamarack-Black Spruce Swamp and the Northern Poor Conifer Swamp communities are dominated by black spruce and tamarack. Shrubs include bog birch, Labrador tea (*Ledum groenlandicum*), leatherleaf (*Chamaedaphne calyculata*), alder (*Alnus* spp.), and willow. A nearly continuous mat of sphagnum moss (*Sphagnum* spp.) and brown moss (*Calleirgon* spp.) form the ground layer. Stemless lady's slipper (*Cypripedium acaule*), pitcher plant (*Sarracenia purpurea*), and sundew (*Drosera rotundifolia*) are found in the Northern Poor Conifer Swamp near Whiskey Lake. The Refuge's coniferous swamp habitat benefits plants like orchids and ferns and bird species such as the olive-sided flycatcher (*Contopus cooperi*), yellow-bellied flycatcher (*Empidonax flaviventris*), yellow-rumped warbler (*Dendroica coronata*), Connecticut warbler (*Oporornis agilis*), Nashville warbler (*Vermivora ruficapilla*), palm warbler (*Dendroica palmarum*), hermit thrush (*Catharus guttatus*), dark-eyed junco (*Junco hyemalis*), chipping sparrow (*Spizella passerine*) and winter wren (*Troglodytes troglodytes*).

(d) Grassland

Agassiz NWR has approximately 1,710 acres (3%) of upland grasslands. Many Refuge grasslands were farmed at one time and are dominated by introduced species such as smooth brome (*Bromus inermis*), red top (*Panicum rigidulum*), and aggressive invaders like reed canary grass and common reed. Recently restored farm fields have been seeded to a native upland mix (mesic) of prairie-harvested seed. Dominant grass species at these sites are big bluestem and Indian grass. Forbs are abundant on these sites, such as Culver's root (*Veronicastrum virginicum*), blazing star, wild bergamot (*Monarda fistulosa*), goldenrod (*Solidago* spp.), and purple prairie clover. The native plant community that represented the prairies in the Refuge area was Northern Wet Prairie

(Zager 2007) with only isolated occurrences of Northern Mesic Prairie. However, the drainage systems that were established to farm the area, have made more sites suitable for Northern Mesic Prairie (Zager 2007). The variation of Northern Wet Prairie found in the Refuge area appears to have been lacking the big bluestem component as the only place big bluestem has been found is where it was seeded and occurring on its own in a small area in the northeast corner of the Refuge and along the east boundary just south of County Road 7, both of which are well drained. Other common species are narrow reedgrass, Buxbaum's sedge (*Carex buxbaumii*), Canada goldenrod (*Solidago canadensis*), sunflowers (*Helianthus* spp.), tall meadow rue (*Thalictrum dasycarpum*), and spotted water hemlock (*Cicuta maculate*; MNDNR 2005).

The Refuge's grasslands provide feeding, foraging, or breeding habitat for numerous species of birds and mammals. Among them are nesting dabbling ducks, marbled godwit (*Limosa fedoa*), northern harrier, rough-legged hawk (*Buteo lagopus*), American kestrel (*Falco sparverius*), sharp-tailed grouse (*Tympanuchus phasianellus*), western meadowlark (*Sturnella magna*), killdeer (*Charadrius vociferous*), short-eared owls (*Asio flammeus*) and great horned owls, and the bobolink (*Dolichonyx oryzivorus*). Mammals that particularly utilize grasslands include the eastern cottontail rabbit (*Sylvilagus floridanus*), plains pocket gopher (*Geomys bursarius*), meadow vole (*Microtus pennsylvanicus*), red fox, white-tailed deer, and gray wolves.

(e) Cropland

Approximately 170 acres (0.3%) on the Refuge are cultivated for crops of value to wildlife. Winter wheat, barley, oats, and sunflowers are grown on seven units: Rodahl, John's Field, East 80, Goose Pen, Golden Valley, North Dahl, and South Dahl. In 1960 there were 860 acres in crop with about 66% being put in by cooperative agreements. At that time the objectives for the cropland program were 1.) left in the field for migrating waterfowl as an aid in reducing depredations on adjacent private lands; 2.) harvested and spread on the ice in February and March to provide food during the spring migration; 3.) harvested as feed for the captive Canada goose (*Branta canadensis*) flock.

The CCP established a course of action that will convert these fields to restored native prairie. These sites need to be evaluated to determine if they should be seeded to big bluestem upland mesic prairie mixes or to wet prairie mixes dominated by prairie cordgrass (*Spartina pectinata*) and bluejoint. Recent seedings can be looked at for success of the big bluestem prairie species and inferences made about similar sites and situations that are going to be seeded.

(5) Management Units

The Refuge has 44 HMUs identified. Many of the units consist of a large impoundment and peripheral wetland edge. Other units have an impoundment and a large area not directly affected by the impoundment except under flood conditions. Additional units do

not have impoundments and consist of natural wetlands and uplands. In the past these units went by several names; burn units, pools and farm units. In this document all the units are referred to as HMUs and have been numbered and named. The HMUs are presented in Figure 5 and the size of each HMU is listed in Table 1. The old numbers are also listed for cross referencing to past records. Each will be described in detail and the management prescription application discussed in the Management Unit Descriptions and Prescriptions.

Figure 5. Agassiz NWR Habitat Management Units.

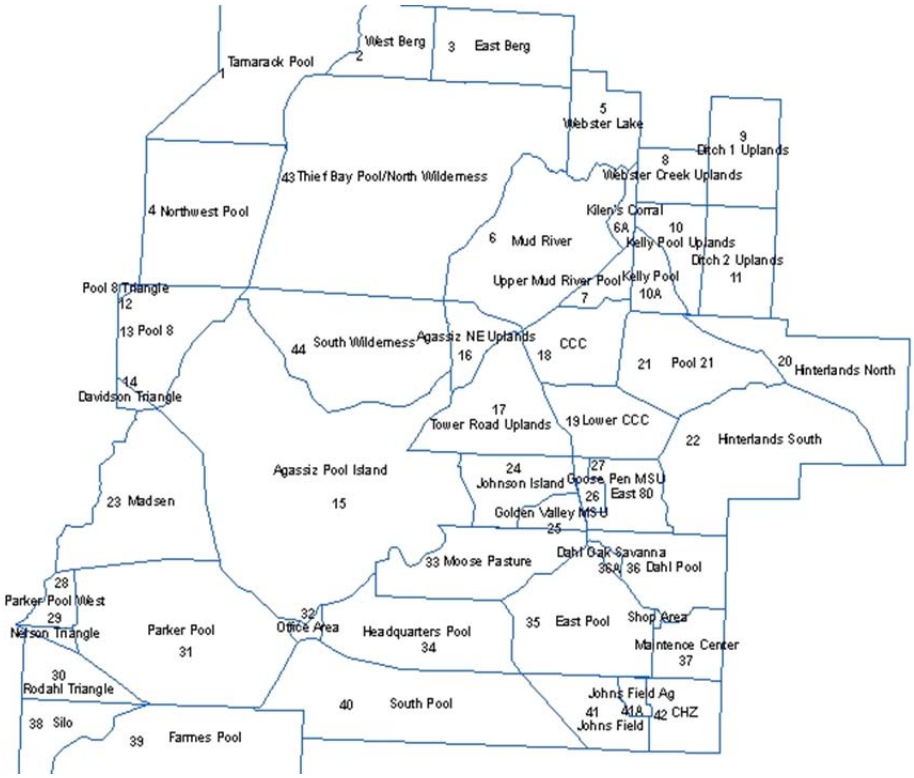


Table 3. Old Burn Unit Numbers Converted to New Habitat Management Unit Numbers at Agassiz NWR (Numbers converted January 2007).

New Unit Number	New Name	Size (Acres)	Old Burn Unit Number
0	Shop Area	16.0	Shop
1	Tamarack Pool	2224.5	1B
2	West Berg	743.1	2B
3	East Berg	1263.5	3
4	Northwest Pool	2242.4	4
5	Webster Lake	786.3	5

6	Mud River	2428.9	6A
6A	Kilen's Corral	169.8	6A
7	Upper Mud River Pool	281.3	6B
8	Webster Creek Uplands	484.4	7A
9	Ditch 1 Uplands	952.4	7B
10	Kelly Pool Uplands	586.0	7C
10A	Kelly Pool	379.5	7C
11	Ditch 2 Uplands	976.8	7D
12	Pool 8 Triangle	23.8	8B
13	Pool 8	1132.9	8A
14	Davidson Triangle	84.2	8C
15	Agassiz Pool	6815.9	8I
16	Agassiz NE Uplands	428.1	8E
17	Tower Road Uplands	1393.9	8F
18	CCC	891.0	9A
19	Lower CCC	908.2	9B
20	Hinter Lands North	1633.9	9E
21	Pool 21	1352.7	9C
22	Hinter Lands South	2527.6	9E
23	Madsen Pool	2025.3	10
24	Johnson Island	779.6	8G
25	Golden Valley MSU	247.4	8G
26	Goose Pen MSU	108.8	9D
27	East 80	680.6	9D
28	Parker Pool West	258.1	11A
29	Nelson Triangle	91.7	11B
30	Rodahl Triangle	616.4	18A
31	Parker Pool	2220.0	12A
32	Office Area	80.5	Headquarters
33	Moose Pasture	1348.4	8H
34	Headquarters Pool	1641.4	13
35	East Pool	1780.2	14
36	Dahl Pool	1054.8	15A
36A	Dahl Oak Savanna	68.5	15A
37	Maintenance Center	557.2	15B
38	Silo	787.0	18C
39	Farmes Pool	2828.1	18B
40	South Pool	2677.1	16B
41	Johns Field	747.4	17
41A	Johns Field Ag	127.9	17
42	CHZ	668.4	17

III. Resources of Concern

Fish and Wildlife Communities

The assorted habitats described in this chapter support a diverse assemblage of wildlife species native to northwestern Minnesota. Many kinds of birds, mammals, fish, reptiles, and amphibians inhabit the lands administered by Agassiz NWR, for which the Refuge is recognized internationally. Wildlife experts have documented the presence of 298 species of birds, 49 species of mammals, 12 species of amphibians, and eight species of reptiles on the Refuge.

Birds

The Refuge was designated a Globally Important Bird Area on March 17, 2001 for its outstanding value to wild birds and their habitats, as well as its efforts to conserve them. The Refuge is especially important to migratory birds, both during the nesting season and migration. It supports 17 species of nesting or breeding ducks, as well as giant Canada geese (*Branta Canadensis maxima*). The following numbers are maximum estimates during the past 10 years. Approximately 11,570 pairs of ducks and 600 pairs of geese nest on the Refuge. During migration, it hosts up to 50,000 ducks, 23,000 geese, and 2,000 sandhill cranes.

The Refuge supports North America's largest consistent colony of Franklin's gulls (between 25,000-40,000 breeding pairs), as well as 750 nesting pairs of black terns (*Chlidonias niger*), 900 nesting pairs of black-crowned night-herons, 50-500 nesting pairs of eared grebes (*Podiceps nigricollis*), and 3,000-5,000 American white pelicans (*Pelecanus erythrorhynchos*). American white pelicans do not nest at Agassiz, but utilize the Refuge as a foraging site and staging area.

Overall, more than 120 species of birds have been recorded breeding and nesting at Agassiz NWR, of which the *formerly* federally threatened bald eagle is one of the most majestic. After a 30-year absence, bald eagles began nesting on the Refuge in 1992. In 2006 there were six pairs.

Mammals

Forty-nine species of mammals have been documented on Agassiz NWR. Without question, the two most prominent mammals on the Refuge – though not the most frequently observed – are the moose and the federally threatened gray wolf. For many years the moose population on the Refuge and adjoining state wildlife management areas averaged approximately 275 animals. The population has been in a steady decline since 1984 and is currently less than 50 animals. Moose were hunted every other year from 1971 - 1993 and an average of 25 were harvested from Agassiz NWR and adjoining MNDNR wildlife management areas (WMA) during hunting years. Two wolf packs

inhabit Agassiz NWR and adjacent WMAs; however, they are rarely seen. The first pack became established in 1981 and the second in 1994.

Two other large mammals found on Agassiz NWR are the black bear and the white-tailed deer. Black bears are observed infrequently, but regularly on the Refuge, while deer are commonplace. In February 2002 the deer population was estimated at 1,600 (approximately 15/mi^2). Deer are hunted at Agassiz NWR, with an average of 143 taken per year taken from Agassiz and neighboring WMAs from 2000 - 2006.

Most mammals, however, are far less conspicuous than moose, wolves, bear, and deer. They include such hairy little creatures as shrews, bats, woodchuck (*Marmota monax*), rabbits, snowshoe hares, red squirrels (*Tamiasciurus hudsonicus*), muskrats, mice, and voles. There are many members of the Mustelid or weasel family, including fisher, ermine (short-tailed weasel; *Mustela erminea*), least and long-tailed weasels (*Mustela rixosa, Mustela frenata*), mink, striped skunk, and river otter (*Lutra canadensis*). Also present are beaver (*Castor canadensis*), porcupine, raccoon, coyote, and red fox. The Refuge's diversity of habitats meets the needs of these mammals for food, cover, and water.

Amphibians

Twelve species of amphibians have been recorded on the Refuge, including the wood frog (*Rana sylvatica*), western chorus frog (*Pseudacris triseriata*), leopard frog (*Rana pipiens*), spring peeper (*Pseudacris crucifer*), gray treefrog (*Hyla versicolor*), Copes gray treefrog (*Hyla chrysoscelis),* American toad (*Bufo americanus*), Canadian toad (*Bufo hemiophrys*), and tiger salamander (*Ambystoma tigrinum*). Marshall County Central High School has set pit fall traps every year since 1994, recording five species of amphibians during these surveys. Since 2000, Agassiz NWR has participated in statewide amphibian surveys coordinated by Hamline University of St. Paul, Minnesota and the MNDNR.

Reptiles

Eight species of reptiles are likely to occur at Agassiz NWR, five of which are snakes. None are threatened or endangered, and none are the subject of management efforts. The reptiles are prairie skink (*Eumeces septentrionalis*), snapping turtle (*Chelydra serpentine*), painted turtle (*Chrysemys picta*), plains garter snake (*Thamnophis radix*), red-sided garter snake (*Thamnophis sirtalis parietalis*), eastern garter snake (*Thamnophis sirtalis sirtalis*), smooth green snake (*Opheodrys vernalis*), and redbelly snake (*Storeria occipitomaculata*). One other species that may occur is the brown snake (*Storeria dekayi*).

Fish

Thirty species of fish have been documented in pools, ponds, and watercourses on the Refuge. Twenty of these species are small fish species like shiners, darters and daces.

The most abundant species are the brook stickleback (*Culaea inconstans*) and the fathead minnow (*Pimephales promelas*). None are threatened or endangered. Fishing is not permitted on the Refuge due to the paucity of sport fish and potential disturbance to marsh-nesting birds. Sufficient water depth to maintain the small fish species is critical to the food chain in supporting a diversity of birds and mammals. Zimmer et al. (2003) suggest that fathead minnows influence the ecological characteristics of prairie wetlands. Presence of these fish in prairie potholes was associated with increased turbidity and lower abundances of aquatic plants compared to fishless wetlands. Reducing and regulating the number of minnows in the impoundments can be accomplished by drawdowns and low over-winter water levels.

A. Identification of Refuge resources of concern.

Table 6. Wildlife Species of Conservation Concern to Agassiz NWR and the RMD.

Species (* = Managing habitat for these species)	**Monitored on Refuge or RMD by staff or MNDNR?**	**Regional/State Status** R3-Conservation Priority in Region 3 E-Federal Endangered T-Federal Threatened SE-State Endangered ST-State Threatened SSC-State Special Concern	**Potential Benefit By Habitat Habitat used for Production (P) or Migration (M)**					
			Wetlands/ Mudflats/Open water	Lowland shrub	Coniferous bog	Upland forest: Aspen &Bur Oak	Grasslands	Cropland
Mammals								
*Gray Wolf *Canis lupus*	Yes	T ST (proposed for delisting from ESA)		P	P	P	P	
*Muskrat *Ondatra zibethica*	Yes		P					
Beaver *Castor canadensis*	Yes		P			P		
*Moose *Alces alces*	Yes		P	P	P	P		
*White-tailed Deer *Odocoileus virginianus*	Yes			P	P	P	P	P
Birds								
Common Loon *Gavia immer*	Yes	R3	M					
Horned Grebe *Podiceps auritus*	Yes	ST	M, P					
American White Pelican Pelecanus erythrorhynchos	Yes	SSC	M					

Table 6. Continued.

Species (* = Managing habitat for these species)	**Monitored on Refuge or RMD by staff or MNDNR?**	**Regional/State Status** R3-Conservation Priority in Region 3 E-Federal Endangered T-Federal Threatened SE-State Endangered ST-State Threatened SSC-State Special Concern	**Potential Benefit By Habitat Habitat used for Production (P) or Migration (M)**					
			Wetlands/ Mudflats/Open water	Lowland shrub	Coniferous bog	Upland forest: Aspen & Bur Oak	Grasslands	Cropland
Double-Crested Cormorant *Phalacrocorax auritus*	Yes	R3 (nuisance)	M, P					
*American Bittern *Botarus lentiginosus*	Yes	R3	M, P				P	
*Least Bittern *Ixobrychus exilis*	Yes	R3	M, P					
*Franklin's Gull *Larus pipixcan*	Yes		M, P					
*Canada Goose *Branta canadensis*	Yes		M, P					M
Trumpeter Swan *Cygnus buccinator*	Yes	R3, ST	M, P					
*Wood Duck *Aix sponsa*	Yes	R3	M, P		M, P	P		
*American Black Duck *Anas rubripes*	Yes	R3	M, P				P	
*Mallard *Anas platyrhynchos*	Yes	R3	M, P				P	M
*Blue-Winged Teal *Anas discors*	Yes	R3	M, P				P	
*Northern Pintail *Anas acuta*	Yes	R3	M, P				P	
*Canvasback *Aythya valisineria*	Yes	R3	M, P					
*Lesser Scaup *Aythya affinis*	Yes	R3	M, P					
*Bald Eagle *Haliaeetus leucocephalus*	Yes	R3, SSC	M, P			M, P		
Northern Harrier *Circus cyaneus*	No	R3	M, P			M, P	M, P	
Northern Goshawk *Accipiter gentilis*	No	R3			M, P			
Swainson's Hawk *Buteo swainsoni*	No	R3					M	

Table 6. Continued.

Species (* = Managing habitat for these species)	**Monitored on Refuge or RMD by staff or MNDNR?**	**Regional/State Status** R3-Conservation Priority in Region 3 E-Federal Endangered T-Federal Threatened SE-State Endangered ST-State Threatened SSC-State Special Concern	**Potential Benefit By Habitat Habitat used for Production (P) or Migration (M)**					
			Wetlands/ Mudflats/Open water	Lowland shrub	Coniferous bog	Upland forest: Aspen & Bur Oak	Grasslands	Cropland
Peregrine Falcon *Falco peregrinus*	Yes	R3, ST	M				M	
*Sharp-tailed Grouse *Tympanuchus phasianellus*	Yes						P	
*Virginia Rail *Rallus limicola*	Yes		M, P					
*Sora *Porzana carolina*	Yes		M, P					
*Greater Yellowlegs *Tringa melanoleuca*	Yes	R3	M					
*Spotted Sandpiper *Actitis malcularia*	Yes		M, P					
*Upland Sandpiper *Bartramia longicauda*	Yes	R3					M	
*Marbled Godwit *Limosa fedoa*	Yes	R3, SSC	M, P				M, P	
*Hudsonian Godwit *Limosa haemastica*	Yes	R3	M					
*Stilt Sandpiper *Calidris himantopus*	Yes	R3	M				M	
*Buff-breasted Sandpiper *Tryngites subruficollis*	Yes	R3	M				M	
*Wilson's Phalarope *Phalaropus tricolor*	Yes	SE	M, P					
Common Tern *Sterna hirundo*	No	R3, SE	M					
Black Tern *Chlidonias niger*	Yes	R3	P, M					

Table 6. Continued.

Species (* = Managing habitat for these species)	**Monitored on Refuge or RMD by staff or MNDNR?**	**Regional/State Status** R3-Conservation Priority in Region 3 E-Federal Endangered T-Federal Threatened SE-State Endangered ST-State Threatened SSC-State Special Concern	**Potential Benefit By Habitat Habitat used for Production (P) or Migration (M)**					
			Wetlands/ Mudflats/Open water	Lowland shrub	Coniferous bog	Upland forest: Aspen & Bur Oak	Grasslands	Cropland
*Forster's Tern *Sterna forsteri*	No	R3	M, P					
Black-billed Cuckoo *Coccyzus erythropthalmus*	No	R3		M, P		M, P	M, P	
Long-eared Owl *Asio otus*	No	R3			M	M		
Short-eared Owl *Asio flammeus*	Yes	R3	M, P				M, P	
Whip-poor-will *Caprimulgus vociferus*	No	R3			M, P	M, P		
Red-headed Woodpecker *Melanerpes erythrocephalus*	No	R3				P		
Northern Flicker *Colaptes auratus*	No	R3				M, P		
Olive-sided Flycatcher *Contopus cooperi*	No	R3			M			
Sedge Wren *Cistothorus platensis*	No	R3	M, P	M, P			M, P	
Golden-winged Warbler *Vermivora chrysoptera*	Yes	R3		M		M		
Cape May Warbler *Dendroica tigrina*	No	R3			M			
Connecticut Warbler *Oporornis agilis*	No	R3		M, P		M, P		
Grasshopper Sparrow *Ammodramus savannarum*	No	R3					M	
Le Conte's Sparrow *Ammodramus leconteii*	No	R3	M, P	M, P			M, P	

Table 6. Continued.

Species (* = Managing habitat for these species)	**Monitored on Refuge or RMD by staff or MNDNR?**	**Regional/State Status** R3-Conservation Priority in Region 3 E-Federal Endangered T-Federal Threatened SE-State Endangered ST-State Threatened SSC-State Special Concern	**Potential Benefit By Habitat Habitat used for Production (P) or Migration (M)**					
			Wetlands/ Mudflats/Open water	Lowland shrub	Coniferous bog	Upland forest: Aspen & Bur Oak	Grasslands	Cropland
Nelson's Sharp-tailed Sparrow *Ammodramus nelsoni*	No	R3	M, P				M, P	
Bobolink *Dolichonyx oryzivorus*	No	R3					M, P	
Western Meadowlark *Sturnella neglecta*	No	R3					M, P	
Rusty Blackbird *Euphagus carolinus*	No	R3			M			
Amphibians								
Tiger salamander *Ambystoma tigrinum*	Yes	R3	P	P		P		

B. Identification of habitat requirements.

Priority Species Accounts

Freshwater Mussels

Distribution

Giant floaters (*Pyganodon* grandis) and cylindrical papershells *(Anodontoides ferussacianus*) are two of the more abundant mussels found on Agassiz NWR. Mussels are found in the river channels and ditches where flows are sustained. They have also been noted in the impoundments in borrow ditches and in areas where ditches empty into the impoundments.

Ecology

Freshwater mussels have a complex life cycle. Males release sperm into the water and females downstream take up the sperm with incoming water and their eggs are fertilized.

After a period ranging from days to months, fertilized eggs develop into glochidia (larvae). In many mussel species, the female displays a "lure" to attract a host fish. When the fish bites the lure, the glochidia are released, clamp down on host tissue (usually gills) and transform into a juvenile mussel over a period of that ranges from hours to weeks, depending on water temperature and the individual species of mussel. Many mussels are host specific. If a glochidium attaches to an unsuitable host, it dies (Heidebrink 2002). Freshwater mussels exhibit a remarkable variation in the degree of host specificity. Some mussels have only one known suitable host fish, whereas over 30 species of fish have been identified as hosts for species such as giant floaters (Watson 2000). Juvenile mussels resemble miniature adults and drop from the fish and burrow into the river bottom. After several (2-9) years, they mature into an adult capable of reproduction (Heidebrink 2002).

Fresh water mussels are filter-feeding burrowers of the benthos. The adult giant floater is a filter-feeding, sessile organism that has a fragile, elongate, oval shell 106- 191 mm (4 - 7.5 inches) in length. The cylindrical papershell has an elongated-oval shell that is yellowish white to olive or dark brown, and can grow to 114 mm (4.5 inches) in length (http://www.dot.state.co.us/environmental/Wildlife/SGPIBO.pdf, August 2006). Mussels are long-lived species; many live more than 10 years, and some are reported to live more than 100 years. Thin-shelled species (i.e., floaters, papershells) grow much faster than thicker-shelled.

Habitat Requirements and Use of Refuge Habitats

Mussels are found in waters where velocity allows for stable substrates for burrowing, but in which siltation does not occur. Being sessile, filter feeders, mussels require good water quality and quantity for feeding, breathing, and reproducing, and thus typically inhabit unpolluted waters that are rich in oxygen, calcium, and suspended food particles. Because they are filter feeders, they are organic-nutrient sinks and are probably significant aquatic decomposers. The giant floater is found in ponds, lakes, and sluggish mud-bottomed pools of creeks and rivers, though it can be found in a variety of other habitats as well. The cylindrical papershell inhabits the mud and sand benthos of small creeks and the headwaters of larger streams.

Research and Monitoring Needs

As a group, native mussels are the most rapidly declining animal group in the United States, and constitute the largest group of federally-listed endangered or threatened invertebrates. There are no conservation plans for mussels found on Agassiz NWR, but the Service has drafted a national strategy for the conservation of native mussels.

The MNDNR has started periodic monitoring of mussels in the Thief River along the west boundary of the Refuge. No other monitoring takes place.

Potential Refuge Contribution to Habitat Needs

Agassiz NWR is host to a population of freshwater mussels. Sufficient water depths during dry years is the most limiting factor for mussels on the Refuge. During drawdowns, water in ditch bottoms provides refugia for short-term dry periods. Fish populations quickly populate impoundments when water levels are restored after drawdowns, bringing with them the glochidia that replenish the mussel community. Healthy fish populations are key to mussel reproduction. Fish populations are dependant on sufficient water depths during the winter months to survive. The quality and amount of water leaving the Refuge is key to mussel populations in the Thief River.

Sustained instream flows, deep water depths in impoundments during winter, long intervals between drawdowns, and decreasing sediment loads coming into and going out of the Refuge are all favorable for mussel populations.

Amphibians

Distribution

Western chorus frogs, wood frogs, and tiger salamanders are the most abundant and representative of the amphibians on Agassiz NWR. An abundance of frogs are found throughout the southern, northern, and eastern portions of the Refuge that are wooded. The tiger salamander is found through out the Refuge. Western chorus frogs are widespread and common in Minnesota. The boreal chorus frog supposedly occurs in northwestern Minnesota and the western chorus frog found is in the southeast. There is a large band of intergradations in all of central and southwestern Minnesota (Moriarity 1998, http://www.herpnet.net/Minnesota-Herpetology.html). Wood frogs are found throughout Minnesota, except in the southwestern and south-central part and are common in northern and central Minnesota. Wood frogs, as their name implies, are a woodland species. The eastern tiger salamander subspecies is found throughout the entire state of Minnesota. It is the state's most common salamander. Tiger salamanders are used by the bait and biological supply trade, but there is no data on the numbers taken. This species is found in open fields, prairies, cultivated fields, pastures, forests, and even towns. Principal habitat requirements include ponds, lakes, marshes, or other permanent bodies of water in which to breed (Moriarity 1998).

Ecology

Chorus frogs begin seasonal activity in late March or early April, and immediately begin calling and breeding. Most breeding activity is done by the end of May, but individuals may be heard giving their advertisement call in June or July, especially during the evening or after rains. Chorus frogs lay small clusters of eggs. The tadpoles metamorphose in about 60-75 days. Western chorus frogs do not move far from their wetlands during the summer, especially in urban environments. They apparently overwinter under rocks or logs (http://www.herpnet.net/Minnesota-Herpetology.html).

Wood frogs are one of Minnesota's earliest emerging herpetofauna. They emerge in late March or early April and begin breeding as soon as they reach suitable wetland habitat. Often they are found calling in the open portions of ice-covered marshes. Males vocalize while floating or resting on submerged vegetation. The vocal sacs are located on the sides of the body. The breeding season lasts a maximum of two weeks. Males call night and day. Females lay a floating cluster of nearly 1,000 eggs. Often, most or all of the females will lay their eggs communally on one end of a wetland, creating a huge mat of eggs. Such clusters may increase the temperature of the masses at the center thus speeding the development of the eggs. These masses may also protect the inner clusters from predators such as leeches and aquatic insect larvae. The tadpoles morph in 45-60 days. The adults move away from breeding ponds after the breeding season ends (http://www.herpnet.net/Minnesota-Herpetology.html). Unlike many Minnesota frogs, wood frogs move considerable distances from permanent water and migrate up to several hundred meters between breeding ponds and non-breeding terrestrial habitats. After leaving a breeding pond, they usually remain in an area without moving more than 100 m. In Minnesota, populations were very similar in allelic frequencies even at distances greater than several kilometers, suggesting large individual movement; however, sample sizes and number of loci examined were small, and genetic patterns do not necessarily reflect movement distances (Squire and Newman 2002). They take shelter under leaf litter and rely upon camouflage for defense. They hibernate under rocks or logs and partially freeze like gray tree frogs.

Western chorus frogs and wood frogs feed on small invertebrates. Chorus frogs may hunt in low shrubs but due to their short limbs, they do not climb very high and they are not quite as acrobatic as wood frogs (http://www.herpnet.net/Minnesota-Herpetology.html).

Tiger salamanders, although abundant, are very secretive. Nearly all of their time is spent underground in burrows of other animals or burrows they have constructed themselves. Occasionally, they are found above ground on damp or humid nights. The only time they are found above ground in numbers is during heavy spring and fall rains while they migrate to and from over-wintering sites. During the fall migration they are often observed crossing the Refuge dikes and roads. Tiger salamanders breed in spring, often before all the ice has melted from the wetlands' surface. Females may lay about 100 eggs in loose masses. The larvae metamorphose in August and September and may be smaller upon transformation then when they were larvae. They overwinter underground in burrows or other debris in October (http://www.herpnet.net/Minnesota-Herpetology.html). Both adults and larvae alike are extremely voracious feeders, consuming anything that is smaller than them. They snap quickly and sometimes use their tongue to catch prey, but they are also very clumsy hunters.

Habitat Requirements and Use of Refuge Habitat

The western chorus frog is found in a variety of habitats, but never far from woodlands. They breed in a variety of wetland habitats, ranging from temporary pools of water to large wetlands, and even in shallow parts of lakes (http://www.herpnet.net/Minnesota-Herpetology.html). Wood frogs frequent the heavily timbered boggy forests of northern

Minnesota. In central Minnesota they are also found in prairie and grasslands, breeding in marshes surrounded by woodland (http://www.herpnet.net/Minnesota-Herpetology.html). Tiger salamanders only require wetlands, lakes, marshes or other permanent bodies of water in which to breed.

Agassiz NWR has an abundance of habitat for amphibians. Over 60% of the Refuge is wetlands. Refuge woodlands are highly dissected with temporary and seasonal wetlands that create ideal breeding habitat for frogs. Populations of amphibians may be restricted during drought, but semi-permanent wetlands provide a nucleus for the populations to rebound.

Research and Monitoring Needs

Marshall County Central High School has set an array of pit fall traps every year since 1994, recording five species of amphibians over that period. Since 2000, Agassiz NWR has also participated in statewide frog and toad surveys coordinated by the MNDNR and Hamline University of St. Paul, Minnesota. One route is on Agassiz NWR and two routes are within the Refuge Management District on private lands.

Potential Refuge Contribution to Habitat Needs

Most of the amphibians found on the Refuge are common and abundant statewide. The Refuge will continue to provide habitat helping to keep them abundant. Spring peepers are also found on the Refuge in the fringes of the conifer bogs. This represents one of the western-most points in their distribution.

The open landscape management area may have a detrimental affect on the wood frog population; however, they also use prairie and grassland wetlands with woodlands nearby. They are the frog with the largest movements after breeding and will also use willow habitats.

Gulls and Terns

This group is primarily represented at Agassiz NWR by the Franklin's gull, black tern, and Forster's tern (*Sterna forsteri*). These birds require similar open emergent marsh vegetation for breeding habitat and similar food habits. The below narrative will focus on the Franklin's gull.

Distribution

The Franklin's gull breeds mainly in Canada's prairie provinces, Montana, the Dakotas, and western Minnesota. The birds generally occupy the eastern part of Montana, but sometimes wander west after the breeding season. Franklin's gulls migrate much farther south than most gull species, wintering chiefly on the shores of Peru and Chile.

Franklin's gulls live inhabit the prairies, rather than the seacoast or large lakes during the breeding season. Once they reach the grasslands in spring, the gulls look for large marshes where their chicks will be safe until able to fly. For nesting, Franklin's gulls require large marshes with emergent vegetation for nest attachment, and deep water to prevent drying before young fledge. Such marshes are vulnerable to natural drought and to draining and other adverse management practices, including burning (Burger and Gochfeld 2009).

Considerable controversy exists concerning recent population trends. Based on U.S. Fish and Wildlife Service Breeding Bird Surveys, a 7.4% annual decline has occurred (1968–1991). If real, this would reflect a 90% decline overall. Although declines noted were widespread, negative trend was significant only for Alberta and North and South Dakota. Negative trend is not consistent with reports from breeding colonies (Burger and Gochfeld 2009).

Natural resources managers report large inter-year variability, depending on water conditions, but little evidence of a long-term decrease in numbers. Many recent range expansions have been noted; with first breeding in Oregon (1948), Idaho (1950), Nevada (1971), California (1990), British Columbia (probable in 1993), and Kansas (probable in 1993). Because of high water conditions in 1994, some refuges reported their highest breeding populations ever (Agassiz NWR, Sand Lake NWR, SD). In Manitoba, the only Canadian province where recent surveys have been completed regularly, there is no evidence of a population decline (Burger and Gochfeld 2009).

Ecology

Franklin's gulls always nest over water on floating mats built on the water's surface, on muskrat platforms, or on floating debris in inland freshwater marshes or lakes and rarely in flooded meadows. Colonies are in cattails, bulrushes, phragmites, or other emergent vegetation. Most nests are at depths of 30–60 cm, with extremes of 12–130 cm. These gulls prefer to nest in areas of low vegetation density or at edges of dense clumps (Burger 1974). Optimal habitat is intermediate density vegetation with patches of open water of varying sizes. Nest dispersion is related to visibility from the nest. At Agassiz NWR, inter-nest distances were 0.5–4.5 m, with most in the 0.6–2.5 m range (Burger 1974).

Franklin's gulls often forage in dense flocks in wet pastures (particularly in early spring when seeds are available). Many authors report large flocks following plows or disk harrows, searching for worms, arthropods, and even rodents. During breeding season they feed aerially on swarming insects, as well as on the ground for earthworms and insects, and on surface water for aquatic insects.

Within its limited scope, the Franklin's gull is an opportunistic feeder, eating both plant and animal matter, as well as fish refuse, small rodents, crayfish, and shellfish. Nonetheless, earthworms, chironomids (Chironomidae), grasshoppers, dragonfly nymphs, and other insects and larvae make up the bulk of their diet during the breeding season. Adults and young take numerous emerging chironomids and sometimes other

aquatic insects. The gulls will eat wheat, oats, and other grains if natural foods are scarce. Many now feed on sunflower seeds near Agassiz NWR which is a relatively recent (≤25 years) crop in northwest Minnesota.

Habitat Requirements

Nesting habitat degradation occurs during the permanent draining of marshes or periodic intentional drawdown for management of duck-nesting habitat. Birds appear to respond to total expanse of water, depth of water, density and dispersion of vegetation, and size and dispersion of open-water areas. Changes in these patterns result in colony desertion or attraction (Burger 1974). Franklin's gulls themselves cause some degradation of habitat because of the net contribution of nitrogen and phosphorus (from defecation load) to the immediate nesting area. Increased fertilization can lead to increased vegetation density, making habitat less suitable for nesting. Optimal habitat is reduced if common reed replaces cattails and bulrushes, as in the coastal plain (Burger and Gochfeld 2009).
Seasonal Use/Refuge Habitats

Franklin's gulls generally arrive at Agassiz NWR in mid-April. The colony is usually located in one or two portions of Agassiz Pool. Parker Pool has been used occasionally and recently Farmes Pool has had several thousand birds nesting in it. Fledging takes place in July. By 31 July all but a few flightless or recently fledged juveniles have left the Refuge. Postbreeding dispersal of color-marked birds from Agassiz NWR showed that both adults and young initially dispersed north into northern Minnesota and Canada and west into North Dakota (Burger 1972).

Upon arrival in early spring at Agassiz NWR flocks walk through near by farm fields searching for grain as well as worms or insects on snow-free patches of ground (Burger 1974). By late April, as marsh ice melts, flocks feed extensively on newly emerging aerial insects. During this period territorial and courtship behavior nearly ceases from 1000 to 1600 hrs, when almost the entire colony "hawks" for insects over marsh. From early May to early July, agricultural activity allows a switch to earthworms and arthropods gleaned behind plows and cultivators. By late May, periodic, large hatches of midges on the marsh keep gulls foraging there. During massive hatches, gulls sit on the water, twirling in circles and pecking midges off the surface as they emerge.

Habitat and/or Population Objectives

Agassiz NWR aims to maintain an annual average of 20,000 nesting Franklin's gull pairs over a five-year period, by providing ideal nesting conditions in Agassiz Pool. Agassiz NWR supports the largest Franklin's gull nesting colony in the United States. In any given year there are roughly 8-14 nesting sites in the lower 48 states, but none as consistently large as at Agassiz NWR. Since 1993, when an aerial census of the nesting colony was initiated, the colony size has varied from 7,000 to 40,000 pairs; with the exception of in 2000 when there were no nesting pairs, because Agassiz Pool was in drawdown. The Refuge plans to conduct annual breeding Franklin's gull surveys with aerial photography and mapping colony acreage to determine density. In Agassiz Pool,

the Refuge will manipulate water levels to maintain bulrush and low-density cattail for nesting habitat. Refuge staff will coordinate its 10-year drawdown interval of Agassiz Pool with Thief Lake WMA (Minnesota), Sand Lake NWR (South Dakota), and Lake Alice NWR (North Dakota), to ensure some nesting habitat is available regionally. During some of the past Agassiz Pool drawdowns the colony has used other Refuge Pools (e.g., Parker Pool) or increased the size of the colony at Thief Lake WMA. Drawdown of Agassiz Pool should not be done when Parker Pool and Farmes Pool are low or dry.

Research and Monitoring Needs

The Refuge makes an annual estimate of the number of breeding pairs based on aerial photography of the breeding colony. Total failure of the Agassiz NWR breeding colony at about the time of peak hatching occurred in 2006 and 2007. In 2008, the Agassiz NWR colony abandoned shortly after nest initiation began. It was suspected that the Franklin's gulls that were originally 'setting up' as colony at Agassiz NWR relocated to Thief Lake WMA. The initial cause of these colony failures is presently unkown, but they do warrant an intensive investigation to attempt to determine the cause. Predation by great horned owls is known to occur, but is usually limited in scope due to the territoriality of the owls. Nesting colonies of black-crowned night-herons are adjacent and intermingled with the gull colony, but there have not been known catastrophic losses of gull chicks due to predation by the herons in the past. Other colonies within the prairie pothole region have also undergone complete failure in recent years (e.g., Lake Alice NWR). Although the cause of these failures are also unknown, mink predation is a suspected cause (Dr. Mark Clark, North Dakota State University, pers. commun.). In 2009, Agassiz NWR monitored gull nesting activity and nest and chick predation occurrences using motion-activated and time delay cameras that were systematically placed at nests (n=15) throughout the nesting colony. To date, these data have not yet been analyzed. A Franklin's gull study of regional scope will be initiated in 2010, to be led by a University of North Dakota graduate student. This study will examine landscape-level factors associated with existing gull colonies and investigate colony site selection influences across the prairie pothole region.

Potential Refuge Contribution to Habitat Needs

Agassiz NWR consistently hosts one of the largest breeding colonies of Franklin's gulls and should continue to play an important role in supporting this population. Agassiz Pool appears to have improved in nesting attractiveness over the past 15 years with the increase in bulrush; the Franklin's gull's preferred nesting vegetation. Frequent drawdowns of Agassiz Pool are not desirable and should be no more frequent than once every 10 years. Drawdowns should be coordinated with other nesting colony locations in the vicinity (i.e., Thief Lake WMA, Sand Lake NWR, Lake Alice NWR).

A small number of Franklin's gulls have nested in Farmes Pool in recent years. The vegetation in this pool is too dense during most of its wetland cycle. High water levels in April that cover the majority of the residual emergent vegetation help attract Franklin's gulls into what becomes dense cattail stands (not desirable nesting habitat) later in the breeding season.

Shorebirds

Distribution and Ecology

There are several species of shorebirds that breed at the Refuge. Breeding shorebirds include Killdeer, Wilson's snipe, American woodcock (*Scolopax minor*), and spotted sandpiper (*Actitis macularia*). Wilson's phalarope (*Phalaropus tricolor*), American avocet (*Recurvirostra americana*), and piping plover have nested at the Refuge in small numbers during some of the drawdowns of Agassiz Pool. Marbled godwit nest in nearby areas that provide the grazed habitat that they prefer. The majority of shorebird use at Agassiz NWR is by migrating birds. The remainder of this discussion will focus on migrating shorebirds and habitat for migration.

Migrating shorebirds include sandpipers, dowitchers (*Limnodromus* spp.), yellowlegs (*Tringa* spp.), godwits (*Limosa* spp.), plovers, red knots (*Calidris canutus*), and dunlins (*Calidris alpina*). In 2003, Peder Svingen and Jeannie Joppru recorded 29 species of shorebirds using the Refuge (Refuge Files). Many of these species are listed as highly imperiled or of high concern by the U.S. Fish and Wildlife Service (U.S. Shorebird Conservation Plan 2004).

Habitat Requirements

The following account of habitat management for shorebirds is an excerpt from Eldridge (1992): In the spring shorebirds that nest in the Arctic usually migrate through the Midwest and stop opportunistically to feed. They accumulate fat reserves that are necessary for continued migration and possibly for reproduction. During migration, many species look for a specific combination of habitat elements that include:

- a wetland in partial drawdown,
- invertebrate abundance of at least 100 individuals per m^2,
- a combination of open mudflat and shallow water (3-5 cm) in a wetland basin with
- gradually sloping sides, and
- little vegetation.

Any one of these elements may be available, but without invertebrates, the birds do not stay. The key to managing habitat for migrating shorebirds is to encourage invertebrate production and then make the invertebrates available to the birds. Aquatic invertebrates increase when wetlands are fertilized by mowing and grazing, but water control in the impoundment makes the job easier. The proper regime of drawdown and flooding can stimulate plant growth and decomposition and create a detrital food source for invertebrates. When the water is drawn down slowly (2-4 cm per week) during the appropriate times of the year, shorebirds are attracted to the available invertebrates. In general, water depth in which birds forage and body size of the birds correlate; larger birds tend to forage in deeper water. Some species may be attracted by shallow water, others by mudflats. Some forage at the edge of the receding water line. If the interface

between mud and water remains constant, they can deplete the invertebrates available to them. A slow, continuous drawdown provides the birds with new habitat and invertebrates.

Seasonal Use/Refuge Habitats

Ranallo (2006) documented shorebird use on the Refuge during 2002 and 2003. She found the majority of shorebird use in the spring to be from mid-May through the first week of June. The peak of the spring migration was during the last two weeks of May. Fall migration began in early July and continued until late October and subsequent freeze up. The peak of migration was spread out over late August to early September. In 2003, Peder Svingen and Jeanie Joppru's volunteer bird survey records for 2003 show similar results, but with the peak of fall migration occurring in early August.

In full pool conditions essentially no shorebird habitat is available on the Refuge due to heavy vegetation on the natural sloping shorelines and steep ditch banks. However, the Refuge impoundments are fairly flat bottomed, but with enough relief that a variety of depths and mudflat conditions are available in during any given drawdown occurence. A few of the Refuge impoundments are nearly covered with emergent vegetation and provide little shorebird habitat even in drawdown conditions (e.g., Kelly Pool), but most impoundments provide hundreds of acres of shorebird habitat when drawn down. Agassiz Pool provides thousands of acres of shorebird habitat and draws large numbers of shorebirds when it is in a drawdown condition.

Habitat and/or Population Objectives

Population objectives are of national scope and beyond the scope of this document. Habitat objectives for the Refuge are to modify timing of drawdown to the extent possible to create shorebird habitat during peak shorebird migration.

Research and Monitoring Needs

A graduate thesis by Odefy (2006) investigated patterns of use by shorebirds on and off the Refuge. Odefy (2006) found that when high water conditions prevailed on the Refuge due to large amounts of runoff, shorebird habitat was being created off the Refuge by wetlands expanding into tilled acres and drained wetlands maintaining moist soil conditions. During dry conditions, off-Refuge sites provide little shorebird habitat, but the Refuge was successful in its drawdown plans and provided suitable habitat.

Monitoring of shorebird numbers has been done by volunteers Peder Svingen and Jeannie Joppru. They have attempted to do complete counts covering all areas observable from the roads during the shorebird migration time periods since 2000. Their efforts have greatly enhanced our knowledge of the timing of migration and the shorebird abundance and species richness on the Refuge.

Potential Refuge Contribution to Habitat Needs

The Refuge can contribute to shorebird habitat needs by timing intentional drawdowns. Growing moist-soil vegetation as practiced in the central part of the country has not been productive this far north. Mid-summer drawdowns to grow moist soil plants are not successful. Our best success has been when the pools are emptied in early June. This early drawdown can be initiated by reducing water levels in early May to a point that further drawdown will begin to expose large amounts of mudflats. Exposing mudflats can then be readily accomplished after 15 May to be timed with the peak of shorebird migration, with complete drawdown accomplished by 5 June.

The objectives for most Refuge drawdowns require keeping the impoundment dry during the remainder of the growing season to have adverse impacts on cattail. However, summer rains and runoff events usually create shorebird habitat in most drawdown pools. Additional habitat for shorebirds can be provided by reducing water levels in pools scheduled for complete drawdown the following year. These lower water levels can be initiated the first of August after 90% of waterfowl and marshbird nesting is complete and in time for peak shorebird migration.

Marshbirds

Distribution

This is a grouping of diverse birds that use emergent marsh and sedge meadows. At Agassiz NWR the group is represented by the Virginia rail (*Rallus limicola*), yellow rail, sora, American coot (*Fulica Americana*), least bittern, American bittern, black-crowned night-heron, great blue heron (*Ardea herodias*), green heron (*Butorides virescens*), great egret (*Ardea alba*), black tern, Forster's tern, common tern (*Sterna hirundo*), pied-billed grebe (*Podilymbus podiceps*), red-necked grebe (*Podiceps grisegena*), eared grebe, horned grebe (*Podiceps auritus*), and western grebe (*Aechmophprus occidentalis*). Agassiz NWR has been the site of ground-breaking research on American bittern and least bittern since 1994. The following discussion will focus on American bittern and least bittern. American bittern represent those species which mostly utilize shallow emergent marsh and sedge meadows and least bittern represent those species which utilize marsh vegetation in deeper water.

Both of these species have a wide distribution. American bittern are found throughout North America. Least bittern are somewhat restricted in distribution in the western states but are found in the Pacific coastal states. Rangewide the loss of wetlands is a direct threat. For American bitterns, the loss of grasslands may be of equal threat.

The American bittern's position in the food chain places it at several trophic levels where it is exposed to pollutants and contaminants. The loud pumping call during the breeding season makes it one of the easiest of the secretive marsh and wading birds to locate and census. These factors make this bird an ideal umbrella species to monitor the health of inland and coastal wetland/grassland habitats as they relate to marshbirds.

Ecology

American bitterns appear to be the most opportunistic and generalist of all the Ardeidae, not depending solely on wetland habitats nor on grassland habitats as they nest and forage on either wetlands and/or uplands. The primary life stage on which American bitterns depend on wetlands is post breeding molting, a vulnerable period when bitterns are semi-flightless (Lor 2007).

Nature Serve (2006) and Gibbs et al. (1992) report the diet to be mainly fishes, crayfishes, amphibians, mice and shrews, insects, and other animals. Bitterns feed young by regurgitation. At Agassiz NWR regurgitated food of juveniles that were captured was most often fish. At other grassland nest sites frogs were most often regurgitated (pers. obs.). American bitterns make extensive use of shallow emergent marsh habitat and sedge meadow habitats. They feed in the edge micro habitats of the emergent vegetation. During spring and fall this is often along the ditches and dikes. During the summer molt the birds utilize habitats in the interior of the large wetlands away from dikes and ditches. The average and range of distances to small water openings were much smaller in foraging sites compared to random sites (Lor 2007).

Huschle et al. (2002) found that American bitterns arrive at Agassiz NWR in mid- to late April. Some bitterns leave the Refuge in early September, but most do not leave until late October. Two-thirds of the American bitterns from Minnesota migrate to southern Florida and one-third go to the coastal marshes of Louisiana. American bitterns migrate at night and use strong northerly winds to start migration. Adult bitterns demonstrated a high fidelity to return to their breeding territories where they were previously captured in subsequent years of the study. Lor (2007) had four adult males return to the same corner of the marsh and four others returned to within 3 km of their original capture site. Two individuals were captured three times. Nearly 13% (9 of 70) of the captured birds returned to the original capture site. In the \prairie pothole region in south-central Minnesota, 4 of 13 (31%) male American bitterns returned to the study area (Lor 2007).

Habitat Requirements

Dechant et al. (2003) Reported that within wetlands and wet meadows, American bitterns nest in rush (*Juncus* spp.), sedge, bulrush, prairie cordgrass, whitetop, tall mannagrass (*Glyceria grandis*), common reed, reed canary grass, burreed (*Sparganium eurycarpum*), or cattail. Bitterns nest on floating platforms in shallow (3-91 cm) water. The average vegetation height above water within 1-10 m of wetland nests in northwestern Minnesota was 126 cm. Water depths within 1-10 m of wetland nests ranged from 8 to 65 cm (Brininger 1996, Azure 1998). Territories in Minnesota were characterized by average values of 10 cm water depth, 1.4 m vegetation height, 8.7% vegetation cover, 114 stems/m² grass density, and 4 stems/m² forb density.

American bitterns prefer relatively large (≥3 ha) wetlands, ranging in size from 3 to 182 ha. The average wetland size for American bitterns nesting in northern Minnesota was 36.7 ha. The occurrence of American bitterns in South Dakota wetlands was related to

the area of adjacent idle grassland. Male and female home ranges in northwestern Minnesota averaged 415 ha and 337 ha, respectively (Brininger 1996). In another study in northwestern Minnesota, the average home range size of 20 radio-marked male American bitterns on Agassiz NWR was 127 ha (Azure 1998). Average size of the core use area (defined as the area of the home range in which bitterns were located 50% of the time) was 25 ha.

Lor (2007) stated that ideal habitat management practices for American bitterns would be to provide a complex of wetlands that function naturally (Weller 1999), with shallow emergent marsh interspersed with open-water areas, with gradual sloping edges that provides sufficient cover and water depth for accessibility to food. Also, a complex of grassland and wetlands that ranges from upland grassland, to sedge meadows and emergent wetlands. Both complexes should have water levels at different stages that facilitate foraging and nesting activities.

Monfils (2003) reported that when compared to the American bittern, the least bittern is more prevalent in deeper water marshes (Weller 1961, Weller and Spatcher 1965). In their study of Iowa marshes, Weller and Spatcher (1965) recorded the species in the greatest abundance during years when ratios of emergent vegetation to open water were approximately equal (the hemi-marsh stage), and the species was not observed in areas of dense vegetation until opened up by muskrats. Brown and Dinsmore (1986) found that least bitterns were observed more often on Iowa wetlands larger than 12 acres (5 ha), suggesting that the species may be area sensitive. While Bogner and Baldassarre (2002) observed a mean home range size of 9.7 ha (11.4 ha for females, 8.1 for males) in their study in western New York, they suggested that vegetation type and cover ratios are likely more important than marsh size to least bittern populations.

Vegetative features of wetland preserves should include dense (100 stems per square meter) and tall (>1 m) stands of emergent vegetation (e.g., cattail, bulrush) in deep-water (10-50 cm) well-interspersed with patches of open water (Weller and Spatcher 1965, Fredrickson and Reid 1986, Reid 1989). Maintaining stands of deep-water (10-30 cm) cattail is important because water levels at or below the base of emergent vegetation may reduce nesting activity by least bitterns (Weller 1961), which prefer foraging over deep water (10-50 cm). Where littoral vegetation is scarce, moist-soil plant management (Fredrickson and Taylor 1982) provides a cost-effective method involving water level manipulation to re-establish and promote growth of dense stands of emergent vegetation. Complete drawdowns, sometimes employed for waterfowl management, should be avoided so that populations of small fish and dragonfly larvae, which make up the majority of the diet, are conserved for the following season. Once germination occurs, maintaining water depths >30 cm throughout the growing season will prevent drying and allow for further growth of the newly established vegetation. Further growth will promote thicker rhizomes, and higher plant survival over the winter, which will in-turn establish a thicker residual structure for the following spring. Water levels >30 cm should be maintained throughout the breeding season in order to maintain sufficient water depths for least bittern foraging and nest building. It is important to maintain water levels

at a fairly stable depth from the time of nest initiation (early – mid-May) through the end of breeding season (late August). Rapid decreases could increase the risks of predation, while rapid increases could result in inundation of nests or young.

Seasonal Use/Refuge Habitats

The average fixed-kernel estimate of American bittern 95% home range was 109.28 ha (± 38.47) in 2000 and 2001 combined and the 50% core area was 18.08 ha (± 1.68). Home ranges for 10 American bitterns during the period of 1994 – 1997 was 147.06 ha (± 22.93) and 50% core area was 28.68 ha (± 5.18; Lor 2007).

Arnold (2005) found that least bitterns used cattail, sedge, bulrush, and common reed as components for nest building at Agassiz. Birds utilized denser habitat at Agassiz NWR than at Mingo NWR. Nests in the smaller habitat patch at Mingo NWR formed a colony while nests were more widely distributed in the larger marshes at Agassiz NWR. Habitat conditions were variable within and among years at Mingo and Agassiz NWRs. Nevertheless, least bitterns adapted to these variable conditions because they successfully nested annually. This adaptability was apparent when bitterns nested in short residual cattail lacking overhead cover after flooding at Agassiz in 2002. Because the least bittern nest is elevated above the water surface in emergent vegetation, the presence of tall robust plants seems essential.

Habitat and/or Population Objectives

Objectives 2.3, 2.4, 2.7 in this document address enhancing habitat suitable for American bitterns. Objective 1.5 stresses the need for continued annual monitoring of population trend.

Research and Monitoring Needs

Population trend monitoring for seven species was implemented in 1999 and is currently being analyzed. American bittern and sora had the highest estimated detection probabilities ($p = 0.85, 0.83$, respectively) compared to Least Bittern ($p = 0.00 – 0.58$), which was the lowest. Management actions (i.e., drawdown, prescribed burn) did not clearly explain variations in occupancy or detection probabilities. The detection probability-adjusted counts for American bitterns ranged from 54 – 76 birds detected each year across all survey points. For least bitterns detection probability adjusted-counts resulted in eight (2000) and 26 (2002) for the survey points.

Arnold (2005) observed that least bitterns may not respond to calls immediately, but are more likely to position themselves closer to the source of the call before responding. For example, Bogner (2001) found only 22% of radio-marked male least bitterns responded to a call within the first minute of broadcast in New York. Similarly, Lor (2000) and Bogner (2001) noted that least bitterns approached the source of the call before responding vocally. Due to the slow response time of this species to call surveys, a more suitable monitoring strategy for least bitterns should include a broadcast of a male call

that lasts for at least four to five minutes in order to increase detection rates. Timing of surveys can also significantly impact detection rates. It is important to conduct surveys early in the breeding season between mid-May and mid-June during nest initiation when the peak in vocalization occurs.

Potential Refuge Contribution to Habitat Needs

The Refuge needs to maintain a variety of water depths and emergent vegetation conditions to satisfy the needs of the many marshbirds that utilize the Refuge. Maintaining water depths >30 cm throughout the breeding period is essential for species such as least bittern that nest in deeper water areas. These areas are also important for the American bittern during the post-breeding molt. Too much of the Refuge in drawdown at any one time would be very detrimental to these species. The high fidelity shown by these species to Agassiz NWR is another reason to maintain adequate amounts of nesting habitat on a continuous annual basis.

Maintaining depths >30 cm during fall and winter is also beneficial to other wildlife species that are important for least bittern and the condition of preferred habitats. Fish and muskrat populations require high winter water levels to insure their survival in northern climes that become ice covered. High populations of small fish are essential dietary components for many marshbird species. Muskrats help provide emergent vegetation conditions that marshbirds find appealing for nesting.

Gray Wolf and Associated Prey Species (White-tailed Deer and Moose)

Distribution

Historically, gray wolves occupied every habitat that had sufficient prey in North America from mid-Mexico to the polar ice pack. Primary prey species included large ungulates such as deer, moose, elk, bison (*Bison bison*), and muskox (*Ovibos moschatus*). Man's persecution of these species reduced the range of the gray wolf to northeastern Minnesota, Canada, and Alaska. This led to the perception that gray wolves were a wilderness animal; however, if human-caused mortality is kept below certain levels, wolves can live in most areas (http://www.wolf.org/wolves/learn/basic/wolfbasic.asp).

Gray wolves were placed on the Federal Endangered Species list in August of 1974 under the Federal Endangered Species Act (ESA) of 1973 as an endangered species. In 1978 they were reclassified from endangered to threatened under the ESA in Minnesota. In April of 2003, the U.S. Fish and Wildlife Service (administers the ESA) reclassified the gray wolf into three distinct population segments (DPS), each with its own designation under the ESA. The gray wolf was delisted in Minnesota on March 12, 2007.

Wolves recolonized the Refuge and established a breeding pack in the early 1980s. A second breeding pack utilizing the Refuge was documented in 1992. Chavez (2002) studied these packs from 1997 to 1999.

White-tailed deer are found in every Minnesota county and adapt well to most surroundings. After fawns are born each spring, there are between 900,000 and 1,000,000 deer in Minnesota (1997 population estimate). The hunting season is important to keep the deer population from getting too large. Each year, Minnesota hunters harvest between 150,000 and 200,000 deer (http://www.dnr.state.mn.us/snapshots/mammals/whitetaileddeer.html).

Ecology

Gray wolves excavate natal dens and may use the same den for several years. Gray wolves also den under tree roots, in hollow logs, rock outcrops, or even in beaver lodges. At Agassiz NWR den sites are usually in spoil banks and may be in old beaver dens. After one to two months these natal dens are abandoned for an open area called a 'rendezvous site'. Here the pups are guarded by a few adult pack members, while the rest of the pack hunts. Territory sizes range from 20-215 mi^2 (54-555 km^2) in Minnesota (http://www.fs.fed.us/database/feis/wildlife/mammal/calu/all.html). Pack territories at Agassiz NWR were found to be 147 to 240 km^2 (Chavez 2006) and early winter pack size averaged seven.

Chavez (2002) found muskrats in the wolf diet at higher incidence than beaver. He also found that wolves only occasionally preyed on domestic livestock. The actual risk that wolves posed to livestock in northwestern Minnesota was very low since there were only eight confirmed depredation incidents during his study within the territory of the wolf packs he studied. The fact that cattle made up only 10.3% of the wolves' diet during the study further exemplified the low actual risk. His study was conducted during 1997 to 1999, during a time when deer numbers were low following the severe winters of 1995-1996 and 1996-1997.

In the north and in montane regions white-tailed deer are limited ecologically by the depth/duration/quality of snow cover. Summer ranges are traditional but winter range may vary with snow conditions.

Habitat Requirements

The gray wolf's habitat preferences appear to be more prey dependent than cover dependent. In Minnesota, where territories encompass only subtle elevational changes, there are no observed changes in territory use by gray wolves between summer and winter (http://www.fs.fed.us/database/feis/wildlife/mammal/calu/all.html).

White-tailed deer eat many foods, such as acorns, corn, soybeans, mushrooms, grasses, tree leaves, buds, twigs and bark, wild grapes, apples and assorted shrubs. White-tailed deer live in prairies, forests, swamps, wood lots and agricultural fields. They are common in both suburban and rural areas. Sometimes they are a traffic hazard. During harsh winters, deer may also become a nuisance to farmers by eating hay or corn that is stored for livestock (http://www.dnr.state.mn.us/snapshots/mammals/whitetaileddeer.html).

Seasonal Use/Refuge Habitats

The Refuge likely cannot support additional packs. The Refuge and adjacent WMAs comprise 130 mi^2 and the pack territories reported by Chavez (2006) were found to be 56 to 92 mi^2 in size. Packs travel extensively off of the Refuge, especially at night and during times of low deer numbers. Pack size will vary depending on deer abundance. In the early 1990s, during record high deer numbers, the observed fall pack size of one of the packs was 12 for two consecutive years. Chavez found the average pack size to be seven during his study, which took place during low deer populations. Maintaining Refuge habitats that support high deer and moose populations will have the greatest affect on maintaining high wolf populations.

White-tailed deer whose home ranges are near the boundary of the Refuge make use of adjacent agricultural crops. Deer within the Refuge may also utilize crops planted in Refuge fields. During winters with snow cover, most of the deer stay within the Refuge surviving on the abundant browse produced by the lowland shrubs and woodland habitats that make up approximately 35% of the Refuge. During early winter or winters with little snow cover deer may continue to use adjacent fields and grasslands.

Habitat and/or Population Objectives

The Refuge intends to maintain two gray wolf packs on the Refuge, based on winter track/scat surveys and periodic howling surveys. Agassiz NWR has supported two gray wolf packs for 12 years, and this number is considered viable and sustainable. The Refuge can manage for wolves only indirectly, by fostering habitat conditions that are favorable to prey populations, and by maintaining populations of the wolves' preferred prey. The following monitoring and/or management activities support the continued existence of two wolf packs on Agassiz NWR:

- Continue to conduct howling surveys every three years.
- Annually collect wolf sign (i.e., tracks, scat, howling, sightings) information during the winter (snow cover) season at the Refuge. This information is collected opportunistically as Refuge staff are completing outdoor work on the Refuge during the period of continuous snow cover (generally November/December to March/April).
- Manage water levels in a manner consistent with maintaining beaver and muskrat populations and regulate trapping to maintain beaver and muskrat populations for a wolf prey base.
- Annually, maintain a deer population within the MNDNR deer Permit Area 203 at densities between 15-20 deer per mi^2, based on annual winter surveys, for a wolf prey base and public hunting opportunities. Based on studies and long-term experience with deer herd management by Minnesota DNR, this is the optimal population density or carrying capacity of white-tailed deer in habitat characteristic of this region. At present, the Refuge's deer herd is healthy and increasing, at a density of approximately 12 per mi^2.

- Continue to utilize regulated firearms hunting every fall during the regular state deer-hunting season and in compliance with Refuge rules as a means of controlling the Refuge deer herd at a level commensurate with the population density objective.
- Monitor the size and population density of the deer herd through an aerial census each winter.
- Monitor for signs of habitat damage (i.e., browse lines, crop depredation) on adjoining private farmland that would indicate that deer carrying capacity has been surpassed.
- Evaluate the health of individual animals and herds using standard techniques, as needed, and by cooperating with the MNDNR.
- Utilize winter mowing and prescribed burning practices to create and maintain browse and cover and maintain shrub/scrub habitats.
- Prepare a step-down management Refuge Hunting Plan to guide hunt decisions.
- Maintain moose population for MNDNR Management Unit 2 between 200 and 350 individuals (if population recovery occurs), based on annual winter surveys and taking into consideration carrying capacity for wildlife viewing and hunting opportunities. As with the white-tail deer population density objective, the target population for moose reflects what biologists believe local habitats can support. Beginning in 1993, the Agassiz NWR moose population crashed for unknown reasons, declining to a low of approximately 40 individuals in 1998 as determined by the quadrat census method. This sharp decline in numbers paralleled a wider collapse throughout northwest Minnesota. The causes for this decline are believed to be liver flukes and brain worm infections coupled with additional stress from warmer than average temperatures.
- Continue to monitor moose numbers by means of annual mid-winter aerial surveys using the transect survey technique.
- Re-open the moose hunting season if/when recovery of the moose herd exceeds the minimum objective of 200 individuals.
- Utilize winter mowing and prescribed fire to maintain shrub/scrub habitats.

Research and Monitoring Needs

The wolf and moose populations on Agassiz NWR were studied in the late 1990s and results from these studies and other studies in Minnesota currently provide adequate information on which to base management decisions.

Mallards and Other Dabbling Ducks

Distribution

Mallards and blue-winged teal (*Anas discors*) are the most abundant dabbling ducks on the Refuge. Northern shovelers (*Anas clypeata*), gadwalls (*Anas strepara*), American wigeon (*Anas americana*), and northern pintails (*Anas acuta*) are also abundant. Green-winged teal (*Anas crecca*) also use the Refuge during migration and occasionally during breeding season. This discussion will focus on the habitat requirements of mallards as

being representative of other dabbling duck species that use the Refuge. Mallards are widespread in North America, with the greatest concentration in the prairie pothole region of the U.S. and Canada, utilizing millions of wetland basins which range from ephemeral shallow potholes to permanent deep lakes. The following excerpts on distribution and ecology are from Drilling et al. (2002).

During migration, mallards respond opportunistically to availability of shallow wetlands such as marshes, small ponds, flooded basins, flooded alluvial plains, and flooded agricultural fields. In autumn, crop-harvest patterns and hunting pressure also affects habitat use. At spring staging areas in Iowa, mallards forage in flooded tilled wetland basins >2 ha in size and flooded agricultural fields during the day and roost in vegetated wetlands at night. In autumn, staging ducks often concentrate at fields of ripe grain in major grain-growing regions of the mid-continental U.S. and Canada. They sometimes cause extensive crop damage.

Mallards are able to withstand cold temperatures and require only a readily available food supply and small area of open water for roosting. They are extremely flexible and quickly adapt to changes in landscape, precipitation, and temperature. In central Nebraska, roosts shift from exposed riverine areas to warmer irrigation drainage canals when temperatures drop. Also, in Nebraska they not only feed in cornfields kept clear of snow by strong winds, but often in cattle feedlots when snow is deep. On a region-wide basis the Mississippi Alluvial Valley (MAV) is the principle wintering area in Mississippi Flyway. More banded mallards are recovered farther south in a cold winters and more banded females and juvenile males are recovered within the MAV during wet winters, suggesting that individuals shift locations depending on temperature and precipitation.

Nesting Ecology and Habitat Requirements

Breeding pairs tend to utilize small temporary and seasonal wetlands, rather than semi-permanent and permanent wetlands. Further, they rarely utilize wetlands which are totally devoid of emergent vegetation. Pairs, females, and broods use ephemeral, seasonal, and semi-permanent ponds and marshes. There is little consistency to which wetland regime is selected they and are often used in proportion to availability.

In Minnesota, females prefer lake shorelines with emergent or overhanging vegetation, bog mats, or seasonal wetlands. Mallards often roost in heavily vegetated river channels. The usual nest site is in uplands close to water in a wide variety of situations with dense cover, including grasslands, marshes, bogs, riverine floodplains, dikes, roadside ditches, pastures, cropland, shrubland, fencelines, rock piles, forests, and fragments of cover around farmsteads. Mallards may nest at extremely high densities on islands. Distance to water depends on distribution of wetlands and suitable nest cover. In 14 studies conducted throughout North America, distances ranged from 2–321 m from water, with a maximum of 1,024 m. A large proportion of upland nests (usually 50–90%) are within 150 m of water. Although they commonly nests in upland habitats, mallards will nest in wetlands, including over water. Reported rates of wetland nesting range from 49 to 76% in four mid-continent studies, but only 2.0–5.6% in two other mid-continent studies.

These differences may reflect search effort. Overwater nests are generally located in densely vegetated wetlands. In North Dakota, wetland nest sites were mostly in small shallow basins, with an average size of 4.5 ha (range 0.5–8.6) and average water depth of 20.9 cm (SD ± 7.5).

Mallards are omnivorous and opportunistic generalist feeders and very flexible in food choice and diet composition, depending on stage of annual cycle, hydrological conditions, invertebrate behavior, and crop-harvesting schedule. During breeding season, mallards eat mostly animal foods (70% volume in esophagus) including insects such as midge larvae (Chironomidae) and other Diptera, dragonflies (Odonata), and caddisfly (Trichoptera) larvae, aquatic invertebrates such as snails and freshwater shrimp, and terrestrial earthworms. Amounts and species vary depending on water regime, invertebrate behavior, and mallard reproductive stage. Laying females eat significantly more animal food (72% esophageal volume) than do non-laying females (37%) and paired males (38%).

Microhabitat for foraging varies with season, nutritional needs, availability of shallow wetlands, and stage of crop harvest. During breeding season, when almost entirely carnivorous, mallards feed in shallow wetlands, shoreline vegetation, or shallows of deeper wetlands. In North Dakota, laying females feed in ephemeral and temporary wetlands. During summer in western Montana, they mostly feed in shallow vegetated aquatic areas, especially in water spikerush (*Eleocharis acicularis*) patches; in autumn, they use natural wetlands until food is available in croplands.

During the post-breeding time period mallards consume increasing amounts of plant foods as the season progresses toward autumn. If available, they switch to crops during and after harvest. The September mallard diet in Saskatchewan parklands is up to 98% dry-weight plant food. Natural plants include duckweeds (*Lemna* spp.), arrowhead (*Sagittaria latifolia*) tubers, and various seeds and nutlets. Post breeding mallards in northern Minnesota consume mostly wild rice (*Zizania aquatica*), pondweeds (*Potamogeton* spp.), and burreed. Agricultural foods usually dominate diet during autumn migration and often during winter, depending on relative availability of natural versus agricultural foods. In winter, urban mallards often rely entirely on human-provided food, such as bread or seeds.

Seasonal Use/Refuge Habitats

Dabbling ducks at the Refuge utilize the extensive shallow wetland perimeters on the upstream sides of the impoundments. Further division of the impoundments by additional cross dikes would decrease these areas. Additional dikes and cross dikes proposed in earlier Master Plans are not proposed in this HMP.

Sedge meadows are utilized for wetland nesting sites, as are the overwater habitats provided by dense cattail. Blue-winged teal often use the dikes for nesting, but suffer high nest predation on these sites. Sedge meadows should be increased or enhanced through willow reduction through the course of action proposed in the HMP.

Flooded moist soil plants such as golden dock (*Rumex maritumus*), smartweed (*Polygonum* spp.), and goosefoot (*Chenopodium bushianum*) created by drawdowns of the impoundments have a history of high use by mallards, gadwall, and Canada geese on the Refuge. The drawdown cycles proposed in the HMP should continue and increase the availability of this foraging opportunity for dabbling ducks. Invertebrate production is also enhanced through drawdowns, providing an increase in forage during the breeding season.

Webster Pool has historically provided submergent vegetation that is used extensively by dense numbers of American wigeon and American coots. The conversion of Webster Pool to a flow-through area of Webster Creek will reduce the extent of the area that provided this feeding situation for American wigeon.

Refuge impoundments provide staging areas for migrating dabbling ducks. The surrounding landscape consists predominantly of well-drained agricultural fields that only provide habitat during wet springs or autumns. The Refuge does harbor flocks of mallards that feed in the agricultural fields during the fall. The Refuge receives complaints from farmers for crop damage caused by mallards, Canada geese, and sandhill cranes. The Refuge keeps a supply of propane guns that are loaned out to farmers that request them to help alleviate crop damage.

Habitat and/or Population Objectives

As one would expect, many of the objectives in the CCP affect waterfowl. The most important of these is Managing Water Impoundments. Many of the other objectives revolve around increasing grasslands and sedge meadows which are of importance to dabbling ducks because of the implications for nesting habitat.

> Objective 2.7 - Managing Water Impoundments: Manage water impoundments as a complex of basins to provide wetland diversity and improve water quality for maximum benefits to migrating and breeding birds. Management will be within the capabilities of the wetland system as a whole and individual impoundments will be drawn down on a 2- to 10-year rotation.
>
> Rationale: Water level manipulation allows managers to simulate different stages of the natural flood/drought cycle at the same time in different impoundments. This increases the diversity of habitat types and food resources in the wetland complex that is available to migrating and nesting birds. The emphasis is on semi-permanent wetlands, as these wetlands can be the most productive type for marsh nesting birds. The larger impoundments on Agassiz NWR provide a wide diversity of habitats within each impoundment. Management can increase this diversity by varying the water regime in nearby impoundments. The outcome will be interspersion of cover and openings for dabbling duck and marshbird pair

and brood habitat, open bays and medium density cover for diving duck broods, as well as post-breeding/molting habitat.

Objective 1.1 - Breeding Ducks: Maintain an annual average of 7,000 breeding pairs of ducks over a five-year period by providing optimal breeding habitats via the HMP.

Objective 1.2 - Duck Production on Agassiz NWR: Based on a five-year average, maintain annual brood production above the long-term average of over 13,000 ducklings.

Objective 2:1 - Lowland Shrub and Grasslands Conversion: Achieve an increase in grasslands by a net decrease of lowland shrub (alder, willow, dogwood) within the OLMA by 115 acres over the next 10-15 years, through conversion to grasslands to benefit wildlife species like the bobolink, sharp-tailed grouse, marbled godwit, western meadowlark, and nesting dabbling ducks.

Objective 2.3 - Open Water/Mudflat Conversion: Beginning in 2005, experiment with decreasing open water/mudflat habitat by 400 acres in Webster, Kelly and Upper Mud River Pools by converting portions to sedge habitats and restoring streams to a more natural watercourse for species such as the Le Conte's sparrow, sedge wren, Nelson's sharp-tailed sparrow (*Ammodramus nelsoni*), and yellow rail. This objective will decrease open water used by dabbling ducks, but will increase nesting habitat for them. This objective will also eliminate one of the foraging areas used intensively by American wigeon in the fall (Webster Pool).

Objective 2.4 - Increasing Sedge Meadow: Beginning in 2005, experiment with increasing sedge meadow by 1,250 acres to benefit wildlife species like the yellow rail, sedge wren, Nelson's sharp-tailed sparrow, and Le Conte's sparrow. Increases in sedge meadow at the expense of willow shrub, common reed, and reed canary grass will have beneficial impacts on nesting habitat for dabbling ducks.

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Objective 2.5 - Reducing Cattail and Common Reed (*Phragmites*) Infestation: Experiment with decreasing cattail and common reed vegetation by 840 acres, converting it to sedge habitat to benefit species like the Le Conte's sparrow, sedge wren, Nelson's sharp-tailed sparrow, and yellow rail in the next 10 to 15 years. Increases in sedge meadow at the expense of willow shrub, common reed, and reed canary grass will have beneficial impacts on nesting habitat for dabbling ducks.

Objective 2.10 - Cropland Phase-out: Beginning in 2005, phase out all cropland by converting to grassland and shrub to benefit species such as the bobolink, Nelson's sharp-tailed sparrow, marbled godwit, and Le

Conte's sparrow. The reduction in cropland on the Refuge will likely reduce fall waterfowl and sandhill crane use on the Refuge; however, this reduction in use is not significant as the 170 acres of Refuge cropland is insignificant when compared with what is available on adjacent private lands. This phase-out will take place over the life of the CCP (10-15 years). It has already begun, and will continue at a similar rate (e.g., 60 acres since 1997). There are presently 170 acres of cropland left. Croplands are generally being phased out at most NWRs in accordance with the Service's Ecological Integrity Policy, which emphasizes native vegetation and natural processes.

Objective 2.13 - Off-Refuge Corridor Habitat: Continue to restore corridor habitat off-Refuge through the Partners for Fish and Wildlife program with priority given to riparian habitats and to increase grassland block sizes within the seven-county RMD.

Rationale: As a result of extensive efforts over the last five years to restore thousands of acres of wetlands on hundreds of private parcels within the RMD (through the CRP and other programs), Refuge staff and the U.S. Fish and Wildlife Service have developed positive relationships with private landowners and cooperating agencies. These relationships can be drawn upon to extend these efforts to develop wildlife corridors off the Refuge, as well as improve water quality and reduce sedimentation off and on the Refuge. This objective is especially beneficial to dabbling ducks that are able to make use of these small wetlands in a largely agricultural landscape.

Research and Monitoring Needs

The following is a list of important research and monitoring needs for the Refuge related to dabbling ducks:

- Continue conducting the Refuge breeding pair count and brood counts. These monitoring procedures have over 40 years of data that can be used to help evaluate major shifts in habitat management.

- Use geo-referenced aerial photography and GIS spatial analyses to monitor long-term changes in habitat and measure progress towards meeting grassland-related objectives.

- Monitor extent of sedge habitat annually by visual inspection, aerial overflights, and GPS mapping. Use digitized geo-referenced aerial photography and GIS spatial analysis every 5-10 years to track long-term trends.

- Continue to monitor habitat changes with aerial photo/GIS analysis and research advancements. Assess whether continuing to expend limited staff and funds to control cattail and willow encroachment on sedge meadow is a worthwhile cost.

- Conduct annual monitoring to ensure that weedy species and non-native plants do not become more problematic than they are at the present time.

Potential Refuge Contribution to Habitat Needs

Most of the new focus on sedge meadows, grasslands, and open landscape in the CCP and HMP are beneficial to dabbling ducks. These habitat changes, along with continued management of the impoundments, should assure that the Refuge provides favorable habitat for dabbling ducks. Many of the techniques proposed in the HMP require summer/fall drawdowns. This may negatively impact the amount of waterfowl use in the fall and reduce the importance of the Refuge as a staging area for fall migrants. The conversion of Webster Pool to a flow-through area of Webster Creek will eliminate or reduce the extent of an area that provided an important staging and feeding site for American wigeons. This may negatively affect several thousand American wigeon, but will provide sedge meadow nesting cover for other dabbling ducks.

Canvasbacks and Other Diving Ducks

Ring-necked ducks (*Aythya collaris*) and redheads (*Aythya americana*) are the most abundant diving duck species on the Refuge. Canvasbacks (*Aythya valisineria*), ruddy ducks (*Oxyura jamaicensis*), buffleheads, and hooded mergansers are also abundant. Scaup (primarily lesser scaup [*Aythya affinis*]) use the Refuge during migration and occasionally during breeding season. This discussion will focus on the habitat requirements of canvasbacks as representative most diving duck species that use the Refuge. The below information is from Mowbray (2002), Sorenson (1997), and http://www.pwrc.usgs.gov/bioeco/canvasback.htm.

Distribution

Canvasbacks are represented in all four North American flyways. They are a short- to medium-distance migrant and scattered populations regularly winter within breeding range in western North America and sometimes as far north as the Great Lakes in central North America.

Ecology

Migration from wintering areas begins in February and during spring migration stopover site locations and numbers of canvasbacks at various stopover sites are influenced by existing conditions. Peak numbers of canvasbacks on Agassiz NWR occur during mid-April. After breeding, males undergo an extensive molt-migration to large freshwater and subsaline wetlands in central and western Canada to molt and stage for fall migration. The majority of molting and staging lakes are in the aspen parklands and

southern boreal forest regions. Distances traveled vary from several hundred meters to over 300 km. Males generally separate about the time females begin to incubate their clutches, first commuting for several days to nearby lakes, where they associate with other males, and then departing the breeding grounds.

Females and their broods generally remain within their breeding habitats to molt, merely traveling overland or by connecting water courses to lakes, ponds, and marshes with more open water and abundant submergent vegetation. Hens will sometimes leave their brood to scout for good brood habitat and then return to the brood and lead them to the better habitat.

Korschgen et.al. (1996) found that mink predation and weather were the main causes of duckling mortality during the first four weeks after hatching. Cold weather with a precipitation event accounted for 21% of the duckling mortality, whereas mink totaled 37%.

Canvasbacks suffer both intra- and inter-specific brood parasitism. During a three-year study in Manitoba, 80% of canvasback nests were parasitized by redheads, other canvasbacks, or both, with an average of 4.7 parasitic eggs per parasitized nest. Parasitism had significant negative effects on the reproductive success of nesting canvasbacks.

In eastern North Dakota, canvasbacks use large shallow wetlands which support dense beds of sago pondweed or wigeongrass (*Ruppia maritima*) during fall staging and migration. Conversely, during the spring, most of the same stopover sites are used, but ducks are more widely dispersed in flooded fields, farm ponds, and smaller wetlands.

Habitat Requirements

Canvasbacks breed in small lakes, deep-water marshes, sheltered bays of large freshwater and alkali lakes, permanent and semi-permanent wetlands, sloughs, potholes, and shallow river impoundments. In the aspen-parkland region of northwest Minnesota, canvasbacks prefer a mix of wetland types, including fresh meadows, shallow and deep fresh marshes, shrub marshes, and shallow (0.7–1.3 m) impoundments. Nesting occurs in dense emergent vegetation (usually cattail) at Agassiz NWR near a small opening of water that provides a landing and take off location for the hen.

Canvasbacks are omnivorous and the foods exploited vary depending upon availability. During winter and migration, the diet is mainly plants (winter buds, rhizomes, and tubers of aquatic plants). When plant foods are limited, they take small clams and snails (Gastropoda). Canvasbacks consume both plant and animal material throughout breeding season, including seeds, buds, leaves, rhizomes, tubers, root stalks of aquatic plants, snails, caddisfly (Tricoptera) larvae, damselfly and dragonfly (Odonata) nymphs, mayfly (Ephemeroptera) nymphs, and midge larvae. Proportions of plant and animal foods do not differ significantly during the reproductive period in females. Sago pondweed (74–98%) and midge larvae (63–66%) are the predominant plant and animal foods,

respectively, except during incubation, when snails (83%) are the major animal food of females.

Seasonal Use/Refuge Habitats

According to Korschgen et.al. (1996), Agassiz NWR was the only refuge in the Midwestern United States with consistent canvasback production during 1954 to 1974. M.D. Sorenson (pers. commun.) found that Agassiz NWR's canvasbacks were genetically unique. They had less similarity to Canadian Canvasbacks in Mantioba than the Manitoba Canvasbacks had with Pacific Coast canvasbacks. K. Kenow reported in a 1989 progress report that two ducklings released at nests in Kelly Pool in June moved through adjacent pools with broodmates. One duckling attained flight status in Webster Creek pool and was discovered approximately 10 km from Webster Creek, in Parker pool, on 29 August. The other duckling attained flight status in Mud River pool and was also found in Parker pool on 29 August. The home range estimates for these two ducklings were 3.355 and 4.236 km^2, respectively. Another duckling released at a nest in Parker pool on 24 June was still present in Parker pool on 30 August. This duckling's home range was 2.435 km^2.

Habitat and/or Population Objectives

In the mid 1970s, the continental canvasback population was estimated to be 500,000, which was 50% less than 20 years earlier. Although the population fluctuates considerably, it seems to be declining. The hunting season on canvasbacks has been closed during many of the past 30 years.

As one would expect, many of the objectives in the Agassiz Refuge CCP affect diving ducks. The most important of these is Managing Water Impoundments. Below is a list of objectives from the CCP that relate to diving ducks:

> Objective 2.7 - Managing Water Impoundments: Manage water impoundments as a complex of basins to provide wetland diversity and improve water quality for maximum benefits to migrating and breeding birds. Management will be within the capabilities of the wetland system as a whole and individual impoundments will be drawn down on a 2- to 10-year rotation.
>
> Rationale: Water level manipulation allows managers to simulate different stages of the natural flood/drought cycle at the same time in different impoundments. This increases the diversity of habitat types and food resources in the wetland complex that is available to migrating and nesting birds. The emphasis is on semi-permanent wetlands, as these wetlands can be the most productive type for marsh-nesting birds. The larger impoundments on Agassiz NWR provide a wide diversity of habitats within each impoundment. Management can increase this diversity by varying the water regime in nearby impoundments. The outcome will be interspersion of cover and openings for dabbling ducks and marshbird pair

and brood habitat, open bays and medium density cover for diving duck broods, and post-breeding/molting habitat.

Objective 1.1 - Breeding Ducks: Maintain an annual average of 7,000 breeding pairs of ducks over a five-year period by providing optimal breeding habitats via the HMP.

Rationale: Diving and dabbling duck breeding pairs are combined in this objective because ideal nesting conditions for either group fluctuate with water management activities and natural environmental events such as drought or flooding. In general, diving ducks nest above water in emergent vegetation and dabbling ducks nest in upland vegetation. In most impoundments, high water increases available over-water nesting sites for diving ducks and decreases available upland nesting sites for dabbling ducks. Conversely, lower water, including drawdowns or drought, increase upland sites and decreases over-water nesting sites. Therefore, a dewatered pool is never actually taken out of production, but merely utilized by different species with more terrestrial nest site preferences. The total number of breeding pairs of all ducks varies widely from year to year, having ranged from below 5,000 to about 13,000 since 1970, with a 30-year average of approximately 7,000.

In addition to availability of nesting habitats, we must also provide for brood rearing, post-breeding/molting, and migration. Optimal duck brood habitat offers abundant food and shelter from adverse weather and predators, all within close proximity. During molting season, ducks are flightless and vulnerable to both avian and mammalian predation. During this time they seek medium-density cover.

Objective 1.2 - Duck Production on Agassiz NWR: Based on a five-year average, maintain annual brood production above the long-term average of over 13,000 ducklings.

Rationale: A variety of habitats must be provided to produce ducks. Habitat for pairing, nesting and brood rearing must be available in close proximity. Fledged ducklings are the best measure of the suitability of waterfowl breeding habitat. Climatic factors that are beyond the control of management can influence habitat suitability so long-term averages are a better measurement of management effectiveness than just a single year alone. Brood counts have been conducted on the Refuge for 45 years and the average production since 1981 has been between 13,000 and 14,000 ducklings.

Objective 2.6 - Maintaining Hardstem Bulrush Emergent Habitat: Maintain 770 acres (1.3 percent of the Refuge) in hardstem bulrush emergent habitat for nesting Franklin's gulls, grebes, diving ducks, black terns, and black-crowned night-herons during April - August.

Rationale: Bulrush emergent habitat, specifically in Agassiz Pool, benefits a number of water-dependant birds such as those listed above. Aggressive narrow-leaved and hybrid cattail readily out-competes bulrush stands. Water-level management is directed toward suppressing the spread of cattails into the bulrush emergent habitat.

Research and Monitoring Needs

Refuge breeding pair and brood counts will continue to provide a measure of production that can be used to determine the effectiveness of management practices.

Potential Refuge Contribution to Habitat Needs

One of the roles that Agassiz NWR plays is consistently providing habitat for diving ducks during regional droughts. Agassiz Pool is the largest of the impoundments that provides diving duck habitat. Care should be taken to not have other pools that provide diving duck habitat in drawdown when Agassiz Pool is in drawdown. This should include Thief Lake on the nearby Thief Lake WMA. Korschgen et.al. (1996) suggested that management of large impoundments can mediate duckling mortality by (1) establishment of brood cover, (2) production of invertebrate foods, (3) protection from predatory mammals, and (4) creation of a large volume of water as a thermal mass to buffer temperature extremes. Although broods have been shown to be mobile, it is important to keep diving duck brood habitat distributed throughout the Refuge. Refuge impoundments which are not scheduled for a drawdown treatment the following year need to be maintained at an over-winter water level which ensures diving duck brood habitat the following year.

C. Potential Refuge contribution to the habitat needs of the resources of concern

See each individual species (or wildlife group) narrative above.

D. Reconciling conflicting habitat needs for resources of concern.

When managing a landbase the size of Agassiz NWR to meet the various life needs of a wide variety of wildlife species, ranging from freshwater mussels, to gulls, to wolves, to moose, to mallards, it is unrealistic to think that certain management actions will provide a similar benefit for all. Therein lies the importance weighing the 'pros' and 'cons' of various Refuge management options through a National Environmental Policy Act (NEPA) framework as part of the CCP decision making process. Further, the importance of conducting management activities with uncertain outcomes under an adaptive management framework and utilizing a structured decision making process to arrive at these choices cannot be underestimated. Throughout both the CCP and this document, habitat management goals and objectives are supported by a science-based rational that

ultimately provides justification for certain management decisions, despite the fact that some species will benefit more than others as a result of certain management actions.

IV. Habitat goals, objectives, and strategies

The following goals, objectives, and strategies listed as bullets were identified in the CCP process and in a habitat management strategy workshop held at the Refuge on 8-9 March, 2006. Natural resource experts familiar with Agassiz NWR were invited to this workshop to identify preferred management strategies and explore application of the strategies to Agassiz NWR. This discussion is based on the workshop discussions and further literature review. The general prescriptions developed to meet Refuge objectives are then presented.

Goal: Restore and enhance a natural landscape within the Refuge and its seven-county RMD to emulate naturally functioning watersheds and habitats within the tallgrass prairie, prairie pothole, aspen parkland, and northern coniferous forest, including habitat corridors for wildlife.

A. Objectives, strategies, and prescriptions

OBJECTIVE 2.1: Lowland Shrub and Grasslands Conversion: Achieve an increase in grassland cover by a net decrease of lowland shrub (i.e., alder, willow, dogwood) cover within the OLMA totaling 115 acres over the next 10-15 years, through conversion to grasslands to benefit wildlife species such as the bobolink, sharp-tailed grouse, marbled godwit, western meadowlark, and nesting dabbling ducks (Figures 6 and 7).

Rationale: Much of the Refuge's low-lying grassland sites are succeeding to lowland shrub, which although it has value, it is not as regionally scarce as upland grasslands have become. On most Refuge sites the lowland shrub is a native, but aggressive (invasive) plant community, which since the mid-1960s has contributed to reducing grassland area (along with decreasing haying and farming) from 4,000 acres to 1,710 acres in 1997 under current the management intensity. We plan to maintain an open landscape in a small portion of the Refuge by redirecting our management activities to convert mainly shrublands and croplands to grasslands. Once conversion to grasslands is achieved, continued maintenance and intervention using mowing and prescribed fire will be necessary to maintain the sites in grasslands. Each of the beneficiary species cited in Objective 2.1 are Regional Conservation Priority species, species of State Special Concern, species of management concern on the Refuge, or all three.

Strategies:
1.) Use prescribed fire, mowing, herbicide, or various combinations of these treatments to prepare a given site for conversion to grassland.
2.) Use seed mixes from sources of prairie grasses and forbs, within 50 miles of the Refuge, to reseed these sites.
3.) Judicious use of herbicides may be necessary to help in the establishment of grasslands.

Figure 6. Focus Habitat Management Areas, Agassiz NWR.

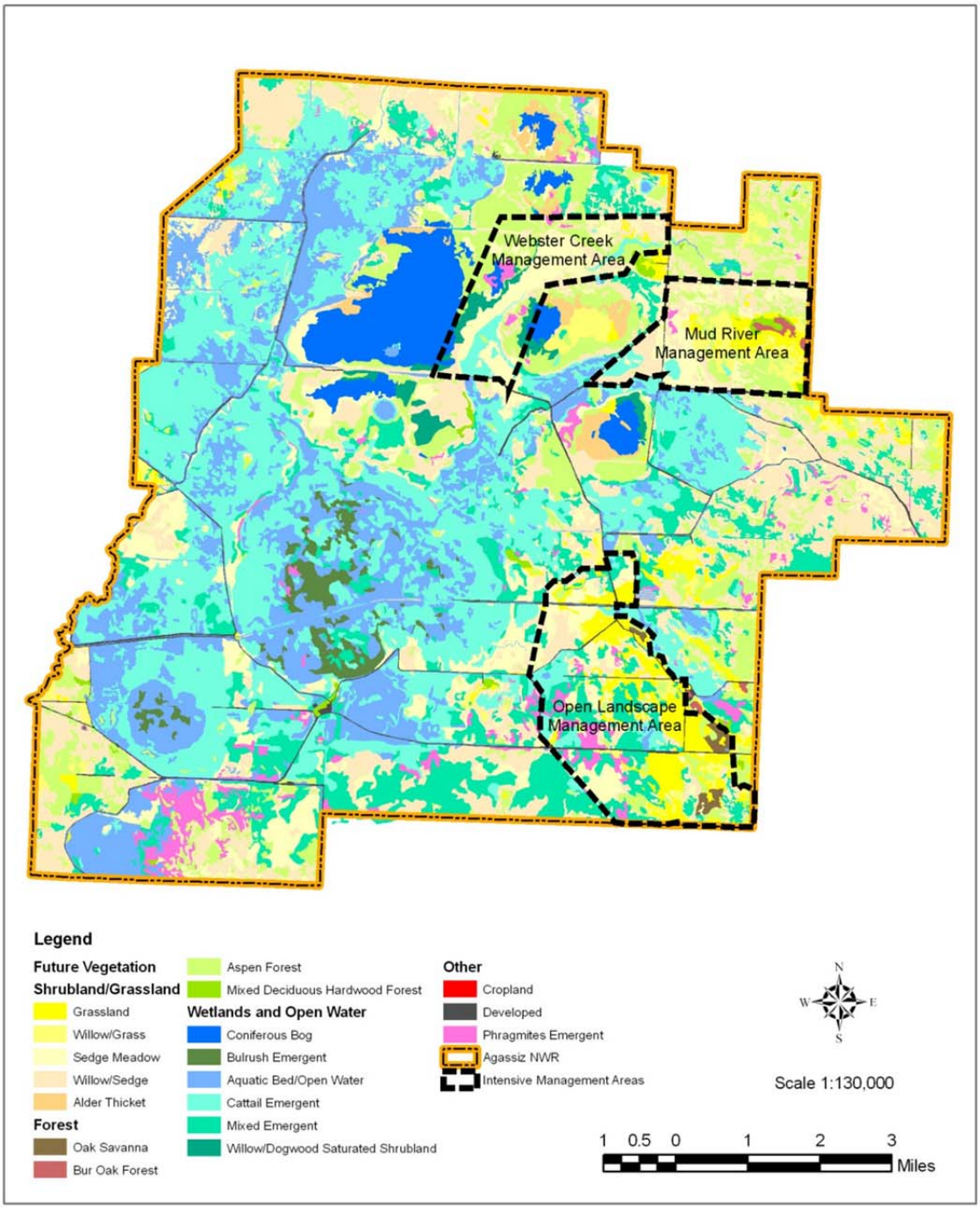
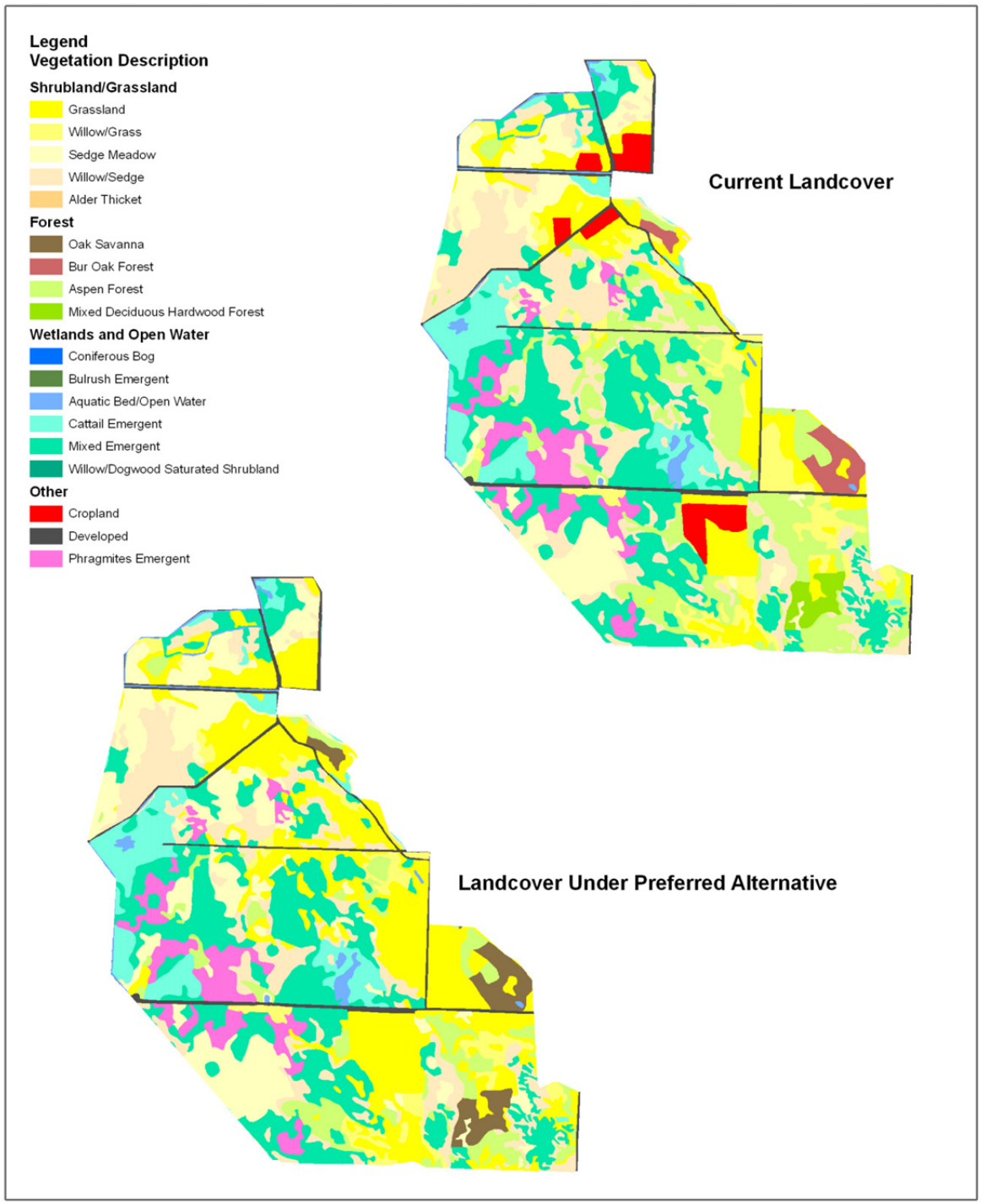


Figure 7. Current and Future Land Cover on the Open Landscape Management Area, Southeast Portion of Agassiz NWR



4.) Use geo-referenced aerial photography and GIS spatial analyses to monitor long-term changes in this habitat and measure pursuit of the objective for grasslands.

Discussion: Efforts to change willow shrub areas to grasslands in some areas will be enhanced by reducing the soil moisture. This may be done by reducing water levels with beaver dam removal or removing old dikes and WCSs. Potential areas may be along the east side of John's Field and along Ditch 201 on the south boundary. Several workshop participants noted that summer mowing of willows and trees reduces the amount of resprouting compared to dormant season cuts; however, compaction of wet soils must be avoided. Summer mowing should be conducted during dry years when the ground can support equipment without disturbing the soil. During dry years changes to annual management plans should be made to take advantage of the dry conditions.

Invasion by common reed into sedge meadow areas is a problem on many sites. Traditionally, spring burning has not stopped this invasion, and in fact it may increase common reed biomass and stem density in subsequent years (Shay et al. 1987). Spring burning is used in Europe to increase common reed in areas where it is harvested. Fall burns are considered to be neutral for common reed, only removing the old vegetation, but summer burns reduce biomass and flowering stem density in subsequent years (Ward 1942, Ward 1968, Cross and Fleming 1989, Shay et al. 1987, Thompson and Shay 1985, Thompson and Shay 1988). Summer burns may be the most effective tool to stop the increase in common reed on a large scale.

A contract was issued in the summer of 2006 to intensively look at the ecological classification based on soils and plants in the OLMA. The report from this effort (Zager 2007) identified areas that were historically Wet Prairie and Wet Brush Prairie which are the best candidates for conversion back to open grasslands. This ecological classification of the existing vegetation (2006) is in Figure 8 and the potential vegetation is in Figure 9. Zager (2007) states "A comparison of soil types between brush prairie (WPN53B) and aspen woodland types (FDW44B) shows that these native plant community (NPC) types occupy the same soils and landscape positions. It is very likely that modern areas of aspen woodlands were mostly brush prairie prior to Euro-American settlement. This and similar observations strongly indicate that open wet prairie/wet meadow can be viably restored from FDW44 woodlands." Annual Habitat Work Plans will concentrate on these areas.

Figure 8. Existing Vegetation Native Plant Communities in the Open Landscape Management Area (2006), Agassiz NWR.

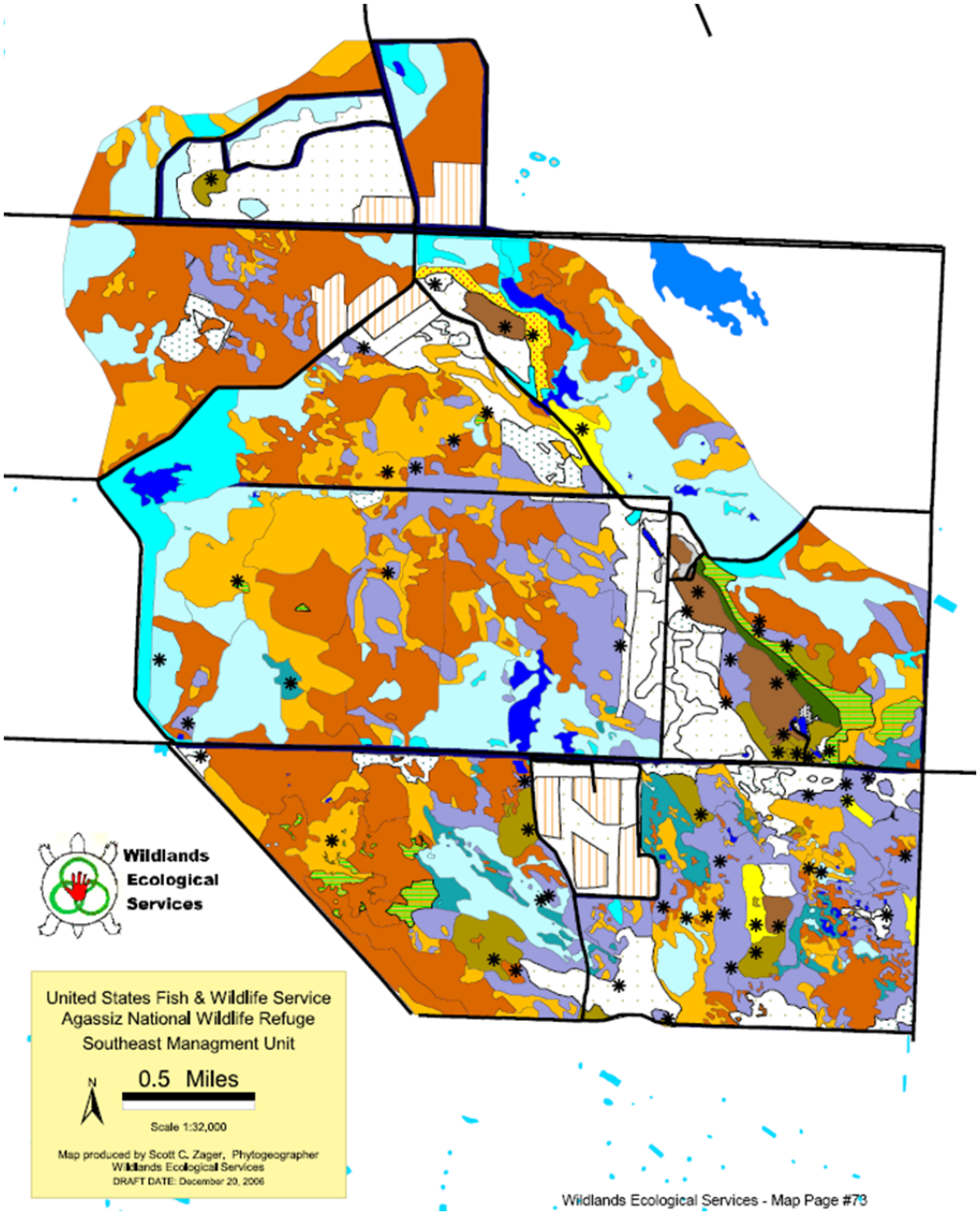
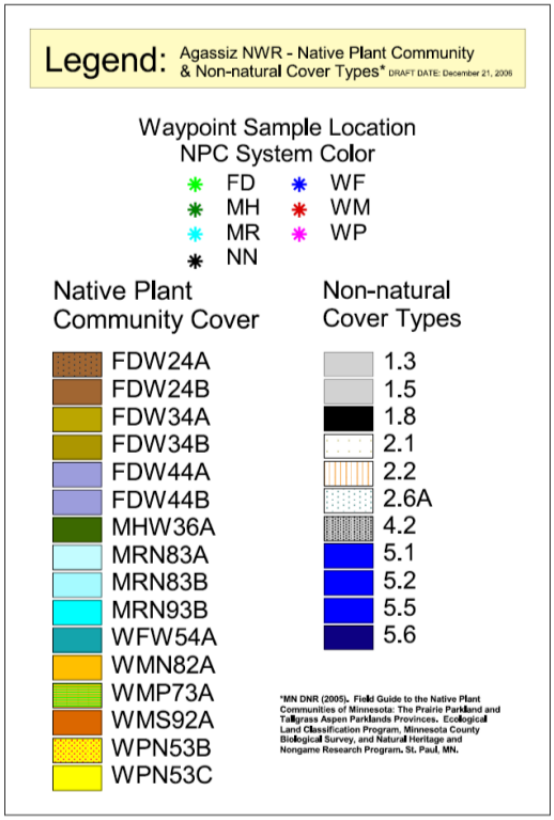


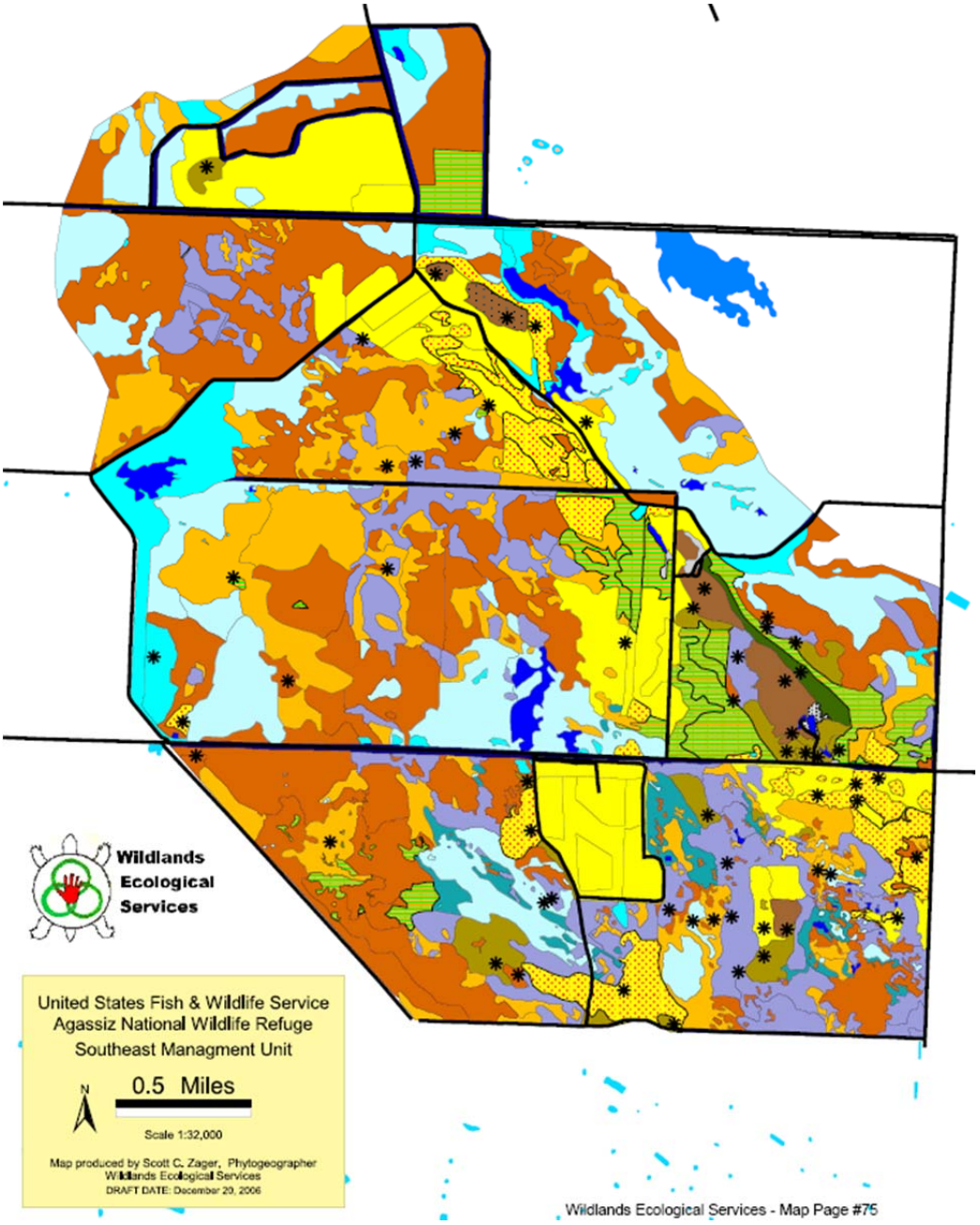
Figure 9. Continued.



Non-natural Cover Types
1.3 – Recreational Activity Area
1.5 – Administrative Area
1.8 – Roads/Trails – Buffered
2.1 – Old Field
2.2 – Cropland
2.6A – Young Forest – (deciduous)
4.2 – Quarry
5.1 – Seasonal Pond
5.2 – Permanent Artificial Ponds
5.5 – Ponds and Potholes
5.6 - Ditches

FDW24A – Northwestern Dry-Mesic Oak Woodland - Prairie Herb
FDW24B – Northwestern Dry-Mesic Oak Woodland - Forest Herb
FDW34A - Northwestern Mesic Aspen - Oak Woodland - Prairie Herb
FDW34B - Northwestern Mesic Aspen - Oak Woodland - Beaked Hazel
FDW44A - Northwestern Wet - Mesic Aspen Woodland - Cordgrass
FDW44B - Northwestern Wet - Mesic Aspen Woodland - Chokecherry
MHW36A – Northwestern Wet - Mesic Hardwood Forest – Green Ash - Bur Oak – Elm Forest
MRN83A – Northern Mixed Cattail Marsh – Cattail - Sedge Marsh
MRN83B – Northern Mixed Cattail Marsh – Cattail Marsh
MRN93B – Northern Bulrush-Spikerush Marsh – Bur Reed Marsh
WFW54A – Northwestern Wet Aspen Forest – Lowland Black Ash - Aspen – Balsam Poplar Forest
WMN82A – Northern Wet Meadow/Carr - Willow – Dogwood Shrub Swamp
WMP73A – Prairie Wet Meadow/Carr - Prairie Meadow/Carr
WMS92A – Southern Basin Wet Meadow/Carr - Basin Meadow/Carr
WPN 53B – Northern Wet Prairie - Wet Brush-Prairie

Figure 10. Potential Native Plant Communities of the Open Landscape Management Area, Agassiz NWR.



Prescriptions and Site/HMU Identification:

Grassland/Sedge Prescription: The objective is to eliminate trees in these units and to reduce willow and other shrubs to acceptable limits (<25%) for Wet Prairie and Wet Meadow plant communities. The units designated for this prescription have complex mosaics of soil and vegetation and will always have a vegetation mosaic that includes areas where trees and tall, dense shrubs will be dominant. However, the application of management tools in the designated units will be to favor open grasslands and sedge meadows. During the conversion stage prescribed burning should be conducted every other year. When conversion has been achieved and the objective is able to maintain the grasslands, the burning frequency should be reduced to every three or four years to allow more available nesting cover. These burns will be late summer burns (15 July to 31 August) when possible and fall burns (15 September to 30 November) when a summer burn cannot be completed.

Herbicide can be used only on a limited scale due to its expense and the amount of woody debris and growth. The most effective application will be with a wick applicator the second year after mowing, since only new willow and tree growth will be high enough to receive the herbicide. Herbicide applications will be in early summer and followed by burning later in the summer, after the woody vegetation has died. In areas that herbicide is not used, mowing should take place during the winter following a burn. Willows will then re-sprout and are subject to burning two years later. Summer burns may reverse the trend for invasion by common reed. Herbicide application with a wick applicator can also be used on common reed the summer after it is burned when only the new growth of common reed will be tall enough to receive the herbicide.

Within the OLMA, HMUs 37 and 41 are under this prescription. Additional HMUs outside of the OLMA that should be managed with these strategies are 12, 14, 28, 29 and 38. Three small areas will be burned annually for a period of five years to evaluate any differences in increasing sedge and grasslands between annual spring, annual summer, and annual fall burning. The west half of HMU 37, South Shop, will be an annual summer burn unit. HMU 14 will be an annual fall burn and HMU 12 will be an annual spring burn (1 April to 5 May). Air photo analysis and quantitative sampling plots will be used to evaluate the effectiveness of these treatments.

OBJECTIVE 2.2: Aspen and Mixed Hardwood, Grasslands, and Lowland Shrub Conversion: By 2009, achieve an increase in grassland and shrubland cover by a net decrease of aspen and mixed hardwood forest within the OLMA totaling 300 acres, through conversion to brushland and grassland for the benefit of wildlife species like sharp-tailed grouse, marbled godwits, and bobolinks.

Rationale: Although patches of aspen and mixed hardwood forests are valuable constituents of aspen parklands, they are not in short supply locally or regionally, as are prairie grasslands. These forests have been aggressively expanding into open plant communities on the Refuge and have contributed to the reduction of grasslands. Hence,

the emphasis is to increase open landscape grasslands at the expense of aspen/mixed hardwood acreage in a small focus area on the Refuge.

Strategies:
1.) Commercially harvest 647 acres of aspen/mixed hardwood forest within the OLMA within five years.
2.) Maintain harvested areas through mowing and prescribed burning.
3.) Continue using prescribed fire on a regular basis in stands of aspen and mixed hardwoods and around their edges to consume seedlings and saplings and prevent re-growth and recruitment by young trees, while encouraging grass growth.
4.) Expand the use of girdling to kill trees in stands planned for conversion to grassland.
5.) Allow the public to collect firewood in these sites.
6.) Coordinate with the MNDNR to manage the appropriate composition of brush and grasslands on adjoining WMAs.

Discussion: The open landscape of shrublands and grasslands in the aspen parklands includes grasslands, brush prairie, bogs, fens, oak savannas, and shrub swamps. Workshop participants noted that summer mowing and harvesting of aspen and balsam poplar reduces the amount of re-sprouting compared to dormant season cuts; however, compaction of wet soils must be avoided. Summer mowing and harvesting should occur during dry summers, when the ground can support the equipment without disturbing the ground. When drought years occur, changes to annual management plans should be made to take advantage of the dry conditions.

Smaller tree class sizes (<3") can be mowed and larger sizes harvested. Herbicides, such as glyphosate or Hidep could be applied with a wick applicator on small re-sprouting trees or glyphosate or Garlon applied with a hand sprayer to the stumps after cutting.

Larger stands of older trees can be cleared by commercial harvesting. Use of exchange of services contracts to complete mowing of small size trees and willows in exchange for the timber harvest should be utilized, if possible. Minnesota Forest Resource Council (2005) Site Level Guidelines for Forest Management state that "for prairie and parkland landscapes or portions of forested landscapes with openland/brushland management, minimizing or eliminating the *leave tree/snag tree* desired future conditions guideline may be appropriate". It may also be appropriate to harvest timber in these landscapes at younger-than normal rotation ages. These principles would hold true for management of the OLMA. Our workshop discussion pointed out that large patch size (i.e., entire HMUs) would also be appropriate in keeping with catastrophic change in the aspen parkland landscape.

The MNDNR participated in the development of Agassiz NWR's CCP and this HMP. They have implemented complementary habitat management on Elm Lake WMA in the area adjacent to the OLMA. The MNDNR has sheared aspen and willows and have increased the frequency of burning on this area.

Many areas of the Refuge outside of the OLMA are invaded by aspen. The Refuge cannot concentrate on all of these areas to keep them in open shrubland/grassland habitat types. These areas can be managed as young, even-aged forests. The discussion group pointed out the need to keep in mind the catastrophic aspect of disturbance in the aspen parkland ecosystem. Niemuth and Boyce (2004) found that sharp-tailed grouse responded to large clearcuts in the Wisconsin pine barrens and had higher densities on recently created sites such as clear cuts. They recommended creating a shifting mosaic of created seral stages rather than trying to maintain one patch as an early seral stage; therefore, entire HMUs will be treated at one time. Units placed in this category have a preponderance of soils that are prairie/forest borders (Haploborolls, Eutroboralfs, and Argiaquolls) or were readily invaded by aspen (Borosaprist – decomposed peat) and have demonstrated a high site potential for aspen.

Prescriptions and Site/HMU Identification:

Open Shrubland/Grassland Prescription: Application of this prescription should create a mosaic of shrubland, brush prairie, grassland, and sedge meadow. Trees should be reduced to an occasional stand near the edge of the open landscape adjoining other woody areas. Within the OLMA, HMUs 24, 27, 33, 35, and 42 should be managed with these strategies. In Figure 9 the areas labeled as FDw44 A & B, Northwestern Wet-Mesic Aspen Woodland are the primary targets of this prescription. Stands of large aspen (>3") should be commercially harvested and the smaller class sizes mowed. Herbicide application with a wick applicator should follow approximately two years after cutting. Most stands of trees in these HMUs should be cut. The entire units will be burned on a three-year rotation during the conversion phase and then on a three- to five-year rotation for maintenance. Burns will be in the summer whenever possible, or in the fall if necessary.

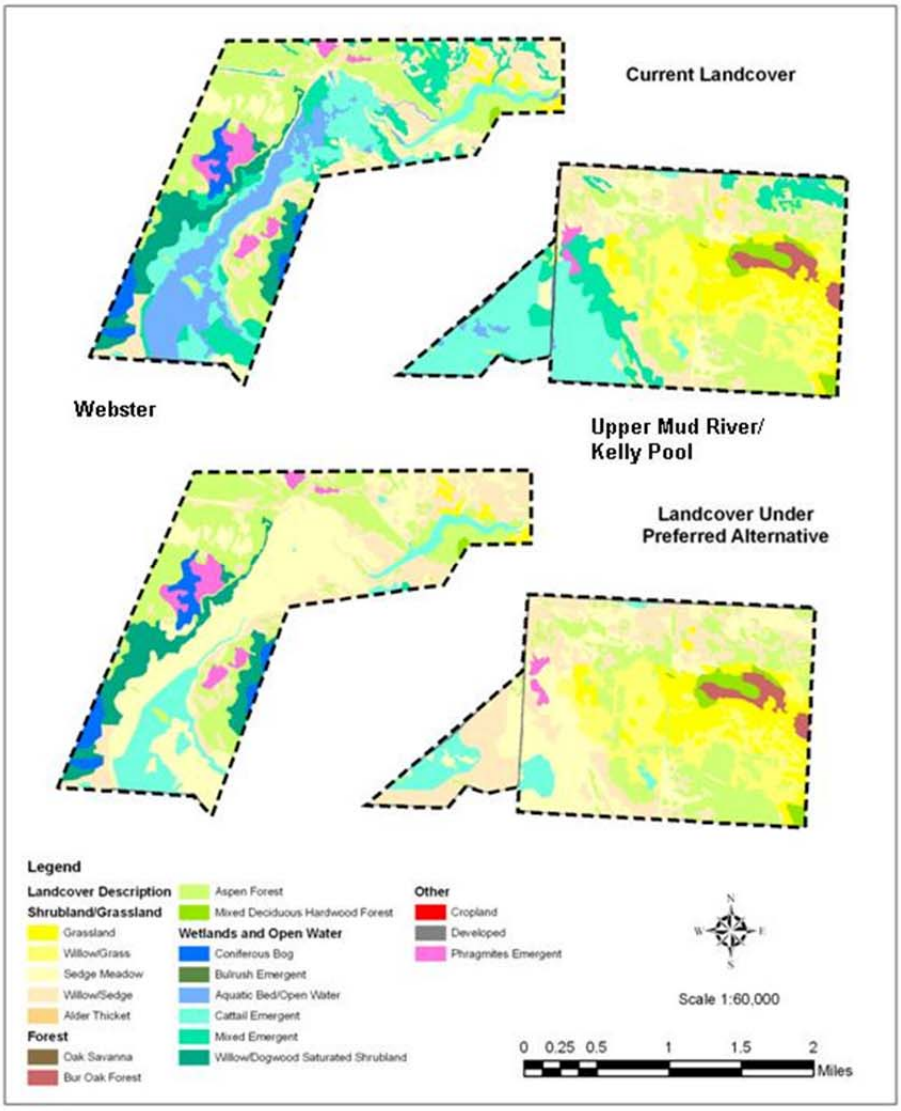
Outside of the OLMA, HMUs 1, 2, 5, 6A, 19, 21, and 34 should be managed with similar prescriptions. These HMUs should be burned in the summer or fall on a three- to five-year cycle. Woody vegetation should be mowed or harvested and followed two years later by prescribed fire. When time and money allow, herbicide application with a wick applicator can also be utilized.

Even-Aged Aspen Management Prescription: The HMUs in this prescription are not solid stands of aspen, nor are they intended to be. The HMUs will always consist of a mosaic of woodland, shrubland, and grassland/sedge. This prescription characterizes management that is favorable to wildlife like deer and ruffed grouse that benefit from woody vegetation in these units. All trees in these HMUs will be subject to a stand altering, catastrophic clearcut on a 42-year rotation. The preferred method of harvest will be short wood logging, where limbing, topping and cut to length is at the stump, leaving the nutrients on site and slash piles are not burned, creating potential weed invasion sites. As much of the shrub areas as possible will be mowed in the unit the same winter as the clearcut. An exchange of service contract would be an excellent way to accomplish the mowing. There are seven HMUs in this prescription, so only one HMU is cut every six years. HMUs 9, 10, 20, 22, 30, 36, and 39 are in this prescription. Based on current

growth and proximity to each other, the suggested clear cut rotation for these HMUs is: HMU 20 in 2007/08, HMU 9 in 2013/14, HMU 30 in 2019/20, HMU 22 in 2025/26, HMU 10 in 2031/32, HMU 39 in 2037/38, HMU 36 in 2043/44. Prescribed burns should be conducted in the spring on these HMUs at about five-year intervals to keep browse plants healthy and available for big game and hares, and to help maintain grasslands and sedge meadows.

OBJECTIVE 2.3: Open Water/Mudflat Conversion to sedge: Beginning in 2005, experiment for five years with decreasing open water/mudflat habitat by 400 acres in Webster, Kelly, and Upper Mud River Pools by converting portions to sedge habitats and restoring streams to a more natural watercourse for species such as Le Conte's sparrow, sedge wren, Nelson's sharp-tailed sparrow, and yellow rail. These HMUs are shown in Figure 10.

Figure 11. Current and Future Land Cover on Webster Creek and Mud River Natural Watercourse Management Areas, Agassiz NWR.



Rationale: Open water and mudflat habitats are much more abundant on the Refuge than sedge meadow. Sedge meadows constituted more than three-quarters of Minnesota's original wetlands and were indispensable habitat for plants like lilies, irises, and native orchids. Moreover, Le Conte's sparrow, sedge wren and Nelson's sharp-tailed sparrow are all Regional Conservation Priority species and the yellow rail is both a Regional Conservation Priority species, as well as a species of State Special Concern.

Strategies:

1.) Place Webster Creek, Kelly, and Upper Mud River Pools in drawdown to create conditions appropriate for sedge growth.

2.) Monitor extent of sedge habitat annually by visual inspection, aerial photography, and GPS mapping. Use digitized geo-referenced aerial infrared photography and GIS spatial analyses to track long-term trends.
3.) Monitor for invasion by reed canary grass and common reed.
4.) Stay abreast of research developments, experimental efforts, and pilot projects elsewhere in and out of the state, with regard to restoration of sedge meadow habitat.
5.) Evaluate results for success after five years. If successful, explore removing WCSs and portions of dikes, where feasible.
6.) If sedge establishment fails, management should return the pools to marsh habitat.

Discussion: The Agassiz NWR HMP workshop participants experience was that sedge germination takes place under cool, wet conditions. The cool conditions for sedge germination may be enhanced by early fall drawdowns, early spring burns, or late summer burns. Agassiz staff noted that the East 80 moist soil unit converted to sedge after a mid-August drawdown. The workshop group was skeptical if sedge will establish on the dead cattail mat in Upper Mud River and Kelly pools. Mechanical disturbance to the cattail organic layer may be necessary to expose mineral soil. Livestock grazing may be a tool that could help disturb the organic layer and help kill remaining cattails. Grazing was not covered in the CCP; however, it could be used on a small scale experimental basis. Van der Valk et al. (1999) suggest that the probability of establishing sedge from seed in created and restored wetlands would be maximized by the use of fresh seed, by keeping soil moist, and if need be raising the soil's organic matter content. Species of sedge found on the Refuge that may become established are Slough sedge (*Carex atherodes),* Lake sedge (*Carex lacustris*), Swartel's sedge (*Carex sartwellii)*, and Brown Bog Sedge (*Carex buxbaumii*; Zager pers. commun.).

Prescriptions and Site/HMU Identification:

The **Natural Watercourse Prescription** applies to three impoundments that will be allowed to stay in drawdown in an attempt to create sedge meadows along the watercourse through the impoundment. The treatment for Webster Pool will be a 2007 mid-August drawdown. The target areas for sedge in this pool are the exposed open water areas. Stop logs will remain out of the WCS for a period of five years. Evaluation of sedge establishment and the amount of invasives will determine if the stop logs will remain out after this time or if the unit will return to the Brood Habitat Prescription. Leigh Fredrickson, Wetland Management and Education Services, Inc., Puxico, MO, is attempting to organize a study to intensively evaluate this effort.

Kelly Pool and Upper Mud River Pool were placed in drawdown in the spring of 2005. Rain events kept water on these areas into August. The pools were burned on 30 August, 2005. The stoplogs will remain out of the WCS for a period of five years. Evaluation of sedge establishment and the amount of invasives will determine if the stop logs will remain out after this time or if the units will return to the Nesting Habitat Prescription.

OBJECTIVE 2.4: Increasing Sedge Meadow: Beginning in 2005, experiment with increasing sedge meadow by 1,250 acres over the next 10 years, to benefit wildlife

species like the yellow rail, sedge wren, Nelson's sharp-tailed sparrow, and Le Conte's sparrow.

Rationale: See discussions above as to the value of sedge meadow habitat, its former abundance in Minnesota, its present scarcity, and the difficulty in restoring habitats throughout Minnesota. Each of the above four bird species mentioned are Regional Conservation Priority Species and species of management concern on the Refuge. This objective would draw on several different habitats, including open water, mudflat, willow scrub, bulrush, and cattail.

Strategies:
1.) Conduct spring drawdowns, followed by mid-summer burning, and mowing in various pools for willow and cattail control.
2.) Monitor for invasion of reed canary grass and common reed.
3.) Annual spring burns.
4.) Herbicide applied to willows with a wick applicator.

Discussion: The Agassiz NWR HMP workshop group identified annual spring burning as a successful technique maintaining a sedge meadow on WMAs near Aitkin, MN. This could be tried on one area of willow encroachment to see if it will not only curtail the spread of, but also substantially reduce coverage of willow. If the annual burning could be replaced by a less frequent routine after a number of years, the areas would more regularly provide nesting habitat for early nesting birds.

The workshop discussion also revolved around mowing or shearing followed by herbicide treatment and/or fire. One participant recommended talking to Dave Dickey (MNDNR) regarding herbicide use coupled with shearing and fire. Mr. Dickey was contacted 11 July, 2006 and reported that he is shearing lowland shrubs during the winter and following that treatment with broadcast spraying two years later. He is currently using an aquatic approved 2,4-D herbicide applied by helicopter, as many areas are exceptionally wet or rough and aerial application may not cost much more than ground application. He has used glyphosate and thought it killed too much of the herbaceous layer. Recently he applied Habitat and Renovate (active ingredient triclopyr), but has not had a chance to evaluate. Mr. Dickey also felt that the addition of fire after the herbicide kill may add to the herbaceous layer development. Habitat and Renovate may also kill too much of the herbaceous layer. Agassiz NWR had four 5-acre plots of cattail in Madsen Pool sprayed with Habitat (active ingredient isopropylamine salt of imazapyr) and AquaNeat (active ingredient Isopropylamine Salt of Glyphosate) in 2005. In 2006, an ocular assessment determined that Habitat was slightly more effective than AquaNeat , but cattail kill for both chemicals exceeded 95%.

Variable water regimes in summer may be beneficial for sedge meadows. The wet mid-late 1990s and early 2000s have not recently allowed for low water levels during late summer.

Invasion by common reed into sedge meadow areas is a problem on many sites. Traditional spring burning has not stopped this invasion, and in fact may increase biomass and stem density in subsequent years (Shay et al. 1987). Spring burning is used in Europe to increase common reed in areas where it is harvested. Fall burns are considered to be neutral for common reed, only removing the old vegetation, but summer burns reduce biomass and flowering stem density in subsequent years (Ward 1942, Thompson and Shay 1985, Shay et al. 1987, Thompson and Shay 1988, Cross and Fleming 1989). Summer burns may be the most effective tool to stop the increase in common reed on a large scale. Whitetop has been found to be enhanced by summer burns (Ward 1968).

Prescriptions and Site/Unit Identification:

The **Sedge Meadow Prescription** objective is to reduce or keep the amount of willow cover below 25% (MNDNR 2005 Sedge Meadow/Carr- Sedge Meadow). The basic prescription will be a complete May drawdown followed by a summer burn on a two-year rotation. HMUs 7, 10a, 23 (management aimed at the sedge meadows on the north half of the HMU), 25, 26, and 40 are under this prescription. Webster Creek, under the Natural Watercourse prescription, is also shown on the map (Figure 10) as part of this prescription. Burns will occur between 15 July and 31 August. The alternate year the impoundments will be set for shallow flooding of the sedge meadow zone, with a gradual lowering of water level in the late summer or early fall.

Herbicide can be used to reduce the amount of willow only on a limited scale due to its expense. The most effective application will be with a wick applicator the second year after mowing or fire, since only new willow and tree growth will be high enough to receive the herbicide. Herbicide applications will be in early summer and followed by burning later in the summer, after the woody vegetation has died. In areas that herbicide is not used, mowing should take place during the winter following a burn. The willows will then re-sprout and are subject to burning two years later.

Summer burns should reverse the trend for invasion by common reed but herbicide application can also be used on re-sprouted common reed later in the summer after burns (Cross and Fleming 1989). Herbicide can be applied with a wick applicator the summer following the burn, when only the new growth of common reed will be tall enough to receive the herbicide.

OBJECTIVE 2.5: Reducing Cattail and Common Reed Infestation: Experiment with decreasing cattail and common reed vegetation by 840 acres, converting this area to sedge habitat to benefit species like Le Conte's sparrow, sedge wren, Nelson's sharp-tailed sparrow, and yellow rail in the next 10 to 15 years.

Rationale: This objective may require advances in technology or control methods to be realized. Displacement of sedge meadow habitat by willow shrub-scrub, common reed, reed canary grass, and cattails is an ongoing problem at Agassiz NWR (and elsewhere), and a solution has yet to be discovered or devised. Prolonged high water – all too

common in recent years – contributes to invasion of the sedge zone by cattails. Present management is to lower water levels prior to fall burning of sedge meadow, as well as cutting 200-300 acres of willows each winter. However, these practices are proving insufficient and net losses of sedge will continue to mount under the present approach.

Strategies:
1.) Utilize an adaptive management strategy that encourages experimentation with a variety of methods for maintaining and expanding sedge meadow acreage. For example, solutions may involve spraying with chemicals (finding a herbicide with specificity for just willows or cattails may be impossible), extending dry periods for each pool, or implementing multiple burns over a short time period might improve success.
2.) Experiment with multiple-year pool drawdowns that would allow sedges to become better established and expand.
3.) Experiment with back-to-back burns of cattail-dominated areas.
4.) Stay abreast of research developments, and experimental efforts on cattail management.
5.) Explore cooperative research and restoration opportunities with the University of Minnesota, MNDNR, and other institutions.
6.) Continue to monitor habitat changes with aerial photo/GIS analysis and research advancements. Assess whether continuing to expend limited staff and funds to control cattail and willow encroachment on sedge meadow is a worthwhile cost.

Discussion: The majority of past cattail control revolved around reducing cattail stem height during the fall and winter months, then reflooding in the spring so that the remaining stems are covered by several feet of water (Mallik and Wein 1986, Sojda and Solberg1993). Madsen Pool was in drawdown from 2003 through 2007. The area of the sedge meadow/cattail interface in the northwest part of the pool can be evaluated to determine if any shifting of this interface has occurred. In the fall of 2006 this interface was walked by Sue Braastad (Agassiz NWR) and recorded with a GPS. This spatial line can be projected on future infrared photos for reference to detect change. Similar on-the-ground GPS mapping activities can be conducted on a limited basis in future years as an accuracy assessment (ground truthing) for infrared air photo vegetation delineation, especially in habitats where delineation is somewhat difficult/problematic.

Twenty acres of cattail were sprayed on 7 September, 2005 along the south edge of Madsen Pool with AquaNeat and Habitat herbicides. Both chemicals achieved acceptable first year kills in 2006, with Habitat being only slightly more effective. Yearly evaluation for longevity of the treatment will be done with the aid of the infrared photos and ground truthing the areas.

Control of common reed has been discussed under Objectives 2.1 and 2.4.

Prescriptions and Site/Unit Identification: *See the Prescription and Sites listed above under Objective 2.4.*

OBJECTIVE 2.6: Maintaining Hardstem Bulrush Emergent Habitat: Maintain 770 acres (1.3 percent of the Refuge) in hardstem bulrush emergent habitat for nesting Franklin's gulls, grebes, diving ducks, black terns and black-crowned night-herons from April - August.

Rationale: Bulrush emergent habitat, specifically in Agassiz Pool, benefits a number of waterbirds like those listed in the objective. Aggressive hybrid cattail tends to out-compete bulrush stands. Water level management is directed toward suppressing the spread of cattails into the bulrush emergent habitat.

Strategies:
1.) Raise water levels to depths that will flood out cattails and favor bulrush emergent habitat.
2.) Use drawdowns where indicated to maintain or re-establish bulrush where open water or mudflats occur.
3.) Monitor extent of bulrush emergent habitat annually by visual inspection, aerial over flights, and GPS mapping by airboat. Use geo-referenced aerial infrared photography and GIS spatial analyses to track long-term trends.
4.) Monitor breeding bird use of bulrush habitats..

Discussion: Agassiz Pool was managed for summer elevations from 1139.5' to 1140.0' msl during 1970-2006, which has favored an increase in bulrush and limited cattail encroachment into the open water areas. Hardstem bulrush has increased with the drawdowns of Agassiz Pool. After the 1980 drawdown the pool was kept at low elevations through 1984 during which time "emergents flourished" (1987 Marsh and Water Management Plan). Pool level was returned to 1140.0' in 1985 and most of the open water areas reverted back to open water with a large increase in submergents like sago pondweed. After the late summer drawdown of 1990, pool levels were at 1139.5' in 1991 and 1140.5' during 1992. During the 1990s, water levels were maintained at 1140.0' most years and a major increase in the abundance of the hardstem bulrush occurred. Approximately 50% of the open water areas became vegetated with bulrush during the 1990s.

Drawdowns that expose mineral soil for 30 days, or at least have less than an inch of clear water are conducive to hardstem bulrush germination (L. Fredrickson pers. commun.). Reestablishment after drawdowns or drought may be favored by shallow water depths and damp soil. O'Neill (1972) recommended shallow depths or gentle alternate drawdowns the first year to allow the seedlings to anchor. He also recommended gradual drawdowns in July to perpetuate established stands. If the bulrush becomes too thick or covers too much of the pool, deeper elevations during spring and summer may curtail its spread.

Prescriptions and Site/Unit Identification:

See **Deep Water Marsh Prescription** under Objective 2.7. Agassiz Pool, HMU 15, is the only HMU with a large persistent stand of hardstem bulrush. Summer pool levels

will continue to be set between 1139.5' to 1140.0' to maintain the bulrush community. Drawdowns will be scheduled at 10-year intervals to maintain early succession submergents like sago pondweed. Sand Lake NWR (SD), Lake Alice NWR (ND), and Thief Lake WMA (MN) will be notified a year ahead of planned drawdowns to avoid their wetlands being drawn down at the same time, thereby limiting the regional alternatives for nesting Franklin's gulls.

In Headquarters Pool there is one small hardstem bulrush patch of about 2,000 sq. feet in the east-central part of the main open water area. It was first noticed in 1998 and has shown little increase in size. It is located on a sandy site. Headquarters Pool is difficult to get into a drawdown condition but hardstem bulrush may expand if moist soil conditions are obtained through a complete drawdown. In 1998, hardstem bulrush seed and tubers were planted according to recommendations in the literature, but without a drawdown (Huschle 1999). No bulrush was established based on these procedures but germination rates >85% for the seeds were documented in a lab. Bulrush management could become a focus for Headquarters Pool in the future if drawdowns successfully spread or establish bulrush.

OBJECTIVE 2.7: Managing Water Impoundments: Manage water impoundments as a complex of basins to provide wetland diversity and improve water quality for maximum benefit to migrating and breeding birds. Management will be within the capabilities of the wetland system as a whole and individual impoundments will be drawn down on 2- to 10-year rotations.

Rationale: Water level manipulation allows managers to simulate different stages of the natural flood/drought cycle at the same time in different impoundments. This increases the diversity of habitat types and food resources in the wetland complex that are available to migrating and nesting birds. The emphasis is on semi-permanent wetlands, as these wetlands can be the most productive type for marsh-nesting birds. The larger impoundments on Agassiz NWR provide a wide diversity of habitats within each impoundment. Management can increase this diversity by varying the water regime in nearby impoundments. The outcome will be interspersion of cover and openings for dabbling duck and marsh bird pair and brood habitat, open bays, medium density cover for diving duck broods, and post breeding/molting duck habitat.

Strategies:
1.) Agassiz Pool (9,350 surface acres) will be in drawdown once every 10 years. The emphasis is on maintaining the hardstem bulrush plant community which is the most desirable habitat for the nesting colony of Franklin's Gulls.
2.) The six small Golden Valley, Goose Pen, and E 80 impoundments (normal summer pool 25 to 52 surface acres in size; total 218 acres) will be in a drawdown cycle of either a two or three years, depending on which cycle they are best suited for.
3.) Sixteen other impoundments, totaling 16,276 acres, will be staggered in a drawdown cycle of four to six years. These impoundments have been further divided into either a three- to four-year nesting habitat cycle or a five- to six-year brood habitat cycle. The emphasis is on keeping cattail in good nesting condition and on maintaining openings in

cattail areas. Burning will be prescribed to occur during the drawdown phase. If the natural watercourse trial objective is not successful in establishing sedge meadow habitat in Webster, Upper Mud, and Kelly Pools, they will be added to this strategy (1,300 acres total).
4.) Provide stable water levels from 1 May to 15 July in a variety of cover types for over-water nesting birds and to prevent flooding of upland nests.
5.) Lower water levels 6 to 12 inches in some impoundments during the fall to provide shallow foraging sites for migrating waterfowl.
6.) Maintain sufficient depth of water during the winter for minnow and muskrat survival. Minnows are an essential food resource for piscivorous birds and muskrats play a key role in increasing openings in cattail and are a vital link in multiple food chains.
7.) Improve water quality on a watershed scale through input and coordination with other agencies (e.g., U.S. Geological Survey [USGS]), within the constraints of the biological parameters for providing habitat for breeding and migratory birds.
8.) Assess status of siltation and nutrient buildup in the Refuge basins. Develop strategies to address these concerns.

Discussion: "Protect wetland complexes that include various hydro-periods and thus sizes of wetlands" is the first of seven principles of wetland conservation listed by Baldasarre and Bolen (2006). One of the Refuge's strengths is the diversity and large size of its wetlands. Plans in the old Master Plan to divide several of the large wetlands have been eliminated in this planning effort, as this would tend to eliminate shallow wetlands and sedge meadows that are regionally in short supply and decrease the diversity of wetlands on the Refuge. The additional dikes would also provide predators access to what are now large wetlands.

To be effective, wetland management requires an understanding of interrelationships among habitat and resources needed by wetland wildlife to survive and reproduce and integrates knowledge of hydro-period, wetland structure, and function with the requirements and timing of life-cycle events of wildlife (Fredrickson and Laubhan 1996). Drawdowns are a necessity to maintain productivity of wetlands. High levels of productivity during the first few years after flooding stem from the flush of soluble nutrients from the store of nutrients released from the soil and decomposing vegetation under the aerobic conditions characteristic of a drawdown (Baldasarre and Bolen 2006). Integrated wetland management does not propose a certain water depth as an infallible rule, as wetland birds rely on several depths to meet their needs (Baldasare and Bolen 2006).

Harris (1957) intensively studied drawdown conditions on eight Refuge pools from 1952 to 1956. The Refuge's management objective at that time was to increase emergent vegetation. He found that the best results were from an early June drawdown one year in duration. Little was gained by additional consecutive years of drawdown for the establishment of emergent vegetation. In fact, willows and aspen became problems in four- and five-year drawdowns. Softstem bulrush (*Scirpus validus*) only persisted after re-flooding in areas where water depths were <15 inches. The first year of re-flooding resulted in heavy fruit production of submergent plants, such as sago pondweed;

however, fruit production diminished over the next several seasons. Harris (1957) also found that willows became established reaching high densities in years four and five of long-term drawdowns. Willows required several years to drown after re-flooding.

The large size and variable bottom contour of the Refuge's wetlands offer a variety of depths and timing during drawdowns. This mosaic of drawdown depth is usually increased in complexity by rain/runoff events and differing rates of drying. Drawdown timing will be aimed at late May and early August to accommodate migrant shorebirds. Ranallo (2006) determined that off-Refuge wetlands complemented the Refuge in providing shorebird habitat during wet periods that usually inundate even planned Refuge drawdown impoundments. However, in years when the Refuge did not provide shorebird habitat, there were fewer birds in the local area. She also determined that the peak in shorebird numbers was variable depending on changing habitat abundance. If habitat is available, the spring and fall shorebird abundance peaks would most likely occur during the last two weeks of May and the first two weeks of August, respectively. By targeting late May for drawdowns some habitat will be available for shorebirds and yet some of the mudflats will be exposed or drying during early June for emergent germination. The uneven drawdowns provided by deeper pockets and ditches provide refugia for amphibians, mollusks, and crustaceans and add to the diversity of response. Large wetlands that maintain water during the molting season are not only important to molting waterfowl and their broods, but also to waterbirds such as American bitterns that move away from wetland edges during the molt in mid-summer (Azure 1998, Brininger 1996).

The detrimental affects that carp (*Cyprinus carpio*) have on wetlands and waterfowl are summarized in Baldasarre and Bolen (2006). Competition between minnows and waterfowl has been suggested as a possible part of the reason for declining scaup populations (Anteau 2005). Thief Lake WMA managers have documented that drawdown of the lake in the fall and subsequent winter-killed fish improved the population of amphipods and the subsequently increased use by diving ducks. Although providing some over-winter habitat for minnows is desirable for diverse marsh life, promoting dense minnow populations or populations of larger fish is not conducive to waterfowl production.

The two primary tools for managing the impoundments are drawdowns and prescribed burning. Herbicide application and mechanical disturbance can be used on a small scale in comparison to the primary tools.

The workshop discussion centered on managing the impoundments with the life span and requirements of priority bird species in mind and matching these requirements to the characteristics of the individual pools. Focus bird requirements are:

- nesting habitat for rails in impoundments characterized by sedge meadow;
- over water waterfowl nesting and American bittern use in wetlands characterized by large cattail marshes with little interspersion and few open water areas;
- diving duck production (nesting and broods), grebes, and least bitterns for wetlands characterized as hemi-marsh (Weller and Spatcher 1965) habitat;

- migration habitat and diving duck production for the impoundments with large open water areas.

Another item discussed was management in terms of bird life spans being less than the disturbance frequency. In this context the focus birds for sedge meadows (rails and nesting dabbling ducks) have 50% or more annual mortality so 75% live less than two years and therefore, have evolved to move nest sites around periodically. Consequently, a short two-year management cycle should be appropriate. During research at Agassiz NWR, one American bittern did return four years in row and several birds returned for two or three consecutive years. Dabbling duck nesting is consistent with opportunistic settling in dynamically varying habitat (Johnson 1996). For these nesting birds, management of wetlands for cattail nesting habitat would allow for a three- to four-year burning frequency. One question with little information in the literature is how long after disturbance does cattail decrease in nest desirability. Puglissi et al. (2005) found Eurasian bitterns (*Botaurus stellaris*) selecting saw sedge (*Cladimn mariscus*) and common reed marshes that had less than four years past disturbance by fire. They recommended a management cycle of at least every four years.

In contrast to dabbling ducks, there are strong correlations in numbers between adjacent years in the diving ducks and ruddy duck, and these are species that make more use of semipermanent wetlands which are more persistent from one year to the next (Johnson 1996). Redheads and canvasbacks have the two highest homing rates of 10 species of ducks that breed in the PPR (Johnson and Grier 1988). Use of more stable habitats would predict a greater homing tendency. Mike Sorenson looked at DNA types in Canvasbacks in 1992. According to M. Sorenson (pers. commun.), Agassiz NWR canvasbacks were fairly unique in that Manitoba canvasbacks had more genetic similarities to west coast canvasbacks than with Agassiz NWR birds. So, a longer cycle would be more appropriate to accommodate high fidelity. A longer cycle needs to be balanced against the fact that these impoundments have existed a long time and are more "stabilized" than a new impoundment and will benefit from frequent disturbance (L. Fredrickson pers. commun.). Based on the previous information, the Refuge's impoundments are divided into four prescriptions which are listed in Table 7. The general prescriptions follow, but how they are applied to the individual pools is discussed in the section that deals with individual HMUs.

Prescriptions and Site/HMU Identification:

Table 4. Drawdown cycles for habitat management.

1- to 2-year cycle: Sedge Meadow	**3- to 4-year cycle: Nesting Habitat**	**5- to 6-year cycle: Brood Habitat**	**10-year cycle: Deep Water Marsh**
Madsen Pool (23)	Pool 8 (13)	Parker Pool (31)	Agassiz Pool (15)
East 80 (27)	East Pool (35)	Tamarack Pool (1)	Headquarters Pool (34)

Goose Pen S. (26)	Dahl Pool (36)	Thief Bay Pool (43)	
Golden Valley S. (25)	Goose Pen N. (26)	Pool 21 (21)	
Golden Valley N. (25)		Mud River Pool (6)	
Golden Valley W. (25)		Farmes Pool (39)	
South Pool (40)		Upper CCC (18)	
		Middle CCC (18)	
Kelly Pool (10A)		Lower CCC (19)	
Upper Mud River Pool (7)	*Kelly Pool (10A)	Northwest Pool (4)	
Webster Pool (6)	*Upper Mud River Pool (7)	*Webster Pool (6)	

*These three pools will be in these prescriptions if the Natural Watercourse trial fails.

Sedge Meadow Prescription is the same prescription listed under Objective 2.4. This prescription is similar to the Grassland/Sedge prescription under Objective 2.1, but is applied to sedge meadows under the influence of impoundments where drawdowns can be applied. These treatments should benefit marsh birds, such as yellow rails and American bitterns, as well as nesting dabbling ducks. The objective is to reduce or keep the amount of willow cover below 25% (MNDNR 2005 Sedge Meadow/Carr-Sedge Meadow), reduce common reed, and to have sedge meadow expand into areas occupied by cattail. The basic prescription will be a May drawdown followed by a summer burn on a two-year rotation. These burns will be between July 15 and August 31. Fall burns would be second choice when summer burns are not accomplished. The alternate year the impoundments will be set for shallow flooding of the sedge meadow zone with a gradual lowering of water level in the late summer or early fall. Of those impoundments in the one- to two-year cycle, only four or five will be placed in drawdown each year.

Herbicide can be used to reduce the amount of willow only on a limited scale due to its expense. The most effective application will be with a wick applicator the second year after mowing or a burn, since only new willow and tree growth will be tall enough to receive the herbicide. Herbicide applications will be in early summer and followed by burning later in the summer, after the woody vegetation has died. In areas where herbicide is not used, mowing should take place during the winter following a burn. Willows will then re-sprout and be subject to burning two years later.

Summer burns may reverse the trend for invasion by common reed, but herbicide application can also be used on re-sprouted common reed later in the summer after burns (Cross and Fleming 1989). Herbicide can also be applied with a wick applicator the summer following the burn when only the new growth of common reed will be tall enough to receive the herbicide. HMUs 7, 10a, 23 (management aimed at the sedge meadows on the north 1/2 of the HMU), 25, 26, and 40 are under this prescription. Webster Creek, under the Natural Watercourse prescription, is also shown in Figure 10 as part of this prescription.

Impoundments in this prescription may periodically present opportunities for mechanical manipulation in the cattail zones, which can be taken advantage of if time and budget allows. This manipulation should be aimed at the fringe near sedge meadow to open the cattail root mat for sedge establishment.

Nesting Habitat Prescription (Semi-permanent Cattail Marsh) is aimed at providing quality nesting habitat for over-water nesting ducks and marshbirds, such as rails and American bitterns. The impoundments in this category are characterized as semi-permanent wetlands with large expansive stands of cattail and little open water. These are marshes that we cannot push to a hemi-marsh covertype by deep water flooding. In these impoundments we are accepting the large expanses of cattail for its value as nesting cover and trying for the best management of cattail for nesting waterfowl and marshbirds. The basic prescription is a drawdown on a three- to four-year cycle with a fall or spring burn after the drawdown. In the three- to four-year cycle prescription only one impoundment will be in drawdown each year. In the three- to four-year cycle units the first choice will be a fall burn of the drawdown year with the following spring as second choice. Summer burns during the drawdown year can be used if other higher priority burns have been accomplished.

Herbicides such as glyphosate can be utilized in the impoundments listed in the Nesting Habitat prescription to create small openings for waterfowl to access nesting cover. Transects can be flown with the herbicide applied in short bursts to create small openings. This treatment has been used in Kelly Pool and East Pool during the 1990s and followed with high water levels. The treatment effects persisted for six to seven years.

Brood Habitat Prescription (Semi-permanent Hemi-Marsh) emphasizes providing ideal conditions for diving duck production and marsh birds, such as least bitterns and grebes. These impoundments are semi-permanent wetlands with a hemi-marsh appearance. These areas need to be managed to keep cattail expansion in check to preserve the open water interspersion. They will be in a five- to six-year drawdown cycle. Drawdowns will be initiated in early May to discourage nesting and to expose mudflats in late May for shorebirds. During the drawdown year the marsh vegetation will be burned in the summer as a first choice or during the fall if not accomplished during the summer. Water levels the following year will be shallow to keep the ephemeral emergent vegetation (e.g., softstem bulrush) available. Years three to five would be to full pool or nearly so to drown out encroaching cattail, depending on character of the individual pool. Only two of these impoundments will be in drawdown

in any given year. There will be some years when either very wet conditions or very dry conditions will modify this. Drawdown effectiveness will vary with the annual variation in summer precipitation events. Refuge staff should not "hold out" for the perfect drawdown nor should they try to hold water in an impoundment scheduled for drawdown in a dry year because other pools are low on water. Take advantage of getting it "dry".

The **Deep Water Marsh Prescription** is to provide habitat for waterfowl migration, diving duck production, and colonial waterbird nesting. The two impoundments in this category will be in a 10-year drawdown cycle and both will not be in drawdown during the same year. Water levels the year following drawdown will be shallow to keep the ephemeral emergent vegetation (i.e., softstem bulrush) available. To stimulate submergent vegetation and invertebrates during the 10-year interim, a shallow water year will be scheduled in year five or six of the cycle. Water levels during other years should be at normal pool levels.

Headquarters Pool will be burned every five years with summer as first choice. Every other burn will be in conjunction with the drawdown. The Agassiz Pool perimeter will be burned in conjunction with the priorities for the adjoining upland management prescriptions.

General Comments on Impoundment Management

Stable water levels will be strived for on all impoundments not in drawdown between 1 May and 30 July as 99% of duck nesting is completed by late July (HAPET unpublished data). After 30 July, several pools in the Brood Habitat prescription can be lowered 0.5' to 1.0' to make submerged vegetation available for migrating waterfowl. This is also beneficial for the duck banding effort on those pools with banding sites, as it exposes additional beach for rocket nets.

Drawdowns will be initiated by 1 May. The exposure of the majority of the mudflats will be aimed for 20 May. Drawdowns will last all summer. There is usually sufficient rainfall to rewet the mudflats several times during the summer and create good shorebird habitat during early August. On dry years the early mudflats may be dry, but there will be shorebird habitat showing up in many of the other impoundments that were not designated for drawdowns.

The Refuge has been participating with a water quality work group with the Minnesota Pollution Control Agency (MPCA) for the past two years. The Thief River between the Refuge and Thief River Falls and between Agassiz NWR and Thief Lake WMA has been designated an Impaired Water and a restoration plan will be developed soon. The Total Maximum Daily Load (TMDL) parameters that are impaired are dissolved oxygen, turbidity, and phosphorus. Hydrogen sulfide issues have also been raised by the city of Thief River Falls. Refuge staff will continue to work with this group. An intensive study is being initiated in 2007 to determine the sources of the impairments in the Thief River Watershed. The Refuge is participating in this study. The slumping ditch banks along Ditch 11 between Parker and Madsen Pools are definitely contributing to the turbidity

impairment. Planning is under way to correct this by re-sloping the ditch banks to 4:1 slopes. Making water discharge adjustments with the radial gates as gradual as possible will also lessen ditch bank erosion in downstream reaches. Another source of turbidity may be the eroding banks of Ditch 11 within Agassiz Pool, especially during drawdown. Dissolved oxygen and hydrogen sulfide issues may not be easily resolved with the inherent qualities of water leaving a large wetland complex. Possibilities for some type of riffle structures to be built into Ditch 11 during the re-sloping of the ditch banks are being investigated.

In early November, the radial gates must be closed before ice accumulates from spray on the side walls which prevents gate closure. The associated screw gate can be left open after freeze-up. If the screw gate is left wide open, the flow of water prevents the ice from getting thick at the structure and the gate can be lowered or closed in mid-winter. If the screw gate is only open a small amount (six inches), ice build up and freezing through the WCS wall can render the screw gate inoperable, even in early winter, which can result in complete draining of the pool over winter. When Thief Lake's early winter releases are more than the screw gate can keep up with (115 cfs), the excess can be stored in Agassiz Pool and allowed to drain out over the remainder of the winter. It can be mid-January before Thief Lake reaches its winter objective level and stops or greatly reduces their outflow. At this time the screw gate, if it has been wide open, can be adjusted based on calculations to have a slow release that will last until March to get the pool down to objective level. The screw gate will freeze in place at this lower setting but should not need and adjustment until spring runoff occurs. Calculations to determine the amount of stored water to be discharged over winter must keep in mind that the top half of the pool is frozen and not available. The water being discharged is off the bottom and normally discharging all of the water is not desirable. During winter 2005-06, Agassiz Pool had a 1.0' raise between freeze up and mid-January and then the screw gate was lowered from 3' open to 1.2' open for the remainder of the winter. We feared that the one foot raise in water level followed by a slow decrease may have had fatal effects on muskrats. Eleven muskrat houses in Agassiz Pool were opened in March and six were still being used (54%) compared to six out of eight (75%) in Parker Pool which had stable water levels. We do not know what the maximum raise could be without completely killing all of the rats, but loosing all the water due to a frozen open screw gate is also fatal. The Refuge Narrative in 1969 states that they had "managed muskrats onto the Agassiz endangered species list" after having fall drawdowns on all pools for the previous four years.

A new stoplog WCS on the west side of Agassiz Pool that will discharge into the Thief River channel (State Ditch 83) may help alleviate the late fall/winter discharge situation. The top stoplogs can be removed to allow for over winter flows without the threat of completely draining the pool. This new structure in conjunction with the screw gate, should be able to keep up with the early winter flows and then allow the screw gate to be closed completely for the remainder of the winter and the stop log structure left to flow. **By agreement with the Red Lake Watershed District (RLWD), the new WCS cannot be used when gauge reading at the County Road 7 Bridge on the Thief River is above 1137.0'.** This is to prevent increasing our outflow capabilities with the new WCS. This WCS should not be used under these conditions, even if the radial gates are at a

reduced opening to prevent the perception that we are increasing our outflow capabilities with the new WCS.

There is a long-standing disagreement with Marshall County over ownership of the Judicial Ditches on the Refuge. The County maintains that they own the ditches and the Refuge maintains that ownership of the ditches was given up in the condemnation and acquisition by the Federal government. The Refuge files on ditches have Solictiors Opinions on the matter that the Refuge bases it position on. The Refuge policy is that the Refuge pays for all ditch cleaning and maintenance activity on the ditches so that the County does not acquire a vested interest in them. When requests are made by landowners or by the County the Refuge will asses the need for the request and make a decision if the maintenance activity is necessary. If it is necessary, the Refuge either does the work force account or by hiring a contractor.

Flood Management

Floods are anticipated in the spring when the snow pack approaches four inches of moisture in late winter and little or no rainfall is received during this time period. When snow pack moisture content is between three and four inches a quick melting event is usually needed to create flooding problems. In excessive of four inches a very slow runoff is needed to avoid flood problems.

Summer flooding is harder to predict due to all the variables, such as how widespread the rain events are, when the last rains occurred and ground saturation and ground cover in agricultural fields. Flooding usually occurs when widespread rain events exceed two inches. Opening radial gates an additional two to three feet can accommodate two inch rains. Rains in the four inch category require gate opening of three to four feet to minimize bounce in Agassiz Pool.

Lowering pool levels (Agassiz, Farmes, and Parker Pools) in late winter in anticipation of a flood event has not worked. If the ditches are full of snow the water freezes and causes the ditches to be plugged. If there were flows during the entire winter then there is space under the channel ice and a small increase in outflow will work, but if the screw gates (Agassiz and Farmes Pools) are opened too far water flows out from under the pool ice in the old ditches within the pool and the ice collapses on the ditch banks preventing any additional water from leaving the pool and causing delays later. This can happen in as little as two days.

When spring thaw begins the screw gate is usually the first that can be opened. Following the screw gate, a gradual opening of the radial gates is needed until ice is out of the channel to keep from having ice jams down stream that can flood out homes. This can be done by opening one radial gate a half foot in morning and an additional half foot again in the afternoon for the first couple days that the gates can be opened. The new stop log structure between Agassiz Pool and the Thief River may be used to increase or establish flows earlier than the screw and radial gates but will need to be closed when the water levels exceed 1137.0' at the County Road 7 Bridge.

Farmes Pool screw gate can be used early to open the channel. The RLWD will request the stoplogs be placed into the Farmes Pool structure to 1141.0' when flooding becomes critical for downstream resources. The strategy is to delay closing late enough to still have storage when the peak flow occurs on the river downstream. The pool level should be lowered gradually when the RLWD gives approval for removing the stoplogs to prevent local flooding. What has worked is to remove the top stoplogs from one side of the 20-bay structure (10 logs) on the first day and then the top stoplogs from the other side (10 logs) of the structure on the next day. Evaluate the situation downstream to determine whether to wait a day before pulling 10 more stoplogs, followed by 10 more on the subsequent day. This is repeated until the stoplogs are at objective level and then the pool level is allowed to slowly recede the last 0.5 to 0.7 feet to objective level. The RLWD accepted the recommendations by Houston Engineering (Ron Adrian) on 24 August, 2006 for trigger points for placing the stoplogs into Farmes Pool under significant flood conditions and removing them when flood waters are receding. Based on the statements in the Engineers Report for construction of the impoundment that "on the average, flood control is expected to be required only one year out of five", the five-year flood elevation was taken from USGS published information for the spring flood and a new elevation calculated from the nearly 100-year data set for the summer flood (May through November) when crops are in the fields. Prior to this decision, "significant flooding" was always debated with a downstream neighbor. This objective trigger point will eliminate uncertainty by the RLWD officials over what is significant, even though the downstream landowners may not agree with the USGS' flood elevation data. The trigger points are listed in Table 8.

Table 5. Recommended Trigger Elevations, Farmes Pool Flood Storage.

Site #	Description	All Seasons Remove Stop Logs Flood Stage Elev. (ft msl)	Summer Install Stop Logs 5-year Summer Elev. (ft msl)	Spring Install Stop Logs 5-year Elev. (ft msl)
1*	First structure downstream of Farmes Pool Control, Beich Property Approach Sec 8/9 Agder Twsp.	1134.0	N/A	N/A
2	Second structure (Bridge) downstream of Farmes Pool Control, County Rd. 120 Sec 7/8 Agder Twsp.	1133.0	1137.4	1138.7
3	First Structure downstream of Farmes Pool Control on State Ditch 83 (CSAH 12) Sec 12/7 Excel/Agder Tswp.	1131.6	1136.0	1137.2

*A gauge does not exist at this site; Red Lake Watershed District has agreed to install one.

If the spring flood crest in Agassiz Pool has been reached prior to 10 April, outflow can be reduced for a couple days to let the channel drop at Co Rd 7 to 1136.5' to let the neighbors fields drain off. Then increase outflow by raising the radial gates about 0.2" per day to keep water level at 1137.0 to 1137. 3' at Co Rd 7 Bridge. Flap gates keep the private fields from re-flooding. If the peak runoff is after April 10 there isn't time to allow for several days of field drainage and outflows should be pressed to the 1137.0'+ mark at Co Rd 7 until within 0.5' of the objective level of Agassiz Pool and then begin ramping down outflows to match inflows for steady water levels. A late flood event may take until mid-June to reach objective level in Agassiz Pool depending on the rain events that follow.

Agassiz Pool's peak level was 1143.8', in spring of 1997. At this level water is flowing over dikes to Madsen, Parker, and Headquarters pools. During extreme spring floods when Agassiz Pool is going to exceed 1143.0' shut off outflows from all pools above Agassiz Pool during peak to store as much as possible above Agassiz Pool. Otherwise let some flow to Agassiz Pool to reach objective levels sooner on smaller pools, but don't accelerate their outflow into Agassiz Pool until after it crests.

When the radial gates are open more than a foot it is hard to know what the actual pool level is due to the sucking down effects of the radial gates. Recording gauge readings at

the Agassiz/Parker structure gauge will give a more accurate picture of what the pool is doing. At either gauge keep in mind the effects strong winds can have in stacking water up at the downwind side of this large pool.

When the radial gates are open more than a foot, the outflow should be gradually reduced as objective level in Agassiz Pool is approached. Sudden decreases in stream flow cause the ditch banks to slide/slough off and can leave fish trapped in oxbows and old stream channels where they are spawning. Ramping down the outflow needs to be started when the pool level is approximately 0.5' above objective level. Decreases in radial gate height can be done in one foot intervals at first. The city of Thief River Falls power plant managers need to be notified of major changes in outflow (>100 cfs; 218-681-3506 or 218-681-5816, ext. 100).

Moose River Impoundments (North and South) and Thief Lake try to minimize their outflows until Agassiz Pool reaches crest and starts to recede. RLWD and Thief Lake WMA personnel are constantly keeping in touch to find out how soon they can start or increase releases.

OBJECTIVE 2.8: Increasing Bur Oak/Savanna Habitat: Increase bur oak/savanna habitat by 50 acres in the OLMA by 2014 for the benefit of wildlife species, such as the whip-poor-will, black bear, and northern flicker (Figure 9).

Rationale: The whip-poor-will, northern flicker, and black bear are all species of management concern at Agassiz NWR and the former two are Regional Conservation Priority species as well. The increase in bur oak/savanna habitat will come primarily from elimination of aspens from stands of mixed deciduous forest.

Strategies:
1.) Utilize techniques previously described to eliminate aspens, especially selective girdling and later removal by firewood cutters.

Discussion: The existing oak woodlands on the Refuge are closest to the Northwestern Dry-Mesic Oak Woodland which had a catastrophic fire event frequency of about 100 years and a rotation of moderate surface fires of roughly 15 years (MNDNR 2005). Northern Mesic Savanna may have been another plant community found on the Refuge. Zager (2007) states that upland prairie species may not have been a significant component of the pre-settlement vegetation on Agassiz NWR. Bluejoint replaced the tall upland prairie grasses as evidenced by its abundance in the existing oak woodland and oak savanna vegetation and the complete lack of upland prairie indicator species. Zager advocates restoring the increasingly rare oak savanna and oak woodland types on the Refuge, but cautions against introducing upland prairie species as part of the restoration. Restoration requires decreasing the tree canopy to 25% to 50% by first removing the aspen and then thinning the oak if necessary.

All savannas quickly succeed to woodlands and forests in the absence of fire. Our savanna and oak woodlands are heavily infested by aspen due to long-term absence of hot

fires. Restoration requires removal of the mature aspen. Accomplishing this with prescribed crown fires is difficult to achieve and may also eliminate the mature oak. Removal of the aspen by first killing the trees by girdling minimizes the amount of re-sprouting. Requests for firewood cutting have been sufficient to keep up with the removal of the dead aspen on the small acreages (10-20 acres) that the Refuge staff and volunteers have been able to girdle. If additional manpower becomes available to girdle more acres per year, the recently killed aspen do have commercial value and a sale can be set up two years after girdling with private loggers or through Ainsworth Paper Mill in Bemidji (218-759-8054, Mike Snyder). A commercial operation would require a minimum of about 30 acres. The restoration will require several cycles of two- to three-year rotation of late May or summer burns to eliminate sprouting aspen. The workshop discussion group thought burns would be required every three to five years to keep aspen out and oak from becoming too dense.

Prescriptions and Site/Unit Identification:

The Dahl Woodlot (HMU 36A) is the only HMU in the maintenance category of the **Oak Savanna Prescription** at this time. Maintenance of these oak savannas and woodlands will require hot burns in May or summer on an approximate four- to five-year rotation.

Restoration efforts will be concentrated on Argiborolls soils such as Reiner fine sandy loams in the Maintenance Center (HMU 37), east half of Johns Field (HMU 42), and on the Garnes and Kittson Soils in Ditch 2 Upland (HMU 11). On these soils the aspen should be girdled in May (after aspen leaf out), allowed to die (2 years), and then be harvested. After the harvest the HMUs should be burned every two to three years for two or three cycles, depending on the results. First choice for these burns will be late May or summer. Second choice would be a dry fall. At least one of these burns must be under conditions for potentially crown killing young saplings. The late May burns will be when the aspen have leafed out and the oak have not leafed out.

OBJECTIVE 2.9: Mature Aspen Stands: Provide mature aspen stands for bald eagle, hooded merganser, and bufflehead nesting activity.

Rationale: Currently seven eagle nests are located in mature aspen or cottonwood on the Refuge. Hooded merganser and bufflehead are cavity nesters and during the past 15 years pairs/broods have increased, which coincides with aspen stands maturing beyond 70 years of age. Studies indicate that aspen need to reach > 25 cm dbh for bufflehead and >35 cm dbh for common goldeneye (*Bucephala clangula*) before cavities of sufficient size will develop (Evans 2002). Diameters >35 cm dbh typically occur in 70-year-old aspen.

Strategies:
1.) Develop a forest inventory through GIS and ground-truthing that identifies existing old growth aspen.
2.) Identify areas that will be managed as old growth aspen.

3.) Conduct prescribed burns in these areas under conditions that will not kill old growth aspen.
4.) Consult experts in aspen management to develop a schedule of management practices that will ensure that mature aspen will be available as old growth areas decline.

Discussion: Mature aspen areas add to the diversity of the Refuge habitats. The discussion group did not have experience with old age aspen management as it is not practiced in forest management settings. It was suggested to look into Ontario's forest management planning as they have promoted all-age forest management. Some of the workshop group suggestions included no cutting – let blow downs and fire create the regeneration, no burns or cool burns, and designate areas that have natural protection from fire as no cut areas.

The Ontario web site for the Ministry of Natural Resources discussed a mandated Forest Management Plan that has to be based on sustainability. The discussion and literature at the site reference mostly boreal forests. One of the references (Kayahara et al. 2004) reported on the Model Forest at Lake Abitibi. Some of the main points were that the length of time between major fire events was essential to determining the proportions of land base that should be managed for each cohort and that about 1/3 of the forest should be older than the fire cycle. Three harvest techniques used were selection cutting to mimic gap dynamics, clear cutting to mimic severe fire, and partial harvest to break up mature stands. Information on Ontario's Ministry of Natural Resource's web site suggests that "selective cutting to mimic gap dynamics in old growth forests" may be one of the cutting techniques employed to keep a replacement age class in the old growth forest, but specific guidelines were not found. Bergeron et al. (1999) reported that it takes 60 to 70 years for certain organisms to show up, such as lichens.

Cumming et al. (2000) had the most applicable information for old growth aspen. Their study looked at gap dynamics in boreal aspen stands in Alberta. They looked at actual data from old stands and developed a model to test the observations. The usual method of gap formation in stands less than 70 years old was adjacent consecutive tree mortality or self thinning. Canopy age structure becomes increasingly uneven in older stands, but becomes stable by stand age of 250 years. It is nearly stable however after 120 years. These old stands could be maintained indefinitely. Their data showed that gaps averaged 52 m^2 and start to form at a stand age of 36 years. The minimum gap size for regeneration was 2.7 trees. Their model came up with similar statistics with gap formation beginning at 40 years, gap size was 48 m^2, length of time for a replacement tree to reach maximum canopy height was 50 years, and the minimum gap size for regeneration was three canopy trees. The maximum life of the trees was 200 years. In a 40-year-old closed canopy of aspen Carlson and Groot (1997) found suckering to be 15 times higher in 60 m^2 openings than under the closed canopy. MNDNR (2005) estimated the stand replacement fire cycle to be about 90 to 100 years with moderate fires to be about a 15-year cycle in the northwestern aspen woodlands.

The Borosaprist soils on the Refuge have some of the largest, oldest aspen on the Refuge. These decomposed peat soils are mostly found around the peat soils that have stands of

black spruce/tamarack. Designating these areas for old growth aspen management meshes well with the cool or no fire in the conifer bog prescription. A low frequency of fire and cool burns that do not crown fire and kill mature trees could be used to keep browse plants in good condition and available for deer, moose, and hares. The oldest aspen stands on Agassiz NWR date back to the 1920s and 1930s. In 1992, large trees that were commercially harvested in Blue Grove south of the shop were approximately 70 years old. In 1960, the Land Use Plan stated there were about 404 acres of aspen and balsum poplar that was ready for pulp cutting and that it was 40 to 50 years old. The current age of these large sized aspen stands is now about 85 years. Blow downs and dead tops are increasing in these large sized aspen stands on the Refuge. Naturally occurring gaps occur in these stands and an uneven age structure has begun to develop. At Agassiz NWR the maximum age of aspen and the length of time for age structure stabilization may be less than that reported by Cummings et al. 2000 due to prescribed burning opening up fire scars that may increase disease and a higher occurrence of blow downs due to peat soils.

Old growth aspen management at Agassiz will be to not harvest or intentionally prescribe a stand replacement fire. Prescribed burning can be done with cool burns at approximately 10-year intervals to keep browse plants healthy and accessible to browsers. These cool burns will also contribute to creating gaps for tree replacement. In the future, if it is determined that a stand is not developing gaps or regeneration is not occurring, gaps could be created by felling three to six trees to create an opening of 50 to 60 m^2. The trees should be cut and left on site to contribute to the decaying biomass needed for some old growth organisms. If 250 years is the length of time it takes to become stable then this would average to be only about 0.4% of the area being opened up by gaps per year (250 x 0.4% = 100%). From a practical standpoint this could be 4.0% of the area treated every 10 years. But if the gaps are occurring naturally, artificial gaps would accelerate the replacement of trees much faster than what is needed and would decrease the age of the oldest cohorts in the uneven aged stand. **At this time it appears that adequate gap formation is occurring and artificial enhancement will not be necessary.** Another management option that can be debated in the future is to treat the old growth stands to a stand replacement clearcut on a 250-year rotation. There are seven HMUs (3, 6, 8,11,17,18, and north of the wilderness area in HMU 43) that have been designated for old growth where managers could decide to cut aspen. One of these HMUs could be clearcut every 35 years and then wait 250 years before that particular HMU is cut again. This decision can be discussed in the future after evaluating the development of the uneven aged stand for the next 35 years when the first stands will reach 120-years-old.

While most islands should be cleared of trees to improve the immediate area for nesting waterfowl, there are several islands that have shown a strong propensity to grow trees. Some of these islands have large cottonwood trees. These islands can be considered to be in old growth management. Bald eagles have shown a preference to nest in these old cottonwood trees as 2 of the 11 Bald Eagle nests on Agassiz NWR are in these rare cottonwood trees.

Prescription and Site/Unit Designation**:**

The HMUs in the **Old Growth** prescription are not solid stands of aspen, nor are they intended to be. The HMUs will always consist of a mosaic of woodland, shrubland, and grassland/sedge. This prescription characterizes how the woody vegetation in these units will be managed and should be favorable to deer, ruffed grouse, woodpeckers, tree cavity nesters, and black bears. The HMUs are 3, 6, 8, 11, 17, 18, 43, and 44. Burn the HMUs on a 10-year rotation with cool, spring burns that will not kill mature trees. No mowing of shrubs and trees is needed. Evaluate stands over time to see if gap cutting or clearcutting is necessary or desirable. If deemed appropriate, the gap cutting guidelines discussed above can be used. In unit 43 south of the Wilderness Area boundary and in unit 44 no cutting will take place in compliance with Wilderness Area regulations.

Islands designated for old growth management are marked on the Habitat Management Prescription Map (Figure 11). Three to six cottonwood saplings should be planted on each of these islands with the aid of tree shelters to increase the chances of a few cottonwoods being replaced. If the islands are burned after the planting of cottonwoods, the saplings will need vegetation removed around them to provide protection from the fire.

Makstadd Grove, the Office Complex Grove, and the Shop Complex Grove are also designated as **Old Growth** management sites for wind protection, aesthetics, and environmental education opportunities. The north side of Webster Creek in HMU 6 and along the Parker Pool spillway outlet channel is also designated **Old Growth** to add riparian diversity.

OBJECTIVE 2.10: Cropland Phase-out: In 2005, begin phasing out all cropland by converting to grassland and shrub to benefit species such as the bobolink, Nelson's sharp-tailed sparrow, marbled godwit, and Le Conte's sparrow.

Rationale: This phase-out will take place over the life of the CCP (10-15 years). It has already begun, and will continue at a similar rate (175 acres since 1997). There are now 170 acres of cropland left. Croplands are generally being phased-out at most Refuges in accordance with the Service's Ecological Integrity Policy, which emphasizes native vegetation and natural processes.

Strategies:
1.) Fields are prepared for seeding and planting through a combination of disking, herbicides, and prescribed fire. It may be necessary for repeated treatments.
2.) Conduct annual monitoring to ensure that weedy species and non-native plants do not become problematic.
3.) Use GIS spatial analyses every 5-10 years to keep track of long-term changes.

Discussion: In 1960 there were 860 acres in crop, of which about 66% were put in by cooperative farmers and the remaining by Refuge employees. The farmed areas on the Refuge have been drained for agricultural purposes and have a drier hydrologic regime

than what occurred naturally as a Northern Wet Meadow/Carr or Northern Wet Prairie. This drier condition may make them suitable for establishing Northern Mesic Prairie which occurs in nearby areas and for which seed is readily available, as some native prairie seed harvest in northwest Minnesota is mesic prairie. Seed mixes could be enhanced with prairie cordgrass and bluejoint, which would add wet meadow components that may establish in the wetter areas and spread over time as ditches fill in and the fields become wetter.

Prescriptions and Site/HMU Identification:

Crop rotations will continue with winter wheat, oats or barley, and sunflowers or corn. Annual work planning over the next 15 years will select portions of the existing farm fields to plant wet prairie/mesic prairie seed mixes. Currently the preferred sequence is to keep the field black for one season, broadcast seed in the fall or winter and if possible spray Roundup twice on green growth the second year, then pack the soil. Results will be evaluated and modifications made as necessary. The HMUs involved are the Rodahl Fields in HMU 38, Johns Fields in HMU 41A, South Dahl Fields in HMU 35, North Dahl Fields in HMU 33, Golden Valley Fields in HMU 25, Goose Pen Fields in HMU 26 and East 80 Fields in HMU 27.

OBJECTIVE 2.11: Coniferous Bog: Maintain 2,380 acres (3.9% of the Refuge) in coniferous bog for the benefit of such species as the olive-sided flycatcher, Connecticut warbler, orchids, and ferns.

Rationale: This acreage is mostly within the designated Wilderness Area of Agassiz NWR, although about 10-15 percent is also located in three other locations. Both the olive-sided flycatcher and the Connecticut warbler depend on these types of habitat for breeding and migration stop-over sites and are Regional Conservation Priority species. Carnivorous pitcher plants and sundews also occur within the coniferous bog. No active vegetation management is conducted within the Agassiz NWR Wilderness Area, though recent mortality of black spruce and tamaracks along its western edge have been attributed to high water levels in Thief Bay Pool (Johnson 2006).

Strategies:
1.) Depending on results of research on tree mortality, it may be necessary to lower water in one or more pools and/or remove portions of the road/ditches that bisect the area into a north and south section.
2.) Complete a plant inventory and determine fire history in black spruce/tamarack bog habitat by 2006.

Discussion: The workshop participants felt there was no need for active management in the conifer swamps on the Refuge. Johnson (2006) recommended that sustained water levels be 30 cm below the peat surface along the edge of the conifer swamp. This is equal to 1143.7' msl in Thief Bay Pool. Johnson did not find evidence of fire in the younger-aged V-shaped area in the North Wilderness Area. MNDNR (2005) lists the historic catastrophic fire rotation in the Northern Poor Conifer Swamp to be about 570

years with moderate surface fires and windthrow at about 90 years. The Land Use Plan of 1960 stated the age of the black spruce stands was 90 to 100 years old with only about 22 acres of reproduction. The tamarack was estimated at 60 to 70 years old with about 1,667 cords of wood available and no reproduction listed. The Land Use Plan stated that the black spruce was of poor quality and that both species were growing on poor peat sites.

R. Johnson (pers. commun.) has raised concerns over invasive plants that are gaining foothold on the dike and ditches that dissect the Wilderness Area. Reed canarygrass, common reed, and Canada thistle are the main species of concern.

Prescriptions and Site/HMU Identification:

Conifer swamps are located within HMUs 3, 6, 18, 43, and 44. These HMUs are in Old Growth Prescription and will not be subjected to any harvesting or mowing. The stands in HMUs 3, 6, and 18 will be subjected to the cool, spring burn treatment on a 10-year cycle in conjunction with the old growth aspen management for that HMU. All HMUs have had prescription burns in the past with only a few trees near the edge of the stand occasionally being killed by fire. HMU 43 and most of HMU 44 are in the designated Wilderness Area and no cutting or mowing will be done in these units. Prescribed burns could be considered in HMUs 43 and 44 on a 50+ year interval.

Thief Bay Spillway will be lowered from the present level of 1144.5' to 1,143.7' msl to prevent sustained water levels from affecting the conifer swamp on the west side of the Wilderness Area.

Herbicide application should be considered a priority for invasive plant control on the dike that splits the Wilderness Area.

OBJECTIVE 2.12: Conservation Easements: Annually, inspect or manage at least 2,000 acres of the 7,000 acres of Conservation Easements in the RMD to improve conservation of natural resources and increase wildlife benefits. Presently, all conservation easement acres in the RMD are of the FmHA type.

Rationale: Management options on private lands in the RMD are limited by the terms of each individual conservation easement. Staff workloads currently limit the amount of contact, inspections, and management the Refuge can conduct on the easements in the RMD. Changes in federal and state farm programs and the expiration of CRP contracts will increase the importance of the habitat conserved by RMD conservation easements.

Strategies:
1.) Fill the Refuge Operations Specialist GS-485-9-WRS position at Agassiz NWR to meet the potential for management and cooperative agreements on private lands in the RMD.
2.) Restore hydrology and naturally occurring habitat that can reasonably be maintained.

3.) Set up wildlife inventories and habitat monitoring procedures (e.g., aerial photos, photo stations, ground inspections) for the conservation easements that can be conducted on a rotating five-year basis. A variety of habitats are represented on easement lands and procedures will need to be tailored to each property.
4.) Inspect at least 2,000 acres annually for trespass and compliance with the terms of the easements. Inspections will include aerial reconnaissance and ground visits.

Discussion: Plan and conduct management activities such as prescribed burns, mowing, haying, grazing, tree cutting, and chemical applications to maintain hydrology and desired habitat on at least 1,000 acres annually.

A workshop was held on August 31, 2006 to discuss implementation of these strategies and identify other possibilities. Aerial inspections are the only current management and should continue as the first priority. Without filling the GS-485-9-WRS position little else will be accomplished, as manpower shortages on the Refuge leave little time for private land-related work. The workshop identified the need to provide the local MNDNR managers with legal descriptions and maps of the easements. This would allow them to do casual inspection and incorporate the easement areas into their management efforts. The lowest priority for the easements is setting up wildlife and/or habitat monitoring procedures. The MNDNR may be able to incorporate some monitoring into their routines.

OBJECTIVE 2.13: Off-Refuge Corridor Habitat: Continue to restore corridor habitat off-Refuge through the Partners for Fish and Wildlife program with priority given to riparian habitats and to increase grassland block sizes within the seven-county RMD.

Rationale: As a result of extensive efforts over the last five years to restore thousands of acres of wetlands on hundreds of private parcels within the RMD through CRP and other programs, Refuge staff and the Service have built good relations with private landowners and cooperating agencies. These relationships can be drawn upon to extend these efforts to develop wildlife corridors off the Refuge, as well as improve water quality and reduce sedimentation on and off the Refuge.

Strategies:
1.) Consult with partners and cooperating agencies like MNDNR, Local Tribes, NRCS, Ducks Unlimited, Minnesota Waterfowl Association, Legislative Council on Minnesota Resources, Watershed Districts, and The Nature Conservancy to find the best opportunities for developing wildlife corridors on private lands in the RMD.
2.) Consult with Watershed Districts on watershed projects.
3.) Utilize existing state and federal programs like CRP enrollment and Legislative Council on Minnesota Resources Corridor Program to find and link together potential corridor lands.
4.) Take advantage of remote sensing, aerial photography, GIS, and gap analysis to explore the landscape within RMD for the most feasible, productive corridor opportunities.

5.) Work with willing sellers interested in federal easements/ownership within designated corridors, large grassland blocks, or flood-prone areas adjacent to the Refuge.
6.) Build positive relationships with County Boards for acceptance of federal easements/ownership from willing sellers within designated corridors, large grassland blocks, or flood-prone areas adjacent to the Refuge.
7.) Increase the budget for management of new acquisition/easements

An August 2006 workshop at Agassiz NWR discussed ways to improve relationships to gain acceptance of federal easements/ownership. It was suggested that providing a better image of the Refuge (e.g., weed control, some cropped acres for visible wildlife) and offering term easements instead of perpetual easements would help gain acceptance. Education of commissioners and citizens on the in-lieu of tax payments, flood control, and ecotourism needs to take place. The Refuge should approach the commissioners for a first project as a "demonstration". The area immediately downstream of the Refuge was identified as a priority area for some sort of floodwater easements with the Watershed District or for expanding the Refuge.

B. Habitat Management Unit Descriptions and Prescriptions

The HMU prescription designation is shown in Figure 11. The treatment cycles are summarized in Tables 1, 2, 3, and 4. The HMUs are described, history documented, and prescription application formulated in the narratives that follow.

Figure 121. Prescriptions for Habitat Management Units.

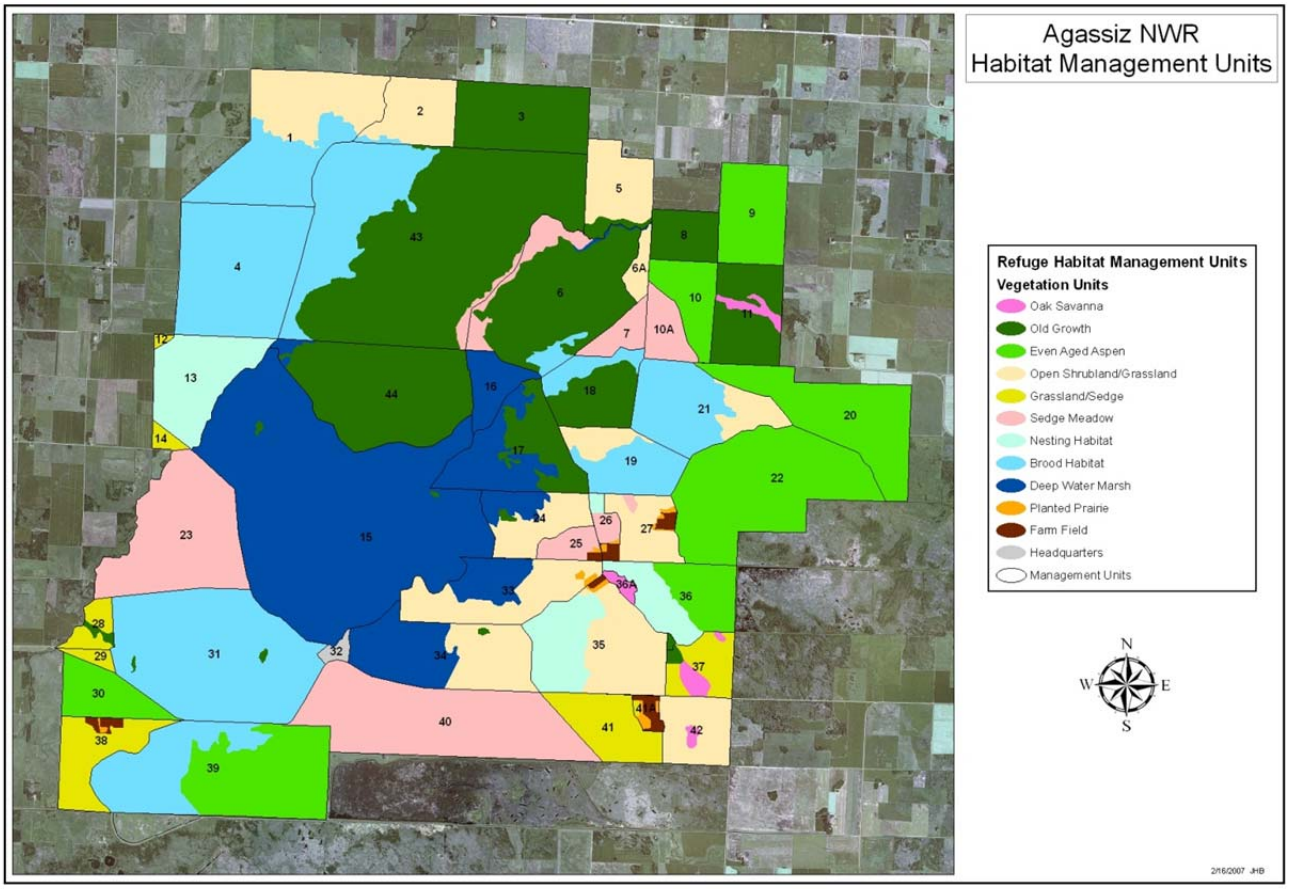


Table 6. Drawdown Schedule Under New Prescription.

POOL	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Agassiz Pool (15)				X								
Dahl (36)	X				X				X			
East (35)		X				X				X		
East 80 (27)		X		X		X		X		X		
Farmes (39)	X					X					X	
Golden Valley (25)	X		X		X		X		X		X	
Goose Pen (26)		X		X		X		X		X		X
Headquarters (34)							X					
Kelly (10A)	X	X	X	X	X	?	?	?	X	X	X	X
Lower CCC (19)				X					X			
Madsen (23)	X	X		X		X		X		X		X
Middle CCC (18)			X					X				
Mud River (6)		X					X					X
Northwest (4)			X					X				
Parker (31)		X					X					X
Pool 8 (13)	X				X				X			
Pool 21 (21)	X					X					X	
South (40)	X		X		X		X		X		X	
Tamarac (1)	X					X					X	
Thief Bay (43)					X					X		
Upper CCC (18)					X					X		
Upper Mud (7)	X	X	X	X	X	?	?	?	X	?	?	?
Webster (6)		X	X	X	X	X	?	?	?	?	X	?

Table 7. Burn Schedule Under New Prescription.

HMU	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Tamarac (1)	su/f					su/f					su/f	
West Berg (2)					su/f					su/f		
East Berg (3)								sp				
Northwest (4)			su/f					su/f				
Webster Lake (5)				su					su			
Mud River (6)							sp					
Webster (6)												
Kilen's Corral (6A)		s/f										su/f
Upper Mud (7)	su		su		su		su		su		su	
Webster Creek Upland (8)		sp										sp
Ditch 1 Uplands (9)	sp					sp					sp	
Kelly (10)					sp					sp		
Kelly Pool (10A)	su/f		su		sp		su		su	sp		su
Ditch 2 Uplands (11)							sp					
Pool 8 Triangle (12)	sp	sp	sp	sp	sp							
Pool 8 (13)					f *or…*	sp			f *or...*	sp		
Davidson Triangle (14)	f	f	f	f	f							
Agassiz Pool (15)										su/f		
Agassiz NE Uplands (16)				su/f						su/f		
Tower Road Uplands (17)			sp									
Middle CCC (18)								sp				
Upper CCC (18)												
Lower CCC (19)				su		sp			su/f			
N. Hinterlands (20)				sp					sp			
Pool 21 (21)		su				f					su	
S. Hinterlands (22)			sp					sp				
Madsen (23)	su			su		su		su		su		su
Johnson Island (24)				f					su			

Golden Valley (25) Goose Pen (26)	su	su	su	su	su	su	su	su	su su	su	su	su
East 80 (27)		su				su				su		
Parker West (28)	su		su		su				su			
Nelson Triangle (29)		su		su		su				su		
Rodahl Triangle (30)						sp					su	
Parker (31)		su					su					su
Office Area Woods (32)					f (10 yr. freq.)							
Moose Pasture (33)				su					f			
Headquarters (34)			f				f					
East (35)		f (if mow)				f				f		
Dahl (36)		sp				sp (36A late May)				sp		
Maintenence Center (37)	su	sw corner - su	sw corner - su	sw corner - su	su				su			
Silo (38)				su				su/f			su/f	
Farmes (39)	f					f					f	
South (40)	su (west side f)		su		su		su		su		su	
John's Field (41)		su		su		su		su				su
CHZ (42)					sp/su if spray			f				su
Thief Bay (43)												

SP = spring burn
SU = summer burn
F = fall burn

Table 3. Willow Mowing Schedule Under New Prescription.

HMU	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Tamarac (1)			X	X				X	X	
West Berg (2)	X	X								
Webster Lake (5)		X					X			
Kilen's Corral (6A)				X						X
Lower CCC (19)	X	X				X				
Pool 21 (21)								X		
P21 Uplands (21)			X							
Johnson Island (24)		X					X			
East 80 (27)			X				X			
Parker West (28)			X							
Nelson Triangle (29)				X						
Moose Pasture (33)		X					X			
Headquarters (34)				X						
East Pool (35)		X	X				X	X		
Maintenance Ctr. (East Side) (37)			X			X				
Silo (38)		X				X				X
CHZ (42)			X							

Table 4. Aspen Cut Schedule Under New Prescription.

HMU	2007/08	2008/09	2009/10	2013/14	2019/20	2025/26	2031/32	2037/38	2043/44
Kelly Pool Uplands (10)							Com.		
Hinterlands N. (20, + any commercial in HMU 21)	Com. clear cut								
Hinterlands S. (22)						Com.			
Nelson Triangle (29)	Firewood cutters	Hydroaxe or Com. w/ HMU 38							
Rodahl Triangle (30)					Com.				
East Pool (35)	Hydroaxe								
Dahl Pool (36)									Com.
Maintenance Center (37; SE corner)	Com.								
Silo (38)		Com.?							
Farmes Pool (39)								Com.	
CHZ (42)			Com.						
Webster Lake (5)		Firewood cutters		Com.					
Ditch 1 Uplands (9)				Com.					

Com. = Commercial logging

Plan the drawdowns and the burns and take your best shot at them. Mother Nature will have the last word on how they turn out. No matter how they turn out some critters will benefit and some critters will not. The management units on Agassiz are numerous and large enough that overall, diversity will be enhanced and the program successful as long as the long-term trend is pushed in the desired direction.

Tamarack Pool (HMU 1)

Size: 2,225 acres

Elevations:

	Pool elevation	Surface acres	Acre-feet
normal summer:	1,143.5'	1,360	1,980
spillway:	1,143.9'	1,450	3,140
drawdown:	1,139.7'		

Depth at 1,144.0': over 10% >4.5 ft.; over 75% <3.5 ft.

Control structures: outlets 2, inlets 0
Spillways: outlets 2, inlets 1
First year operation: 1955

Physiography:

Cattail is the dominant emergent throughout. Sedges occur near pool perimeter and around numerous scattered hummocks. Submergents and associated invertebrates are relatively abundant and diverse in this pool. Interspersion of open water and emergents is high in the south half but decreases to the north. A large expanse of open water dominates the eastern one-third of the pool.

The uplands in the northern portion of the HMU consist of a large circular area of Borasaprist soils. This area may have been a bog prior to altered hydrology but now is sedge and willows. The remaining area is loamy muck soils that also give rise to sedge and willows and very few aspen clones.

Water movement:

Principle water supply is runoff from Branch B of County Ditch 35 that enters the Refuge through four culverts through the north boundary road. There are two outlet WCSs. A single bay screw gate in the southwest corner outlets to County Ditch 35. A three bay stoplog WCS on Tamarack Trail outlets to Northwest Pool. There are two outlet spillways from Tamarack Pool into Northwest Pool. There is one inlet spillway from the Thief River into Tamarack Pool that pushes water into Tamarack during flood stage on the River.

Estimated time to dewater the pool is two weeks.

Complete dewatering is usually through the Ditch 35 structure or through Northwest Pool when it is less than 1,139.5'.

Drawdown history:

The pool was dewatered in 1961 and was dry except for a few potholes most of the summer. The 1966 drawdown began June 20 and was nearly complete by 1 September. Pool was recharged in the spring of 1967. Submergent vegetation showed a marked increase in 1967.

A summer drawdown was attempted in 1991, but due to spring rains and inadequate water control, the drawdown was only partially successful.

A complete drawdown was initiated in April 2001. Mudflats were exposed in July and September, which resulted in excellent shorebird use. The pool remained in drawdown in 2002.

Burn history:

Year	Area	Acres Burned	Time of Year	Type
1980	Entire	905	Spring	P
1984	Entire	1,200	Spring	P
1989	South	18	Fall	P
1993	Entire	1,434	Spring	P
1996	North	0.3	Spring	Wild
1997	North	128	Fall	Wild
1998	North	15	Spring	Wild
1998	South	95	Spring	Wild
1999	North	15	Fall	Wild
2003	Entire	2,000	Spring	P

The prescribed burns in 1993 and 2003 were both hot and killed trees along the north boundary. The wildfires were all cool, creeping burns set by arsonists.

Wildlife:

This pool has a long history of being one of the most productive diving duck pools in the Refuge. When water levels are near spillway elevation, vast emergent areas are inundated in one to two feet of water, the range preferred by most diving ducks, especially canvasbacks, redheads, and ringed-necked ducks. Brood use on Tamarack Pool also ranks among the highest on the Refuge. The study by Huschle (2000) determined the optimum water level for diver broods to be 1,143.1'.

In the 1970s and 1980s, several thousand lesser scaup annually concentrated in the eastern one-third of the pool in the large open bays during fall migration, presumably in response to abundant amphipods and other invertebrates. During the 1990s, Thief Bay received more use by diving ducks and Tamarack was used more by dabbling ducks. This pool's water level is usually lowered to about 1,143.0 in August to make the area attractive for mallards near the banding site and provide more area for the rocket nets. This is usually the best banding site, with occasional catches exceeding 500 birds.

Facility improvements:

Year	Project	Location
2003	new gauge	+0.2' correction
2001	screw gate repair	Ditch 35
1999	dike-core work	Part of dike between Pool and Thief River
1998	dike-core work	Part of dike between Pool and Thief River
1988	dike-core work	7,000 feet along west embankment of Thief River
1986	Install 3-36" CMP	Tamarack Trail
	Install 100' metal SP	Tamarack Trail
1980	Clean .5 mi. ditch	Ditch 35, Branch B
1979	Install 4-36" culverts	North boundary Rd., D-35, Br. B

CMP = Corrugated Metal Pipe, SP = Spillway

Needs, restrictions, and objectives:

Refuge neighbors have complained in the past that water released into County Ditch 35 from Tamarack Pool aggravates flood conditions on private farm land, particularly during spring runoff. The 1986 addition of a WCS between Tamarack and Northwest Pools provides an alternative to move water from Tamarack Pool to Northwest Pool, rather than releasing off-Refuge to Ditch 35. Although the Refuge has legal authority to use County Ditch 35, water normally will be discharged into Northwest Pool. The Ditch 35 WCS will be used to complete Tamarack drawdowns or to avoid putting water into Northwest Pool when it is in drawdown, but only when the addition of water to Ditch 35 will not aggravate flood conditions on adjacent privately owned land all the way south to Ditch 83.

The pool was in drawdown in 2001 and 2002. Water level in 2003 was 1,142.1' and allowed cattail encroachment in many areas in the west half. Elevation 1,143.2' in 2004 was not sufficient to reverse the trend. In 2005 the pool objective level was at 1,143.7' and the pool was at this or higher during most of the season and the trend for increasing cattail was reversed.

The present vegetative conditions appear optimal for diving duck nesting and brood rearing. Maintaining the open water to emergent vegetation interspersion is key to this pool.

Prescription:

Tamarack Pool is in the **Brood Habitat** prescription. The drawdown and summer burns will be on a five-year rotation. The upland areas of the unit are in the Shrubland/Open Grassland prescription, so the entire HMU will be burned at the same time in the late summer or fall. Mowing of willows can take place two years ahead of the planned burns.

The pool will be in drawdown in 2007. A summer burn is planned with fall burn as backup. In 2008 the water level should be returned to 1,142.5' followed by two years at 1143.7', and then 1,143.1'. Late August elevations can be lowered to 1,143.0' for banding operations.

Mowing of decadent willows and willows in sedge areas should be done in the winters of 2009-10 and 2010-11 in preparation for the next drawdown and burn in 2012.

West Berg (HMU 2)

Size: 743 acres

Physiography:

The HMU is bordered by the Thief River (State Ditch 83) on the west, the North Boundary Road on the north, grass ditch spoil on the east, and Branch 4 State Ditch 83 on the south. The HMU contains the north reaches of Thief Bay Pool in the southwest corner. Vegetation is cattail in the southwest and grades into mostly sedge and willows through the center of the unit on a depressional muck soil. The north quarter of the HMU is grassland. Black willow trees line the Thief River.

Burn history:

Year	Acres Burned	Time of Year	Type
1960	UNK	Spring	P
1972	UNK	Fall	P
1981	650	Spring	P
1993	1	Spring	P
1993	620	Spring	P
2000	400	Spring	P
2004	UNK		Firebreak

2005	UNK	Spring	Wild
2005	17.3		Firebreak

Wildlife:

The area usually has deer present during the winter inventory as they move frequently on and off Refuge to feed in privately owned agricultural fields. The grasslands have a history of use by sharp-tailed grouse with a dancing ground present in the 1980s. Geese make use of the grassy spoil banks along the perimeter of the unit and heavy use of the River. Gosling depredation to adjoining privately owned fields is an increasing problem.

Needs, restrictions, and objectives:

The HMU is well suited to be managed for open shrubland and grassland habitat to provide nesting opportunity for dabbling ducks, geese, and grassland birds. Shrubs need to be in young, palatable condition and of sufficient quantity to provide browse and cover for deer and moose.

Burning plans need to consider the close proximity of residences. The firebreak on the south side of the unit is hard to maintain and defend.

Prescription:

HMU 2 will be burned on a five-year cycle in the drawdown years of Thief Bay Pool. This HMU should be burned in the summer at least every other time to keep shrubs from invading the sedge meadows and grasslands. Mowing of willows and trees should occur two years ahead of the burn year. The next burn year is 2011.

This HMU contains part of Thief Bay Pool which is in the **Brood Habitat** prescription. The drawdown cycle will be five years and follow the Agassiz Pool drawdown, so the next drawdown is in 2011. In 2007 the pool elevation will be 1,143.5' since it was at a low water level during 2006.

East Berg (HMU 3)

Size: 1,264 acres

Physiography:

The HMU is bordered on the north by the graveled north boundary road, on the west and south by ditches, and on the east by private farmland and a grassy access trail. A large portion of the center of this HMU is a Borosaprist peat bog soil that is an open bog. The center of this area is occupied by a black spruce/tamarack forest. The surrounding soil is

a decomposing peat that readily grows aspen. The fringe areas are various muck and loam soils with mostly sedge and willow components.

Burn history:

Year	Acres Burned	Time of Year	Type
1959	UNK	Spring	P
1972	UNK	Fall	P
1984	1,010	Spring	P
1987	1,100	Spring	P
1997	8	Summer	Wild
2004	1,282	Spring	P
2004	192	Spring	P
2005	22		Firebreak

Wildlife:

Beaver activity has flooded a large area along the east edge. A riprap spillway in the southeast corner of the HMU was established to help regulate the water level in this area. Deer make extensive use of the area's cover for on- and off-Refuge movements to feed in adjacent fields.

Needs, restrictions, and objectives:

The HMU is well suited for the **Old Growth** management prescription. The bog component is surrounded by the Cathro soils that have proven to be a good site for aspen. The HMU is easily burned because of the good firebreaks, but fire doesn't carry well due to the extra water in the east portion and the bog in the middle. Occasional fire will be desirable to keep the browse accessible and palatable for deer using the area.

Prescription:

The HMU is in the **Old Growth** prescription with a 10-year burn cycle. Burns will be conducted in the spring to minimize trees killed. No cutting of trees or mowing is necessary in the HMU. Trees along the edge may need to be manicured for trail maintenance. The next burn is scheduled for 2014.

Northwest Pool (HMU 4)

Size: 2,242 acres

Elevations:

	Pool elevation	Surface acres	Acre-feet
normal summer:	1,141.2'	1,811	2,657
spillway:	1,141.5'	1,865	2,997
drawdown:	1,139.0'		

Depth at 1141.5': over 5% >4.5 ft; over 90% <2 ft.

Control structures: 2 outlets, 1 inlet
Spillways: 1 outlet, 2 inlets
First year operation: 1953

Physiography:

The consistent high water of the 1990s has created a desirable mosaic of emergent vegetation and open water through out most of the pool. Cattail is the dominant emergent. Uplands containing shrubs and trees are intermixed through out the impoundment. Sedges and common reed ring these uplands and are replaced by cattails in deeper areas. The north-central portion of the pool is the largest block of solid vegetation and consists primarily of common reed and cattail.

There is one large open bay along Northwest Trail in the middle of the south half of the pool. The old Thief River channel meanders north and south through the length of the pool in the east half and connects with three large open bays, one in the southeast quarter, one in the northeast corner adjacent to Tamarack Trail, and one in the middle. Peat fire in the fall/winter of 1989 increased the interspersion of open water and emergents in the northwest corner of the pool.

Water movement:

The only water supply is from Tamarack Pool. Prior to construction of the three-bay WCS in Tamarack Trail in 1986, this pool had no inlet and was dependent on precipitation for recharge. There are two spillways from Tamarack Pool into Northwest Pool. The spillway and WCS in Northwest Trail outlets to Pool 8. The WCS in the southwest corner outlets to State Ditch 35 and is used only during drawdown or emergencies and then only if flooding is not occurring in farm fields adjacent to the Refuge all the way south to the Thief River.

The estimated time to dewater is three to four weeks.

Dewatering is possible through Ditch 35 and/or when Pool 8 is at or below 1,139.0'. There have been times when water is being discharged at slow rates and no inflow from Tamarack Pool is occurring that the pool level seems to be sustained by spring or

underground inflows. The source of this water is unknown but it maybe from the adjoining Thief River channel.

During flood events, when we are trying to store water to alleviate downstream flooding, Agassiz Pool will spill water into Pool 8. When this happens Pool 8 will fill up and back water into Northwest Pool so that Northwest Pool provides additional flood storage.

Drawdown history:

This pool was in drawdown from 1949 to 1952, then re-flooded in the spring of 1954. goosefoot. coverage was excellent. Cattail became permanently established over 50% of the former open water area.

In 1961, the pool was dry, except for potholes, most of the summer. Cattail established during the 1950-52 drawdown was aerially sprayed with Amitrol T resulting in a permanent kill that persisted through the mid 1980s. During the drawdown in 1986 and 1987 disking was attempted with little success, as the soil was still too wet. Some winter disking with a Caterpillar was also completed. The southwest portion of the pool was disked in the fall of 1987 and the winter of 1988. In addition, approximately 30 small (0.01 ac) breeding ponds were created with the D-6 dozer within the disked areas.

The pool was also in drawdown in 2003. Water seeps through the marsh at a very slow rate and the north and east sides of the pool did not go dry.

Burn history:

Year	Acres Burned	Time of Year	Type
1961	UNK	Fall	P
1963	UNK	Spring	P
1963	UNK	Fall	P
1966	UNK	Fall	P
1970	UNK	Fall	P
1972	UNK	Fall	P
1974	UNK	Fall	P
1981	976	Spring	P
1986	600	Fall	P
1986	1,200	Fall	P
1989	2,200	Fall	P
1998	400	Spring	P
2003	1,800	Fall	P

In 1989, the pool was prescribed burned in October and the resulting peat burn lasted until January, when the peat fires were put out with the D-6 dozer.

Wildlife:

Nesting conditions for diving ducks are best when water level is near spillway elevation making the interspersion of open water available throughout most of the pool. The large bay along Northwest Trail is used heavily by waterfowl during migration.

The peat burnout areas in the northwest corner of the pool are often used in the fall by staging waterfowl using the banding site or feeding in fields off-Refuge. It is also a favorite roost site for sandhill cranes that feed in fields west of the Refuge.

Facility improvements:

Year	Project	Location
2003	gauge replaced	no change
2002	Outlet structure repaired	Ditch 35, needs more work, done in 2003
1987	RODEO treatment	SW part
1986	(see Tamarack)	
1983	Install 24" CMP	Northwest Trail
1982	Replace 24" CMP with 21" CMP	West boundary

Needs, restrictions, and objectives:

Although the Refuge has legal authority to use State Ditch 35, water normally will be discharged into Pool 8. The State Ditch 35 WCS will be used to complete Northwest Pool drawdowns or to avoid putting water into Pool 8 when it is in drawdown, but only when the addition of water to State Ditch 35 will not aggravate flood conditions on privately owned land.

At the present, dredge spoil along the old Thief River channel and the lack of a ditch along Thief River Road prevents water in the east one-half of the HMU from being drained during drawdown. This could be remedied by digging a short connecting ditch from the southeast end of the river channel south to the east-west ditch along Northwest Trail.

Elevation of the southern end of the east dike (Thief River Road) needs to be increased to keep the Thief River from overflowing into Northwest Pool during high runoff events. Since this pool does not have direct inflows it can be managed at spillway level which has created the hemi-marsh interspersion of emergent vegetation and open water. This interspersion probably reached the full extent of what high pool levels are capable of producing in the late 1990s when approximately 50% of what was cattail in 1992 had reverted to open water.

The old Master Plan called for a cross dike that would subdivide the pool into north and south units to improve management capabilities. This dike is not recommended in the current planning effort, as it would decrease wetland diversity and decrease sedge areas in the northwest portion of the HMu.

Prescriptions:

Northwest Pool is in the **Brood Habitat** prescription. It will be in a five-year cycle of drawdown, with a summer or fall burn during the year of drawdown. Water level the year after drawdown can be an intermediate level to allow dabbling ducks to take advantage of any flooded annuals and ephemeral emergents, such as softstem bulrush. However, the following two years should return to spillway level to stop any new cattail from becoming established. Water levels 0.5' to 1.0' below spillway level should be acceptable the year before drawdown if the previous two years have been high and maintained the openings.

The dry conditions in 2006 resulted in low water levels after mid summer. The objective level in 2007 will be 1,141.5'. The next drawdown will be in 2009.

If herbicide applied with a wick applicator proves to be an effective way to control common reed and have it replaced by sedge, this technique could be used in the north-central and the west-central areas of the HMU.

Webster Lake (HMU 5)

Size: 786 acres

Physiography:

The east boundary of this HMU is the graveled township road, the south side is a prepared firebreak that follows the north side of Webster Creek, the west side a mowed firebreak, and the north side borders private fields. The HMU is difficult to burn due to the amount of mowed firebreaks with heavy fuels on either side. The majority of the HMU is a ponded mucky peat that is a sedge willow community. The east edge of the HMU consists of loams and mucky loams that are a mix of sedges, willows, and grass. There are some small aspen patches along the east side that occur on mollisol loams. There are trees along much of the south border of the HMU along Webster Creek. The HMU contains a small shallow lake called Webster Lake.

Burn history:

Year	Acres Burned	Time of Year	Type
1973	UNK	Spring	P

1985	326	Spring	P
1988	670	Spring	P
2000	700	Spring	P
2006	828	Spring	P

Wildlife:

This HMU borders privately owned agricultural fields and has a lot of on- and off-Refuge use by deer.

Needs, restrictions, and objectives:

The HMU has mowed firebreaks on the south and west sides that take a lot of time to prepare and black line during prescribed burning. The HMU has been successfully burned twice in the past six years. All of the past burns have been in the spring and willow encroachment and aspen clone expansion is a problem. Invasion by common reed is also a problem that summer burns may reverse.

This area is in the **Open Shrubland/Grassland** prescription. The trees along the east edge of the HMU need to be removed. Trees along the south side in will be kept as part of the riparian zone along Webster Creek. The firebreak can be used as the line of demarcation that trees on the south side (in HMU 6) are spared and those on the north side are subject to being cut.

Prescription:

HMU 5 is in the **Open Shrubland/Grassland** prescription. Burning should continue on a five-year rotation, with summer or fall burns. At least one of the next two burns should be a summer burn. The next burn is the summer of 2010 (four years from last burn to coordinate with HMUs 2 and 9). Mowing of the willows and young aspen should be done two years prior to burning, in 2008-09 and in 2013-14. Trees along the east edge of the HMU should be harvested. These could be taken by firewood cutters in 2008-09 or in conjunction with the commercial harvest of HMU 9 in 2013-14. The HMU will be burned again in 2015.

Mud River Pool (HMU 6)

Size: 2,429 acres

Elevations:

	Pool elevation	Surface acres	Acre-feet
normal summer:	1,141.5'	155	198

spillway:	1,143.0'	170	275
drawdown:	1,139.5'		

Depth at 1,143.0': over 80% <3 ft

Control structures: 1 outlet, 1 inlet
Spillways: 1 outlet
First year operation: 1941

Physiography:

The western two-thirds of the pool is open water. The eastern one-third contains proportionately more emergent vegetation, primarily cattail. Emergent vegetation in the large open water area is highly variable in coverage depending on drawdown and water-level sequences. Bulrushes do establish on the eastern part of the open water areas during drawdowns. The west edge of the pool is a dense stand of cattail that blends into a large expanse of sedge meadow between Mud River Pool and Webster Pool. The two pools are connected over this meadow during extreme flood events.

Wild rice was seeded in this pool in 1997. This was also done in the late 1930s, shortly after Refuge establishment, and in the early 1980s in various pools and creeks on the Refuge. As was reported in the early Annual Narrative Reports, seeding wild rice was not successful and should not be tried again.

The upland portion of this HMU consists of black spruce/tamarack bog surrounded by a narrow band of mature aspen that has started developing an uneven age class. The east portion of the upland unit is a large expanse of grassland. This area has a history of being prescribed burned separately and has been designated as management sub-HMU 6A (Kilen's Corral).

Water movement:

Primary water supply is from Ditch 1 (Branch 1 JD 11). A second source is from Ditch 2 (Branch 2 JD 11) via Kelly and Upper Mud River pools. The WCS on the south side outlets into Agassiz Pool.

Complete dewatering is possible only when Agassiz Pool is below 1,140'. Estimated time to dewater is 8-10 days.

The inability to adequately control inflow from Ditch 1 limits management for over-water nesting. Pulling stoplogs after rain events must be done much more aggressively than on the other pools of similar size due to the large inflows from Ditch 1 that also sustain the high water levels. In several years the spillway has flowed for months.

Drawdown history:

This pool was dewatered completely in 1951 to make repairs on the dike and establish emergent vegetation in the open basin. Smartweed was aerially seeded and germination and growth were excellent. The pool remained dry in 1952 and softstem bulrush was well established by the end of the growing season. In 1954, softstem bulrush disappeared when water was raised to approximately 1,142' during the summer. The pool next was dewatered in the spring of 1984; however, a five-inch rain in early June raised the level to 1,143.2'. A second drawdown resulted in a dense growth of cattail seedlings by mid-July. A level of 1,143'+ in 1985 resulted in a complete kill of extensive stands of yearling cattail.

A drawdown of Mud River, along with Upper Mud River and Kelly Pools, was initiated on September 1, 1990. Thousands of shorebirds used the mudflats and shallow ponds attracted green-winged teal, mallards, and American wigeon. The drawdown continued through the summer of 1991 and the basin was re-flooded in September.

A successful drawdown occurred in mid-July of 1997 and a crop of golden was produced on the mudflats. This attracted a crowd of mallards and Canada geese during the fall when stop logs were added and put a three inches of water back in the pool. There was also a drawdown in 2003. A prescribed burn in the fall of 2003 did not successfully burn the cattail vegetation.

Burn history:

Mud River (HMU 6)

Year	Acres Burned	Time of Year	Type	
1960	10	Spring	P	10 acres at old secondary
1973	UNK	Spring	P	5,754 acres burned - HMUs 3,5,6
1981	140	Spring	P	
1983	995	Spring	P	
1985	348	Spring	P	
1998	900	Spring	P	burned both 6 & 6A
2003	1,860	Fall	P	burned both 6 & 6A

Kilen's Corral (HMU 6A)

Year	Acres Burned	Time of Year	Type	
1981	100	Spring	P	specifically targeted 6A
1983	UNK		P	south of Ditch 1

1985	UNK		P	burned all of 6A
1998	UNK	Spring	P	burned both 6 & 6A
2003	UNK		P	burned both 6 & 6A

Wildlife:

Over-water nesting is subject to drastic bounce, but the nearby sedge meadow and grassland provide upland nesting sites. Brood use by diving and dabbling ducks was very high prior to the 1984 drawdown, declined dramatically in 1985, and improved somewhat in 1986. Except during drawdown years brood use has been fairly consistent. Pair and brood use includes buffleheads, which may result from the close proximity to the mature aspen on the north side of this pool. Use by migrant waterfowl is excellent in most years and the banding site at this location can be productive. Tundra Swan use is high during most falls. Black tern use is often very high.

The upland portion of this unit has a history of high moose density. Red osier dogwood is heavily browsed even at the current low moose population.

Facility improvements:

Year	Project	Location
2003	Gauge replaced	change unknown
1990	Replace WCS	Upper Mud River
1978	Install 1-42" CMP	Mud River angle dike
	Install 100' E spillway	Mud River angle dike
1976	Replace 3'x4' CB with 2-42" CMP	Webster Trail
1970	(see Middle CCC)	

Needs, restrictions, and objectives:

Stoplog adjustments during runoff events must be done aggressively to minimize bounce in this pool. Pull twice as many stoplogs as your first inclination calls for. The objective in Mud River Pool is to keep a mosaic of emergent vegetation in the center portion of the pool. This pool also has a history of being able to provide a good crop of moist soil annuals and attention should be paid to the drawdown to try and produce this crop. The mudflats need to be exposed gradually during June so they stay moist and runoff events pass quickly to prevent drowning the new plants.

HMU 6 includes the north bank of Webster Creek up to the established fire line. The trees on the north bank of the Creek are included with the HMU 6 prescription and will add to the riparian component of Webster Creek.

HMU 6A is one of the largest expanses of grassland and is a separate burn unit. This will allow more frequent burning to maintain the open grassland component in this area.

Prescription:

Mud River Pool is in the **Brood Habitat** prescription. It will be in drawdown on a five-year cycle, but will only be burned on the 10-year spring burn cycle with the entire HMU 6. The balancing of emergent vegetation with open water in the central part of the pool should be done by annually oscillating water levels around 1141.5'. Pool level in 2007 will be 1,141.5'. Deeper water levels can be used if needed to reclaim open water from cattail encroachment. The last drawdown was in 2003, so the next drawdown is in 2008.

HMU 6 uplands are in the **Old Growth** prescription. No cutting of trees or mowing of shrubs will be done. Spring burns will be prescribed but should not be conducted under drought conditions. The next spring burn for the entire unit is in 2013.

Kilen's Corral (6A) will be burned in summer or fall of 2008 and again in 2018 to set back invading shrubs and trees. Willow mowing can be done in this area in 2010-11 and 2016-17.

Webster Pool (HMU 6B)

Elevations:

	Pool elevation	Surface acres	Acre-feet
normal summer:	1,143.3'	660	1,230
spillway:	1,144.3'	1,260	2,190
drawdown:	1,138.3'		

Depth at 1144.3': over 5% >5 ft; over 30% <3 ft

Control structures: 1 outlet
Spillways: 1 outlet
First year operation: 1943

Physiography:

This long (2 mi) and narrow pool is predominately (90%) open water with a narrow fringe of cattail most of its length. The pool is bordered on both sides by willow shrubland. A broad area of emergents at the north end has a good interspersion of cattail and open water and provides suitable over-water nesting habitat. Submergent growth is

fair to excellent. This pool lies on the old creek channel of Webster Creek. It separates two large bogs that are black spruce/tamarack forests.

Water movement:

The primary water source for this pool is Webster Creek. Local runoff from the bogs and the watershed to the north of the pool also make major contributions to the hydrology of this pool. The outlet WCS and spillway at the south end outlet into Agassiz Pool. Complete drawdown is contingent on an Agassiz Pool level of 1138'.

Estimated time to dewater is two weeks.

During extreme flood events like 1997, Webster Pool exceeds 1145.0'. At this level it is connected to both Thief Bay Pool and Mud River Pool. This combined water area floods 6,360 acres and stores 13,400 acre-feet.

Drawdown history:

This pool was lowered to 1,140.8' in late summer 1950 as part of a two-year drawdown to increase emergent vegetation. In 1951, at 1,140.4' (level of Agassiz Pool), considerable mudflats were exposed in the north end and the east and west sides. In 1952, the pool again was at a common level with Agassiz Pool (1,139.3') and was essentially dry. The 1953 level was near 1,140' and was raised to about 1,142.5' in 1954. The two-year drawdown resulted in the establishment of emergent vegetation, as originally planned.

A drawdown attempted in 1983 was incomplete due to fluctuations in Agassiz Pool. The level varied from 1,139.3' on June 13 to 1,141.1' on June 27. Extensive cattail seeding was evident in late summer on mudflats in the north end. The pool level was raised to 1,143.0' in 1984.

A drawdown was attempted in 2001, but the open water areas did not dry out. To accomplish a drawdown without an exceptionally dry summer, Agassiz Pool needs to be below 1,138.0' to allow complete drainage.

Wildlife:

Over-water nesting is fair at best; however, waterfowl brood use is good in most years. Shallow areas often develop by late summer in the north end and are well utilized by dabbling ducks. Diving ducks typically are abundant during migration in the deeper south portion of the pool. American wigeons, gadwall, scaup, and American coots make heavy use of a narrow strip of the pool on the south side of a wooded island each fall.

Facility improvements:

Year	Project	Location
2003	gauge replaced	+0.3’
1977	Replace 3'x4' CB (1941)	
	22 2-42" CMP	Webster Trail
1970	Install 100' WP spillway	Webster Trail

Needs, restrictions, and objectives:

Because total dewatering of this pool is dependent on the level of Agassiz Pool, complete drawdowns have to coincide with partial or complete dewatering of Agassiz Pool.

During the early 1990s Webster Pool water levels were around 1,142.8' and produced a nice mosaic of vegetation and open water in the north end of the pool. During the mid-1990s pool level was raised to 1,143.3' and then 1,143.8' to try and flood additional areas in the north end. However, diving duck use in the fall tapered off, apparently as a result of less submergent growth in the south end of the pool. Water levels during the late 1990s were lowered to 1,141.3' and 1,141.8' to encourage submergent plant growth and increase waterfowl use in the fall. This was successful. Water levels at and above 1,143.3' have proven to be too high for managing this pool, especially if held for successive years. Elevations around 1,142.8' were the optimum level during the 1990s.

There are remains of two old goose nesting islands in Webster Pool that show up as sheets of metal that lined log island walls. One of these is near the spillway and the other is on the edge of the cattails in the north end of the pool. The pool did not get dry enough to remove this metal during the most recent drawdown.

The proposal for converting Webster Pool into a flow-through creek unit in the CCP was accepted. The stoplogs will be kept out of the pool for a five-year evaluation period to determine if the experiment is successful. Leigh Fredrickson, Wetland Management and Educational Services, Puxico, MO, is attempting to initiate a cooperative study to intensively monitor the biotic and abiotic parameters of this attempt to establish sedge along the historic creek channel. Study plots should be north of the large wooded island where the influence of Agassiz Pool will be minimal.

Prescription:

Start of this experimental flow-through will begin in 2007, allowing Dr. Fredrickson time to develop the monitoring study. The pool will be put into drawdown during August. Since sedges are cool temperature germinators, the August timing will expose the mudflats for the fall and the spring seasons. In 2007 the pool will be at 1,141.8' until 1 August and then stoplogs will be removed. The pool will be kept in drawdown for five successive years. Vegetation changes will be monitored to see if sedge germinates on the exposed mudflats to increase the sedge meadow component of the Refuge habitat. If Dr.

Fredrickson is unable to establish the study, infrared photos and on-the-ground inspections can be used to monitor results. If cattail, common reed, or reed canary grass become dominant along the creek channel, the pool will be returned to a Brood Habitat management regime. It is expected that the south end of Webster Pool will remain inundated by backwater from Agassiz Pool. This lower end may turn into an emergent marsh. Sedge meadow may only be possible north of the large wooded island above elevation 1,140.0'.

This area does not lend itself to frequent burning by itself. The only burning will be when all of HMU 6 is burned in the spring (2013), unless some pattern for firebreaks becomes apparent at a later date.

Upper Mud River Pool (HMU 7)

Size: 281 acres

Elevations:

	Pool elevation	Surface acres	Acre-feet
normal summer:	1,144.5'	260*	
spillway:	Unknown		
drawdown:	1,141.5'		

Control structures:	1 outlet, 1 inlet
Spillways:	1 outlet, 1 inlet
First year operation:	1979

*Estimated-engineering data not available

Physiography:

This triangular pool is dominated by cattail, except for a narrow stretch of whitetop and sedge along the east side bordering Northgate Road. The historic Mud River channel passes through the south portion and is the main source of drainage. There is a fine matrix of cover:water interspersion in the south portion. The north portion contains very little open water.

Water movement:

The only water source is from Kelly Pool. The outlet WCS and spillway on the west end empty into Mud River Pool. Drawdown is possible when Mud River Pool is less than 1,141.5'. Sustained high water during flood events occurs because this is part of the Ditch 2 drainage.

Estimated time to dewater is five days.

Drawdown history:

In September 1991 the pool was dewatered to re-flood Mud River Pool which was in summer drawdown. The pool was in and out of drawdown conditions in 1998 due to inflows.

Burn history:

Year	Acres Burned	Time of Year	Type
1973	UNK	Spring	P
1978	UNK	Fall	P
1981	180	Spring	P
1987	50	Spring	P
1996	63	Fall	P
2005	140	August	P

Wildlife:

Over-water nesting is fair in years when the pool is at full level.

Facility improvements:

Year	Project	Location
2003	gauge replaced	no change
1986	(see Upper Middle CCC)	Narrow Dike

Needs, restrictions, and objectives:

This pool is sandwiched between Kelly and Mud River Pools and is dependent on the management of these two pools. For example, it must be lowered to permit drainage of Kelly and, conversely, it cannot be dewatered unless Mud River is at a drawdown level (1141.5'). Ditch 2 flows often sustain high water levels in this pool. Ditch 2 flows can also be attributed to Ditch 1 sustaining high water in Mud River Pool.

The need to increase sedge meadows and riparian habitat in the landscape that was identified in the CCP gave rise to the idea to try and establish a sedge meadow and riparian area in Kelly and Upper Mud River pools. This pool will be in a flow-through sedge meadow prescription for the next several years. The inability to pass runoff events quickly may doom this process. The historic Mud River channel may need to be cleaned out so the east end will drain, unless the channel erodes and cuts down on its own after one or two seasons.

Prescriptions:

Upper Mud River Pool and Kelly Pool will be in a flow-through prescription. Stoplogs will remain out of both the Kelly to Upper Mud River WCS and the Upper Mud River to Mud River WCS. This will allow runoff events to pass as quickly as possible. HMU 7 will be burned every other year during the summer to suppress cattail and encourage sedge. The next burn is in 2007. Stoplogs can be put in during severe flooding events to maximize storage.

Wick application of Rodeo to a band of cattail at the cattail/sedge interface may increase the spread of sedge into the pool area. This could possibly be done annually moving further west into the cattail zone each year, if it is successful. The spray plots in Madsen Pool may give some insight if this is worth trying. If this experimental flow-through scenario is successful it should be evident in the infrared photos. If no progress is made in converting the cattail to sedge or if the area is taken over by common reed or reed canary grass, the pool should be returned to marsh management. If this occurs, this pool would be in the **Nesting Habitat** Prescription.

Webster Creek Upland (HMU 8)

Size: 484 acres

Physiography:

This HMU has the graveled Northgate road on the west side, private fields on the north side, a mowed firebreak along a ditch on the east side, and Ditch 1 on the south side. The main feature of this HMU is Webster Creek bisecting it east to west. Webster Creek often has beaver dams in it that add to the intrigue of the HMU. The majority of this HMU has a loam soil that has a mature aspen stand growing on it. Most of the other soils are depressional mucks that have a sedge and willow vegetation community.

Burn history:

Year	Acres Burned	Time of Year	Type
1983	195	Spring	P
1993	81	Spring	P
1993	106	Spring	P

Wildlife:

At least one beaver colony is usually in residence on this portion of Webster Creek. Beaver have often tried to incorporate Northgate Road into a dam. A large dam and

colony occupied the east part of the creek through most of the 1990s. The HMU has high deer use as it provides cover for deer visiting privately owned fields and pastures on the north side. The aspen stand is mature and starting to provide habitat for cavity dwellers, including woodpeckers.

Needs, restrictions, and objectives:

The east side of the HMU is the only difficult firebreak to maintain and blackline. The mature aspen stand adds to the riparian nature of Webster Creek and is why this HMU has been placed into the **Old Growth** prescription. The objective will be to allow an uneven aged stand of aspen to develop. Beaver will play a role in this HMU and artificial openings in the canopy near the creek should not be needed. This HMU will have less blowdowns than some of the other **Old Growth** HMUs because it is on loam rather than peat soil.

Prescriptions:

The HMU is in the **Old Growth** prescription with a 10-year burn cycle. Burns will be conducted in the spring to minimize tree kill. No cutting of trees or mowing is necessary in the HMU. Trees along the edge may need to be removed for road and ditch maintenance. The next burn is in 2008.

Ditch 1 Uplands (HMU 9)

Size: 952 acres

Physiography:

The north, east, and north half of the west sides are bordered by private fields, the south side by Ditch 1, and the south half of the west side is mowed firebreak along a ditch. Soils in this HMU are evenly divided between depressional muck and loams. The muck soils are in sedge and willow complex. The loams are divided between grassland and aspen. Either differences in past history or slight differences in elevation are likely determining what has already been invaded by aspen. Most of the trees are in the south half of the HMU and the grassland in the north half.

Burn history:

Year	Acres Burned	Time of Year	Type
1973	UNK	Spring	P
1983	585	Spring	P
1993	312	Spring	P
2002	2,012	Spring	P

Wildlife:

The area is bordered by fields on several sides and has high deer use. The east edge is open grassland and is complemented by the open landscape adjacent to it.

Needs, restrictions, and objectives:

The HMU can be burned fairly easily with only one mile of firebreak that is difficult to black line. The HMU could have been placed in the Open Shrubland/Grassland prescription due to the large amount of grassland that still exists. However, the burn history has been spring burns at 10-year intervals and these grasslands have persisted. The **Even-Aged Aspen** burning cycle of spring burns every five years should maintain grasslands without repeated assist from mowing; therefore, freeing up mowing time for other portions of the Refuge. Rather than try to eliminate the trees in the south portion of the HMU, a clearcut and extensive mowing every 42 years will complement the open grassland for a short time and provide part of the shifting mosaic of open landscape. Burning will also keep the browse plants available and palatable for big game and hares.

Prescriptions:

HMU 9 is in the **Even-Aged Aspen** prescription. The HMU will be burned in the spring on a five-year rotation. The next burns are in 2007 and 2012. The stand altering clearcut will be in 2013/14. The aspen stumpage can be traded for as much mowing as possible in this HMU. Added to this aspen sale can be the east side of HMU 5. Following a couple growing seasons the HMU will be burned again in 2017. If evaluation shows substantial loss of grassland areas prior to the clearcut, the burn in 2017 should be changed to a summer burn.

Kelly Pool Uplands (HMU 10) and Kelly Pool (HMU 10A)

Size: 586 acres

Elevations:

	Pool elevation	Surface acres	Acre-feet
normal summer:	1,145.0'	380	400
spillway:	1,145.0'	380	400
drawdown:	1,143.0'		

Depth at 1,145'; over 60% <2 ft

Control structures: outlets 3

Spillways: outlet 1
First year operation: 1937; 1956 – 1st year after rehab and raised dike

Physiography:

This is a small pool that has become dominated by a dense floating mat of cattail. Dikes border the pool on the west and south sides. Along the east side, the marsh grades into shrub uplands. A few deep holes along the creek channel and elsewhere provide access to the cattail for nesting diving ducks.

Water movement:

Primary water supply is Ditch 2. A secondary water supply is from Pool 21. Drawdown is possible when Upper Mud River is 1,142.0' or lower. A WCS between Kelly and Upper CCC Pool was installed in 2005 allowing water to be discharged into both Upper Mud River and Upper CCC pools. This will allow high flows to be passed at a faster rate and give more flexibility for drawdowns.

This pool is subject to rapid high bounce during runoff events. Pulling stoplogs needs to be aggressive if bounce is going to be minimized.

Estimated time to dewater is seven days.

Drawdown history:

A natural, late summer drawdown in 1966 and 1967 resulted in total conversion of open water to cattail by 1968. The pool was dewatered in the fall of 1972 and cattail was rotary-mowed in strips during December. Summer levels averaged about 1,144.7' in 1973 and by December, all but one of the strips could still be distinguished. In subsequent years, cattail eventually invaded the mowed areas. The pool again was drained in late fall 1980 and numerous circular openings were sheared with a D-6 dozer during January and February 1981. The water level of 1,144.6' in summer 1982 covered the areas and the openings persisted until about 1987.

A drawdown in September 1990 was only partially successful. Silt accumulation, peat build-up, and beaver activity impaired downstream drainage. By 1992 the pool was again dominated by dense cattail.

A spot aerial application of Rodeo was applied on 3 September, 1993 and created open spots in the cattail that persisted for five years. The pool was dewatered in the fall of 1999 and a burn was attempted, but wet conditions resulted in only 15 burned acres. A strip application of Rodeo was made in August 2000 and was evident through 2004. The pool was scheduled for drawdown in 2005 and although the stop logs were out during the entire season, the pool didn't reach low levels until August. The pool was

burned on August 30, but only the southwest corner and the east edge near the firebreak burned. The pool was left in drawdown in 2006 and standing water was absent during the entire season.

Burn history:

Kelly Pool Upland (HMP 10)

Year	Acres Burned	Time of Year	Type
1973	UNK	Spring	P
1976	UNK	Spring	P
1981	879	Spring	P
1985	523	Spring	P
1994	UNK	Spring	P
2006	88	Spring	P

Kelly Pool (HMU 10A)

Year	Acres Burned	Time of Year	Type
1999	15	Fall	P
2005	140	summer	P

Wildlife:

This was considered one of the most productive Refuge pools for several years after it was made operational. Waterfowl pair use declined dramatically after cattail became well established. Efforts to locate diving duck nests in the early 1980s were unsuccessful. However, this was a productive area to find canvasback nests during the mid-1980s and early 1990s. During fall migration, gadwall and mallards use the ditches and small openings.

Facility improvements:

Year	Project	Location
2005	Control structure	Kelly to Upper Middle CCC
2003	Gauge replaced	- 0.2' to old readings
2000	Herbicide treatment	Similar to 1993 treatment except solid lines
1997	Spillway reshaped	
1993	Herbicide strips	Two north-south passes in short spurts
1986	Install 1-48" CMP	Ditch 2
1979	Remove stop log culvert	North Gate Road
1978	Clean 2 mi. ditch	Ditch 2
1971	Install 1-36" CMP	Northgate Road
	Reslope .5 mi. dike	Northgate Road

1955 Raise and rehab dike Northgate Road and Ditch 2

Needs, restrictions, and objectives:

Management of emergent vegetation by deep flooding is limited by the spillway elevation of 1,145.0' and because the cattail mat floats up. Water depths in excess of 1,145.0' may cause flooding on adjacent private land along Ditch 2. Because of this restriction, cattail must be controlled using alternative methods.

When managed for over-water nesting, openings in the cattail need to be created. This can be done by dewatering in summer, burning and disking, shearing cattail on the ice, or herbicide (via spot application). Any of these treatments needs to be followed by maintaining water levels at near spillway elevations for two or more growing seasons.

This pool will be in a flow-through sedge meadow prescription for the next several years. The inability to pass runoff events quickly may doom this process. If this is the case, the unit will be returned to the **Nesting Habitat** prescription.

Prescriptions:

The need to increase sedge meadows and riparian habitat in the landscape (identified in the Agassiz NWR's CCP) gave rise to the idea to try and establish a sedge meadow and riparian area in Kelly and Upper Mud River pools. Stoplogs will remain out of the Kelly to Upper Mud River WCS and stoplogs in the Kelly to Upper CCC Pool WCS will be kept at the water level in Upper CCC Pool. This will allow runoff events to pass as quickly as possible. Stoplogs can be put in during severe flooding events to maximize storage.

HMU 10A should be burned every other year during the summer to suppress cattail and encourage sedge. The next burn is in 2007. During the years that the all of HMU 10 is burned in the spring, sub-HMU 10A could be burned with the entire HMU in the spring rather than the summer of that year. However, most burns will need to be conducted separately.

Wick application of Rodeo to a band of cattail at the cattail/sedge interface may increase the spread of sedge into the pool area. This could possibly be done annually moving further to the west into the cattail zone each year if it is successful. If no progress is made in converting the cattail to sedge or if the area is taken over by common reed or reed canary grass, the pool should be returned to marsh management. If this occurs this pool would be in the **Nesting Habitat** Prescription.

The Kelly Pool Uplands (HMU 10) is in the **Even-Aged Aspen** prescription. The HMU was burned in spring of 2006; therefore, the next five-year burn cycle is in 2011. These are spring burns. The clearcut and mowing treatment will occur in 2031/32.

Ditch 2 Uplands (HMU 11)

Size: 977 acres

Physiography:

The north side and the south side are bordered by large ditches, Ditch 1 and Ditch 2, respectfully. The east side borders private fields, woods and hay meadow, and the west side is a mowed firebreak. Prescribed burning the HMU requires extensive preparation and slow black lining. The HMU is split by an east-west beach ridge (Kelly Ridge). This sandy portion of the HMU supports a bur oak woodland with other deciduous trees, such as ash (*Fraxinus* spp.) and aspen. The surrounding areas are open grassland and sedge on loam and mucky loam soils. The north and south portions of the HMU are a mixture of loams with aspen and mucks with willows.

Burn history:

Year	Acres Burned	Time of Year	Type
1973	UNK	Spring	P
1976	UNK	Spring	P
1985	578	Spring	P
1990	<5	Spring	Wild
1994	UNK	Spring	P
1995	210	Spring	P
2005	50	Spring	P
2006	1.2	Summer	Wild
2006	50	Spring	P

Wildlife:

The beach ridge adds diversity to this HMU. It is often used by black bears for late summer foraging on acorns. The open spreading oak trees on the east end give evidence of a more savanna like woodland in the past. A pair of bald eagles set up house keeping in the southwest corner of the HMU in 2005.

Needs, restrictions, and objectives:

The firebreak on the west side requires diligent maintenance and preparation prior to burns. The eagle nest tree needs to have litter removed from its base prior to burns. The differences between the **Old Growth** aspen management and the oak savanna management present some conflicts to overcome. **Old Growth** management calls for

spring burns that will kill few aspen. The oak savanna management calls for burning after aspen leaf out in May to kill aspen and allow the bur oak to be unharmed.

Prescriptions:

Old Growth prescription burns will be every 10 years in the spring. The next burn is in 2013. No mowing or cutting is required.

Firebreaks can be mowed in the grass around the grassland area surrounding the oak woodland to facilitate burning the oak woodland and surrounding grassland by itself every three or four years in between the 10 year early spring burn. These burns would be in mid-May after aspen leaf out and before oak leaf out. These burns are not recommended until girdling the aspen trees has started.

Girdling aspen and ash in the oak woods in this area can be started as soon as manpower becomes available. Oaks can also be selectively removed to open the canopy to about 50%, if necessary. Inter-seeding upland prairie grass in the grassland areas is **not** recommended. This ridge has not been heavily affected by drainage and yet upland prairie grasses like big bluestem are not present. The native sedges and grasses of the wet prairie and sedge meadow are the native component under this oak savanna and woodland.

Pool 8 Triangle (HMU 12)

Size: 24 acres

Physiography:

This is a small triangle of sedge and willow vegetation on the outside of the west boundary road. The HMU is bordered on the north and east sides by gravel roads and the west side by farm field. It is easy to burn, but is often too wet. The soil is a depressional muck.

Burn history:

Year	Acres Burned	Time of Year	Type
1976	UNK	Spring	Wild
1983	25	Spring	P
1998	21	Spring	P
2005	UNK	Spring	Wild
2006	26	Fall	P

Wildlife:

The vegetation is suitable for upland nesting waterfowl and other birds, but due to its small size, nest success is presumed to be low due to predation.

Needs, restrictions and objectives:

The size of the HMU is small, but representative of much of the willow sedge complex on the Refuge. It will be used as a test area for burning and spraying prescriptions.

Prescriptions:

The HMU is in the **Grassland/Sedge** prescription. In HMUs under this prescription we are trying to reduce willow and other woody invasives. This HMU will be the test unit for annual spring burning to assess impacts of annual burning on willows. For the next five years, beginning in 2007, the HMU will be burned in the spring season, usually in April. Evaluation will be with photo points and analysis of the infrared photos.

Pool 8 (HMU 13)

Size: 1,133 acres

Elevations:

	Pool elevation	Surface acres	Acre-feet
normal summer:	1,141.5'	1050*	Unknown*
spillway:	1,142.0'	1070*	Unknown*
drawdown:	1,138.5'		

Depth at 1,142.0' over 90%: <2 ft.

Control structures: outlets 1, inlets 2
Spillways: outlets 1, inlets 2
First year operation: 1982

*Estimate-engineering data not available. It may still be included in with Agassiz Pool.

Physiography:

The basin is very flat and uniform with little relief except near three aspen islands. Cattail predominates over a vast expanse, with occasional small stands of whitetop and sedge present along the east and west boundaries. Interspersion is poor, but has reached

the extent attainable by high water during the 1990s. A large open water area borders Northwest Trail in the north-central portion of the HMU. This opening drains out to the southeast through a natural cut during drawdowns.

Water movement:

The principle water source is Northwest Pool via a single-bay WCS and a rip-rapped spillway. A secondary source of water is available through a screw gate in the River Road when Agassiz Pool is above the elevation of Pool 8. The screw gate outlet WCS and steel spillway in the southwest corner empties into Ditch 83, the historic Thief River channel.

Under flood conditions, Agassiz Pool spills over into Pool 8 through a rip-rapped spillway in the south end of the River Road. When Pool 8 fills it also backs into Northwest Pool before over flowing its steel spillway, creating a large area of stored water.

Estimated time to dewater pool is five days. Drawdown usually is not contingent on downstream levels due to a drop of approximately 10 vertical feet.

Drawdown history:

Pool 8 had not been dewatered since construction in 1982 until the pool was in drawdown during spring and summer of 1994, mainly due to a broken screw gate. The HMU was burned in the fall of 1994, which along with high water levels, improved open water/cattail interspersion.

The pool was in drawdown in 2001 and was able to be burned successfully that May. An attempt was made to burn the HMU again in the fall with very limited success due to a lack of fuel. Only 200 acres were burned on the west side. The pool was again in drawdown in the spring of 2002. The pool was also put in drawdown in 2006. This was only four years since the last drawdown, but was done intentionally to stagger the drawdowns on the west side of the Refuge. The pool was used as a study pool for the inter-regional U.S. Fish Wildlife Service/USGS cattail burning study.

Burn history:

Year	Acres Burned	Time of Year	Type
1960	UNK	Fall	P
1963	UNK	Spring	P
1980	1,108	Fall	P
1981	80	Fall	P
1984	560	Spring	P
1992	3	Fall	P

1994	UNK	Fall	P
2001	1,170	Spring	P
2001	200	Fall	P
2001	200	Fall	P
2001	200	Fall	P
2006	1,077	Summer	P

The 2006 summer burn was one of the first large scale summer burns conducted in recent times. Most of the pool burned with flank fires that had a very uniform rate of spread and flame length. The south end was burned by a head fire that reached out to the aspen islands and killed the south perimeter trees. Study plots were on the northeast corner of the HMU and were burned by backing or flanking fire.

Wildlife:

The pool was developed in 1981 and provided the capability of having normal pool levels above those of Agassiz Pool. Diving duck nesting, particularly redhead and canvasback, increased dramatically during the 1980s in response to small openings, formed by dying vegetation that became evident in 1986. Muskrat activity also increased substantially during this time. The wet 1990s provided water that kept the pool level just below spillway level, all season long for multiple years. Additional openings developed, but the pool is still low on interspersion. An analysis of aerial infrared photography showed that an additional 249 acres of open water were added between 1993 and 1997. American bitterns utilize the pool for nesting. One year during an American bittern research study seven nests were found in the southeast corner of the pool.

The first trumpeter swan (*Cygnus buccinator*) pair to nest on the Refuge chose Pool 8 in 2004. The historic Thief River channel oxbow along the west side was the nest site in 2004 and 2005 and the road ditch just south of that location was the nest site in 2006.

Facility improvements:

Year	Project	Location
2003	gauge replaced	no change
1994	Screw gate repair	outlet structure
1981	Rehab. 1.9 mi. dike	East dike
	Install 36" CMP	Northeast corner
	Install 150' steel SP	West Gate Road
	Install 100' spillway	Thief River dike

Needs, restrictions, and objectives:

An insufficient water supply limited management options prior to the new WCS structure in Northwest Trail (installed in 1985). This structure is still smaller than desired to move

water from Northwest Pool into Pool 8. This pool can be managed for its nesting potential as adjacent brood habitat is available in both Agassiz and Northwest Pools.

Prescriptions:

Pool 8 is in the **Nesting Habitat** prescription and will be on a four-year drawdown followed by a spring burn cycle. The cycle can be modified to miss drawdowns in Northwest and Agassiz Pools. The frequent burning will help keep the sedge meadow areas on the perimeters and limit the trees on the islands. A late summer burn once every third or fourth cycle will be appropriate to set back trees and shrubs.

Pool 8 has to be kept in drawdown condition in 2007 so the inter-regional U.S. Fish and Wildlife Service/USGS cattail study research crew can obtain cattail root samples in study plots during the growing season. If Agassiz Pool or Northwest Pool have excess water in the fall of 2007, Pool 8 could be shallowly flooded to provide flooded annual vegetation for migrating waterfowl. In 2008 the pool should be managed at high water levels to make nesting cover available to diving ducks. In 2008 the objective level will be 1,141.5'. The next drawdown will be in 2011 and should be followed by a fall burn or a spring burn in 2012. The effectiveness of the 2006 summer burn will be of interest when Pool 8 is reflooded in 2008. If the evaluation of the unit in 2008 and 2009 show that a significant amount of interspersion developed due to the summer fire, this sequence should be tried again to see if a hemi-marsh condition can be developed. Results of this cattail study may also point to summer fires on other Refuge impoundments with a perennial lack of interspersion.

Davidson Triangle (HMU 14)

Size: 84 acres

Physiography:

This is a small, triangular HMU with sedge and willow vegetation. The HMU is bounded on the west and north sides by graveled roads and the south side is Ditch 83 and a lateral ditch with a private trail along side. The soil is a loam and mucky loam complex.

Burn history:

Year	Acres Burned	Time of Year	Type
1978	UNK	Fall	P
1981	UNK	Fall	P
1984	105	Spring	P
1993	70	Spring	P
1998	10	Fall	P

2006 85 Fall P

Wildlife:

The vegetation is suitable for upland waterfowl and other migrating bird nesting. A borrow pit along the north side is used by waterfowl pairs, including ring-necked ducks. Willows provide cover for deer using the adjacent private fields.

Needs, restrictions and objectives:

The HMU is small and highly accessible by predators due to roads and ditches. Beaver dams in the ditch on the south side often keeps the area saturated. The HMU is representative of much of the willow-sedge complex on the Refuge. It will be used as a test area for burning and spraying prescriptions. The beaver dam can be removed as needed over the next five years to make the HMU burnable.

Prescriptions:

The HMU is in the **Grassland/Sedge** prescription. In HMUs under this prescription we are trying to reduce willow and other woody invasives. This HMU will be the test unit for annual fall burning to assess impacts of annual burning on willows. For the next five years the HMU will be burned in the fall season, typically in October. Evaluation will be with photo points and analysis of the infrared photos.

Agassiz Pool (HMU 15)

Size: Unit 15 – 6,816 acres; additional units in this pool listed separately.

Elevations:

	Pool elevation	Surface acres	Acre-feet
normal summer:	1,140.0'	9,350	15,445
spillway:	1,141.0'	10,580	25,410
drawdown:	1,136.0'		

Depth at 1,141.0': over 15% >5 ft.; over 75% <4 ft.

Normal summer pool levels of 1,139.5' to 1,140.0' provide the best distribution of water for nesting of over-water nesting waterfowl and marshbirds. The record high elevation was on 23 April, 1997 at 1,143.85'. This elevation exceeds the dike tops to Madsen and Parker Pools for over one mile.

Physiography:

All but the northwest and northeast portions of Agassiz Pool comprised the historic Mud Lake. Prior to settlement, the lake was fed from the east by the Mud River and to a lesser degree by Webster Creek and Lost River. The primary drainage was to the northwest via a short stream that connected the lake to the Thief River. Today, the pool's hydrology is altered by diversion ditches, dikes, and WCS. Until 1980, the pool was managed at elevations around 1,141.0' with emergent vegetation restricted to shoreline and islands. Cattails expanded greatly in the shallow areas along the east side during the 1980s, but appear to have stabilized now at the 1,140.0' elevation. Cattail along the west side is in a desirable state of flux as pool levels are adjusted below 1,140' and then back to 1,140'. During the 1990s, hardstem bulrush became established throughout the deeper portions of the pool that had previously been open water.

Water movement:

Principle water supply is from Judicial Ditch 11 and the Mud River Diversion, which flows directly into the pool from the east, as well as the Thief River from the north. The following pools drain directly into Agassiz Pool: Thief Bay, Headquarters, Lower CCC, Middle CCC, Dahl, Mud River, and Webster. The main outlet is via the Ditch 11 control structure on the west side. Secondary drainage is provided by control structures into Pool 8, Madsen, and Parker Pools. During flood conditions, there is no direct spillway flow from Agassiz Pool into the Thief River (Ditch 83). The spillways on Agassiz Pool flow into Pool 8, Madsen, and Parker Pools, maximizing storage and providing additional buffering of the flooding effects before water leaves the Refuge. In addition, water is backed into Headquarters Pool during extreme flood events.

Estimated time to dewater is four weeks and is contingent on no inflow.

Drawdown history:

The first drawdown was a two-year partial drawdown due to drought in 1952 and 1953 (Harris 1957). This was part of an intensive research proposal which examined vegetation change and waterfowl use on eight pools. Mudflats in Agassiz Pool were exposed with an average elevation of 1,138.9' during the summer. Today these areas are covered with cattail. The mudflats during the study were colonized by softstem bulrush and cattail. Softstem bulrush was densest on areas that had two inches or less of water in the fall/winter before being exposed in early June the following year.

The first complete drawdown wasn't until 1980. The pool was dewatered beginning in April 1980 to make repairs on the Ditch 11 outlet structure. Below normal precipitation and above normal temperatures resulted in near drought conditions and by mid-June the pool was practically dry. Mudflat annual forbs, especially goosefoot, covered the basin by late summer. It was decided to manage for emergents by maintaining shallow water for the next several years, gradually increasing levels to control cattail. The plan was

successful. Emergents flourished from 1981-1984 and were greatly reduced by high water (1,140') in 1985. Submergents, particularly sago pondweed, greatly increased in abundance in 1986 when the pool reverted to a mostly open water condition. The Pool was placed in drawdown in the fall of 1990 to make repairs to the radial gates. Spring and summer runoff brought the pool back to normal pool level in May of 1991.

A drawdown was initiated in 2000 and all but the deepest portions of the pool were dry most of the summer. Shorebird use was excellent. Shallow areas that came back to cattail after this were drowned out in 2002. Hardstem bulrush increased in much of the open water and some previous cattail areas.

Burn history:

Year	Acres Burned	Time of Year	Type
1963	UNK	Spring	P
1970	UNK	Fall	P
1980	369	Fall	P
1981	UNK	Fall	P
1983	105	Spring	P
1984	540	Spring	P
1990	UNK	Spring	Wild
1994	UNK	Spring	P
1995	70	Fall	P
2001	472	Spring	P

Wildlife:

Because of its large size, this pool has tremendous wildlife potential. It is used for nesting by a great variety of waterbirds, including diving ducks, five species of grebes, Franklin's gulls, Forster's terns, black-crowned night-herons, double-crested cormorants (*Phalacrocorax auritus*), American and least bitterns, and others. The Franklin's gull colony is one of the largest consistent colonies of its kind in North America. Maintaining adequate cover and water stability for the Franklin's gull colony is of regional importance. Waterfowl brood use is very high in most years. Spring and fall migrants concentrate in great numbers to feed on submergent vegetation and invertebrates.

Facility improvements:

Year	Project	Location

2007	New Stop Log Structure to Ditch83	SW corner of Pool next to Pool 8 outlet WCS
2006	Rehab spillway	Agassiz to Parker
2006	South Radial gate	Bottom rubber seal replaced
2005	New Gauge	< -0.1' from old readings
2000	Radial and screw gate repairs, rubber seals, corrugated metal surface, stainless steel cable	
1991	Radial gate repairs	Replace rubber seals and lift cables
1987	Wild Celery planted	Near Ditch 11 in center of pool
1979	(see Headquarters) (see Thief Bay)	
1977	(see Webster) (see Thief Bay)	
1976	(see Mud River)	
1973	Replace 3'x4' CB with 2-72"x44" arch pipes	Diversion ditch
1970	(see Webster)	
1967	Replace 5'x5' screw gate with 2-14' radial gates and 1-36" screw gate	Ditch 11 outlet

Needs, restrictions, and objectives:

Seventy years of wave action have taken a toll on the drainage of this pool. Sedimentation caused by severe erosion of the Ditch 11 and Diversion spoils within Agassiz Pool has occurred. In addition, excessive siltation deposits have occurred where the two ditch systems and the Thief River enter the pool. These silt deposits are the result of soil erosion due to expanded agriculture and subsequent ditching activity east and north of the Refuge. It may be necessary to clean Ditch 11, the Thief River (north), and the Diversion Ditch their entire lengths within Agassiz Pool or at least short segments of the ditches where sediment deltas are forming. The cuts in the spoil banks that allow the pool to drain into the ditch need to be cleaned at that time also. During drawdown significant amounts of sediment are eroded out of these cuts as the low water finds its way into Ditch 11.

The pipe portion of the control structure between Agassiz and Pool 8 is beginning to show deterioration and needs to be replaced in approximately five to ten years. During the next drawdown the old bridge piling at the junction of the Mud River Ditch and Ditch 11 needs to be cut off.

In 1970, a mutual verbal agreement of understanding with neighboring landowners established a maximum winter pool level of 1,139.0'. At that level, adequate flood

storage would be provided to accommodate spring runoff in most years, yet maintain water levels for muskrats and minnows.

By agreement with the RLWD, the new four-bay stoplog WCS that empties directly into Ditch 83 next to Pool 8 cannot be used when gauge readings at the County Road 7 Bridge on the Thief River are above 1137.0'. This is to prevent the perception that we are increasing our outflow capabilities with the new WCS. This WCS is intended to increase flexibility for winter flows and low summer flows and is not to be used to augment high flows during flood conditions.

The MPCA has designated the Thief River between Agassiz Pool and Thief River Falls as impaired for suspended sediments and dissolved oxygen. In 2007, a joint study will be implemented for more intensive sampling of the ditch and streams in the area to determine sources of sediment and low oxygen. After the study the MPCA will develop recommendations using voluntary practices to reduce the TMDL to the accepted standard. These recommendations may influence how the Refuge discharges water.

The 1987 Marsh and Water Plan recommended to not manage Agassiz Pool for nesting habitat because of its large size and inability to safely control water levels during the nesting season (i.e., keep summer water level fluctuations to less than six inches). The recommendation was to maintain a summer pool level of 1,140.0' or more to limit emergent nesting cover throughout most of the basin and create habitat for brood rearing and migrational use, not for nesting. For the majority of years between 1992 (after drought years of late 1980s) and 2006, the water level was managed at 1,140.0' for the summer with many summer floods exceeding this level. Cattail areas have remained relatively unchanged with some decrease along the west side, but hardstem bulrush has increased dramatically. The current vegetation mix is very conducive to both nesting and brood use. Jeannine Vorland's (pers. commun.) study in the early 1980s found that there can be over 1.0' difference in the elevations of the pool during major inflow events as the crest moves through the pool. She also felt that the pool was capable of being managed for nesting cover.

The current recommendation is to manage the pool for nesting and brood use, recognizing that there will be pool bounces during some summers that eliminate most waterfowl nests in the emergent cover. During the nesting season, strive to keep water level bounce during runoff events to less than six inches. While the floating nests of the gulls and grebes and elevated nests of the herons usually survive the major flood events, they become very susceptible to wave action and nesting success is greatly diminished. The best summer pool elevation appears to be 1,140.0' for the majority of years, with some years dropping down to 1,139.0' – 1,139.5' to keep the emergent cover from disappearing. University of Minnesota-Morris student Sarah Huschle examined brood count and water level records in 2000. The optimum level for diving duck broods was predicted to be 1,140.7' and the optimum level for dabbling duck broods was associated with 1,139.8'. The highest total numbers of both brood types combined was at 1,140.2'.

The option for elevations above 1,140.0' may be necessary in the future to reduce emergent cover; however, an increased frequency of summer floods may make planning for these elevations unnecessary (e.g., the 1990s was the wettest decade of the past century). Elevations around 1,141.0' were commonly employed in the 1940s, 1950s, and 1960s and the pool was nearly devoid of emergent cover.

Prescription:

The recommended management prescription is for **Deep Water Marsh** with a 10 year complete drawdown cycle. The drawdown will only be successful on years without major summer runoff events or prolonged spring flooding. Drawdown may need to be postponed or retried a second year if runoff events spoil the effort. These drawdowns will start in early May and target the third week in May for exposing mudflats for shorebird use. Planning a drawdown requires coordination with Thief Lake WMA, Lake Alice NWR, and Sand Lake NWR, so that adequate water is available regionally for Franklin's gull colonies. Within the Refuge, drawdown planning should avoid concurrent drawdowns in Parker, Farmes, Thief Bay, Tamarack, Northwest, and Madsen pools. The next drawdown should be in 2010.

To stimulate submergent vegetation and invertebrates during the 10-year interim, set the summer objective level to 1,139.0' in year six, followed by 1,139.5' the following year, and return to 1,140.0' thereafter. For example, in 2006 the drought kept the pool at or below 1,139.0' and so 2007 will be planned for 1,139.5'. Year six of the cycle is used for the 1,139.0' elevation to accommodate drawdown of Thief Bay Pool. This is the best time to conduct burns of the islands and large areas of cattail within that pool. It should be noted that at lower water levels it is very hard to get around with the airboat to make firebreaks.

During September and October, the water level should be gradually lowered to 1,139.0' for over winter. Freeze-up normally occurs in early November and renders use of the radial gates very difficult. At that time shift the outflow to the new four-bay stoplog WCS near Pool 8 that empties into the old river channel (Ditch 83) below Pool 8. Prolonged winter outflows from Thief Lake WMA and the South Moose River Impoundment can be estimated at that time and the proper amount of stoplogs removed to meter out the water over winter. The screw gate at the Ditch 11 structure can also be kept **wide open** to augment larger flows in early winter until sub zero weather arrives. The screw gate will freeze in place after exceptionally cold weather arrives unless it is wide open keeping a strong flow of warm water moving. When the screw gate is wide open we found that it can be closed or lowered to smaller opening during mid-winter. In early winter try to have a large enough outflow to keep the increase in Pool level to less than 1' to prevent drowning out muskrat houses, etc. and then adjust to meter out the increased levels over the remainder of the winter until 31 March.

When water is needed to fill Pool 8, Madsen, or Parker pools in the spring, runoff should be captured in Agassiz Pool to elevation 1,141.5' and held until the other pools are filled or until late April. However, releasing the extra water out of Agassiz Pool in late April needs to be done with a ramp up and ramp down sequence to minimize ditch bank erosion down stream and to prevent the stranding of spawning fish.

Agassiz NE Upland (HMU 16)

Size: 428 acres

Physiography:

This triangular HMU has a graveled road (Webster Trail) on the north side, the Wilderness Area on the west side, and the dredged outlet channel of Mud River Pool on the east side. The HMU consists of emergent marsh and open water that is part of Agassiz Pool. It contains one wooded island. The north end has a decomposed peat soil that is capable of growing aspen, but is currently vegetated by grass, sedge, and willow.

Burn history:

Year	Acres Burned	Time of Year	Type
1973	UNK	Spring	P
1980	400	Spring	P
1984	710	Spring	P

Wildlife:

The open water areas receive high use in the fall by migrating dabbling ducks. Broods are also regularly observed in this area.

Needs, restrictions, and objectives:

The area is difficult to burn due to the lack of an adequate fireline between it and the Wilderness area. The dike on the east boundary is difficult to travel, even for the tracked vehicles.

Prescriptions:

Agassiz Pool is in a 10-year drawdown cycle with a low water year in year six. This HMU can be burned during either of those time periods during the fall. Airboats would be used to establish firebreaks when there is sufficient water and Marsh Master tracked vehicles when the pool is dewatered. The next drawdown is 2010 and the next low water year is 2016.

Tower Road Upland (HMU 17)

Size: 1,394 acres

Physiography:

The HMU has a graveled road on the east side, the Diversion Ditch and Tower Trail on the south side and ditch channel on the west side. The west half and south side of the HMU consists of a portion of Agassiz Pool and grades into sedge and willow before becoming mostly woodland. The east side of the HMU is a continuation of the peat bog found in the CCC HMU. At this time there are no tamarack or black spruce growing, but there are areas of open sphagnum bog with bog shrubs and sedges present. The decomposed peat soils surrounding the bog have a high site potential for aspen, but many of the older trees were killed in a prescribed burn in the drought year of 1980. Additional trees were killed along in the south-central portion of the HMU in 1987.

Burn history:

Year	Acres Burned	Time of Year	Type
1980	900	Spring	P
1987	700	Spring	P

Wildlife:

The pool portion of the HMU is used by nesting birds. A spoil bank in the HMU is used as a den site by a wolf pack. Ruffed grouse and deer use the upland area extensively.

Needs, restrictions, and objectives:

The west boundary of the HMU is difficult to black line and defend, making it hard to prescribe burn. The objective in the HMU will be to allow aspen to grow to an uneven-aged stand. Black spruce and tamarack should be encouraged to colonize the bog areas of the HMU.

Prescription:

The HMU is in the **Old Growth** prescription, with a 10-year burn cycle. Burns will be conducted in the spring to minimize trees killed. Burning should only be done under parameters that will not develop crown fires and kill trees. No cutting of trees or mowing is necessary in this HMU. Trees along the edge may need to be manicured for road and trail maintenance. The next burn is in the spring of 2009.

CCC (HMU 18)

Size: 891 acres

Elevations: **Middle CCC Pool**

	Pool elevation	Surface acres	Acre-feet
normal summer:	1,142.5'	144	147
spillway:	1,144.5'	194	531
drawdown:	1,140.0'		

Depth at 1,144.5': over 50% >3-4 ft.; over 30% <2 ft.

Control structures: outlets 1, inlets 1
Spillways: outlet 1
First year operation: 1972

Physiography: **Middle CCC**

This small pool is predominately open water with a narrow band of cattail and common reed that contains few openings. The open portion of the basin is flat and uniform. Bottom elevation abruptly increases one to two feet in the emergent zone. Vegetation grades into sedges, grasses, and willows along the south side and into hardwoods along the east end. High pool levels will drown out the emergent vegetation in the south and north sides of the pool and create some dispersion in the emergents along the south side. Moist soil annuals respond well during drawdowns. Beaver activity below the WCS in the Mud River channel can prevent drawdowns from being effective.

Water movement: **Middle CCC**

Primary water source is Upper Middle CCC Pool. When Upper Middle CCC Pool fills to above capacity the water overflows through the bog on the south side and into Middle CCC Pool. The WCS on the west end outlets into Agassiz Pool.

Estimated time to dewater is five to seven days. Agassiz Pool must be lower than 1,140' for complete drainage.

Drawdown history: **Middle CCC**

The pool was dewatered in April 1982 to repair a leaking control structure. Exposed mudflats were aerially seeded with Japanese millet (*Echinochloa esculenta*) and buckwheat in early July, but germination did not occur. Good growth of dock and spike rush (*Eleocharis* spp.) covered the mudflats by late July. In 1983, the pool was again

dewatered in April to establish moist soil vegetation. Some water remained in the center of the basin during the summer. Dense stands of spike rush and softstem bulrush colonized peripheral areas and sago pondweed was present in shallowly flooded areas. In 1984, spillway level was maintained to retard cattail growth. Some reduction of cattail did occur, particularly along the northwest. The open basin was nearly covered by a dense stand of sago pondweed in August. In 1986, the pool once again was in drawdown to manage for moist soil vegetation. Complete dewatering did not occur due to high water in Agassiz Pool (1140.0'), combined with a new beaver dam below the outlet.

Dewatering was started in the fall of 1996 and the pool was in drawdown in 1997. In 2003 the pool was in drawdown, but beaver activity below the WCS kept the pool from going dry. HMU 18 was last burned in April 2003. The pool was kept in drawdown in 2004 and mudflats were exposed most of the summer.

Burn history: **Upper Middle and Middle CCCs**

Year	Acres Burned	Time of Year	Type
1982	280	Spring	P
1984	375	Spring	P
1989	500	Spring	P
2003	700	Spring	P

In 1991, a stand of aspen growing between Upper Middle CCC Pool and Middle CCC Pool was clearcut.

Wildlife: **Middle CCC**

The main value of this pool appears to be food production as evidenced by periodic heavy use by fall migrant waterfowl. Shorebird response to drawdowns has been excellent. Black terns often select the area for nesting. Waterfowl pair and brood use includes buffleheads, which may result from the close proximity to the mature aspen on the south side of this pool.

A wolf pack uses the dike in the southwest corner as a den site in some years.

Facility improvements: **Middle CCC**

Year	Project	Location
2003	New gauge	no change
1994	WSC repair	
1987	Disking	Basin and higher contours
1974	Install 1-36" CMP	Northeast corner
1970	Dike lift	North dike

Needs, restrictions, and objectives: **Middle CCC**

Other than when beaver create problems, this pool can be reliably dewatered. The additional water from Kelly Pool entering through the new Kelly to Upper Middle CCC control structure may make reflooding during drawdowns occur more often in the future. This pool will be in the five-year drawdown cycle and managed for brood habitat. Some increase in emergent vegetation in the open water area of the pool would be desirable.

Prescription: **Middle CCC**

The pool will be in the five-year drawdown cycle but will only be burned every 10 years, when all of HMU 18 is burned in the spring. Extra attention should be given to the drawdowns to establish the crop of moist soil annuals that this HMU is capable of and to provide shorebird habitat. Moderate water levels between 1,141.0' and 1,142.0' should be used for several years to encourage an increase in emergent vegetation in the open areas of the north side of the pool. Deeper water levels have proven to easily keep these in check.

The next drawdown is in 2009 and the next drawdown and burn in 2014. The water levels should be lowered in the late summer and fall in 2013 in preparation for a more complete burn on the emergents along the south side.

The uplands of HMU 18 are in the **Old Growth** Prescription. The HMU consists mostly of a large black spruce/tamarack bog with a narrow band of aspen surrounding it. These trees will not be cut and mowing will not be done in this HMU. Burning will be done in the spring, only when ample saturation of the bog is present to prevent the fire from crowning and killing trees. The current burn plan reflects this objective. Upper CCC Pool should not be in drawdown for these burns.

Elevations: **Upper Middle CCC Pool**

	Pool elevation	Surface acres	Acre-feet
normal summer:	1,144.9'	90	Unknown
spillway:	--		
drawdown:	1,141.9'		

Depth at 1,144.9': 100%<3 ft.

Control structures: outlets 1, inlets 2
Spillways: none
First year operation: 1974

*Estimate-engineering data not available

Physiography: **Upper Middle CCC**

The pool is basically linear in shape. The deeper north portion is dominated by cattail, whereas sedge is dominant along the south side. The south side is bordered by a deep peat bog with a black spruce and tamarack overstory. An open bay at the east end is surrounded by dense cattail with little open water interspersion. Openings in the west end are dependant on high water levels.

Water movement: **Upper Middle CCC**

Primary water source is Pool 21 through its outlet WCS. A newly installed WCS between Kelly Pool and Upper Middle CCC will provide an additional water source. Kelly Pool has excess water more often than Pool 21. The outlet WCS at west end dumps into Middle CCC. While there isn't a constructed spillway, the pool spills into Middle CCC Pool by way of the edge of the bog. There is no spillway flow into Upper Middle CCC Pool, but under extreme flood conditions Kelly Pool overflows the dike into the Pool.

Estimated time to dewater is five days. Middle CCC Pool must be 1,142.0' or lower for complete drainage.

Drawdown history: **Upper Middle CCC**

The pool has not undergone a complete drawdown since it became operational. Partial dewatering has occurred at least twice in response to structure failures. The pool was in and out of drawdown conditions during 2002.

Burn history: **Upper Middle CCC**

See Middle CCC Pool

Wildlife: **Upper Middle CCC**

Canvasbacks and redheads nest in fair numbers, but brood use is usually low. Each spring, canvasback and redhead courting pairs typically are numerous in the open bay in the east portion of the pool.

Facility improvements: **Upper Middle CCC**

Year	Project	Location
2005	structure replaced	outlet structure
2003	gauge replaced	+0.4'
1986	3' lift over 4500'	Narrow dike
1970	Filled 100' E spillway	Narrow dike

Needs, restrictions, and objectives: **Upper Middle CCC**

To maintain some interspersion on the west end, water levels above 1,144.0' are required for part of the cycle. Beaver have historically been a problem with the outlet WCS.

Prescription: **Upper Middle CCC**

Upper Middle CCC Pool is in the **Brood Habitat** prescription and in a five-year drawdown cycle. Prescribed burns will be spring burns at 10-year intervals when all of HMU 18 is burned. Upper Middle CCC Pool is the water firebreak on the east, south, and half of the north side of the HMU. It probably has the strongest influence on the saturation level of the peat bog. Since HMU 18 is designated an **Old Growth** prescription the fires are not intended to be hot, crown killing fires. Upper Middle CCC Pool should not be in drawdown during the burns and should have a water level of at least 1,143.9'.

In 2007 Upper Middle CCC Pool will be at a moderate level of 1,143.0'. This level will accommodate the drawdown on Pool 21. In 2008 and 2009, the water level should be returned to 1,144.9' to reclaim the interspersion after two years of low water levels. The next drawdown is in 2011, which misses (as intended) the HMU 18 burn year of 2014 and the surrounding pool drawdowns.

Lower CCC Pool (HMU 19)

Size: 908 acres

Elevations:

	Pool elevation	Surface acres	Acre-feet
normal summer:	1,144.5'	495	916
spillway:	1,145.0'	556	1,163
drawdown:	1,142.0'		

Depth at 1145.0': 100% <3 ft.

Control structures: outlets 1, inlets 1
Spillways: outlets 1, inlets 1
First year operation: 1972

Physiography:

The majority of the pool is dominated by cattail along the west and central portions, but there are areas of good interspersion with open water in the north-central and southwest portions. Sedges and common reed dominate along the southern and eastern portions. High water levels can be effective in decreasing emergent vegetation along the west side.

The uplands in the north portion of this HMU are peat bog soils that are capable of growing black spruce and tamarack trees. The deep-water pockets in the north-central portion of the pool may be from peat burnouts.

Water movement:

Primary water source is Pool 21. One WCS and the Pool 21 spillway flow into Lower CCC Pool. The outlet structure and Lower CCC Pool spillway flow into Agassiz Pool. During extremely high flood events the Diversion Ditch overflows into Lower CCC Pool in several places along the south side. This pool is one of the easiest to control water levels in.

Estimated time to dewater this pool is seven to ten days. The potholes in the north-central portion do not drain completely.

Drawdown history:

In 2000, a drawdown was initiated in March and April and the pool was burned in October. The planned drawdown for 2005 was successful and the pool was burned on 23 August, 2005. This was Agassiz's first summer burn of a large area and the cattail burned hotter than expected.

Burn history:

Year	Acres Burned	Time of Year	Type
1973	UNK	Spring	P
1976	UNK	Spring	P
1981	933	Spring	P
1987	430	Spring	P
1994	UNK	Spring	P
2000	800	Fall	P
2005	475	August	P
2006	368	Spring	P

Wildlife:

In the 1980s general waterfowl use increased as openings increased. The pool receives consistent use by nesting diving ducks, broods, and late summer and fall use by dabbling ducks.

Facility improvements:

Year	Project	Location
2003	Gauge replaced	+ 0.2' to old readings
1990	Disking	23 acres in SW portion
1970	Dike lift	North Gate Road

Needs, restrictions, and objectives:

This pool is well suited for nesting and brood rearing due to a good control of water levels. The emergent vegetation can be controlled by high water levels on the west portion of the pool.

When the pool is in drawdown, the outlet WCS needs to be watched for Agassiz Pool backing into Lower CCC Pool. During drawdowns, pumping is effective to remove the water remaining in the roadside ditch.

Prescriptions:

Lower CCC Pool is in the **Brood Habitat** prescription and will be on a five-year drawdown and summer burn cycle. A fall burn would be a second choice if the summer burn is missed. The drawdown year should be followed by a near spillway water level to control emergent vegetation. Subsequent years can be adjusted according to the results observed. For example, 2006 although scheduled to be at 1,144.5' turned out to be a low water year, so 2007 will also be planned to be at 1,144.5'. The last drawdown and burn was in 2005, so the next one is scheduled for 2010.

The uplands are in the **Shrubland/Open Grassland** prescription and are also in a five-year summer or fall burn cycle so the entire HMU should be burned together. Aspen clones and willow should be mowed at least two years prior to the scheduled burns. A lot of mowing and tree cutting was done in 2004/05, but there are still aspen areas in the southeast portion and on islands in the pool that should be cut. Firewood cutters or commercial cutters could harvest the aspen near the road in 2008/09 or subsequent years.

Hinterlands North (HMU 20)

Size: 1,634 acres

Physiography:

The south and west boundary of the HMU is a grassy dike along the Diversion Ditch and Pool 21. The north side is the road along Ditch 2 and in the east half of the HMU it is bounded by a private field. The east side of the HMU is a mowed firebreak on the

Refuge boundary with Eckvoll WMA. The east side is the only difficult fireline to prepare and blackline. A joint burn with the MNDNR eliminates the need for this firebreak. The southeast half of the HMU is a ponded peat that is a mixture of sedge, willow, and common reed. The north half of the HMU is a mixture of loams and mucks. The loams have some mature aspen and many young aspen clones. The muck soils are in willows and sedge meadows. Part of this HMU is the watershed that feeds Pool 21 and the southern part of the HMU drains into the Diversion Ditch through a culvert 100 m east of the Diversion Ditch Weir.

Burn history:

Year	Acres Burned	Time of Year	Type
1960	UNK	Spring	P
1973	740	Spring	Wild
1980	UNK	Spring	Wild
1987	1,170	Spring	P
1990	200	Spring	Wild
1999	1,000	Spring	P
2003	1,590	Spring	9E-N Wild
2003	1,275	Spring	Wild

Wildlife:

This HMU often has a high deer density in the mid-winter big game survey. In past years it also was a favored site by moose. The distance to emergent marsh brood habitat limits its value for waterfowl nesting.

Needs, restrictions, and objectives:

Several field ditches from private land empty onto this HMU. U.S. Fish and Wildlife Service special use permits (SUP) are issued to allow the cleaning of the ditches onto the Refuge to facilitate farming operations. The HMU is bounded by dikes that keep the water levels higher than naturally would occur and yet do not create an impoundment. The HMU is best suited for deer and ruffed grouse management. **Even-aged Aspen** management will also benefit sharp-tailed grouse as part of the shifting mosaic of open landscape. Burning will be used to keep the browse available and nutritious.

Prescription:

The HMU is in the **Even-Aged Aspen** prescription. The HMU will be clear cut in 2007/08. As much mowing as possible should also occur in the tall decadent willows. An exchange of service contract should be issued for the aspen stumpage and the willow mowing. The HMU will be burned in the spring every five years, starting in 2010. This

starting year will give two growing seasons of grass and sedge to accumulate to carry the fire into areas that did not get mowed and thin aspen resprouting. Future burns are not intended to kill the maturing aspen but should top kill most of the shrubs so they resprout to provide browse.

Pool 21 (HMU 21)

Size: 1,353 acres

Elevations:

	Pool elevation	Surface acres	Acre-feet
normal summer:	1,146.9'	1,401	3,233
spillway:	1,147.1'	1,627	3,502
drawdown:	1,143.6'		

Depth at 1,147.1': over 2%>4 ft; over 60%<2 ft.

Control structures: 4
Spillways: 1
First year operation: 1972

Physiography:

Pre-construction aerial photos reveal that the basin was dotted with small peat burnouts. These burnouts account for the fine matrix of interspersed open water and emergent vegetation that remains evident. There are also many small islands of willow scattered throughout. A narrow band of willow and sedge lines the west edge and to the east, emergents grade into uplands. The eastern quarter of the HMU is sedge meadow and willow sedge being invaded by aspen. The highest areas in the southeast give rise to grassland.

Water movement:

Principle water supply is from the Diversion Ditch through the two screw gates located at the Diversion Ditch WCS. During flood events the Diversion Ditch over flows the dike between the two and spills water into Pool 21 in at least three places. As flood waters recede, the water reverses and flows back into the Diversion Ditch. In 1997, one of the resulting cuts was lower than the spillway.

The purpose of the Diversion Structure was to create enough head to supply water to the CCC pools through Pool 21. During the wet decade of the 1990s and early 2000s these screw gates were rarely used as the local watershed to the east kept Pool 21 flowing into

Upper CCC Pool. This local flow comes across a low water crossing at the north end of the angle dike that forms the east boundary of the HMU.

Primary outlet is into Upper Middle CCC. Secondary outlets are to Lower CCC and Kelly Pool.

Estimated time to dewater is three to four weeks. Dewatering is dependent on a low water level in at least one of the downstream pools.

Drawdown history:

In 1986, the pool was dewatered to re-establish early successional emergents and to permit a burn within the basin and adjacent uplands. Many pockets of open water remained during the summer but gradually dried by evaporation. Seedlings of cattail, softstem bulrush, smartweeds, and spike rushes became well established by late summer. A prescribed burn was not achieved. Only a partial drawdown was achieved in 2001 due to inflows.

In 2005 and 2006, the pool was in drawdown as part of an inter-regional U.S. Fish and Wildlife Service/USGS impoundment study to look at bird response to two different drawdown sequences. The study plot was approximately eight acres in the northwest corner that is traditionally an open water area. In 2005, the drawdown was in late summer. In 2006, the drawdown was initiated in May and was season-long, with the intention of shallow water being placed back on the mudflats in October. Lack of precipitation prevented the planned reflooding from occurring.

Burn history:

Year	Acres Burned	Time of Year	Type
1977	UNK	Fall	P
1981	100	Fall	P
1987	180	Spring	P
1990	UNK	Spring	Wild
1996	10	Spring	P
1998	250	Spring	P

Wildlife:

Diving duck nesting use was excellent in the early 1980s and continues to be good in this pool. Fall use by migrants, especially gadwalls and mallards, is high in years when lowered water levels create extensive shallow feeding sites. Migrant sandhill cranes roost along the east edge of the marsh in most years. The shallow inundation of the mudflats in the northwest corner during the fall of 2005 made it extremely popular with green-winged teal.

Huschle (2000) determined the best water level for diving duck broods was 1,146.0' and for all duck broods 1,146.7'.

During the moose research in the 1990s, several neonate calves were captured in this pool. The small islands are excellent moose calving sites.

Facility improvements:

Year	Project	Location
2003	gauge replaced	+0.6' Pool 21 to Upper Middle CCC
1986	(see Kelly)	

Needs, restrictions, and objectives:

The interspersion of cover:water that existed in the early 1980s was optimal for this pool based on nesting studies. This interspersion was attributed to maintaining the water levels near spillway elevation during at least some years. This was also true for the 1990s. The maintenance of this interspersion is dependant upon maintaining near spillway water levels at least several years in every five and should be part of the management of this pool. The Diversion Ditch WCS can usually supply water to bring this pool to objective levels in the spring. When this is needed the screw gates should be opened as soon as possible as the head may be of short duration.

Prescriptions:

Pool 21 is in the **Brood Habitat** prescription. The pool will be in a five-year drawdown and summer burn cycle. If competition for summer burn time occurs fall burns will be acceptable since interspersion is has been adequate in this pool in recent years. Water level the year following the drawdown can be at a mid-pool level to encourage growth of ephemeral emergent vegetation. This should be followed by two years at near spillway levels prior to the next drawdown.

The upland area in the east end of the HMU is in the **Open Shrubland/Grassland** prescription. This area should be burned every five years along with the pool portion of the HMU. This area will benefit from at least occasional summer burns. Mowing of willows and young aspen should be done two years prior to the burns. Any commercially attractive timber can be sold with a clearcut contract for HMU 20 in the winter of 2007/08 or subsequent years.

The pool is in drawdown in 2007 and has been in drawdown for portions of three years as of 2007. The HMU cannot be burned in 2007 due to constraints of the inter-regional impoundment research protocol. The HMU will be burned in the summer of 2008. The pool should be brought up to an elevation of 1,145.0' in 2008 and to 1,146.9' for at least

the following two years. The next drawdown and burn is in 2012. Mowing of the HMU should take place in 2010. Any commercially desirable aspen should be taken with the clearcut in HMU 20 in the winter of 2007-08 or subsequent years.

Hinterlands South (HMU 22)

Size: 2,528 acres

Physiography:

HMU 22 is bounded on the north side by the Diversion Ditch and the grassy dike along side it. This dike is graveled on the west half and the East 80 crop fields make up the west border of the HMU. The south side is the grassy dike along Ditch 11 and then mowed firebreak between the Refuge and the Eckvoll WMA. This HMU is difficult to burn without a joint burn with the MNDNR (burning a portion of the adjacent state tract). The HMU is mostly ponded peat and ponded muck soils that have sedge and willow growing on them. There are isolated pockets of aspen on the limited amount of loamy soils and a large area in the southwest corner. The historic Mud River channel traverses the HMU from east to west. Siltation has filled the channel and it is not discernable on the ground, but is still evident on aerial photos. Water flows across the HMU when the Diversion Ditch floods out of its banks. A control structure at the East 80 farm fields impounds water in the east/west drainage ditch in the middle of the HMU.

Burn history:

Year	Acres Burned	Time of Year	Type
1975	325	Fall	Wild
1976	UNK	Spring	P
1980	UNK	Spring	Wild
1984	264	Fall	Wild
1986	UNK	Fall	Wild
1990	UNK	Spring	Wild
2005	5.7	Spring	blackline
2005	2037	Spring	P

Wildlife:

This HMU often has a high deer density in the mid-winter big game survey. It also was a favorite with moose in past years. The distance to emergent marsh brood habitat limits its value for waterfowl nesting.

Needs, restrictions, and objectives:

The HMU is bounded by dikes that keep the water levels higher than would naturally occur and yet do not create an impoundment. The HMU is best suited for deer and rail management. **Even-aged Aspen** management will also benefit sharp-tailed grouse as part of the shifting mosaic of open landscape. Burning will be used to keep the browse available and nutritious. The spring wildfire of 1990 killed most of the older aged aspen trees in this HMU.

Discussions about restoring the historic Mud River channel to a meandering riparian river have been discussed. This is probably not feasible without a full scale dredging of the old channel so that it is lower than the Diversion Ditch. This would create another set of spoil banks affecting runoff of the adjacent sedge meadows. The Diversion Ditch structure does create a head on the upper end of the Diversion Ditch now and it is insufficient to force water down the old channel except during floods when the whole area is under water. The first step to be tried would be to give the old Mud River channel an outlet into the Diversion Ditch opposite the Pool 21 road turn off. There is a control structure at the East 80 farm fields that backs water up in the lateral ditch that drains the area. This control structure could be left open to facilitate water movement across this HMU and a more natural hydrology. The historic Mud River channel would have provided this drainage in this area.

Prescription:

The HMU is in the **Even-Aged Aspen** prescription. Aspen in the HMU will be clear cut in 2025-26. This is the direct opposite of the HMU 20 rotation to provide maximum diversity in these two large, adjacent HMUs. As much mowing as possible should also occur in the tall decadent willows at the time of the aspen cut. An exchange of service contract should be issued for the aspen stumpage to have the willow mowed. The HMU will be burned in the spring every five years, starting in 2009. Burns are not intended to kill the maturing aspen but should top-kill most of the shrubs so they resprout to provide browse.

An outlet for the historic Mud River channel should be created by breaching the spoil bank of the Diversion opposite the Pool 21 Road turn off. Connectivity between the east/west ditch and the historic channel should be explored. Meanwhile the WCS at the East 80 boundary should be left open to allow more natural hydrology on the HMU.

Madsen Pool (HMU 23)

Size: 2,025 acres

Elevations:

	Pool elevation	Surface acres	Acre-feet

normal summer:	1,141.0'	1,845	4,562
spillway:	1,141.5'	1,845	5,485
drawdown:	1,137.0''		

Depth at 1,141.5': over 10%> 4.5 ft; over 75%<2 ft.

Control structures:	outlets 1, inlets 1
Spillways:	outlets 1
First year operation:	1938

The water gauge was replaced in 2003. A very large discrepancy was found in the elevations that must be considered when referring to elevations prior to 2003. The new staff gauge reads 1.1' lower than the old gauge and needs to be subtracted from old readings. The gauge corrections that were done in 1972 also require subtracting 0.84' from the readings prior to that date. It seems unlikely that the gauge would have been sinking during both of those time periods. Most of the gauges tend to lift over time and require a positive correction.

Physiography:

A large expanse of sedge, whitetop, and willow dominates the northwest area of the HMU. Sedge mixed with common reed and cattail covers most of the southeast portion, while the southwest corner consists of a matrix of open water and cattail that is readily managed by water depth manipulation. Large open bays occupy the northeast corner. In the 1980s high water converted many sedge areas to open water in the southwest which have since been taken over by cattail. Willows have been expanding in the sedge meadows and cattail has been encroaching into the sedge fringe.

Water movement:

Principle water source is snowmelt and precipitation. The inlet WCS on the Westgate road was replaced in 1989 with a three-bay WCS and provides adequate inflow when sufficient head is developed in Agassiz Pool. The outlet WCS and spillway in the southwest corner drain into the Thief River. Dewatering is not dependent on other pools because the outlet is directly into the Thief River which normally does not restrict outflow from this pool.

Estimated time to dewater the south ½ is two weeks. The deep pockets in the northeast corner do not drain, even after a 1989 ditch cleanout. This adds diversity to the drawdown, as these pockets get very low and are heavily used by dabbling ducks during the drawdown years.

In the 1970s the spillways from Agassiz Pool into Madsen Pool were filled in to gain better control over water levels in Madsen Pool. During extreme flood events Agassiz

Pool still spills across Westgate Road for over ½ mi north of the radial gates. Madsen Pool provides flood storage and meters out the water at a slower rate through its smaller armored spillway.

Drawdown history:

All but the northeast bay was dewatered in 1961 and 1962 due to leaks in the south and west dikes. Partial reflooding occurred in 1963 and high water levels returned in 1964. This pool was in drawdown in 1987, 1988, 1989, and 1997. Madsen was also in drawdown from 2003 through 2007 due to poor condition of the outlet structure and impending replacement.

Burn history:

Year	Acres Burned	Time of Year	Type
1959	UNK	Spring	P
1961	UNK	Fall	P
1962	UNK	Fall	P
1963	UNK	Spring	P
1963	UNK	Fall	P
1967	UNK	Fall	P
1970	UNK	Fall	P
1972	UNK	Fall	P
1974	UNK	Fall	P
1978	UNK	Fall	P
1983	630	Spring	P
1984	370	Spring	P
1985	848	Spring	P
1987	1,600	Fall	P
1988	200	Spring	P
1991	700	Fall	P
1998	300	Spring	P
2003	2,025	Fall	P
2004	3	Summer	cattail island S side
2004	2	Summer	cattail peninsula S side
2005	1,900	Summer	P
2006	3	Summer	Island
2006	20	Summer	Spray Plots

Wildlife:

When pool levels are high, diving ducks use the entire pool. Dabbling ducks nest in the sedge area in the north and the sedge hummocks in the south-central portion when water levels permit. Extensive use by molting dabbling ducks, particularly mallards, was noted

in the early 1980s in the sedge areas in the south ½ of the pool. American bittern research documented a high density of American bittern males and yellow rails using the sedge meadow in the northwest portion of the HMU during several years. The optimum water level for diving duck broods is 1,142.0', for dabbling duck broods 1,138.0', and for all duck broods combined is 1,140.0', as determined by Huschle (2000).

Facility improvements:

Year	Project	Location
2007	Outlet structure replaced	Southwest corner
2007	Spillway rehab	Southwest corner
2003	Gauge replaced	- 1.1' from old readings
1997	Spillway repairs necessary due to high water damage	
1989	Ditch cleanout	5,400 feet within Madsen
1989	WCS	Between Agassiz and Madsen
1988	Scarifying and disking	Southwest portion
1977	Filled in 300' of E spillway	Between Agassiz and Madsen Inlet WCS
1975	Convert 1947 control to 100' E spillway	Southwest corner
	Install 42" CMP	Southwest corner
	Filled in 500' E spillway	1 mi. no. of D-11 control
1976	Bridge portion removed	

Needs, restrictions, and objectives:

The dike on the west side between the pool and the Thief River channel is old dredge spoil and does not have an appropriate core. During flood conditions it needs to be watched closely as several times leaks have been detected and sealed with wood piling. This dike should be scheduled for rehabilitation.

The new Agassiz to Madsen WCS has increased the water management flexibility of Madsen Pool by increasing the rate at which it can be filled during the short time frame in the spring when there is sufficient head on Agassiz Pool to flow water into Madsen Pool. The new outlet WCS (constructed in 2007) will match the inflow capabilities and allow for passage during flood conditions or quickly dewatering the pool. Madsen Pool does provide an important role for water storage when Agassiz Pool is reaching its upper limits and provides additional buffering of flood waters being spilled out of Agassiz Pool.

The east-west ditch clean-out in 1989 did not improve the ability to drain the open water basins in the northeast corner. The deep pockets should be accepted the way they are, as part of the habitat diversity of the pool and refugia for less mobile species during drawdown.

Management of this pool is being changed to emphasize the sedge meadows, rather than the over-water nesting potential. It is easier to control water levels on Madsen Pool than many of the other pools and the increased flexibility with the new WCSs should make it even easier.

Prescriptions:

Madsen Pool will be under the **Sedge Meadow** prescription. Drawdowns will start during May and be followed by late summer burns during the same year. The drawdown and burn will be on a two year rotation. Burns should be between 15 July and 30 August. The normal summer pool level on the wet alternate year should be at elevation 1,138.5' - 1,139.0' and slowly dropped another 0.5' in August. The sedge meadows in the northwest portion should be checked when the water level is at 1,139.0' for adequate saturation and this figure adjusted accordingly. The need for drawdowns may become less frequent over time if this strategy is successful in increasing the area of sedge meadow in this HMU. The high frequency of fire should keep willows and aspen in check.

In 2007, the pool will still be in drawdown for the Madsen Pool outlet and spillway replacement project. In 2008, the pool will be in drawdown due to the Ditch 11 rehab project. From a habitat availability perspective it would be best if Madsen and South Pools are in opposite alternating years of drawdown and burn. South Pool will be in drawdown in 2007, 2009, etc. to match up with Parker and Headquarters drawdown in 2013. This means that Madsen Pool should end up in drawdown in 2008, 2010, etc. We plan to burn Madsen in summer 2007. The next burn will be in 2010.

The sprayed plots along the south boundary of the HMU should be watched to see if sedge colonizes these areas, rather than cattail. Results could be appropriate for determining if spraying cattail along the sedge/cattail interface would be a successful strategy on Madsen, Upper Mud River, Kelly, South, and Webster pools.

Johnson Island (HMU 24)

Size: 780 acres

Physiography:

HMU 24 consists of a portion of the east side of Agassiz Pool and water levels and drawdown events are tied to Agassiz Pool. The north boundary of the HMU is the Diversion Ditch. The east side is Northgate Road and the grassy dike separating the Golden Valley HMU. The south side is Ditch 11. The west side has a variable boundary in Agassiz Pool that takes advantage of natural breaks in the cattail and historic Mud River channel. In the middle of this HMU is a large wooded island (Johnson Island). It

has several large cottonwood (*Populus deltoides*) trees, one of which contained held a bald eagle nest until it blew over 2005. In the extreme northwest corner is the Diversion Ditch Island. This island also has several large cottonwoods. One of these trees has an active eagle nest. Trees on both of these islands are mostly aspen and black willow (*Salix nigra*).

The majority of this HMU is muck soils that have emergent cattail marsh habitat. This grades into a sedge/willow complex on the east side. The islands are loam soils.

Burn history:

Year	Acres Burned	Time of Year	Type
1980	740	Spring	P
1980	497	Fall	P
1987	1,000	Spring	P
1990	UNK	Spring	Wild
1990	3	Fall	Wild
1995	340	Spring	P
2000	160	Fall	P
2001	160	Fall	P
2001	160	Fall	P
2005	1,716	Spring	P

Wildlife:

The marsh in this area receives high use by waterfowl broods and migrating dabbling ducks. The area has been used by a bald eagle pair since 1995 and has had two nests on the wooded islands in the HMU. One of the nest trees blew over in 2005. Points for the breeding bird point count in deep marsh cattail habitat are in this HMU. Yellow rails were heard during the 2003 surveys, as the cattail had been damaged by high water the previous year and did not have typical cattail structure.

Needs, restrictions, and objectives:

The marsh habitat is being managed within the Agassiz Pool prescription with drawdowns every 10 years and at least one planned low water season in year six of the cycle. The eastern edge is sedge meadow that is invaded by willows. The objective will be to decrease the amount of willow in the sedge meadows. Bald eagle nests require some attention during prescribed burns. The litter and vegetation should be cleared from around the base of nest trees. Fire personnel should minimize time spent near the nest while monitoring the fire.

Prescriptions:

For marsh vegetation refer to Agassiz Pool HMU 15. This HMU is in the **Open Shrubland/Grassland** prescription. The HMU will be burned in the summer or fall every five years. Burning of this HMU should be coordinated with HMU 33, which is a similar portion of Agassiz Pool. When one is burned in the summer, the other will be burned in the fall, and then the opposite will be true during the next five-year cycle. The next burns for these two HMUs are in conjunction with the Agassiz Pool drawdown in 2010.

Mowing of willows and aspen clones in this HMU should take place in 2008/09

The two wooded islands in this HMU are in the **Old Growth** prescription. No mowing or cutting of trees will be done on these two islands. Cottonwoods should be planted to start replacement trees for the mature cottonwoods. It is likely that the flooded bare soil required for cottonwood establishment will not occur under impoundment management. While the two islands will be included in the summer and fall burns of the HMU, efforts to make the islands burn, such as helicopter lighting of the islands, should not occur. Litter and vegetation will be cleared from the base of eagle nest trees prior to the burns.

Golden Valley Moist Soil Units (HMU 25)

Size: 247 acres

Elevations:

Unit	Elevation	Surface Acres	Acre-Feet
Golden Valley North			
Full Pool	1,143.6'		
Golden Valley South			
Full Pool	1,143.6'		
Golden Valley West			
Full Pool	1,143.1'		

Physiography:

These are the low portions of old farm field areas in which conversion into moist soil units was attempted in the late 1970s. Since that time they have not been successful as moist soil units, either because of too much perennial emergent vegetation or lack of consistent water supply and drainage. The Golden Valley farm fields are in the southeast corner of the HMU.

Water movement:

Local runoff in the small watershed supplies some of the water for these HMUs. Water backing into the HMUs from the Diversion Ditch also supplies water, but usually too much and at unwanted times. Crusifoli pumps are sometimes used to pump water from Ditch 11 into the HMUs.

Drawdown History:

These HMUs were developed in the late 1970s as moist soil units. The attempt to manage these small HMUs as moist soil units soon fell out of favor and little was done as evidenced by the following statement from the 1989 Annual Water Plan: "The west portion of this HMU was managed for moist soil vegetation for the first time in 1988 since development in 1977. The dominant vegetation, consisting primarily of sedges and cattail, was burned in fall 1987 and disked using a D-6 in winter 1987-88. In early May (1988), water was pumped into the HMU from Ditch 11 using a Crusifoli pump. The low elevation of the west dike precluded flooding the upper contours. Water was pulled off immediately once maximum elevation was reached. However, the level of Ditch 11 precluded drawing the Golden Valley ditch level below the pool bottom and resulted in oversaturated soils. Consequently, sedges and cattails out competed desirable annuals."

In 2001 we replaced the WCS and started the following management rotation:

Treatment 1: gradual drawdown 15 May through June. Disc and burn when dry.
Treatment 2: gradual filling 15 May through 31 May.
Treatment 3: remain full all season.

The Golden Valley and Goose Pen HMUs were coordinated so one Golden Valley HMU was placed into drawdown in May and one Goose Pen HMU was placed into drawdown in late July, so one of these small HMUs was always attempting to provide shorebird habitat for migration. We were only successful in disking the West HMU one time. The only HMU that developed open water and provided shorebird habitat was the Goose Pen North HMU.

Golden Valley North was kept in drawdown in 2001 and was burned in November.
Golden Valley South was also kept in drawdown in 2001 and was burned in November.
Golden Valley West was in drawdown in 2002.
Golden Valley North was in drawdown again in 2004.

Burn history:

Unit	Year	Acres Burned	Time of Year	Type
Both	1990	UNK	Spring	Wild
North	2001	UNK	fall	P
South	2001	UNK	fall	P

Facility improvements:

Year	Project	Location
2001	New WCS	Between GV West and GV North and GV N and S and Diversion

Needs, restrictions, and objectives:

The small size of these impoundments decreases their priority for maintenance and management with limited Refuge staff time and money. Placing these HMUs into a simple two-year drawdown and summer burn cycle will improve success. All three of the Golden Valley HMUs will be in the same cycle and opposite the cycle of the nearby Goose Pen HMUs. This will simplify burning and improve success of flooding and drawdown versus trying to accomplish different things on each sub-HMU separately. The objective will be to convert the HMUs to sedge communities that will be available for marshbirds and nesting waterfowl. During drawdown years, the stoplogs will need to be placed into the Golden Valley North HMU whenever a flow is expected in the Diversion Ditch to keep water from backing into the HMUs.

These HMUs are included in the OLMA. The objective will be to convert the impoundment areas to sedge meadow and reduce the trees and willows.

Prescriptions:

All three sub-HMUs are in the **Sedge Meadow** prescription and will be in a synchronized two-year drawdown and summer burn cycle. Summer burns (15 July to 30 August) will be preferred to convert the area from cattail and discourage the invasion by willows that is occurring. If it is not burned in the summer, then it will be burned in the fall. Mowing willows during the winter will help keep their distribution in check. The drawdown and burns will start in 2007.

The farm fields taken out of production over the last 10 years have been seeded to upland prairie with big bluestem as the dominant grass. Current information provided by Zager (2007) indicates that upland prairie may not have existed on the Refuge historically. Wet prairie vegetation with blue joint as the dominant grass may have been the prairie in this locality; however, drainage has affected the hydrology of the fields and they may have areas that will support big bluestem prairie. Restoration of the remaining fields should consider blue joint wet prairie in seed selection. The steps for restoring prairie vary by site and results and will be worked out in the Annual Habitat Work Plans.

Goose Pen Moist Soil Units (HMU 26)

Size: 109 acres

Elevations:

Unit	Elevation	Surface Acres	Acre-Feet
Goose Pen North			
Full Pool	1,143.1'		
Drawdown	1,141.2'		
Goose Pen South			
Full Pool	1,143.0'		
Drawdown	1,141.0'		
East 80			
Full Pool	1,145.0'		
Drawdown	1,142.0'		

Physiography:

These are the low portions of old farm field areas in which conversion into moist soil HMUs was attempted in the late 1970s. Since that time they have not been successful as moist soil units, either because of too much perennial emergent vegetation or lack of consistent water supply and drainage.

Drawdown History:

These HMUs were developed in the late 1970s as moist soil units. The attempt to manage these small HMUs as moist soil units soon fell out of favor and little was done again until 2001. In 2001 we replaced the control structures and started the following management rotation:

Treatment 1: gradual drawdown 15 July through August, burn and disc.
Treatment 2: gradual fill 15 May through 31 May.
Treatment 3: remain full all year.

The Golden Valley and Goose Pen HMUs were coordinated so one Golden Valley HMU was placed into drawdown in May and one Goose Pen HMU was placed into drawdown in late July so one of these small HMUs was attempting to provide shorebird habitat for migration. The only HMU that developed open water and provided shorebird habitat was the Goose Pen North HMU.

The East 80 HMU was open water during the 1990s but is now sedge meadow. During the 1990s full pool was approximately 0.5' higher, but we have set a lower elevation to protect the road edge from saturation. The sedge came in after a drawdown treatment in 2003. Drawdown was initiated on 18 July at which time the pool was only 0.1' low. The pool was dry on 2 September. The pool was filled during spring runoff in 2004, but

stabilized at the new full pool level of 1,145.0'. These dates are noted for possible successful sedge establishment.

Goose Pen North was in drawdown in 2001 and was burned in the fall of that year.
Goose Pen South was in drawdown in 2002, but was not burned or disked in the fall.
East 80 was in drawdown in 2003, but was not burned or disked.
Goose Pen North was in drawdown in 2004 and was burned in the spring of that year.

Burn history:

Unit	Year	Acres Burned	Time of Year	Type
Entire Unit	1990	109	Spring	Wild
North	2001	UNK	Fall	P
North	2004	UNK	Spring	P

Facility improvements:

Year	Project	Location
2001	new WCS	East 80 wetland, Goose Pen N and S

Needs, restrictions, and objectives:

The small size of the impoundments decreases their priority for maintenance and management with the limited Refuge staff time and money. Placing these HMUs into a simple two-year drawdown and summer burn cycle will improve success. All three of the Goose Pen HMUs will be in the same cycle and opposite the Golden Valley cycle. During drawdown years the stoplogs will need to be placed into the all three of these HMUs whenever a flow is expected in the Diversion Ditch to keep water from backing into the HMUs. The East 80 HMU is within the larger HMU 27 and will be burned only when HMU 27 is burned.

These HMUs are included in the OLMA. The objective will be to convert the moist soil HMUs to sedge communities that will be available for marshbirds and nesting waterfowl.

Prescription:

Two HMUs will be in the **Sedge Meadow** prescription and in a synchronized two-year drawdown and summer burn cycle. The cycle will be opposite that of the Golden Valley HMUs. Summer burns (15 July to 30 August) will be preferred to convert the area from cattail and discourage the invasion by willows that is occurring. If it is not burned in the summer, then it will be burned in the fall. Mowing willows during the winter will help keep the willows in check. The third HMU (East 80 moist soil unit) will be in drawdown every other year, but only burned every four years when the entire HMU 27 is burned.

HMUs 26 and 27 can be burned as one unit every four years. Goose Pen HMUs will be in drawdown and burned in 2008 and will be burned with the entire HMU 27.

East 80 (HMU 27)

Size: 681 acres

Physiography:

The HMU is bounded on the north side by the gravel road along the Diversion Ditch and on the south side by Ditch 11. The west side is the grassy dike that separates it from HMU 26 and the east side is the mowed firebreak between this HMU and HMU 22. The HMU has a wetland impoundment in it. The East 80 impoundment lies in the middle of the north side. It is dominated by sedge meadow plants. The impoundment receives local runoff and is subject to flooding when the Diversion Ditch is out of its banks. The HMU drains into the Diversion Ditch. The impoundment was included in the description and prescription for HMU 26.

The soils are mostly Smiley loams that are mollisols, but have a strong tendency to be invaded by aspen without properly timed management. The East 80 farm fields are also within the HMU. A portion of these fields have been seeded to native upland prairie. The remainder of the fields are scheduled to be restored to prairie.

Burn history:

Year	Acres Burned	Time of Year	Type
1960	UNK	Spring	P
1963	UNK	Fall	P
1970	UNK	Fall	P
1976	UNK	Spring	P
1980	50	Spring	Wild
1981	61	Spring	P
1983	UNK	Spring	P
1985	424	Spring	P
1988	340	Spring	P
1990	UNK	Spring	Wild
1999	100	Fall	P
2001	520	Fall	P
2004	790	Spring	P
2004	1	Fall	East 80

Wildlife:

This area is on the north end of the OLMA designated in the CCP. The open grassland of this HMU has potential to be an intricate part of the habitat available for open landscape (i.e., sharp-tailed grouse) birds and other wildlife. The wolf pack on the east side of the Refuge uses this area as the summer rendezvous site nearly every year. This HMU affords the highest probability of seeing wolves in the summer months.

Needs, restrictions, and objectives:

This area currently has a small area of woods along the north side and a few other small scattered aspen clones. Mowing along the north side several years ago made a visual impact on the openness of the farm fields. The objective will be to reduce trees and shrubs. Management of the impoundment will be integrated with the burning of the HMU.

Prescriptions:

The HMU is in the **Open Shrubland/Grassland** prescription. The HMU will be on a four-year cycle of burning, so that the burns coincide with the drawdown of the Goose Pen and East 80 impoundments. The next burn is in 2008. The East 80 impoundment is in drawdown every other year, but will be burned only every fourth year with the entire HMU. The burns will take place 15 July to 30 August. If not burned in the summer, the HMU should be burned as early as possible in the fall. HMUs 26 and 27 will be burned together on these four-year cycle years. Current cropland will be excluded from the burn. Restored prairie will be burned with the HMU when deemed appropriate.

Mowing of shrubs and small trees can be done on a four-year cycle. The winter of 2009-10 should focus on mowing. The hydroaxe will be needed on the larger trees and willows during the first two cycles.

The farm fields taken out of production during the last 10 years have been seeded to upland prairie, with big bluestem as the dominant grass. Current information provided by Zager (2007) indicates that upland prairie may not have existed on the Refuge historically. Wet prairie vegetation, with blue joint as the dominant grass, may have been the prairie in this locality; however, drainage has affected the hydrology of the fields and they may now have areas that will support big bluestem prairie. Restoration of the remaining fields should consider bluejoint wet prairie in seed selection. The steps for restoring prairie vary by site and results and will be worked out in the Annual Habitat Work Plans.

Parker Pool West (HMU 28)

Size: 258 acres

Physiography:

The HMU is bounded on the north by Ditch 11, the west side by the Thief River (Ditch 83), the south side by the Parker outlet ditch, and on the east by the graveled Parker Road. The northern 2/3 of the HMU is all muck soils with sedge meadows. The south third is a mixture of muck and loam soils. There is a wooded riparian component to the west side along the River on dredged spoil bank and through the middle of the HMU along the Parker Pool spillway outlet channel on loam soil. The loam soil on the southern edge is dominated by the invasive reed canary grass.

Burn history:

Year	Acres Burned	Time of Year	Type
1961	UNK	Fall	P
1962	UNK	Fall	P
1976	UNK	Spring	P
1984	280	Spring	P
1985	307	Spring	P
1989	UNK	Spring	P
1994	180	Spring	P
1999	150	Fall	P
2004	258	Spring	P

Wildlife:

The HMU receives a lot of on- and off-Refuge use by deer feeding on adjacent private lands. The large sedge meadow on the north end is used by marshbirds and nesting waterfowl. A borrow pit wetland exists next to the Parker outlet WCS. The pond is heavily used by hooded mergansers, buffleheads, and other diving duck pairs and broods. The Marshall County Central High School Ecology class annually collects population trend data on small mammals in this woodland.

Needs, restrictions and objectives:

The photo station record (#28) of the sedge meadow on the north end shows extensive invasion by willows. The willows need to be decreased. A very large beaver dam in the spillway outlet channel has increased the water level on this sedge meadow and flooded out the riparian trees along the channel. The dam should be removed during years scheduled for burning to allow for hotter burns. A low water crossing was established over the spillway channel next to the river. This crossing needs to be maintained to facilitate safe and efficient burn operations.

Prescriptions:

The HMU is in the **Grassland/Sedge** prescription. The HMU needs to be burned every other year for about three cycles to set back the willow invasion. These burns will be in 2007, 2009, and 2011. If willow coverage is decreased, the burn frequency can be reduced to every four years. These burns will be summer burns when possible and fall burns if the summer burn cannot be accomplished. Air photo analysis will be used to determine change in willow coverage and should be done in 2012. This HMU will be on an opposite alternating year cycle with HMU 29.

Herbicide application with a wick applicator can be tried on the south end of this HMU to control reed canary grass.

The beaver dam on the spillway channel should be removed in the summer of the burn years to dry the sedge meadow out to create hotter burn conditions.

The woodlands along the riparian areas will be **Old Growth** designation and will not be cut or mowed. This includes the woods surrounding the old borrow pit between the Parker outlet WCS and the spillway. This designation will keep nesting sites (i.e., tree cavities) available for buffleheads and hooded mergansers.

Nelson Triangle (HMU 29)

Size: 92 acres

Physiography:

This triangular shaped HMU is bounded by the Parker outlet ditch on the north side, the graveled Parker Road on the east side, and the graveled County Road 7 on the south side. Muck soils with sedge meadows are found on both the east and west ends. A band of loamy soil wet prairie that is invaded by aspen is found in the center. The sedge meadows are invaded by willow and reed canary grass is also invading the grassland.

Burn History:

Year	Acres Burned	Time of Year	Type
1962	UNK	Fall	P
1970	UNK	Spring	P
1970	UNK	Fall	P
1972	UNK	Fall	P
1976	UNK	Spring	P
1980	60	Fall	P
1984	70	Spring	P
1985	77	Spring	P
1989	UNK	Spring	P
1996	0.1	Spring	Wild

1997	80	Fall	P
1999	30	Fall	P
2003	2	Fall	P
2005	90	Fall	P
2005	7.2		Firebreak
2006	30	Fall	P

Wildlife:

The HMU receives a lot of on- and off-Refuge use by deer feeding on adjacent private lands. The sedge meadows and grassland are used by marshbirds and nesting waterfowl.

Needs, restrictions, and objectives:

The photo station record (#2) of the sedge meadow on the east end shows extensive invasion by willows. The willows need to be decreased. Fall burning and mowing have kept the willows short and in check, but have ultimately not reduced their coverage. Reed canary grass has been difficult to get ignited and does not carry the fire during fall burns.

Prescriptions:

The HMU is in the **Grassland/Sedge** prescription. The HMU needs to be burned every other year for about thee cycles to set back the willow invasion. These burns will be in 2008, 2010, and 2012. If willow coverage is decreased, the burn frequency can be reduced to every four years. These burns will be summer burns when possible and fall burns if the summer burn cannot be accomplished. Air photo analysis will be used to determine change in willow coverage and should be done in 2013. This HMU will be on an opposite, alternating year cycle with HMU 28.

Herbicide application with a wick applicator can be tried on the north side of this HMU to control reed canary grass and on willows on the east end.

The trees on this HMU are close to County Road 7. Removal by firewood cutters is feasible.

Rodahl Triangle (HMU 30)

Size: 616 acres

Physiography:

This triangular piece is bounded by County Road 7 on the north side, the grassy trail Rodahl Cut Across on the south side, and the graveled boundary road on the west side. The HMU is easily burned, but has seldom carried a hot fire due to excessive moisture. The majority of the HMU is made up of depressional muck soils with sedge and willow plant communities. There are a handful of loam soil fingers that have aspen woodlands growing on them.

Burn history:

Year	Acres Burned	Time of Year	Type
1973	UNK	Spring	P
1981	630	Spring	P
1984	455	Spring	P
1988	460	Spring	P
1994	UNK	Spring	P
2001	15	Fall	P
2006	12	Spring	P

Wildlife:

The on- and off-Refuge use by deer is very high, as deer use the adjoining private lands to feed. The HMU has mostly woody vegetation plant communities and is suited well to deer, woodcock, and ruffed grouse. The Marshall County Central High School Ecology class has been collecting population trend data annually on small mammals and amphibians at one site in this HMU since 1994.

Needs, restrictions, and objectives:

The HMU can be burned easily, but during the last wet cycle fire has not carried well through the unit. The suitability of this HMU as an Old Growth designated area was discussed. It does have a mature stand of aspen in the southwest corner that attracts attention. However, the soils the aspen are on in this HMU are loamy mollisols rather than the decomposing peat soils that have received the Old Growth designation elsewhere on the Refuge. It also does not have other associated old growth qualities (i.e., riparian, oak woodlands). Conversely, most of the HMU has a willow plant community on it and would be difficult to convert to a very open plant community designation, such as sedge meadow, given the poor success of recent burns. The **Even-Aged Aspen** management scheme, with its associated mowing of willows seems the most appropriate management of this HMU to sustain deer and ruffed grouse habitat.

Prescriptions:

HMU 30 is in the **Even-Aged Aspen** prescription. The HMU will be burned in the spring on a five-year rotation. The next burns are in 2012 and 2017. No mowing or

cutting will take place until the stand altering clearcut in 2019/20. The aspen stumpage can be traded for as much mowing as possible in this HMU that winter. Added to this aspen sale can be any remaining aspen in HMUs 29 and 38. The HMU will be burned again in 2022.

Parker Pool (HMU 31)

Size: 3,220 acres

Elevations:

	Pool elevation	Surface acres	Acre-feet
normal summer:	1,141.0'	2,271	3,171
spillway:	1,141.5'	2,755	4,273
drawdown:	1,137.0'		

Depth at 1,141.5': over 15%>4.5 ft; over 80%<3 ft.

Control structures: outlets 1, inlets 1
Spillways: outlets 1, inlets 1
First year operation: 1938

The water gauge was replaced in 2003. A very large discrepancy was found in the elevations that must be considered when referring to elevations prior to 2003. The new staff gauge reads 1.0' higher than the old gauge and needs to be added to readings back to 1972. The 1972 gauge corrections require subtracting 0.99' from older readings, thus canceling out the need for corrections prior to 1972.

Physiography:

The pool is comprised of a 600-acre open water basin (Green Stump Lake) surrounded by emergent cattail marsh. Submergent vegetation abundance in Green Stump Lake basin is variable due to wave action and turbidity which is affected by drawdowns. A scattering of hardstem bulrush is also found in the basin. Cattail is the dominant emergent in the western 2/3, whereas sedges, common reed, and willow dominate the eastern 1/3. An extensive cattail marsh is located on the far northeast portion adjacent to West Gate Road. The northeast corner along Ditch 11 has sedge meadow, containing numerous small potholes created in the 1960s by blasting. Good cover:water interspersion occurs in most of the west portion of the pool.

Parker Pool is dissected by an east–west ditch that splits the Green Stump Lake basin and Preacher's Grove. The office complex is at the east end of the ditch and the outlet structure and spillway are on the west end of the ditch. The northeast area is connected

with the main pool by a north-south ditch that drains into the main ditch east of Preacher's Grove. This ditch also conveys the spillway and control structure flows from Agassiz Pool into Parker Pool.

Several large wooded islands are located in the south half of the Pool.

Water movement:

Primary water supply under normal flows is from South Pool which enters Parker Pool on the south side under a bridge on County Road 7. A three-bay WCS and spillway in Westgate Road provides a secondary water source from Agassiz Pool. Spring runoff into Agassiz Pool can often get high enough to provide sufficient flow into Parker Pool to raise it to objective level. During flood events, Agassiz Pool spills a very large flow over into Parker Pool, maximizing the storage capacity of both pools. The spillway and the two-bay WCS on the west dike of Parker Pool dump into ditches that drain into the Thief River/Ditch 83. The steel spillway on the west end of Parker Pool is the primary spillway for flood waters of the Ditch 11/Mud River system leaving the Refuge. Drawdown is largely contingent on no or minimal discharge from South Pool and Agassiz Pool.

Drawdown history:

This pool was dewatered from fall 1953 to spring 1955 to vegetate a large open bay in the northwest corner. Excellent stands of softstem bulrush, burreed, cattail, and other emergents developed on the exposed mudflats in 1954.

A drawdown attempted in 1957 was incomplete due to inadequate facilities and heavy summer rains. A complete drawdown in the spring of 1958 was followed by partial reflooding in July due to heavy rain. In 1959, hundreds of acres of softstem bulrush were evident. Wild celery (*Valisnaria americana*) was found in plant transects for the first Refuge observations of this species in six years.

A complete drawdown of all but Green Stump Lake occurred during the summers of 1967 and 1968.

A complete drawdown was also attempted in the summer of 1985. Sedimentation in the ditch resulted in more than one foot of standing water remaining in Green Stump Lake. Also, the open bays between Green Stump Lake and Ditch 11 remained nearly full of water.

In 2001 the pool was in drawdown and all but the Green Stump Lake basin was dry. Shorebird use was excellent. Ephemeral emergents and annuals responded well in the northwest corner and along Ditch 11. The open water area near the outlet WCS came up in willows which were subsequently drowned out two years later. The pool was burned in the fall of 2001; 2,420 acres burned in a hot fire. The pool was in drawdown in the

spring of 2002, full for the summer, and drawn down again in the fall. The pool was again burned in the fall of 2002. About 600 acres burned, mostly along the HMU's perimeter.

Burn history:

Year	Area	Acres Burned	Time of Year	Type
1959	N&S	UNK	Spring	P
1960	N&S	UNK	Spring	P
1960	N&S	UNK	Fall	P
1961	N&S	UNK	Fall	P
1963	North	UNK	Spring	P
1975	North	UNK	Fall	P
1976	South	UNK	Spring	P
1978	North	UNK	Fall	P
1981	South	1,100	Spring	P
1986	N&S	730	Fall	P
1997	South	200	Fall	P
1998	South	500	Spring	P
2001	N&S	2,420	Fall	P
2002	N&S	610	Fall	P
2003	N&S	200	Spring	P

The fall burn in 2001 burned hot and had flame lengths that killed many of the trees on islands in the southeast corner of the Pool. The pool was also burned in the fall of 2002. About 600 acres burned, mostly along the HMU's perimeter

Wildlife:

This is an excellent diving duck nesting pool when water levels are near spillway elevation. Each fall large numbers of dabbling ducks annually concentrate in the emergent zone between Green Stump Lake and Ditch 11. Oftentimes the open water areas around the Parker Observation Deck provide good viewing for the public. A spotting scope has been mounted on the deck, allowing visitors to observe the diving ducks making use of the Green Stump Lake basin in the fall. In some years the diving ducks and American coots number in the thousands. The open water area near the outlet WCS has been a favorite spot for gadwalls and American wigeons during the present decade.

For many years, up through the 1960s, a large nesting colony of Franklin's gulls occupied the cattails between Green Stump Lake and Ditch 11. This area is still is used when conditions are not favorable for Franklin's gull nesting on Agassiz Pool. Eared grebes have nested in Green Stump Lake in years when lowered water levels provided dense stands of hardstem bulrush. Red-necked grebes also readily nest throughout this pool.

Presently, three bald eagle nests exist in this pool. In recent years the two nests located on aspen islands in the southwest corner of the pool have been used alternately, whereas the nest in Preacher's Grove has been commandeered by earlier-nesting great horned owls.

Facility improvements:

Year	Project	Location
2005	42"CMP replaced with 36"pipe	Outlet Structure
2003	Gauge replaced	+1.0'
1988	Wild celery planting	Green Stump lake in 2' of water
1984	Eliminate Concrete Box control	Next to new control
1977	Install 2-42" CMP	West dike
	Replace 200' Concrete weir spillway With 200' SP	West dike

Needs, restrictions, and objectives:

Sedimentation in the east-west ditch presently precludes complete drainage of Green Stump Lake basin. A ditch cleanout could remedy this problem, but without it, the basin adds diversity to the drawdown and provides a refugia for mussels and salamanders. The 1987 RefugeWater Plan referred to the need for a structure on Ditch 11 to drain the north half of the pool which didn't dry out in 1985. These areas did drain and dry out in the recent drawdowns. Precipitation may have been the limiting factor in 1985. A control structure into Ditch 11 is not recommended. Not all planned drawdowns on this pool will result in dry conditions, due to uncontrolled inflows during high runoff events from South and Agassiz Pools.

Beaver dams need to be removed from the Preacher's Grove area during drawdown years to drain the northeast portion of the pool.

The pool needs to be managed to maintain the interspersion of open water and emergents in the northwest portion of the pool that was lost in the 1970s and 1980s. This required several years of deep water to reclaim. The islands in the southeast corner should be kept treeless to improve waterfowl nest success.

The study by Sarah Huschle predicted optimum diving duck brood habitat at elevation 1,141.1'

Prescriptions:

Parker Pool is in the **Brood Habitat** prescription. The drawdown and summer or fall burn cycle will be every five years. The year after drawdown the water level can be kept shallow to make annuals and ephemeral emergents available for waterfowl food. The pool needs to return to near spillway levels in subsequent years to maintain the interspersion of open water and emergents. Fall pool levels can be lowered 0.5' to 1.0' to make it more attractive to migrant waterfowl, if evaporation has not already done so.

Burns should be done in late summer or fall. At least one of the next couple burns should be under good conditions to finish killing the remaining young trees on islands in the southeast area. Mowing should take place on these islands and the willow areas in the east end of the pool two years prior to burning. The islands in the southwest corner and Preacher's Grove will be **Old Growth** prescription areas. These trees will not be cut. The bald eagle nest trees require raking the vegetation away from their base prior to burns. Cottonwoods can be planted on these islands to increase the likelihood of replacement.

The banks of Ditch 11 between Parker and Madsen Pools are scheduled to be resloped in 2008. Parker Pool has to be in drawdown that year. Water levels should be reduced in the fall of 2007 or maybe even start the drawdown if construction starts that fall. Water levels in 2009 may be limited by the progress of the project. A low level that puts water on the west end may be possible and make ephemeral emergents available. An elevation of 1,141.1' should be strived for in 2007, as well as after the construction project to maintain interspersion. Burning the HMU should be a priority for the summer of 2008. The next drawdown and burn cycle will be 2013. During this cycle, Headquarters Pool and South Pool will also be in drawdown and drained through Parker Pool.

Office Area (HMU 32)

Size: 81 acres

Physiography:

This HMU consists of the area around the office complex. Management of the HMU, other than mowing lawns, consists of burning the small prairie plots and the woodland. A walking trail with signage and nesting boxes needs to be kept a priority in this HMU.

Burn history:

Year	Acres Burned	Time of Year	Type
2002	2		Headquarters Prairie
2002	2		Headquarters Prairie
2004	2	Summer	Headquarters Prairie
2005	1		Headquarters Butterfly

2006	3	Spring	Headquarters Prairie
2006	1	Spring	Headquarters Prairie

Wildlife:

Bird nesting boxes have been placed along the walking trail for demonstration purposes. The garage buildings have a large colony of cliff swallows (*Petrochelidon pyrrhonota*) using the eaves. The wooded area within this HMU can host an abundance of migrating warblers during both the spring and fall and its proximity to the Refuge headquarters makes it a favorable location for visiting birders.

Needs, restrictions, and objectives:

The buildings, trail, and associated visitor service facilities are the priority in this HMU.

Prescriptions:

Prescribed burns will be conducted on the prairie plots, as deemed necessary, to keep them in flowering condition for visitor use and to reduce the incidence of invasive species (i.e., smooth brome). The woodland is an **Old Growth** prescription and will not be cut or mowed. Manicuring of specific trees for visitor safety will take place. The woodland can be burned on approximately 10-year intervals. Lawns will be mowed for the appropriate Midwest "well-kept" look.

Moose Pasture (HMU 33)

Size: 1,348 acres

Physiography:

HMU 33 consists of a portion of the southeast side of Agassiz Pool and water levels and drawdown events are managed as a part of Agassiz Pool. The north boundary of the HMU is Ditch 11. The east side is the graveled Northgate Road and the south side is the graveled auto tour route. The west side has a variable boundary in Agassiz Pool that takes advantage of natural breaks in the cattail.

The majority of this HMU is muck soils that have emergent cattail marsh habitat. This grades into a sedge/willow complex on the south and east sides. The south side also has stands of whitetop within the sedge meadows. The southeast corner of the HMU increases in elevation on the west side of a beach ridge and consists of loam soils that have been part of the Dahl farm fields.

Burn history:

Year	Acres Burned	Time of Year	Type
1960	UNK	Spring	P
1960	UNK	Fall	P
1961	UNK	Fall	P
1963	UNK	Spring	P
1963	UNK	Fall	P
1968	UNK	Spring	P
1970	UNK	Fall	P
1972	UNK	Fall	P
1974	UNK	Fall	P
1978	UNK	Fall	P
1980	UNK	Fall	P
1986	672	Spring	P
1990	1,348	Spring	Wild
1996	319	Fall	P
1999	710	Fall	P
2002	14	Spring	Dahl Prairie
2004	10	Summer	P
2004	20	Fall	P
2004	13	Spring	P
2004	13	Spring	Dahl Prairie
2005	1392	Spring	P

Wildlife:

The sedge/willow complex on the east half of this HMU is referred to as the moose pasture due to its history of supporting a high density of moose during the winter. The sedge meadow and whitetop components of this area are used by yellow rails, Nelson's sharp-tailed sparrows, and Le Conte's sparrows, and serve as an accessible area for visitors to find these rare species.

Needs, restrictions, and objectives:

The east half of the HMU is included in the OLMA. Photo stations in this HMU document the increase in willows and aspen clones. Aspen, and to a lesser extent willows, need to be decreased in the HMU. The marsh habitat is being managed within the Agassiz Pool prescription with drawdowns every 10 years and at least one planned low water season in year six of the cycle. The farm fields in this HMU will need to be protected when the crop situation does not warrant burning. Native prairie seedings can be meshed with burning the entire HMU, whenever possible.

Prescriptions:

For the marsh vegetation refer to Agassiz Pool HMU 15. The HMU is in **the Open Shrubland/Grassland** prescription. The upland portion of this HMU will be burned in the summer or fall every five years. The burning of this HMU should be coordinated with HMU 24 which is a similar portion of Agassiz Pool. When one is burned in the summer, the other is burned in the fall, and then the opposite is true during the next five-year cycle. The next burn for these two HMUs will be in conjunction with the Agassiz Pool drawdown in 2010. This HMU will be burned in the summer and Unit 24 in the fall.

Mowing of willows and aspen clones in this HMU should take place in 2008/09.

The farm fields taken out of production during the last 10 years have been seeded to upland prairie, with big bluestem as the dominant grass. Current information provided by Zager (2007) indicates that upland prairie may not have existed on the Refuge historically. Wet prairie vegetation, with bluejoint as the dominant grass, may have been the prairie in this locality; however, drainage has affected the hydrology of the fields and they may have areas that will support big bluestem prairie. Restoration of the remaining fields should consider blue joint wet prairie in seed selection. The steps for restoring prairie vary by site and results and will be worked out in the Annual Habitat Work Plans.

Headquarters Pool (HMU 34)

Size: 1,641 acres

Elevations:

	Pool elevation	Surface acres	Acre-feet
normal summer:	1,141.0'	815	1,413
spillway:	1,142.0'	1,080	2,800
drawdown:	1,138.0'		

Depth at 1,142.0': over 40%>4 ft; over 50% <3 ft.

Control structures: outlets 2, inlets 1
Spillways: outlet 1
First year operation: 1938

Physiography:

The west half of Headquarters Pool is open water and the east half is nearly closed by emergents. The mid-zone is readily influenced by pool level shifting between open water and emergents. The emergent zone is predominately cattail and grades to sedges, grasses,

and willows to the east. The bottom contour is fairly uniform throughout the open basin, with the exception of a cattail island and two small (<1 acre) areas of bulrush.

Water movement:

Primary water supply is from drainage ditches to the east and south that enter via the concrete bridge on County Road 7. Secondary water supply is from East Pool which passes through the Lost Bay portion of Headquarters Pool via a small stoplog WCS located at Maakstad Grove along the auto tour. Primary outlet is into South Pool and secondary outlet is into Agassiz Pool. Drawdown is possible when South Pool is at or below 1138, but this is a very flat flow; therefore, high evaporation rates and no rain are needed to be successful. The bottom of the Headquarters to Agassiz Pool structure is only 1,139.0' and complete drawdown is not possible through this outlet.

This pool is subject to sustained bounce during runoff events. Pulling logs needs to be aggressive if bounce is to be minimized and the length of time decreased.

Estimated time to dewater is three weeks.

Drawdown history:

This pool was 2.9' below normal in 1952 and 2.4' below normal in 1953. The pool was reflooded in spring 1954, but decreased 1.5' – 2.0' during the summer. Emergents (e.g., softstem bulrush) became well-established as a result. In 1967, the pool was gradually dewatered in late summer and was dry by September. Reflooding to 1,140' in 1968 resulted in a lush growth of submerged aquatics that year. In 1969, muskgrass (*Chara* spp.), milfoil (*Myriophyllum* spp.), and pondweeds were common. Cattail heavily invaded the shallow mudflats.

In 2001, the pool was drained and pumped but still remained at 1,139.0' by mid-October. There were still 10 inches of water in the open basin area. The pool was kept in drawdown in the spring of 2002 due to inadequate runoff.

Burn history:

Year	Acres Burned	Time of Year	Type
1960	UNK	Fall	P
1961	UNK	Fall	P
1962	UNK	Fall	P
1971	UNK	Spring	P
1972	UNK	Fall	P
1975	UNK	Fall	P
1976	UNK	Spring	P
1980	1004	Fall	P

1981	UNK	Spring	P
1987	1115	Spring	P
1990	UNK	Spring	Wild
1993	500	Spring	P
1995	344	Spring	P
1998	850	Spring	P
2001	1560	Fall	P
2006	1236	Fall	P

The fall burn in 2006 started peat fires in the southeast corner of the HMU. The fires were allowed to burn through the winter months.

Wildlife:

Waterfowl use of the open bay varies as the abundance of submergent vegetation changes in response to the partial drawdowns. Sustained deep water in the 1990s reclaimed open water areas just east of the main open basin. This made these areas very attractive to dabbling ducks. In addition to high duck pair use, the area receives high use by gadwall and other dabbling ducks in the fall. Over-water nesting use is good when levels are near spillway elevation. Brood use declined in the 1980s but has been high in the past 10 years. The pool is also used by migrating geese.

Optimum diving duck brood use occurs at 1,141.2', according to Huschle (2000).

Facility improvements:

Year	Project	Location
2003	Gauge replaced	+0.2' to older readings
1998	Hardstem bulrush planting	East side of main open basin, none grew
1990	CMP replacement	under County 7
1989	Ditch cleanout	2 miles along county ditch, Branch 201
1989	2000 Wild Celery planted	Not successful
1979	Replace 1938 3'x4' Concrete box with 42"CMP	Auto drive
1978	Install riser on 24" CMP	Maakstad Grove

Needs, restrictions, and objectives:

The old Master Plan called for subdividing the pool into east and west units by constructing a north-south dike and installing control structures to move water between each unit and from the east unit into South Pool. This idea is no longer thought to be

desirable. The diversity of wetland types, including the increasingly rare sedge meadows would be decreased.

Dewatering currently is limited by dependence on levels in South and Parker pools or South and Farmes pools. When the Headquarters to Agassiz structure is replaced in the future it should be at a lower level to allow complete drainage of this pool into Agassiz Pool.

During the 1990s and early 2000s, the water level objectives were often set at 1,141.5' and runoff events often kept the water level above this for prolonged periods of time. These water levels have eroded the roadsides of the auto tour route and County Road 7. Using an objective level of 1,141.0' most years should help alleviate the erosion. The use of 1,141.5' should be used sparingly to flood out cattails east of the main open basin.

Prescription:

The recommended management prescription is for **Deep Water Marsh** with a 10-year complete drawdown cycle. The drawdown will only be successful on years without major summer runoff events or prolonged spring flooding. Drawdowns will be initiated in early May to discourage nesting. Since evaporation is needed for complete drawdown, this pool may provide migratory shorebird habitat in August. Planning a drawdown requires having South and Parker pools or South and Farmes pools in drawdown. Within the Refuge, drawdown planning should avoid drawdown on Agassiz Pool. Complete drawdown needs to be synchronized with Parker Pool and South Pool. All three of these pools will be in drawdown 2013. This is only seven years from 2006, but is necessary to achieve synchronization.

To stimulate submergent vegetation and invertebrates during the 10-year interim, set the summer objective level to 1,139.5' in year four or five (drained out through South Pool) followed by 1,140.0' the following year, and return to 1,141.0' thereafter. It is desirable to have Headquarters Pool full during the year that Agassiz Pool is in drawdown (2010).

During September and October, the water levels should be gradually lowered to 1,140.0' or 1,140.5' to make the submergent vegetation available for migrating waterfowl and to allow for spring storage.

The uplands in HMU 34 are in the **Shrubland/Open Grassland** prescription. This HMU should be burned in the summer or fall on a five-year cycle matching the partial and complete drawdowns of the pool. Woody vegetation should be mowed or harvested two years prior to the drawdowns and burned by prescribed fire during the drawdown year. When time and money allow, a herbicide application with a wick applicator can also be applied. Since the next drawdown is only seven years away, the next burn should be a fall burn in 2009 and then a summer burn in 2013. The increased frequency at the start of this prescription should be benefited by decreasing the willows and aspen clones. There

are old field ditches in the east half of the HMU that can be filled in to restore hydrology of the wet meadow.

East Pool (HMU 35)

Size: 1,780 acres

Elevations:

	Pool elevation	Surface acres	Acre-feet
normal summer:	1,144.1'	90*	Unknown
spillway:	1,144.8' (road)		
drawdown:	1,142'		

Depth at 1,144.1': 100% <2 ft.

Control structures: outlets 1, inlets 1
Spillways: none: Northgate road 1,144.8'
First year operation: 1940

*Estimate-engineering data not available.

Physiography:

The pool is surrounded by cattail. The cattail is replaced by sedges, common reed, and willows to the east. Ditch 194 bisects the pool east-west. Cover:water interspersion is good in the northwest portion only. The remainder of the pool is covered by emergents.

Water movement:

Water supply is from Dahl pool via Ditch 194 and local runoff. The WCS at the west end outlets into Lost Bay Pool. Drawdown is possible when Lost Bay and Headquarters Pools are below 1,142.0'.

Estimated time to dewater is 7-10 days, with suitable gradient.

Drawdown history:

In the fall of 1979, this pool was dewatered to facilitate mowing of cattail. The pool was recharged to 1,143.4' in April 1980, but had dropped to approximately 1,141.6', by July as a result of drought, thus nullifying the effects of mowing cattail.

In 1990, after a summer in drawdown, 24 acres in the main basin were disked.

A multi-year drawdown was started in 1994, to last through 1996. The drawdown in 1996 was not successful due to major rain events. The next drawdown was accomplished 2001, but summer rains kept the pool from completely drying out. The pool was left empty over winter and spring anticipating having a second year of drawdown. A runoff event filled the pool on 9 June, 2002 and it was maintained as full for the remainder of the year. A Rodeo (glyphosate) treatment was applied via airplane in one strip along the west side in August of 2000. The intent was to apply the herbicide in patches by turning the spray on and off instead of one continuous strip. The interspersion obtained in 2002 is probably the best that can be obtained via water manipulation.

Burn history:

Year	Acres Burned	Time of Year	Type
1960	UNK	Spring	P
1961	UNK	Fall	P
1962	UNK	Fall	P
1963	UNK	Fall	P
1971	UNK	Spring	Wild
1980	1700	Spring	P
1981	UNK	Spring	P
1983	810	Spring	P
1987	370	Spring	P
1988	1060	Spring	P
1990	1,780	Spring	Wild
1994	UNK	Fall	P
1995	31	Spring	P
1995	220	Fall	P
1997	200	Spring	P
2000	1500	Fall	P
2002	14	Fall	Prairie – South Dahl
2004	2	Fall	P
2004	280	Fall	P
2005	16	Spring	Prairie – South Dahl

Wildlife:

Over-water nesting by diving ducks is only fair, owing to the pool's small size and distance from a brood pool. Dabbling duck breeding pair use is generally good. Upland nesting habitat is abundant adjacent to this pool.

Facility improvements:

Year	Project	Location

2003	new gauge	-0.3' to old readings for comparison
1997	WCS replacement	Outlet
1987	Reshape spoil banks	Ditch 194 (2.9 miles)
1986	Clean 1.75 mi. ditch	Ditch 194 east to Dahl Pool

Needs, restrictions, and objectives:

There is no spillway for this pool. Water overflows Northgate Road at elevation 1,144.8'. Water levels just below this keep the shoulder too wet and encourages erosion and rodent burrows. The maximum summer pool level is now 1,144.1'.

The HMU is included in the OLMA. The objective is to eliminate trees and reduce willows.

Prescription:

East Pool is designated as a **Nesting Habitat** pool. It will be on a four-year drawdown and burn cycle. The uplands in HMU 35 are designated as **Shrubland/Open Grassland** and will follow the same burn rotation of four years. Since this HMU is a combination of **Nesting Habitat** objective in the wetland and **Shrubland/Open Grassland** in the upland, the best time for burns will be fall. The first drawdown will be in 2008, followed by a burn that fall. If mowing is scheduled for the winter of 2007/08, then the drawdown and burn should be pushed back one year to allow adequate growth of grass and sedge to carry fire into the mowed areas.

Dahl Pool (HMU 36)

Size: 1,055 acres

Elevations:

	Pool elevation	Surface acres	Acre-feet
normal summer:	1,147.5'	280*	Unknown
Maximum Pool	1,148.0'		
drawdown:	1,145.5'		

Depth at 1,147.3': 100% <2 ft.

Control structures:	4
Spillways:	none
First year operation:	1964

Physiography:

This narrow pool is 1.5 mi long and is bordered on the east and west by an upland ridge. An area of high ground divides the pool into north and south pools at low water levels. Cattail is the dominant emergent at the north and south ends, whereas sedge and common reed increases in abundance in the central, and more shallow portion of the HMU. Cover:water interspersion increased in the 1990s due to high summer water levels. A low, poor dike enhances a natural shallow basin to the east of Dahl Pool that sometimes overflows into Dahl Pool.

Water movement:

Water enters from the east through a WCS located at the intersection of Ditch 194 and the east boundary road and also from local runoff on the east side of the pool. A WCS at the south end outlets into Ditch 194 and drains the south portion of the pool. A WCS in the north dike outlets into Ditch 11 and is the primary outlet for the north portion of the pool. A small WCS in the northwest corner permits water to flow into a small wetland west of the Northgate Road. Because of the high area that separates the north and south portions of the pool at low water levels, the WCSs at both ends of the pool need to be used for drawdowns.

Estimated time to dewater is about one week. Drawdown is independent of other pools.

Drawdown history:

This pool was dewatered in the summer of 1981 to permit habitat work. Summer rains prevented adequate drying for habitat work. The pool level was returned to 1,147.3' in 1982. Cattail germinated over many of the exposed mudflats.

The pool level was lowered in the summer of 1997 to facilitate replacing the Dahl-Ditch 11 structure. The pool was nearly dry that fall. The pool was in complete drawdown in 2003.

In 2005, the Pool was placed into a inter-regional U.S. Fish and Wildlife Service/USGS impoundment study for three years. In 2005 the drawdown was initiated in May and kept dry all summer. In 2006 the drawdown was started in late July. Drawdown timing will be the same in 2007. Vegetation and bird use is being monitored and will be analyzed with data from the other participating Refuges. An increase in cattail is anticipated after three consecutive years of drawdowns. The pool will be burned in the fall of 2007 and returned to high water levels in 2008 to gain open water interspersion.

The natural basin in the east Dahl Pool area has not been dry since 1992. This area could benefit from a drawdown. We attempted to pump and drain it in 2004 and failed to get it

dry. The water table in the drought year of 2006 was still high enough to keep this pool from going dry.

Burn history:

Year	Acres Burned	Time of Year	Type
1962	UNK	Fall	P
1963	UNK	Fall	P
1971	UNK	Spring	P
1981	948	Spring	P
1984	740	Spring	P
1987	800	Spring	P
1990	UNK	Spring	Wild
1994	UNK	Spring	P
1998	2	Spring	Hydroaxe Wild
1998	1000	Spring	P
2002	1205	Spring	P

SUPs were issued in 1990-1992 to woodcutters to cut down 30-50 year-old fire-killed aspen and balsam poplar trees that were burned during the 21-23 April, 1990 wildfire.

Dahl Oak Savanna (HMU 36A)

Size: 69 acres

Burn history:

Year	Acres Burned	Time of Year	Type
1990	69	Spring	Wild
1997	69	Spring	P
2004	69	Spring	Dahl Woodlot

Wildlife:

Waterfowl breeding pair use increased sharply in the 1980s in response to improved cover:water interspersion. Nesting diving ducks include redhead, ring-necked ducks, and ruddy ducks. Fall migration use by mallards and Canada geese has been high during the recent drawdowns.

Waterfowl and sandhill crane use in the fall on the natural basin east of Dahl Pool has decreased significantly after the first two years of flooding in 1992 and 1993, but is still substantial in some years. Diving ducks also use the basin for pair and brood habitat.

Facility improvements:

Year	Project	Location
2003	New Gauge	+ 0.6' to readings 1997 to 2002. Gauge destroyed in 1997
1997	WCS replaced	Ditch 11/Dahl
1997	WCS replaced	Under North Gate Road
1995	WCS replaced	Ditch 194 on east boundary
1987	WC structure reactivated	Ditch 194, behind Maintenance Ctr. Failed again.
1986	Clean 1 mi. ditch	Ditch 194 to E Boundary
1984	Install riser on 1-18" culvert	Northgate Road

Needs, restrictions, and objectives:

The south WCS on Ditch 194 to East Pool was constructed in 1962, but immediately leaked around wing walls. An earthen plug was constructed on the upstream side in 1962, but the WCS was never repaired. In 1986, the WCS was re-activated and Ditch 194 was cleaned. In spring 1987, the WCS was still leaking and the earthen plug replaced. The WCS was repaired in 2003 by pushing aluminum sheeting below the footing to seal off the seepage and the WCS is now useable at this time.

Higher summer levels can reduce cattails in north end. However, emergent vegetation control elsewhere is somewhat limited by maximum pool elevation (approximately 1,148.0'). The small amount of open water interspersion that can be achieved in this pool does make it desirable for overwater nesting birds. The high water levels near full pool are needed to maintain these openings.

Prescription:

This pool will be managed in the **Nesting Habitat** prescription for over-water nesting in the three- to four-year drawdown and burn cycle. The pool will be in drawdown in 2007, so the next drawdown is scheduled for 2011.

The uplands on the east side of the pool are in the **Even-Aged Aspen** prescription, so the burns will be spring burns on the year after drawdowns. The frequency of burns will be four years instead of five to mesh with the pool and oak savanna burns. The entire HMU should be burned in the spring of 2008. This first burn in 2008 should be late April or early May, as the impoundment research study will still be evaluating bird use through April.

The oak savanna restoration area in HMU 36A should be burned with the entire HMU in 2008. The next burn would be in the spring of 2012. HMU 36A should be burned by itself periodically after aspen leaf out to maintain the oak savanna.

The Dahl Pool uplands east of the pool will be clear cut and mowed in the year 2042. There are some small stands of bur oak in the middle of this HMU. These bur oak should be left unharmed so an oak woodland can potentially develop.

Maintenance Center (HMU 37)

Size: 557 acres

Physiography:

This HMU includes the maintenance center complex. The HMU is bordered on the north side by the graveled road that follows Ditch 194 and on the east side by the graveled boundary road. The south side is bounded by County Road 7 and the west side is Airport Road. This HMU has a beach ridge running basically north to south through its midsection. The maintenance center is on the north end of the ridge and Blue Grove woodland occupies the remaining portion of the ridge. The main soil on the beach ridge is a fine sandy loam. It is currently an aspen-oak woodland and is capable of being managed towards a Northwestern Dry-Mesic Oak Woodland type. Another short stretch of beach ridge is found in the northeast corner and has similar properties. These are the driest vegetation types on the Refuge.

Zager (2007) identified a narrow zone of Northwestern Wet-Mesic Hardwood Forest along the east side of the beach ridge bordering the Dry-Mesic Oak Woodland. Black ash (*Fraxinus nigra*) and green ash are significant in the sub-canopy under the bur oak and aspen overstory.

In between the two beach ridges is a mosaic of muck and loam soils with sedge and grassland, respectively. Aspen are invading the loam soils. Southwest of the beach ridge is a loam and sandy loam soil that is sedge meadow with invading willow.

A commercial aspen pulping operation removed 673 cords of aspen from Blue Grove south of the maintenance center during the winter of 1992-93. Only the larger marketable aspen was removed to encourage oak and ash regeneration and to release the younger aspen and oak for increased growth and acorn production. Growth rings on the large stumps indicated an approximate aspen stand age of 60 years. Many large trees that were already too rotten for marketing were left standing for woodpecker and squirrel habitat.

Burn history:

Year	Acres Burned	Time of Year	Type
1962	UNK	Fall	P
1981	515	Spring	P
1983	60	Spring	P
1985	237	Spring	P
1988	90	Spring	P
1990	UNK	Spring	Wild
1996	87	Spring	P
1997	40	Spring	P
1999	300	Spring	P
2003	523	Fall	P
2005	13.7		Firebreak
2005	20		Oak Girdling
2005	78	Fall	P

Wildlife:

The oak woodland in the HMU attracts many animals for the mast crop. Bear and their sign are often observed in late summer. Deer are abundant in the HMU. One of the Refuge's small mammal trapping sites is in Blue Grove.

Needs, restrictions, and objectives:

Trees around the maintenance center function as a desirable wind break. Also, the maintenance center facilities need to be protected from fires.

In Blue Grove and the oak woodland in the northeast corner Zager (2007) recommends restoring the Northwestern Dry-Mesic Oak Woodland by removing woody vegetation and promoting a grass-dominated woodland. The overall canopy cover needs to be reduced to less than 50% by first removing the aspen and then thinning oaks, if needed. The green ash in this woodland type is considered an invader and should also be removed. A sub-canopy of trees should be nearly absent. The historic fire frequency is estimated at 15 years; however, it will need to be more frequent than that during the restoration phase and possibly continued at a higher frequency since prescribed fires may not occur during dry periods like wildfires do. Zager (2007) recommends reducing hazel in the under story and promoting other shrubs like juneberries, choke cherry (*Prunus virginiana*), and dogwoods. These shrubs should develop with the opening of the canopy.

Zager (2007) recommended maintaining the rare narrow zone of Northwestern Wet-Mesic Hardwood forest as a climax forest. It has a canopy coverage of 50 to 75% of aspen and bur oak and a nearly 100% sub-canopy of black ash and occasional choke cherry.

Zager also recommended trying to restore Prairie Wet Meadow on the open area between Blue Grove woodland and Airport Road. This type should have 5% or less willow and other shrubs. The MNDNR (2005) states that frequent fire is the main cause for the absence of shrubs. Zager (2007) recommended mowing small patches and adding some sod disturbance similar to bison hoof action to promote forbs.

The other major vegetation type in the HMU is Southern Basin Wet Meadow Carr. It is found in areas between marshes and uplands. Zager (2007) recommended reducing willows and other invasives and creating pockets of disturbance to create openings for forbs. Burning the surface peat is one of the methods to create these openings. The MNDNR (2005) states that this community is found in fire-prone landscapes where frequent fire reduces the presence of shrubs.

Prescriptions:

The HMU as a whole has been placed into the **Grassland/Sedge** prescription to reflect the management required in the Southern Basin Wet Meadow Carr and Prairie Wet Meadow vegetation. The Wet Meadow Carr in the southwest portion of the HMU is going to be part of the annual burning study. This HMU is going to be burned annually for five years in the summer. Results will be determined by photo station and air photo analysis. The other two treatments are in HMUs 12 and 14.

The entire HMU will be burned in the summer every two years for two cycles. If the aspen regeneration in the oak woodlands has been killed, the fire frequency can be reduced to once every four years. Burn years will be 2007, 2009, 2011, and then 2015 if results are favorable.

Girdling of aspen and green ash in Blue Grove will continue until the entire woodland south of the maintenance center has been covered. Dead trees will be removed two years after they are girdled by firewood cutters. The Mesic Hardwood zone on the east edge of the woodland needs to be identified and excluded from the girdling and fire wood cutting activity.

Zager (2007) identified a small area in the southeast corner where Northwestern Wet-Mesic Aspen Woodland can be cut and changed to a Northern Wet Brush-Prairie and where Northwestern Wet Aspen Forest can be cut and changed to Prairie Wet Meadow. Following the aspen harvest the prescribed burns will be needed to incur the change.

The north end of the HMU, including the maintenance center, will be excluded from the prescribed burns. Over-mature aspen in this area will need to be removed if they become a blowdown threat to the facilities. Gap management of the aspen in the area surrounding the maintenance center may be appropriate. The minimum gap size for regeneration is about the trees or 48 m^2. The frequency for creating the gaps should be

8% of the area every 10 years to keep the density of trees high for wind break protection. The open grassy area north of the shop has had some spruce trees planted. Planting a scattering of bur oak in the remaining area would be a better choice and would add to the open oak woodland on this beach ridge.

Silo (HMU 38)

Size: 787 acres

Physiography:

The Silo HMU occupies the southwest corner of the Refuge west of Farmes Pool. It is bounded on the north side by the grassy Rodahl Cut Across Trail, on the east by Farmes Pool Dike, on the south and west by the graveled boundary roads. There is a wide band of peat soil along the east side and angling across to the southwest corner. This soil is occupied by wet meadow carr. The remainder of the HMU is a matrix of loams and mucky loams, most of which are occupied by a wet meadow carr. There are some isolated aspen woodlands that have invaded onto mollisol loams. The Rodahl farm field complex is in the north-central part of the HMU.

Burn history:

Year	Acres Burned	Time of Year	Type
1993	844	Spring	P
1995	230	Spring	P
1998	150	Fall	P
2001	15	Spring	P
2003	675	Spring	P
2004	11.8	Spring	Rodahl prairie
2005	22.3		Firebreak

Wildlife:

Deer use is high in the HMU, as deer go on and off the Refuge to feed in adjoining private lands and in the Refuge fields. Sharp-tailed grouse have a history of establishing dancing grounds in this HMU and adjoining private lands. The HMU is adjacent to Farmes Pool and upland nesting ducks are expected to make use of the sedge meadow and wet prairie for nesting.

Needs, restrictions, and objectives:

The new Rodahl Hiking Trail and Farmes Pool Observation Deck are in this HMU. One of the woodlands is along the trail. The woodland should be cut to blend in with the open

landscape meadow in this area. The need for open landscapes for grassland birds can be interpreted at this site. A shelter and bench can be put up to provide shade for resting visitors.

Peat fires are numerous along the Farmes Pool dike when this HMU is burned. Plains pocket gopher (*Geomys bursarius*) mounds are the usual ignition sites. Another ignition site is along the road cut in the southwest corner where this peat soil meets the roadway.

The farm fields taken out of production during the last 10 years have been seeded to upland prairie, with big bluestem as the dominant grass. The seedlings in the Rodahl farm fields have not been very successful. Current information provided by Zager (2007) indicates that upland prairie may not have existed on the Refuge historically. Wet prairie vegetation, with bluejoint as the dominant grass, may have been the prairie in this locality. Some of the soils in this HMU are muck or mucky loam that would have been wet meadows and the remaining soils are loams that would have been wet prairie. Field drainage may have made these sites suitable for wet prairie but not upland prairie. Restoration of the remaining fields should consider blue joint wet prairie in seed selection.

Prescriptions:

The HMU is placed in the **Grassland/Sedge** prescription. With the exception of the small, woodland areas, woody vegetation is not as problematic as in other area of the Refuge. The HMU will be burned on a four-year cycle, starting in 2010. Burns will be in the summer whenever possible and in the fall as a second choice. All of the trees in the HMU should be harvested in 2008/09 (two years before the next burn cycle). Mowing of willows in the most invaded areas is recommended at the same time. Mowing of willows will need to be done to augment the effectiveness of burning and should be done two growing seasons before the burn.

The steps for restoring prairie on the farm unit will vary by site and results and will be worked out in the Annual Habitat Work Plans.

Farmes Pool (HMU 39)

Size: 2,828 acres

Elevations:

	Pool elevation	Surface acres	Acre-feet
normal summer:	1,140.0'	2,100	5,500
spillway:	1,142.1'	2,700	11,000
Maximum summer pool	1,141.0'	2,400	7,500

Maximum winter pool	1,139.0'	1,700	3,500
Top of Dam	1,145.0'	3,200	19,700
drawdown:	1,137.0'		

Depth at 1,142.1': 57% >4.0 ft.; 24% <3.0 ft.

Control structures: outlets 1, inlets 1
Spillways: outlets 1
First year operation: 1991

Spring runoff and summer precipitation in 1991 were not adequate to flood the basin north of Ditch 200. The only surface water occurred in scattered peat burnout areas south of the Refuge line and in the perimeter borrow ditch. Fifty percent of the state-owned segment was flooded to a depth of two to five inches throughout most of the summer and fall. The pool was first entirely flooded in 1992. Waterfowl usage was very high.

Physiography:

Prior to settlement, the 400-acre Elm Lake occupied the west portion of this pool. After drainage, no surface water remained in this basin during the summer months. Dense emergent vegetation, primarily sedge, cattail, and common reed now dominate the former lake bed. To the east, stands of grass, sedge, willow, dogwood, and aspen dominate. The center of the area to the east is a large wet meadow.

During construction the WMA side was burned to remove peat and deepen the wetland basin. This elevation difference and different objectives for hunter use in the fall present challenges in managing this pool. It is imperative to maintain emergent plants in the WMA side to prevent wind erosion of the south perimeter dike. Our experience during the first 15 years of operation is that elevation 1,140.0' will slowly drown out the emergent vegetation on the WMA side of the impoundment over a two- to three-year period. This elevation does create some interspersion on the Refuge side of the impoundment. Balancing this desire for interspersion on the Refuge and keeping emergent vegetation on the WMA side is one of the many challenges associated with this pool.

Water movement:

The water supply is from Ditch 200. This ditch was enlarged from Elm Lake upstream eight miles to where the Lost River enters the ditch from the south. The inlet ditch has an average depth of 7.5' and bottom width of 8'. Ditch 200 is split at Trent Stanley's farm, 1.5 miles east of Elm Lake WMA, and high flows go into both Lost River Pool and Farmes Pool. Lost River Pool's outlet is back into Ditch 200 two miles above Farmes Pool.

The outlet WCS is a drop inlet closed conduit type control spillway. The outlet consists of one six foot diameter concrete pipe. The outlet weir is 100' (20 bays of five-foot stoplogs). There is a three foot square screw gate in the WCS to adjust outflows and complete drawdowns.

Drawdown history:

A drawdown was initiated in 1998 to facilitate repairs to the dike/roadside damage from 1997 flooding and high winds. Cattail and bulrush covered most of the open water areas on the Refuge side by August. During this drawdown, several elevations were worth noting. At 1,138.0' approximately 75% of the Refuge side of the Pool is dry. At 1,137.7' the Refuge side is dry. At 1,137.6' the WMA side is mostly covered by shallow water. At 1,137.0' the WMA side is also dry. The perimeter ditches, even on the Refuge, did not go dry.

The pool was put into drawdown in May of 2003. The pool was brought down to 1,137.9' by 12 May and then slowly lowered to expose mudflats over the following two weeks to provide shorebird habitat on the WMA. The screw gate was left open during the summer and then closed on 2 September to catch water for fall migration and hunter use of the WMA area. The pool recovered to 1,137.6' and waterfowl use on the Refuge was phenomenal.

Burn history:

Year	Acres Burned	Time of Year	Type
1973	UNK	Spring	Wild
1977	UNK	Spring	Wild
1985	2334	Spring	P
1987	UNK	Spring	Wild
1993	1,130	Spring	P
2000	2,000	Spring	P
2003	3,060	Fall	P

Wildlife:

Waterfowl use of the new impoundment was very high in the early 1990s and gradually lessened as the emergent vegetation thickened. Drawdowns have been very successful in stimulating annuals and temporary emergents which brings a sharp increase in bird use. In October, 2003 there were an estimated 200 Canada geese, 100 sandhill cranes, 2,000 green-winged teal, and 3,000 mallards using a small shallow flooded area in the northwest corner of the pool. Franklin's gulls and black-crowned night-herons established nesting colonies in the pool in 2005 and 2006.

The optimum water level for diving duck broods is 1,140.4' and for dabbing duck broods it is 1,139.7', as determined by Huschle (2000)

Facility improvements:

Year	Project	Location
2005	Control Structure	South Pool to Farmes Pool
2005	Outflow gauge	Inside the outlet structure
1998	Roadside repairs from damage by high water and wind, SW corner	
1997	Roadside repairs from damage by high water and wind, SW corner	
1990	Completion of perimeter dike, cleanout of 7 mi of Ditch 200, breech old township road, graveling new township road, installation of two box culverts.	
1989	Construction of water control structure and box culvert/bridge over JD 200	
1989	351,200 cubic yards of embankment construction	
1988	11,300' of perimeter dike	

Needs, restrictions, and objectives:

Construction of this pool was brought about by a cooperative agreement between the RLWD representing its constituents, MNDNR, and the Refuge, and was mostly paid for by Ducks Unlimited. The management agreement specifies that the maximum summer and winter elevations (listed above) and that the RLWD, in consultation with the U.S. Fish and Wildlife Service and the MNDNR, can determine the need for the stoplogs to be placed into the outlet structure to the maximum level of 1,141.0' during significant flood events and provide operating instructions to Refuge staff. In response to dissatisfaction by two downstream landowners, the RLWD contracted Houston Engineering to determine trigger point elevations for when the stoplogs will be put in and taken out during flood events. The five-year summer flood event was calculated for the time period of May through October, which is lower than for spring events, but still higher than the approximate elevations that had been used by the RLWD in consultation with the Refuge. The trigger point for removing the stoplogs was also determined from when Ditch 200 recedes below flood stage. This may result in longer periods of high water than what has occurred in the past.

Recommended Trigger Elevations
Farmes Pool (Elm Lake Impoundment)
RLWD

Site #	Description	(All Season) Remove Stoplogs (Flood Stage) Elevation (ft)	(Summer) Install Stoplogs (5-Yr Summer) Elevation (ft)	(Spring) Install Stoplogs (5-Yr) Elevation (ft)
1	*First structure downstream of Elm Lake on Branch 200, JD #11 (Dr. Beich Driveway) Sec 8/9 Agder	1,134.0'	na	na
2	Second structure downstream of Elm Lake on Branch 200, JD #11 (County Rd 120, C. Larson Bridge) Sec 7/8 Agder	1,133.0'	1,137.4'	1,138.7'
3	First structure downstream of Elm Lake on State Ditch #83 (CSAH #12, RangeLine Road) Sec 12/7 Excel/Agder	1,131.6'	1,136.0'	1,137.2'

* RLWD will install a gauge at this location in 2007.

A cooperative agreement between the RLWD and the Refuge covers the use of the South to Farmes Pool WCS. This WCS was put in by the Refuge to facilitate management of South Pool at low water levels. To alleviate the perception that it would have any affect on Ditch 200 outflows, the Refuge made an agreement with the RLWD. The WCS is not to be used during high flows in Ditch 200 and should have all of the stoplogs put into it during times when the RLWD has placed Farmes Pool into flood storage. The purpose of the WCS was to provide an alternative way to put South Pool into drawdown.

Annual work plans should be coordinated with the MNDNR Area Manager in Thief River Falls and the RLWD engineering technicians. Copies of the plan should be provided to them.

A gauge at Dr. Beich's driveway may be beneficial in light of the trigger points set by the RLWD. However, gauge readings at the Conley Larson bridge have been the readings that have dictated operational changes in the past. A gauge at Dr. Beich's driveway may be most beneficial during post flooding stoplog removal. This gauge would need to be placed by the RLWD and they agreed to install one at the March 2007 inter-agency coordination meeting.

There is a history of tampering with the Farmes Pool outlet WCS. Several times the screw gate has been found opened up despite the locking mechanism. Modifications have been made to help prevent tampering in the future. Stoplogs that were left on top of the WCS for a prolonged time period to dry off have been thrown off into the pool. Stoplogs need to be removed within a day or two of being moved and stored at the Refuge maintenance center.

There is a historic ditch on the north end of the HMU that drains the wet meadow into the County Road 7 road ditch. Filling in this ditch may be beneficial for the wet meadow site.

Prescriptions:

Farmes Pool is in the **Brood Habitat** prescription for semi-permanent wetlands with open water areas and a five- to six- year drawdown cycle, followed by a summer or fall burn. The objective is to maintain interspersion of open water and emergent vegetation for nesting diving ducks and duck brood use. The east side of HMU 39 is in the **Even-Aged Aspen** prescription which is a five-year spring burn cycle. The best scenario to mesh the burn season discrepancy for this HMU as a whole is fall burns. The pool management takes precedent and, if warranted, for emergent vegetation control, a summer burn should be conducted.

The last drawdown and fall burn was in 2003, so the next drawdown and burn would be in 2008, but it is moved ahead one year so that Parker and Farmes are not in drawdown at the same time. Parker has to be in drawdown in 2008 due to Ditch 11 rehabilitation. Try to avoid having Parker, Agassiz, and Farmes Pools in drawdown at the same time.

Farmes Pool will be in drawdown in 2007. This should start by lowering water levels to 1,137.9' by 15 May and then slowly lower the pool level to expose mudflats over the following two weeks to provide shorebird habitat on the WMA. The screw gate can be left open during the summer and then closed in early September to catch water for fall migration and hunter use of the WMA. The fall increase should be limited to 1,138.0'. Water for the fall increase may be available from Lost River Pool by coordination with the MNDNR. In subsequent years, depending on vegetation response and uncontrolled water levels, a typical course of action might be: in 2008 the pool level should be 1,138.5', in 2009 raise to 1,139.0', in 2010 raise to 1,139.5', in 2011 raise to 1,140.0'. The next drawdown sequence would be 2012.

There is a ditch in the middle of the north part of the unit that drains the open wet meadow in the east-central part of the HMU to the north into County Road 7 road ditch. This ditch should be filled to restore the wet meadow hydrology to the area.

Management Unit 40 South Pool

Size: 2,677 acres

Elevations:

	Pool elevation	Surface acres	Acre-feet
normal summer:	1,141.1'	647	786
spillway:	-		
drawdown:	1,138.0'		

Depth at 1,141.1': over 10% >3 ft; over 70% <2 ft.

Control structures: outlets 2, inlets 1
Spillways: none
First year operation: 1961

Physiography:

The pool is approximately ½ open water and ½ emergent cattail, with little interspersion. Prior to the 1990s the only open water area was divided into two bays separated by the north-south drainage ditch. During the 1990s several more open water areas developed along County Road 7, east of the Office. Dense cattail adjacent to the open bays changes into sedges, common reed, and willows to the south, east, and west.

Water movement:

The primary water source is runoff from the three sections to the east that parallel County Road 7. A secondary source of water is Ditch 201 via two courses. At normal flows Ditch 201 water is diverted north to Headquarters Pool by the angle ditch west of John's Field. This water can be passed to South Pool by the control structure under County Road 7 in the southwest corner of Headquarters Pool. At high flows water flows directly down Ditch 201 into South Pool.

South Pool is drained to the south ½ mile by a north-south ditch that intersects with the old Ditch 201 which flows west to an old bridge/WCS that is the outlet WCS for South Pool. The discharged water is diverted north back under County Road 7 bridge into Parker Pool. In 2005 a new WCS was placed in the old Ditch 201 to connect South Pool with Farmes Pool. Now two drawdown options exist for South Pool; when Parker Pool is less than 1,138.0' or when Farmes Pool is less than 1,138.0'.

Estimated time to dewater through Parker Pool is two weeks. Dewatering takes much longer through the new South to Farmes WCS due to the flat grade to get to Farmes Pool.

In 2006, the pool only went down to 1,138.9' by using the new control structure. This dewatered the east end of the pool, but not the main basin along the north-south ditch.

Drawdown history:

A complete drawdown was attempted in both 1965 and 1966, but was not successful because Parker Pool was held near 1,140.0'. In 1967, Parker was lowered to 1,137.3', allowing complete drawdown South Pool. Although drawdown again was attempted in 1968, excess runoff raised pool level to 1,140.0' during summer. Submergents increased substantially in 1968 as a result. A drawdown was accomplished in 2003.

Burn history:

Year	Area	Acres Burned	Time of Year	Type
1960	East	UNK	Spring	P
1973	East	UNK	Spring	Wild
1977	West	UNK	Spring	P
1977	East	UNK	Spring	Wild
1985	West	172	Spring	P
1985	East	20	Spring	Wild
1990	All	All	Spring	Wild
1994	West	UNK	Spring	P
1998	West	120	Spring	P
1998	East	1850	Spring	P
2002	East	2800	Spring	P
2003	East	2830	Spring	P

Wildlife:

Diving duck nesting has been very high when the water level is high. Migrational use is high when the water level is lowered in late summer. The mudflats exposed in the summer by the drawdown in 2003 drew the flightless Canada geese off of County Road 7 and reduced the number of road kills. American bitterns were documented making extensive use of the west end of this pool during the research study.

Facility improvements:

Year	Project	Location
2003	gauge replaced	no change
2001	bridge top on South Pool outlet replaced with removable catwalk	
2005	new South-Farmes Pool water control structure constructed	SW Corner of South Pool

Needs, restrictions, and objectives:

Complete drawdown of South Pool is still problematic since the new WCS did not result in complete dewatering in 2006. Complete dewatering will still only be possible when Parker Pool is at least in partial drawdown. This restriction also affects drawdown management options for Headquarters Pool which outlets into South Pool.

Common reed is abundant in this HMU and Refuge staff should strive to decrease it. Summer burns are presently the most promising tool.

In 1994, two oval areas of approximately five acres each were outlined in the dense cattail of the west half by repeated trips with the airboat. The idea was to burn these two areas of cattail to create openings. The burns did not take place. One oval airboat track remained evident for several years. The other one became indistinguishable the following year due to an opening up of the cattail because of sustained high water. Muskrats appeared to take advantage of these tracks into the cattail and many houses were observed, further contributing to the open water.

The plan for the new South to Farmes WCS was submitted to the RLWD, MNDNR, and Marshall County Ditch 11 Authority because Farmes Pool and Ditch 11 were involved. We offered to the RLWD that the structure would be closed whenever they ordered Farmes Pool to be placed into flood control. They accepted the idea in a draft agreement and approved the project but the formal agreement hasn't yet been signed. The MNDNR also approved the project. Marshall County Ditch 11 Authority denied the permit, but the Refuge decided to go ahead without their approval since they had no factual basis for their denial. The structure was installed in late summer 2005.

Prescriptions:

South Pool is taking a change in management direction. It is now placed in the **Sedge Meadow** prescription and will be in a two-year cycle of partial drawdown and summer burn one year followed by shallow water levels the second year. Objective water levels will be the same as either Farmes Pool or Parker Pool. Coordinating a mid-pool level on either Farmes or Parker during the partial drawdown year will allow for a lower partial drawdown. The shallow water level will also be dependent on the same level as either Parker or Farmes pools.

South Pool needs to be synchronized with the Headquarters Pool drawdown that is also dependant on Parker Pool to be in drawdown. The synchronized drawdown year is 2013, so South Pool will be in partial drawdown in 2007 and every other year thereafter. The entire HMU will be included in the summer burn during the drawdown year, except in 2007, when the west part of the HMU will be burned in the fall of 2007 to complete the U.S. Fish and Wildlife Service/USGS inter-regional fire/cattail study.

John's Field (HMU 41)

Size: 747 acres

Physiography:

The HMU is bounded by County Road 7 on the north side, Ditch 201 on the Refuge boundary on the south side, and the grassy angle dike/ditch on the west side. The north half of the east side is the grass dike on the east side of the old farm fields. The south half of the east side is mowed firebreak that will be established by taking advantage of open grassland areas south of the farm fields. The northeast corner of this HMU contains the John's Field farm fields. The farm fields are mostly a loam soil. The area south of the farm fields are mollisol loams and the southeast corner is fine sandy loam that is capable of oak woodland and is currently mostly grassland. Most of the remainder of the HMU is decomposed peat muck, of which most is ponded. This area is sedge meadow heavily invaded by common reed. Willow is most dense along the west edge. Aspen has become established on the east side of the HMU, south and west of the farm fields on the mollisol loams.

Burn history:

Year	Acres Burned	Time of Year	Type
1960	UNK	Spring	P
1969	UNK	Spring	P
1971	UNK	Spring	P
1973	UNK	Spring	Wild
1977	UNK	Spring	Wild
1982	895	Spring	P
1989	UNK	Spring	P
1990	747	Spring	Wild
1996	118	Spring	P
2000	600	Spring	P

Wildlife:

The last active sharp-tailed grouse dancing ground on the Refuge, in the early 1990s, was in bog vegetation in the middle of this HMU. The HMU has a high deer density during winter surveys. Geese and ducks make use of the farm field crops in the spring and fall. Bear also use the crops and nearby acorn crops.

Needs, restrictions, and objectives:

The HMU is included in the OLMA. Zager (2007) identified a Mesic Aspen Oak woodland area on the west side of the farm fields that can be converted to Wet Brush

Prairie. There are no existing oak trees in this area. A second area of existing Mesic Aspen Oak woodland was identified in the south-central part of the HMU. This area also does not have any existing oak trees. Oak trees will not become established in these areas with the existing stands of aspen present. Since oak are not present and over 80% of the HMU is wet meadow and marsh, the HMU is being placed into the **Grassland/Sedge** prescription. The objective will be to eliminate trees and reduce willows in the HMU. The elimination of trees and keeping the area in brush prairie may allow for oak to establish on the fine sandy loam at some time in the future. Application of herbicide after cutting the trees will most likely be needed on these woodland vegetation types to eliminate tree re-sprouting. Cutting the trees in this HMU was done in the winter of 2006/07. Willows on the west side of the HMU were also mowed in 2006/07. Willow mowing in the south part of the HMU was done in 2004/05.

This HMU has a severe problem of common reed invasion. Putting the HMU into a summer burn prescription will have the greatest impact in obtaining a decrease in common reed (Ward 1942, Ward 1968, Thompson and Shay 1985, Thompson and Shay 1988). Herbicide (glyphosate) can also be applied to regrowth after burns with a wick applicator in some of the most problematic areas along the west and north sides. The wick application will keep the under story sedges from being killed.

Prescription:

This HMU is in the **Grassland/Sedge** prescription. During the conversion of trees to grassland phase of this prescription the HMU will be burned in the summer every other year. If the conversion is successful after three or four cycles, the frequency of burning can be reduced to every four years. The trees and willows were mowed in the winter of 2006-07. The first summer burn is scheduled for 2008. Herbicide application can be applied in early summer 2008 when the aspen, willow, and common reed are high enough to reach the wick applicator and spare the sedge understory. The areas that are currently in Mesic Aspen Oak Woodland are the highest priority for herbicide application, followed by the Mesic Wet Aspen Woodlands, as mapped by Zager (2007).

John's Field (HMU 41A)

Size: 128 acres

Physiography:

This sub-HMU consists of the farm fields in the northeast corner of HMU 41. There is a perimeter dike and ditch surrounding the units that was established to improve drainage for farming and to allow pumping into the HMU for moist soil unit management. The soils are nearly all mollisol loams.

Burn history:

Year	Acres Burned	Time of Year	Type
1990	128	Spring	Wild
1997	20	Spring	P
2001	126	Spring	Ag Field
2003	15	Spring	P
2003	14	Spring	Ag Field
2005	29	Spring	Prairie
2005	35	Spring	F-10
2005	4	Fall	Prairie prep on E side.
2006	85	Spring	Ag, prairies, mixed grasses

Wildlife:

The sub-HMU has a history of substantial use by Canada geese use in the fall. It is also readily used by deer.

Needs, restrictions, and objectives:

The objective is to convert the farm fields to prairie. The farm fields taken out of production during the last 10 years have been seeded to upland prairie, with big bluestem as the dominant grass. Current information provided by Zager (2007) indicates that upland prairie may not have existed on the Refuge historically. Northern Wet Prairie vegetation, with bluejoint as the dominant grass, may have been the prairie in this locality; however, drainage has affected the hydrology of the fields and they may have areas that will support big bluestem prairie. Restoration of the remaining fields should consider bluejoint wet prairie in seed selection.

Some discussion has taken place on the prudence of leveling the perimeter dike and filling the ditch back in. The discussion has not resulted in a decision. Thought should be given to the need for maintaining a firebreak between HMUs 41 and 42. The dike on the east side of HMU 41A provides this firebreak and good access to the south part of the unit when it is needed. This dike could be lowered several feet and still provide this function. The value, however it is to be defined, may not warrant the cost of leveling the ditch. Hydrology of the sub-HMU will still be affected by County Road 7 ditch. The sub-HMU has proven to be wet enough to only marginally support big bluestem and so still may be wet enough to support the native wet prairie without filling the ditches. More economical results may be obtained by closing the small field ditches in the fields.

Prescriptions:

The steps for restoring prairie vary by site and results and will be worked out in the Annual Habitat Work Plans.

Management Unit 42 CHZ

Size: 668 acres

Physiography:

The HMU is bordered on the north side by County Road 7 and on the east side by the graveled boundary road. The south side is Ditch 201 on the Refuge boundary and the west side is the mowed firebreak and grassy dike that separate this HMU from HMU 41. This HMU is the south end of beach ridge and most of the soils in this HMU are a mosaic of mollisol loams and depressional sandy loams. There are some drier sites that have fine sandy loam that support the Dry Mesic Oak Woodland. The loam soils are those of the zone of contention between woodland and grassland, oscillating back and forth in time.

Burn history:

Year	Acres Burned	Time of Year	Type
1960	UNK	Spring	P
1969	UNK	Spring	P
1971	UNK	Spring	P
1973	UNK	Spring	Wild
1977	UNK	Spring	Wild
1982	895	Spring	P
1989	UNK	Spring	P
1990	UNK	Spring	Wild
1996	118	Spring	P
2000	600	Spring	P
2004	25.2	Spring	Prairie
2004	13.4	Spring	Prairie
2004	9.4	Spring	Prairie
2004	3.2	Spring	Prairie

HMUs 41 and 42 were one burn unit prior to this HMP. The burns listed above, prior to 2000, are the same as listed in HMU 42.

Wildlife:

The area has some oak trees that provide mast crop. The HMU has a high deer population that makes use of the adjacent Refuge farm fields and adjacent private lands.

Needs, restrictions, and objectives:

The HMU is included in the OLMA that Zager (2007) examined and made recommendations on. In general, the objective will be to reduce the amount of the area

that is in trees and keep it in a more open shrubland/grassland landscape. This HMU adjoins the MNDNR's Elm Lake WMA which is also going to be managed as part of this open landscape vista.

The mowed fireline along the west side is the only difficult line to maintain and blackline. Frequent burning will be the primary tool to keep aspen from reinvading the area.

Prescriptions:

The HMU is in the **Open Shrubland/Grassland** prescription. Zager (2007) identified areas in the northeast corner of the HMU that can be converted to Wet Brush Prairie by removing the aspen. Part of this area has a scattering of oak. Leaving the oak trees when the other trees are removed will create an oak savanna extension of the oak woodland found in HMU 37 to the north. Aspen in this area can be harvested and followed up two years later with herbicide applied with the wick applicator to kill resprouts. Oak trees must be avoided during the herbicide treatment.

In the middle of the HMU is an area of open grassland and Dry-Mesic Oak Woodland. On the south side of this vegetation type is an area of Mesic Aspen-Oak Woodland. The aspen in these two types should be girdled, and then removed two years later by a harvest contract with the surrounding Wet Mesic-Aspen Woodland. All of this Wet Mesic-Aspen Woodland west and south of the Dry-Mesic Oak Woodland should be harvested. The Wet Mesic-Aspen areas can be clearcut and followed up two years later with herbicide treatment if that action is not cost prohibative.

The Wet Aspen Forest in the northwest part of the HMU should be left as mature balsam poplar and aspen. The Mesic Aspen-Oak Woodland in the northwest corner can be included in the areas to be girdled if manpower allows. If not, the aspen can be harvested and herbicide used as follow up.

The girdling should be completed in 2007. The clearcut and harvest of girdled trees should be in the winter of 2009/10. Mowing of willow and non merchantable trees should also be completed the same winter. The first burn in 2012 should be a late summer burn several weeks after applying the herbicide to resprouting aspen. If herbicide cannot be afforded or not applied for other reasons, the burn should be in mid- to late May after the aspen have leafed out. Subsequent prescribed burns should be in the summer or fall on a three-year interval for at least two cycles, then potentially reduced to every four to five years.

Thief Bay Pool/North Wilderness (HMU 43)

Size: 6,444 acres

Elevations: **Thief Bay Pool**

	Pool elevation	Surface acres	Acre-feet
normal summer:	1,143.0'	1,722	2,147
spillway:	1,144.5'	3,310	6,965
drawdown:	1,139.0'		

Depth at 1,144.5': over 30%>5.5 ft.; over 60% <3 ft.

Control structures: outlet 1
Spillways: outlet 1, inlets 2
First year operation: 1955

Physiography:

This narrow pool is about 2.5 mi long and is bordered by a dike on the west side and a cattail fringe on the east side. The emergent fringe is quite narrow along the south portion and widens to the north. Cover:water interspersion is very low in the south with mostly open water. Conversely, in the north interspersion is lacking due to excessive cattail. The cattail fringe along the east side leads into a narrow sedge meadow zone and then into the coniferous bog of the Wilderness Area.

The upper end of the pool consists of East and West Olson Lakes. The East Olson Lake is only connected during the highest water levels. A narrow strip of high ground divides the Olson Lakes. During the 1990s these lakes and the northern part of Thief Bay Pool developed some open water interspersion due to the prolonged high water levels.

Remnant ditches exist on the section lines. These are branch ditches from the State Ditch 83 system. The ditches stretch to the east across the wilderness area, but all stop short of tying in with Webster Pool/Creek which was in the Judicial Ditch 11 system. Whiskey Lake is found in the middle of the black spruce/tamarack forest that occupies most of the HMU. The lake is shallow (three to four foot normal water depth) with a deep mucky bottom (five to six feet).

Water movement:

The primary water supply is from field drainage into the Olson Lakes via two large culverts located one mile east of the Thief River along Branch 2 of State Ditch 83. Additional water is brought in from the east from private lands at the end of Branch 4 of State Ditch 83. There are two inlet spillways from the Thief River that push water into the pool to be stored during flood events. The flow is usually reversed as the River drops

and at times it runs into the pool in the north spillway and out of the pool in the lower spillway.

The outlet WCS is at the southwest corner and the outlet spillway at the southeast corner of the narrow pool, both of which empty into Agassiz Pool.

Johnson (2006) investigated the reason conifer trees died along the west edge of the Wilderness Area during the 1990s. While objective water levels for Thief Bay Pool had been set as high in the past as they were in the 1990s, the water levels were never reached or sustained in prior years. Johnson attributed tree mortality to the sustained high water levels and the sinking of mature trees. **Johnson recommended that sustained water levels be 30 cm below the peat surface along the edge of the conifer swamp. This is equal to 1,143.7' msl.** The metal spillway elevation was 1,144.5' and has been heaved out of the ground so only a small portion of it remains at the proper elevation. It needs to be cut off, so it will be cut off at 1,143.7'. This level is more in line with the spillway elevation of Webster Pool (1,144.3') on the opposite side of the Wilderness Area where tree mortality has not been observed and is positioned higher in the watershed.

Estimated time to dewater is two weeks. Complete drawdown is only possible when Agassiz Pool is held at 1,139' or lower.

Drawdown history:

The pool was dry except for potholes in the summer 1961. The pool was in drawdown in November 1966 and reflooded in June 1968. In 1986, summer level was two to three feet below normal resulting in drying of the north end. The pool was in drawdown in 2003 and dried out except for puddles in the borrow ditch along the Thief River dike.

Burn history:

Year	Acres Burned	Time of Year	Type
1972	UNK	Fall	Wild, Whiskey/Olson
1973	UNK	Spring	Whiskey/Olson Lakes
2005	<1	Spring	Wild (trapper's car and dike top)

Wildlife:

Diving duck nesting conditions are best when this pool is at or near spillway elevation. At this elevation canvasbacks have been found to nest in modest numbers, especially near West Olson Lake.

Fall migrational use by dabbling ducks such as gadwall and American wigeon was very high in the 1970s, but declined in the 1980s, presumably due to reduced submergents

resulting from sustained high water. Lesser scaup were abundant in the fall through the 1990s, presumably due to an abundance of amphipods (scuds). Scaup use has declined in the 2000s. It is not known if this due to a lack of food or a lack of scaup.

The second trumpeter swan pair to nest on the Refuge chose Thief Bay Pool in 2006. The nest was approximately 300 m east of the Thief River dike, directly opposite Tamarack Trail (south side of old ditch Branch 6 of State Ditch 83).

Facility Improvement:

Year	Project	Location
2003	gauge replaced	no change
1998	Dike core/level	between Pool and Thief River
1995	Dike repair	Between Thief Bay and the river
1988	Ditch cleanout	1.25 miles which began at confluence of N/S Berg Ditch and Branch 4 SD 83 and going to the west
1986	Rehab. 1.25 mi. dike	Thief River dike, north end
1983	Rehab. 1.75 mi. ditch	East boundary to E. Olson
1981	Rehab. 1 mi. ditch	Berg's to E. Olson Lk.
1980	Rehab. 2.5 mi. dike	West and south dike
1979	Replace 24" CMP with 2-42" CMP	Outlet structure South dike
1977	Replace spillway with metal SP	South dike

Needs, restrictions, and objectives:

The elongated shape of the pool poses some limitations on management. Water levels that maximize over-water nesting in the north end create excessive water depths for good submergent growth near the south end. A partial drawdown needed to stimulate submergent growth requires complete dewatering of the primary nesting cover. Drawdowns need to be coordinated with Agassiz Pool.

The spillway needs to be rehabbed and lowered to a level that will prevent additional areas of the Wilderness Area being flooded for prolonged periods of time. The easiest cure is to cut off the existing spillway at elevation 1,143.7'. If the metal heaves again it can be replaced with a riprap spillway.

Prescriptions:

Thief Bay Pool is in the **Brood Habitat** prescription. The drawdown cycle will be five years and follow the Agassiz Pool drawdown. In 2007 the pool elevation will be 1,143.5'

since it was at a low water level during 2006. HMU 2 is the only portion of the pool that is burned. Burning of HMU 2 should be coordinated with the Thief Bay drawdowns and the next drawdown and burn year is 2011.

The remainder of HMU 43 is the Wilderness Area and is in the **Old Growth** management prescription. No cutting or mowing is allowed. Wildfire control is addressed in the Fire Management Plan.

South Wilderness (HMU 44)

Size: 2,307 acres

Physiography:

This HMU is the south half of the Wilderness Area above the normal pool elevation of Agassiz Pool. The soils in the HMU are deep peat Borosaprist soils. Black spruce and tamarack forest is growing on the central part of this HMU. Open bog surrounds the forest. Altered hydrology from Agassiz Pool creates a willow swamp and wet aspen forest fringe in this HMU. Kuriko Lake is shallow with a cattail and common reed border and located in the open bog.

Water movement:

Water movement in the bog is affected by the east-west ditch that separates HMUs 43 and 44. Johnson (2006) found lower water levels in the ground water wells south of the ditch/dike. Beaver make dams that anchor into the dike and cause flooding of the bog along the dike. Flooding effects from Agassiz Pool made modifications to the peripheral vegetation in the early years of the Refuge and Refuge staff now view this as just part of the 'natural scene'.

Burn history:

Year	Acres Burned	Time of Year	Type
1984	1,180	Spring	P

Wildlife:

The area has a history as one of the high density moose wintering grounds.

Needs, restrictions, and objectives:

The entire HMU is designated Wilderness Area. The objective is to leave it as untouched by human intervention as possible.

Prescriptions:

Historically, catastrophic fire in conifer swamps was not common. The MNDNR (2005) states the catastrophic fire rotation at about 570 years and the light surface fires at about 90 years. This HMU can be easily prescribed burned with north winds. Prescribed burns could be done on a 50- to 90-year rotation. The next prescribed burn would be scheduled for no sooner than 2034.

Restoring hydrology by allowing water movement through the east-west dike has been discussed. The dike could be leveled back into the ditch with breaches of peat spaced along the way. Another more feasible alternative would be to put culverts through the dike at some spacing to be determined that would allow for more flow. Beaver problems should be considered as part of the installation design. Screens or other beaver proofing would need to be considered.

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APPENDIX 1.

Addendums to Existing HMP.