INTEGRATED PEST MANAGEMENT PLAN
2004-2009
Devils Lake Wetland Management Complex
Devils Lake, North Dakota

Submitted: Concurrence:

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TABLE OF CONTENTS

Page

FIGURES:

TABLES:

APPENDIXES:

Background Information

Legal Mandate and Responsibility

The following is a comprehensive Integrated Pest Management (IPM) Plan for controlling or eliminating invasive and noxious weeds affecting Devils Lake Wetland Management Complex (Complex). This plan is developed under the authority of the Federal Plant Protection Act of 2000, the Federal Noxious Weed Act of 1974, Executive Order 13112, the Refuge Administration Act of 1965, the National Wildlife Refuge System Administration Act of 1966 as amended by the National Wildlife Refuge System Improvement Act of 1997 (16 U.S. C. 668dd-668ee), and the North Dakota Century Code Noxious Weed Control (63-01.1), and is in following with the requirements of the Refuge Manual for the National Wildlife Refuge System (7 RM 14) and other draft guidance from the U.S. Department of the Interior(DOI) and the U.S. Fish and Wildlife Service (Service). This plan is intended to address the Director's priorities to control invasive species in the Refuge System's "*Fulfilling the Promise*" document (recommendation WH7) and related work group efforts. This plan builds upon national, regional and local policies concerning invasive weed species including: Pesticide Use Policy (517 DM 1); Pest Management Policy and Responsibilities (30 AM 12); The National Invasive Species Management Plan (Drafted as per Exec. Order 13112, National Invasive Species Council, January 18, 2001, 90pp.); Compatibility (603 FW 2), Biological Integrity, Diversity, and Environmental Health (601 FW 3), "The national strategy for management of invasive species", Fulfilling the Promise, National Invasive Species Management Strategy Team, September 10, 2002; Region 6 Invasive Species Cross Program Team report, October 19, 2000: "A report on the state of invasive species management, U.S. Fish and Wildlife Service - Region 6".

National Perspective

The influx of non-indigenous species is one of the most important issues the continent faces today, second only to habitat loss and conversion. These species decrease the quality of important native habitats for fish and wildlife and ultimately decrease the biological diversity of ecosystems. Many changes that occur directly impact society by invoking major environmental changes. These changes alter water, energy, and nutrient cycles, decrease productivity, and affect biomass (Mac et al. 1998).

When considering only plants, there are greater than 3,723 species that are categorized as non-indigenous (Mac et al. 1998). Many of these plants, introduced intentionally and unintentionally, have displaced native plant communities and cause major economic burdens at an estimated annual cost of $138 billion (USFWS 2000). Often times when these plants arrive in areas where they did not ecologically evolve, there are no natural enemies or other plants that compete well against them. Without natural limits to their expansion in new environments, they invade areas quickly, resulting in monotypic stands of vegetation. When this occurs, many species that relied on native plant communities decline.

Regional Perspective.

The above scenario has made noxious weeds successful in grassland areas of the United States. In grassland systems alone, non-indigenous species now account for 13% to 30% of prairie species

(Mac et al. 1998). Their unprecedented spread has caused major ecological problems. This is evident in the Northern Great Plains region of the Prairie Pothole Region (PPR) (Fig. 1).

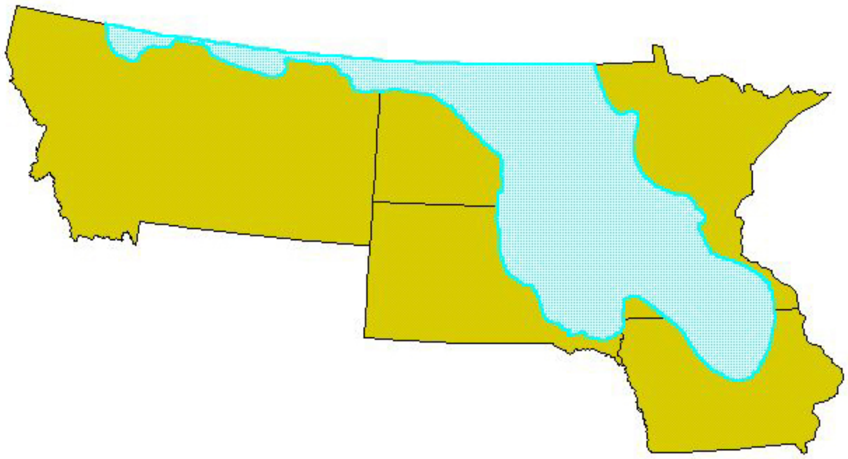

Figure 1. U.S. Northern Great Plains Region of the Prairie Pothole Region

For instance, the extent of leafy spurge (*Euphorbia esula*) infestation is well documented. This invasive species, introduced to the United States in 1827, plagues 26 states and six Canadian provinces (Wallace et al. 1992). Nearly 3 million acres of rangeland in Montana, the Dakotas, Nebraska, and Wyoming have been invaded. In North Dakota alone, it is found in every county in the state (Wallace et al. 1992) and infests 1.2 million acres (Lym et al. 1998), the most in any state. Between the years of 1950-1985 the acreage of leafy spurge doubled every ten years. The widespread infestation results in the reduction of grazing land productivity by 50-75% and costs North Dakota over $75 million annually. Leafy spurge expansion is compounded by its' difficulty to control. Effective control must be considered a long-term integrated management program. No single treatment will eradicate leafy spurge (Lym et al. 1998). Leafy spurge is not the only extensive noxious weed problem in North Dakota. Ken Eraas, (Noxious Weed Specialist, ND State Agriculture Department) reports that North Dakota has 1.4 million acres infested with Canada thistle (*Cirsium arvense*).

North Dakota State-listed noxious weeds (Table 1.) have been declared by the State to be detrimental to the production of crops or livestock. The Weed and Pest Control Commission has designated certain weeds as noxious because of their difficulty to control and the costs associated with loss of agricultural production. All of the designated noxious weeds have been introduced from other ecosystems and have flourished in the absence of natural controls.

Local Impacts

Invasive and noxious weeds on the Complex have already reduced wildlife habitat and biodiversity. These plants are not only problematic on the Complex, but also infest off-refuge sites. The spread of invasive weeds occurs by root spread or by seed dispersal via wind, water, refuge visitors, equipment, or animals. While invasive weeds spread between privately owned and Service owned lands, these are not the kind of contributions to the ecosystem expected from our National Wildlife Refuges and Waterfowl Production Areas.

Significant infestations on Service lands have resulted in more than a loss of habitat for wildlife, and a decline in species diversity in prairie grasslands. Weed issues have been great sources of contention between the Service, neighboring landowners, the State of North Dakota, and county officials. For many years, the Service did little to effectively manage invasive weed species on our lands. Control efforts were often cosmetic, short sighted, and reactive. Many times, control efforts utilized only one technique instead of implementing an integrated approach to weed management designed to meet a habitat objective.

Managing the problem- an IPM strategy.

The Complex Staff have given careful consideration to demonstrate land stewardship in controlling invasive plants by implementing an IPM strategy, while striving toward the goal of restoring the functions and values of prairie grassland and wetland habitats. It is this integrated approach to invasive species control that we believe will be necessary to successfully control invasive weeds, thus allowing us to achieve management goals and refuge acquisition purposes. Coordination of efforts will be crucial if we are to accomplish our goals. It will take many partnerships with neighbors, local/State governments, researchers, and others to succeed in controlling invasive species and restore the health of the Complex's ecosystem.

This document presents IPM strategies selected to control invasive plant species according to the Complex’s various site and soil types, with attention to resource needs. All control methods are considered, specific to each invasive and other pest species, as are prevention, monitoring, mapping, and restoration methods. Previous experiences in controlling pests are also described, so that only methods that are likely to be effective in the future are used. If there are sensitive resources present at some of the sites, such as rare or listed species, these resources and their locations are discussed and low-risk treatment options are selected to protect the sensitive species or sites. For example, if an infestation is present on lands deemed “high risk potential” for ground water contamination, a herbicide treatments that might contaminate ground water resources would be inappropriate. Similarly, a broad-spectrum herbicide would be inappropriate unless it was used as a spot treatment only on the targeted pest and precautions are identified to reduce drift, leaching, and runoff to nearby sensitive areas. In many cases, more than one invasive weed species is present on a site. In these instances, treatments are designed to treat the highest priority invasive plant species. This plan recognizes that pest control, and particularly invasive species control, will require a multi-year commitment, with follow up monitoring, assessment of the successes and failures of treatments, and development of new approaches when proposed methods fail.

Complex Planning, Refuge Purposes, Goals and Objectives

This planning effort is designed to meet the purposes for which the refuge units were established/purchased. These purposes gave rise to a vision, and specific IPM management goals for the Devils Lake Complex. Establishing and maintaining high-quality habitat is critical to fulfilling the purpose and vision of the Complex. Understanding that the native landscape where the Complex is situated was at one time a continuous prairie, and that the native prairie has been fragmented and significantly altered and disturbed due to a history of agricultural practices, is vital in developing the goals, objectives and strategies for invasive weed control and habitat restoration efforts on the Devils

Lake Complex.

Devils Lake Complex Enabling Legislation and Purposes

Sullys Hill National Game Preserve-

"... all the lands that are now reserved or may hereafter be included within the boundaries of the ... Sullys Hill National Park Game Preserve ... are hereby further reserved and set apart for the use ... as refuges and breeding grounds for birds." Executive Order 3596, dated Dec. 22, 1921.

"... as a big game preserve, refuge, and breeding grounds for wild animals and birds, ... Provided, That the said game preserve is to be made available to the public for recreational purposes in so far as consistent with the use of this area as a game preserve: Provided further, That hunting shall not be permitted on said game preserve." 46 Stat. 1509, dated Mar. 3, 1931.

Devils lake Wetland Management District-

"... as Waterfowl Production Areas" subject to "... all of the provisions of such Act [Migratory Bird Conservation Act] ... except the inviolate sanctuary provisions ..." 16 U.S.C. 718(c) (Migratory Bird Hunting and Conservation Stamp Act)

"... for any other management purpose, for migratory birds." 16 U.S.C. § 715d (Migratory Bird Conservation Act)

"… for conservation purposes …" 7 U.S.C. § 2002 (Consolidated Farm and Rural Development Act)

Lake Alice NWR

"... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. § 715d (Migratory Bird Conservation Act)

Kellys Slough NWR

"... as a refuge and breeding ground for migratory birds and other wildlife." Executive Order 7320, dated Mar. 19, 1936.

"... the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions ..." 16 U.S.C. § 3901(b) (Emergency Wetlands Resources Act of 1986)

Devils Lake Complex Vision Statement

The vision of the Devils Lake Complex is to conserve, manage, restore and enhance a diverse mosaic of habitats and wildlife resources in the northeast prairie region of North Dakota for the benefit of present and future generations.

Devils Lake Complex IPM Goals, Objectives, and Strategies:

Goal: The primary goal is to promote the successful restoration of prairie grassland habitat, increasing biodiversity of grasslands and optimizing the quality of habitats on the Complex. Restored, healthy grassland ecosystems provide habitat necessary for meeting the Complex's vision and purpose, and resist encroachment from invasive plants and other weeds.

The following objectives, and non-inclusive strategies were developed to guide and implement the Station's IPM program:

Inventory and Mapping:

<u>Objective a:</u> Inventory all NWR's, and WPA's in the Complex for priority invasive weed species infestations (Table 1) by 2004 using a systematic approach.

Strategies:
- Work with others (eg. North Dakota State University, etc.) to develop / utilize remote sensing data to identify areas of invasive weeds.
- Utilize force account labor (permanent and seasonal) to conduct inventories, and prepare accurate field maps.
- Utilize contracted and/or cooperative partnerships to conduct inventories, and prepare accurate field maps.

<u>Objective b:</u> By 2004, enter all field inventory data into refuge lands geographic information system (RLGIS) and prepare accurate habitat maps of Complex grasslands, including extent and type of priority invasive weed species in the Complex.

Strategies:
- Work with others (eg. North Dakota State University, etc.) to develop / utilize remote sensing data to identify areas of invasive weeds.
- Utilize force account labor (permanent and seasonal) to conduct inventories, and prepare accurate field maps.
- Utilize contracted and/or cooperative partnerships to conduct inventories, and prepare accurate field maps.

<u>Objective c:</u> Beginning in 2005, annually re-inspect 40%-50% of all NWR's and WPA's in the Complex to identify new emerging infestations of invasive weeds.

Strategies:

- Encourage reports from Refuge cooperators, neighbors, county weed boards, rural mail carriers and others regarding the presence of invasive weeds on the Complex.
- Work with others (eg. North Dakota State University, etc.) to develop / utilize remote sensing data to identify areas of invasive weeds.
- Utilize force account labor (permanent and seasonal) to conduct inventories, and prepare accurate field maps.
- Utilize contracted and/or cooperative partnerships to conduct inventories, and prepare accurate field maps.

Prevention:

<u>Objective d:</u> Ensure that all seed purchased for use on the Complex is certified, “weed free”, or tested to ensure that invasive weed seeds are not present.

Strategies:

- Purchase seed from reputable dealers, requiring the disclosure of seed origin and testing

<u>Objective e:</u> Prepare “weed-free”, well packed, seedbeds on all tracts scheduled to be seeded before establishing/re-establishing prairie grasslands.

Strategies:

- Use cooperative farming agreements, and crop rotations to prepare seedbed
- Consider the use of multiple applications of roundup in year prior to seeding to ensure weed seeds are “eradicated”
- Ensure ground is adequately packed, and that proper grass seed drills are utilized
- Make sure edges of fields and hard to access areas are treated when noxious weeds are present. Often times a cooperative farming agreement to reestablish grass will be initiated, but the edges and hard to access areas will not be farmed nor treated for weeds so that weeds do not encroach back into newly established grasslands.
- Limiting site disturbance, and/or improving decadent grasslands.

<u>Objective f:</u> Immediately implement proper vehicle sanitation procedures as described in the “prevention” section of this plan.

Strategies:

- Purchase portable air compressors for each maintenance utility vehicle so that weed seed can be blown off tractors and other equipment before leaving the site to prevent spread of weed seed to other areas.

Control new infestations:

<u>Objective g:</u> Provide a minimum of 95% control of all newly discovered invasive plant infestations less than 5 acres in size and from all locations that present the best opportunities for infestations to spread

Strategies:

- Implement control measures on areas such as roadsides, ditches, public use areas; essentially anywhere vehicles and equipment could transport seeds or plant parts to new locations.
- Spot spray, or wetblade new infestations with high efficacy herbicides.
- Maintain healthy grass stands thru proper management including early detection of invasive weed infestations.
- Train staff, including temporary and cooperators to recognize invasive weed species.

Containment of established invasions under the following 3 situations:

Objective h: Create a "containment buffer" surrounding large (>5 acres), established priority invasive plant infestations that propagate via root system spread by providing 95% control of priority weeds within a 100 foot buffer surrounding these infestations.

Strategies:

- Utilize cooperative hay/spray agreements to prevent seed dispersal and control established plants.
- Utilize force account labor to control noxious weeds.

Objective i: Prevent 95% of seed set and dispersal of all invasive weed infestations to ensure that infestations do not grow or generate new infestations.

Strategies:

- Utilize cooperative hay/spray agreements to prevent seed dispersal and control established plants.
- Utilize force account labor to control noxious weeds.

Objective j: By 2008, provide 95% control of invasive weed infestations in locations, where re-infestation is not likely due to the absence of these weeds in the surrounding landscape. These would be small areas of weeds and/or new infestations.

Strategies:

- Utilize cooperative hay/spray agreements to prevent seed dispersal and control established plants.
- Utilize force account labor to control noxious weeds.

Long-term management:

Objective k: Reestablish and/or maintain healthy prairie grasslands for migratory birds and other wildlife by aggressively planting competitive grassland seed mixtures (native grass mixtures and DNC)

Strategies:

- Where appropriate, utilize cooperative agreements, and force account labor/equipment when necessary, to prepare a weed-free seedbed and seed competitive grass species adapted for onsite soil and climatic conditions.

Objective l: Elimination or control of invasive plant infestations will be immediately followed with aggressive management actions to restore competitive, beneficial grassland plants within 5 years of control.

Strategies:

- Where appropriate, utilize cooperative agreements, and force account labor/equipment when necessary, to prepare a weed-free seedbed and seed competitive grass species adapted for onsite soil and climatic conditions.

Objective m: Continually research the potential impacts of grassland management techniques (including burning, grazing, and haying) on desirable grass and invasive weed species.

Strategies:

- Where appropriate, utilize cooperative agreements, and force account labor/equipment when necessary, to prepare a weed-free seedbed and seed competitive grass species adapted for onsite soil and climatic conditions.

Protection of biologically sensitive areas and ground/surface water:

Objective n: Compare all chemical treatments to endangered species and ground/surface water sensitivity analysis models to ensure that herbicide applications pose a minimal risk to these biologically sensitive areas.

Objective o: Ensure that all biological control organisms are thoroughly tested by U.S. Department of Animal and Plant Health Inspection Service (APHIS), and are not released until they are found to be species specific in their impact.

Objective p: Ensure label directions are carefully followed for all herbicide applications, and herbicides are applied in accordance with federal and State law.

Partnership Development:

Objective q: Develop 1 new funding and/or research partnership in the Complex by 2008.

Strategies:

- Build upon existing National Fish and Wildlife Foundation, “Pulling Together Initiative” partnership by sharing successes and failures with partners.
- Attend county commissioner meetings and county weed board meetings to discuss invasive species control.
- Discuss research needs with U.S. Geological Survey, non-government organizations, U.S. Department of Agriculture and chemical corporations.
- Further develop and maintain partnerships with State, county, and local governments, corporations, non-government organizations, and universities to control invasive weed species.

Site Description/General Overview

The Complex is located in the heart of the Prairie Pothole Region of the United States. The northeastern North Dakota counties of Towner, Cavalier, Pembina, Benson, Ramsey, Walsh, Nelson, and Grand Forks are included in the Complex (Figure 2). Managed by the U.S. Fish and Wildlife Service, the Complex primarily provides prairie grassland and wetland complex habitats needed by waterfowl in the spring and summer for nesting and feeding. Hundreds of thousands of waterfowl also use Complex wetlands in the spring and fall for feeding and resting during migratory flights.

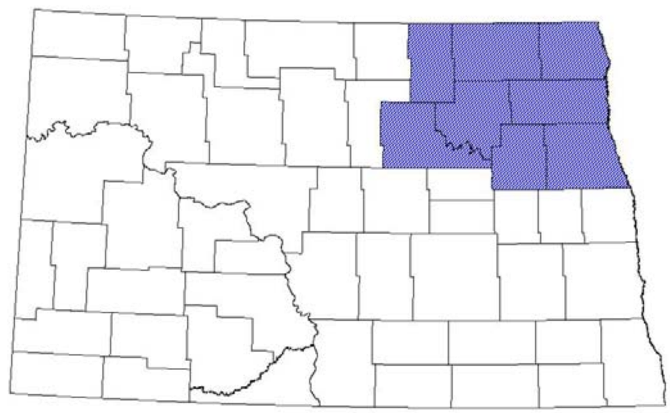

Figure 2. Counties of the Devils Lake Complex

The Devils Lake Complex manages wetlands (over 47,000 acres) and other wildlife habitats located on 211 separate Waterfowl Production Areas (WPA's), Lake Alice National Wildlife Refuge (NWR) (13,100 acres), Sullys Hill National Game Preserve (NGP) (1,674 acres), Kellys Slough NWR (1,867 acres), eleven easement refuges, and 154,000 acres of wetland easements (Figure 3). WPA and NWR lands are owned by the U.S. Fish and Wildlife Service and managed to establish and protect waterfowl breeding and nesting habitats. Easements on private lands protect wetlands from draining, filling, leveling, and burning.

Deterioration of many grassland habitats within the Complex had occurred for many years prior to, and in some cases, after fee title acquisition by the Service. Many tracts purchased on the Complex have past histories of tillage for crop production, or over-grazing by livestock. Farming eliminated many native plant species prior to Service acquisition. Grasslands that do not have farming histories may still face threats from the introduction of exotic plant species. On these tracts, native plant communities may have been altered due to past over-grazing, fire suppression, or over-rest which provides exotic species an opportunity to out-compete native grasses. Canada thistle, musk thistle, leafy spurge, and absinth wormwood are examples of invasive weeds that have flourished on the Complex. These species continue to alter the species composition and structure of grassland ecosystems, reducing their value as wildlife habitat.

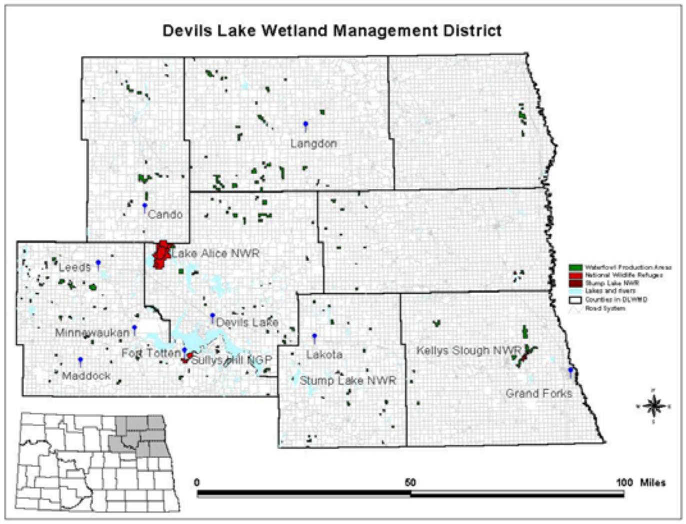

Figure 3. Lands of the Devils Lake Complex

Devils Lake Wetland Management District –

Two major physiographic regions divide the Devils Lake Wetland Management District (Figure 4). The Northeastern Drift Plain, consisting of many shallow potholes or lakes scattered among rolling hills, covers the western two-thirds of the Complex, while the Aggasiz Lake Plain, a remnant of glacial Lake Agassiz, covers the Red River Valley in the east.

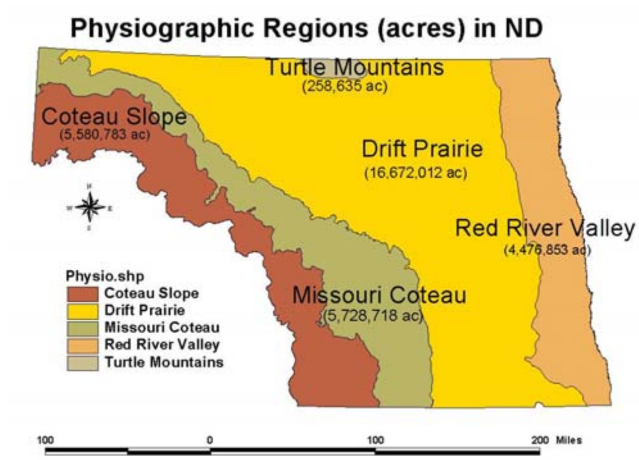

Figure 4. Physiographic Regions of North Dakota

Historically, lands comprising the WMD were tall or mixed grass prairie. Grassland plant communities included associations dominated by Big Bluestem (*Andropogon gerardii*), Indian grass (*Sorghastrum nutans*), Little Bluestem (*Andropogon scoparius*), Switchgrass (*Panicum virgatum*), Prairie Cordgrass (*Spartina pectinata*), Western Wheatgrass (*Agropyron smithii*), Reed Canary (*Phalaris arundinacea*), and Slender Wheatgrass (*Agropyron caninum*). Native American tribes in the region found these grasslands and wetlands rich with wildlife. Early settlers also found abundant wildlife, but changes in land use practices and intensive agricultural development have caused depletion of the native prairie as well as of countless numbers of bison, elk, and clouds of migratory birds.

Sullys Hill National Game Preserve **–**

Sullys Hill National Game Preserve is located in Benson County on the south shore of Devils Lake near the town of Fort Totten. Consisting of 1,674 acres of wooded glacial moraine hills and open native grassland meadows, it is one of four refuges managed by the U.S. Fish and Wildlife Service for American bison and elk. President Theodore Roosevelt set aside Sullys Hill as a National Park in 1904, and in 1917 and 1918 bison, elk, and deer were reintroduced to Sullys Hill, establishing the big game herds. Sullys Hill was transferred from the National Park Service to the National Wildlife Refuge System in 1931.

Lake Alice National Wildlife Refuge **–**

Lake Alice National Wildlife Refuge is located in Ramsey and Towner Counties near the town of Churchs Ferry. Originally an easement refuge, lands within the Refuge were privately owned, and no hunting was allowed. In 1972, the Fish and Wildlife Service purchased 8,600 acres of the original easement refuge. The Service now manages 13,100 acres at Lake Alice. The relatively flat landscape of the area is intertwined with wetlands and marshes. These wetlands were created by large continental glaciers during the last ice age, and are extensively used by colonial nesting waterbirds. Most of the refuge was farmed at one time, and very little native prairie remains. Mixtures of native and introduced grasses/legumes have been planted throughout most of the Refuge. High water levels associated with the flooding of nearby Devils Lake have inundated much of the Refuge.

Kellys Slough National Wildlife Refuge **–**

Kellys Slough is located eight miles west of Grand Forks, North Dakota. Thousands of years ago, as glacial Lake Agassiz receded, it left dark rich soils that supported a diverse plant community consisting of native, tallgrass prairie plants. However, a century of intensive agriculture has left only a remnant of the native landscape. The Refuge was established in 1936 by President Franklin D. Roosevelt. Since then native grasses and forbs have been planted on the areas in which the existing upland habitat was in need of rejuvenation. In 1991 dikes and water control structures were installed. By 1994 the Service was managing water levels in eight pools covering almost 900 acres.

Surrounding Land Uses –

Much of the private land in the Complex is intensively farmed, with wheat, barley, flax, corn, sunflower, canola, soybeans, and mustard being the dominant crops. Noxious weeds are actively managed in agricultural fields with herbicides or tillage. Other areas within the Devils Lake Complex include rangelands used for pasture, or grasslands tracts seeded under various wildlife habitat programs including: Conservation Reserve Program (CRP) lands, state waterbank tracts, or habitat plots. Other locations may include idle field margins, alongside highways, railroads, or woodlots.

Climate –

The Complex has a continental climate characterized by relatively warm, short summers and long cold winters. Precipitation averages about 17 inches annually, some three-fourths of which falls between April and September. Winter snows melt, and spring rains often combine in April to form the run-off which replenish wetland basins.

The maximum-recorded temperature is 112˚ and the minimum is -46˚ F below zero. The average date of the last killing frost is May 15 and the earliest is September 23. The growing season is short, averaging 131 days. The lowest annual precipitation record is 10.08 inches recorded in 1967 and maximum is 27.77 inches recorded in 1986. The mean annual snowfall at the City of Devils Lake is 36 inches.

Sensitive Complex Sites and Species

Threatened and Endangered species habitat-

Endangered species in the Devils Lake Complex include the bald eagle (*Haliaeetus leucocephalus*), whooping crane (*Grus Americana*), gray wolf (*Canis lupus*), and piping plover (*Charadrius melodus*). Protecting endangered species habitat is of paramount concern. Though chemical control methods used on the Complex pose a minimal impact to most of these species, of particular concern is the protection of critical habitat of the Piping Plover.

Several alkali wetlands in NW Benson County are documented as known plover breeding locations (Appendix 1). A section 7 consultation and environmental assessment conducted in 2002 indicated that applying certain herbicides (Appendix 2) within ½ mile of these known breeding areas could detrimentally affect plover populations. Although the Devils Lake Complex does not apply any of the listed pesticides of concern, we are concerned with the ability of certain herbicides to move into surface waters, and negatively impact aquatic invertebrate populations that the plovers depend on. Several WPA's exist within these ½ mile buffers of plover critical habitat. Care will be taken to ensure that any herbicide applications made within theses buffer zones are done in a manner than minimize risks to plovers. As with any weed treatment site, mechanical, biological, and cultural alternatives will be evaluated as a first means of treatment before using any herbicides. If the use of a herbicide is required to meet treatment objectives, care will be used to select those herbicides that pose the least risk to aquatic invertebrates or terrestrial vertebrates. In addition, application techniques such as use of a Burch ® wetblade mower, or shielded booms will be used to minimize the potential for chemical drift.

Sullys Hill National Game Preserve has a black-tailed prairie dog town (listed as a candidate species under the Endangered Species Act of 1973). A Section 7 consultation covering black-tailed prairie dog towns was prepared and approved in 2001. No invasive weed infestations occur within or adjacent to the prairie dog towns, and therefore, no IPM treatments are planned or expected.

State listed rare species-

The North Dakota Natural Heritage Program prepared a listing of rare species within Complex. The listing includes numerous species of plants, insects, birds, fish, mussels, and mammals. While specific life history information for many of these species is lacking, it is well accepted that the loss of critical habitat has played a significant role in their decline. Many of the listed species are dependent on native prairie communities, or pristine wetland or woodland habitats. The specific locations of various rare plant and animal species within the Devils Lake Complex are attached (Appendix 3).

The spread of invasive weeds poses a significant threat to many of these species through direct habitat degradation, and the loss of biological diversity. Although relatively few rare plant or animal species were cataloged on Service lands in the Complex, IPM treatments made under this plan will limit the abundance and spread of invasive weeds, while limiting impacts to non-target organisms. Before an IPM treatment is selected for a particular site, managers will consider potential impacts of this treatment to State listed rare species. Examples may include not using a herbicide treatment option where rare plant species may be impacted, or not using a mechanical treatment if rare ground nesting birds may be disrupted during their breeding season. Efforts to control invasives, and restore native habitats in locations where invasive weeds now predominate may benefit many of these rare species.

Prairie grassland sites during the nesting season-

Undisturbed grasslands are critical breeding habitat to a variety of ground nesting birds in the Complex. Waterfowl nest densities of up to one nest/acre have been documented in grassland habitats. Activities that remove vegetative cover during the nesting season (eg. early haying or mowing), can destroy nests, limit re-nesting opportunities, or even kill hens. Repeated, large scale mechanical control treatments which provide short-term control of invasive weeds are discouraged under this plan. Previously on the Devils Lake Complex, hundreds of acres of musk thistle, Canada thistle, and leafy spurge were mowed or hayed year after year to treat the spread of these species. These treatments repeatedly removed available habitat for prairie grassland birds, and did not accomplish the stated objective of reducing the spread of the targeted invasive weeds.

Although haying or mowing grassland habitats during the nesting season may be a necessary component to control the spread of invasive weed species, IPM treatments prescribed under this plan will combine other methods. These include biological, cultural, and chemical treatments used in concert with mechanical treatments to accomplish long-term control of invasive weeds. Once invasive weeds are controlled, restoration of these sites to healthy prairie grassland communities will be undertaken for the long-term benefit of prairie grassland birds and other wildlife.

Areas of Service owned native prairie-

Native prairie habitats are extremely rare on the Complex, with this habitat type accounting for less than 10% of all Service owned lands in the Complex. Native prairie tracts have a high capacity for biological diversity. Although many of these sensitive plant communities are currently suppressed with non-native plants (i.e. smooth brome (*Bromus inermis*) and Kentucky bluegrass (*Poa pratensis*) or invasive weed species (i.e. leafy spurge and Canada thistle), these sites contain native plant seed sources and dormant native plants with the potential for tremendous biological diversity. In addition to rare native plants, these sites may provide critical habitat for a variety of rare insect populations. Broadcast applications of broad-spectrum herbicides may be extremely detrimental to many native broadleaf forbs on native grasslands. The Complex will prescribe IPM treatments in these locations that pose the least risk to native plant (and dependent insect) populations. These treatments are outlined in the following section.

Pollinators Present During Treatment-

Many different species of native pollinators occur on the Complex. A butterfly survey was conducted at the Sully's Hill National Game Preserve in 1996 by Dr. Ron Royer (Minot State University) to help quantify the baseline occurrence of these species. A comprehensive annotated list of native butterflies with the potential to occur on Sully's Hill National Game Preserve (and many other locations within the Complex) was included in the study report, (Appendix 4).

Of particular concern are three rare butterflies: the Dakota skipper (*Hesperia dacotae*), powesheik skipper (*Pyrgus centaureae freija* (Warren)), and the regal fritillary(*Speyeria idalia*) because they are only found on native prairie sites that have diverse plant communities. Dakota skipper habitat consists of mesic tallgrass to mid-grass native prairie. Larval foods include little bluestem and needle-and-thread grasses. Nectar plants include yellow and purple coneflower (*Echinacea spp*.), white prairie clover (*Dalea candida*), black-eyed susans (*Rudbeckia triloba*), and white camus (*Zygadenus elegans*)(Royer 1997). Powesheik skippers require undisturbed wet to mesic prairie habitat composed of sedges for larval food and available nectar sources that include yellow coneflower and black-eyed susans (Royer and Marrone 1992). The principal habitat requirements for the regal fritillary are large extensive native tallgrass prairie tracts with native violets and nectar supplies including long-headed coneflower (*Ratibiba columnifera*), black-eyed susans, fleabane (*Inula dysenterica*), and blazingstars (*Liatris spp*.) (Royer and Marrone 1992). Swengel (1996) suggests that management treatments, such as haying or prescribed burning, be limited to smaller tracts to minimize impacts to these species.

Domestic honeybees are commonly found throughout the Complex. Lands planted to canola or sunflowers are targeted by honey producers, and bee yards are commonly established adjacent to these agricultural fields. Honeybees also pollinate sweetclover, alfalfa, and in some cases musk thistle, in areas of Conservation Reserve Program, or Service lands. IPM techniques that damage the legume components of Service grasslands would be detrimental to domestic honeybees.

IPM techniques utilized under this plan will consider impacts to these sensitive species. Managers must consider several factors specific to these species when prescribing IPM treatments. Rare butterflies depend on native plants and forbs for their life history requirements. The spread of invasive species in areas of native prairie diminishes the habitat available to these rare species when the plants they depend upon are crowded out. Several locations exist within the Complex where native prairie grasses and forbs have been replaced by monotypic stands of leafy spurge, or other invasive weeds. Failure to treat the presence and spread of invasive weed species, diminishes the availability of native grasses and forbs, and has a direct negative impact on many native butterflies.

Biological controls may prove to be beneficial control measures in some cases where the biological control organisms are species specific. Flea beetles (*Apthona sp.*) have demonstrated their ability to control leafy spurge, and are not known to damage other native plants or insects. Other species of biological control, such as many of the insects that have been utilized to control Canada thistle, are known to also damage native thistles as well as Canada thistle. The potential for these biological control organisms to affect native thistle populations is not well documented, or presently well understood; however, the potential to damage native plant communities (and the pollinators that depend upon them) is of concern to managers on the Complex, and their use is discouraged for this reason. Large scale grazing, haying, or burning of prairie for weed control poses a significant risk to native butterfly species. Similarly, broadcast applications of herbicides can also be extremely detrimental to native prairie forbs, or desirable legumes and impact the pollinators that depend upon them. While the toxicity of herbicides applied under this plan do not appear to be of concern to native pollinators or domestic honeybees, the impacts to non-target plant species is of paramount concern.

IPM treatments made on areas of native prairie in the Complex will target invasive weeds, while limiting impacts to native plant populations and the insects that depend on them. The use of flea beetles to control widespread infestations of leafy spurge in native prairie will be the preferred method of control. Prescribed fire will be utilized to help establish flea beetle populations, reduce wormwood infestations, and promote competitive native plants; however, widespread burning of large continuous tracts of prairie will be discouraged due to potential impacts to butterfly populations. Small areas of leafy spurge, and Canada thistle will be treated with the Burch® wetlblade mower (described later in this plan) to limit their spread, while minimizing impacts to native plant species.

High potential for pesticide leaching; area where herbicides could impact useable ground water resources-

Groundwater supplies are used for human drinking water, irrigation, or for domestic animals. Once contaminated with a pesticide, groundwater resources may be extremely difficult or impossible to reclaim (B. Seelig, NDSU Ext. Soil Scientist, Fargo, ND, personal comm.). In order to effectively protect groundwater, managers must first know specifically where the groundwater resources are located. Also, it is important to understand the many other factors that affect the potential for a herbicide to contaminate groundwater supplies including: the presence of groundwater recharge sites, percent soil organic matter, herbicide half-life, solubility, and chemistry, soil permeability, and depth to groundwater (Seelig 1994).

A methodology to assess the potential for contamination to priority glacial aquifers in the Complex exists, and is outlined in a technical paper entitled “An assessment system for potential groundwater contamination from agricultural pesticide use in North Dakota” (Seelig 1994). North Dakota State University Extension Service groundwater specialists have applied this model to geo-referenced data with the use of a geographic information system (GIS), allowing the analysis of pesticide chemistry, soil morphology, and aquifer resource data in a spatial context. The analysis incorporates soil permeability, percent organic matter, depth to saturated aquifer, recharge areas, and overlays this information with known aquifer locations across the entire Wetland Management Complex. These factors are then integrated with the leaching potential of each pesticide determined as the ratio of the of the pesticide organic mater absorption coefficient (K_{oc}) to the half-life (T_{12}). When multiplied by

10 this is referred to as the Hornsby index. These values are grouped into a category of “high”, “intermediate”, or “low” potential to leach into groundwater (listed in the “Review of Selected Herbicides” section of this plan, Table 2). The result of this pesticide leaching potential modeling is the production of three different geo-referenced “aquifer sensitivity maps” per county (a separate map for pesticides with high, intermediate, and low leaching potential). These maps, and the associated methodology/metadata used to prepare them are attached to this plan (Appendix 5).

Each geo-referenced map identifies specific locations with “high”, “intermediate”, and “low” sensitivity to the type of pesticide considered for application. The production of these maps/data layers, permit managers to overlay Service lands (and geo-referenced weed infestation maps) with aquifer sensitivity layers to more specifically determine if the particular tract considered for herbicide treatment has “high”, “intermediate”, or “low” potential to impact known aquifer resources. The resulting analysis allows managers to effectively apply herbicides on the Complex while minimizing risk to known aquifers. As outlined by Seelig (1994) in ER-18 “An Assessment System for Potential Groundwater Contamination from Agricultural Pesticide Use in North Dakota” useable groundwater resources or aquifers are the first priority for protection in North Dakota. The North Dakota Technical Advisory Committee for the Pesticide/Groundwater Protection Management Plan stated this philosophy in a related position paper. Water resources that meet human needs are of highest priority. Protection of all groundwater is recognized as a desirable goal: however, the real world dictates that priorities must be set. In North Dakota, aquifers located in glacial or alluvial materials deposited during the Pleistocene are of greatest value due to their comparatively good water quality, high yields, and shallow depths. All of these types of aquifers are considered as a first priority for protective actions, particularly those shallower then 50 feet. For these reasons the Ground water Pesticide Sensitivity model is focused on glacial and alluvial aquifers in North Dakota. The current pesticide leaching analysis developed by NDSU is currently the best available tool to use to assess impacts from pesticides to groundwater locations over large areas. This model is currently being used to assess groundwater in all counties in North Dakota. The NRCS county soil survey geographic (SURRGO) database is an important component of the assessment, so counties are assessed at the rate that the SSURGO information becomes available. Currently, only the maps for Ramsey County are included in Appendix 5, because it was the pilot to test the concept of incorporation into the U.S. Fish and Wildlife Service (Service) IPM Plan. Aquifer Sensitivity maps for Walsh and Grand Forks counties are also available. Cavalier, Towner, and Pembina Counties are expected to be completed by the end of 2004. The SURRGO database for Benson and Nelson Counties has not been completed so it is difficult to estimate when the Groundwater Assessment will be done. However, it is possible that one or both of these counties may be done in 2004.

Using the information yielded by these assessments poses the next challenge to managers. Many factors influence the potential for herbicide applications to contaminate groundwater. Information from these assessments will indicate if a particular herbicide application will be in an area of “high”, “intermediate”, or “low” sensitivity to leaching. Factors such as acres treated, herbicide rate, application method, and climatic conditions (i.e. precipitation) will have direct impacts on the likelihood of potential leaching of these chemical agents through the soil profile and into groundwater. Particular attention to these factors will be needed when applying certain herbicides in areas where the model predicts that there is a “high” or “intermediate” potential for the selected herbicide to leach into groundwater. Although the details of any particular management action will be unique to the situation at hand, the Complex will use the Sensitive Groundwater Location Herbicide Application Decision Matrix (Figure 5) when considering herbicide treatments in these highly sensitive areas.

The methodology in figure 5 will be followed to minimize the potential for groundwater contamination. Of course, the initial decision to use herbicides will result from an analysis that indicates that herbicide use is the only reasonable alternative to address the particular invasive weed issue, and that other methods of control (biological, mechanical, or cultural) are not an effective alternative. Whenever possible land managers will avoid the use of herbicides, that have a higher potential to leach into groundwater. In addition, the model uses several factors in determining if an applied pesticide has a potential for leaching, primarily permeability of the soil, recharge capability of the soil to ground aquifers, percent organic matter, and the depth to the saturated aquifer as described by the metadata in Appendix 5. All the factors are on equal footing, not weighted, when determining whether the applied chemical will have a “high”, “intermediate” or “low” potential for leaching into ground water.

The model has the capability of isolating each of the four major factors that that are used in determining aquifer sensitivity. The Sensitive Groundwater Location Herbicide Application Decision Matrix (Figure 5) makes the assumption that if only one of the four factors yield a “high” potential for leaching into the underlying aquifer then the potential to leach is minimal, as opposed to having two or more of the major determining factors yielding a “high” potential for leaching into the aquifer. In the second scenario the potential for leaching is greatly increased. As depicted in the Sensitive Groundwater Location Herbicide Application Decision Matrix above; if there is only one of the four factors yielding a “high” potential for the applied herbicide leaching into the ground water the application will proceed; if two or more of the major determining factors yield a “high” potential for the applied herbicide leaching into the ground water, the decision to apply the herbicide will have to undergo further scrutiny by being run through another model developed by EPA, referred to as SCI-GROW (Screening Concentration in Ground Water Program) model.

SCI-GROW uses a regression model that uses candidate chemical’s soil/water partition coefficient and degradation half-life values to estimate groundwater concentrations arising from labeled uses at a highly vulnerable agricultural site. The program assumes herbicide application at the maximum label rate to a field that is highly vulnerable due to a rapidly permeable soil overlying shallow groundwater (Full description can be found in Appendix 5). Basically, this model depicts a worse case scenario. If the SCI-GROW model of the applied herbicide yields toxic concentrations leaching into the ground water that are less then toxicity levels established for aquatic invertebrates, then the application of the herbicide can proceed. The SCI-GROW model is very conservative and will produce a level of confidence necessary to proceed with the herbicide application. On the other hand, if the model yields toxicity concentrations greater then the established toxicity levels for aquatic invertebrates then the herbicide cannot be applied without further approval. It is assumed that pesticide concentrations will reach toxic levels to aquatic organisms much sooner than for humans; therefore, using aquatic organism toxicity as a trigger will also protect human health. Herbicide information necessary to run this model can be found in “The Herbicide Handbook” Weed Science Society of America Eighth Edition – 2002.

INSERT FIGURE 5

In addition, only minimum rates will be used in these sensitive areas, and no applications will be made on sensitive areas over 5 acres in size where multiple annual applications will be necessary to achieve stated objectives (without additional approvals). If only one herbicide application will be made in one year, treatments larger then 5 acres will be acceptable. This careful review process will greatly reduce the total concentration of herbicides in sensitive areas, and thus diminish the potential for groundwater contamination. A written decision matrix will be filled out and will become part of the Pesticide Use Proposal (Appendix 10).

Currently, the Ground Water Assessment model has only been completed for Ramsey County. The SCI-GROW Model will be used on all pesticide use proposal in all other counties in the Devils Lake WMD until such time the Ground Water Assessment model is completed for those counties.

The following is a step by step progression on how the Decision Matrix will evaluate a proposed herbicide application:

1. You first choose the ground water map (1 or 3) that is appropriate for the pesticide mobility.
2. You check to see if the area of interest has an intermediate or high potential for pesticide delivery. If it does you proceed down the right side of the decision tree. If it is low you go no further. Pesticide applications are acceptable, even though some of the individual factors may be rated as intermediate or high. If not you go to step 3.
3. You check to see if you can reduce overall potential delivery simply by changing to a low mobility pesticide or a different application procedure that would lower the mobility. If you can, you proceed no further. Pesticide applications are acceptable. If not you go to step 4.
4. If one or more of the other factors is high (permeability soils, recharge soils, water table or organic matter) you continue to proceed down the right side. If none of the other factors have a high potential for delivery you go no further. Pesticide applications are acceptable. If not you proceed to step 5.
5. You run the EPA SCI-GROW model. If the modeled results show that the estimated aquatic toxicity MCL will be exceeded in ground water you continue to the right side and must seek special approval to use this pesticide. If the aquatic toxicity MCL is not exceeded you go no further. Pesticide applications are acceptable.

Potential for Translocation Herbicides into Surface Waters-

The protection of surface waters from contamination is of particular concern on the Complex. Small, isolated “prairie pothole” wetland basins are common throughout the Complex. In fact, it is the density of these wetland basins that are attractive to waterfowl, and why these tracts were identified for acquisition as waterfowl production areas. Cowardin et. al. (1979) described the various water regimes of wetlands of the United States. Under this classification system, the majority of the wetlands found in the Devils Lake Complex have nontidal water regimes that include: permanently flooded, semi-permanently flooded, seasonally flooded, temporarily flooded, intermittently flooded, and artificially flooded. Kantrud, et. al. (1989) described the prairie basin wetland communities found in the Dakotas which are the most important and desirable to waterfowl. These include wetlands with temporary, seasonal, and semi-permanent water regimes.

Understanding the potential for herbicide applications to move in the environment and impact surface waters is critically important to land managers. Herbicides may alter vegetative and aquatic invertebrate populations in wetland basins, resulting in direct impacts to waterfowl, and other wetland dependant or obligate wildlife. These impacts may be short term or of longer duration depending on the rate and type of the herbicide used, and the herbicide's ability to move into surrounding wetland basins. To understand the potential impacts of herbicide applications to surface waters in the Devils Lake Complex, one must first understand the different types of wetlands found on the Complex.

Temporary wetlands- Small, shallow temporary basins are the first wetlands to be filled by snowmelt run-off and spring rains. Due to their shallow nature, these wetlands rapidly warm in early spring and quickly develop invertebrate populations that are used extensively by breeding waterfowl and migrating shorebirds during this time period. In addition to providing an invertebrate food supply early in the nesting season, these wetlands provide for waterfowl reproductive pair isolation, and are thus critical habitat for waterfowl nesting ecology.

Temporary basins are typically only wet for a few weeks in early spring. It is this temporary water regime that makes these wetlands very productive and attractive to wildlife. This temporary water regime also makes these sites good candidates for certain invasive weed species to gain a foothold when the basins dry out, and desirable upland vegetation has not yet become established. Invasive weed species such as Canada thistle and Russian olives (*Elaeagnus angustifolia*) can become established in and immediately adjacent to these wetland basins, facilitating spread of these invasive species into surrounding uplands. Temporary wetlands pose additional challenges to managers when prescribing herbicide applications. Often, herbicide applications are made during the growing season or in the fall when these wetlands are dry and field identification is more difficult. However, through proper training, applicators can more effectively identify these wetlands via identification of facultative wetland plants.

Seasonal wetlands- Seasonal wetlands are a major source of invertebrate protein for early laying female ducks, and provide pair isolation for breeding waterfowl. These wetlands also may provide nesting habitat for over-water nesting birds, or brood habitat in wet years. Unlike temporary wetlands, seasonal wetlands are more permanent in nature, often holding water for longer periods early in the growing season. Early fall migrant shorebirds may feed on aquatic invertebrates found in seasonal basins during their early fall (July) southward migration. The fluctuating presence of water in these wetlands poses many of the same challenges to managers as the temporaries when considering invasive weeds and herbicide applications.

Semi-permanent wetlands- These wetlands contain water throughout the growing season in most years. Semi-permanent wetlands serve as important brood and over-water nesting habitat for many species of wetland birds. These wetland basins are important for both waterfowl and shorebirds during their fall migration, and some alkaline semi-permanent wetlands serve as breeding habitat for piping plovers. The more permanent nature of these wetlands, combined with the presence of emergent vegetation makes them attractive to an increased diversity of both wetland dependant and obligate wildlife throughout the year.

Lakes- Lacusterine habitats have a permanent water regime. These wetlands contain water in most years and are used as staging and resting areas by migratory birds during fall migrations. The deep water, permanent nature of these wetlands makes them attractive to many forms of aquatic dependent wildlife.

Rivers- Riparian systems are utilized by a large diversity of wetland dependant and obligate species throughout the year. Many species of plants and animals, including several State listed species of concern, rely on this habitat type. These systems may serve as colonization corridors for certain invasive weed species including salt cedar (*Tamarix spp*.) and purple loosestrife (*Lythrum salicaria*). The dynamic nature of these systems also poses special concerns for managers when considering herbicide applications. River systems often seasonally flood beyond their banks into surrounding uplands. Soils, and herbicide residuals found in these soils may be transported down stream during these flood events where their fate in the environment is not certain.

A breakdown of wetland acres by type was calculated by the Service Habitat and Population Evaluation Team (HAPET) Office for the Devils Lake Complex as follows:

Wetland Type	**Acres**
Temporary	748
Seasonal	2588
Semi-permanent	9516
Lake	13445
River	33

Service lands in the Complex have a high concentration of temporary, seasonal, and semi-permanent wetlands, with relatively few large lakes and rivers. Although, the lake surface acres are larger then the number of acres of temporary, seasonal and semi-permanent wetlands the lakes are smaller in number and are large contiguous bodies of water, as opposed to the smaller wetlands being scattered through the landscape fragmenting the upland areas. The edges of these wetland basins provide an excellent conduit for weed species to become established as water levels recede exposing bare soils. Wetland basin densities on the Complex preclude a simple arbitrary “buffering” around all surface waters where herbicide applications may not take place. For instance, a 150’ buffer placed around all surface waters on the Martinson WPA (Ramsey County) encompasses over 50% of the uplands on the WPA. The areas that are greater than 150’ away from any wetland basin are irregular “slivers” of uplands that would be very difficult, if not impossible, to practically identify or treat in the field. This approach also precludes land managers from effectively managing noxious weed problems before they spread and become larger infestations resulting in increased expenditures and heightening the potential for long-term habitat loses. In addition, this type of cursory analysis does not consider several of the other factors which influence a herbicide’s ability to move into surface waters including: pesticide formulation-application, pesticide/solution interaction, pesticide/sediment interaction, runoff, erodibility, land use, and flooding frequency. Nor does this simple analysis estimate the potential of any herbicide reaching surface water to impact plant or animal communities. Clearly, a more sophisticated analysis is warranted to determine areas where herbicide applications may enter surface wetlands, and assess the potential of impact of these herbicide applications to non-target organisms.

To address this problem, water quality, soil, GIS, and contaminant experts from NDSU, NRCS, and the USFWS discussed possible models that may help predict those areas of surface water most vulnerable to possible herbicide impacts. One assessment methodology entitled “Protecting Surface Water from Pesticide Contamination in North Dakota- Recommendations for Assessment and Management” (Seelig 1998) seemed to address many of our concerns. This particular assessment evaluates 6 factors when predicting the potential for surface water contamination from pesticides including: soil erodibility, runoff potential, proximity to wetlands, incidence of flooding, land use, and pesticide application/properties. When applying this assessment to the landscape, the pesticide application/properties factor uses a combination of formulation-application, pesticide affinity to sediment, and pesticide affinity to water to rate each pesticide's potential for translocation. The composite pesticide translocation potential is assigned to one of three categories (high, intermediate, low). The pesticide translocation potential is then combined with the other 5 factors to produce an overall rating. Three overall ratings are possible for each area assessed depending on the types of pesticides applied. Utilizing this model, land managers would have the ability to predict the probability of contaminating surface waters based upon site-specific conditions and herbicide properties.

Seelig developed a preliminary model that he presented to the group, applying the methodology from this existing assessment system using digital wetland inventory (NWI) data, NRCS digital soils (SURRGO) data, and 2001 NDASS land use data for Ramsey County (Appendix 6). Once this model is refined, it appears that a countywide assessment of this type may provide a good example for identifying those areas where surface water concerns to herbicide applications would be greatest. Service lands with surface waters identified as having a high risk for herbicide contamination could then be subjected to a more detailed analysis to further assess possible impacts to wetland wildlife, aquatic invertebrates and wetland vegetation. This “second phase” assessment would consider other variables such as herbicide rate, application method, and acres treated in the watershed to anticipate any resulting impacts. There are other models that can be used for the “second phase” as discussed below.

The following three decision matrices depict methodology to minimize the potential for surface water contamination. The first Decision Matrix (Figure 6) is the first step in evaluating the potential for an applied herbicide to translocate into adjacent surface water. The Pesticide Potential for Translocation to Surface Water (PPTSW) Model developed by Dr. Bruce Seelig and Staff at ND State University (NDSU) will be used for the initial analysis. If the model yields a “high” or “intermediate” potential for an applied herbicide to move into surface water other management actions and/or application of lower mobility herbicides need to be evaluated for effectiveness. If there are no other herbicides of lower mobility or management actions that can effectively treat the invasive weed infestations the matrix divides the next level of evaluation by the two major land use types that are used on the Devils Lake WMD, grasslands and croplands. The predominant uses of Service lands are managed grasslands, which provide wildlife habitat. Crop land is only an intermediate use of Service lands over a 2-4 year period when grasslands are being reestablished. Farming the area can provide a clean weed free seedbed prior to reestablishing grassland habitat.

INSERT FIGURE 6

INSERT FIGURE 7

INSERT FIGURE 8

There are some important differences on how herbicides may translocate from cropland to surface water as opposed to grassland. Accordingly, separate decision matrixes were developed for grasslands and cropland. One of the major differences is erodibility. In grassland situations where there is very little exposed ground the potential for erosion is minimal, as opposed to cropland where exposed ground is great, the potential for erosion is also relatively greater.

Application methods are addressed in the first part of both matrixes. Hand spraying is usually very specific, confined to very small areas and drift is easy to control, as opposed to aerial and/or broadcast spraying, where drift is harder to control and is spayed over large areas. Subsequently, hand spraying with an approved pesticide use proposal (PUP), is allowed without any further evaluation. Washington Office approval is required for all aerial applications. Proposed aerial herbicide applications will receive the same evaluation as broadcast spraying prior to submitting the PUP to the Washington Office.

In addition to land cover, environmental factors that have a major influence on whether applied herbicides will translocate to surface water include: flooding probability, proximity to surface water, erodibility and runoff. Each is explained in detail in the Metadata located in Appendix 6 and each factor can be isolated in the PPTSW model. Once it has been determined that broadcast spraying is the most effective way to treat an area infested with an invasive weed species, the four main environmental factors will be looked at individually in the PPTSW model. Three assumptions are being made in the grassland (figure 7) and cropland (figure 8) decision matrixes as follows: First if the herbicide is being applied more then 250 feet from surface water then there will be minimal to no herbicide movement from the treated area into surface water. Secondly, erosion in grassland for the most part is negligible and will only be considered in the cropland matrix. Lastly, if the remaining environmental factors (flooding, erodibility, and runoff) have a modeled “Low” potential for herbicide to translocate into adjacent surface water, the application will be allowed to proceed. The reasoning behind this assumption is that the potential to contaminate surface water with the herbicide in question is relatively low unless most of the environmental factors have a high potential. In this case, the need to control the targeted noxious weed outweighs the potential for surface water contamination, even if the treated area is less then 250 feet from surface water. On the other hand, if one or more of these factors have a high potential to cause pesticide translocation to surface water, the herbicide application cannot take place without further evaluation.

In order to further evaluate the potential to contaminate surface water, the proposed herbicide application will be run through a second model developed by EPA to screen chemicals proposed to be labeled, which is similar to the SCI-GROW model, called GENEEC (Generic Estimated Environmental Concentration Model). As with the SCI-GROW model, this model is very conservative. GENEEC was designed to meet certain criteria required by the Environmental Fate and Effects Division (EFED), of the US Environmental Protection Agency (EPA), Office of Pesticide Programs (OPP), required by the Federal Insecticide Fungicide Rodenticide Act (FIFRA) that would preclude the possibility that potential hazardous chemicals pass early screening in the assessment process and escape sufficient review. The model uses a chemical’s label application information, its soil/water partition data and its degradation kinetics to estimate high-level exposure values as in a “standard agriculture field-farm pond” scenario. The “standard agricultural field-farm pond” scenario assumes that rainfall onto a treated, 10-hectare (24.7 acre) agricultural field causes pesticide-laden runoff into a one hectare; 20,000 cubic meter volume; 2.00 meters (6.5 feet) deep water-body. Basically, the GENEEC model is used in the Grassland and Cropland Decision

Matrixes to determine potential toxicity levels, due to concentrations resulting from herbicide translocation into surface water. The modeled potential toxicity is then compared to established toxicity levels for aquatic invertebrates. If the modeled toxicity is greater then the toxicity level maximum concentration level (MCL) for aquatic invertebrates the herbicide application cannot take place without further approvals. On the other hand if the modeled toxicity level is less then the aquatic invertebrate toxicity level then the herbicide application can proceed. The full description of the EPA GENEEC model can be found in Appendix 6. Again, as stated earlier, it is assumed that pesticide concentrations will reach toxic levels to aquatic organisms much sooner than for humans. Herbicide information necessary to run this model can be found in “The Herbicide Handbook” Weed Science Society of America Eighth Edition – 2002. As with the groundwater/aquifer assessment a written decision matrix will be filled out and become part of the Pesticide Use Proposal (Appendix 10).

The assumptions in this model do not fully fit the Prairie Pothole Region and we are currently working with Jim Warren (Ecological Services, Conway, AR) to modify the model to make it more representative of the Prairie Pothole Region. The model assumes a one hectare pond, two meters deep within a 10 hectare agriculture field. A more appropriate assumption for the Prairie Pothole Region would be a one hectare wetland approximate .5 meters deep, which is a standard EPA wetland depth. The model assumes uniform mixing within the 1 hectare pond that is two meters deep so the same exposure concentrations can be calculated using a smaller volume. Kevin Johnson (Ecological Services, Bismarck, ND) calculated the volume of a one hectare wetland .5 meters deep to be 5000 L or ¼ the volume of the same wetland 2 meters deep. Until the model can be modified, this station will multiply the GEENEC model results by 4 which will reflect a smaller volume of water and be more representative of the shallower wetlands in the Devils Lake WMD.

Currently, the PPTSW model has only been completed for Ramsey County. The GEENEC Model will be used on all pesticide use proposal in all other counties in the Devils Lake WMD until such time the PPTSW model is completed for those counties.

Modeling the potential for surface and groundwater contamination is an important tool to help managers predict potential impacts of herbicide applications; however, it is through the use of “best management practices” (BMP’s) when applying the herbicides that will ultimately limit the potential contamination of these sensitive resources. A full listing of these BMP’s are listed in the Improved Pesticide BMP section of this plan.

The following is a step by step progression on how the Decision Matrix will evaluate a proposed herbicide application:

Let's run through an example.

1. You first choose the surface water map (1 or 3) that is appropriate for the pesticide mobility.
2. You check to see if the area of interest has an intermediate or high potential for pesticide delivery. If it does you proceed down the right side of the decision tree. If it is low you go no further. Pesticide applications are acceptable, even though some of the individual factors may be rated as intermediate or high. If not you go to step 3.
3. You check to see if you can reduce overall potential delivery simply by changing to a low mobility pesticide or a different application procedure that would lower the mobility. If

you can, you proceed no further. Pesticide applications are acceptable. If not you go to step 4 and follow either the cropland path or grassland path.

4. If the proximity potential is high you continue to proceed down the right side. If the proximity potential is intermediate or low you go no further. Pesticide applications are acceptable. If not you proceed to step 5.
5. If one or more of the other factors (erodibility, runoff, flooding, and landuse for cropland) (runoff and flooding for grassland) you continue to proceed down the right side. If none of the other factors have a high potential for delivery you go no further. Pesticide applications are acceptable. If not you proceed to step 6.
6. You run the EPA GENEEC model. If the modeled results show that the estimated aquatic toxicity MCL will be exceeded in the runoff water you continue to the right side and must seek special approval to use this pesticide. If the aquatic toxicity MCL is not exceeded you go no further. Pesticide applications are acceptable.

Washington Office Guidance- Protection of Surface and groundwater-

On January 22, 2001, the Service, Division of Environmental Contaminants, prepared draft guidance concerning herbicides that require/do not requires Washington-level review. In this draft guidance, 8 herbicides used at the Devils Lake Complex were identified as requiring Washington–level review. The predominate reason that these herbicides were identified, was due to item 5 of the draft guidance "All pesticides with a high potential to leach or which have been frequently found in surface or groundwater". Two separate assessments were referenced as used to prepare this listing, "US Geological Survey, Pesticides National Synthesis Project, National Water-Quality Assessment, provisional data for 21 most commonly detected pesticides in ground and surface water", and "Protecting Groundwater in North Carolina-A Pesticide and Soil Ranking System".

A review of the USGS Pesticides National Synthesis Project yielded additional information specific to the particular assessment made in North Dakota. The Red River Basin Assessment (Appendix 7) abstract states "Pesticides are used extensively in the largely agricultural Red River Basin, but, unlike many other agricultural basins, only small amounts are routinely detected in samples from streams in the Basin…. Although low, concentrations are related to pesticide application and runoff. Flat slope, organic soils, pesticide management, and degradation may all limit pesticide contamination that reaches Red River Basin streams." This plan focuses on implementation of the best management practices necessary to minimize risks to surface waters.

A review of the publication "Protecting Groundwater in North Carolina-A Pesticide and Soil Ranking System" (Appendix 8) also yielded additional information. This publication states "…we describe methods of determining soil leaching potential and pesticide leaching potential. We then use both of these values to determine the contamination potential of pesticide-soil combinations. Because the concern for leaching is greater in the coastal plain than in the piedmont or in the mountains of North Carolina, we focus on the soils of the coastal plain." Clearly, soils are vastly different between the coastal plains of North Carolina, and those found in North Dakota; however, the method of assessing the pesticide leaching potential (PLP) of herbicides found in this publication is of interest.

The North Carolina publication calculated PLP as follows:

PLP= ($T_{1/2}$ X R X F)/K_{oc}

Where

$T_{1/2}$ = Persistence of the pesticide, measured as half-life in days
R= Median rate of application (pounds of active ingredient) recommended for application in North Carolina
F= Fraction of pesticide reaching the soil during application

K_{oc}= Affinity for soil organic matter

The assessment system used in North Dakota (outlined above, and used in this plan), uses a herbicide's Hornsby Index to assess PLP. The Hornsby Index is calculated by dividing the K_{oc} by the $T_{1/2}$ and then multiplying by 10. A pesticide with a high Hornsby Index is more likely to leach to groundwater than a pesticide with a low Hornsby Index.

Although the assessment systems differ slightly, both assessment systems share the common method of dividing the K_{oc} by the $T_{1/2}$ to calculate PLP. Both assessment systems also share other common "soil filtration" factors to identify the potential of a herbicide to move downward through the soil including: soil organic matter, and texture. We believe that the NDSU assessment system outlined in this plan is consistent with Washington Office guidance, and will yield quality data for use in preventing contamination to sensitive groundwater resources that would be highly applicable to the Northern Great Plains.

Identification and Control of Pest Plant Species

Plant pest terminology is often confused, or inappropriately interchanged. "Plant pests", or "weeds" include those plants that are unwanted where they are found. These pests may include native, or introduced species. "Noxious weeds", for the purposes of this plan, is a legal designation. In the North Dakota Noxious Weed Law and Regulations Guide, the North Dakota Department of Agriculture has identified noxious weeds as weeds that are difficult to control, easily spread, and injurious to public health, crops, livestock, land, or other property. "Invasive" species, are introduced organisms which colonize and rapidly spread in native systems due to the absence of natural controls. Invasives often share characteristics such as: effective seed dispersal/rapid colonization and expansion capacities, or toxic/allelopathic effects which can result in dense monospecific stands of undesirable weed species forming to the exclusion of native species, and suppression of crop yields very rapidly.

The Complex conducted a preliminary habitat inventory of Service lands in 2002 to identify invasive weed species on the Complex and map their locations as a necessary first step in the development of control strategies and this IPM Plan. Preliminary surveys revealed numerous infestations of Canada thistle, musk thistle, leafy spurge, and absinth wormwood on Service lands, and throughout northeastern North Dakota. A 0.1-acre patch of purple loosestrife is known to exist on the Nikolaisen WPA (Towner County). Smaller infestations of species such as: yellow star thistle, salt cedar, and spotted knapweed have been reported in the State, but are not currently known to be on the Complex.

State law, and agreements between the USFWS and the State mandate the control of State listed noxious weeds on Service owned land. Many of the State listed noxious weeds are also invasive species. Table 1 compares North Dakota’s noxious weeds, to those weeds that are considered invasive in nature, and indicates whether or not these species are currently known to be present on Service lands in the Complex.

TABLE 1. WEED SPECIES ON THE DEVILS LAKE COMPLEX

Common Name	Scientific Name	State Listed Noxious Weed (Y/N)	Invasive characteristics (Y/N)	Present on Service lands (Y/N)
Canada thistle*	*Cirsium arvense*	**Y**	**Y**	**Y**
Musk thistle*	*Carduus nutans*	**Y**	**Y**	**Y**
Absinth wormwood*	*Artemisia absinthium*	**Y**	**Y**	**Y**
Leafy spurge*	*Euphorbia esula*	**Y**	**Y**	**Y**
Purple loosestrife*	*Lythrum salicaria*	**Y**	**Y**	**Y**
Field bindweed	*Convolvulus arvense*	**Y**	**N**	**Y**
Dalmatian toadflax*	*Linaria genistifolia ssp. dalmatica*	**Y**	**Y**	**N**
Diffuse knapweed*	C*entaurea diffusa*	**Y**	**Y**	**N**
Russian knapweed*	A*croptilon repens*	**Y**	**Y**	**N**
Saltcedar*	*Tamarix roamosissiam*	**Y**	**Y**	**N**
Spotted knapweed*	*Centaurea maculosa*	**Y**	**Y**	**N**
Yellow starthistle*	*Centaurea solstitialis*	**Y**	**Y**	**N**
Russian olive*	*Elaeagnus angustifolia*	**N**	**Y**	**Y**
Perennial Sow Thistle*	*Sonchus arvensis*	**N**	**Y**	**Y**
Hybrid Cattail	*Typha spp.*	**N**	**Y**	**Y**
False Chamomile	*Matricaria maritima*	**N**	**Y**	**Y**

* “Priority” invasive weed species for management on the Devils Lake Complex

Unfortunately, limited resources constrain a land manager’s ability to effectively control all weed species on the Complex. Prioritization is necessary to determine which weed species will be controlled first. The selection of these “priority weed species” needs to be based the weed’s potential adverse impacts to Complex grasslands, wildlife, and economic capital. These adverse impacts are anticipated from the life history, species biology, and control techniques of the selected species. Although outlined in more detail in the individual biology accounts later in this plan, those species selected as the highest priority for control (marked with an asterisk in Table 1) are those known to be invasive in their characteristics.

Smooth Brome (*Bromus inermus*), Kentucky Bluegrass (*Poa pratensis*), Crested Wheatgrass (*Agropyron cristatum*), and quackgrass (*Agropyron repens*) are several species of tame grasses that have been seeded on lands within the Complex. These grasses have been seeded by neighboring landowners for forage or in CRP plantings, or by USDA for bank stabilization projects. In some cases, the Service has seeded some of these species on Complex lands for wildlife habitat. Although these grass species are invasive in their characteristics, and can damage native prairie grasslands when they invade, they are not considered as "invasive/noxious weeds" under this IPM plan. Although the Service will continue to treat these grasses in native prairie (through the use of grazing and prescribed fire), or when re-vegetating decadent grasslands (using glysophate, prescribed fire, and grazing), no prescriptions for treatment of these grasses are made under this plan. The treatment of these species (and others) will be covered under other Station habitat management plans.

Pest Management Overview and Integrated Pest Management (IPM) Practices:

There is a variety of management options considered under this IPM plan for managing weeds and invasive plant infestations on the Complex. Preventing the spread of existing infestations will be given a high priority, as this is the least expensive and most effective means of control. The second priority will be to eradicate small new infestations and control larger satellite and major infestations. The primary tools for control are biological, cultural, mechanical and chemical (herbicide). The ultimate goal on the Complex's disturbed lands will be to reestablish healthy prairie plant communities that are resistant to invasion. The specific control options are discussed for each pest species later in this section. Priority invasive weed species (Table 1) will be managed on the Complex using three important components: Inventory and mapping, treatment, and monitoring.

Integrated Pest Management combines various management strategies to deal with pest problems. Masters (2001) showed that using multiple techniques together is the most effective means of controlling invasive weed species. Likewise, employing only a singular control strategy may even make the original problem worse. Advocates of IPM recognize that reliance on any single form of pest management does not provide optimal results. Adoption of multiple pest management methods, including the judicious use of pesticides often results in overall reduction in the total amount of pesticides applied.

Selected IPM treatments on the Devils Lake Complex will be comprehensive treatment strategies. Although any specific strategy will be adjusted to meet site conditions such as: sensitive areas, time of year, soil types, presence of non-target organisms, topography, available facilities, etc., all treatments made will consider the life history attributes of the target pest species (growth strategy, phenology, root structure, rates of spread, dispersal mechanisms, seed production, and seed viability). Mechanical, cultural, biological, and chemical control techniques will be combined where practical to achieve stated objectives, maximizing control of targeted pests with minimizing impacts to non-target species and the environment.

Only herbicides expected to be effective and approved for use, have been selected as treatments in this plan, and among these, those that are lowest in environmental risk, considering specific resources at the site, are identified. Table 2 summarizes approved herbicides and their uses on the Complex. Weeds listed in this table include priority invasive species and other weed species. Certain herbicides, prone to volatilization and/or runoff, and/or with potential adverse effects to non-target vegetation or wildlife, were excluded from consideration as alternatives even though they are effective against some of the above weed pests. Excluded herbicides included Atrazine (prone to both volatilization and runoff with likely subsequent contamination of groundwater and surface waters and toxicity to invertebrates, amphibians, and fish); 2,4-D ester formulations (more toxic than amine formulations to invertebrates and fish and more prone to volatilization). Tordon (a restricted use, persistent pesticide), and Pramitol (leaches into groundwater).

IPM Methods for Priority Species:

IPM methods for priority species were assembled from a variety of sources. One source, "Creating an integrated weed management plan", Division of Plant Industry, Colorado Dept. of Agriculture, March 2000, was extensively used to prepare the following section as it contains valuable species profiles and IPM treatment strategies.

Separate "Action thresholds" for individual weed species are not a practical or effective means to prioritize or identify the type or level of control. For instance, an isolated one-acre musk thistle infestation found in an area that is otherwise not infested would be a high priority to treat before it became a large, established problem. Likewise, a 200-acre infestation of this same species may be a good candidate for containment first, until long-term control can be achieved. Action thresholds for treating all priority invasive species are identified as specific weed control objectives in the "goals and objectives" section of this plan, and relate to infestation size, propagation phenology, and likelihood of re-infestation.

<u>The following priority species are currently commonly found on the Devils Lake Complex:</u>

Canada Thistle (*Cirsium arvense*)

Biology **–**

Canada thistle (*Cirsium arvense*), a native to southeastern Eurasia, is a highly aggressive, colony-forming perennial in the aster family (Asteraceae). Canada thistle causes lumpjaw in cattle and is a serious agricultural pest. Its leaves are considered irritating to most grazing animals, including wildlife, and the plant negatively impacts crops and range sites by forming thickets through vegetative growth, without the need for seed production, crowding out other species. It can invade wet or dry areas in sandy, silty, or clay soil types. It can also invade saline soils. Although it primarily invades disturbed areas, including fields and roadsides, it can also invade natural areas, including wetlands and grasslands.

In comparison with native thistles, Canada thistle is a darker green plant with spiny, alternate leaves. Plants grow to a height of 2 - 4 ft . On the Complex, plants produce off-pink flowers in June and July. Plants erupt and bolt in the spring to their full height with spine-tipped, wavy leaves. Plants remain near the soil surface until bolting is triggered with photoperiods reaching at least 14 hours of daylight (Harderlie, et. al 1991). This thistle develops a vigorous, extensive perennial root system that extends both horizontally and vertically in the soil. Canada thistle are sun-loving and thrive in disturbed or cultivated sites; shading by healthy native plants can be an important limiting factor. Growth ceases at temperatures above 30^{o}C (= 86^{o}F).

Plants spread either through vegetative growth from root material or, if both male and female plants are present in a colony, by seed. Existing patches on the Complex reproduce primarily vegetatively; however, these colonies also disperse to other locations through the production of viable seed. The root system can be extensive, growing horizontally as much as 18 feet in one season (Nuzzo 1998). Most Canada thistle patches spread at a rate of 3-6 feet/year, crowding out more desirable species and creating thistle monocultures. Even fragmented root parts from mechanical activities can result in production of new plants, rendering mechanical methods ineffective (Rutledge and McLendon 1998). The only exception is complete removal of young thistles in the early growth stage. Canada thistles can produce up to 5000 seeds per plant, but normally produce only about 1500 (Rutledge and McLendon 1998). Most seeds remain viable for only 2-3 years.

Extent of Problem - This weed currently infests over 1 million acres in North Dakota, and is widespread on the Complex. In year 2002 surveys, infestations of this thistle were found on WPA's and Refuges in all corners of the Complex, as well in ditches and on surrounding private lands. Canada thistle infestations are usually found in a cluster with a common root system, appearing to spread vegetatively once established.

***Treatment Goal* –** Treatment goals for Canada thistle would include those identified for invasive weed species.

Treatment Options and Selected Management Methods –

	Mechanical	**Cultural**	**Biological**	**Chemical**
Currently existing control options	Yes-limited	Yes-limited	Yes-limited	Yes

Control of this species will require a sustained, multiple-year effort. Treatments will focus on eliminating seed production and attacking the perennial root system. As discussed above, manual and mechanical methods alone are mostly ineffective and may actually promote the spread of Canada thistle. An exception to this rule is young plants without an established root system, atypical of the perennial patches found on the Complex.

***Mechanical Control Options**

Repeated monthly mowing of Canada thistle over long periods of time has been demonstrated to provide some control of Canada thistle. Part of the purpose of the Complex as a National Wildlife Refuge "for migratory birds" is to provide nesting opportunities for those birds. Locally nesting species include not only ducks, but "grassland obligate" species such as the grasshopper sparrow and eastern meadowlark. These ground nesting species require overlying vegetation to nest successfully, and management needs to be mindful of their nesting requirements. Repeated mowing of all Canada thistle infestations in not a practical control method on the Complex and is counter to the purpose of WPA's and NWR's that comprise the Complex. The "rosette technique", described in the following section, combines mechanical treatments with herbicide application and seeds to provide control of this species in the Complex.

***Cultural Control Options**

Prescribed burning, or prescribed burning followed by a herbicide application, have been suggested as treatments to reduce the number of mature plants, limit seed production, and foster native grass growth (www.fs.fed.us/database/feis/). However, burning without a follow-up herbicide treatment has been shown to actually increase Canada thistle stem densities in North Dakota by enhancing seed germination (Lym 2002). Fire will be considered as a viable management tool predominantly on grassland sites that have been successfully restored, or where Canada thistle plants can be treated with a follow-up herbicide treatment. High precipitation over the last decade in North Dakota may be the primary reason that controlled burning alone has not caused significant stress to Canada thistle. An additional important cultural control component for Canada thistle will be the purchase of weed-free seeds for use in reseeding grassland and disturbed sites with native species that can compete with and shade out the thistle.

***Biological Control Options**

Although many different biological control organisms have been imported to control Canada thistle, none have proven to be effective in North Dakota (Lym 2002). The seedhead weevil (*Rhinocyllus conicus)* whose larvae forage on thistle flowers, reducing seed production, is sometimes partially effective on Canada thistle and musk thistle. Unfortunately, this species also attacks native thistles and poses a risk to their populations. Its' use would be inconsistent with protecting native thistle species, and dependent native pollinating insects in North Dakota, some of which are declining or rare. The gall fly (*Urophora cardui*), and stem-mining weevil (*Ceutorhynchus litura*) have also been introduced into various patches of thistle on the Complex with little success.

*** Chemical Control Options**

The North Dakota weed guide (2002) recommends a combination of mechanical and chemical control known as the "rosette technique". This technique utilizes summer mowing or cutting to provide additional stress on the plant and delay the onset of a plant rosette until fall. A fall herbicide treatment is then made to the Canada thistle rosettes with greatly improved efficacy. Lym (2002) demonstrated that this same technique also may be modified using a June/July burn down application with 2,4-D, followed by a fall treatment of clopyralid. This rosette technique has shown to eliminate Canada thistle after two years. A similar treatment of repeated mowing can be followed by a glyphosate application in the fall. This option may be useful in areas where a highly leachable pesticide, such as clopyralid, is inappropriate.

The rosette technique will be the Complex's primary control strategy for Canada thistle. In areas with substantial overstory, a bush hog may also be used to remove the over-lying vegetation to aid in visually locating thistles and improve herbicide effectiveness, whether by hand-held spot treatment or over-the-top boom application. Other methods that combine a mechanical control option with a herbicide application (such as the Burch® wetblade mower) will also be used. Although short-term impacts to individual grassland birds may result from mechanical treatments made during the nesting season, long-term benefits to grassland bird populations may result when grasslands are returned to a healthy condition.

***IPM Summary**

Use of the "rosette technique" (combining mechanical and chemical treatments) will be the primary method of control utilized on the Complex during years of high precipitation. However, the tendency of this species to grow in wet areas (and other sensitive sites) may preclude this treatment option. Other application techniques, such as the Burch® wetblade mower, may help deliver effective control in locations where the rosette technique would be inappropriate. Management strategies on the Complex will be adaptive to weather/precipitation conditions. In times of drought, herbicide effectiveness on Canada thistle may be limited when these plants are stressed; however, mowing or burning may prove to be more effective under these same conditions. Control treatments on the Devils Lake Complex will be adapted to site and climatic conditions to deliver effective control.

Musk Thistle (*Carduus nutans*)

***Biology* -** Musk thistle is native to southern Europe and western Asia. Like Canada thistle, musk thistle (*Carduus nutans*) causes lumpjaw in cattle and is a serious agricultural pest, in addition to adversely affecting crops and range sites. However, unlike Canada thistle, musk thistle is a biennial that develops annual tap roots, but lacks the perennial root system of Canada thistle. Typically, seeds germinate in the spring or fall, forming large rosettes that bolt the following year. On occasion, individual musk thistle plants may exhibit an annual growth habit, forming a rosette and bolting in a single growing season. It has pink to purple flowers, although musk thistle can occasionally have white flowers.

Musk thistles have alternate leaves with spiny margins that clasp the stem; rosettes are smooth to densely hairy. Mature plants can reach 6 ft in height and have a fleshy taproot. This species has the potential to spread much more rapidly than Canada thistle due to its seed dispersal capabilities combined with its tremendous seed production (as much as 100,000 seeds per large plant). Seeds remain viable for up to 10 years. Although most easily established on bare soil or cracked soil, the plant can invade wetlands, grasslands, crop fields and other sites (Dinkler 2002). Seedlings establish only on bare soils and grow less when shaded by neighboring plants (Beck 1999). Musk thistle spreads rapidly and forms extensive stands, which force out desirable vegetation (Rutledge and McLendon 1998). Musk thistle may also produce alleopathic chemicals that inhibit desirable plants beyond the spread of the rosettes (Wardle et al. 1993).

Extent of the Problem - The worst locations of musk thistle infestations are currently found in Ramsey and Cavalier Counties, with scattered tracts found elsewhere. Although not as widely spread as other weed species, musk thistle infestations form dense stands that can extend up to several hundred acres

***Treatment Goal* -** Treatment goals for musk thistle would include those identified for invasive weed species.

Treatment Options and Selected Management Methods –

	Mechanical	**Cultural**	**Biological**	**Chemical**
Currently existing control options	Yes-limited	Yes-limited	Yes-limited	Yes

***Mechanical Control Options**

Repeated mowing, hand pulling, or cutting can be used to stop the spread of musk thistle. Mowing or hand-chopping after flowering, but before seed set, prevents seed development and dispersal (Heidel 1987). Weekly mowing is necessary over the growing season as cut stems may re-bolt, and not all plants mature at the same time (Heidel 1987). When hand pulling, it is important to remove the entire root crown, a few inches below the level of the soil, so that the plant does not simply re-bolt and produce seeds (Heidel 1987). Musk thistle patches that have started to go to seed should not be mowed as the action will only spread seeds and seed heads. In fact, a cut plant with a maturing seed head will attempt to make seed if the seed head is left attached to the plant. If musk thistles do flower and set seeds, the seed heads must be pruned off, collected, and incinerated before seed drop occurs. Although this pruning method is very labor intensive, it is the only way to eliminate seeds after the mature flower has developed and seed set has occurred.

A singular mechanical control treatment has predictably proven to be ineffective at stopping seed production in the Devils Lake Complex. Cutting off the plant above the rosette one time during the growing season does not kill the plant and only hastens the development of buds and flowers as the plant becomes stressed. The repeated mowing of musk thistle infestations that would be necessary to prevent seed production of this invasive weed has not been pursued due to the significant negative impacts on the grassland nesting birds that would result.

***Cultural Control Options**

Preliminary, qualitative data from research plots on the Devils lake Complex have shown that prescribed fire may promote seed germination of this species. Preventing the establishment of new infestations by minimizing disturbance and seed dispersal, eliminating seed production and maintaining healthy native communities are preventative cultural controls for this species.

***Biological Control Options**

Two biocontrols are available that have been reported to assist in musk thistle control: *Rhinocyllus conicus,* and *Trichosirocalus horridus*. *Trichosirocalus horridus* is a shoot feeder as an adult. The shoot feeding causes the plant to sprout multiple seed heads that weaken the root system and lower overall seed production. Multiple seed heads produced by this mechanism are advantageous for *Rhinocyllus conicus.* The larvae of *Trichosirocalus horridus* weaken mature musk thistle plants by feeding on the root crowns; however, this species us unlikely to provide significant control on its own and performs best in the presence of *R. conicus* (Rees et al. 1995). Although *R. conicus* is widely established throughout the Complex, this seed head weevil has provided very limited control.

Poor control of the seed head weevil on musk thistle is due to the weevil's life cycle. Unfortunately, the timing of the seed head weevil's larval stage does little to damage secondary musk thistle buds in this locality. In addition to providing poor control, this weevil species may also attack native thistles (Louda et al. 1997).

***Chemical Control Options**

Several herbicides have shown to be effective in controlling musk thistle. Herbicide applications have shown up to 97% control in an experiment in Minnesota (Butterfield, et al. 1996). The most effective means of control occurs when musk thistle plants are still in the rosette stage, and quickly decreases once the plant has bolted (Butterfield, et al. 1996). Recommended herbicides include 2,4-D, and tank mixes of 2,4-D and clopyralid. A fall application of herbicide to musk thistle rosettes when other plants are dormant is often effective and has less impact on non-target species (Butterfield, et al. 1996).

*** IPM Summary**

Many years of control efforts may be required because of the lengthy seed viability of this species. Biological control organisms are well established in many areas of the Complex, and although no new colonies will be released due to concerns over impacting native thistles, existing colonies will continue to provide some measure of control. Where only a few individual plants occur, young plants without flowers may be repeatedly mowed, or dug up at a point 2 inches below the rosette. These methods will be supplemental, at best, since the prostrate growth form of the rosettes is difficult to detect from any distance and sufficient staff for large efforts of this kind are unlikely. This method may be used in sensitive sites, or around open water

Most effective control has been achieved by disrupting the biennial growth habit of this species. Under this management regime, an early July haying or mowing treatment is used to prevent the bolting plants from producing a seed head. This prevents most seed dispersal, and the probability that new rosettes we become established the following year. To eliminate the rosettes that will produce next year's bolts, a fall application of 2,4-D is made. This rotation of summer mechanical control, followed by fall spraying has eliminated up to 95% of existing musk thistle rosettes in the year following treatment on the Complex. Due to the long seed viability of this species, repeated applications of this type are anticipated until all viable seeds on the soil surface have germinated and been treated. Prescribed fire may be combined with this treatment strategy to encourage the germination of viable seeds, and reduce the timeframe necessary to deplete the existing seed bank. Other locations (with a previous cropping history) may be farmed, incorporating mechanical tillage with multiple applications of roundup to prepare a clean seedbed in the years prior to seeding.

Competitive grass seedings will be an important cultural control once the seed bank has been depleted. One location on the Complex has been successfully transformed from a solid stand of musk thistle, to a field of native grasses and forbs. Competitive grass seedings of this type will limit the amount of bare ground and therefore limit future opportunities for the establishment of this invasive weed.

Leafy Spurge *(Euphorbia esula)*

Biology - Leafy spurge grows primarily in pastures and rangeland, tree rows, waste areas, and along roadsides and is persistent and difficult to eradicate. It normally grows 2 to 3 feet tall from a woody crown that is below the soil surface. Each crown area produces several upright stems, giving the plant a clump-like appearance. The plant bears numerous linear-shaped leaves with smooth margins. The leaves have a characteristic bluish-green color but turn yellow or reddish-orange in the fall. Stems originating from crown buds and roots begin growth in late April, making leafy spurge one of the first plants to emerge in the spring. Peak germination occurs in late-May through early-June. If adequate moisture is present, germination can occur throughout the growing season. The early and rapid growth gives leafy spurge a competitive advantage over crop and grassland plants. All parts of the plant contain latex (Lym et al. 1998).

Leafy spurge produces a flat-topped cluster of yellowish-green bracts, which bear the true flowers. The showy, yellow bracts appear in late May and early June, giving the plant the appearance of "blooming." However, the true flowers, which are small and green, do not develop until mid-June. Each flowering stem produces from 10-50 capsules with a seed yield range of 200-250 seeds per flowering shoot (Best et al. 1980). A large plant may produce up to 130,000 seeds (Rutledge and McLendon 1998). Seed viability may extend up to 5-8 years; however, 99% of the viable seeds will germinate in the first two years (Butterfield et al 1996). The root system of leafy spurge is extensive and consists of numerous coarse and fine roots which occupy a large volume of soil (Lym et al.1998). Despite being a successful seed producer, reproduction of the plant is primarily vegetative.

Extent of Problem - Leafy spurge is widely established throughout the Complex. Spurge is found in small, isolated patches, or large, monotypic stands. Spurge grows in heavy loam soils, sandy hills, in native prairie, or tame grass plantings.

Treatment Goal - Treatment goals for leafy spurge would include those identified for invasive weed species.

Treatment Options and Selected Management Methods –

	Mechanical	**Cultural**	**Biological**	**Chemical**
Currently existing control options	No	Yes-limited	Yes	Yes

***Mechanical Control Options**

Tillage is not generally a practical control method for areas on the Complex where leafy spurge is found. Mowing can actually increase the density of leafy spurge, and may not be effective even when combined with some herbicides (K.G. Beck, pers. Comm.). Pulling leafy spurge is ineffective, even for small infestations because of the deep root system and presence of numerous root buds.

***Cultural Control Options**

Prescribed fire alone does not provide adequate control of leafy spurge due to regeneration from the root system. This technique may even cause germination of viable spurge seeds on the soil surface. The use of prescribed fire; however, has proven to be effective in stimulating the growth of desirable native grasses that compete with spurge infestations. Prescribed fire (early in the spring) has also been demonstrated to help flea beetle colonies to become established, and also increases the palatability of spurge plants to grazing goats/sheep. Re-establishment of desirable vegetation through prescribed burning, and/or re-seeding may be combined with other control techniques designed to impact new spurge seedings and the established spurge root system to achieve control.

***Biological Control Options**

Management of Leafy spurge control must be considered a long-term management program. Multi-species grazing with goats and sheep has been effectively used on the Complex and is targeted at those areas of infested stands of planted natives, tame dense nesting cover (DNC), or severely infested native sod. Goats and sheep prefer spurge plants to grasses, and if properly stocked (approximately .2 AUM/ac), their diets will consist primarily of spurge. Sheep and goats, however, remove other forb and shrub species, and this must be considered. Areas of grasslands with desirable forb populations, or areas not easily fenced, may not be suitable for grazing. Grazing sheep or goats on native sod areas heavily infested with spurge may be desirable as the native forb component of these grasslands is usually limited due to the predominance of spurge (USDA Publication 2002).

Approximately 115 acres of spurge-infested grasslands have been grazed with goats on Pleasant Lake WPA for weed control. An additional 75 acres of grazing sheep for leafy spurge control began in 1999 on Lake Alice NWR. Results of this control measure have been satisfactory. These areas will continue to be grazed each year until the spurge infestation has been significantly reduced, or until other biological controls become established. Sheep grazing on the Complex has demonstrated that this technique can quickly provide control of leafy spurge, and if grazed year after year, may provide adequate control. Grazing sheep or goats does require facilities (fence and water supplies), which can require a sizeable initial startup cost. Another factor affecting goat/sheep grazing is the lack of cooperators in the area that have available animals on a regular basis.

Although many of the insect biological controls discussed for invasive species thus far have not been very effective in providing effective control, this is not the case for leafy spurge. Several species of flea beetle have provided excellent control of leafy spurge in many areas throughout the Complex. The Complex has several established field insectory sites (FIS) of *Apthona czwalinae, A. lacertosa, A. cyparissiae, A. flava,* and *A. nigriscutis.* Over 150 FIS' are currently established in place, with a total of approximately 7,000,000 beetles released at these sites. Each release site is approximately 1 acre in size, and many grew larger over time. Once insects are established at a site, the FIS' is "harvested" and these insects are re-distributed to additional suitable sites. Unfortunately, not all leafy spurge infestations are suitable FIS. Soil types, soil moisture, aspect, and other factors make certain locations poor candidates for flea beetle introductions (USDA Publication, 2002).

Biological control of weeds through sheep/goat grazing and insect releases will hopefully continue to reduce the chemical inputs applied to Complex grasslands. Unlike grazing, which is often a short-term control measure, insects have played an important role in effective long-term control in many leafy spurge infestations. Both biological control programs have allowed us to give a management treatment to grassland areas that are otherwise inaccessible, or extremely time consuming to treat with mechanical or chemical means.

***Chemical Control Options**

Chemical control for leafy spurge has proved to be effective in many of the locations where biological controls are impractical, or were ineffective. While tank mixes of picloram and 2,4-D have been demonstrated as effective controls, these chemical treatments affect many other desirable forbs, and have groundwater contamination concerns. Plateau® herbicide, applied at a rate of 8 oz/acre in the fall has shown excellent control up to 24 months after treatment. Plateau has also been used in the Burch® wetblade mower during the summer and fall of 2002, although results of this application method have not been evaluated. Long-term evaluation of this wetblade control technique is necessary before economic benefits and exact control recommendations can be determined; however, it is hoped that this may provide an even more targeted method of application of herbicide to spurge plants in sensitive sites. In addition to effectively controlling spurge, Plateau® is damaging to several species of invasive tame grass species (smooth brome and Kentucky bluegrass), while many native warm season grasses (big bluestem, Indian grass, etc.) and forbs (asters, and legumes) are relatively tolerant to this herbicide. Masters et al. (1996) demonstrated that areas of smooth brome and leafy spurge could be treated with Plateau® and seeded to warm season grasses to provide long term competition.

*** IPM Summary**

The Complex will continue to aggressively pursue the release, monitoring, and re-distribution of flea beetle FIS. Locations of spurge that have been grazed with sheep and goats will continue to be grazed, and new sites will be established where cooperators/facilities permit. Locations chosen for Plateau ® herbicide application may include larger acreages that have not supported numerous flea beetle release attempts, and cannot be grazed with sheep due to a lack of facilities or cooperators. Chemical control sites may also include small patches of spurge that have colonized tracts, but have not yet become large infestations. Perimeters of large infestations may also be held in check with chemical applications giving biological control measures time to work (Lym et al. 1998). Prescribed fire and the re-establishment of desirable grasses/forbs will be utilized with the above listed control techniques to achieve stated objectives for this species. It is important to keep in mind that there are no "silver bullets" or cure-alls for managing and controlling leafy spurge - simply put, there just is not any single tool that will work every time in every situation. When taking an IPM approach, various methods of control and treatment are incorporated together to provide the optimum long term results in a much quicker manner than any single treatment used alone (Lym et al. 1998).

Absinth Wormwood *(Artemisia absinthiuim)*

Biology **-** This plant is also known as American or common wormwood, mugwort or madderwort, and wormwood sage. Absinth wormwood is a perennial forb that is easily recognized by its strong sage odor. Absinth wormwood is an escaped ornamental introduced from Europe and has spread rapidly in the pasture and rangeland of North Dakota, especially in dry years. It commonly is 3 feet tall at maturity but can grow over 5 feet tall. The plant is woody at the base and re-grows from the soil level each spring. Leaves are light to olive green in color, 2 to 5 inches long, and divided two or three times into deeply lobed leaflets. Leaves and stems are covered with fine silky hairs that give the plant a grayish appearance. Flower stalks appear at each upper leaf node and produce numerous flower heads 1/8 inch in diameter, which appear from late July through mid August in North Dakota. Many small, inconspicuous yellow flowers are produced in each head. The small seeds are easily scattered by wind, water, animal, and hay. The plant causes economic losses by reducing available forage, tainting the milk of cattle that graze it, and medically as a pollen source for allergies and asthma. It is a prolific seed producer but also can spread by short roots. The plant is most often found in a variety of soils, in over grazed pasture and rangeland, wastelands, and roadsides (Lym et al., 1995). The plant prefers wet conditions, but can also survive in dry sites, or gravely hilltops. Wormwood colonizes open, disturbed sites, and establishment is minimal where there are closed grass stands (FEIS).

Extent of the Problem – Wormwood is widely distributed throughout the Complex. This species colonizes new seedings, and established fields alike; however, most severe infestations have been in areas where grasslands were re-seeded before desirable vegetation became established.

Treatment goal – The treatment goal for absinth wormwood is that for invasive weed species.

Treatment Options and Selected Management Methods –

	Mechanical	**Cultural**	**Biological**	**Chemical**
Currently existing control options	Yes-limited	Yes	No	Yes

*** Mechanical control Options**

Repeated mowing may prevent seed development and dispersal. Established plants are not impacted by mowing, and will experience rapid re-growth after treatment.

***Cultural Control Options**

Low-severity fire readily top-kills absinth wormwood and may completely kill some plants. Absinth wormwood has perennial buds at or near the soil surface, which are susceptible to fire, but will sprout if they survive. Annual early spring prescribed fires conducted in South Dakota were found to kill only one third of the worm wood plants, but four consecutive annual spring fires reduced absinth wormwood by 96 percent. Competitive grass seedings may help provide control of this species by limiting bare ground that new seedlings require to become established.

*** Biological Control Options**

Currently, no information exists regarding biological controls for this species. Anecdotal evidence on the Complex suggests that sheep/goats may ingest wormwood plants when grazing; however, no evidence of control was noted.

***Chemical Control Options**

Control of absinth wormwood is much easier and more economical than for most perennial weeds. Herbicides commonly used to control absinth wormwood on the Complex include: 2,4-D, Triclopyr+Clopyralid (Redeem) and Glyphosate (Roundup). Herbicides are best applied when the plant is at least 12 inches tall and actively growing. Herbicides applied from late June until mid

August have given better residual control the following growing season than either spring or fall treatments. If fall treatments are selected, plants should be mowed in early to mid summer to promote active regrowth prior to the fall treatment (Tu et al., 2001).

*** IPM Summary**

The primary method of wormwood control on the Complex will be through proper seedbed preparation, and the resulting prevention of wormwood infestation. Several locations on the Complex have seen rapid, dramatic infestations of wormwood in new grass seedings. These locations previously had scattered wormwood plants, but when competing grasses were removed through tillage/herbicide applications, viable seeds on the soil surface sprouted and gave way to dense monotypic stands of wormwood. Repeated, chemical fallow of the soil surface with roundup for an entire year prior to re-seeding has shown to be effective in eliminating newly germinated plants, and depleting the soil surface of viable seeds. Chemical fallow with roundup in the preceding year, followed by a final roundup treatment made in the spring of seeding will be done an all fields on the Complex. Proper seedbed preparation of this type which results in a weed-free, packed seedbed is critical to eliminate any additional wormwood (or other species) that may compete with newly seeded grasses.

Areas where wormwood has become established will be treated with the use of repeated prescribed fire to promote desirable species, and damage established wormwood plants. Herbicides may also be used alone, or in combination with prescribed fire to improve control of established plants. Use of the Burch® wetblade mower on wormwood is not yet tested; however, this method of mechanical/chemical application may be used in the Complex to treat wormwood infestations in a more targeted manner in sensitive sites.

Russian Olive (*Elaeagnus angustifolia*)

Biology **-** This tree species (*Elaeagnus angustifolia*), introduced from Europe as an ornamental, grows to a height of 25 ft and is armed with 1-2 inch thorns. Although it is recognized as a source of food and habitat for wildlife, it invades moist grasslands, meadows and waterways, and can become a serious weed problem in North Dakota riparian systems.

Infestations of Russian Olives occur throughout the Complex. Sensitive sites, such as tall grass prairie located in Grand Forks County, host the Complex's largest stands of Russian olives.

***Treatment Goal* –** The treatment goal for Russian olives is that for invasive weed species.

Treatment Options and Selected Management Methods –

	Mechanical	**Cultural**	**Biological**	**Chemical**
Currently existing control options	Yes-limited	No	No	Yes

*** Mechanical control Options**

Mechanical control of Russian olives is somewhat limited. Trees that are cut with chainsaws or brush hog mowers, rapidly sucker, producing new branches. In addition to creating a major site disturbance, attempts to pull Russian olive trees out by the roots have proved to be both expensive, and ineffective. Trees that were removed in this manner at the Tewaukon NWR were actually found to regenerate from the roots that were left, and some trees that were piled up to be burned, re-rooted themselves in the piles.

***Cultural Control Options**

Russian olives often invade in areas where site disturbances allow the seedlings to become established. Spoil banks adjacent to stock tanks may provide an opportunity for Russian olives to become established, where they spread into adjoining lands which are heavy grazed with cattle. In addition, Russian olives have historically been used in shelterbelts, where they quickly expand into adjoining lands. This is especially true in the mesic prairie of the Red River valley where moisture and soil conditions favor the growth of Russian olives. Cultural controls for this tree include maintaining healthy grasslands, and minimizing areas of disturbance where these trees may become established. In addition, Russian olives present in shelterbelts on all Service lands will be removed before allowing them to spread to adjoining lands. The effect of prescribed fire on Russian olives is not well documented, but may provide control if fire intensity damages the cambial layer of this plant.

*** Biological Control Options**

Currently, no biological controls exist for this species.

***Chemical Control Options**

The use of Imazapyr (Arsenal) in drier locations, and Glyphosate (Rodeo) for wet sites has proved to be an effective means of control for this species at the Complex. “Hack and squirt” applications, or cut stump treatments have resulted in limited re-growth of this plant. Due to the distribution of the cambium in the tree, all main “trunks” of the tree must be treated to achieve effective control. Treating only one of the “trunks” may result in this portion of the tree being killed, and the remaining portions of the plant to be seemingly un-affected. Use of wetblade mower technology with arsenal may provide a method of controlling smaller trees before they become too large to mow.

*** IPM Summary**

The Complex will continue to use preventative cultural controls, prescribed fire, and mechanical/chemical control techniques cut stump/hack and squirt) to treat this weed species. Younger stands of this species will be mowed or cut with the WetBlade to determine the effectiveness of this control technique.

Perennial Sowthistle (*Sonchus arvensis*)

Biology - Perennial sowthistle (*Sonchus arvensis*) is a native of western Asia and Europe. Its spreads both by seed and creeping roots, and it grows under a wide range of environmental conditions. Plants can be produced from root buds as deep as 2 feet, often resulting in large, dense colonies. Root sections 1 cm long or more can produce new shoots from previously formed buds or develop adventitious buds. Perennial sowthistle has crowded, spatula-shaped to deeply lobed dandelion-like leaves up to 10 inches long near the base of the plant. Stem leaves are much reduced, usually unlobed, and scarce; all leaves are prickly toothed along the margins. Stems are hollow, sparsely branched, and up to 6 feet tall. Both leaves and stems exude a milky latex when broken. Yellow, dandelionlike flower heads to 2 inches wide are borne from June until frost. The flower heads and their stems bear coarse, spreading, gland-tipped hairs. Seeds are reddish-brown, 1/8 inch long, flattened, ribbed, and tipped with white plumes. The plant has extensive horizontal roots.

Seed disperses with wind, water, and by clinging to fur or feathers of animals and clothing of people. Flower heads produce viable seed within 5-6 days and disperse seed in ~ 10 days after opening. Some immature seed can continue to mature on cut stems. Isolated plants or clonal patches produce little seed because of self-incompatibility. Newly matured seed lacks a dormancy period. Most seed germinates in spring after soil has warmed to ~ 20º C. Seed can remain viable under field conditions for 3 or more years. Seedlings emerge from soil depths to 3 cm, but survival is typically low, especially on bare soils. Seedling establishment increases on sites with high moisture and protective plant cover or litter.

Treatment Goal – The treatment goal for Perennial sowthistle is that for invasive weed species.

Treatment Options and Selected Management Methods –

	Mechanical	**Cultural**	**Biological**	**Chemical**
Currently existing control options	Yes-limited	Yes	No	Yes

*** Mechanical control Options**

Tillage implements that either deeply bury root fragments below 30 cm or leave them on the soil surface to dessicate may reduce infestations. The optimal timing for cultivation to reduce root energy reserves is when plants are in the 6-9 leaf rosette stage. Repeated cultivation will be necessary for most infestations. Cultivation may also spread the extent of the infestation if relocated root fragments are not deeply buried. Repeated mowing before seed set will limit seed production and may reduce infestations, but will not kill perennial sowthistle.

*** Cultural Control Options**

Perennial sow thistle response to fire is variable. Perennial sow thistle cover and frequency may increase, decrease, or remain the same after fire in grasslands (FEIS). Prevention is the key to controlling this species on the Complex. As with many invasive weeds, the maintenance of healthy native communities with minimum site disturbance is a key to prevention. Preventing seed or root fragment distribution on vehicles and in hay have been identified as key elements to prevent the spread of this species into new locations. Competitive grass seedings following treatments may provide additional control.

*** Biological Control Options**

Currently, there are no labeled biocontrol agents for use on perennial sowthistle. However, cattle and sheep have been observed to readily graze the weed and reduce infestations.

***Chemical Control Options**

Auxin type herbicides such as 2,4-D, dicamba, MCPA, and clopyralid have been effective with repeated applications when plants are in the seedling or late rosette to early bud stages. Glyphosate may also be applied as an effective spot treatment (Bell 1973) (Devine and Vanden Born 1985).

*** IPM Summary**

As with many other invasive species identified in this plan, perennial sowthistle favors disturbed sites. The primary method of control for this invasive species will be preventing its' establishment in the Complex. Maintaining healthy grassland communities resistant to invasion, combined with the prevention of seed and root fragment transportation into the Complex are key elements of this plan. Although preventative measures are a key first line defense, rapid detection and immediate response to new infestations are critical to preventing large infestations of this invasive in the Complex. Treatments would include herbicide application of 2,4-D (or roundup for seedbed preparation) and competitive grass seedings followed by intensive monitoring to ensure the success of these treatments. Use of the Complex's wetblade mower may also be used to battle any new infestations.

Hybrid Cattail (*Typha*)

Biology - All species of cattails (*Typha*) in the United States are native. Three species (*T. latifolia L., T. angustifolia L., T. domingenis Pers*.) of *Typha* are commonly recognized as well as *T. x glauca Gordon* which is a hybrid between *T. latifolia and T. angustifolia*.

Cattails grow erect and are perennial herbs with rhizomes. Leaves are long-linear, glabrous, arranged in 2 ranks on opposite sides of the stem and in 2 vertical ranks, not differentiated into petiole and blade. The leave sheaths are at the base, and the sheath cylindrical, auricled or tapering at the shoulder. The flowers are unisexual, densely crowded in terminal, elongate cylindric spikes, the male flowers above the female. Male flowers are comprised of stamens, the female of pistils. The fruit is a minute achene with a long, hairy stalk.

Typha grows in shallow water of marshes, wet ditches, and along the shorelines of rivers and lakes. All species tolerate, in decreasing degree, some salinity: *T. domingensis, T. angustifolia, T. latifolia, T. x glauca*. Seeds are dispersed by wind, animals and water and germinate on wet mud. Once established, the plants spread under water at varying depths. The juveniles are submersed; the adults immersed or sometimes even appearing terrestrial.

Extent of Problem - Cattails commonly grow in monospecific colonies and may be the dominant plant over large areas. Dense colonies sometimes are a serious pest in irrigation systems and can impair small boat navigation and recreational activities in shallow water areas of lakes and reservoirs.

Treatment Goal – Although not a "priority invasive weed species", the primary treatment goal for cattails is to promote hemi-marsh habitat on selected Complex wetlands. Wetlands that are covered by cattail growth are typically unattractive to most species of wildlife. Cattail control is also desirable where dense stands threaten natural plant diversity or habitat heterogeneity.

Treatment Options and Selected Management Methods -

	Mechanical	**Cultural**	**Biological**	**Chemical**
Currently existing control options	Limited-yes	Limited-yes	No	Yes

***Mechanical Control Options**

Due to wet conditions, mechanical methods of control of cattails are almost impossible. During dry climatic periods, discing or mowing of cattails can provide very temporary control of these species, but when water conditions improve, these mechanically treated areas invariably return to dense stands of cattails.

***Cultural Control Options**

High-intensity fire can provide temporary control of cattails, but without the ability to hold water over the freshly burned plants, the marsh can return to a state of monotypic stands of cattails.

*** Biological Control Options**

Currently, there are no known biological controls for this species.

***Chemical Control Options**

Chemical control of cattails has proven to be effective in the past. Managers in the Complex have contracted with the USDA's APHIS office in the past to apply Rodeo on dense stands of cattails on Service lands. Rodeo was applied via fixed-wing aircraft on specified areas.

This method consisted of applying Rodeo in alternating strips the width of the booms on the airplane. Application of this herbicide controlled cattails for several years in the sprayed strips, providing open water habitat in an otherwise cattail-choked marsh.

***IPM Summary**

Most wetlands within the Complex support a desired interspersion of cattail. The density of hydrophytes (including cattail) in these wetlands are controlled with natural hydrological cycles. Selected wetlands (many of which are wetland creations) that are predominated by cattail may be selected for control using a combination of methods. Water management, where the capability exists, will be pursued to control cattail by drying out wetlands to allow for prescribed burning and/or tillage, followed by holding water at depths that are detrimental to the growth of this species. Other methods may include the application of herbicide (Rodeo) via aircraft, where water management capabilities are not possible, or where access to the site is restricted.

The following priority species have not currently been documented on the Devils Lake Complex. Treatment goals for these species are prevention, early detection, and immediate eradication:

Russian Knapweed (*Centauria repens*)

Biology - Russian knapweed (*Centauria repens*) is a perennial with a reputation for resisting control treatments. A single Russian knapweed plant has been reported to spread over 14 square yards in two years, averaging a linear rate of over 10 feet each year. This knapweed species normally forms dense clusters with a common root system. It is chemically active, causing dermatitis to humans, toxicity to equines, and exhibits allelopathy. While it freely expands stand size vegetatively, it is also good at pioneering new sites through transported seed. Seed viability may last from 2-8 years (Carpenter and Murray 1998). Although this species is commonly found along roadsides some roadsides, Russian knapweed can be very hard to detect from any distance unless in bloom (June and July) (Lym 1998).

Extent of Problem -According to the North Dakota State University Extension Office, Russian knapweed infested approximately 3,500 acres in North Dakota in 1997 with the largest infestations generally found in southwestern corner of the State. It is often found in areas with a supplemental water source such as the Little Missouri and Heart Rivers. Russian knapweed will also infest roadsides, pasture, and rangeland and is the only knapweed in the State that causes significant losses in cropland.

Treatment Options and Selected Management Methods –

	Mechanical	**Cultural**	**Biological**	**Chemical**
Currently existing control options	Yes-limited	Yes	Yes-limited	Yes

*** Mechanical control Options**

Cutting or removal of the above ground portion of the plant reduces the current year growth, and may eliminate seed production, but will not kill the plant. Cutting several times before the plants bolt stresses Russian knapweed plants by forcing them to use nutrient reserves stored in the root system. Once plants have bolted, there are no more buds capable of reproduction until buds begin to form again in mid-august to September. A combination of cutting and herbicides can be used to control this species.

*** Cultural Control Options**

Prevention is the key to controlling this species in the Complex. As with many invasive weeds, the maintenance of healthy native communities with minimum site disturbance is a key to prevention. Preventing seed distribution by vehicles and in hay have been identified as key elements in preventing the spread of this species into new locations. Competitive grass seedings following treatments have shown to provide additional control.

*** Biological Control Options**

As of the writing of this plan, no biological controls are currently approved for general distribution. Two species of gall fly (*Urophora kasachstanica* and *U. xanthippe*) are currently undergoing a comment period for their release.

***Chemical Control Options**

Picloram, and curtail have been identified as the most effective herbicides for use on this species. Fall applied herbicides timed to target the late bud/fall regrowth stage can be effective when combined with mowing during the growing season.

*** IPM Summary**

The primary method of control for this invasive species will be preventing its' establishment in the Complex. Maintaining healthy grassland communities resistant to invasion, combined with the prevention of seed transportation into the Complex are key elements of this plan. Although preventative measures are a key first line defense, rapid detection and immediate response to new infestations are critical to preventing large infestations of this invasive in the Complex. Treatments would include summer mowing, followed by a fall application of curtail and competitive grass seedings. Use of the Complex's wetblade mower may also be used to battle any new infestations.

Saltcedar (*Tamarix ramosissima*)

Biology - Saltcedar, also known as tamarisk (*Tamarix ramosissima*), is a highly invasive tree species that can grow to 20 ft or more in height. The plant is a deciduous evergreen from Eurasia that has now become a serious problem throughout the West, especially in riparian areas along streams and canals, reservoirs and other water bodies. Saltcedar displaces native tree species, such as cottonwood, by exuding salts that are phytotoxic, and they alter hydrology because of a larger water demand than native riparian species. Hence, sites infested with saltcedar are sometimes difficult to restore (Lym 2002). A mature saltcedar plant can produce 600,000 minute seeds annually which are easily transported by wind and water (FEIS 1996). Seeds remain viable up to 45 days , and can complete germination within 24 hours following contact with water (Carpenter 1998). Reproduction of this plant is also by vegetative spread, as new plants can form through the plant's root crown or submerged/buried stems (FEIS 1996). Saltcedar is well adapted to expand it's range along riparian courses following floods when stems/seeds are removed from parent plants and deposited in sediment.

Extent of the Problem -Saltcedar has been sold in North Dakota for many years as a various tamarisk species (tamrix). Homeowner plantings can escape to waterways. However, the largest infestation is from a vigorous wild type of saltcedar, which is spreading into western North Dakota along the Yellowstone and Missouri Rivers from Montana. These plants have been found along the rivers and on the banks several hundred yards away from the rivers. The latter were likely established during spring flooding. Saltcedar has also been found along the shores of Lake Sakakawea and in a wildlife management area in Sargent County. It also likely occurs in Slope and Bowman Counties in the southwestern corner of North Dakota. Saltcedar is not currently known to occur on the Complex; however, there is a record of it being collected in Benson County in 1968, likely from ornamental plantings (Lym 2002).

Treatment Options and Selected Management Methods –

	Mechanical	**Cultural**	**Biological**	**Chemical**
Currently existing control options	Yes-limited	Yes-limited	No	Yes

*** Mechanical control Options**

Use of a bulldozer or prescribed fire can be used to open up large stands of saltcedar, allowing resprouted plants to be treated with herbicide.

*** Cultural Control Options**

Prevention, rapid detection and immediate control are important cultural controls for this species. Use of prescribed fire may be used as indicated above. It is important to re-establish a canopy cover on treated areas with seeded grasses and planted cottonwood cuttings to reduce the chances of re-infestation (Frasier and Johnson 1991).

*** Biological Control Options**

No biological control organisms are available for general release.

***Chemical Control Options**

Arsenal is the most widely used herbicide to control saltcedar and should be applied alone at a 1% solution to the foliage or at 12oz. per gallon of water as a cut stump treatment. Arsenal can also be applied with a glyphosate formulation labeled for use in water such as Rodeo. Over 95% control has been achieved in field trials using these herbicides during the late summer or early fall (Carpenter 1998). Foliar applications may be appropriate for large infestations; however, cut stump treatments will be the preferred method for controlling new infestations as this technique will limit impacts to non-target species. Cultural control methods such as burning or bulldozing may be a precursor to herbicide use on large infestations.

*** IPM Summary**

The primary method of control for this invasive species will be preventing its' establishment in the Complex. Maintaining healthy riparian communities resistant to invasion, combined with the prevention of seed/ornamental tree transportation into the Complex are key elements of this plan. Although preventative measures are a key first line defense, rapid detection and immediate response to new infestations are critical to preventing large infestations of this invasive in the Complex. Treatments would include cut stump treatments using arsenal, combined with intensive monitoring to ensure the success of these treatments. Use of the Complex's wetblade mower may also be used to battle any new infestations of small trees.

Yellow Starthistle *(Centaurea solstitialis)*

Biology - Yellow starthistle is an extremely invasive, fast spreading member of the knapweed family and a native of the Mediterranean region. It is an annual which often grows 3 feet tall or more and is branched with winged stems. Its seeds can germinate either in the fall following cool rains and over-winter as a rosette or in the spring after snow melt. Yellow starthistle begins to bolt in late May to early June. Flowering starts in early to mid July, similar to Canada thistle. Yellow star thistle can often go unnoticed until the plant begins to flower, but once the bright yellow, dandelion-like flowers bloom, the plant is easily detected. Flowering continues until mid to late August, then the plant dries to a straw color, the seeds mature, and the cycle repeats. Adult plants may produce up to 170,000 seeds per plant, which remain viable for several years (Herzog and Randall 1998). Yellow starthistle was first found in North Dakota in the Devils Lake Complex. This infestation was detected in Grand Forks County in 1964 and removed. Yellow starthistle has the potential to dramatically reduce crop and forage production, decrease native plant and wildlife habitat, poison horses, and cause severe economic loss in both crop and wildlands (Lym 2002).

Extent of Problem- Yellow starthistle is most likely to be found in recently seeded pastures or CRP fields; along highways, railroad tracks and other transportation or communication lines, or anywhere livestock is brought into the state. Previous infestations in the state can be traced to the contaminated grass seed including those used in CRP, contaminated hay, and from movement of out-of-state livestock and vehicles into North Dakota. All known infestations in North Dakota have been treated and the areas are being observed for reinfestion. Even though yellow starthistle only spreads by seed, it has infested over 15 million acres in California alone. Yellow starthistle presently infests over 1 million acres in Idaho and has been found in the neighboring states of Montana, South Dakota, and Minnesota. Prevention is the best method to keep yellow starthistle from invading North Dakota cropland, rangeland, and wildlands (Lym 2002).

Treatment Options and Selected Management Method-

	Mechanical	**Cultural**	**Biological**	**Chemical**
Currently existing control options	Yes-limited	Yes	Yes	Yes

*** Mechanical control Options**

Although mowing alone is ineffective as a control method, it can help stress starthistle plants growing above desirable seeded plants during re-vegetation (Sheley et al. 1999).

*** Cultural Control Options**

Prevention, rapid detection and immediate control are important cultural controls for this species. Use of prescribed fire during the early flowering stage (before seed set) has shown to be effective (Hastings and DiTomasso 1996). It is important to maintain/re-establish healthy grassland habitats to prevent infestation/re-infestation.

*** Biological Control Options**

Several biological control organisms exist that can dramatically reduce seed production. The most commonly used is *Bangasternus orientalis,* a seed head weevil. Grazing of yellow starthistle with cattle or sheep can also provide some control if done before the plant produces spines; however, several grazing periods are necessary.

***Chemical Control Options**

Herbicides are most effective when applied from the seedling to bolt stages. 2,4-D applied at 1 lb AI/Ac has shown to provide effective control.

*** IPM Summary**

As with many other invasive species identified in this plan, yellow starthistle favors disturbed sites. The primary method of control for this invasive species will be preventing its' establishment in the Complex. Maintaining healthy grassland communities resistant to invasion, combined with the prevention of seed transportation into the Complex are key elements of this plan. Although preventative measures are a key first line defense, rapid detection and immediate response to new infestations are critical to preventing large infestations of this invasive in the Complex. Treatments would include herbicide application of 2,4-D and competitive grass seedings followed by intensive monitoring to ensure the success of these treatments. Use of the Complex's wetblade mower may also be used to battle any new infestations.

Spotted Knapweed (*Centaurea malculosa)*

Biology- Spotted knapweed is an aggressive, introduced weed species that rapidly invades pasture, rangeland and fallow land and causes a serious decline in forage and crop production. The weed is a prolific seed producer with 1000 or more seed per plant. Seed remains viable in the soil 8 years or more, so infestations may occur a number of years after vegetative plants have been eliminated. Spotted knapweed germinates in the spring or fall (Beck 1997). Seedlings develop and remain as rosettes for at least growing season while root growth occurs (FEIS 1996). It usually bolts for the first time in May of its second growing season and flowers August through September (Rutledge and McLendon 1998). Most seeds are shed immediately after reaching maturity. Spotted knapweed has few natural enemies, and the plant releases a toxin that reduces growth of other grass species. Areas heavily infested with spotted knapweed often must be reseeded once the plant is controlled.

Historical records indicate that spotted knapweed was introduced from Eastern Europe into North American in the early 1900s as a contaminant in crop seed. It now infests several million acres of grazing land in the northwestern United States (Lym 1998 and Lym et al. 1992).

Extent of Problem- Spotted knapweed infestations in North Dakota have been found primarily along highways, waterways, railroad track, pipelines, and recently installed utility lines in the western part of the state. Spotted knapweed also has been found in eastern North Dakota. The infestations can largely be traced to seed or hay brought in from neighboring states, especially Montana and Minnesota, which have large areas infested with spotted knapweed. Researchers in other areas have observed that spotted knapweed may remain for several years in a confined location and then spread rapidly to adjacent areas (Lym et al. 1992).

Treatment Options and Selected Management Methods-

	Mechanical	**Cultural**	**Biological**	**Chemical**
Currently existing control options	Yes	Yes	Yes-limited	Yes

*** Mechanical control Options**

Repeated mowing of bolted plants, or hand pulling in small areas will prevent seed set, and reduce stand densities. Long-term repetition of this control technique is necessary due to length of seed viability in the soil seed bank.

*** Cultural Control Options**

Preventing the establishment of new infestations by minimizing disturbance and seed dispersal are important preventative cultural controls. Prescribed fire has shown to promote, or control spotted knapweed; this variability probably reflects environmental conditions before and after the burns and the competitiveness of the plant communities that were burned.

*** Biological Control Options**

There is no singular biological control that has proven to be effective for control of this species. Several species of gall fly (*Urophora spp*.) have been approved for release; however, some researchers believe it may require a combination of up to 12 species of insects to reduce knapweed infestations (Beck 1997). Cattle and sheep will graze knapweed, but sheep appear to provide better control (Olson et al. 1997)

*** Chemical Control Options**

Clopyralid and 2,4-D are herbicides that have been demonstrated to provide control when applied at bolt or early bud stages (Sheley et al 1999). Picloram is also very effective at providing control; however, groundwater contamination concerns and persistence of this herbicide make this a less desirable tool for use on the Complex.

*** IPM Summary**

Spotted knapweed can spread readily by stems or seed carried on vehicles or in cut hay. Early detection and rapid response to new infestations on the Complex is critical to prevent large infestations on the Complex. Control of this species would be accomplished through a combination of mechanical, chemical, and cultural (prescribed fire/re-seeding) controls. Treated areas will be monitored for several years and retreated as necessary. Many attempts to control spotted knapweed have failed because follow-up treatments were not applied.

Diffuse Knapweed *(Centaurea diffusa)*

Biology- Diffuse knapweed is generally a short-lived perennial or biennial in North Dakota and invades habitats similar to spotted knapweed. The physical appearance or diffuse knapweed is similar to spotted knapweed, except diffuse knapweed is generally shorter and more highly branched. Rosettes of diffuse knapweed have more finely divided leaves tan those of spotted knapweed; however, it is very difficulty to distinguish spotted and diffuse knapweed in the rosette stage. Flower bracts are the key distinguishing feature between spotted and diffuse knapweed. Diffuse knapweed bracts have a rigid terminal spine about one-third of an inch long with four to five pairs of shorter, lateral spines. The spiny bracts resemble a crab in appearance, are very sharp, and can puncture skin if touched. The flowers can be white or purple, so flower color is not a distinguishing feature between knapweed species. Diffuse knapweed flowers from July to September (Lym et al. 1992).

Extent of Problem- Diffuse knapweed is not found on the Complex. It was found in one North Dakota County in 1996 and infested approximately 20 acres.

Treatment Options and Selected Management Methods-

Recommended control methods are identical to those of spotted knapweed listed above.

Purple Loosestrife *(Lythrum salicaria)*

Biology- Purple loosestrife is a rhizomatous perennial forb introduced to North America from Eurasia and Africa. Wild infestations are associated with moist or marshy sites, generally found in downstream of urban areas. The most identifiable characteristic of purple loosestrife is the rose to purple colored flowers. The flowers are arranged on a spike, which can be a few inches to 3 feet long. The plant usually flowers from early July to mid-September in North Dakota. The seed capsule is two celled and contains many very small seeds. Spread of purple loosestrife is primarily by seed, but the plant can also spread vegetatively from stem cuttings. Research has shown that seed viability of purple loosestrife growing in North Dakota wetland ranged from 50-100 percent. With approximately 2.7 million seeds produced per plant, purple loosestrife has the potential to spread rapidly once established in an area (Lym 2002).

Extent of Problem- In 2002, one acre of purple loosestrife was located and treated on the Complex in Towner County. However, most known purple loosestrife infestations are small, in North Dakota.

These infestations can usually be traced to escapes from public or private horticultural plantings, often from seed that finds its way to streams and rivers through storm drains. However, because it is an aquatic plant it will go directly into wetlands, lakes and rivers.

Treatment Options and Selected Management Methods-

	Mechanical	**Cultural**	**Biological**	**Chemical**
Currently existing control options	Yes-limited	Yes	Yes	Yes

Several Methods are available for purple loosestrife control, including mechanical, cultural, biological, and chemical. The size and location of specific infestation will determine the best control methods. In general, small infestations of a few plants can be controlled by digging, especially when plants are only a few years old. Larger infestations require treatment with herbicides and/or biological control agents.

***Mechanical Control Options**

Removing all plants, roots, and underground stems before seed set can control small infestations. It is difficult to remove all of the roots in a single digging, so monitoring the area for several growing seasons is essential to ensure that purple loosestrife does not re-sprout from roots or seed. This method is most useful on garden plantings or young infestations. Disposing of plants and roots should be done by drying and burning or by composting in an enclosed area. It is important to take care to prevent further seed spread from clothing or equipment during the removal process. The complete removal of all plant material is important, as small segments of purple loosestrife stems can become rooted and reestablish the infestation.

*** Cultural Control Options**

Preventing the establishment of new infestations by minimizing disturbance and seed dispersal are important preventative cultural controls. Other preventative measures would include the removal of plants from ornamental garden plantings.

***Biological Control Options**

Three biocontrol insect species were first released in North Dakota in 1997 and include:
Galerucella pusilla - a leaf-feeding beetle
Galerucella calmariensis - a leaf-feeding beetle
Hylobius transversovittatus - a root-mining weevil

Of these insects, the two *Galerucella spp*. (leaf feeding beetles) have been the most successful. These insects over-winter as adults and lay eggs in early June in North Dakota. The adults and especially the larvae feed on the leaves and flowers of purple loosestrife. Following several summers of heavy feeding, purple loosestrife infestations have been greatly reduced.

***Chemical Control Options**

Herbicides can be used to control purple loosestrife in areas too large to be controlled by digging. Also, trained professionals can apply herbicides to individual plants selectively in landscape situations to prevent specialized equipment and application.

Glyphosate (Roundup or Rodeo) will provide good control of purple loosestrife when applied from July to early September. Eliminating the entire vegetative cover will promote purple loosestrife seed germination, which can result in an increase in plant density rater than control. Since glyphosate does not provide residual control, treated areas will need to be monitored for re-growth from the roots or seedlings for several years, and re-treated as necessary. If adult plants are sprayed after seed set occurs, seed heads should be pruned and burned to prevent seed dispersal.

*** IPM Summary**

Early detection and rapid response to new infestations is critical to prevention and eradication of large infestations on the Complex. Control of this species would be accomplished through a combination of mechanical, chemical, and preventative cultural controls. Treated areas will be monitored for several years and retreated as necessary.

Dalmatian Toadflax *(Linaria genistifolia spp dalmatica)*

Biology- Dalmatian Toadflax is an escaped perennial ornamental that was introduced in the mid-1800s. It is native to the Mediterranean region and can grow up to four feet tall. The plants begin re-growth from roots as soon as the soil warms in early spring. Waxy green leaves are heart shaped, 1 to 3 inches long, and clasp the stem. Flowers are 1 inch long, yellow, and often tinged with orange or red, and similar in shape to snapdragons. Plants flower from late June through August in North Dakota. Seeds are produced in a ½ inch pod and are irregularly wing angled. A single plant may produce over 500,000 seeds that can be distributed by wind, rain, wildlife, and movement of forage and livestock. Seed dispersal begins a few weeks after flowering and continues into winter. Dalmatian toadflax seedlings are relatively poor competitors with grass species; but once established, the weed can become extremely invasive, especially on dryland sites, disturbed areas, and roadsides. Once an area becomes infested with dalmatian toadflax it can dramatically reduce forage production and decrease native plant and wildlife habitat (Lym 2002).

Treatment Options and Selected Management Methods-

	Mechanical	**Cultural**	**Biological**	**Chemical**
Currently existing control options	Yes-limited	Yes	Yes	Yes-limited

*** Mechanical control Options**

Repeated mowing or hand pulling of the above ground portion of plants will prevent seed set, and reduce stand densities. Long-term repetition of this control technique is necessary due to length of seed viability in the soil seed bank. Repeated discing on agricultural lands during the growing season has shown effective control of this species (Morishita 1991).

*** Cultural Control Options**

Preventing the establishment of new infestations by minimizing disturbance and seed dispersal are important preventative cultural controls. Other preventative measures would include the removal of plants from ornamental garden plantings. Re-seeding efforts should follow other treatments to prevent re-infestation.

*** Biological Control Options**

One species, *Calophasia lunula*, has been shown to feed on the leaves and flowers of this plant causing severe damage.

***Chemical Control Options**

Herbicide applications of picloram and 2,4-D have shown to be the most effective; however, results have been extremely variable. A six year study found that phenoxypropionic herbicides such as diclorprop were more effective than phenoxyacetic herbicides such as 2,4-D (Robocker 1974).

*** IPM Summary**

Early detection and rapid response to new infestations is critical to prevent large infestations on the Complex. Management of this species will focus on reducing the rate of vegetative spread and seed production. Due to the highly variable genetic strains of this invasive species, mechanical, cultural, biological, and chemical controls may all need to be used as local populations may respond differently to various treatments.

Weed Spread Prevention

As stated numerous times in this plan, the ultimate control action against all invasive plant species on the Complex will be to maintain and re-establish healthy prairie plant communities (before and after treatment). Limiting site disturbance, and/or improving decadent grasslands will reduce opportunities for invasive establishment. Healthy prairie grasslands are a stated goal of this and other Complex management plans, and are perhaps the single most important factor relating to the prevention of invasive weed infestations.

Complex personnel will aggressively scout for, and eliminate, any new individuals or colonies of priority species that may colonize Service lands. Complex staff will be trained to recognize the priority invasive weeds identified in Table 1, and instructed to notify the refuge manager of their location so that appropriate treatment methods can be aggressively pursued. Removal actions will occur immediately following documentation, including mapping with a Global Positioning System. Post-application monitoring to evaluate effectiveness and detect possible re-growth that may require a touch-up application will be a routine practice on the Complex.

Another aspect of prevention will be emphasis on weed control along roadsides and boundary lines by crop fields since these are key production areas of seeds of invasive weeds, and seeds from these sites are especially likely to be transported by vehicles or water to other locations. Cleaning vehicles and equipment that is to be transported off Service lands or brought onto Service lands is another important part of employing integrated cultural controls. All equipment used off-road or in the field, including tractors, mowers, 4-wheelers, trucks, and fire equipment, will be thoroughly cleaned before being taken to another location. Likewise, any equipment coming to the refuge from another area will be cleaned before arriving, preferably at its origin.

Complex cooperators will also be required to use weed-free seed (in grass or crop seedings). This will become a requirement in all cooperative agreements entered into on the Devils Lake Complex. Likewise, all force account grass seedings will utilize weed-free seed.

Site Restoration

The re-establishment and maintenance of healthy prairie grasslands for migratory birds and other wildlife is specifically listed as an IPM objective in this plan (objective “k”), and intimately tied to stated invasive weed prevention as outlined above. The Complex also recognizes that simply treating invasive weed species, without addressing the underlying causes of these weed infestations is short sighted, and destined to failure. Controlling weeds without proper site restoration does not accomplish long-term weed control, nor does it accomplish habitat management objectives on the Complex.

The Complex has used a variety of techniques to restore healthy grassland habitat and control invasive weeds. Native grasslands have been burned to rejuvenate desirable grasses and forbs. These burns not only improved competitive grass growth, they also aided in the establishment of leafy spurge biological control agents, or controlled absinth wormwood. Old stands of DNC that lost their vigor and were riddled with pocket gopher mounds (which serve as re-infestation locations) have been completely re-seeded once the invasive weed issues were addressed. Using these techniques, several locations on the Complex have been successfully transformed from solid stands of invasive, to dense stands of native grasses and forbs that may better resist future infestations.

Education, Outreach & Coordination

Since the ecosystem and the pest plant invasion does not start or stop at the Services boundaries, working with neighboring landowners and other partners in the community is vital in the successful management of invasive plant infestations. The first step in this direction has already been taken with the Benson-Towner Weed Cooperative Pulling Together Initiative. In a grant from the National Fish and Wildlife Foundation and Challenge Grant Funding, the Complex has partnered with the Benson and Towner County Weed Boards in a collaborative public-private three year effort to control noxious weeds utilizing an IPM strategy to promote the conservation of grasslands in northeastern North Dakota and to develop a long-term weed management plan. In 2002, the first year of the project, baseline weed inventories were gathered and were compiled with existing data; demonstration plots on federal and adjacent private land were set up to evaluate and demonstrate new weed management techniques. Organizing and/or participating in weed cooperation is providing a good vehicle for outreach and coordination on weed control and related issues.

In addition, the Complex will familiarize all permanent and seasonal staff with the Refuge's invasive species control program, and will produce bulletins and pictures of unwanted invasive species, enabling staff, volunteers, and visitors to assist in its control efforts. Infestations of invasive species and their management will be an important subject for interpretation to Complex visitors, as well as to Service land neighbors and the community in general.

Monitoring and Mapping-

Managers and biologists now have the capability to use and create spatial data to track habitat type and condition, including noxious weeds. Geographic information systems (GIS) is a process of creating user-interfaced geo-spatial data that is linked to management databases. The Complex has full capability to track management and habitat type utilizing the ArcView 3.2 platform. The Refuge Lands GIS extension (RLGIS) allows the user to enter refuge specific data including noxious weeds. Habitat data collected in this manner will follow the standard protocol and mapping standards established by the RLGIS core team (see Appendix 9). Noxious weed infestations and treatment areas will be mapped utilizing Global Positioning Systems (GPS) such as hand-held Trimble or other over-the-counter models. Geo-spatial data will be collected utilizing Universal Transverse Mercator (UTM), Zone 14, NAD 27. Priority weed management sites will be evaluated and mapped annually to determine objectives met.

To ensure that treatments are having the desired effect, they will be monitored. Infestation perimeter, stand density, and non-target plant data will be collected, and entered into the Complex's RLGIS database. Post-treatment data will be compared to pre-treatment data to ensure that management actions are having the desired effect. Analysis of follow-up monitoring will allow treatments to be improved over time, as additional data is gathered. Pre and post treatment monitoring will include stem density counts and ocular/visual analysis. Stem density counts will be completed on a limited basis due to the shear amount of noxious weed infestations and the lack of resources to complete stem density counts on all noxious weed infestations. In addition, many of the infestations are similar and to complete stem counts on all infestations would be redundant. Similar treatments will be completed on similar weed infestations with only one site being monitored by stem counts and compare data to similar sites that were monitored by visual methods.

In Fiscal year 2003, temporary employees were hired to complete preliminary/baseline habitat inventories on the Devils Lake WMD. As described above, GPS and Trimble Units were used to map areas of each habitat type, including noxious weeds. All upland habitat types were classified according to the Region 6, RLGIS protocol included in Appendix 9. Inventory methods included traversing Waterfowl Production Areas (WPAs) either on foot and/or on ATVs. Broad scale delineations were completed in areas that had scattered noxious weeds, such as Canada thistle, existing throughout a stand of grassland habitat and more confined delineations when small patches of noxious weeds were observed, such as small patches of leafy spurge. All noxious weeds that were observed were then entered into RLGIS. Examples of this year's inventory are included in Appendix 9. Although, accuracy of the inventory has not been assessed, draft baseline data inventory maps can now be given to the managers and used as field copies when they complete annual visits to WPAs to determine management needs. The size of the Devils Lake WMD Complex precludes annual comprehensive inventories/monitoring of every WPA due to the lack of staff, lack of funding and other competing priorities. It is obvious from the initial noxious weed inventory that not all infestations will be able to be addressed at once. Priorities will be set up according to criteria based on station IPM objectives set forth in this Plan and tempered by all other objectives set forth at the Devils Lake WMD Complex not included in this plan. A major goal of this plan is to become a working document. If the actual fieldwork required by this plan overwhelms station resources then the plan becomes impudent. The following Priority guidelines are set forth to prevent overwhelming station resources to complete the monitoring/inventory work intended for, by this plan. Annual inventories and monitoring will be completed in priority order as follows:

1. Inspect/monitor annually, WPAs that were treated, for noxious weeds the previous year, to determine if further treatment is needed.
2. Inspect/monitor annually, WPAs with small known noxious weed infestations. 1 acre or less. These areas should actually be included in the first priority as they should be the first category of weeds treated until eliminated.
3. Inspect/monitor annually, newly seeded tracts of land, to assess the area for invading noxious weed species, giving particular attention to the edges of the field.
4. Inspect/monitor annually, WPAs and NWRs that have been determined to be focus areas. These areas have been determined to be the highest priority areas for management on the Devils Lake WMD Complex. A list of the focus area WPAs is included in Appendix 9.
5. Inspect/monitor annually, Non focus areas and areas where weed complaints have been received.
6. The remaining uplands will be inspected on a 5-year rotation.

If priorities 1-4 were accomplished approximately 45% of the Devils Lake Complex fee title uplands would be inspected annually. This priority list does not exclude any opportunistic observations of noxious weed species and areas that we receive reports of weeds from constituents, such as neighboring landowners, mail route carriers, weed boards or other interested parties. All reports will be inspected and corresponding data will be entered into the RLGIS system. This priority has been set up to give managers some guidance as to where weed issues should be addressed first. As stated above, all weed issues in any given year will not be able to be addressed due to limited resources, but the inventory will be an on going process and each year re-evaluated to determine if IPM objectives are being met.

Review of Selected Herbicides

The use of herbicides, although a last resort, is an important element in the Complex’s IPM control plan. Selective use of herbicides, in combination with other IPM control techniques, may be necessary to control the infiltration and spread of certain invasive weed species (as outlined in the “IPM control strategies for priority species” section above). The use of any herbicide needs to be well thought out before an application takes place. The potential of a herbicide to contaminate ground/surface waters, impact non-target organisms, or make the weed infestation worse, need to be considered to avoid unintended consequences of application. The table below lists chemical trade names, target species, treatment sites, and the leaching potential of each herbicide that may be used under the authority of the project leader and this approved plan. Example pesticide use proposals (PUPS), labels, and Material Data Safety Sheets (MSDS) for each herbicide are attached (Appendix 10).

TABLE 2. APPROVED HERBICIDES, THEIR USES AND LEACHING POTENTIAL.

Chemical Trade Name	Chemical Common Name	Leaching potential (Seelig 1994)	Target Species	Treatment Site	Crop Type
2,4-D	2,4-D Amine	High	Knapweeds, wormwood, Canada thistle, musk thistle, yellow starthistle, Broadleaf weeds	Grasslands Croplands	Small Grains
MCPA Amine	MCPA	High	Broadleaf weeds	Cropland	Small Grains/Flax
Roundup/Rodeo	Glysophate	Low	Grasses, broadleaf weeds, salt cedar, purple loosestrife, hybrid cattail, , Russian olives, knapweeds, wormwood, thistle species	Cropland grasslands wetlands (Rodeo)	Small grains beans flax canola
Assure II	Quizalofop	Intermediate	Grasses	Cropland	Canola
Curtail	2,4-D Amine + Clopyralid	High	Canada thistle, musk thistle, wormwood, knapweeds, broadleaf weeds	Cropland grassland	Small grains
Poast	Sethoxydim	Intermediate	Grasses	Cropland	Canola/flax
Arsenal	Imazapyr	High	Russian olives, salt cedar	Grasslands	N/A
Harmony Extra	Thifensulfuron+Tribenuron	High	Broadleaf weeds	Cropland	Small grains
Plateau	Imazapic	Intermediate	Leafy spurge, broadleaf weeds	grasslands	N/A
Redeem	Triclopyr+Clopyralid	Intermediate/High	Wormwood, thistles	grasslands	N/A
Transline	Clopyralid	High	Thistle species, knapweeds	grasslands	N/A

TABLE 2. APPROVED HERBICIDES, THEIR USES AND TRANSLOCATION POTENTIAL.

Chemical Trade Name	Chemical Common Name	Translocating potential (Seelig 1994)	Target Species	Treatment Site	Crop Type
2,4-D	2,4-D Amine	Low	Knapweeds, wormwood, Canada thistle, musk thistle, yellow starthistle, Broadleaf weeds	Grasslands Croplands	Small Grains
MCPA Amine	MCPA	Intermediate	Broadleaf weeds	Cropland	Small Grains/Flax
Roundup/Rodeo	Glysophate	High	Grasses, broadleaf weeds, salt cedar, purple loosestrife, hybrid cattail, Russian olives, knapweeds, wormwood, thistle species	Cropland grasslands wetlands (Rodeo)	Small grains beans flax canola
Assure II	Quizalofop	Intermediate	Grasses	Cropland	Canola
Curtail	2,4-D Amine + Clopyralid	Low	Canada thistle, musk thistle, wormwood, knapweeds, broadleaf weeds	Cropland grassland	Small grains
Poast	Sethoxydim	Low	Grasses	Cropland	Canola/flax
Arsenal	Imazapyr	High	Russian olives, salt cedar	Grasslands	N/A
Harmony Extra	Thifensulfuron+Tribenuron	Low	Broadleaf weeds	Cropland	Small grains
Plateau	Imazapic	Intermediate	Leafy spurge, broadleaf weeds	grasslands	N/A
Redeem	Triclopyr+Clopyralid	Intermediate/ Low	Wormwood, thistles	grasslands	N/A
Transline	Clopyralid	Low	Thistle species, knapweeds	grasslands	N/A

<u>The following are additional information regarding herbicides that may be used on Complex grasslands:</u>

<u>Glyphosate</u> (Rodeo or Roundup, or similar products). (the following information is taken from Tu et al 2001) Glyphosate is a systemic herbicide with little soil residual activity. Because glyphosate tends to suppress rather than control thistles and because it adversely affects both broadleaves and grasses, roundup is mainly used as a preplant or fallow treatment. These fallow Roundup applications are an integral part of seedbed preparation for grassland re-establishment on the Complex. Multiple roundup applications are made in the year prior to grassland seeding to provide broad spectrum control of weeds and grasses. These treatments have proven to greatly reduce the soil surface noxious weed seed bank. Chemical fallow treatments are made to previously hayed fields, or when Roundup is used in crop rotations either for broad spectrum weed control in Roundup ready soybeans, or as a post-harvest treatment for Canada thistle. Efficacy can be increased if there is no tillage occur for 14 days after application and there are at least 21 frost-free days after application.

This herbicide will be used immediately adjacent to wetlands and water bodies. Roundup is occasionally used as a spot, wick, or wipe treatment to target plants amid desired species. Trials in other locations show that glyphosate can provide excellent thistle control, but that control is reduced when glyphosate is tank-mixed with 2,4-D, so this practice will be avoided when the targeting thistles.

On an acute toxicity basis (48-114 hour exposures, depending on species), glyphosate ranks as slightly to moderately toxic to mammals and birds and slightly toxic to practically nontoxic to fish and aquatic invertebrates. At labeled doses, toxicity to wildlife is expected to be negligible. The surfactant in Roundup is somewhat more toxic to fish, amphibians, and invertebrates than glyphosate itself. Thus, Rodeo, a glyphosate product that lacks this surfactant, is labeled for wetland and aquatic sites rather than Roundup. The refuge will use Rodeo together with relatively nontoxic surfactants, such as LI700, in sites immediately adjacent to aquatic sites or in sites with amphibian, fish, or invertebrate species of concern.

One attribute of glyphosate is that it sorbs well to soil and sediment with little continued herbicidal activity, making this herbicide less likely to leach or affect adjacent nontarget plants. A possible problem with poor herbicide performance is that glyphosate tends to be most effective when diluted with low hardness, clean (sediment-free) water. Also, studies show that glyphosate tends to be most effective on Canada thistles when groundwater is close to the surface. Water high in solids or hardness (high alkalinity waters), or when plants are drought stricken can greatly diminish effectiveness.

<u>Clopyralid</u> (Transline). Clopyralid is an auxin-mimic type herbicide. It is more selective than some other herbicides of this same type (picloram, triclopyr, or 2,4-D). This chemical has little effect on grasses and other monocots, and does little harm to members of the mustard (*Brassicaceae*) family, and other groups of broad leaf plants. While this chemical is similar to picloram, it has a shorter half life, is more water soluble, and has a lower absorption capacity than picloram. Clopyralid's half-life in the environment averages one to two months, and ranges up to one year. It is degraded almost entirely by microbial metabolism in soils or aquatic sediments. The inability of clopyralid to bind with soils and it's persistence implies that this chemical has the capacity to be highly mobile in the environment and a contamination threat to water resources and non-target plant species, although no extensive offsite movement has been documented to date. Use of the Burch ® wetblade mower may help target application of this herbicide. On an acute toxicity basis, clopyralid ranks as practically nontoxic to aquatic species and slightly to practically nontoxic to mammals and birds.

Lym (2002) demonstrated that clopyralid alone can be up to 87% effective in providing Canada thistle control 12 months after treatment.

2,4-D Amine. (the following information is taken from Tu et al. 2001) The amine formulation of 2,4-D (e.g., Weedar 64) ranks as only slightly toxic to practically nontoxic to aquatic species and practically nontoxic to birds and mammals. Although this form is prone to leaching, it is less toxic to aquatic species and less likely than other (ester) 2,4-D formulations to volatilize and affect adjacent nontarget plants or crops through atmospheric transport. Also, 2,4-D amine has a short half-life in water, normally 1-3 weeks and is unlikely to persist. Use of the Burch ® wetblade mower may help target application of this herbicide. This herbicide was found to be effective as a summer "burn down" treatment for Canada thistle as part of the "rosette technique" described earlier. Also, 2,4-D alone may be used effectively for many broadleaf weeds when plants are young and growing in the spring or fall rather than during the summer. Desired legumes may be affected by 2,4-D, so precautions need to be taken near desired native legumes or crops such as alfalfa. Musk thistle, cocklebur, and common ragweed are effectively controlled by 2,4-D treatments.

2,4-D Amine/Clopyralid Mixture (the following information is taken from Tu et al. 2001) (Curtail). This mixture has proved promising results on the Complex to date to control musk thistle, although a follow up treatment is sometimes necessary. It is also labeled for controlling Russian knapweed and yellow starthistle The combination of the two pesticides is less likely to result in herbicide resistance in the thistles. This combination is a control option for Canada thistle co-located with infestations of musk thistle (but gave variable results on Canada thistle), and is also listed as suppressing Russian knapweed. Use of the Burch ® wetblade mower may help target application of this herbicide to reduce potential surface/groundwater impacts of this herbicide.

Because of the phytotoxicity of clopyralid, uses of this mix will need to be based on label restrictions discussed above and on protecting desired Complex broadleaves. Reseeding with any broadleaves in fallowed sites will only occur after bioassays or field observations of seedling growth indicate it is safe.

Imazapic (the following information is taken Tu et al. 2001) (Plateau) Has successfully been used to date on the Complex in the control of leafy spurge, particularly in conjunction with the establishment of native warm-season prairie-grasses and certain legumes. Preliminary results show that Imazapic (applied at 8oz/ac) can control leafy spurge by 90% following 2 years of treatment, but in some cases negatively impact the surrounding native vegetation. Its average half-life is 120 days. In aqueous solutions however it is rapidly broken down by photolysis with a half-life of just one or two days. It is moderately persistent in soils, and has not been found to move laterally with surface water. Imazapic does not volatilize when applied in the field. It does not bioaccumulate in animals, as it is rapidly excreted in urine and feces. It is therefore, essentially non-toxic to a wide range of non-target organisms, including mammals, birds, fish, aquatic invertebrates, and insects. Imazapic can be applied using conventional application methods such as broadcast sprayers or using spot treatments. It was extensively applied in 2002 on the Complex with a Burch ® Wet Blade Mower, thus targeting the application and minimizing drift.

Triclopyr+Clopyralid (the following information is taken from Tu et al. 2001) (Redeem) provides control of annual and perennial broadleaf weeds in rangeland and permanent grass pastures, non-crop areas such as fence rows, non-irrigation ditch banks, and around farm buildings, and Conservation Reserve Program (CRP) acres. On the Complex it has proven to be effective on absinth wormwood, musk thistle, and Canada thistle and has little impact on desirable grasses. Active ingredients in the low-odor formulation are clopyralid and triclopyr amine. The product does not contain 2, 4-D and does not require a license to purchase or apply. Clopyralid is a chemical which can travel (seep or leach) through soil and under certain conditions contaminate ground water which may be used for irrigation or drinking purposes. Care should be taken not to apply clopyralid where soils have a high permeability and where the presence of a high water table or underlying aquifer is known. Use of the Burch ® wetblade mower may help target application of this herbicide to avoid sensitive sites or non-target organisms.

Primary use of this herbicide has been for Canada thistle control in the Complex. It is anticipated that use of this chemical may be phased out with the recent approval of transline (discussed earlier) for use in the State. This chemical formulation of clopyralid has been shown to be more effective in providing Canada thistle control (Lym 2002).

Imazapyr (the following information is taken from Tu et al. 2001) (Arsenal) (the following information is taken from Tu, et al 2001) Imazapyr is a non- selective herbicide used for the control of woody species. Because imazapyr is a weak acid herbicide, environmental PH will determine it's chemical structure. Soil PH's below 5-limit movement of this chemical in the environment. In soils, imazapyr is degraded primarily by microbial metabolism. The half-life of imazapyr in soils ranges from 1-5 months. In aqueous solutions, imazapyr may undergo phodegredation with a half-life of 2 days. Imazapyr is not highly toxic to birds and mammals. Studies indicate that imazapyr is excreted by mammalian systems rapidly with no bioaccumulation. It has low toxicity to fish, but studies on the effect to imazapyr on other aquatic organisms is lacking. Because imazapyr can be highly mobile, persistent, and can affect a wide range of plants, care must be taken in the application of herbicide to prevent accidental contact with non-target species. Additionally, this chemical may be exuded by the root systems of some treated trees, and adversely affect surrounding native vegetation.

The use of Arsenal on the Complex will be limited to cut stump, or "hack and squirt" treatments for Russian olives or saltcedar. Care will be taken to meter herbicide amounts exactly to prevent over application. It has been shown on the Devils Lake Complex that minimizing the amount of herbicide applied, also minimizes risk of herbicide being exuded by the root systems of treated trees.

Other chemicals such as Assure (quizlofop), Poast (sethoxydim) and Harmony Extra (thifensulfuron+tribenuron) are used, by cooperative farmers, to control annual broadleaf plants and undesirable grasses that compete with their crops. Cooperative farming is used to provide a clean seed bed to reestablish DNC grasslands that have become decadent and can no longer be rehabilitated and DNC stands that have been invaded by invasive weeds. There is a real cost/benefit to the Service by using Cooperative farmers. The Service does not have the resources to carry out large-scale farming that is needed to control large expanses of invasive weeds like Canada thistle. Cooperative farming these areas is usually short lived, lasting on average for 3 years, but can range from 2-5 year.

Improved Pesticide Best Management Practices (BMP's)

Burch Wetblade®Technology

The use of herbicides as part of this plan is of particular concern because most FWS lands managed in the prairie pothole region are Waterfowl Production Areas (WPA's) (269,528 hectares; 665,995 acres) that have high wetland densities. Hence, reducing the potential impact and off-target movement of herbicides into surface or ground waters is of great importance to the Complex. The FWS is continually seeking site-specific herbicide application methods to reduce potential environmental effects of herbicides. Recently, the Complex began using the Burch Wet-Blade® because early investigations indicate that a range of herbaceous plants can be controlled at reduced herbicide rates (Whitson 2000a, 2000b). This implement may also reduce the amount of herbicide exposure to non-target species. The wet-blade mower consists of a no spray system that delivers herbicide to cut plant surfaces from an area underneath the cutting blade. Studies have demonstrated that this stem-cut-blade delivery system results in efficient uptake of herbicides that is rapidly translocated to root systems (Wahlers et al. 1997a, 1997b).

Reducing the environmental impact and off-target movement of herbicides is critical on WPA's with high wetland densities. The presence of wetlands on WPA's makes effective control of Canada thistle particularly problematic. For example, wetlands typically exhibit dynamic water-level fluctuations, including frequent drawdowns that expose barren moist soil areas that are often colonized by Canada thistle. Thus, wetlands edges are often core areas that facilitate the spread of Canada thistle into surrounding uplands. Controlling the spread of Canada thistle at the origin of infestation is problematic because herbicides that effectively control Canada thistle (e.g., clopyralid) cannot be applied near wetlands due to label restrictions.

Wet-blade technology may reduce environmental effects of herbicide on Service lands while maintaining ability to control invasive plants. Though studies have shown the wet-blade mower to control noxious weeds effectively at reduced applications with little or no drift, the Complex seeks to evaluate/demonstrate the herbicide risk reduction associated with using the wet-blade relative to other conventional herbicide application methods used on Service lands in 2003.

The following are BMP's that were listed by Seelig and Nowatzki (1996) to help limit potential contamination of both surface and groundwater resources. These BMP's have been adopted for use under the Devils Lake IPM plan, and are divided into those that will take place when mixing/storing herbicides and those that will take place when applying herbicides. The most important BMP to limit potential impacts to groundwater and surface waters is the IPM approach to treating invasive weeds. As articulated in this plan, this approach will use herbicides sparingly, only when necessary, and in combination with other treatments to limit the amount of herbicides applied.

Mixing Site BMP's

- As a precaution against spillage, sprayer tanks will never be left unattended during filling.
- Whenever possible, the mixing, loading, and rinsing of pesticides will take place over an impermeable surface that is designed to drain to a sealed catchment.
- All chemical containers will be triple rinsed; rinsate will be used as part of the make up water in the sprayer tank and applied to treatment areas.
- All pesticide sprayers will be properly cleaned. Rinsate will be used as part of the make up water in the sprayer tank and applied to treatment areas.
- Empty, triple rinsed pesticide containers will be recycled at local herbicide container collections. These containers will not be stockpiled from year to year.
- All unused herbicides that are no longer needed, will be properly disposed of at local "safe send" collections.
- Herbicides will be stored in a secure, properly ventilated location where product usefulness can be maintained, and any spillage will be easily contained.
- All herbicide spills will be attended to immediately.

Improved Pesticide Application BMP's

- The Devils Lake Complex will utilize herbicides with low mobility and persistence wherever the use of these alternatives will meet treatment objectives.
- Use of the Burch Wetblade® Mower will be used wherever possible to specifically target herbicide applications, and minimize impacts to sensitive sites or non-target organisms.
- Herbicide formulations that reduce drift will be utilized wherever possible.
- Spray equipment will be adjusted to produce the optimum droplet size for coverage of the target organism while reducing drift.
- Herbicide spray applications will be made at the optimal height to cover target plants, and reduce drift potential.
- Herbicide applications will never be made when weather conditions may facilitate drift or runoff (high winds, precipitation, or inversions)
- Equipment will be calibrated regularly to ensure that the proper amount of herbicides are applied.
- Adjuvants (MSO) will be used when recommended to allow for better contact with target organisms, and lower rates of herbicides to be applied.

Additional information- Best Management Practices and Personal Protective Equipment

All chemical applications will be planned and conducted with the coordination and under the supervision of a licensed applicator certified in the appropriate State category that covers the application. Boom spraying will only be conducted when wind speeds average 7 miles per hour (mph) or less, and preferably in the 3 to 5 mph range, with no gusts greater than 10 mph. Anti-drift nozzles will be utilized. Inversion conditions, typical in calm and very low wind conditions, will be avoided since these conditions facilitate large-scale herbicide drift off site. Only enclosed cab equipment with air conditioning will be used to boom spray, offering the maximum protection from contamination to the operator/applicator. Due to frequent windy conditions during afternoon periods and early spring in general, boom spraying will typically be conducted in the early morning in late spring or summer, based on observations and the weather forecast. Spray applications will not be conducted on days when there is a 30% or higher forecast for rain within 6 hours, except for products that are rapidly rainfast (e.g., glyphosate in 1 hour). Applications of herbicides prone to leaching will also not be made within 24-48 hours of likely (greater than 50% chance of) moderate to heavy rainfall. Certain herbicides are less likely to leach and more effective following a light rainfall that moistens the soil, and these conditions are usually indicated as optimal on the label. Complex herbicide applications will take these factors into consideration, and when feasible, will take advantage of these factors. Large-scale applications will primarily be conducted by cooperators or contracted labor; smaller areas to be sprayed will be done by force account.

A hand held wind meter will be used to determine wind speed at the application site, and wind direction will also be evaluated relative to any sensitive sites. If the wind temporarily increases during boom spraying, lowering the nozzle pressure, thereby reducing droplet size, can reduce drift. However, this practice will reduce the application rate for the area affected, and would have to be combined with shifting to a lower gear (reduced speed) to approximate the same standardized application rate. When boom spraying, it is desirable to maintain the same combination of gear and rpm's used in calibrating the boom sprayer, so any exceptions to this standard practice will be minimized. Also, the Complex will routinely limit herbicide drift by using anti-drift nozzles with openings of not greater than 1/16 inch and boom pressures of no more than 30 psi, with 20 psi adjacent to sensitive sites not in the treatment area. A nontoxic anti-drift agent will also be used when allowed by the label, especially adjacent to sensitive sites. Equipment will be calibrated as necessary to ensure that herbicide application rates are accurate.

To aid staff involved in mixing, a conversion table will be developed and posted in the mixing area stating the amount of product needed for any given percentage of tank mix for each size of tank used on the Complex. Also, each tank will be clearly labeled "Pesticides Only", or in a similar warning.

Personal Protective Equipment. Applicators will wear personal protective equipment (PPE) in accordance with the specific labeling requirements for each product, and the Station as needed, will supply all PPE. The required PPE, as specified by the label, will be worn at all times during handling, mixing and application. Fresh clean clothing, such as coveralls, laundered after each use, will be put on daily before handling pesticides used in application and removed before engaging in other duties unrelated to the application. Mixers and applicators will wear a pair of footwear specially designated for herbicide use, and will not wear the designated footwear for other operations to minimize contamination.

As exposure to concentrated product is usually greatest at mixing, extra care will be taken during the mixing period. Persons involved in mixing will be best protected if they wear extra long gloves, an apron, and designated footwear and face shield throughout the mixing process, in addition to the protective clothing required by the label. Coveralls and other clothing used in an application will be laundered separately from other laundry items, or disposable Tyvek clothing may be used. Transportation, storage, handling, mixing and disposal of pesticide containers will be consistent with label requirements, EPA and OSHA requirements, and Service policy.

Currently, there are no products requiring the use of a respirator proposed in this plan. Should changes occur, any respirator use by Service personnel will take place following establishment of a written Respirator Program, fit testing, physical examination (including pulmonary function and blood work for contaminants), and proper storage of the respirator. Alternatively, the Complex may contract with a commercial certified pesticide applicator in the area for some applications.

Surfactants and anti-drift agents. Surfactants provide benefits by increasing plant uptake of the applied herbicide and will normally be used if specified on the label. To the maximum extent possible, consistent with label specifications, the refuge will select surfactants and anti-drift agents that are themselves low in toxicity by comparing information available from the product MSDS's and by consulting contaminant specialists when additional information is needed.

Dyes. A non-toxic dye may be used to assist applicators in visually determining target acquisition, potential drift or over-spray, the amount of treatment applied, and to aid in discovering equipment leaks. If a leak is discovered, the application will be stopped until repairs can be made. Any dyes or foam markers used must also be non-toxic.

Spills. If a spill occurs, the top priority will be the decontamination of any personnel involved. Any gloves, clothing or other PPE involved in the contamination will be removed as soon as practical and cleaned or discarded appropriately, and the applicator will be provided with the time and opportunity to wash up and decontaminate as thoroughly as needed. A continuous emergency eye wash station will be available near the mixing station. Whenever possible, mixing stations will be located near a shower stall or other means of thoroughly washing off and decontaminating the entire body. A "spill kit" with absorbent material will be kept on hand wherever pesticides are stored, mixed, or when transported, and the storage and mixing areas will provide containment appropriate for the volume of material involved. A tarp will be used to cover any spill site until retrieval of the spilled material, cleanup or capping of the site occurs. If the spill cannot be cleaned up and contained immediately, State spill response personnel will be contacted.

Labels and Material Safety Data Sheets. Prior to each treatment season and prior to mixing or applying any product for the first time each season, all applicators will review the label, MSDS, and Pesticide Use Proposal (PUP) for each product, determining the target pest, appropriate mix rate(s), PPE, and other variables listed on the label. Labels and MSDS's will be maintained both in the shop and as separate, laminated copies in the mixing area. These same documents will be carried by field applicators. A written reference for each tank to be mixed (on a note pad, chalk board, dry erase board, etc.) will be provided in the mixing area to use as a quick reference while mixing is in progress.

Notification. Staff, volunteers, and members of the public who could be in or near the treatment area within the stated reentry time period on the label will be alerted concerning treatment areas, and posting will occur in any site where the individuals might inadvertently become exposed to a pesticide during other activities on the refuge. Where required by the label, sites will also be posted on all corners and at other locations of likely site entry, such as trailheads. The Refuge will also notify any adjacent property owners of an intended application, if private individuals have requested notification. Special efforts will be made to contact neighbors that are beekeepers or who have indicated that they have special chemical sensitivities.

Pesticide Disposal. Empty product containers will be triple rinsed and the rinsate will be applied to target sites in accordance with the label/PUP. Empty containers will be triple rinsed and recycled at local collection sites. Solutions used to clean equipment after application such as water, will be recaptured and reused or applied to an appropriate pest plant infestation.

Training and Supervision of Pesticide Applicators. At least one staff member will be certified by the State of North Dakota as a "Public Lands Applicator", and any staff member applying a herbicide must be operating under his/her **direct** supervision. Preferably, all staff involved in the station pest management program will be afforded the opportunity to attend appropriate training. New staff unfamiliar with the station procedures for storage, mixing, handling, applying and disposing of herbicides and containers, will receive orientation and training **before** handling or using any products, and documentation of that training, and related training, will be placed in the refuge files for documentation.

Log of Pesticide Use. A log will be maintained to record and document each application, applicator, amount of product(s) used, location, time of day, acreage and, for boom spaying treatments, wind speed. These records will assist in producing the annual Pesticide Use Report and will meet other documentation requirements.

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