Chapter 3: Refuge Environment and Current Management

Section 1 – Refuge Environment

Introduction

Crane Meadows NWR was established in 1992 to protect one of the largest, most intact wetland complexes remaining in central Minnesota. Described as a 'sand plain wetland/upland complex', the Refuge habitats are a unique mosaic of droughty, sandy uplands consisting of prairies, oak savannas, and mixed forests; and diverse, poorly-drained wetland habitats including sedge meadow, shallow lake, scrub-shrub, and bottomland forest communities. These habitats provide valuable respite from surrounding agricultural and developed land uses for many species of migratory birds, fish, reptiles, and other wildlife. Species present on the Refuge include a number of state and federally listed plants and animals such as the tubercled rein-orchid and Blanding's turtle.

In the thin transitional zone between the continent's central prairies and northern boreal forests, Crane Meadows NWR's location provides an interesting case study for the effects of global climate change as weather patterns and disturbance regimes change, biomes shift, and species distributions, phenologies, and interactions evolve. The Refuge also drains nearly 275,000 acres of upstream watershed area extending northeast to the periphery of Lake Mille Lacs, making it an important filter for the Mississippi River just 5 miles downstream.

Within the 13,540-acre area proposed for acquisition encompassing the wetland system, the mix of land ownership includes the Service (just over 1,800 acres), state landholdings (approximately 900 acres), as well as hunt clubs, a diversity of agriculture interests, and private residences. Land acquisition for the Refuge continues slowly as resources permit. Beyond the natural resource conservation innate to national wildlife refuges in the form of ecological services, habitats, and wildlife, the acquisition boundary also contains an array of archaeological sites and recreation opportunities. With a local staff of two and support from Sherburne NWR (the two refuges form the Sherburne-Crane Meadows National Wildlife Refuge Complex), Crane Meadows NWR maintains strong relationships with conservation partners and surrounding communities through its Partners for Fish and Wildlife Program, Friends group, and a number of popular Refuge programs.

Crane Meadows NWR Office. Photo Credit: FWS

As one of the most recent additions to Minnesota's 12 national wildlife refuges, it contributes to the Refuge System mission by enhancing the "…national network of lands and waters for…fish, wildlife, and plant resources, and their habitats…"

Other Units Administered

Farm Services Administration Conservation Easements

The 1985 Farm Bill's 'Consolidated Farm and Rural Development Act' contained provisions for the protection of wetlands against conversion to agriculture. The Farmers Home Administration (FmHA) was given authority for the Farm Debt Restructure and Conservation Set-aside Conservation Easements – properties foreclosed on by the federal government, otherwise known as "inventory properties." Lands appropriate for the conservation easement program had important natural resource interests such as wetlands, floodplains, riparian corridors, endangered species habitat, and the uplands necessary to protect bottomland habitats.

An agreement between the FmHA and the FWS authorized the Service, as the 'easement manager,' to protect these lands for conservation, recreational,

and wildlife purposes. The Service Easement Manual (D.O.I. 2005) states that, "The agreed upon purposes of this easement are the preservation and maintenance of the wetland and floodplain areas existing as of the date of this conveyance as well as protection and enhancement of plant and animal habitat and populations." Farm Service Administration (FSA, previously FmHA) easements are administered by the Service as part of the National Wildlife Refuge System pursuant to the National Wildlife Refuge System Administration Act (16 U.S.C. 668dd et. seq.), and thus they are subject to compatibility regulations and other relevant NWRS policy.

The Sherburne-Crane Meadows NWR Complex is responsible for the FSA easements in six Minnesota counties: Benton, Isanti, Kanabec, Mille Lacs, Morrison, and Pine. Of these counties, Crane Meadows NWR staff is responsible for the oversight and management of the 21 easements in Morrison County, including a total of 1,683.2 acres (see Figure 3).

The Service is authorized to protect and manage important natural resource interests on FSA easement properties. Ownership of the easement land is typically retained by private individuals, but with deed restrictions related to conservation management. Because of the high degree of variability between individual FSA easements, review of the easement files is necessary in evaluating Service-related management actions and enforcement activities.

In general, service employees are responsible for habitat management and are granted access for maintenance, monitoring, enforcement, and other necessary management activities. The Service Easement Manual describes management rights as follows:

> "…include, but are not limited to, inspection for compliance with the terms of this easement; research regarding water, wetlands, fish and wildlife and associated ecology; and any other activity consistent with the preservation and enhancement of wetland functional values (D.O.I. 2005)."

Crane Meadows NWR waterfowl. Photo Credit: Beau Liddell

There is no public access to these easement properties unless explicitly stated in an individual easement document. According to policy, FSA conservation easements are checked annually using aerial or ground surveys for compliance, including boundary signs, trespass, and various other infractions.

The Local Conservation Landscape

With a greater emphasis now being placed on land conservation networks, habitat corridors, and the strategic growth of the conservation estate, existing conservation landholdings may serve as the foundation on which a web of lands with conservation values can be designed and created.

The Minnesota DNR is the single largest player in the conservation landscape of Minnesota. There are also a number of other constituent groups that contribute to the conservation estate of the area surrounding Crane Meadows NWR. See Figure 4 and Figure 5 for illustration of the conservation lands within the acquisition boundary, those within 5 and 10 mile buffers of the acquisition boundary, and the large conservation landholdings in the broader landscape.

Within the Crane Meadows NWR authorized acquisition boundary, three DNR divisions own a combined acreage of almost 900 acres. The largest is held by the Division of Fish and Wildlife (848 acres) and is divided among the four units of its Rice-Skunk Wildlife Management Area and the single-unit Crane Meadows Wildlife Management Area. State Wildlife Management Areas (WMAs) form the backbone of Minnesota DNR wildlife management by providing important habitat for wildlife, as well as public recreation opportunities including hunting, trapping, fishing, hiking, cross-country skiing, snow shoeing, and wildlife observation. Currently there are more than 1,380 WMAs in the state of Minnesota, encompassing over 1.2 million acres.

The larger of the two WMAs inside the Refuge acquisition boundary is the Rice-Skunk WMA at 659 acres. The largest of its four units is the Skunk Lake East Unit (426 acres), and as the name infers it is located on the southeast side of Skunk Lake. This unit is accessible from 113 Street on the north side of the parcel, with some limited access from the Soo Line trail, and provides public access onto Mud Lake during waterfowl season. The other Rice-Skunk WMA units include the Skunk Lake West

Figure 3: FSA Easements Administered by Crane Meadows NWR

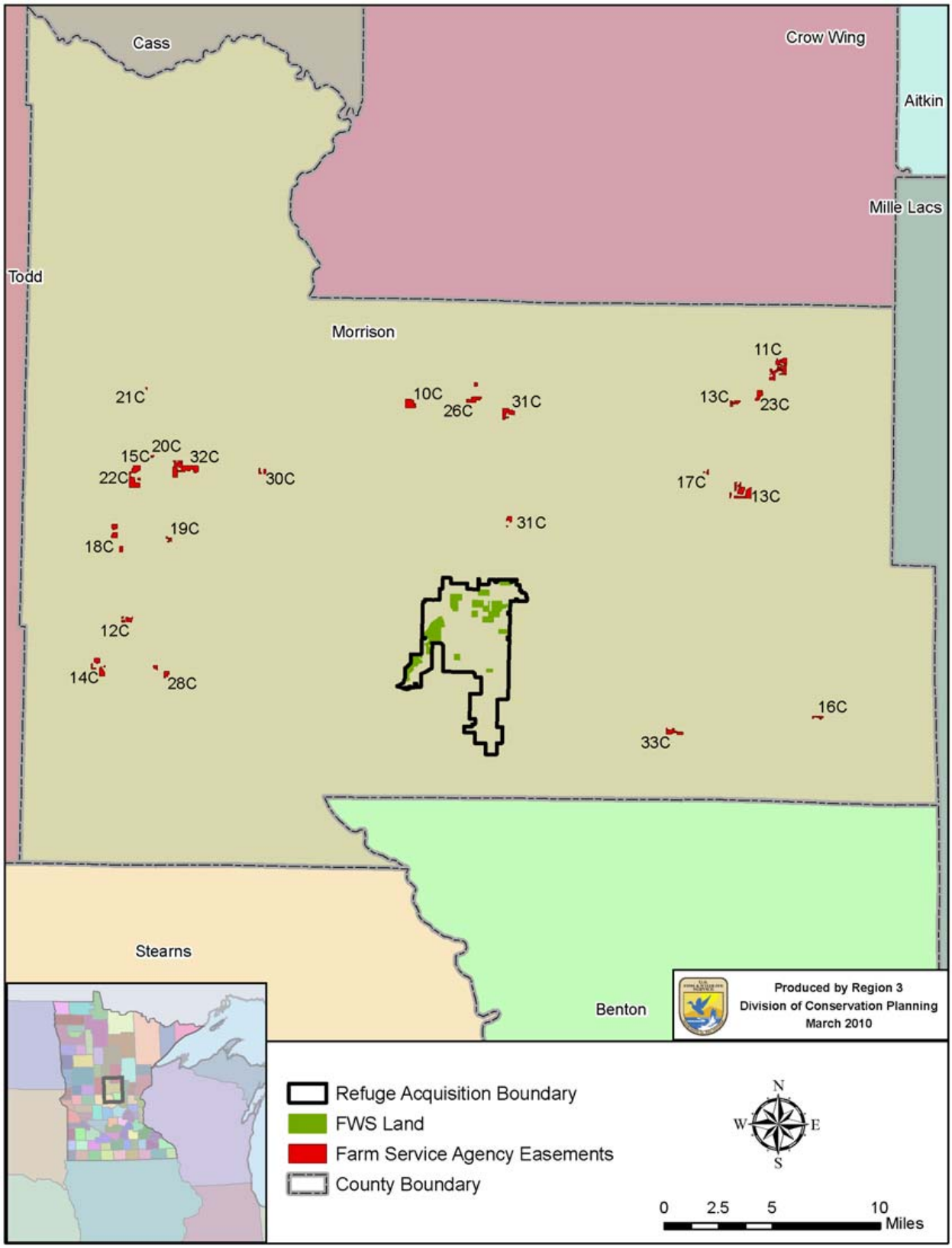


Figure 4: Surrounding Conservation Lands, Crane Meadows NWR (1)

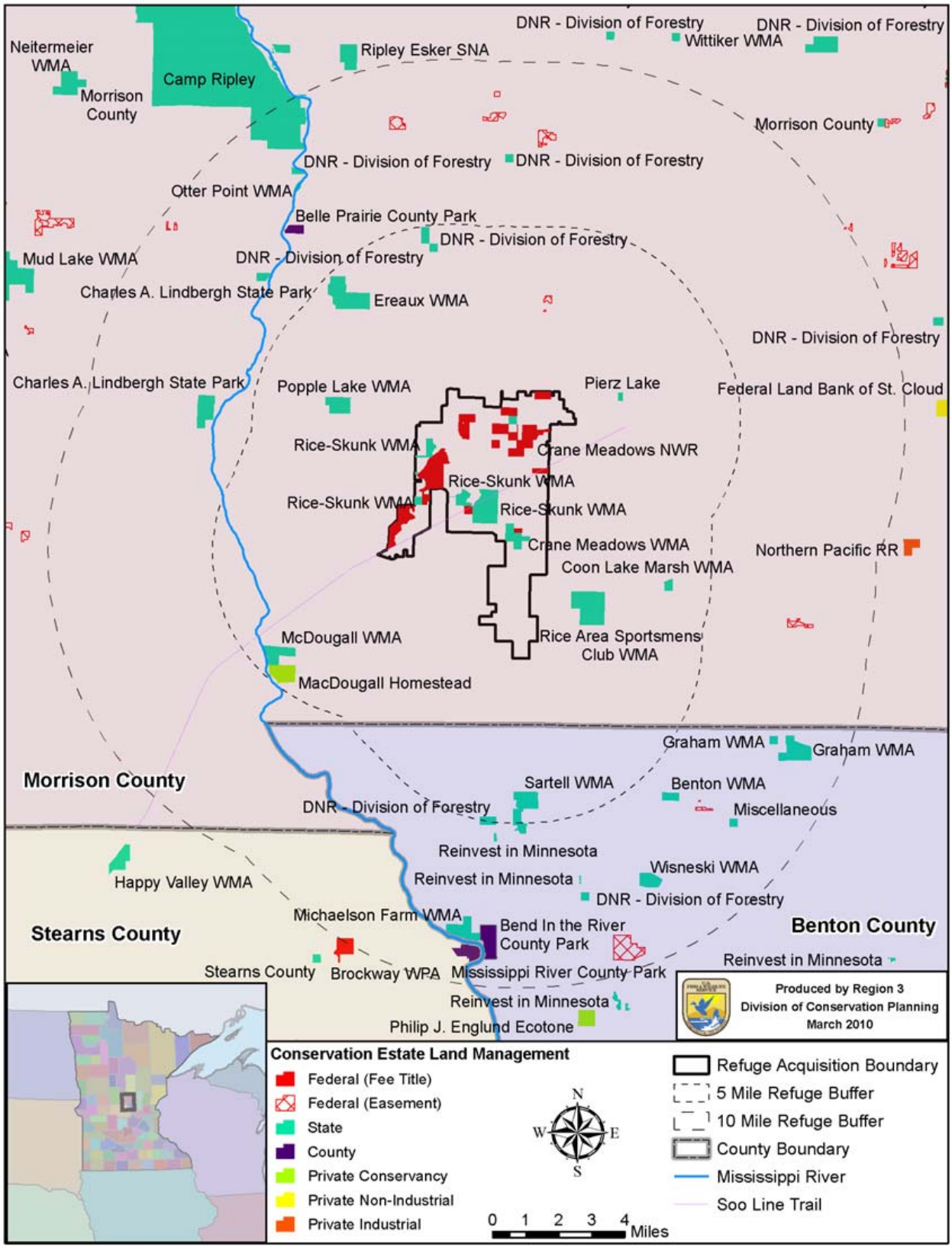
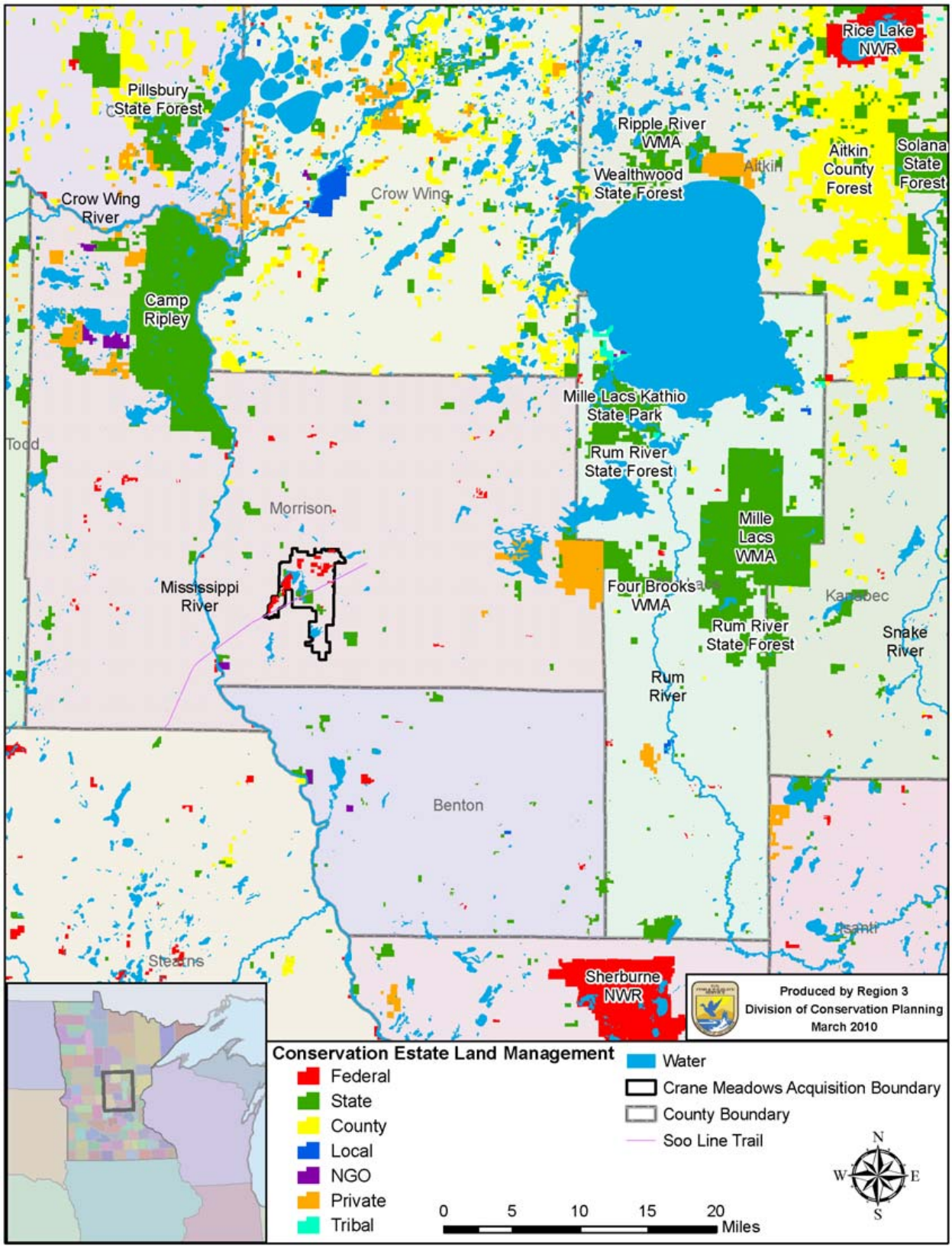


Figure 5: Surrounding Conservation Lands, Crane Meadows NWR (2)



Unit, 112 acres located on the southwest edge of Skunk Lake, just north of a Crane Meadows NWR tract, and providing access to Skunk Lake; the Rice Lake Unit located east of where Rice Lake empties into the Platte River. This 84-acre area contains the George Selke Memorial Dam and provides public access to the Platte River above the dam and to the entire shallow lake complex. The last unit of the Rice-Skunk WMA is called the Platte River 40. This 37-acre tract is located along the east side of the Platte River south of County Road 35.

The other WMA within the Refuge boundary is the Crane Meadows WMA. Its 189-acre tract is located just south of Kettle Road and provides water access onto Buckman Creek.

The Division of Forestry owns a 40-acre property located in Agram Township (southeast quarter, southeast quarter, Section 16). During the original land surveys in Minnesota, sections 16 and 36 of each township were given to the state as timber units to help fund local school systems. If sold, the revenue generated from these sections would either go into a trust for the school or be used for the betterment of the school system. Because the 40-acre section in the Crane Meadows NWR acquisition boundary consists of predominantly bottomland and wetland habitats, it is not considered productive forest land and little interest has been shown in the property.

The third and final state division represented within the authorized acquisition boundary is the Division of Parks and Trails Sauk Rapids office, which owns an unnamed 3.5-acre public water access area on the west side off County 256. This parcel gives boaters access to the Platte River south of the low-flow dam.

There are six additional WMAs and a few miscellaneous conservation lands outside of the Refuge acquisition boundary but within 5 miles of the Refuge. Rice Area Sportsmen's Club WMA (580 acres) is located approximately 1 mile east and Coon Lake WMA (54 acres) is just over 3.5 miles east of the Refuge. Four miles due south in Benton County there is a 368-acre WMA, Sartell, which is the site of the first habitat project funded by the state Duck Stamp. The McDougall WMA (228 acres) is 4 miles southwest of the Refuge, and it is bordered on the south by 215 acres of The Nature Conservancy land know as the McDougall Homestead. Popple Lake (223 acres) is just over 2 miles west of the Refuge and Ereaux WMA (527 acres) is located 3.5 miles northwest of the Refuge. The same DNR Division (Fish and Wildlife) also manages the Pierz Lake Fish Management Area 1.5 miles northeast of the Refuge, and a number of additional Division of Forestry School Trust Fund sections are found within the 5-mile radius.

Several conservation areas are located within a 10-mile radius of the Refuge's acquisition boundary. Areas south of the Refuge and east of the Mississippi River in Benton County include:

- Graham WMA (Main Unit is 329 acres, Northwest Unit is 40 acres)
- Benton WMA (82 acres)
- Wisneski WMA (164 acres)
- Michaelson Farm WMA (276 acres along the Mississippi River)
- Bend in the River Regional Park (289 acres)
- The Minnesota DNR, Division of Waters, Benton County Water Bank

The Mississippi River County Park (209 acres) and the Brockway Waterfowl Production Area (FWS) in Stearns County are southwest of the Refuge and west of the Mississippi River. The Charles A. Lindbergh State Park has two units west and northwest of the Refuge, the Main Unit (436 acres) and North Little Elk Heritage Preserve Unit (93 acres) respectively. With both units are located along the Mississippi River, there is a visitors center, the Lindbergh House and Weyerhaeuser Museum, trails for hiking and skiing, picnic areas, fishing, and canoeing access. Adjacent to the Main Unit of the State Park is the 7.3-acre Pike Creek/ Mississippi Boat Landing, which provides boat access, a parking area, fishing dock, and restrooms. Otter Point WMA (34 acres) and Belle Prairie County Park (138 acres) in Morrison County are west and northwest of the Refuge, respectively. The Belle Prairie County Park offers a variety of recre-

Green-backed Heron, Crane Meadows NWR. Photo Credit: FWS

ational amenities such as hiking trails, a boat landing, parking areas, a picnic shelter, a playground, restrooms, scenic overlooks, and open-site picnic areas.

The southeastern tip of Camp Ripley also falls within the 10-mile radius. Camp Ripley is a military training site occupying 52,758 acres (approximately 82 square miles) in the northwestern extension of Morrison County. The Mississippi River forms its eastern boundary, and the Crow Wing River runs along its northern border. Although the state-owned land is managed by the Department of Military Affairs and serves as a National Guard training site, the site is managed via dual objectives to provide military training and minimize disturbance to the compound's natural resources. The site is a mosaic of upland and bottomland habitats, historical sites, old farmsteads, unrestricted training areas, and restricted access sites. The forests and other vegetative communities are actively monitored and managed, including 16 Forest Inventory and Analysis (FIA) plots located on the compound. There are active wildlife monitoring programs ranging from fisheries surveys to monitoring two gray wolf packs that inhabit the site. There is also an active hunting program. The facility's land conservation mission extends beyond the boundaries in the form of an Army Compatible Use Buffer (ACUB). Using conservation easements and other means, the goal of this zone is to limit development and encroachment within a 3-mile buffer of the site. By 2007, approximately 175 willing landowners had enrolled in the program, representing 25,000 acres of conserved land (Dirks, Diets, & DeJong 2008).

Major conservation landholdings in the broader landscape surrounding Crane Meadows NWR include Sherburne NWR (30,700 acres) to the southeast, Camp Ripley (see above) and the Pillsbury State Forest – Minnesota's first state forest (25,612 acres) to the northwest, and to the west are Mille Lacs Kathio State Park (10,585 acres), Mille Lacs WMA (38,729 acres), and the Rum River State Forest with 33,180 acres in the statutory boundary – 17,164 acres are state-owned and 16,016 are privately owned.

One additional feature of the conservation landscape in the vicinity of the Refuge is a former railroad grade of the Soo Line Railroad that has been converted to a recreation trail. Administered by the county, west of trailhead at Highway 10 the Soo Line Recreational Trail is paved. From April 1 through October 31 of each year the west trail is available to walkers, hikers, cyclists, and in-line skaters, and with adequate snow cover (3-plus inches) from December 1 through March 31 the trail is open to snowmobilers and cross-country skiers. The east portion of the trail, which bisects the Refuge, is considered a multi-mode trail. It's open to walkers, hikers, cyclists, horseback riders, and all-terrain vehicles from April 1 through October 31 each year. The remainder of the year the east trail has the same use as the west section.

The Refuge System is positioned well to play an integral role in the design and implementation of a regional conservation network, the foundation of which is likely to be the existing conservation estate. The growing emphasis on landscape-level issues has demanded a shift in the scale at which environmental problems are approached. To continue providing the ecological services that sustain wildlife and human populations alike, the Service is looking outside Refuge boundaries and engaging in conversations with other members of the conservation community. It is only through collaborative efforts and partnerships – both public and private – that natural resource issues of modern magnitudes and larger geographic scales can be effectively addressed.

Ecological Context

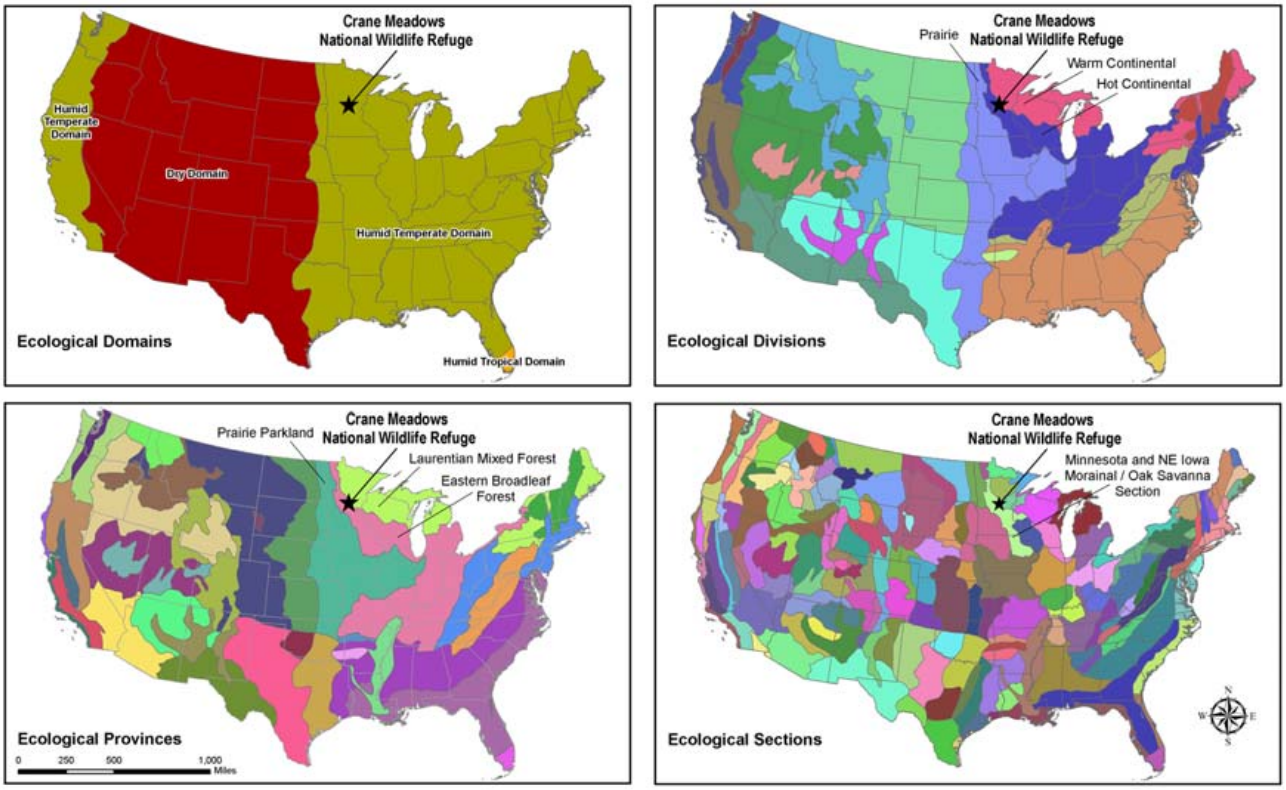
From largest to smallest spatial extent in the National Hierarchy of Ecological Units, which delimits geographic areas of different biological and physical potential, Crane Meadows NWR lies in the Humid Temperate Domain, the Hot Continental Division, Eastern Broadleaf Forest Province, the Minnesota and Northeast Iowa Morainal/Oak Savanna Section, the Anoka Sand Plain Subsection, and the Agram Sand Plain Landtype Association (Bailey 1980, 1995; Cleland, et al. 1997).

The Humid Temperate Domain (see Figure 6 on page 21) encompasses the non-arid mid-latitude land masses from 30 to 60 degrees north latitude. This includes the West Coast of the United States, and most of the eastern half of the country. Polar and tropical air masses interact in these zones creating a diversity of weather conditions, and in general there is a strong seasonality to temperature and precipitation regimes.

The geographic variability of winter frost determines to which division an area belongs, with Crane Meadows NWR in the Hot Continental Division (see Figure 6). This division is characterized by hot summers and cool winters, with a growing season of 3-6 months, varying with latitude. It is also dominated by tall broadleaf trees with canopy cover in the summer and a leafless, dormant winter period (Bailey 1995).

The Eastern Broadleaf Forest (Continental) Province (see Figure 6) marks the transition zone between open grasslands to the west and the mixed forests to the east, covering approximately 270,000

Figure 6: Ecological Context, Crane Meadows NWR

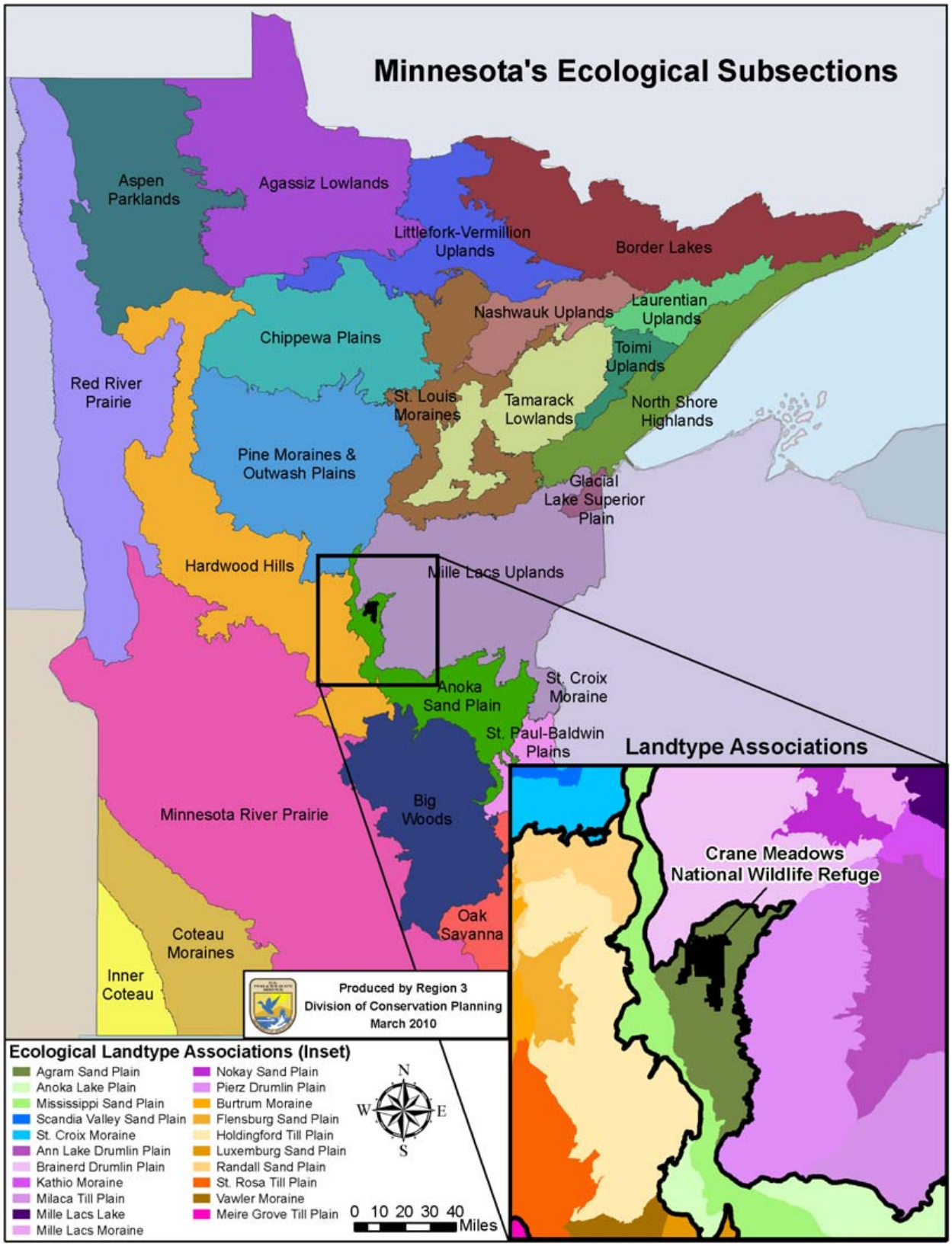


square miles of the nation. This ecotype extends in an arc from Minnesota along the southern edge of the Great Lakes, and reaches as far south as the top of Alabama. It is typified by rolling moderate relief and drought-resistant oak-hickory associations of broadleaf forest with increasing maple-basswood associations in northern ranges. The Minnesota portion of this province encompasses nearly 12 million acres and is characterized by a precipitation that is approximately equal to the rate of evapotranspiration, an annual precipitation range from 24 to 35 inches northwest to southeast, and a normal annual temperature that varies from 38 degrees to 46 degrees Fahrenheit northwest to southeast. This is a species-rich province, and many of the species are at the western edge of their ranges. The Minnesota DNR recognizes 205 Species of Greatest Conservation Need (SGCN) in this province, citing habitat loss and degradation, invasive species, pollution, and interactions with humans as major factors affecting their survival (MN DNR 2005, 2006b & 2009b, Bailey 2009).

The Minnesota and Northeast Iowa Morainal/ Oak Savanna Section (see Figure 6) is a mosaic of morainal, till, and outwash plain areas 30 to 500 feet thick resulting from past glacial activity. In general, poor drainage is associated with the section, leading to an abundance of fluvial systems but relatively few open water and wetland features. However, terminal moraines in the northern reaches near Crane Meadows NWR have led to an abundance of surface waters, wetlands, and undeveloped drainage networks. Fire frequency, duration, and intensity played a major role in the configuration of pre-settlement habitats and forest cover, therefore, the landscape is dominated by prairie, savanna, and oak and aspen woodlands; and patches of forest were able to form along rivers, streams, and lakes. Descriptions of the historic vegetation vary by account, but include bluestem prairie, oak savanna, maple-basswood forest, oak-hickory forest, and floodplain forest. Elevation in the Section ranges from 1,000 to 1,600 feet (MN DNR 2009c, USFS 2009).

The Anoka Sand Plain Subsection (see Figure 7) is nearly 1.2 million acres of broad, flat, sandy lake plain deposited by Gransburg sublobe meltwater from the Des Moines lobe of receding Pleistocene glaciers. Both drought and fire played major roles in shaping the vegetation structure. The vegetation communities consisted of aspen woodlands, oak barrens, prairie and savanna openings, dry prairies,

Figure 7: Minnesota's Ecological Subsections and Landtype Associations



and brushlands on the droughty uplands, with bogs, fens, wet prairies, emergent marshes, shrub swamps, and bottomland forest in low-lying areas. Trees characteristic to this subsection include bur oak, northern pin oak, and jack pine (Kratz and Jensen 1983). Bottomland forest formed along the Mississippi, and upland prairie formed in areas with enough moisture to sustain a diversity of prairie grasses. Ninety-seven Species of Greatest Conservation Need occur in this subsection, 39 of which are threatened, endangered, or of special concern at the federal or state level. This subsection contains some of the best oak savanna habitats in Minnesota, and provides important stopovers for migratory birds (Albert 1995, MN DNR 2006b & 2009a).

Crane Meadows NWR falls completely with the Agram Sand Plain Landtype Association (LTA), one of 291 LTAs in Minnesota defined primarily by their soil complexes and vegetation communities (see Figure 7 inset). The description of the LTA portrays a rolling glacially-formed outwash plain, sandy soils with a coarse loamy surface mantle, and a pre-settlement vegetation mixture of oak savannas, wet prairies, and brush prairies.

Historic Vegetation

Land surveys were conducted by the General Land Office (GLO) between 1848 and 1907 in Minnesota. These records note tree species and diameters, general topography, soil quality, and vegetative cover along a 1-mile by 1-mile grid of section line transects. It is important to note that the Public Land Survey notes were not taken with the intention to objectively document vegetation, but were instead compiled to record land information for the sale of the nation's lands to generate revenue for the federal government (Almendigner 1997). Despite certain biases, these records can be used to gain insights into the pre-settlement landscape and to establish a baseline for historic vegetation conditions.

The survey descriptions for the lands within the Crane Meadows NWR acquisition boundary occur primarily in two townships. The Rice-Skunk wetland complex is in Agram Township, (T40, R31), and the southern extension of the Refuge is in Buckman Township, (T39, R31). Both townships were surveyed in December 1849 and August 1852.

There are countless accounts of entering and exiting marshes, swamps, rivers, streams, and brooks in survey descriptions for Agram Township. The land is described as ranging from level, slightly/gently rolling, to hilly, with widths of brush areas and streams measured in links, with one link equaling 7.92 inches. The bearing trees described consist of only five species. The dominant bearing tree species is bur oak with an average diameter of 8-10 inches, and ranging from 5-24 inches. Black oak and jack pine are also commonly used as reference trees. The black oaks are slightly larger in diameter than the bur oaks, with an average of 10-15 inches, and the jack pines ranged from 8-30 inches with no distinguishable average. All three of these wooded areas were encountered as "oak and pine barrens," "scattering timber," or "occasional oaks" alluding to an oak savanna cover type. Areas of willow-alder brush are also very common in the descriptions. Aspen appear sporadically, and there is only one mention of a 10-inch maple in the entire set of survey notes. Prairie and grass areas are mentioned less often, perhaps due to the limited utility of these areas for survey delineation. There are numerous accounts of "marshes unfit for cultivation" and "mostly uncultivable willow and alder swamps." Interestingly, the Rice-Skunk wetland area has at least two descriptions of wild rice, including, "The lake is full of wild rice," and "The lake is so filled with vegetation and wild rice that it is impassible (US OSG 1852)."

To the south, Buckman Township tends to have slightly less marsh areas and wetlands, more grass, more aspen, and a larger surface area described as oak barrens with slightly smaller tree diameters (5-10 inches) than the northern. There are more descriptions of soil conditions being either poor or great, and even occasional references to marshes being good for hay. Again, bur and black oak, aspen, and jack pine are the dominant bearing trees. A typical description in this township may state something similar to, "The land is broken marshy prairie, some scattering oaks," or "The land is gently rolling, soil great, the timber is scattering oak and pine (US OSG 1852)."

The GLO Public Land Survey Notes in Minnesota were analyzed in 1930 by Francis Joseph Marschner, a geographer with the USDA's Bureau of Agriculture Economics. The survey notes, along with supplementary information such as landforms, were used to classify the state lands by vegetation type, then compiled into maps subsequently digitized by the Minnesota DNR. Consistent with the GLO notes but adding the spatial distribution, the Marschner map for Crane Meadows NWR (see Figure 8) shows two dominant vegetative types: wet prairie and oak openings/barrens. Small areas within the acquisition boundary are also depicted as prairie, brush prairie, or conifer bogs/swamps (Marschner 1930). Approximate GIS acreages for these historic cover types are illustrated in Table 2 on page 25.

In addition to the GLO survey notes describing historic vegetation conditions, information contained in soil surveys can be used to understand the

Figure 8: Presettlement Vegetation Based on the Marschner Map, Crane Meadows NWR

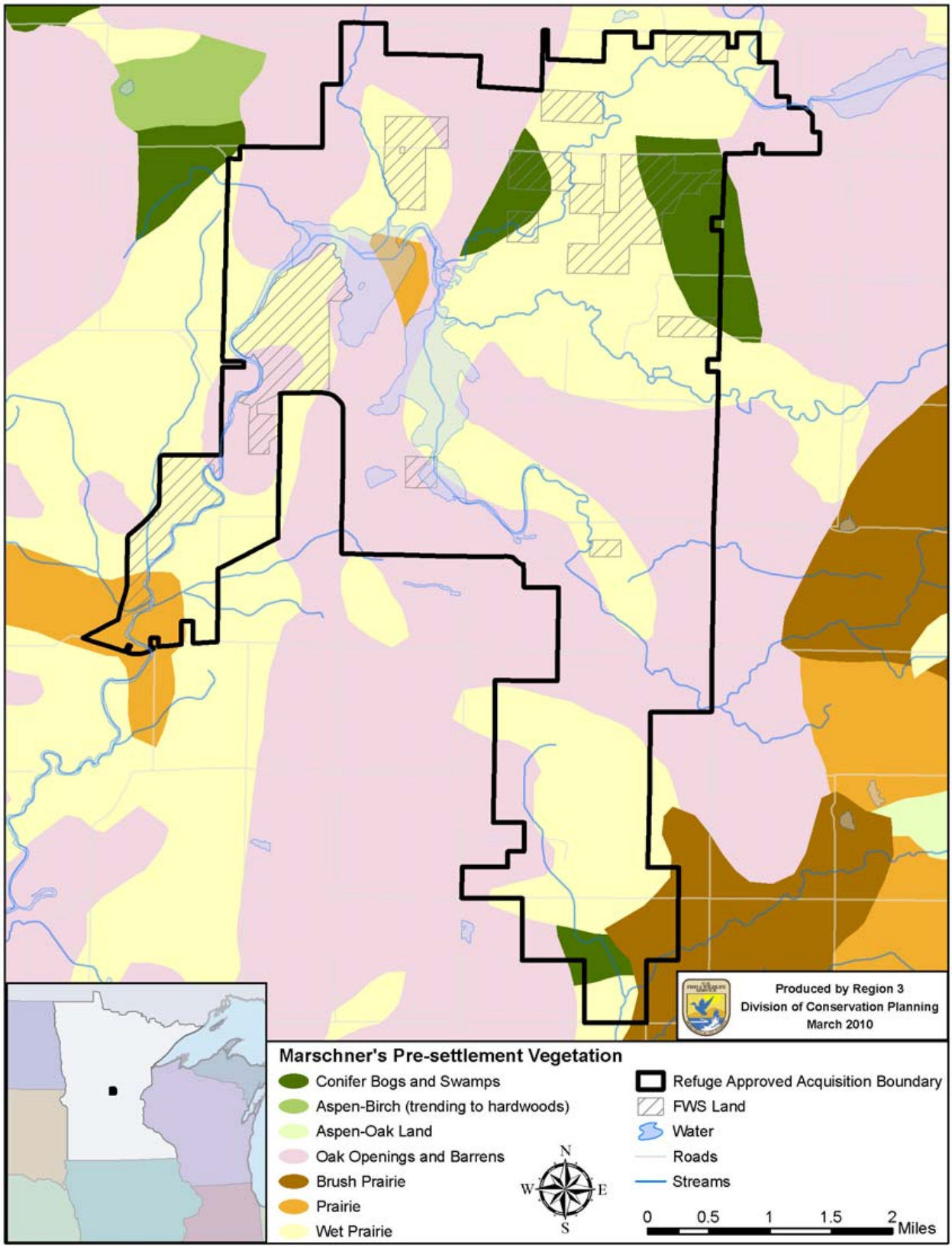


Table 2: Marschner's Pre-settlement Vegetation

General Vegetation Type	*GIS Acres*[a]	
	Acquisition Boundary	Service-owned land
Conifer Bogs and Swamps	803.2	203.5
Oak openings and barrens	5871.5	242.5
Brush Prairie	197.1	0.0
Prairie	3,48.2	40.1
Wet Prairie	6,630.0	1,269.6
Total Calculated GIS Acres	13,850.0	1,755.7

a. All acreages are approximate GIS acres

vegetative capacity of a landscape. The soils in a given locality are a result of the parent rock material, organisms, climate, and relief as they interact over time. These factors, and the resulting soils, limit which vegetation communities can take hold in a geographic locale. Soil survey data collected over the past century by the USDA's Natural Resource Conservation Service includes written descriptions of native vegetation, which can be linked to the primary soil unit and mapped. Figure 9 on page 26 uses data from the Soil Survey Geographic (SSURGO) Database to display the potential natural vegetation at Crane Meadows NWR. Using the information from this database, wetland areas and open water constitute nearly half of the area in the acquisition boundary (6,332 acres), another quarter (3,679 acres) is in upland forest, and the remainder is either upland forest with prairie openings / oak savanna (1,836 acres), bottomland forest with wetland openings (1,717 acres), or simply bottomland forest (245 acres). All acreages (see Table 3 on page 27) are approximations based on USGS NRCS GIS data (USDA 2009).

Current Land Use / Land Cover

According to work done by the University of Minnesota and the Minnesota Pollution Control Agency, Morrison County's 1,124 square miles are less than 6 percent developed, and agriculture is the dominant land use comprising approximately 37 percent of the county. Additionally, over a quarter of the county is forested (29 percent) and another quarter is some form of grass/shrub/wetland (26 percent) cover type. Open water comprises just over 2 percent of the County (University of Minnesota 2007).

The 21-class land cover dataset developed by the Multi-Resolution Land Characteristics Consortium using 2001 Landsat imagery[1] can be used to understand the geographic distribution of land use in the area around the Refuge (USGS 2003). Using a 10-mile buffer, 67.7 percent of the land use surrounding the Refuge is row crops or pasture, forests make up another 14 percent, herbaceous wetlands 7 percent, grasslands another 3 percent, and open water is just under 2 percent. Developed or urban areas comprise just over 5 percent of the 10-mile peripheral zone, including the towns of Little Falls, Pierz, Royalton, and Rice, parts of the Camp Ripley National Guard Training Center, and major roadways. Figure 10 on page 28 and Table 4 on page 29 portray and summarize these data.

The land use proportions change in an analysis of the land only within Crane Meadows NWR's acquisition boundary. Agriculture is still a major component at approximately 33 percent, but is surpassed as the largest cover type by herbaceous wetlands (36 percent). Roads become the only distinguishable developed areas, and natural cover types increase slightly in proportion; forest is over 18 percent, and open water and grassland are around 5 percent each (see Figure 11 on page 30 and Table 4 on page 29).

Migratory Bird Conservation Initiatives

North American bird conservation efforts have evolved in recent decades from predominantly localized efforts to landscape-level initiatives with separate planning emphases on guilds of birds and a greater emphasis on collaborative management. With more than 700 species of birds in the United States, Crane Meadows NWR hosts a diversity of waterfowl, waterbirds, shorebirds, and land birds. The Refuge's position in the Mississippi Flyway (see

1. *This medium resolution data is based on a classification of 30-meter Landsat imagery from 2001. The land surface is generalized to some extent in assigning pixel values, and land uses may have changed since the data was created.*

Figure 9: Soil Survey Vegetation Data, Crane Meadows NWR

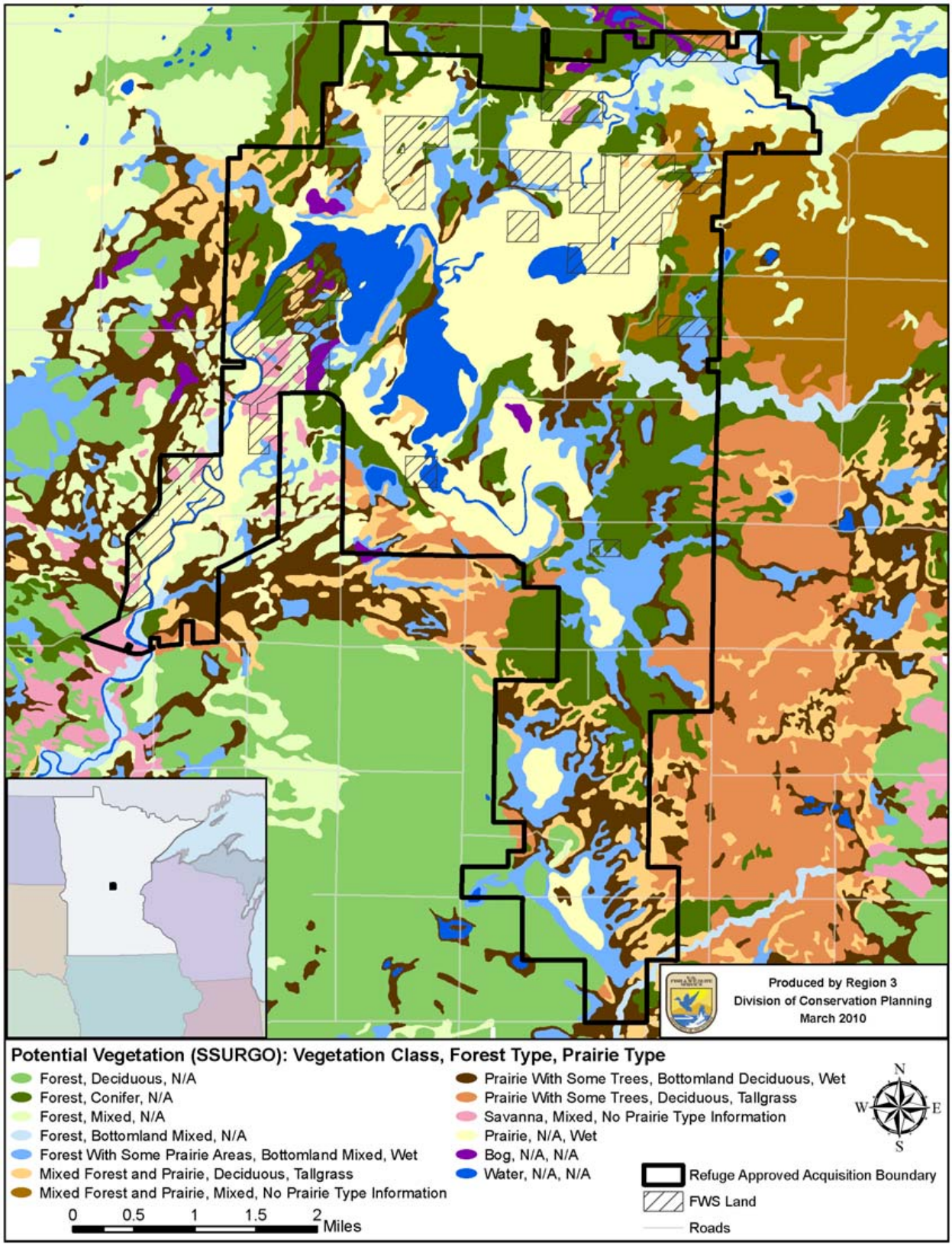


Table 3: Potential Vegetation Derived from Soil Survey (SSURGO) Information

Landscape Position	Cover Type Classification	Forest Type	Prairie Type	GIS Acres[a]	
				Acquisition Boundary	Service-owned Land
Upland	Forest	Deciduous	-	316.9	2.3
Upland	Forest	Conifer	-	2,601.9	197.5
Upland	Forest	Mixed	-	759.9	173.8
Upland	Savanna	Mixed	No Prairie Type Info	179.4	110.6
Upland	Mixed Forest and Prairie	Deciduous	Tallgrass	827.3	60.8
Upland	Mixed Forest and Prairie	Mixed	No Prairie Type Info	352.1	37.0
Upland	Prairie With Some Trees	Deciduous	Tallgrass	476.7	19.9
Bottomland	Forest	Bottomland Mixed	-	245.0	20.0
Bottomland	Forest With Some Prairie Areas	Bottomland Mixed	Wet	1717.4	89.1
Bottomland	Prairie With Some Trees	Bottomland Deciduous	Wet	1,461.6	129.4
Bottomland	Prairie	-	Wet	3,864.1	797.8
Bottomland	Bog	-	-	118.3	52.2
Bottomland	Water	-	-	887.6	62.8
Total Calculated GIS Acres				13,808.2	1,753.2

a. All acreages are approximate GIS acres

Figure 12 on page 31) makes this wetland complex an important stopover as birds travel from their breeding grounds in the North to their wintering areas in the South.

North American Waterfowl Management Plan

Waterfowl (family Anatidae, including ducks, geese, and swans) are economically important for both hunting and wildlife observation activities, can be used as indicators of environmental health, and are an important part of wetland ecosystems. Habitat loss resulting from agriculture, urbanization, and industrial activities has caused their numbers to decline in recent decades.

The North American Waterfowl Management Plan (FWS 1986 - updated in 1994, 1998, and 2004) is a 15-year plan that sets up a framework for cooperative planning and coordinated management between the United States and Canada to increase populations to acceptable and desired levels. It describes appropriate waterfowl population goals, and also provides recommended actions for reaching the population levels. One major result of the plan was the establishment of joint ventures between private and government organizations within geographic regions to coordinate waterfowl research and management activities. These joint ventures assist in integrating continental migratory bird priorities into regional, state, and local level conservation programs. Constituents include individuals, businesses, nongovernmental organizations, and local, state and federal government representatives.

Crane Meadows NWR lies within the Upper Mississippi/Great Lakes Joint Venture (UM/GL JV) region, yet it is only 10 miles from the border with the Prairie Pothole region (see Figure 12 on page 31). The UM/GL JV was formed in 1993 and has protected, restored, and enhanced more than 522,000 acres of habitat. Habitat conservation strategy handbooks for each bird-group – shorebirds, landbirds, waterbirds, and waterfowl – along with an overarching implementation plan were released in 2007 to provide guidelines for the habitat types and quantities required to sustain target bird populations. These new plans use the latest geospatial analysis tools along with the most current scientific

Figure 10: Land Cover Within a 10-mile Radius of Crane Meadows NWR

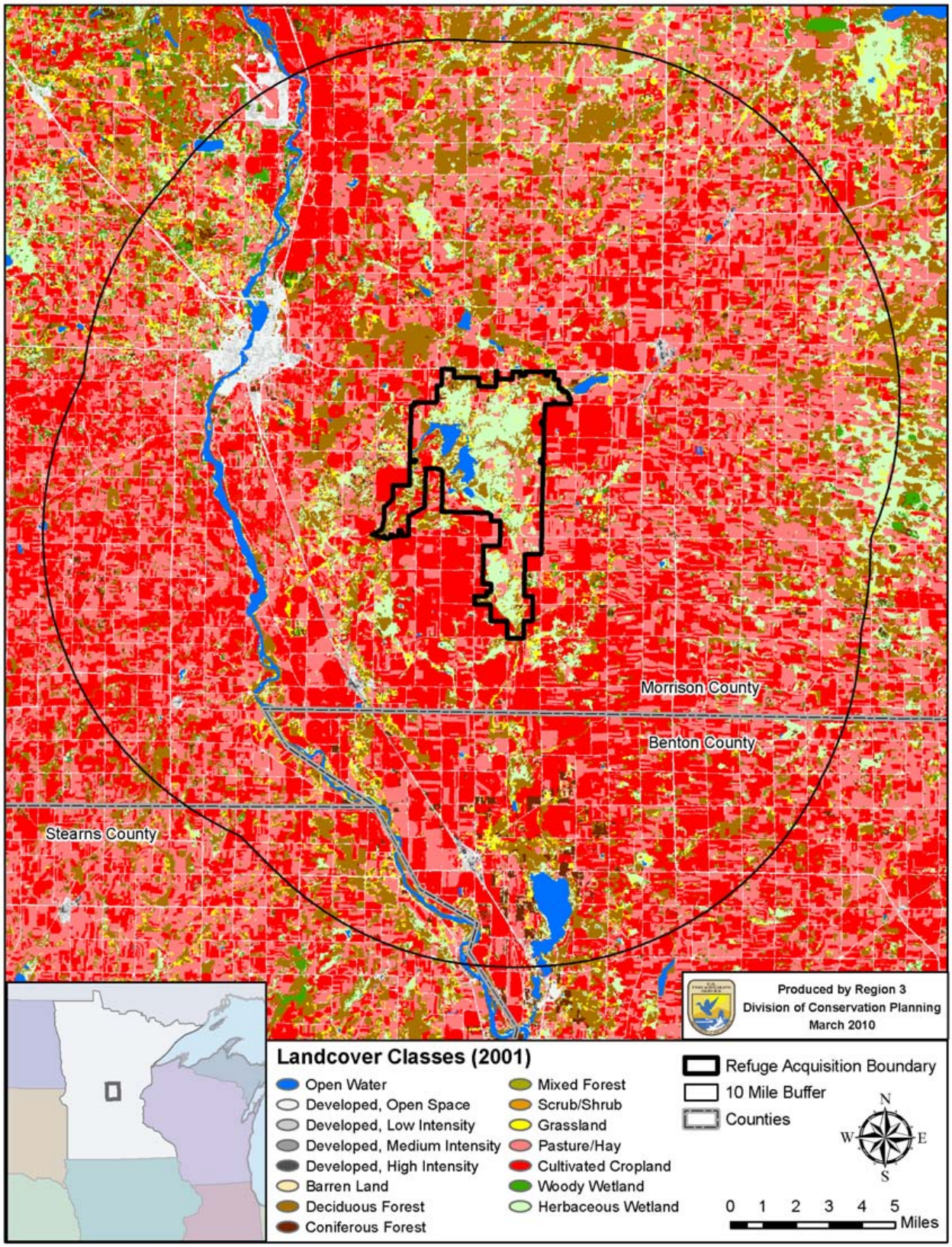


Table 4: Land Cover Types in the Vicinity of Crane Meadows NWR

Cover Type	Percent	
	10 Miles	Acquisition Boundary
Open Water	1.7	5.1
Developed, Open Space	4.7	1.7
Developed, Low Intensity	0.5	-
Developed, Medium Intensity	0.1	-
Developed, High Intensity	-	-
Barren Land	- -	-
Deciduous Forest	12.8	17.6
Coniferous Forest	1.3	0.9
Mixed Forest	-	-
Scrub/Shrub	0.2	0.1
Grassland	2.8	4.5
Pasture/Hay	32.1	19.2
Cultivated Cropland	35.6	14.2
Woody Wetland	0.9	0.5
Herbaceous Wetland	7.2	36.2

knowledge in their biological planning, regional landscape design, and strategies for projects, monitoring, research, communication, and outreach.

Established in 1987, the Prairie Pothole Joint Venture includes one-third of North America's Prairie Pothole Region contained within the United States (approximately 100,000 square miles). This landscape of depressional wetlands and grasslands combined with the Prairie Pothole Region in Canada constitute one of the largest and most productive concentrations of wetland habitat in the world. Native birds include 18 species of waterfowl, 96 species of songbirds, 36 species of waterbirds, 17 species of raptors, and five species of upland game birds. Due to productive soils and abundant water, much of the Prairie Pothole region has been drained and used for agriculture or grazing. The Joint Venture works to counter this trend by saving or restoring high priority wetland areas and adjacent native prairie and grassland habitat throughout the region. Their 2005 Implementation Plan calls for the protection of 1.4 million additional wetland acres and 10.4 million acres of grassland (Ringelman 2005).

North American Land Bird Conservation Plan

In contrast to the other three bird plans referenced here, the target species of the North American Land Bird Conservation Plan (Partners in Flight 2004) focuses on birds that inhabit predominantly terrestrial habitats.

Approximately 448 landbirds breed in the U.S. and Canada, and as international resources this plan is drawn at a continental scale. Landbirds contribute to the economy in a number of ways. First and foremost they provide ecosystem services including pollination, seed dispersal, and the consumption of insect pests. They also provide recreation opportunities such as wildlife observation and photography. The loss, modification, degradation, and fragmentation of habitat constitute the primary threat for landbirds, including neotropical migrants, short-distance migrants, and largely resident species. This plan identifies 192 species of continental importance. Approximately half (100) of these species are on a 'Watch List' because of a threatened/endangered population status. The remaining 92, as well as 66 species from the Watch List, are considered 'Stewardship Species' because they characterize and typify biogeographic regions of North America (See Figure 12 on page 31). These regions are based on Bird Conservation Regions (BCRs) devised by

Figure 11: Land Cover Within Crane Meadows NWR

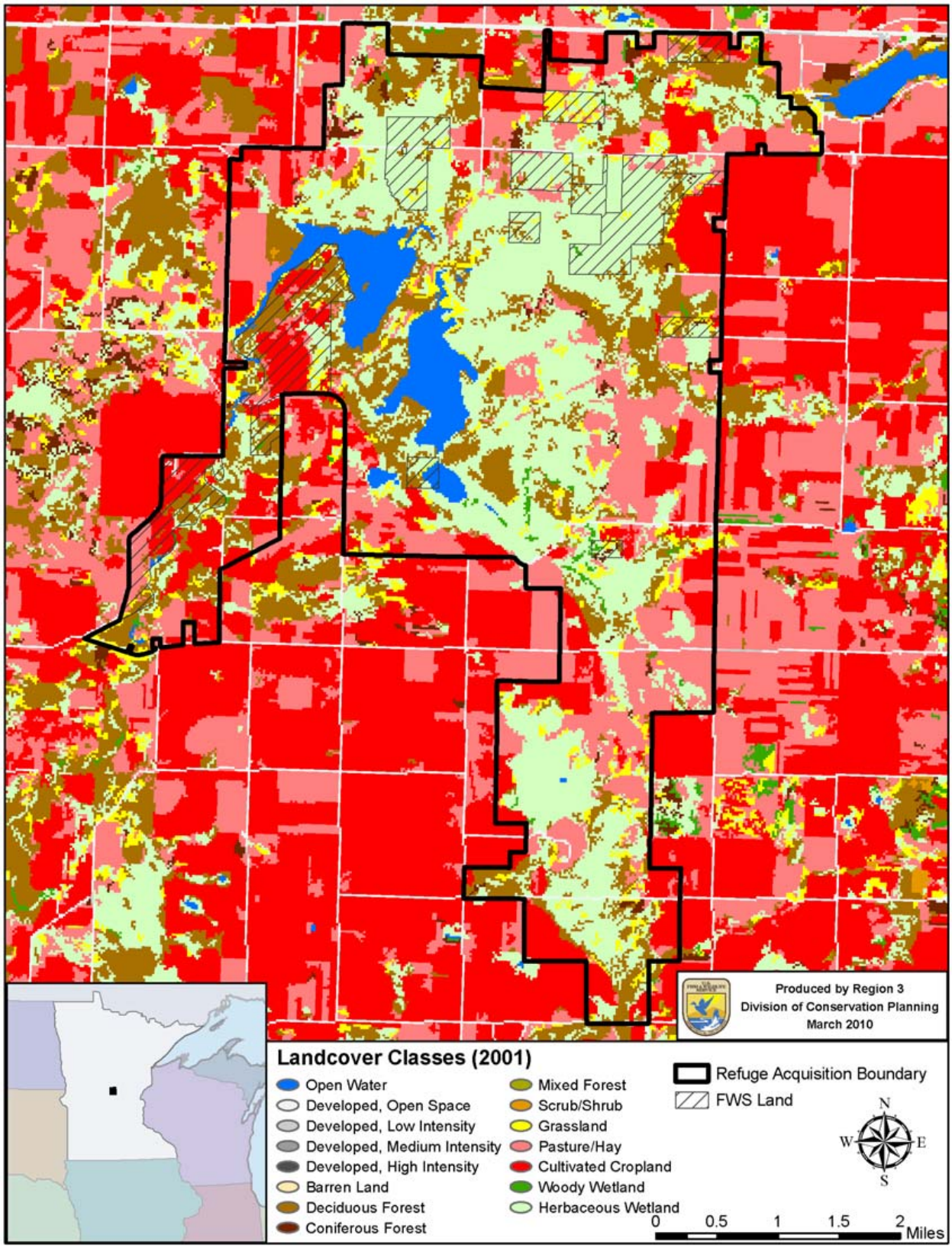


Figure 12: Ecological Regions Related to Crane Meadows NWR

the North American Bird Conservation Initiative (NABCI), but have been merged into larger biogeographic units shown in Figure 12 (Rich et al. 2004).

Second only to portions of the western U.S., the next highest diversity of breeding landbirds occurs in the transition zone between the eastern deciduous and northern boreal forest. Crane Meadows NWR lies in this transition zone and is classified as just inside the Prairie Avifaunal Biome. This area forms the heart of North America's grasslands, with tallgrass prairie and oak-savanna on the eastern edge where Crane Meadows NWR is located. Just over 99 percent of the original tallgrass prairie has been lost to agriculture and urban development. The second characteristic of this region is the glacial depressions forming diverse wetland complexes and large river systems. This biome provides the wintering habitat for many Arctic species of landbirds, and nearly 40 percent of the species on the 'Watch List' used to identify species with multiple reasons for conservation concern across their entire range breed here.

U.S. Shorebird Conservation Plan (2001)

The U.S. Shorebird Conservation Plan (2001) was drafted by a national partnership of national, state, private, and academic organizations committed to shorebird conservation. The designation 'shorebird' is applied to those birds commonly known as sandpipers, plovers, oystercatchers, avocets, and stilts. Of the 214 shorebirds worldwide, 50 regularly breed or occur in the United States.

The challenges of shorebird conservation stems from their great migration distances crossing multiple jurisdictions, low rates of reproduction, concentrated use of dispersed migration stopovers, a general loss of their habitat across the landscape, and a lack of shorebird population data. This plan groups the Bird Conservation Regions to create 11 shorebird planning regions. Within each, a regional working group sets conservation goals, identifies critical habitats, assesses research needs, and recommends strategies for outreach and education. Founded on collaboration and cooperation between partners, the goal of the plan is to stabilize populations of shorebird species by protecting adequate quantities of wetland, shoreline, and grassland habitat to meet their breeding, wintering, and migrating needs (Brown et al. 2001.)

Crane Meadows NWR lies within the Upper Mississippi Valley/Great Lakes (UMVGL) shorebird planning region (see Figure 12 on page 31). This region contains five BCRs and 32 shorebird species, nine of which are of high conservation priority: Greater Yellowlegs, Whimbrel, Buff-breasted Sandpiper, Short-billed Dowitcher, Marbled Godwit, Wilson's Phalarope, Upland Sandpiper, American Woodcock, and the Piping Plover. This region is noted for its climatic variability, and its primary habitat threats result from agriculture, river manipulation, and urban development. Objectives for meeting shorebird needs in this region include the protection of 9.6 million acres of ephemeral and permanent wetlands with associated upland habitats.

North American Waterbird Conservation Plan (2002)

The North American Waterbird Conservation Plan (2002) was created through voluntary, collaborative efforts of many individuals and organizations interested in the future of seabirds and other colonial nesting birds. In response to threats like habitat loss, invasive and exotic species introductions, pollution, industrial activity, and site disturbance, the activities proposed by the plan range from continent-wide monitoring to local conservation actions that promote the distribution, diversity, and abundance of waterbirds. The plan covers 210 species, including seabirds, coastal waterbirds, wading birds, and marshbirds. Of the freshwater habitats noted in the plan, nearly all are found at Crane Meadows NWR. These habitats provide for the nesting, feeding, roosting, and resting needs of waterbird species. Through inventory and monitoring this plan is able to help identify the most threatened birds and the most critical habitats (Kushlan et al. 2002).

Crane Meadows NWR falls within the Upper Mississippi Valley/Great Lakes (UMVGL) waterbird planning region (See Figure 12 on page 31). Though the other regions differ between the waterbird and shorebird plans, the UMVGL region for waterbirds follows the same geographical boundary as the UMVGL for shorebirds. The region contains approximately 40 species of waterbirds, among them are priority species of terns, herons, bitterns, rails, and loons. Also, superabundant species are present including Double-crested Cormorants and Ring-billed Gulls. Freshwater habitats at Crane Meadows NWR that are used by waterbirds include wetlands, lakes, shorelines, rivers, floodplains, and small islands. Because of the Refuge's proximity to the Mississippi River, it serves as an important stopover for migratory waterbirds within the Mississippi Flyway.

Region 3 Fish and Wildlife Conservation Priorities

Every species and habitat is important, however there is a subset that requires immediate attention and efforts for their conservation, protection, and/or recovery. At the federal level, conservation priority is directed first toward migratory birds, interjurisdictional fish, and those species that are nationally threatened or endangered with extinction.

In accordance with the Government Performance and Results Act (GPRA) the Service must direct ample resources towards its most important functions and responsibilities. In 1997 a group of employees and subject specialists in the Midwest Region (Region 3) of the Service gathered together to create a list of Fish and Wildlife Resource Conservation Priorities. The report, published in January of 2002, identifies 243 species in the region as resource conservation priorities, along with habitat indicators, obstacles, strategies, and desired outcomes (FWS 2002). The report emphasizes species as conservation targets over habitats for three primary reasons:

- Species are the primary element of biological diversity; irreplaceable if extirpated.
- Identifying species implies maintaining specific habitats in a way that meets the life cycle requirements of the target species.

- By assessing multiple species within a single landscape, locations can be identified where elements overlap and the most essential habitats occur.

In the report, Crane Meadows NWR falls within what is identified as the Mississippi Headwaters/ Tallgrass Prairie ecosystem. Appendix D gives a complete list of the Resource Conservation Priority species found at Crane Meadows NWR.

Minnesota Comprehensive Wildlife Strategy

In 2005, Minnesota completed the Minnesota Comprehensive Wildlife Strategy (CWCS) (2006a), a 10-year strategic plan for managing Minnesota's populations of rare, declining, or vulnerable animals, or "species in greatest conservation need (SGCN)." The plan, developed with the support of funding from the State Wildlife Grant Program created by Congress in 2001, assesses nearly 1,200 animal species and identifies 292 species in need of conservation. This strategic plan is the result of a partnership of conservation organizations across Minnesota dedicated to sustaining viable wildlife populations and the habitats that sustain them. Headed by the Minnesota Department of Natural Resources, the partnership also includes the U.S. Fish and Wildlife Service, The Nature Conservancy, Audubon Minnesota, the University of Minnesota, and over 100 other agencies and conservation organizations.

The 10-year plan is designed to provide information on the distribution and abundance of species, describe key habitats, identify threats, prioritize research and monitoring needs, outline and prioritize conservation actions, facilitate coordination with other wildlife conservation and land management agencies and organizations, and engage the public in the process. The plan adheres to a wildlife conservation approach which first protects the key habitats used by species in greatest conservation need, thereby also providing habitat for the majority of Minnesota's wildlife. Consideration is then given to individual, species-specific needs and requirements that are not met by more general approaches to wildlife conservation.

Based on climate, geology, topography, soils, hydrology, and vegetation, Minnesota's Ecological Classification System delineates four ecological provinces, 13 sections, and 25 subsections (see Figure 6 on page 21 and Figure 7 on page 22). At the province level, the Eastern Broadleaf Forest Province in which Crane Meadows NWR is located contains both the largest number of SGCN (205) and the greatest number of species (51) unique to any single province.

However, the primary organizational units used in the CWCS are the 25 ecological subsections in Minnesota. Crane Meadows NWR is located in the Anoka Sand Plan subsection, which contains 97 SGCN, and one species that is unique to the subsection. Thirty-nine of these species are endangered, threatened, or of special concern at the federal or state level. Highlighted species in the area include Sandhill Cranes, Trumpeter Swans, Bald Eagles, Bobolinks, Lark Sparrows, badgers, Blanding's turtles, and gopher snakes. Out of 14 generalized habitat types identified for Minnesota's SGCN, the Anoka Sand Plain subsection contains seven. The habitat types used most by the SGCN are prairies, rivers, and wetlands, all of which are found at Crane Meadows NWR. Some of the best examples of dry oak savanna in Minnesota also occur in this subsection. Landcover summarized within the subsection finds over 50 percent of the subsection in agriculture and pasture, another 12 percent developed, approximately 5 percent as water, which leaves just under 30 percent in forest or wetland/open cover types (MN DNR 2006b and 2009a).

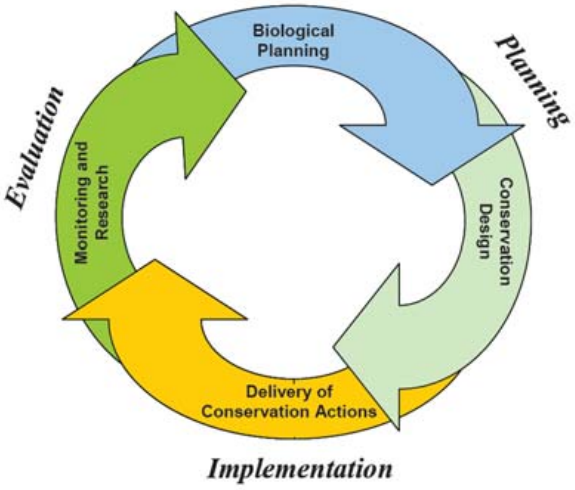
The information and strategies of the CWCS were used as a means to assist with development of Refuge objectives in the CCP. The townships that contain Crane Meadows NWR have been identified as having a high abundance of species of greatest conservation need within the Anoka Sand Plain subsections, which suggests that the Refuge plays an important role in the state's conservation partnership. Appendix C of Minnesota's CWCS contains a summary of other conservation plans and efforts for each subsection (MN DNR 2006b).

Strategic Habitat Conservation

Recognizing numerous advancements made in the fields of conservation, ecology, adaptive management, and technology, a panel of policy and technology experts from the Fish and Wildlife Service, U. S. Geologic Survey (USGS), and the National Conservation Training Center (NCTC) formed the National Ecological Assessment Team (NEAT) in June of 2004. The goals of this team were to discuss and make recommendations to the FWS on its approach to trust resource conservation, with efficiency, prioritization, and transparency as key drivers. The outcome of these meetings was the Strategic Habitat Conservation (SHC) framework, which is an iterative cycle of: 1) biological planning, 2) conservation design, 3) conservation delivery, and 4) monitoring and research (see Figure 13 on page 34 – from FWS 2006).

The principles of SHC are not new to Service programs and projects, but the NEAT report formally establishes SHC as the new 'business model' or

Figure 13: Diagram of the Strategic Habitat Conservation Framework



operating platform for the Service in light of the 21st century's changing conservation landscape. Trends in the new millennium addressed by SHC include a focus on conservation science that is increasingly collaborative and interdisciplinary, spans multiple jurisdictions, uses a range of scales, and intertwines ecology with socio-economic considerations. In addition, the face of the conservation workforce is changing, expectations from the public are increasing, and the complexity of environmental issues is intensifying. Whereas the previous era sought balance in the conservation and utilization of natural resources, the upcoming era has forced a recognition of limits to our environmental systems and the challenge of sustaining resources despite increasing pressures from threats such as urban development, energy consumption, water use, and climate change (FWS 2008a).

Stratetic Habitat Conservation emphasizes a landscape-scale consideration of resources and the importance of understanding and integrating the goals of collaborative partners as key ways to effectively achieve conservation objectives. This will require management support for work that not only spans program areas within the Service, but support that extends beyond our agency to the interests and programs of our conservation partners. The Service has been encouraged to take immediate steps in implementing the SHC framework. These steps involve setting measurable, outcome-based objectives to guide visible progress towards conservation goals, using spatially-explicit models to provide the means for systematic identification of conservation targets, and increasing the integration of science into planning and management decisions DOI 2006).

The work outlined in this CCP for Crane Meadows NWR adheres to the SHC framework by conducting a thorough review of science relevant to management at the Refuge, feeding that information and issues identified during scoping directly into near- and long-term goals and objectives, and defining strategies to guide conservation delivery through the 15-year life of the plan and beyond.

Landscape Conservation Cooperatives

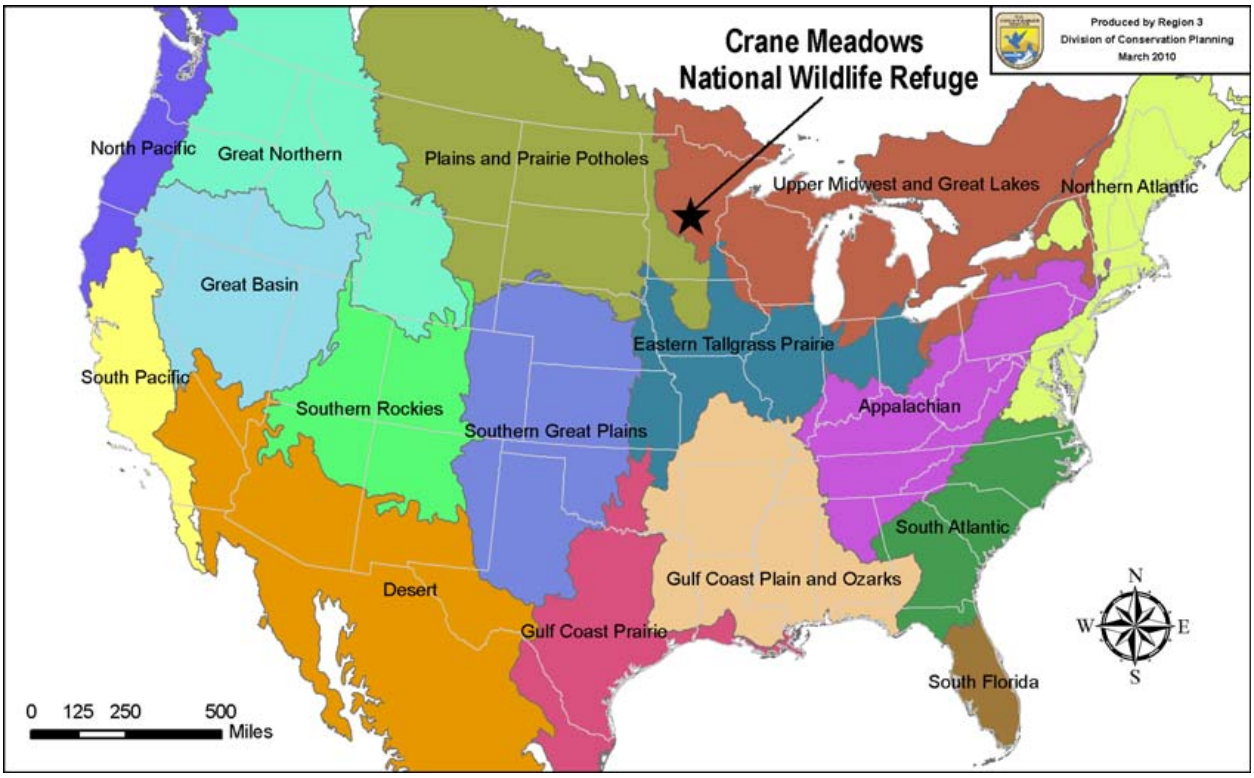
In 2009, with SHC as the guiding philosophy, the Service established a national 'geographic framework,' or a continental platform on which to establish landscape-level conservation partnerships and implement conservation actions in the 21st century. The framework establishes boundaries for 22 geographic areas, each to serve as a base for the establishment of a Landscape Conservation Cooperative (LCC). LCCs will provide a spatial context and an organizational structure for facilitating conservation planning, shared science, information exchange, and decision support in response to broad-scale, complex, and dynamic issues such as climate change.

Crane Meadows NWR falls within the Upper Midwest and Great Lakes LCC geographic area (see Figure 14 on page 35). This LCC formed near the end of 2009 to provide science support and engage partners in the Great Lakes region. The Great Lakes are the largest system of fresh, surface water in the world, and contains 5,472 cubic miles of water. The region has a diversity of habitats including deepwater zones, beaches, coastal wetlands, more than 35,000 islands, major river systems, boreal forests, and prairie-hardwood transition zones - the latter of which includes Crane Meadows NWR. Work has begun to assess driving issues, set conservation priorities in the form of species and habitats, and undertake research needed to fill gaps in our scientific understanding of the region.

Conservation Corridors and Green Infrastructure

Increasing urbanization and widespread land use changes are greatly affecting natural landscapes and healthy ecological systems by fragmenting and degrading habitats (Ahern 1995). In addition, the effects of global climate change have severe implications for natural systems and ecological balances. Strategically conserving lands to protect habitat, wildlife, and ecosystem services is an attempt to reduce and mitigate human impacts on the landscape. Traditional approaches to land conservation

Figure 14: U.S. Fish and Wildlife Service Landscape Conservation Cooperatives



are often opportunistic, piecemeal, site specific, and narrowly focused. However, an increasing emphasis is being given to collaborative landscape conservation efforts that are proactive, strategic, comprehensive, and integrative. Regional analyses that consider larger geographic extents are helping to focus conservation efforts among a growing consortium of stakeholders and partners. Creating a network of ecological hubs and linkage corridors can increase the connectivity, resiliency, and effectiveness of the biological systems that preserve biodiversity and essential ecological services.

Green Infrastructure is one planning framework for strategic, landscape-level conservation design. This framework emphasizes the need to integrate ecologic, social, and economic considerations in the design of truly sustainable landscapes. A green infrastructure case study (Bowman, 2008) was conducted using basic GIS models to understand the opportunities and challenges of establishing conservation networks between Sherburne NWR and Crane Meadows NWR. Two overlay models incorporating a diversity of information and decision factors were developed to assess the biophysical and social suitability for green infrastructure in the five-county area between and surrounding these Refuges. The results are displayed in Figure 15 on page 36 and Figure 16 on page 37. Areas in green identify regions with the greatest ecological integrity in the biophysical suitability model (Figure 15) and highest potential social support in the social suitability model (Figure 16) for future land conservation, with a gradation to red indicating lesser degrees of suitability.

The biophysical suitability model incorporates GIS layers such as land cover; sensitive species; native plant communities and areas of biodiversity significance; wetlands, lakes, rivers and streams, floodways, watersheds, and major drainages; and roads, railroads, and municipalities. The results show strong support for connectivity between the Refuges, between Crane Meadows NWR and state landholdings to the east, and to areas across the Mississippi River directly southwest of Crane Meadows NWR. The red silhouettes of municipalities and transportation corridors are distinguishable as less suitable areas and potential barriers to a land conservation network.

The second model (Figure 16) assesses social implications for conservation corridors using marketing indices and past conservation activities summarized by zip code and township respectively. Though sets of social data are less common and more difficult to acquire, this type of assessment

Figure 15: Biophysical Suitability Model Results for Green Infrastructure

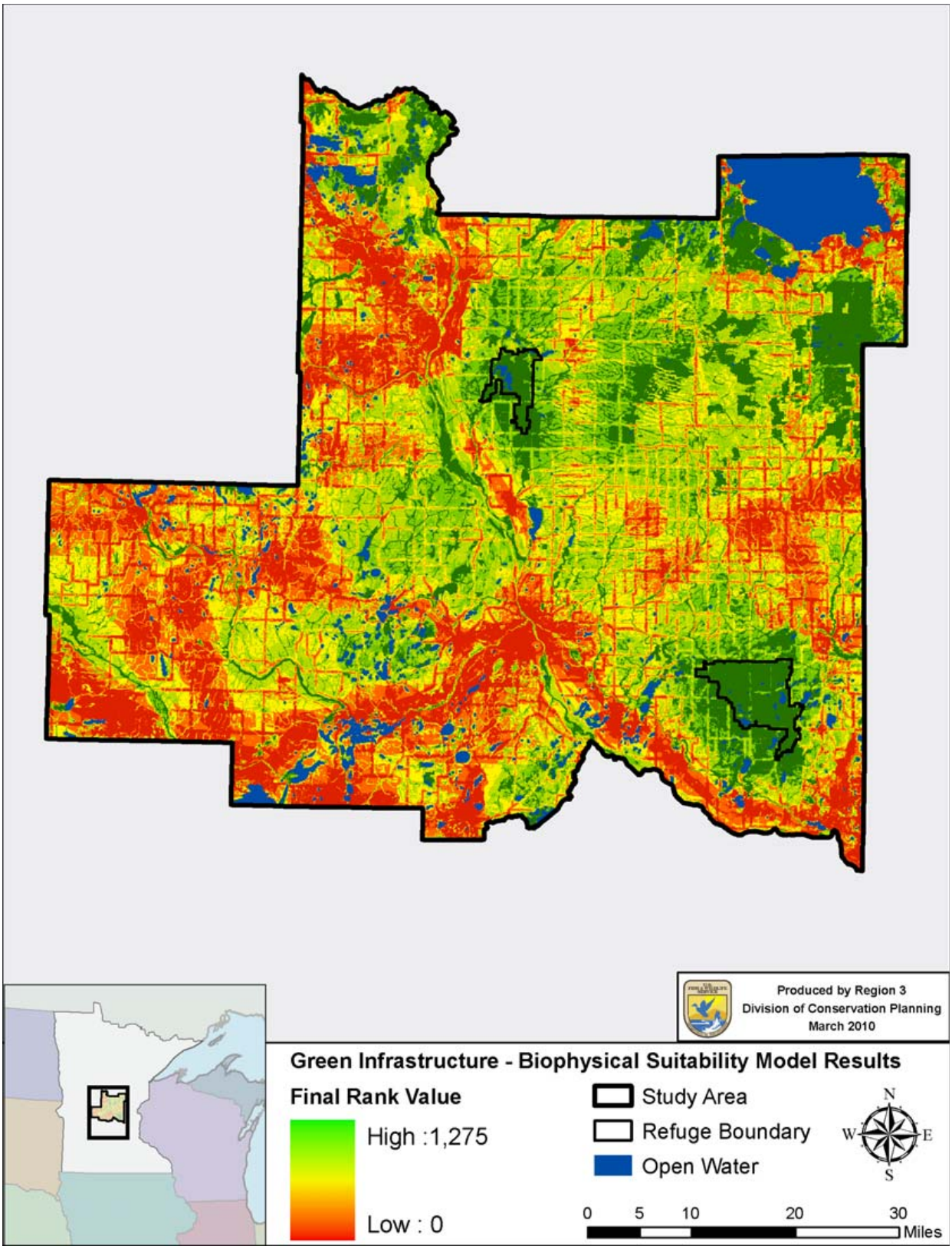
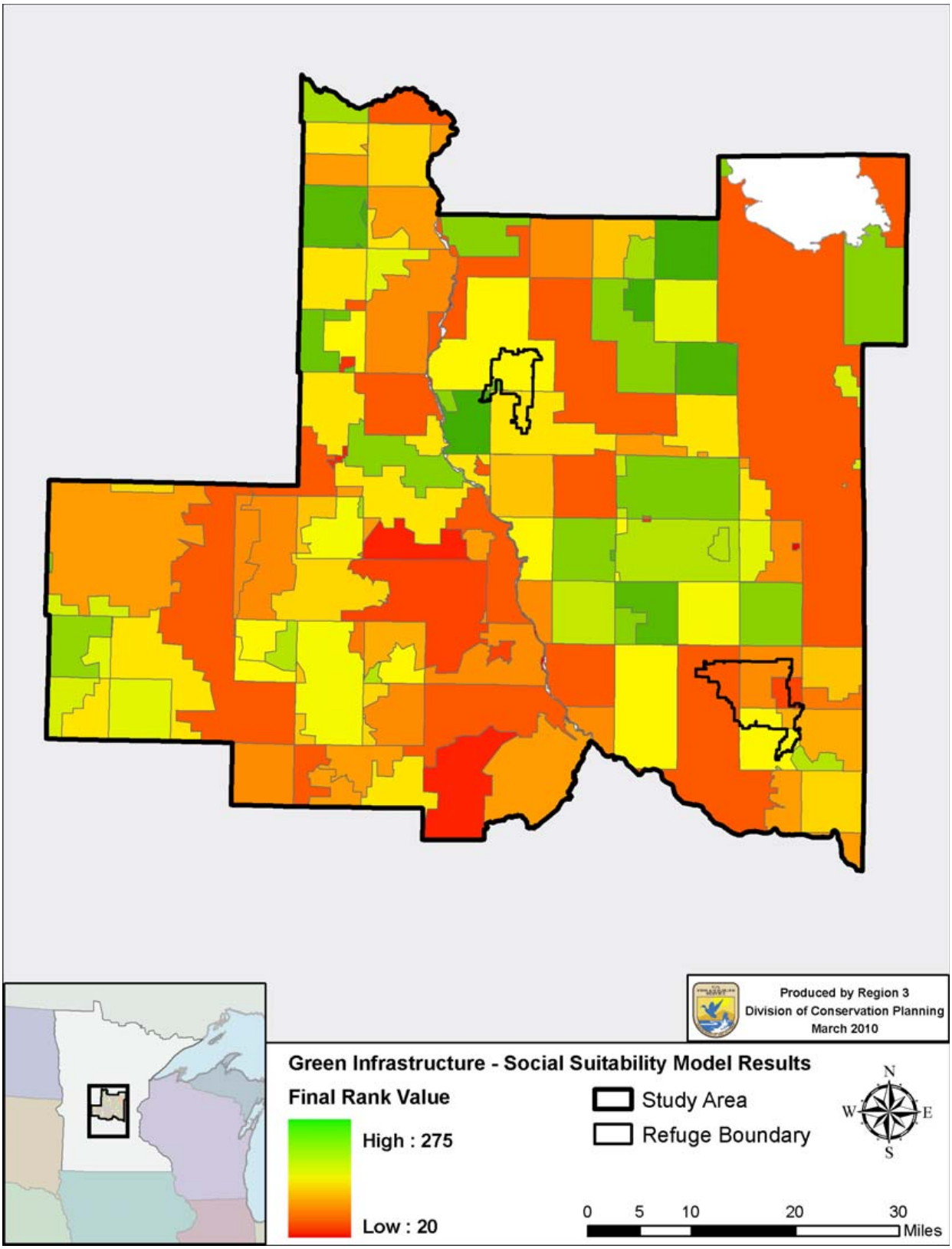


Figure 16: Social Suitabililty Model Results for Green Infrastructure



may help identify areas and populations that favor and support the development of a network of conservation lands. Again, this data indicates stronger support between the Refuges, as well as in pockets east and southwest of Crane Meadows NWR.

Comparing these maps to the current lands with some form of conservation value (see Figure 17 on page 39) provides a measure of progress towards the network concept. A number of ecological hubs exist, and many small parcels are in potential corridor zones. This and other models and design criteria can be used to direct strategic conservation in the form of acquisitions, easements, and partnerships to fill gaps in the current conservation system.

A similar analysis could also be used to assess potential corridors and connectivity between Crane Meadows NWR and Rice Lake NWR 50 miles to the northeast. Multiple corridor pathways may be possible due to the course of the Mississippi River west the Refuges, the presence of Lake Mille Lacs directly between the two, and the large quantity of protected lands north and east of Crane Meadows - south and west of Rice Lake (see Figure 5 on page 18).

Socioeconomic Setting

Crane Meadows NWR's entire acquisition area falls within Morrison County, Minnesota, whose population accounts for only 0.6 percent of the state population of over 5 million people. Compared to state averages, the county's population is growing more slowly, is less ethnically diverse, has a lower maximum education status, greater home ownership rate, a higher number of people per household, a greater number of persons below the poverty level, and is less densely populated (U.S. Census Bureau 2009).

Population, Demographics, and Housing

The last decennial census was conducted in the year 2000. According to this data, Crane Meadows NWR's acquisition boundary acreage (13,540) is approximately 1.9 percent of the total landmass in Morrison County (1,124.5 square miles). The county's 2000 population was 31,712, indicating a 6.6 percent increase over the 1990 population of 29,604, and a 27.8 percent increase over the 1900 population of 22,891. A 2008 estimate places the population at 32,893 people. Larger communities, from greatest population to least, include Little Falls (county seat), Pierz, Royalton, and Randall, and the county averages 28.2 people per square mile (U.S. Census Bureau 2009).

A study by the Minnesota State Demographic Center used the cohort-component method to project that the state population will grow to 5,709,700 by 2015 and 6,446,300 by 2035, with the majority of growth occurring in the major suburbs of the Twin Cities, in the cities of Saint Cloud and Rochester, as well as in the lakes area in north central Minnesota. Morrison County is contained within this north central development region (Region 5), as are Cass, Wadena, Crow Wing, and Todd Counties. Morrison County is projected to grow to 36,050 by 2015 and 40,110 by 2035; an 8.8 percent and 21 percent increase respectively (McMurry 2007).

The average age of the county residents is 36.9 years, with 6.6 percent of the population under 5 years of age, and 15.6 percent over 65. The county is of relatively homogenous ethnicity, with non-white minorities accounting for less than 3 percent of the population, no single minority comprising over 1 percent of the county population, only 1 percent foreign born persons, and 3.9 percent (over 5 years of age) speaking a language other than English in the home. Perhaps influenced by the presence of Camp Ripley, 14.7 percent of the county residents are civilian veterans.

There are 13,870 housing units in the county. Of these, 11,816 are occupied; 81.9 percent are owner occupied. There is an average of 2.64 persons per household (U.S. Census Bureau 2009).

Employment and Income

According to the 2000 Census, of the available working population in Morrison County 16 years or older (16,043), 62.9 percent are employed, 3.8 percent unemployed, and 33.1 percent are not in the labor force. The economic sectors providing employment in the county include the following:

- 29.2 percent management, professional, and related occupations
- 21.8 percent production, transportation, and material moving occupations
- 20.7 percent sales and office occupations
- 14.3 percent service occupations
- 11.5 percent construction, extraction, maintenance, and repair occupations
- 02.4 percent farming, fishing, and forestry occupations
- At 73.1 percent, the majority of workers are private wage and salary, another 13.7 percent work for the government, and 12.5 percent are self-employed.

The average income for all types of households in Morrison County is $37,047, but increases to $45,451 if counting only families generating income. According to 2000 data, 7.5 percent of the population lives below poverty level, slightly above the state average of 5.1 percent. More recent census estimations from

Figure 17: Green Infrastructure Hubs and Links with Conservation Lands

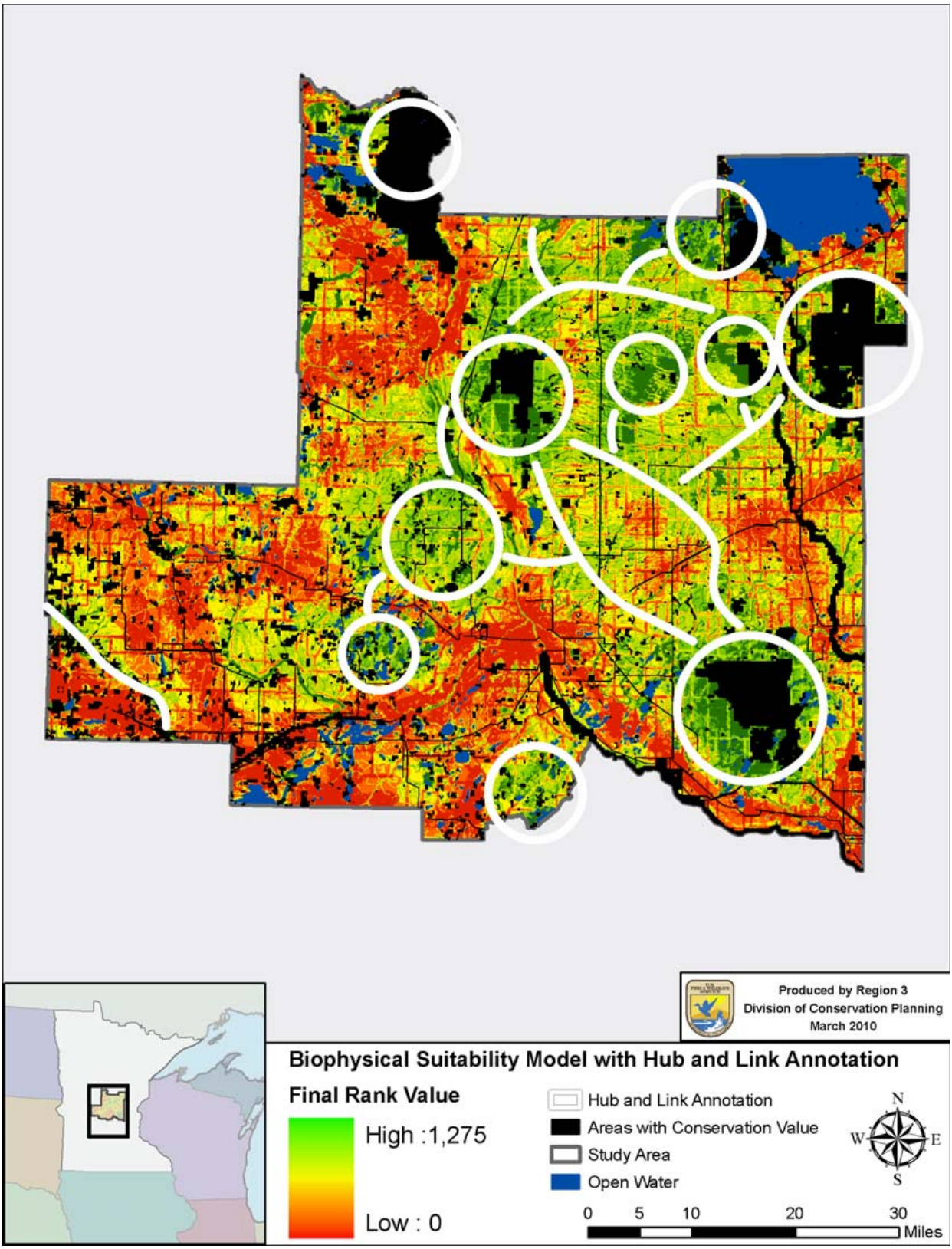


Table 5: Potential Visitation to Crane Meadows NWR in Five Categories

Approximate Driving Distance to Refuge	No. Zip Codes	Total 2001 Population	Photography	Birdwatching	Fishing	Hunting	Contribute to Environmental Organizations
10 Miles	11	56,262.0	1,069.0	2,545.0	1,505.0	1,746.0	1,064.0
30 Miles	55	316,602.0	5,371.0	11,763.0	7,391.0	8,356.0	5,195.0
90 Miles	426	3,700,930.0	41,052.0	73,987.0	51,569.0	57,007.0	41,846.0

2007 indicate that the county average is closer to 10.4 percent, and the state, 9.5 percent. Average male income is $31,037, and average female income $22,244 (U.S. Census Bureau 2009).

Education

According to 2000 data, 25.7 percent of the population over 3 years of age is enrolled in school at some level. Education levels are lower than the state averages; 79.7 percent are high school graduates as compared to 87.9 state-wide, and 12.6 percent have bachelor's degrees compared to the state average of 27.4 (U.S. Census Bureau 2009). The county public education system in Morrison County includes five high schools, three middle schools, and seven elementary schools. There is also one private high school, and two private elementary schools. Schools in the communities of Little Falls, Pierz, and Royalton are closest to the Refuge. There are no colleges or universities in the county, but there is an extension office of the University of Minnesota in Little Falls. Crane Meadows NWR works with two institutions of higher education in the region: Central Lakes College in Brainerd and Saint Cloud State University in Saint Cloud.

Economic Value of Crane Meadows to the Regional Economy

National wildlife refuges provide a number of benefits and services to individuals and society as a whole. Some can be tracked fiscally such as expenditures in local communities, payroll, and operations costs, while benefits such as recreation opportunities, species protection, ecosystem services, and environmental education don't come as directly connected with economic values.

According to an assessment of the economic benefits of visitation to national wildlife refuges, in 2004 Crane Meadows NWR had 4,998 (4,498 residents, 500 non-residents) visits for non-consumptive recreational activities; primarily the use of nature trails, observation platforms, wildlife observation in general, and other similar recreation activities. It is estimated that individuals associated with these visits brought approximately $15,600 ($9,300 residents, $6,300 non-residents) in recreation-related expenditures (i.e. food, lodging, transportation, and other expenses) that year to local communities, and that a total benefit of $21,200 and two jobs in final demand was added to the regional economy because of the Refuge (Caudill and Henderson 2005.) The final demand calculation simply takes actual visitor expenditures and adds benefits gained by those local individuals who earned income from the visitors' activities.

Potential Refuge Visitation

In order to estimate potential Refuge visitation, 2007 consumer behavior data was acquired and summarized for approximately 10, 30, and 90-mile zones around the Refuge (Table 5). The data is organized by zip code areas and tied to census demographics data. The three distances were selected because they represent reasonable driving distances to the Refuge for an outing by different groups, and because they encompass a number of major and minor population centers. The three closest local communities, Pierz, Royalton, and Little Falls, all fall within the 10-mile radius; Saint Cloud, Brainerd, and numerous smaller communities fall within the 30-mile radius; and the 90-mile area includes the major communities of the Twin Cities metropolitan area, as well as Fergus Falls, Willmar, and Hutchinson. Visitors from local communities are known to come to the Refuge for hiking and wildlife viewing. Little is currently known about Refuge visitation from longer distances, but their proximity to the Refuge makes these populations potential audiences.

The consumer behavior data used in the analysis is derived from Mediamark Research Inc. The company collects and analyzes data on consumer demographics, product and brand usage, and exposure to all forms of advertising media. The results are then associated with other populations of similar demographic and socioeconomic composition throughout the country. A basic assumption in the analysis is that people in demographically similar neighborhoods will tend to have similar consumption, ownership, and lifestyle preferences. Because of the

Table 6: Outdoor Recreation Activities of Minnesota Adults [a]

Activity	Percent Population
Walking	54
Boating of all types	43
Swimming or wading all places	41
Driving for pleasure on scenic roads	37
Picnicking	36
Fishing of all types	30
Biking outdoors of all types	29
Visiting outdoor zoos	27
Camping of all types	26
Visiting nature center	25

a. Table from Minnesota SCORP (MN DNR, 2008a)

assumptions made in the analysis, the data should be considered as a relative indication of potential recreation activity, not actual participation.

The marketing categories chosen as surrogates to potential interest in recreating at Crane Meadows NWR include photography, birdwatching, fishing, and hunting. In order to estimate the general environmental orientation of the population, the number of people who might contribute to environmental organizations was also considered. Table 5 displays the consumer behavior numbers for each of the three distances to the Refuge. The projections represent the maximum local and regional populations that may travel to the Refuge with drive times of 10 minutes, 1 hour, and 1 and one-half hours. These numbers estimate a maximum, thus only a fraction of these people can be expected to travel to the Refuge and actual visitor numbers will be smaller.

We also considered the maximum number of students that might potentially participate in environmental education offered by the Refuge by looking at the school populations in Morrison County. The school enrollment in preschool through grade 12 was 7,293 according to the 2000 census (U.S. Census Bureau 2009). The projected school age (5-19) population for the county in 2005 was estimated at 6,942, and is expected to increase only slightly to 6,990 by 2015 and 7,020 by 2035 (McMurry 2007).

Additional perspective on wildlife-dependent recreation is gained from Minnesota's Statewide Comprehensive Outdoor Recreation Plan (SCORP) 2008-2012. Outdoor recreation is an important component of a healthy lifestyle, and when faced with a state-wide 132 percent increase in obesity since 1990 (United Health Foundation 2006), may play an important role in the health of the state populations. The SCORP report outlines the trends in outdoor recreation in the state, identifying priorities and recommendations to increase and improve recreation experience opportunities. The report points out the importance of recreation to Minnesotans. A 2004 outdoor participation survey found that recreation is very important to 57 percent of those surveyed, and moderately important to an additional 25 percent. It identifies the top 10 recreation activities of Minnesotans 20 years of age or older (see Table 6), citing that more adults participate in boating and fishing activities than any other state, and that two-thirds of all recreation occurs within 30 minutes drive from home. Despite these facts, participation in outdoor recreation such as hunting, fishing, boat usage, and park visits has decreased nationally and in Minnesota over the past decade. In Minnesota, and nationwide, the population is aging, becoming more ethnically diverse, and is increasingly concentrated in urban areas. These trends are changing the nature of recreation throughout the country, and recognizing these changes affords land managers the opportunity to adapt their approach to recreation provision (MN-DNR 2008a).

Climate

The climate of east-central Minnesota is classified as 'sub-humid continental' and is characterized by significant variations in seasonal temperatures. This region has four distinct seasons with moderate spring and fall temperatures, short, warm summers,

and cold, dry winters. The town of Little Falls, Minnesota, near Crane Meadows NWR, has an annual average temperature of 43.4 degrees Fahrenheit.

For all of Morrison County the average temperature during the winter months is approximately 12 degrees Fahrenheit with an average daily minimum of 1 degree. The lowest recorded temperature was minus 41 degrees Fahrenheit on January 9, 1977. Summer temperatures average 68 degrees Fahrenheit with a maximum daily average of 81 degrees. The highest recorded temperature in Little Falls was 101 degrees Fahrenheit on August 18, 1976. There is an average of approximately 136 frost-free days throughout the year, which constitutes the growing season. Frost often persists until mid-May and returns the end of September. The latest occurring frost in the spring is June 9, and the earliest in fall is September 3.

Annual precipitation in Morrison County is well distributed throughout the growing season. Approximately 17.1 inches, or 65 percent of the total annual precipitation, occurs from May through September. The annual average precipitation in Little Falls is 26.3 inches. The heaviest daily rainfall recorded in the county was 4.70 inches in Little Falls on August 1, 1953. Snowfall persists from October through April and occasionally falls in May. The average annual snowfall in Little Falls is 50.4 inches, and snow usually persists on the ground all winter.

Air Quality

Greenhouse gasses, fine particles, ozone, air toxics, mercury, and lead are all airborne pollutants that affect human health, as well as the health of natural ecosystems. The protection of air quality has been formally monitored and regulated since the passage of the Clean Air Act in 1970, and its subsequent revisions in 1977 and 1990 have intended to keep policy at pace with the evolving state of science and technology. The threats associated with global climate change have reinvigorated efforts to monitor both point sources of contaminants and non-point sources such as transportation and residential combustion.

According to the Minnesota Pollution Control Agency's (PCA) 2009 report to the legislature, Minnesota air quality is "generally good and has been improving for most pollutants (MPCA 2009a, pg.1)." Partially because it cannot as easily be regulated, non-point sources are by far the greatest overall contributors to air pollution emissions. These emissions come from highway vehicles (38 percent), off-highway equipment (18 percent), or other small, non-point stationary sources (34 percent). Point source pollution by major facilities only contributes 10 percent of the total state emissions (MPCA 2009a).

To monitor the sources of air pollution, the EPA maintains composite databases of air pollution emissions estimates derived from state and local regulatory agencies, industry, and EPA records. The National Emission Inventory (NEI) contains emissions data from 2002 divided into two groups: criteria air pollutants and hazardous air pollutants.

Criteria Air Pollutants

To protect public health, the Clean Air Act established concentration limits on six criteria air pollutants: carbon monoxide, nitrogen dioxide, ozone, sulfur dioxide, particulate matter, and lead. The NEI database documents 27 facilities in Morrison County whose emissions are estimated for one or more criteria air pollutants by state and federal agencies. The list includes a diversity of farms and industrial businesses such as a boat manufacturer, a food preparation company, an ethanol cooperative, and several stone processing or construction enterprises. The list also includes the major county wastewater treatment plants, Camp Ripley, and a local high school, airfield, landfill, and hospital. In 2002, the total quantity of criteria pollutants emitted yearly by these facilities was approximately 1,555 tons. Morrison County ranks it at 36 of 87 Minnesota counties with 0.28 percent of the state's total point source emissions. The total quantity emitted by the state in 2002 from all sources was 40,009 tons (EPA 2009).

Hazardous Air Pollutants

The National Emission Inventory also identifies 15 facilities in Morrison County that emit hazardous air pollutants. The NEI monitors 188 hazardous air pollutants that are known to or suspected to cause serious health problems. This list of facilities

Prairie opening. Photo Credit: FWS

directly overlaps and is a subset of the criteria air pollutant emitters. All but three facilities (wastewater treatment plants) are in Little Falls. In this list, the number of pollutant types emitted by each facility ranges from 17 to 33, and all but 3 emit 0.01 percent or less of the total state emissions. According to these 2002 data, approximately 455,000 pounds of hazardous air pollutants are emitted yearly by these facilities (EPA 2009). The county ranks number 22 of 87 Minnesota counties in the quantity of hazardous air pollutants emitted at 1.14 percent of the state total (EPA 2009).

Though an ambient air quality station was active in Little Falls from 1996-1997, there are currently no air quality monitoring stations in the county.

Geology and Soils

Crane Meadows NWR is located on the Anoka Sand Plain, a large, flat sandy outwash landscape thought to be lacustrine in origin and created by glacial recession (Minnesota DNR 2009a). This landform contains small dune features, low ground moraines, outwash plains, kettle lakes, and tunnel valleys (Wright 1972). The Refuge consists of primarily flat uplands with some gently rolling hills, and peat-filled lowlands interspersed with shallow lacustrine wetlands.

Morrison County is underlain by layered bedrock of both metamorphic and igneous rock – primarily Cambrian and Ordovician dolomite, sandstone, and shale (Morey 1976). The bedrock surface slopes southward and subsurface depth to bedrock can range from 0-200 feet.

Nearly all of the Midwest was covered by glaciers during portions of the Pleistocene Epoch, which ended about 10,000 years ago. There were four major southward advances of the Laurentide Ice Sheet over the last 2 million years, including the Nebraskan, Kansan, Illinoisan and Wisconsinian stages. The Wisconsinian was the most recent, with three glacial maxima. The last of these maxima (Tioga) began 30,000 years ago, reached its maximum extent 21,000 years ago, and ended 10,000 years ago. The Tioga glaciation had the greatest impact on the modern interglacial landscape configuration in North America by leveling large areas, creating numerous lakes, rivers and wetlands, and leaving a number of glacial deposits. As a result, Morrison County is characterized by glacial features such as rolling morainic hills, drumlins, eskers, kames, and outwash plains. Two major lobes of ice advanced during the most recent glacial period. The Superior Lobe came down first, extending from eastern Ontario, across what is now Lake Superior, and down through the Anoka Sand Plain, depositing reddish-brown sandy loam soils. The second, the Des Moines Lobe, came down from Manitoba and reached as far south as Iowa. The Grantsburg Sublobe of the Des Moines lobe also pushed into the Anoka Sand Plain area, carrying a limestone-derived, light brown sandy loam. These two lobes formed a substrate over which large amounts of sediment-laden water ran as the lobes retreated. An evolving sequence of large rivers, streams, and lakes distributed predominantly sand deposits over the glacial till layers. Dunes and other aeolian features were added to the diversity of landscape features during a warm period from 4,000-8,000 years ago. The sand plain wetland/upland complex at Crane Meadows is the result of this turbulent geologic history. It is located within a geographic area characterized by its flat topography, sandy soils, and shallow water table (Anoka Conservation District 2009).

Information on farmland suitability and drainage characteristics has been collected by the USDA Natural Resources Conservation Service and is contained in their Soil Survey Geographic Database (SSURGO). According these data 95 percent of the area in the Refuge acquisition boundary is not prime farmland, with only 352 acres of prime farmland, and 309 acres of farmland of statewide importance (see Figure 18). Drainage is also an important soil characteristic, affecting land suitability for a number of human uses and determining habitat type for wildlife. SSURGO information indicates that 58 percent of the Refuge lands have poor drainage characteristics, 35 percent have good drainage, and the remaining 6.4 percent is open water (see Figure 19 on page 45) (USDA-NRCS 2009).

According to the SSURGO database, 18 major soil series occur within Crane Meadows NWR acquisition boundary, with open water comprising 6.4 percent of the Refuge (See Table 7 on page 46 and Figure 20 on page 47). All of the soils found on the Refuge are very deep and were formed as a result of glacial events. The primary constituent soil series are Menahga, Seelyeville, Markey, Isan, Bowstring, and Duelm, together accounting for over 75 percent of the Refuge soils. The remaining minor constituent soil series each constitute less than 5 percent of the Refuge acreage (USDA-NRCS 2009). Most soils in this area are subject to wind or water erosion without conservation measures in place, contain excess water, or have insufficient water holding capacity.

Major Soil Constituents

The major soil constituents are organized by landscape position – upland to bottomland).

Figure 18: Soil Survey Farmland Status, Crane Meadows NWR

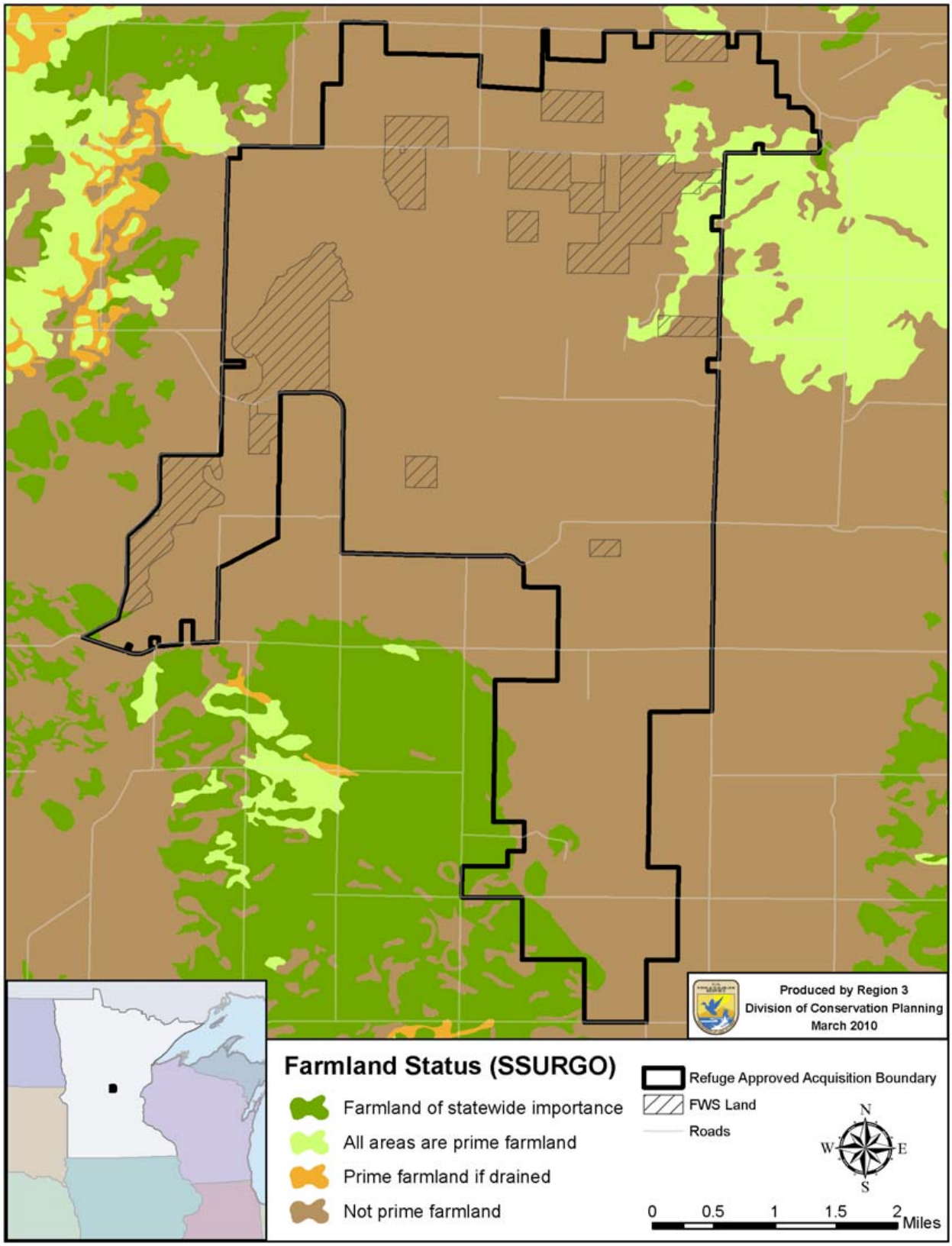


Figure 19: Soil Survey Drainage Classes, Crane Meadows NWR

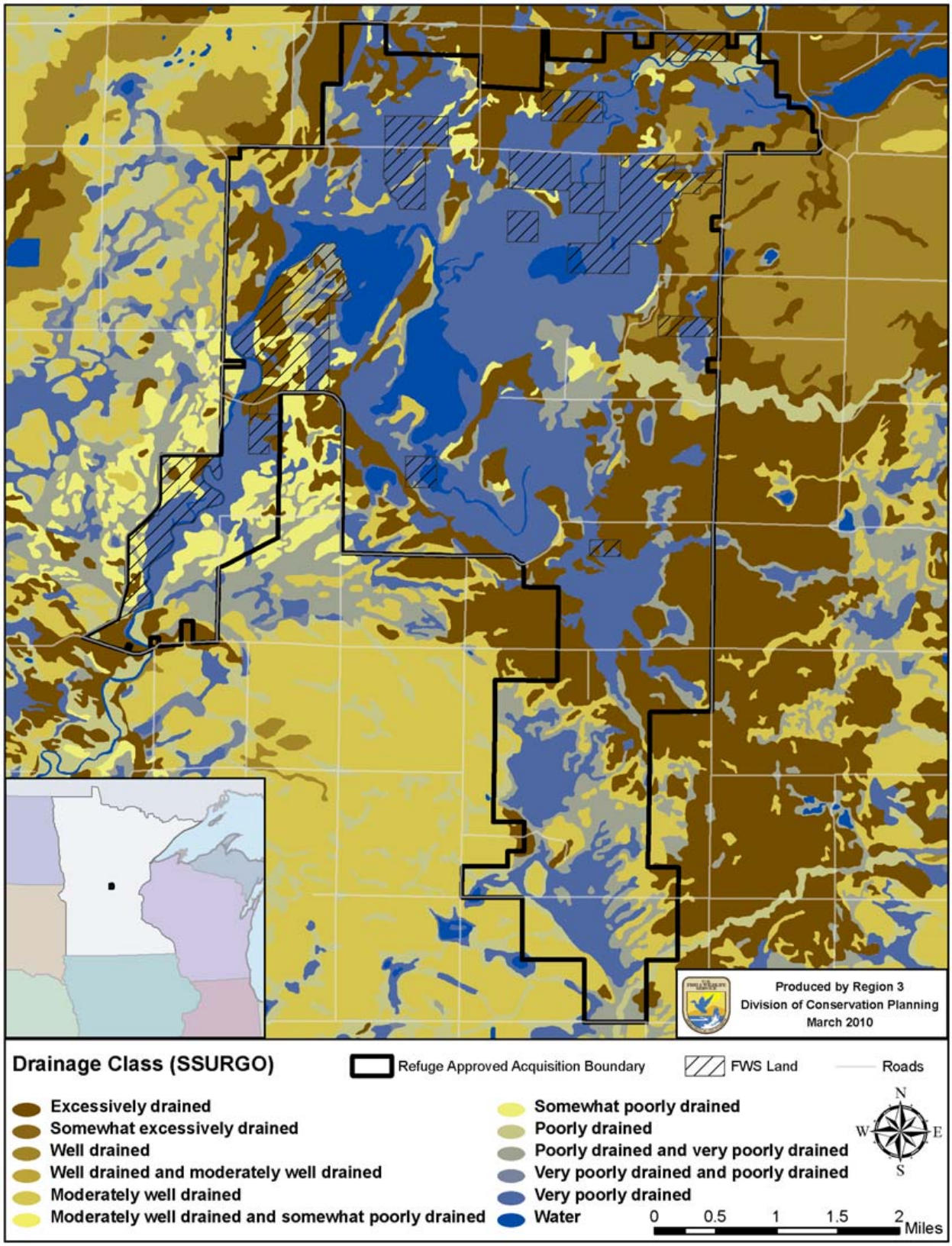


Table 7: Soils Present at Crane Meadows NWR

Soil Series Name	GIS Acres [a]	Percent
Menahga	2601.9	18.8
Seelyeville	2538.7	18.4
Markey	1717.4	12.4
Isan	1459.4	10.6
Bowstring	1325.4	9.6
Water	887.6	6.4
Duelm	827.3	6.0
Meehan	555.1	4.0
Hubbard	476.7	3.5
Pierz	352.1	2.6
Fordum	245.0	1.8
Pomroy	211.4	1.5
Mahtomedi	196.7	1.4
Sartell	179.4	1.3
Rifle	118.3	0.9
Watab	105.4	0.8
Chetek[b]	7.3	0.1
Nokasippi[b]	2.2	0.0
Flak[b]	0.7	0.0

a. All acreages are approximate GIS acres.
b. Written description not included.

Menahga soils (18.8 perent) cover the largest extent of any soil series on the Refuge and form many of the sandy upland areas at Crane Meadows NWR. Often supporting jack pine forest, Menahga soils are very deep, excessively drained or well drained soils with rapid permeability, formed in thick, sandy glacial outwash sediments on outwash plains, and may include moraines and drumlins.

Duelm soils (6 percent) are also primarily upland soils, but represent conditions more favorable for tall prairie grasses and deciduous forest habitats. They are very deep and moderately well-drained sandy soils on outwash plains.

Isan soils (10.6 percent) are often found in the interface between sandy uplands and poorly drained bottomland areas on the Refuge. Isan soils are very deep, poorly and very poorly drained, have moderately rapid permeability, and formed in sandy glacial outwash plains. Native vegetation was grasses and sedges with occasional willow and alder.

Seelyeville soils (18.4 percent) are second most abundant in total Refuge acres and form many of the bottomland sedge meadow areas on the Refuge. Like the upland soils on the Refuge they are very deep and formed on outwash plains, glacial lake plains and moraines. However, these soils are very poorly drained – often forming in depressions, composed of up to 51 inches of organic material from decomposed herbaceous plants, and have only moderate permeability. Vegetation typically consists of sedges, grasses, and scattered alters, willow, tamarack, and bog birch.

Markey soils (12.4 percent) are similar to Seelyeville - very deep, very poorly drained, and organic, but are at the interface between sandy and organic bottomlands and tend to have more forest cover. The herbaceous organic material ranges from 15-50 inches in depth, but is typically overlying sandy deposits from outwash plains, lake plains, flood plains, river terraces, and moraines. Permeability and drainage varies depending on the soil horizon, with slow permeability in the organic layers and rapid permeability in the sandy horizons. Most of these bottomlands are forested with black ash, quaking aspen, balsam fir, black spruce, tamarack, northern white cedar, and paper birch, with some areas in cattails, marsh grasses, reeds, and sedges.

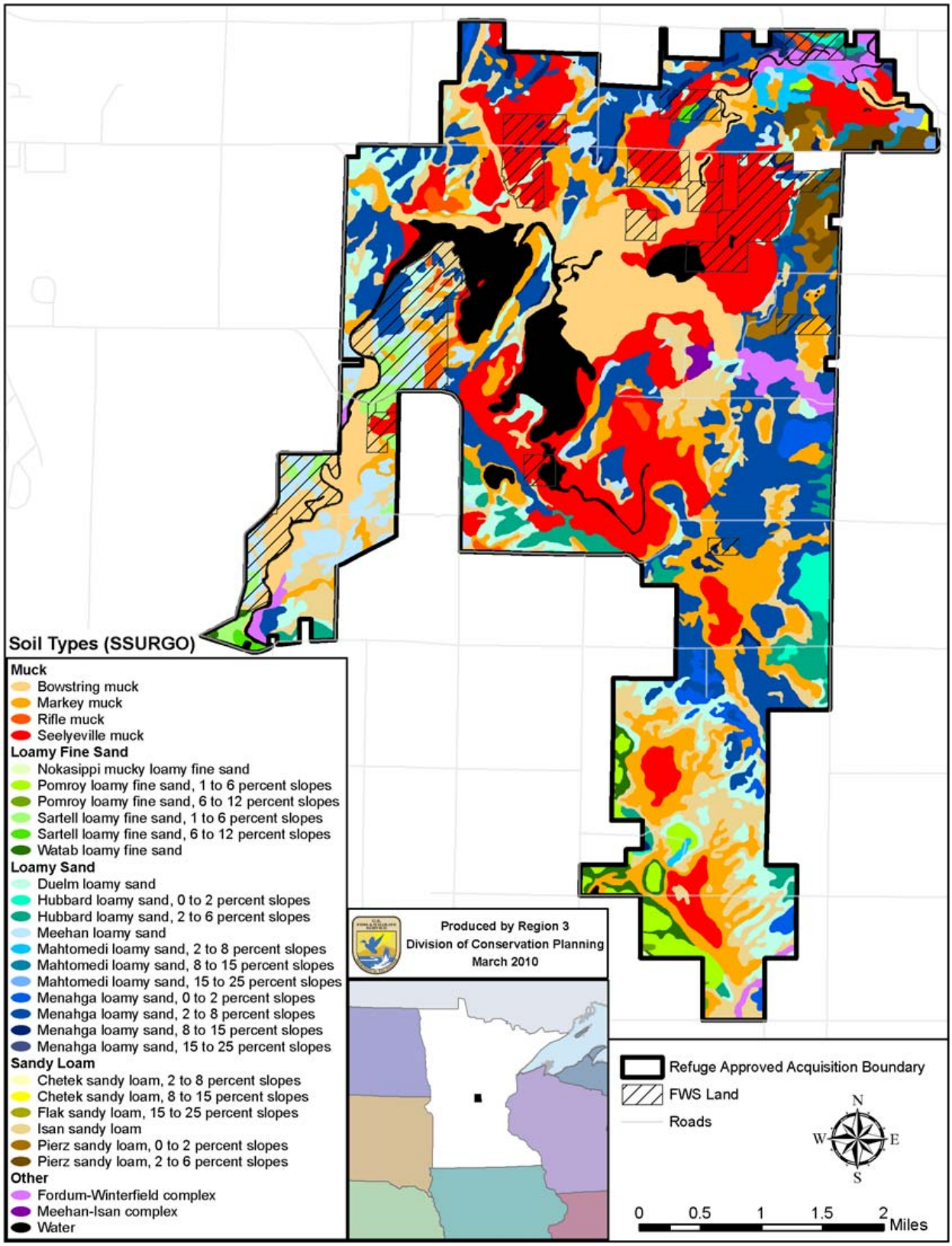
Bowstring soils (9.6 percent) are formed in floodplain environments and tend to surround the main stream courses on the Refuge. Bowstring soils are very deep, poorly drained, and formed as a stratification of decomposed organic material and thin layers of sandy or loamy material. Native vegetation is sedges with scattered willows and alders, and in some locations these soils are used to produce wild rice.

Minor Soil Constituents

Meehan (4 percent – some areas complexed with Isan) form mixed upland forests, and are deep, somewhat poorly drained, have rapid or very rapid permeability, and form in deep sandy alluvium on outwash plains. These areas tend to be a mix of conifer and deciduous forests, with trees such as jack pine, white and black spruce, paper birch, northern pin oak, red pine, eastern white pine, quaking aspen, balsam fir, and red maple.

Hubbard (3.5 percent) soils are commonly vegetated by upland oak savanna or tall grass prairie, and are very deep, excessively drained, and form in sandy glacial outwash plains.

Figure 20: Soil Types, Crane Meadows NWR



Pierz (2.6 percent) typically begin as upland prairie and later succeeded to a mixture of upland deciduous and conifer forest. They are very deep, well-drained, and form in a loamy mantle over sandy and gravelly sediments.

Fordum (1.8 percent - complexed with Winterfield) soils are a bottomland soil series. Recently formed soils, they are a part of floodplain systems directly adjacent to stream or river channels and are created as a part of meanders, overflow channels, scours, and other micro-relief features. They are poorly drained, moderately deep, and contain a loamy upper alluvium strata and sandy lower alluvium strata. The vegetation can be either forest (silver maple, red maple, quaking aspen, big tooth aspen, paper birch, American elm, white spruce, yellow birch, and tag alder are common) or marsh grasses, reeds, sedges, and shrubs.

Winterfield (1.8 percent – complexed with Fordum) are very deep, somewhat poorly drained, rapidly permeable sandy alluvium soils on flood plains with frequent, short-term inundations. They are often covered by lowland hardwoods including elm, red maple, swamp white oak, and quaking aspen.

Pomroy (1.5 percent) are often forest or wooded pasture – primarily deciduous, with scattered conifer areas. The soils are very deep, moderately well drained, and form in a mantle of glacial outwash or loamy glacial till.

Mahtomedi (1.4 percent) hosts mixed deciduous and conifer forests, and are very deep, excessively drained, readily permeable, and form from sandy glacial outwash.

Sartell (1.3 percent), like Hubbard, are covered by savanna habitat with occasional red oak, bur oak, or jack pine trees. They are very deep, excessively drained, have rapid permeability, and form from glacial outwash sediments.

Rifle (0.9 percent) are characterized by bog woodland vegetation, including tamarack, black spruce, paper birch, balsam fir, black ash, northern white-cedar, and a ground cover of sphagnum moss, leather leaf, blueberry, and Labrador tea. They are very deep (51 inches or greater), very poorly drained, have rapid permeability, and form in ground and end moraines, or outwash and lake plains.

Watab (0.8 percent) are often deciduous forest, and very deep, compact, poorly drained, and form in a mantle of sandy glacial outwash or dense loamy glacial till.

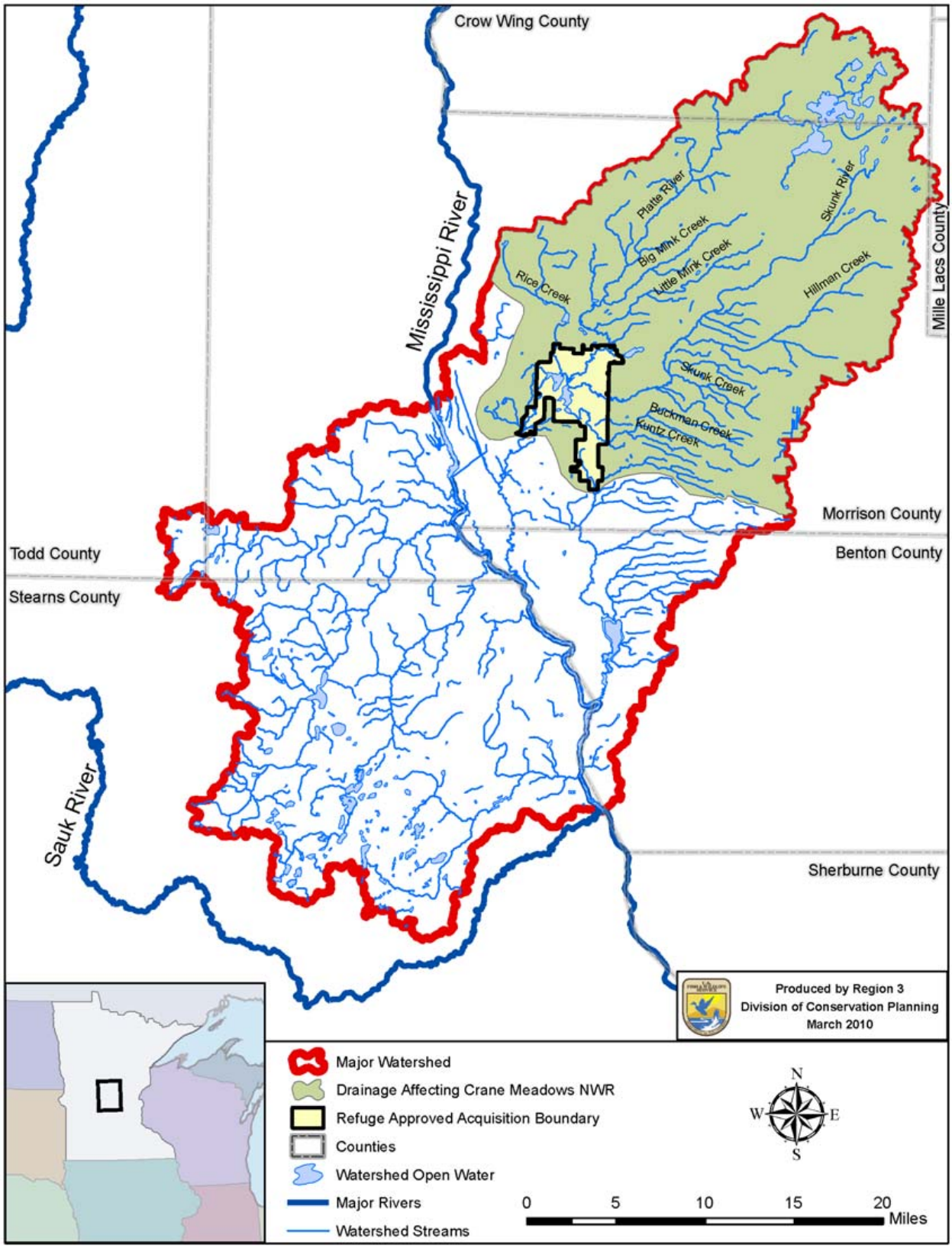
Water and Hydrology

Crane Meadows NWR falls within the Platte-Spunk Watershed (MN HUC 7010201) of the Upper Mississippi River Basin. The Upper Mississippi River Basin begins at the headwaters of the Mississippi River, extends southward throughout central Minnesota, and ends near the city of St. Paul, Minnesota. The Platte-Spunk River sub-watershed begins in southern Crow Wing County, runs diagonally northeast to southwest through Morrison County, includes the northwest section of Benton County, and ends in northeast Stearns County (see Figure 21 on page 49). There are approximately 56,000 people and 1,919 farms within the 652,667-acre watershed. The primary resource concerns include soil erosion, woodland management, surface and groundwater quality, and surfacewater and wetland management (USDA NRCS 2008.)

The wetland complex that comprises the majority of Refuge includes two large shallow lakes, Rice Lake (320 acres) and Skunk Lake (314 acres), and one smaller open water basin, Mud Lake (56 acres). The Rice-Skunk Lakes wetland complex is also the confluence of four major waterways: Rice Creek and the Platte River, which flow into Rice Lake from the north, and Skunk and Buckman Creeks, which enter Skunk Lake from the east and southeast and pass through to Rice Lake (see Figure 2 on page 3). The headwaters of these four creeks ultimately pass through the Refuge as well, and include Wolf, Little Mink, and Big Mink Creeks above the Platte River, Hillman Creek above Skunk Creek, and Kuntz and Mischke Creeks above Buckman Creek. In addition to waters that drain through the wetland complex, the southern spur of the Refuge contains the upper reaches of a cold water stream, Little Rock Creek. There are approximately 32 linear miles of stream and river channels within the acquisition boundary that migrate and meander slowly through the wetland complex. In total, the drainage from more than 272,000 acres of upstream land passes through the Refuge. The majority, (256,254 acres or approximately 400 square miles) passes directly through the Rice-Skunk Wetland Complex (353:1 watershed to basin ratio) before eventually making its way to the Mississippi River near Rice, Minnesota 8 miles down the Platte River (DNR 2006a). The remaining effective watershed area drains through the Little Rock Creek System and finally drains into the Mississippi River just north of the city of Sartell.

This wetland complex has a history of extreme water level fluctuations following seasonal variations in rainfall and runoff. Flooding is common in the spring due to snowmelt and runoff from surrounding uplands and via watercourses that drain into the area. Typically water levels decrease during the summer months, then a resurge of flooding

Figure 21: Platte-Spunk Watershed



occurs in the fall. The Federal Emergency Management Agency (FEMA) maintains information on the 100-year floodplain levels for insurance purposes. An area of 6,888 acres, approximately 50 percent of the Refuge acquisition boundary, falls within these designated flood zones (see Figure 22 on page 51). These zones overlap, and are a surrogate for areas of bottomland habitat, and indicated that less than 50 percent of the Refuge is suitable for development – residential or agricultural – based solely on flood potential.

All open waters in the area of the Refuge are public and are managed by the state. During the first half of the 20th century there was high demand from local sportsmen in the area to provide minimum water levels in the Rice-Skunk shallow lake complex for hunting and boating navigability – particularly during drier periods of the year. In response, in 1961 the Minnesota Legislature mandated the construction of a weir for water level stabilization where the Platte River exits Rice Lake. After acquiring flowage easements, purchasing physical properties, and conducting studies and monitoring activities in the area, the George Selke Memorial dam was constructed between 1971 and 1974. The dam consists of 300 feet of sheet piling with six 5-foot variable crest stoplog bays on the west end. Historical average annual water level fluctuations in the area of the dam varied from El. 1,095 to 1,104 feet (mean sea level datum), with occasional flooding events of up to 1,107 feet. The crest of the dam was set at El. 1,097.0 feet – the normal full pool elevation of the Rice-Skunk wetland system. Stoplogs are placed in the bays only between late July and November 23 as necessary to facilitate public access (MN-DNR 2006a). Despite this major water structure, the remainder of the hydrology in the wetland complex remains relatively intact, its streams unchannelized, and its open waters undeveloped.

According to the 2001 land cover data (see Figure 23 on page 52), the portion of the watershed upstream of Crane Meadows is comprised of 31 percent pasture/hay, 24 percent deciduous forest, 20 percent cultivated cropland, 14 percent herbaceous wetland, 4 percent grassland, 3 percent developed/open space, and 2 percent open water. The other cover types all have 1 percent or less coverage within the affected watershed for the Refuge. Pasture land and agriculture make up the dominant land use in the watershed at over 50 percent. Though agricultural land retains some natural value, there are a host of concerns and threats associated with this land use. See "Threats to Resources" on page 64 for more information these issue.

Water quality in the watershed, and within the Crane Meadows NWR wetland complex, has been sampled by various agencies over the past few decades. There are more than 40 sites in the drainage affecting the Refuge with data relative to the quality of waters, according to the Minnesota Pollution Control Agency's Electronic Data Access database (MN-PCA 2009b). Figure 24 on page 53 shows the location of these monitoring sites. With the exception of Buckman Creek, all other tributaries leading into and flowing out of the Refuge, as well as some of the lakes within the Refuge, have some degree of water quality data available. The distribution of these sites allow for the assessment of waters entering the Refuge, the impact on the wetland complex, and the quality of waters exiting the Refuge. Data from these sites indicate that water quality within the watershed ranges from good, during low water conditions, to poor, during high water event samples. Poor water quality during high water events are likely the result of non-point source run-off upstream of the Refuge. Continued and expanded monitoring is needed throughout the watershed to assess the impacts of specific contaminants and identify their pathways into Refuge waters.

Additional data provided by the Minnesota PCA indicate that portions of three waterways are state-listed as impaired within the Refuge Boundary. "Section 303(d) of the Clean Water Act requires states to publish and update a list of waters that are not meeting one or more water-quality standards" (MN-PCA 2009c). The list, known as the 303(d) Total Maximum Daily Load (TMDL) list, designates streams and lakes with impairments based on state water quality standards. Skunk Creek, Little Rock Creek, and the Platte River (downstream of the shallow lake complex) are all on Minnesota's 2010 Draft List of Impaired Waters (MN-PCA 2009c) for a variety of water quality impairments. Of the three, only Little Rock Creek currently has a Total Maximum Daily Load pollution reduction study under way to identify pollution sources and improve water quality to meet state standards. It will be important for the Refuge to collaborate with state and local partners as additional work is done to monitor and address water quality issues in the watershed.

Wild Rice

Wild rice (*Zizania sp.*) in Minnesota has great cultural, ecological, and economic value, and has been harvested in the Great Lakes region for thousands of years (Valppu 2000). It is important from an ecological perspective as well, by providing food and shelter for many fish and wildlife species. Wild rice serves as one of the most important food sources for waterfowl in North America, with an ability to produce more than 500 pounds of seed per

Figure 22: Federal Emergency Management Agency Floodplain Map, Crane Meadows NWR

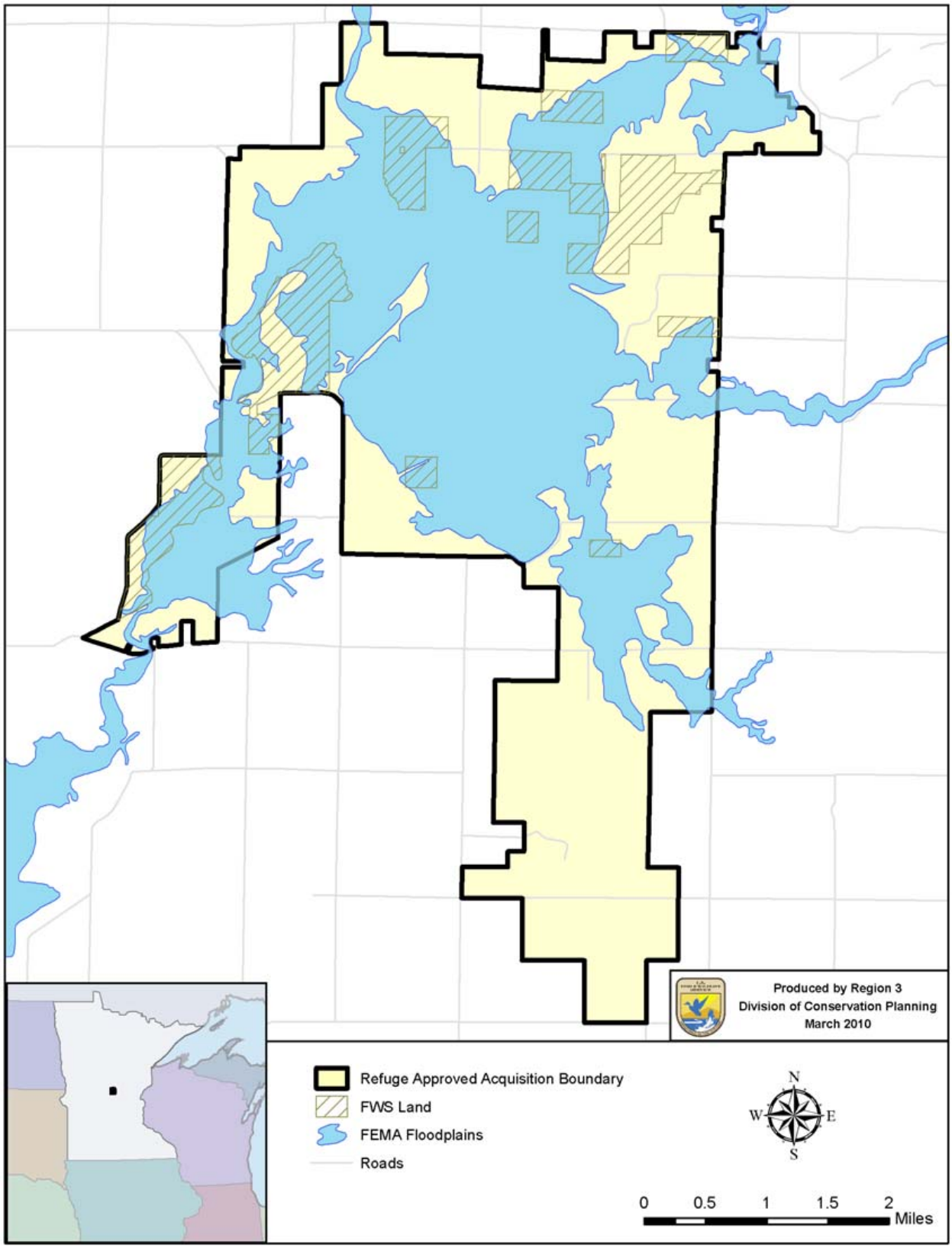


Figure 23: Land Cover in the Platte-Spunk Watershed

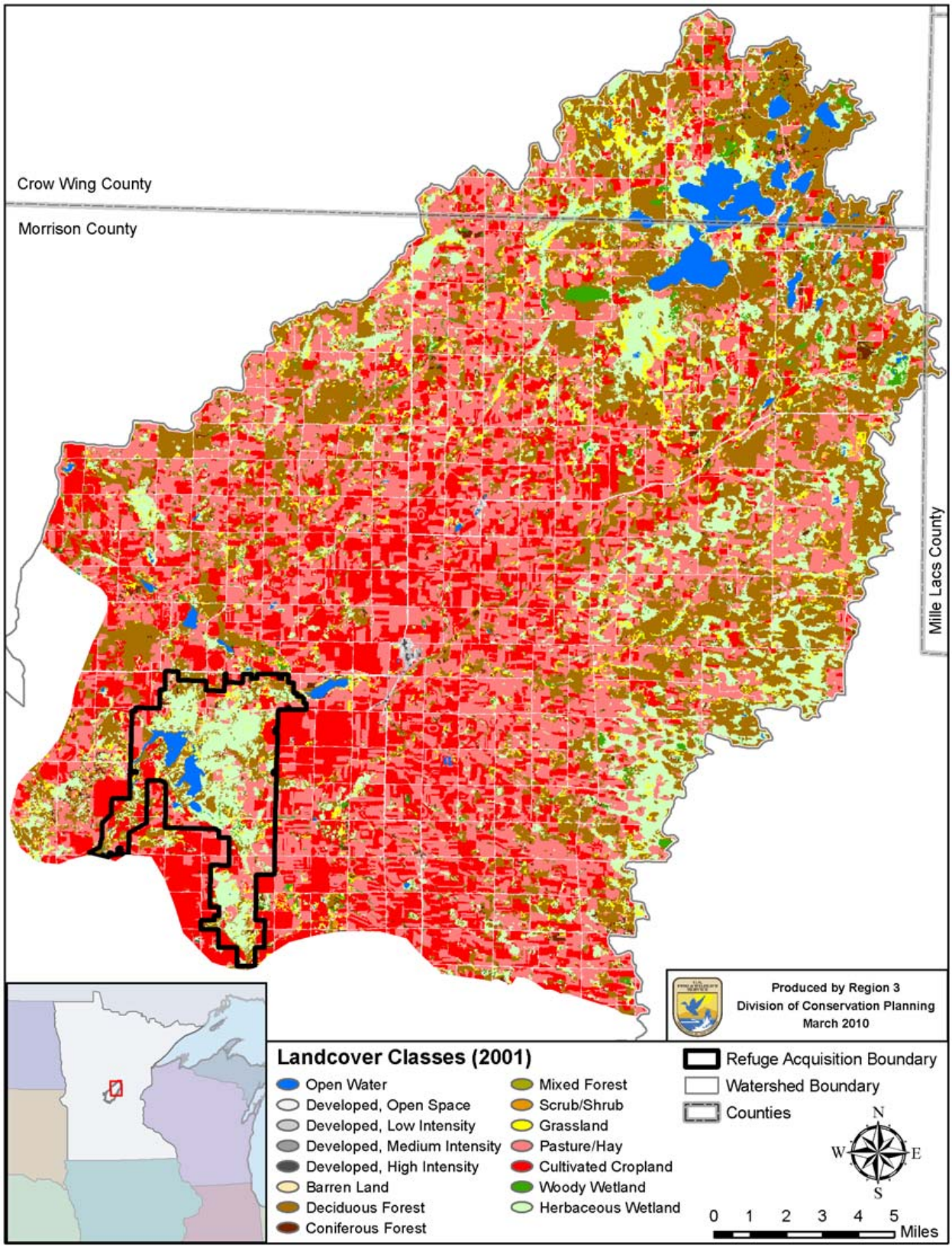


Figure 24: Water Quality Monitoring Sites, Crane Meadows NWR

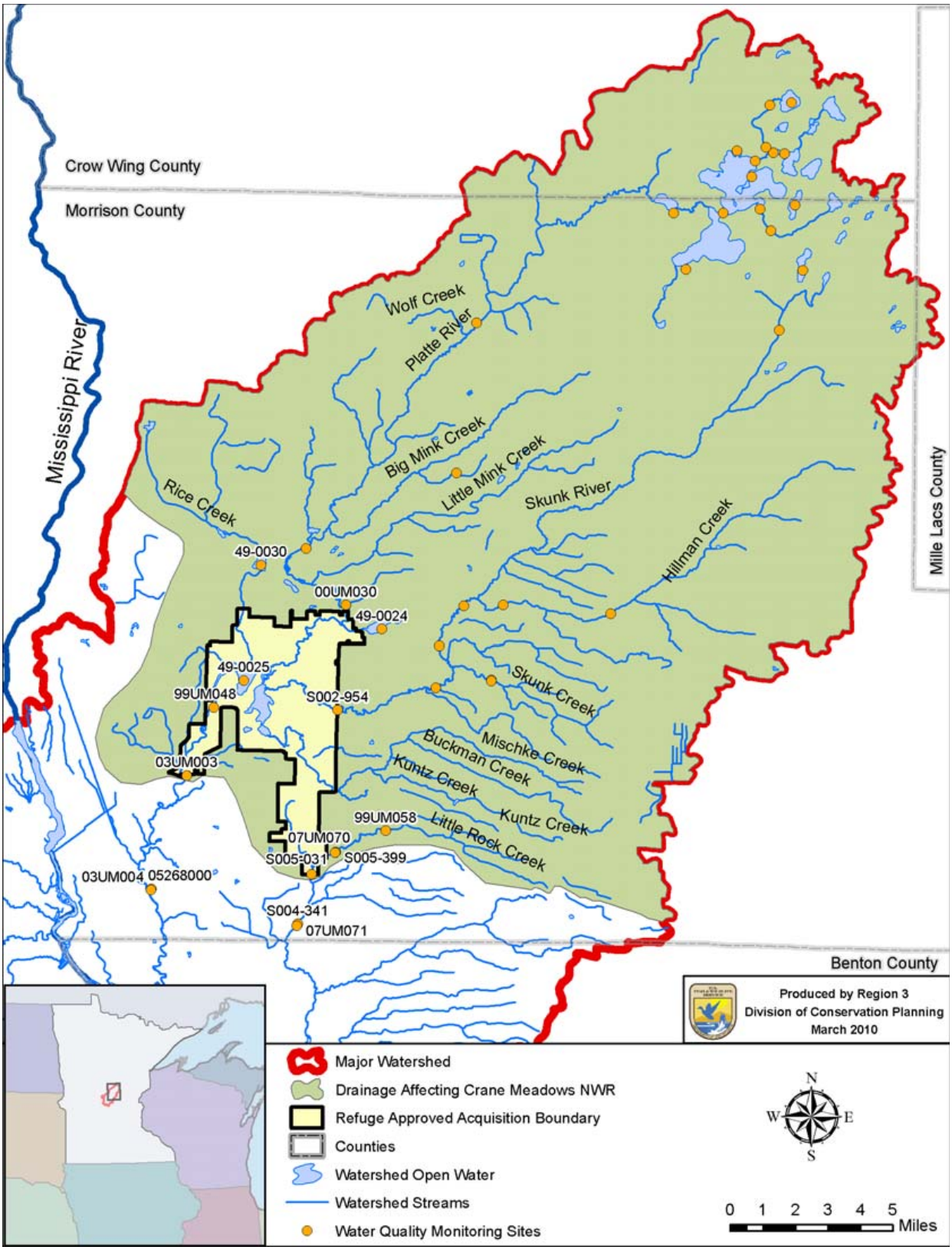


Table 8: Wild Rice Productivity at Crane Meadows NWR

Lake Name	Size (Acres)	Estimate Wild Rice Coverage (Acres)
Mud	23	9
Rice	323	250
Skunk	320	256

acre and host a diversity of invertebrates that also help feed many wetland species. At least 17 bird species on Minnesota's 'species of greatest conservation need' list use the habitat provided by wild rice – primarily for reproduction and foraging (MN-DNR 2006b). The historic range of wild rice included the entire state, but it now occurs most commonly in the central and north-central portions of the state (55 Minnesota counties.) As an 'annual', the plant requires moving, relatively shallow water (0.5 – 3 feet), and germinates each spring from seeds dropped in previous fall seasons. The growth cycle and productivity can be threatened by a number of factors: water quality, seasonal water levels, lakebed conditions, climate change, other aquatic vegetation (including invasives), genetic modification, water-based recreation, shoreland development, and industrial activities (MN-DNR 2008b). Although the productivity of natural wild rice populations varies on a 3-5 year cycle, annual crops can be greatly affected by the aforementioned threats. The time period from late May to mid June is a particularly critical stage at which floating leaves first appear and fluctuations in water levels can uproot or otherwise significantly stress the plant.

Limited development in the area has minimized a number of the aforementioned threats, but a few of the issues such as system water fluctuations and climate change could be affecting the annual production of wild rice at Crane Meadows NWR. The wild rice study submitted by the DNR to the Minnesota Legislature in 2008 stresses the importance of water levels during the critical floating leaf stage. The following passage may provide insights to factors influencing wild rice stands within the Crane Meadows NWR complex:

> "At the (floating leaf) stage, any rapid increase in water level can cause damage to natural stands. Changes in lake outlets that reduce flow capacity can also significantly impact wild rice by increasing the frequency and severity of these temporary flood events. For example, permanent dams, beaver dams, culverts, and debris such as mats of vegetation can reduce outlet flow capacity and impact wild rice habitat (Ustipak 1983)…Changes in upstream watersheds can also reduce the productivity of natural wild rice stands. Drainage ditches and tiles, pumps, and channelization can increase the quantity and speed of waters moving downstream. The resulting peaks in water levels can produce the same effects as reduced outlet capacity by creating abrupt "bounces" or rapid increases in water depth…Dams that maintain stable water levels can have long-term deleterious effects on natural wild rice, as well. Water levels that are held stable year after year can create conditions that favor perennial vegetation and shoreline encroachments that impair wild rice habitat (p. 21-22)."

In this same report, wild rice inventories were noted for the water bodies within the Crane Meadows NWR wetland complex; Rice, Skunk, and Mud Lakes (see Table 8). This information estimates the potential wild rice coverage and associated productivity in each lake within the complex.

Refuge Habitats

As discussed earlier in this CCP, the Refuge lies within the Anoka Sand Plain Subsection of the Eastern Broadleaf Forest Province of Minnesota (MN-DNR 2005). The narrow band of this province traverses diagonally (from northwest to southeast) across the state, forming a transition zone between tallgrass prairie to the southwest and deciduous forests to the northeast-leading to a distinctive set of vegetative communities. In pre-settlement times the flat, sandy outwash plain of the Anoka Sand Plain was characterized predominantly by oak barrens and openings in uplands prior to European settlement (Minnesota DNR 1993, Marschner 1930). Lowlands consisted of mostly conifer bogs, swamps, and wet prairies (Marschner 1930). Conifer bogs were important in the landscape historically, but are no longer present on the Refuge due to land draining efforts for agriculture. This habitat type was a tamarack-dominated swamp; typically on shallow to deep peat in lowland basins and occasionally on floating mats at edges of ponds. Other trees species that may have been present in this habitat include elm, red maple, and paper birch (Minnesota-DNR 2005). Fire suppression and agricultural practices began with European settlers around 1850. Such activities altered the landscape and significantly changed vegetative communities from those that existed previously in the presence of fire initiated by

weather events and Native Americans. Fire suppression in the uplands resulted in succession from oak savanna to oak woodlands (Wovka et al. 1995).

The Refuge acquisition boundary currently contains a great variety of upland habitat types including woodlands, prairie, southern dry savanna remnants, conifer plantations, and agriculture. Refuge woodlands contain jack pine, northern pin oak, bur oak, and aspen. Small pockets of open prairie knolls and southern dry savanna remnants can be found throughout the area. Although many of these remnant communities are altered because of past cultivation or grazing, they contain native sand prairie species such as big bluestem, Indian grass, little bluestem, porcupine grass, junegrass, prairie sand reed, rough dropseed, and prairie dropseed. Common native forbs include hoary puccoon, prairie violet, rough blazing star, prairie larkspur, heath aster, black-eyed Susan, stiff goldenrod, lead plant, purple prairie clover, butterfly weed, and prairie smoke.

The lowland habitats on the Refuge consist of emergent marsh, sedge meadow, and willow-dogwood shrub swamp. The vegetative communities along the edges of Rice and Skunk Lakes and associated rivers/creeks, include wild rice, bulrushes, bur-reed, arrowhead, cattails, sedges, reed canary grass, and phragmites. Lowland marshes and meadows with completely saturated soil or areas covered with shallow water are dominated by sedges, blue joint grass, and prairie chordgrass. Pockets of floating sedge mats can be found in these areas as well. Lowlands also support a variety of shrub species such as willow, red-osier dogwood, and bog birch.

The diverse vegetative composition and habitat types of this area correlate to a high diversity of wildlife species that are typical of wetlands, forests, and grasslands. The current habitat composition of the Refuge acquisition boundary consists of approximately 50 percent wetland, 20 percent agriculture, 17 percent woodlands, 6.6 percent grassland/prairie, 1.4 percent conifer plantation, 1.3 percent oak savanna, 1.2 percent pasture, and 2.5 percent developed areas. A list of habitat types, definitions, and acreages for both the acquisition boundary and Service-owned property can be found in Table 9 on page 56. For consistency, the habitat names used in Table 9 and throughout this document have been adapted from general vegetation classes to habitats defined by the Minnesota DNR (2005). See Table 10 on page 58.

Wetlands and Open Water

Due to its low position in a relatively flat landscape, diversity of water features, and distinctive geologic history, the wetland complex at Crane Meadows NWR supports a unique combination of wet bottomlands and droughty uplands. According to the National Wetlands Inventory, the proposed Refuge acquisition boundary encompasses approximately 7,787 acres (56 percent) of various wetland and open water habitats that together comprise an extensive and diverse wetland complex (FWS 2004). This inventory included areas recorded as partially drained/ditched; approximately 1,792 acres (13 percent) within the Refuge acquisition area, 267 of which occur on properties currently owned by the Service. The wetland types in the inventory include open water, emergent, scrub-shrub, forested, unconsolidated bottom, and a few lacustrine and riverine areas. The 2004 NWI inventory classified most of the system as palustrine, and 852 acres as either riverine or lacustrine. Of the palustrine environments, 4,509 acres were classified as emergent, 941 acres were scrub/shrub, 181 were forested, 61 were considered unconsolidated bottom, and 1,243 acres contained a mixture of these classes (see Figure 25 on page 59, Cowardin et al. 1979, FWS 2004).

Similarly, a 2006 vegetation mapping project for the Refuge acquisition boundary (see Figure 26 on page 60) cites 6,894 acres of wetland habitat excluding forested wetlands, which are covered in the following section. Habitat classes for this 2006 classification include open water, rivers and streams, emergent marshes, sedge meadows, and willow-dogwood shrub swamps. Rice and Skunk Lakes account for approximately 643 acres of these Refuge wetlands and are characterized as emergent marsh. The four tributaries flowing into the lakes – the Platte River, Rice Creek, Skunk River, and Buckman Creek – combined with the Platte River exiting the complex, together account for a total of 32 stream miles within the acquisition boundary. The Platte River flows into Skunk Lake from the northeast corner of the Refuge and flows out the southwest spur and ultimately into the Mississippi River. The Platte River watershed drains approximately 345 square miles. Rice Creek is further west and flows into Rice Lake from the north. The Skunk River flows into the Refuge from the east side, and Buckman Creek, located further south, flows into the Refuge from the southeast. Buckman Creek flows into Mud Lake first, then into Skunk, then Rice, and finally exits the Refuge via the Platte River (refer to map in Figure 2 on page 3). In addition to the lakes (emergent marshes) and tributaries, other important wetland habitats within the complex include a relatively intact, extensive sedge meadow and willow-dogwood shrub swamp. These two habitats extend along the perimeter of the lakes (emergent marshes), rivers and creeks and together cover approximately 5,140 acres of proposed Refuge lands (Figure 26 on page 60). During periods of heavy rainfall or high spring runoff, the entire complex can be inundated. During regular flow cycles,

Table 9: Habitats Found at Crane Meadows NWR

HABITAT[a]	DESCRIPTION	ACRES[b]	
		Authorized for Acquisition	Currently Owned
Open Water	Portion of a lake with a water depth of >1m and without emergent vegetation (Cowardin et al. 1979). Skunk, Rice, and Mud Lakes are the three lakes with varying 'open water' status.	153.9	17.8
River/Stream	Lotic or running water environment (Goldman and Horne 1983). The Platte and Skunk Rivers, and Rice and Buckman Creeks flow through the Refuge.	32.0 miles	3.1 miles
Emergent Marsh	Shallow water wetland (water depths 20-60 inches) dominated by cattails, bulrushes, and submergent and floating aquatic plants (coontail, milfoil, pondweeds, water-lilies, etc.); floating mats; areas along shorelines of lakes, ponds, rivers, or in shallow basins.	1,599.3	102.2
Sedge Meadow	Open wet meadow dominated by sedge, with broad-leaved graminoids and < 25 percent shrub cover.	2,640.4	458.9
Willow-Dogwood Shrub Swamp	Open wetlands dominated by broad-leaved graminoids and > 25 percent shrub cover. Shrubs include willows, red-osier dogwood, speckled alder, and bog birch.	2,499.9	410.0
Southern Rich Conifer Swamp	Tamarack-dominated swamps on shallow to deep peat, occasionally on floating mats at edges of ponds. Found in basins on moraines and outwash plains. Other trees species include elm, red maple, and paper birch.	0	0
Northern Floodplain Forest	Deciduous riparian forests on sand alluvial soils along rivers and streams. Typically dominated by silver maple, but on the Refuge this habitat includes ash, American elm, box elder, basswood, etc.	435.3	52.4
Wet Prairie	Tallgrass-dominated herbaceous vegetation, some forbs, shrub layer is absent to sparse, and no trees. Typic species include prairie cordgrass, big bluestem, Indian grass, woolly sedge, and Canada goldenrod.	911.0 [c]	379.1[c]
Southern Mesic Prairie	Tallgrasses dominant, but several mid-height grasses also important, forb rich, shrub layer sparse, no trees. Typic species include big bluestem, Indian grass, little bluestem, porcupine grass, stiff goldenrods, purple and white prairie clovers. Some Refuge areas have been planted to this habitat type.		
Southern Dry Prairie	Shortgrass-dominated herbaceous vegetation, some forbs, no trees. Typic species include little bluestem, side-oats grama, prairie dropseed, porcupine grass, junegrass, silk aster, purple coneflower, pasqueflower, harebell, etc.		
Southern Dry Savanna	Scattered trees 25-50 percent (mostly bur oak with some black oak and jack pine), typically graminoid-dominated, forb-rich herbacious layer includes side oats grama, prairie dropseed, stiff goldenrod, silk aster, etc.	185.1	5.3

Table 9: Habitats Found at Crane Meadows NWR (Continued)

HABITAT[a]	DESCRIPTION	ACRES[b]	
		Authorized for Acquisition	Currently Owned
Jack Pine Woodland	Dry-mesic pine or hardwood forest dominated by evergreens (primarily jack pine). Other species may include red pine, quaking aspen, bur oak, and northern red oak.	84.5	8.8
Oak Woodland	Dry-mesic hardwood forests; typically deciduous-dominated, but at times mixed deciduous-conifer. Tree species include bur oak, pin oak, northern red oak, white oak, basswood, and American elm.	1,181.5	201.9
Oak-Aspen Woodland	Commonly dominated by northern pin oak, with quaking aspen, paper birch, big-toothed aspen, bur oak, northern red oak or red pine also abundant. At Crane Meadows, this habitat is dominated by aspen.	671.9	66.0
Agriculture	Land used for crop production and raising livestock. Common crops cultivated within the proposed Refuge boundary includes corn, small grain, and alfalfa. Livestock is dairy, pork, or poultry.	2,942.2	10.8
Conifer Plantation	Planted native or non-native conifers. Jack, red, and white pine are native to the area.	199.5	11.9

a. For consistency, vegetation classes from the 2006 vegetation assessment were compared to habitats defined by MN DNR (2005) and reclassified to these standards (see Table 10).
b. All acreages are approximate GIS acres.
c. The 3 prairie types are not easily distinguished on the aerial imagery used to assess these habitat types. Acreages for all three prairie sub-types are combined here.

Rice, Skunk, and Mud Lakes are generally less than 3 feet deep and are rich in aquatic vegetation including dense stands of wild rice when growing conditions are favorable. In the past decade the wild rice crop throughout the wetland complex has been poor, with an exception in 2007 when the state of Minnesota experienced a severe drought and the rice crop was fairly dense.

Woodlands

Based on the 2006 vegetation map (Figure 26 on page 60), the Refuge acquisition area has approximately 2,572.2 acres of woodlands including both upland and bottomland forests that support a variety of tree species. Areas of upland forest include oak woodlands (1,181.5 acres) dominated by bur oak and northern pin oak, oak-aspen woodland (671.9 acres) dominated mostly by aspen species, and jack pine woodland (84.5 acres) comprised mostly of jack pine but interspersed with quaking aspen and northern pin oak. Bottomland forests are designated as northern floodplain forests (435.3 acres) which is essentially a riparian zone following the watercourses and/or forested areas near and adjacent to the lakes. Tree species inhabiting bottomland forests include silver maple, aspen, elm, ash, basswood, box elder and a small amount of tamarack. Also included in this total are 199.5 acres of conifer plantations in private ownership, including spruce, and jack, red, scotch, and white pines.

Oak Savanna

The distribution of oak savanna throughout the Midwest was widespread before European settlement. This habitat type once occupied as much as 50 percent of Midwestern landscape covering 11 to 13 million hectares (Nuzzo 1986). Most oak savanna habitat has been lost due to timber cutting, fire suppression, conversion to agriculture, and development. Only 0.02 percent of pre-European oak savannas remain today in small fragments and scattered remnants. Today, oak savanna is among the world's most threatened plant communities. Small patches totaling approximately 185 acres of a native oak savanna subtype, identified as southern dry savanna, have been retained in the Refuge acquisition area from pre-settlement times. This oak savanna subtype is characterized by a relatively open community of scattered or clumped (25-50 percent canopy cover; 5-50 square-feet per acre basal

Table 10: Vegetation Cover Type Reclassification

2006 Vegetation Map Cover Types	Associated Habitat Type	GIS Acres	Habitat Type Summary	GIS Acres
Agriculture	Agriculture	2,770.0	Agriculture	2,942.2
Pasture	Agriculture	172.3	Conifer Plantation	199.5
Jack Pine Plantation	Conifer Plantation	22.0	Emergent Marsh	1,599.3
Red Pine Plantation	Conifer Plantation	98.3	Jackpine Woodland	84.5
Scotch Pine Plantation	Conifer Plantation	39.4	Northern Floodplain Forest	435.3
Spruce Plantation	Conifer Plantation	24.1	Willow-Dogwood Shrub Swamp	2,499.9
White Pine Plantation	Conifer Plantation	15.7	Oak Woodland	1,181.5
Developed	Developed	1,70.1	Open Water	153.9
Roads-Roadside	Developed	1,75.2	Sedge Meadow	2,640.4
Bulrush (Scirpus)	Emergent Marsh	6.8	Southern Dry Savanna	185.1
Cattail (Typha)	Emergent Marsh	409.0	Prairie [a]	911.0
Giant Reed Grass (Phragmites)	Emergent Marsh	240.2	Oak-Aspen Woodland	671.9
Reed Canary Grass (Phalaris)	Emergent Marsh	144.2	Southern Rich Conifer Swamp	0.0
Wild Rice (Zizania)	Emergent Marsh	40.0		
Rooted Floating Aquatic	Emergent Marsh	456.5	River/Stream	32 Miles
Submersed Vegetation	Emergent Marsh	302.6		
Oak-Jackpine Mixed Forest	Jackpine Woodland	84.5		
Lowland Broadleaf	Northern Floodplain Forest	435.3		
Alder Shrub	Willow-Dogwood Shrub Swamp	50.8		
Willow-Dogwood Shrub	Willow-Dogwood Shrub Swamp	2449.2		
Northern Pin Oak-Bur Oak Forest	Oak Woodland	718.4		
Upland Broadleaf	Oak Woodland	463.1		
Open Water	Open Water	153.9		
Blue Joint Meadow	Sedge Meadow	569.5		
Sedge Bluejoint Mixed Meadow	Sedge Meadow	1498.5		
Sedge Meadow	Sedge Meadow	296.8		
Wet Meadow-Mixed Emergents	Sedge Meadow	275.7		
Oak Savanna	Southern Dry Savanna	185.1		
Cool Season Grasses	Prairie[a]	549.2		
Warm Season Grasses (planted)	Prairie[a]	361.8		
Aspen	Oak-Aspen Woodland	671.9		

a. The term "Prairie" refers to all prairie subtypes including: Southern Mesic Prairie, Southern Dry Prairie, and Wet Prairie

Figure 25: National Wetland Inventory Wetland Vegetation Classes, Crane Meadows NWR

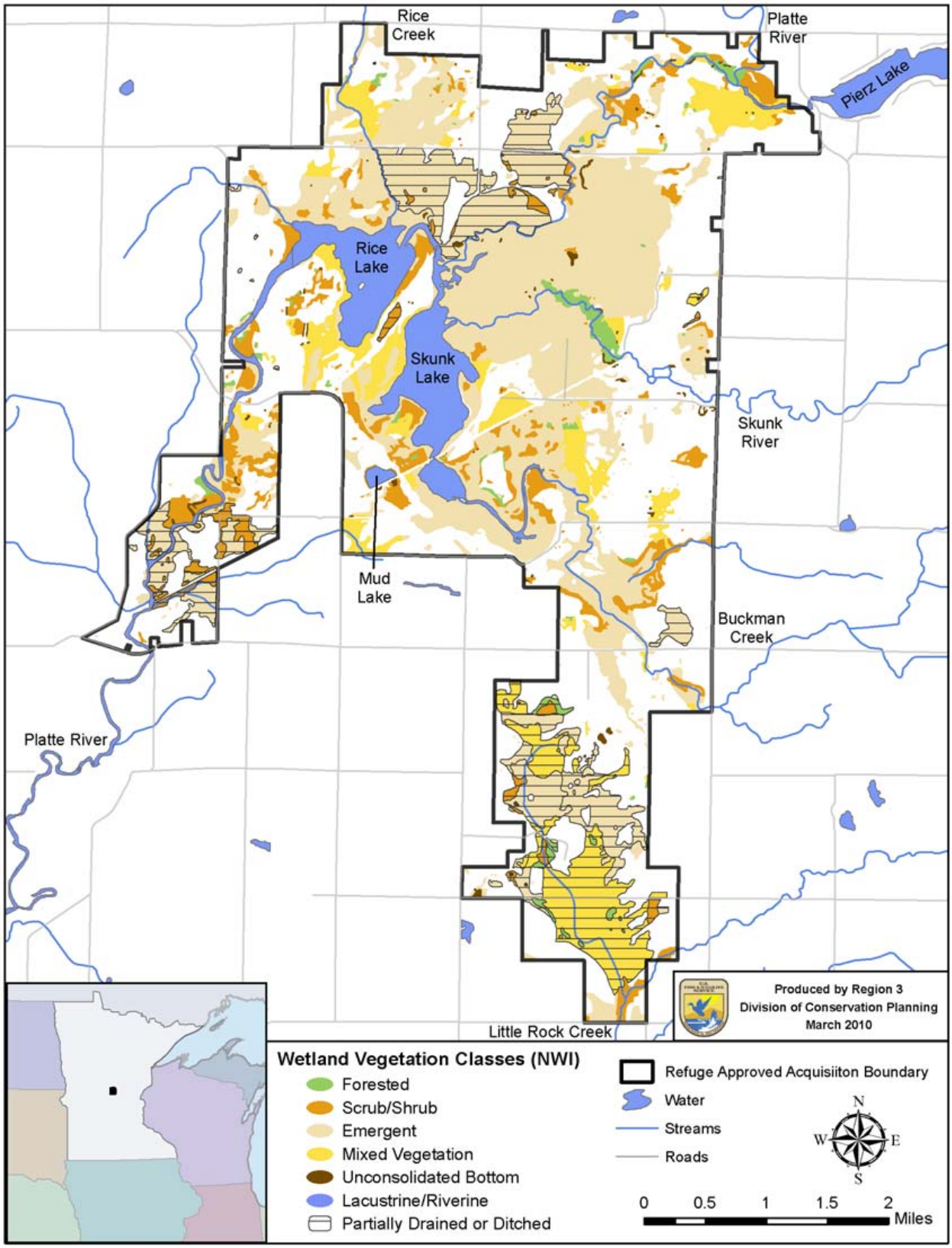
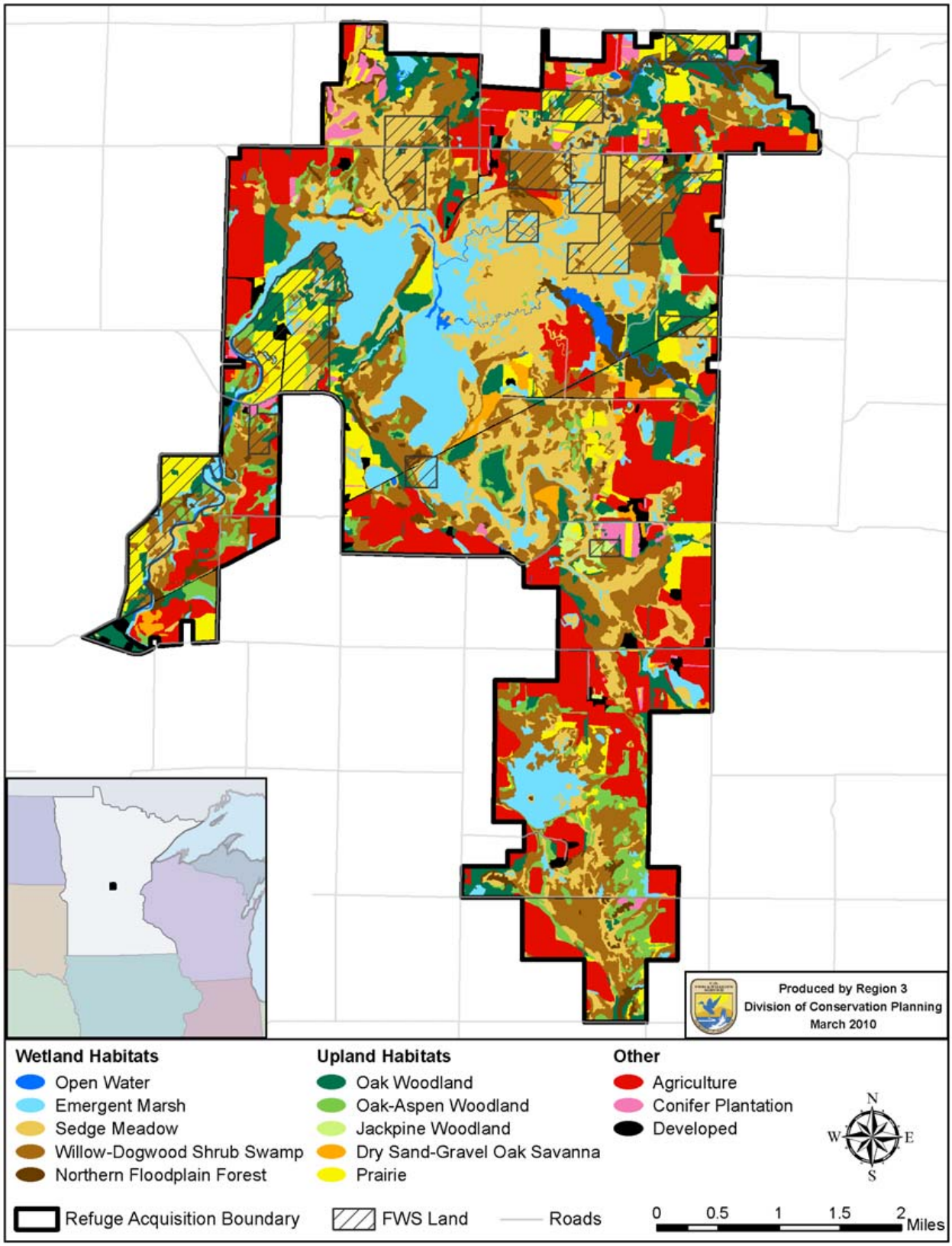


Figure 26: Refuge Vegetation Based on 2006 Imagery, Crane Meadows NWR



Grasslands at Crane Meadows NWR. Photo Credit: FWS

area), short (15-45 feet), open grown bur oak trees that are usually interspersed with northern pin oak, may have black oak and jack pine components, and with a nearly continuous cover of both prairie and forest forbs and graminoids (Wovcha et al. 1995).

Grasslands

The Refuge contains approximately 911 acres of grassland habitat including a few small remnants of native southern dry prairie (sand prairie). Other open grasslands on the Refuge include southern mesic prairie, consisting mostly of native warm season grasses and tallgrass prairie species that were planted during restoration efforts; and wet prairie characterized by both warm and cool season grasses, sedges, and forbs. (Note: the diversity of prairie types and grassland habitats were not distinguishable during the 2006 aerial cover type classification). These grasslands support a variety of grassland-dependent wildlife species. Prairie habitats throughout North America have also declined significantly due to fire suppression and conversion to agriculture.

Agriculture

Agriculture remains the leading economic activity in Morrison County. Because Crane Meadows NWR falls within the Anoka Sand Plain, the soil is porous sand and susceptible to rapid water percolation, typically undesirable for agricultural practices. However, once marginal farmland has now become profitable because of large-scale irrigation and fertilization. Incidentally, the rapid infiltration and passage of water through the sandy soils also leads to an increased transfer of fertilizers, pesticides, and other agricultural chemicals into surface and ground waters.

Many of the Refuge in-holdings are currently being used for agricultural purposes. Crop production within the proposed Refuge boundaries consists mainly of corn, small grains, and alfalfa. Other agricultural uses in the immediate vicinity include diary, pork and poultry farms. A number of pasture / grassland areas are used for grazing livestock as well. Also, some sedge meadows and wetland edges are hayed during years of normal or below average precipitation. The wetland complex is experiencing pressure from large scale farming and, to a lesser extent, residential development on adjacent lands within the acquisition boundary. Several large-scale agricultural and livestock operations have developed in recent years. Large installations have been erected to house hundreds and even thousands of animals. It will be increasingly difficult for the Service to acquire lands where costly structures have been erected. Similarly, central pivot irrigation systems continue to be constructed at an alarming rate on and adjacent to the Refuge. Many woodlots, windbreaks, and fence lines have been removed to accommodate these large irrigation structures.

Refuge Wildlife

Birds

The Refuge supports populations of many bird species and attracts more than 200 species each year with its diverse habitats. The abundance of wetland habitat attracts a variety of wetland-dependent species to the area including the Greater Sandhill Crane, a bird that was almost completely extirpated from Minnesota by the beginning of the 20th century. Historical records show cranes used Rice and Skunk Lakes in pre-settlement times. The first recorded sighting after extirpation was in 1958. Sandhill Cranes have been recorded every year since, and the area has emerged as one of the most important nesting areas for cranes in central Minnesota, with a current estimate of 40 breeding pairs in the area. The Refuge also serves as a staging ground for thousands of cranes during fall migration.

Waterfowl are generally abundant in the spring and into the fall, and include most species of ducks and geese found in the Prairie Pothole Region of Minnesota. Some waterfowl species of conservation concern use the Refuge during certain life-stages including Northern Pintail (migration), Lesser Scaup (migration), American Black Duck (migration/winter), Mallard (breeding/resident), Canvasback (migration), and Trumpeter Swan (migratrion). The most common nesting species of ducks are Mallard, Blue-winged Teal, and Wood Duck. During spring and fall migration, up to 10,000 ducks, a mixture of both divers and dabblers, and geese may be present at one time on Rice and Skunk Lakes and surrounding wetlands. High concentrations of Mallards, Ring-necked Ducks, Wood

Rose-breasted Grosbeak. Photo Credit: FWS

Ducks, Lesser Scaup, and Blue-winged Teal can be observed in the fall and thousands of Canvasbacks and Mergansers are present in early spring.

Other wetland-dependent birds found in the area include Great Blue Heron, American Bittern, Common Loon, Horned Grebe, Common Snipe, Sora (Rail), Sedge Wren, Black Tern, Foster's Tern, and Northern Harrier. Exposed mud flats that occur sporadically on the edges of Refuge wetlands attract some shorebirds including Wilson's Phalarope, Greater and Lesser Yellowlegs, Solitary Sandpiper, and Spotted Sandpiper.

More than 100 other bird species have been recorded during the breeding and migration seasons. Some of the common songbirds attracted to the woodlands and open grassland areas on the Refuge include:

- Eastern Kingbird
- Eastern Bluebird
- Northern (Baltimore) Oriole
- Rose-breasted Grosbeak
- Brown Thrasher
- Scarlet Tanager

Several songbirds of conservation concern also inhabit the Refuge woodlands and grasslands during the breeding season including:

- Golden-winged Warbler
- Black-billed Cuckoo
- Red-headed Woodpecker
- Bobolink
- Eastern Meadowlark

Year-round residents include:

- Black-capped Chickadee
- Red-breasted Nuthatch
- White-breasted Nuthatch
- Downy Woodpecker
- Hairy Woodpecker
- Pileated Woodpecker
- Red-bellied Woodpecker
- Ruffed Grouse
- Ring-necked Pheasant
- Wild Turkey.

Common birds of prey that inhabit the Refuge include:

- Bald Eagle
- Red-tailed Hawk
- Northern Goshawk
- Red-shouldered Hawk
- American Kestrel
- Osprey
- Sharp-shinned Hawk
- Coopers Hawk
- Barred Owl
- Great Horned Owl

See Appendix C for a list of all bird species found on the Refuge.

Mammals

The Refuge lies within the known breeding range of 54 mammal species. Of these, 35 species have been confirmed on Refuge lands. Bison and elk were historically present on the landscape, but were extirpated in the early 1900s.

The largest mammal that inhabits and breeds on the Refuge is the white-tailed deer. Other large mammals common to the Refuge include coyote, red fox, and on occasion black bear. Gray wolves will occasionally pass through the area, but do not have established packs on the Refuge. Other predators on the Refuge include mink, river otter, short-tailed weasel, and badger. Small mammals typical of this area include:

- Short-tailed shrew
- Star-nosed mole
- White-footed mouse
- Deer mouse
- Plains pocket gopher
- Thirteen-lined ground squirrel

Observations of two state special concern species on the Refuge include plains pocket mouse and the prairie vole. Little brown bats and red bats have also been identified on the Refuge. Muskrat, beaver, raccoon, and mink are common in wetland habitat, while uplands harbor a variety of mice, voles,

shrews, and ground and tree squirrel species. See Appendix C for a list of all mammal species found on the Refuge.

Amphibians and Reptiles

Ten species of amphibians and 11 species of reptiles have been documented on the Refuge. Many of these species are dependent on Refuge wetlands, such as painted turtles, snapping turtles, and tiger salamanders while others, including eastern garter snake, brown snake, eastern and western hognose snake, and gopher (bull) snake, are associated with the upland habitats. The state-listed threatened Blanding's turtle is dependent on both upland and wetland habitats. The eastern gray tree frog, Cope's gray tree frog, wood frog, and western chorus frogs are commonly heard on the Refuge and inhabit wooded areas adjacent to sedge meadows, emergent marshes, or potholes. See Appendix C for a list of all herpetofauna found on the Refuge.

Fish

Forty fish species have been identified in lakes and rivers on the Refuge. Game fish species include:

- Northern pike
- Walleye
- Smallmouth bass
- Largemouth bass
- Bluegill
- Black crappie

A large population of carp and other roughfish also inhabit the open waters. Species that are indicators of ecosystem health within Refuge waters include redhorse suckers and shiners. Many fish in these areas experience winterkill caused by depletion of oxygen during the winter months. Much of the watershed is restocked naturally from the Mississippi River by way of the Platte River downstream from the Refuge. See Appendix C for a list of all fish species found on the Refuge.

White-tailed deer fawn. Photo credit: FWS

Threatened and Endangered Species

Animals

Gray wolves, a federally-listed endangered species, are also currently listed under a threatened status in the state of Minnesota. Wolves do not have any established packs on the Refuge but intermittently disperse through the area. Reintroduction of the federally listed endangered Whooping Crane to the eastern United States was begun in Wisconsin in the year 2000. On rare occasions, individuals from this experimental population have been observed in the area near Crane Meadows NWR. The mosaic of vegetation communities at Crane Meadows NWR can provide habitat for this species if the population continues to grow and disperse. Bald Eagles were once federally listed as threatened, but were delisted on August 9, 2007 and moved to a protected status under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act. This species is commonly observed in the area during spring and fall migration and the Refuge currently supports three nesting pairs. Peregrine Falcons, a species that is federally-listed as endangered and state-listed as threatened, are occasionally seen during spring and fall on the Refuge as well.

State-listed threatened or special concern birds species documented on the Refuge include Trumpeter Swan, Wilson's Phalarope, Horned Grebe, Nelson's Sharp-tailed Sparrow, Short-eared Owl, Red-shouldered Hawk, American White Pelican, and Forster's Tern. Greater Prairie Chickens were once documented using a cultivated field within the Refuge acquisition boundary. Two locally extirpated bird species, but historically present in the area and of conservation interest to the Refuge, are the Loggerhead Shrike and Upland Sandpiper. The Refuge supports a Blanding's turtle population, a state-listed threatened species, and other reptiles with special concern status including snapping turtles, western hognose snake, and gopher snake. Two species of mussel with state special concern status have also been documented on the Refuge, the creek heelsplitter and black sandshell found in the Skunk River (see Appendix C for a list of the mussel species present at Crane Meadows NWR).

Plants

Three species of rare plants have been documented on the Refuge. Small populations of blunt sedge and Hill's thistle (state-listed special concern species) were found in southern dry prairie (sand prairie) and southern dry savanna remnants on the Refuge. The state-listed endangered tubercled rein-orchid has been documented in two locations on the Refuge in southern mesic/wet prairie and sedge meadow habitats.

Threats to Resources

Agricultural Development

Agriculture is the primary land use and leading economic activity in Morrison County. More natural areas have been converted to cropland in the county than to any other cover type, and many of these areas were already converted by the middle of the 20th century.

Threats associated with agriculture continue to pose the greatest challenges for the Refuge and its resources. This land conversion adversely impacts wildlife species by decreasing habitat availability, quality, and connectivity, and thereby increasing overall fragmentation of habitat. However, a parallel issue is the intensification of agriculture adjacent to the Refuge. Runoff from crop fields, pastureland, and feedlots creates non-point sources of pollution. Refuge resources are adversely affected by the application of pesticides, herbicides, and fertilizers on neighboring and upstream lands. These substances are not only a source of contamination but can also lead to increased erosion, sedimentation, and eutrophication in the watershed and Refuge wetlands. Many of these substances, such as organochlorines and organo-phosphates, are known to be toxic to fish and wildlife via direct exposure, bioaccumulation, and bio-magnification (Cox 1991).

There are a number of agricultural practices in the area that pose threats to the Refuge and the area's natural resources.

Animal Barns and Poultry Houses

Large animal husbandry projects occur and continue to be developed near the Refuge acquisition boundary. At the time of writing, one installation exists within the acquisition boundary and five additional installations can be found within 1 mile of the boundary. In addition to habitat loss and fragmentation, these installations may pose threats regarding undesirable nutrient levels, wastes, contaminants in surface waters, and rapid infiltration through sandy soils into local aquifers.

Public health issues for people such as E. Coli, as well as impacts on wildlife (e.g. avian influenza, salmonella, etc.) are also risk factors. The risks posed by Concentrated Animal Feeding Operations (CAFOs) include environmental contamination with nitrogen, phosphorous, pathogenic bacteria, hormones, antibiotics, and ammonia; noxious odor; habitat loss; and groundwater depletion (EPA and USDA 1999).

Center Pivot Irrigation

Center pivot irrigation systems have been erected in dryland farming areas increasing habitat loss and fragmentation. This activity also depletes groundwater sources and impact the levels of local water tables; create field scars and increase erosion, runoff, and sedimentation; impact adjacent habitats by increasing local moisture levels; degrade soils by increasing soil mineral levels and salinity if applied long-term; and these practices are typically accompanied by increased usage of pesticides, herbicides, and fertilizers – each with environmental implications (Johnson and Lewis 2007).

Tiling, Channelization, and Draining

Another serious threat to the natural function of the Rice-Skunk wetland system is tiling and channelizing waterways for agriculture.

This activity destroys wetlands and increases bottomland habitat fragmentation. In addition, the rapid removal of water from large areas leads to water volume surges in streams and wetlands, increased sediment, nutrient (especially nitrates), and agrochemical transport and deposition in waterways and Refuge wetlands, and reduces infiltration for groundwater recharge. Channelization also increases soil erosion, while tiling may help reduce surface runoff and erosion.

Invasive Species

Several invasive species occupy the Refuge, many of which are exotic. Invasives are often able to tolerate a wide range of environmental conditions and don't require the same external mechanisms for pollination and seed dispersal as natives. These species have the potential to negatively impact biodiversity and the quality of important habitat for native wildlife species. They also complicate efforts to preserve or restore natural vegetation communities.

Currently, the following invasive plants pose the greatest threat to Refuge uplands:

- Siberian elm
- Black locust
- Buckthorn
- Canada thistle
- Leafy spurge
- Common tansy
- Spotted knapweed

Proliferation of aspen may also lead to problems in upland restoration sites.

Invasive and exotic species also pose a threat to Refuge wetlands. Purple loosestrife is an exotic species, is invasive to the wetland areas near the Refuge, and merits routine monitoring due to its high

level of invasiveness. Reed canary grass is also an aggressive invasive species that competes with and displaces native wetland vegetation. Phragmites requires monitoring for increases in abundance within the complex; as some subspecies are invasive and others native. These species can reduce the quality of habitat for wetland-dependent wildlife species. Routine monitoring is required to understand and prevent the spread of these and other invasive species on the Refuge.

Urban and Residential Development

The Refuge is located 7 miles southeast of the closest town, Little Falls, Minnesota, which has an estimated population of 8,200 and 545 housing units. Within the last decade, the population of Little Falls has grown by 5.5 percent.

The population of Morrison County increased by 10 percent in the last 20 years, and 3.6 percent in the last decade to reach a current count of 33,000 people. The number of housing units in Morrison County has increased 12.8 percent within the last decade, with approximately 16,000 house or condo units (U.S. Census 2009). Increased population and development may impact the Refuge resources and land acquisition by adding to habitat loss and fragmentation, changing property ownership and zoning, and increasing other human activities that may conflict with the Refuge purposes and the Refuge System mission.

Even more relevant to the Refuge than growth and development within the county and adjacent towns is development in and immediately adjacent to the Refuge. Because the Refuge is not at full acquisition within its congressionally designated acquisition boundary, private landowners are free to build and develop any areas not owned by the Fish and Wildlife Service.

To gain a sense of development levels and distribution, 2008 Farm Services Agency imagery was used to identify existing structures both within the Refuge acquisition boundary, and within a 1-mile buffer of the Refuge (see Figure 27 on page 66). More than 35 developed sites (residences, farmsteads, and agricultural installations) with approximately 100 associated structures such as houses, garages, barns, storage silos, and others were identified within the acquisition boundary. The wetland complex itself has limited the amount of development in the center of the Refuge, and the majority of these developed sites lie along the periphery of the acquisition boundary.

An additional 250 developed sites with more than 600 structures exist within 1 mile of the Refuge. The highest concentrations of developed sites follow Highway 27 along the northern boundary of the Refuge, and surround the shorelines of Pierz Lake to the northeast. Moderate or little development has occurred on the west, south, and east flanks of the acquisition boundary (Figure 27 on page 66). As the city of Little Falls grows, it is likely that development surrounding the Refuge will increase – particularly on the north and west sides.

Contaminants

An aerial survey of possible contamination sites in the area was conducted by the Service in August of 1991. No unusual sources of contaminants were found other than abandoned private waste sites.

The Greater Morrison County Sanitary Landfill is located approximately 1.5 miles west of the Refuge. Surveys of the area surrounding the landfill have indicated contamination in the form of volatile organic compounds (VOCs) in the underlying groundwater. However, measured VOC levels are low (less than 300 parts per billion at the edge of the groundwater plume) and have not been detected beyond 500 feet from the landfill boundary. The general direction of the upper aquifer groundwater movement beneath the landfill heads away from the Refuge-to the southeast toward the Platte River.

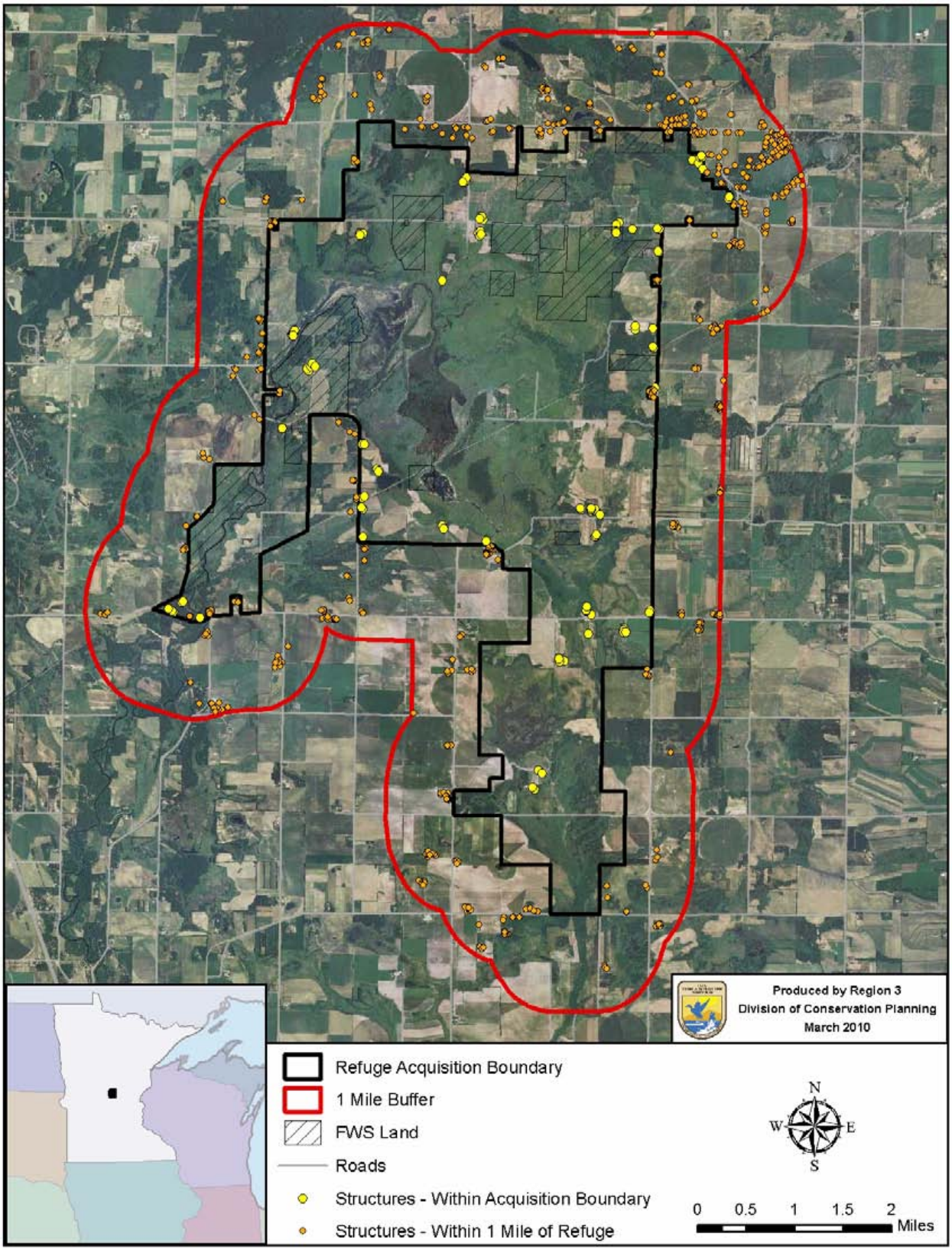
Other potential sources of contamination (i.e. high concentrations of phosphorous, manure, etc.) are associated with agricultural lands currently within and adjacent to the Refuge acquisition boundary as discussed in the previous section.

Climate Change

The increase of carbon dioxide and other greenhouse gasses in the Earth's atmosphere resulting from the burning of fossil fuels has been linked to the gradual rise in surface temperature, commonly referred to as global warming. In addition to rising air and water temperatures, there are a number of other effects associated with a changing global climate including intense heat waves, shrinking permafrost zones, winter snow cover, sea ice, and glaciers, ocean acidification, changing precipitation patterns and associated effects on water availability (drought, flooding), a general decrease in open water areas and soil moisture levels, increasing fire severity – intensity, extent, and frequency, migrating plant productivity and agricultural zones, habitat shifts at all scales from ecosystems and biomes to specific sites, dislocation of species as habitat ranges experience shifts, reductions, and/or expansions, increasing issues with plant and animal pathogens and pests – both exotic and endemic, and more.

Several examples of potential climate change impacts on wildlife have been identified. The following are just a few issues that may require further

Figure 27: Development Near Crane Meadows NWR



attention as climate change progresses (Green et al. 2000, Schneider and Root 2002).

- Habitat available for cold water fish such as trout and salmon in lakes and streams could be reduced.
- Forest distributions and compositions may change, with some species shifting their range northward, higher in altitude, or being replaced as other tree species move in to take their place.
- Ducks and other waterfowl could lose breeding habitat due to more severe and frequent drought events.
- Changes in the seasonality of life cycle stages such as migration and nesting could put some animals out of sync with the life cycles of their prey species.
- Herpetofauna may have trouble meeting the moisture conditions required for reproduction, and even respiration in their local habitats, and difficulty dispersing through inhospitable environments.
- Animal and plant species, including invasive or pest species, shift their ranges north in latitude as winter climatic conditions become more moderate and the warm seasons lengthen.

The resiliency of natural systems is tied to biodiversity. The diversity of organisms may be one of our greatest weapons against climate change; each organism will react and respond differently (Scott et al. 2009). Biological communities will not shift or remain intact because of the variability in each organism's sensitivity to climate change, size, mobility, lifespan, and the availability of food, shelter, and other resources it requires (Karl, Melillo, & Peterson 2009). In response, we must assess and provide for increased representation and redundancy across seasonal, geographic, and ecologic thresholds. Initial prioritization of action should be directed to those species for which climate change poses the greatest threat, namely those with limited distributions, highly specific ecological niches, and/or limited mobility. For example, plants and animals that are highly temperature sensitive or are confined to high altitudes or polar areas (Scott et al. 2009).

The U.S. Department of the Interior issued Secretarial Order Number 3226 in January 2001 requiring all federal agencies with land management responsibilities within the DOI to consider potential climate change impacts as part of long range planning efforts. This report was amended in January of 2009 to further expand and define bureau climate change, carbon sequestration, and energy conservation responsibilities.

In its 2009 strategic plan, 'Rising to the Urgent Challenges of a Changing Climate,' the Service calls for bold, aggressive, and strategic action to address climate change on three broad fronts: adaptation, mitigation, and education. Despite considerable uncertainty regarding the magnitude, extent, and timing of changes, the Service vision includes measures to "…sustain diverse, distributed, and abundant populations of fish and wildlife by conserving healthy habitats in a network of interconnected, ecologically-functioning landscapes (p. 8)."

The plan also describes six principles deemed essential to achieving this vision: priority setting, partnership, best science, landscape conservation, technical capacity, and global approach. Climate change was a key factor in the discussions and decision-making for the future management proposed in Crane Meadows NWR's CCP.

Mitigation and Adaptation

According to the 2009 report, 'Global Climate Change Impacts in the United States,' there are two broad categories of responses to global climate change: mitigation and adaptation. Mitigation refers to actions taken 'before' change occurs – efforts to reduce climate change as we move forward from the present, and curb its effects before they increase in severity or reach critical thresholds. Adaptation measures can be applied both 'before' (anticipatory) and 'after' (reactive) climate changes have occurred, and are actions aimed at avoiding or coping with harmful impacts and taking advantage of new opportunities presented by new climatic and environmental conditions (Karl, Melillo, & Peterson 2009; FWS 2009).

National wildlife refuges help mitigate the onset of climate change by increasing our ecological resiliency and reducing environmental stressors. Refuges will also play a critical role in adaptation strategies in the future. Table 11 on page 68 lists a number of examples in which refuges may contribute to climate change mitigation and adaptation.

The following paragraphs are excerpts from the 2000 report, 'Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change,' produced by the National Assessment Synthesis Team (NAST), an advisory committee chartered under the Federal Advisory Committee Act to help the U.S. Global Change Research Program fulfill its mandate under the Global Change Research Act of 1990. These excerpts are from the section of the report focused upon the eight-state Midwest Region.

Climate Trends of the Past Century

> "Over the 20th century, the northern portion of the Midwest, including the upper Great Lakes,

Table 11: Refuge Contributions to Climate Change Mitigation and Adaptation

Problems Associated with Climate Change	Refuge Mitigation Potential
Rising ambient air temperatures caused by increasing greenhouse gasses. Increased water temperatures.	Sequester carbon in vegetative biomass and serve as 'sinks' for greenhouse gasses. Set an example by moving towards agency-wide carbon neutrality. Contribute to efforts for increasing renewable energy development.
Changing precipitation frequency and intensity, including overwhelming water management systems	Provide floodplains as protection against surges, and reservoirs to buffer periods of drought. Enhance wetland and bottomland habitats for groundwater recharge and to filter waterborne pollutants (fertilizers, pesticides, excessive sediment).
Disrupted ecological processes and basic life support functionality	Tailor refuge management to protect or, if necessary, restore essential ecological processes and services such as pollination, seed dispersal, soil formation and stabilization, primary production, photosynthesis, and air, water, and nutrient cycling.
Rising sea levels and increasing tropical storm intensities	Where possible, buffer coastal areas with natural cover types thus minimizing socioeconomic losses as waters advance inland and storms pass from the oceans inland.
Modified fire frequency and intensity	Use controlled burn programs to reduce fuel loads on-refuge and serve as a source of trained fire professionals for other areas in need.
Loss of species and their required habitats	Protect lands with a diversity of habitats for declining species and spearhead efforts to protect species of concern. Protect genetic diversity and serve as a source for repopulation efforts.
Geographical shifts in biomes and species' ranges	Serve as large ecological hubs in a greater network of conservation lands allowing for species migration.
Altered species phenologies and interactions (competition, predations, parasitism, and disease)	Provide natural, minimally-altered settings for the evolutionary process and wildlife interaction.
Advancement of exotic invasives, pest species, pathogens, and contaminants	Manage to control and eradicate invasives on refuge lands, providing habitat for endemic species. Direct efforts to reduce species susceptibility to disease, pathogens, pests, and contaminants.
Limited scientific understanding of long-term climate change implications	Develop inventory and monitoring sites for ecological and climatic variables. Conduct directed research to address climate change topics. Continue to build scientific capacities and expertise in the Agency. Foster collaboration among conservation science community.
General lack of knowledge and understanding regarding climate change	Increase climate change education, training, and outreach both within the agency, and to external audiences. Tailor environmental education and interpretation programs to climate change topics. Provide conservation support to partners and other interested parties. Collaborate and share information and resources both internally and externally.
Inadequate legal, regulatory, and policy framework to address climate change	Assist in the review and revision of environmental laws, regulations, policies, guidance, and protocols to increase incentives and eliminate barriers to conservation actions addressing climate change. Revise grant programs to direct funding to projects that address climate change.

has warmed by almost 4°F (2°C), while the southern portion, along the Ohio River Valley, has cooled by about 1°F (0.5°C). Annual precipitation has increased, up to 20 percent in some areas, with much of this coming from more heavy precipitation events (NAST 2000)."

Climate Projections for the Next Century

"During the 21st century, it is highly likely that temperatures will increase throughout the region, likely at a rate faster than that observed in the 20th century, with models projecting a warming trend of 5 to 10°F (3 degrees to 6

degrees Celsius) over 100 years. Precipitation is likely to continue its upward trend, with 10 to 30 percent increases across much of the region. Increases in the frequency and intensity of heavy precipitation events are likely to continue in the 21st century. Despite the increase in precipitation, rising air temperatures and other meteorological factors are likely to lead to a substantial increase in evaporation, causing a soil moisture deficit, reduction in lake and river levels, and more drought-like conditions in many areas (NAST 2000)."

Midwest Key Issues

Water Resources

Water levels, supply, quality, and water-based transportation and recreation are all climate-sensitive issues affecting the Midwest Region. Despite the projected increase in precipitation, increased evaporation due to higher summer air temperatures is likely to lead to reduced water levels in the Great Lakes. Of 12 models used to assess the future of Great Lakes hydrology, 11 suggest significant decreases in lake levels while one suggests a small increase. The total range of the 11 models' projections ranges from a less than 1-foot increase to a more than 5-foot decrease. A 5-foot (1.5-meter) reduction would lead to a 20 to 40 percent reduction in outflow to the St. Lawrence Seaway. Lower lake levels will cause reduced hydropower generation downstream, with reductions of up to 15 percent by 2050. The projected increase in demand for water across the region while there is a simultaneous decrease in net flows is of particular concern. As demands for water increase there is a possibility for increased national and international tension related to growing pressure for water diversions from the Lakes. For smaller lakes and rivers, reduced flows are likely to make water quality issues more acute. In addition, the projected increase in very heavy precipitation events will likely lead to an increase in flash flooding, and thus worsen agricultural and other non-point source pollution as more frequent heavy rains wash pollutants into rivers and lakes. Lower water levels are likely to make water-based transportation more difficult, with increases in navigation costs from 5 to 40 percent. Some of this increase may be offset as reduced ice cover extends the navigation season and the geography of navigable waters changes. Reduced water levels may also decrease shoreline damage resulting from high lake levels by 40 to 80 percent.

Adaptations: A reduction in lake and river levels would require adaptations such as re-engineering of ship docks and locks for transportation and recreation. If flows decrease while demand increases, international commissions focusing on Great Lakes water issues will become even more important in the future. Improved forecasting of extreme precipitation events could help reduce some related impacts.

Agriculture

Agriculture is of vital importance to this region, the nation, and the world. Agricultural systems have exhibited a capacity to adapt to moderate differences in growing season climate, and it is likely that agriculture will be able to continue to adapt. With an increase in the length of the growing season, double cropping, the practice of planting a second crop in a single year after the first is harvested, is likely to become more prevalent. The fertilization effects of carbon dioxide are likely to enhance plant growth and contribute to generally higher yields. The largest increases are projected to occur in the northern areas of the region, where crop yields are currently temperature limited. However, yields are not likely to increase in all parts of the region. Consumers may pay lower prices due to increased yields, while producers are likely to suffer reduced profits because of declining prices. Increased use of pesticides and herbicides are very likely to be required, presenting additional challenges.

Adaptations: Plant breeding programs can use climate prediction models to direct research to breeding new varieties for new growing conditions. Farmers can then choose varieties better suited to the expected climate. It is likely that plant breeders will need to use all tools available in adapting to climate change, including genetic engineering. Modifying planting and harvest dates, planting densities, and using integrated pest management, conservation tillage, and new farm technologies are additional options. There may be opportunities to shift or expand the area where certain crops are grown if climate conditions become more favorable. Weather conditions during the growing season are the primary factor in year-to-year differences in corn and soybean yields. Droughts and floods result in large yield reductions. Severe droughts like the drought of 1988 cause yield reductions of over 30 percent. Reliable seasonal forecasts would help farmers adjust their practices from year-to-year to respond to such events.

Changes in Semi-natural and Natural Ecosystems

Forests: Different U.S. forest types are expected to expand (oak-hickory), contract (maple-beech-birch), or disappear altogether (spruce-fir) (Ryan et al. 2008). The Upper Midwest has a unique combination of soil and climate conditions that favor the growth of conifer forests. Higher temperatures and increased evaporation will likely reduce boreal forest acreage, and make current forestlands more susceptible to pests and diseases. It is likely that the southern transition zone of the boreal forest will be

susceptible to expansion of temperate forests, not to mention increased competition from other land use pressures. However, warmer weather (coupled with beneficial effects of increased carbon dioxide on vegetation), are likely to lead to an increase in tree growth rates on marginal forestlands that are currently temperature-limited. Most climate models indicate that higher air temperatures will cause greater evaporation and hence reduce soil moisture, a situation conducive to forest fires. Increased temperatures and longer growing seasons may also speed up decomposition rates and nutrient cycling, depending on water availability. As the 21st century progresses, there will be an increased likelihood and intensity of environmental stress on both deciduous and coniferous trees, making them susceptible to disease, pest infestation, and ultimately, mortality.

Water Habitats: As lake water temperatures increase, major changes in freshwater ecosystems will very likely occur. For example, a shift may occur from cold water fish species such as trout, to warmer water species such as bass and catfish. Warmer water is also likely to create an environment more susceptible to invasive, non-native species. Runoff of excess nutrients (such as nitrogen and phosphorus from fertilizer) into lakes and rivers is likely to increase due to an increase in heavy precipitation events. This, coupled with warmer lake temperatures, is likely to stimulate the growth of algae, depleting dissolved oxygen content in the water to the detriment of other living organisms. Reduced lake levels will likely impact the current distribution of wetlands. There is a chance that some wetlands could migrate gradually over time, but in areas where their migration is limited by the topography or anthropogenic land change, they would disappear. Changes in bird populations and other native wildlife have already been linked to increasing temperatures, and more changes are likely in the future.

Outdoor Recreation

The climate change impacts on environmental systems will have direct consequences to humans. In the context of Service management responsibilities, this may result in effects on appropriate and compatible Refuge uses. Popular winter activities such as cross-country skiing, snow-shoeing, and ice fishing may have shorter seasons, and have the potential to be compromised by thinner ice and reduced snow cover. Opportunities for warm-season activities can be expected to see similar but opposite changes. Not only may warm-weather recreation seasons lengthen, but changing life cycles and distributions of wildlife may alter opportunities for hunting, wildlife viewing, and photography. Changes in activities not only affect Refuge management, but the local and regional economy.

Administrative Facilities

Because of Crane Meadows NWR's small size and limited land in fee-title ownership, there is a small staff and minimal administration facilities. The main office (a converted private residence), four maintenance buildings, and their associated gravel parking lots comprise the administrative headquarters. The office building was renovated in 1992 when the Service began managing the first Refuge tracts, and has three offices and a small kitchen /common area.

Cultural Resources

The geology and hydrology in the area surrounding the Crane Meadows NWR have combined to produce one of the most potentially rich archaeological locations in the region. The pre-settlement habitats of oak savanna, tallgrass prairie, and sedge-meadow wetland, co-mingled with a large number of water features (Rice Lake, Skunk Lake, Mud Lake, Platte River, Skunk River, Rice Creek, Buckman Creek, and Little Rock Creek), would have provided an inviting wealth of animal and plant resources (particularly wild rice) for the prehistoric inhabitants of the region.

To date, only three prehistoric archaeological sites have been positively identified within the boundaries of the Refuge acquisition boundary. All three are habitation and mound sites containing between 2 and 10 circular burial mounds each. The largest of the mounds is reported to be between 15 and 25 feet high – likely the largest mound in Morrison County. Archaeological research conducted in the habitation areas has revealed that these locations were occupied for at least the last 3,000 years. Two of the mound sites were determined to be so significant and unique, that they were designated

Green-wing teal. Photo credit: Beau Liddell

the *Rice Lake Prehistoric District* and listed on the National Register of Historic Places (NRHP) on October 2, 1973.

The Pelkey Lake Site, which is located only 1 mile north of the Refuge, was also listed on the NRHP in 1973. Archaeological evidence there indicates that the site was used for the last 10,000 years by people of the Paleo-Indian, Archaic, and Woodland periods. In addition, dozens of local residents have collected artifacts from the area (four archaeological sites are known to exist immediately adjacent to the Refuge) that reflect a long and continuous occupation of the region beginning with the Paleo-Indian period approximately 10,000 years ago.

The use of the area historically includes ricing, gathering, and hunting (bison and large herds of elk were observed as late as 1806) by the Dakota and Ojibwe. The Platte River also served as a major canoe route between Lake Mille Lacs and the Mississippi River by Native Americans and Euro-American explorers, trappers, and traders. Dams were built on the Platte River during the mid 1800s and the first log drive occurred in 1856, the practice continued until the turn of the century. Euro-American settlement of the area began about 1850 with farmers clearing the land and building homesteads. The Minneapolis, St. Paul, and Saulte Ste. Marie (Soo Line) railroad laid new track between Mud and Skunk Lakes and plated the town of Vawter around 1908. The town contained several stores, a grain elevator, community church, and school. By 1940, the town was abandoned.

Archaeological and historic sites associated with the above events have not been previously identified or recorded, but are believed to exist within the Refuge. To date, only one archaeological investigation covering 5 acres has been conducted within the Refuge since it was established in 1992.

Section 2 – Current Management

The following section describes current and past management of Service-owned lands within the Crane Meadows Refuge acquisition boundary. To more easily facilitate management descriptions throughout this CCP, a temporary naming convention is used to reference the Service-owned properties within the Refuge acquisition boundary. A series of unit names was created as a part of the planning process to identify 12 distinct management areas (see Figure 28.)

Habitat Management

Wetlands

The greatest conservation priority at Crane Meadows NWR is protecting one of Minnesota's largest remaining wetland complexes through land acquisition. Several wetlands within the proposed Refuge boundary are completely or partially drained for agricultural purposes and need to be restored. Restoration, protection, mechanical treatment of invasive species, and rotational prescribed burning are currently the only active management on Refuge-owned wetland habitat. Prescribed burning is limited due to difficult mobility in these areas and because of fragmented Service land ownership. Burns are often coordinated with adjacent private landowners.

Open Water

Open waters, including Mud, Rice, and Skunk Lakes, are under state jurisdiction and management. A weir with a water control structure was built on the Platte River where it exits Rice Lake to maintain minimum water levels in the lakes for recreational use in the fall.

River/Streams

No direct management is currently associated with river and stream areas. A spring clean-up day is conducted on many creeks and rivers throughout the Refuge acquisition boundary.

Emergent Marsh

No active management is currently associated with this habitat type other than the presence of the state-managed weir on the Platte River. Ditch plugs were used in 1996 to restore emergent marsh on the Headquarters Unit. Various methods for controlling invasive plant species, particularly purple loosestrife, have been used in these areas.

Beaver leveler used on a Private Lands project. Photo Credit: FWS

Sedge Meadow

There is currently little active management directly associated with this habitat other than protection and suppression of woody encroachment through prescribed burning and mechanical cutting.

Willow-dogwood Shrub Swamp

These areas undergo rotational prescribed burns where possible to control the spread of woody vegetation into other adjacent habitats.

Northern Floodplain Forest

No active management programs are currently associated with this habitat type. Natural flood events occur regularly and wind throw occurs over time.

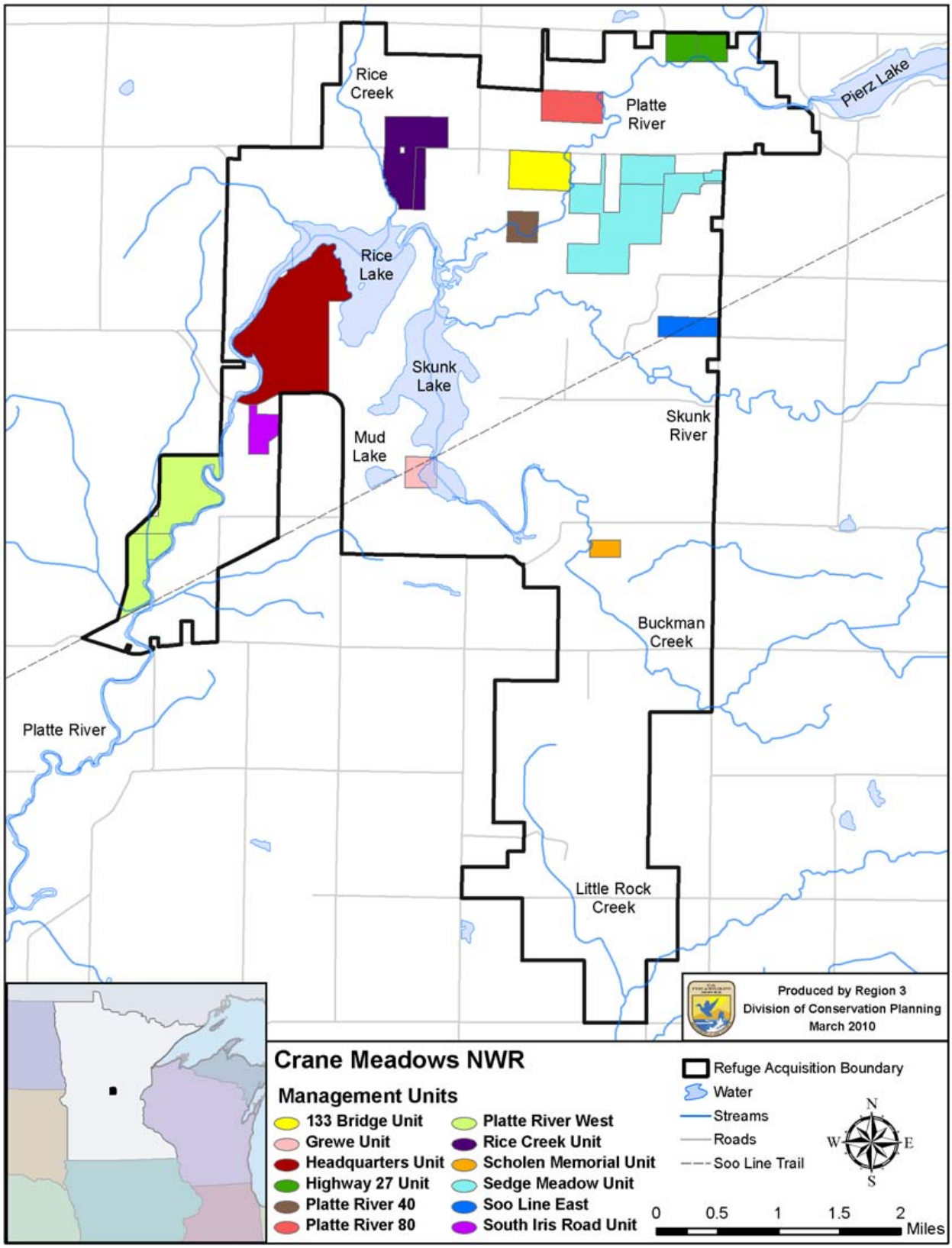
Uplands

Grasslands (Southern Dry Prairie, Southern Mesic Prairie, and Wet Prairie)

Prescribed fire is used to rejuvenate grassland and prevent woody encroachment. The Refuge has a greenhouse in which native grasses and forbs are propagated for use during restoration activities. As new properties are acquired by the Refuge, upland areas formerly in agriculture are seeded with prairie grass and forb species:

- Prior to the creation of the Refuge, several former agricultural fields on the Headquarters Unit were seeded to native warm-season grasses.
- 1994: The Platte River 80 Unit and the northern half of the Platte River West Unit were seeded with a mix of native prairie grasses from Big

Figure 28: Refuge Unit Names, Crane Meadows NWR



Stone NWR near Odessa, Minnesota. Plant species included in this mix were primarily big bluestem, little bluestem, and Indiangrass, with lesser components of switchgrass, side-oats gramma, purple prairie clover, and black-eyed susan.

- 1997: The front field of the Soo Line East Unit and some areas on the Sedge Meadow Unit were seeded with the same Big Stone mix.
- 1999: The Highway 27 Unit was seeded to a short dry grass mix, predominantly little bluestem. This area has become a seed production area for the Refuge.
- 2003: The Highway 27 Unit was inter-seeded using a local, dry, shortgrass mix purchased from Prairie Restorations, Inc.
- 2005: A home site was removed from the north half of the Platte River West Unit and the site was seeded with prairie grasses of local origin. Also, the south half of the Platte River West Unit, and a small field on the east edge of the Sedge Meadow Unit were seeded to a big bluestem/Indiangrass mix. These two sites are used as seed production areas for the Refuge. The seed is harvested at maturity each year and used to seed other areas at Crane Meadows and Sherburne NWRs.
- 2006: Forty acres on the Headquarters Unit were seeded to big bluestem/Indiangrass and now serve as a seed production area.
- 2007: The 9-acre interior field on the Soo Line East Unit was seeded to Indiangrass of local origin, and is now used as a seed production area.

Oak Savanna (Southern Dry Savanna)

Current management consists of rotational prescribed burning to restore a historical disturbance and to suppress woody encroachment on sections of the Headquarters Unit.

Woodlands (Oak, Oak-Aspen, and Jack Pine)

Management of woodlands includes rotational prescribed burning in wooded areas on the Platte River West and Sedge Meadow Units to reduce hazardous fuel loads, and the removal of conifer plantations:

- 2005-2006: A windbreak of spruce trees was removed along the periphery of the home site on the north half of the Platte River West Unit.
- 2007: Conifer plantations were removed from the Platte River 80, Highway 27, and an east portion of the Sedge Meadow Unit.

Agriculture (Cropland/Pasture)

The last 40 acres of agricultural land on the Refuge were removed from production in 2005 on the Headquarters tract, just east of the road to the Refuge office. Following the purchase of the South Iris Road Unit in 2008, the property's 4 acres of agriculture were removed from production. Staff will continue to eliminate agriculture from all newly acquired properties, restoring these areas to native upland habitats.

Fish and Wildlife Management and Monitoring

Refuge fish, wildlife, and habitat monitoring activities and surveys are conducted to provide information for management decisions, to enhance biological integrity of the Refuge, and to support statewide and national conservation efforts. Many of the surveys on the Refuge are done in collaboration with other agencies such as the Minnesota Department of Natural Resources, the International Crane Foundation, the Bluebird Recovery Team, etc. Fish, wildlife, and vegetation monitoring activities include:

Migratory and Resident Birds

Sandhill Crane Survey: (Unison Call Survey) A unison call survey is conducted each spring (late April) at the peak of the crane nesting season. The purpose of this survey is to estimate the number of Greater Sandhill Crane breeding pairs. The survey lasts 2 hours, beginning one-half hour before sunrise and ending 1 and a half hours after sunrise. At numerous survey locations observers record the time, compass direction, and distance of unison calls heard. During the field season, general observations of known pairs in the area or nest site locations validate and supplement the unison call data.

Annual Midwest Crane Count: This survey is one of the largest citizen-based inventories in the world. It is hosted by the International Crane Foundation (ICF), and Morrison County is one of only 12 counties in Minnesota included in the survey. The purpose of this survey is to monitor the abundance, distribution, and population trends of cranes in the Upper-Midwest. One Saturday in April observers record individual birds and breeding pairs (identified by unison calls).

Waterfowl Survey: Waterfowl surveys are conducted one morning each week during early migration each spring and fall. The data are used to provide managers and the public with up-to-date information on the presence and abundance of waterfowl species using the Refuge. This survey is also used to monitor long-term trends of waterfowl populations.

Marsh Bird Surveys: A survey of secretive marsh birds was conducted between April and June from 2002 to 2004. Play-back calls were used to detect the presence of Yellow Rails, Virginia Rails, Soras, Least Bitterns, American Bitterns, and Pied-billed Grebes. Data is used to inform managers and direct habitat management objectives and strategies for wetlands on the Refuge. This data also contributes to the National Marsh Bird Monitoring Program which tracks marsh bird population trends throughout the nation.

Bald Eagle Monitoring: All Bald Eagle nests on the Refuge are monitored each spring (March to May) during the waterfowl survey and periodically throughout the year.

Songbird Point Counts: Every 3 to 5 years, point counts are performed for 2 consecutive years. This survey tracks the population trends and habitat use of breeding songbirds.

Christmas Bird Count: The Christmas Bird Count is an annual 1-day event in December hosted by the National Audubon Society and conducted by volunteers. Each species is recorded as well as the number of individuals within a species. This survey provides a basic inventory of birds observed at the Refuge during the winter.

Mourning Dove Survey: Call count surveys are conducted annually in the 48 contiguous states to monitor Mourning Dove populations and to provide managers with an annual index of population size. The data is used by wildlife administrators to set annual hunting regulations. The Refuge has participated in this survey for approximately 15 years.

Woodcock Survey: Singing ground surveys of woodcock are conducted annually to provide indices of recruitment, hunting success, changes in abundance, and annual population changes. The Refuge has participated in this survey for approximately 15 years.

Bluebird and Wood Duck Boxes: Nest boxes for Bluebirds and Wood Ducks were built and implemented on the Refuge in 2007 and 2008.

Native Resident Wildlife

Small Mammal Survey: A survey was conducted in 2004 using live traps to inventory small mammal species on the Refuge.

Frog and Toad Calling Survey: Frog/toad calling surveys were conducted in 2002-2004. The purpose of these surveys was to inventory species presence or absence, and to determine population status and diversity. Survey methods were adopted from the North American Amphibian Monitoring Program, and the data collected was shared with Minnesota Frog Watch.

Fish and Other Aquatic Resources

Fish Surveys: Several fish surveys have been completed on the Refuge in collaboration with the Minnesota DNR. These surveys use electro-shockers to document the fish species present, number of individuals caught, and their lengths. The surveys track diversity, population estimates, spawning information, and aid in the development of habitat management plans and public fishing regulations.

Habitat Monitoring and Management

Prescribed Fire Monitoring: Fire monitoring is accomplished using protocols established by the National Park Service and the U.S. Forest Service. The Refuge has seven designated burn units that are used to monitor the long-term effects of fire on vegetation composition and to determine if habitat management objectives are being met. Three are grassland plots and four are woodland plots. All plots are sampled pre-burn, immediately post-burn, and at intervals of 1, 2, 5, and 10 years following any prescribed burns.

Invasive Plant Monitoring and Management: Annual purple loosestrife monitoring occurs on the Refuge, and a biological control is used as needed to manage infestations. The presence of other invasive species such as Siberian elm, black locust, spotted knapweed, Canada thistle, leafy spurge, and buckthorn are monitored on the Refuge, and are treated where possible.

Wildlife Lake Habitat Survey: The Minnesota DNR has conducted lake habitat surveys for Rice and Skunk Lakes (1950, 1962, 1966, 2003, and 2006). These studies sample along transect lines that traverse each lake, and are used to assess the condition of the system and document wildlife diversity and plant species composition.

Wild Rice Surveys: The Minnesota DNR has monitored wild rice trends in the complex since the mid-1970s, and in more recent years has conducted wild rice surveys using aerial imagery to determine its abundance and distribution on Rice and Skunk Lakes.

Water Surveys: Water surveys occur on and around the Refuge in collaboration with various agencies and organizations, including the DNR, USGS, and Aquatech. See "Water and Hydrology" on page 48 for more information.

Wetland Health Evaluation: Beginning in 2009, Releve plots have been established to survey and inventory wetland vegetation and invertebrates.

Table 12: Refuge Visitation – Crane Meadows National Wildlife Refuge

Refuge Activity	2005	2006	2007	2008
Platte River Trail	1,960	2,098	4,508	5,388
Habitat Day	500	550	450	475
Environmental Education	615	151	396	688
General Refuge Visitation	8,171	3,925	5,380	6,317

Theresults are then used to develop indices of biological integrity, providing insight to the health of the wetland system.

Visitor Services

The National Wildlife Improvement Act of 1997 established six priority uses of the Refuge System:

- Hunting
- Fishing
- Wildlife observation
- Wildlife photography
- Environmental interpretation
- Environmental education.

All but hunting and fishing are a part of current management at Crane Meadows NWR. The Headquarters Unit is currently the only Refuge property with public access and accommodations for public use. The Refuge provides a number of facilities including trails, observation platforms, kiosks, and benches to facilitate wildlife-dependent recreation, and overall visitation for Refuge activities has increased in recent years (see Table 12).

Hunting

The Refuge is not currently open to hunting because Service land ownership inside the Refuge acquisition boundary is relatively small, scattered, and interspersed with privately owned land. Consistent with its establishment goals, Refuge staff are seeking ways to overcome these and other obstacles to provide safe and manageable hunting opportunities at Crane Meadows NWR.

Fishing

Fishing is permitted on all state-managed public waters, including Rice, Skunk and Mud Lakes, and the Platte River. Fishing, however, is not permitted on Crane Meadows NWR property along the banks of Refuge rivers, streams, or lakes. Public boat access to these areas is available at two sites maintained by the state. One is located above the low flow dam and affords access to Rice, Skunk, and Mud Lakes. Another site just below the dam provides access to the Platte River.

Wildlife Observation and Photography

Opportunities to observe and photograph wildlife are provided year-round on the scenic 3.7-mile Platte River Trail (see Figure 29 on page 77). The trail leads visitors along the banks of the Platte River to the edge of Rice Lake, then returns to the trailhead through oak woodland, oak savanna and prairie habitat. The trail has four loops. Two shorter, inner loops are available for visitors with limited time or mobility. Long and medium length loops are also available. The entire trail was improved and surfaced with crushed granite in June 2008. Two observation platforms are provided, one adjacent to the Platte River near the trailhead and the other overlooking Rice Lake. The Rice Lake Overlook was constructed with a permanent spotting scope and a wide middle section to accommodate larger groups and provide a space for environmental education programs. Bicycles and horses are not permitted on Refuge trails.

During the winter season, the Platte River Hiking Trail is groomed for cross country skiing as snow conditions permit. A double wide groomer is used to set a side-by-side track. Snowshoers and winter hikers are asked to be respectful of tracks set for skiers and hike to the side of the trail.

Interpretation and Programs

Habitat Day

The Refuge, the Friends of Crane Meadows NWR, and numerous other co-sponsors annually host Habitat Day for Wood Ducks and Bluebirds during March. Since 2000, this event has developed and enhanced partnerships among more than 40 natural resource agencies, conservation organizations, area schools, and local businesses. During the event, participants learn about Wood Ducks and Bluebirds and have the opportunity to assemble a free nest box to place on their own property. In addition to creating nest boxes for wildlife, this program also introduces people to conservation groups in the area and creates opportunities for future involvement.

Additional results of this event include two Bluebird trails established on the Refuge and several others created off-Refuge within the county. The

Figure 29: Existing Visitor Services Facilities, Crane Meadows NWR

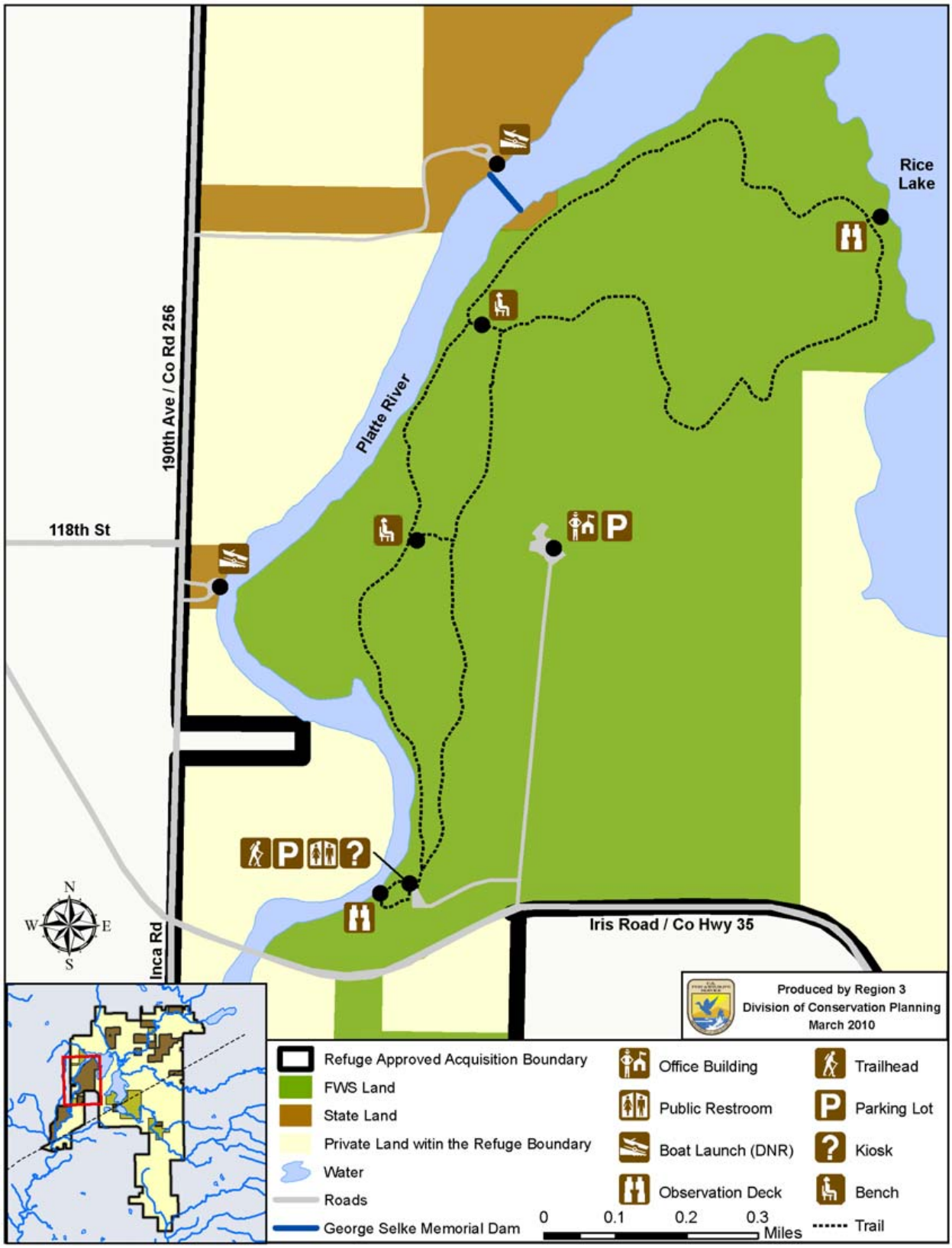


Table 13: Volunteerism at Crane Meadows National Wildlife Refuge

Volunteer Participation	2004	2005	2006	2007	2008
Total Number of Volunteers	32	37	41	63	71
Total Volunteer Hours	1,722	2,326	1,865	2,543	2,626

Refuge trails are monitored weekly by Refuge volunteers, and off-refuge trails are monitored by the local Boys and Girls Club. Results are tabulated at the end of each breeding season and submitted to the Bluebird Recovery Program. Birdhouses assembled during Habitat Day have led to the first recorded Bluebird nesting results in Morrison County.

Platte River Clean-up

The Refuge, the Friends of Crane Meadows NWR, and the Royalton Lions Club host an annual river cleanup each June. Participants clean a 26.5-mile stretch of the Platte River from Highway 27 south to the Mississippi River. The northern section of this route flows through the Refuge, and participants have the opportunity to fish and birdwatch while picking up litter.

Bat Program

The Refuge hosted a bat program in 2007 and 2008. Participants were able to built bat houses to take home, attend presentations on bats species in Minnesota, take tours to locate bats, and learn about the mechanics of echolocation.

Bird Tour

The Refuge, its Friends Group, and the Morrison Birding Club offer a guided bird tour on the Platte River Trail each spring. The Morrison County Birding Club has helped the Refuge develop a birding brochure, and lists Crane Meadows NWR on their website as an excellent birding spot in the county.

Environmental Education and Outreach

Staff and volunteers lead educational programs at the Refuge for organized groups upon request. For a number of years, Royalton Elementary School has used Crane Meadows NWR in the spring as an outdoor classroom. In 2009, the Friends of Crane Meadows established an Environmental Education Committee to initiate dialog with area school superintendents, principles, and teachers to use the Refuge as an outdoor classroom for their students. The Royalton School District will be the pilot project.

Refuge staff and Friends members bring a Refuge exhibit to local business expos, the Morrison County Fair, home and garden shows, senior expos, and other off-site events as opportunities arise. Refuge staff assists with the U. S. Fish and Wildlife Service exhibit at the annual Game Fair in Anoka County in October. They also work with chapters of Pheasants Forever during their Youth Day Programs.

The Refuge participates in the Morrison County Water Festival held at Camp Ripley each year during the third week in September. Several hundred fifth-grade students from Little Falls and other area schools attend and participate in a variety of 30-minute environmental education programs conducted by staff from the Refuge, Camp Ripley, Morrison County Soil and Water Conservation District, The Nature Conservancy, and the Minnesota Department of Natural Resources.

Friends Group

The Friends of Crane Meadows NWR, a non-profit 501(c)(3) organization formed in September 2006, assists the Refuge with educational programs and provides financial backing for selected programs and projects through fund-raising activities. At the end of fiscal year 2008, the Friends Group had 61 members. The Friends' projects have included funding and assistance with the construction of the Rice Lake observation deck, and the development of the greenhouse program which grows native wildflowers for planting on the Refuge.

Volunteer Program

Volunteers actively participate in a wide variety of visitor services and biological programs on the Refuge. Their activities include wildlife surveys, wildflower gardening, assisting with special events, and trail maintenance. Table 13 shows an overall increase in volunteership on the Refuge over the past 5 years.

Partnerships

The staff at Crane Meadows NWR has a strong history of working with partners to implement Service policy, programs, and projects. Many initial partnerships began during the creation of Crane Meadows NWR or have been developed through the land acquisition processes. Saint Cloud State University, The Nature Conservancy, and the Minnesota DNR have been involved with the Refuge since

Pileated Woodpecker. Photo Credit: FWS

its establishment, and have been strong allies in protecting this unique and important area.

Additional partnerships have been formed through the Service's Partners for Fish and Wildlife Program. This program has strengthened working relationships with the Morrison County Soil and Water Conservation District, the Natural Resources Conservation Service, Ducks Unlimited, the Minnesota Waterfowl Association, and many private land owners in Morrison County.

In its ninth year, the Habitat Day Program has also led to the development of a number of relationships. In addition to those entities mentioned above, collaboration for this event includes many area schools, all of the sportsmen clubs in Morrison County, the Central Minnesota Audubon Society, the St. Cloud Environmental Council, the Minnesota Deer Hunters Association, Pheasants Forever, Morrison County Sentence to Serve, Boy Scout troops, 4-H clubs, Camp Ripley Environmental Office, and the Morrison County Chapter of the National Wild Turkey Federation.

Other important sources of support for the Refuge have come from the Friends of Crane Meadows NWR group. Since 2006 this group has promoted the Refuge's identity, advocated on its behalf, and increased its environmental education program. As a result, the Refuge partners list has grown to include the Little Falls Chamber of Commerce, the Visitors Bureau, Morrison County Birding Club, the Central Minnesota Audubon Society, Royalton Lions, Royalton Elementary, the Pine Grove Zoo, and the Lindbergh State Park and Historic Site.

Cultural Resources

Cultural resources (archaeological sites, historic structures, and Native American traditional cultural properties) are important parts of the nation's heritage. The Service strives to preserve evidence of these human occupations which can provide valuable information regarding not only human interactions with each other, but also with the natural environment. Protection of cultural resources is accomplished in conjunction with the Service's mandate to protect fish, wildlife, and plant resources.

The Service is charged with the responsibility, under Section 106 of the National Historic Preservation Act of 1966 (NHPA), of identifying historic properties (cultural resources that are potentially eligible for listing on the National Register of Historic Places) that may be affected by our actions. The Service is also required to coordinate these actions with the State Historic Preservation Office, Native American Tribal Governments, Local Governments, and other interested parties. Cultural resource management in the Service is the responsibility of the Regional Director and is not delegated for the Section 106 process when historic properties could be affected by Service undertakings, for issuing archaeological permits, and for Indian tribal involvement.

The Archaeological Resources Protection Act of 1979 (ARPA) Section 14 requires plans to survey lands and a schedule for surveying lands with "the most scientifically valuable archaeological resources." This Act also affords protection to all archeological and historic sites more than 100 years old (not just sites meeting the criteria for the National Register) on federal land, and requires archeological investigations on federal land be performed in the public interest by qualified persons.

The Regional Historic Preservation Officer (RHPO) advises the Regional Director about procedures, compliance, and implementation of these and other cultural resource laws. The actual determinations relating to cultural resources are to be made by the RHPO for undertakings on Service fee title lands and for undertakings funded in whole or in part under the direct or indirect jurisdiction of the Service, including those carried out by or on behalf of the Service; those carried out with federal financial assistance; and those requiring a federal permit, license, or approval.

Prescribed burn at Crane Meadows NWR. Photo Credit: FWS

The responsibility of the Refuge Manager is to identify undertakings that could affect cultural resources and coordinate the subsequent review process as early as possible with the RHPO and state, Tribal, and local officials. Also, the Refuge Manager assists the RHPO by protecting archeological sites and historic properties on Service managed and administered lands, by monitoring archaeological investigations by contractors and permittees, and by reporting ARPA violations.

Private Lands Program (Partners for Fish and Wildlife)

Outright fee-title acquisition of property by the federal government can be a difficult, costly, and lengthy process. Furthermore, to ensure the persistence of entire natural communities and ecosystems, habitat management has to be done on a much broader scale and include the private sector; an estimated 60 percent of our Nation's lands are held in private ownership (Lubowski et al. 2006).

The Partners for Wildlife Program is a voluntary program that has been offered nationwide by the Service since 1987 to provide landowners with technical and financial assistance in restoring habitat and managing private property to benefit wildlife. The responsibility for the Partners Program among Minnesota's 87 counties is divided between the 15 Minnesota field stations and a State Private Lands Office in Waite Park, Minnesota. The success of this program in Minnesota is demonstrated on more than 17,000 sites with over 120,000 wetland, upland, streambank, and aquatic habitat acres restored since the program began, as well as the partnerships developed with federal, state, local, private conservation organizations, communities, schools, groups, businesses, and other private individuals.

Private lands activities for six Minnesota counties are managed out of the Crane Meadows NWR Field Office. At the Refuge level, Morrison County is assigned to Crane Meadows NWR, while Sherburne, Anoka, Isanti, Kanabec and Pine Counties are covered by Sherburne NWR. However, both private lands coordination positions are currently stationed at Crane Meadows NWR. It is also common for Service field stations to assist one another with activities due to a project's location, time constraints, required expertise, or equipment needs. As such, Crane Meadows NWR staff have also assisted restorations in Benton, Todd, and Cass Counties.

A priority for the Private Lands Program is to work on projects that have the potential to affect and improve Refuge resources. At Crane Meadows NWR, assisting landowners within and immediately adjacent to the acquisition boundary has been a primary focus of restoration. The Refuge is able to implement many of the same conservation practices on private lands as it would on Service-owned and managed land. Because water quality is a high priority for the Refuge, priority is also given to projects located in the watershed above the Refuge. In addition, the Refuge is involved with a project to restore oak savanna habitat within the Anoka Sand Plain. Priorities include lands adjacent to public natural areas or parks, those that are adjacent to larger contiguous natural areas, and conservation corridor areas that facilitate wildlife movement.

Most projects involve wetland restorations. Ditching was a common method for draining wetlands in the area, so wetlands are often restored by creating an impoundment with an earthen dam. Restoration of native upland prairie has increased in the last several years, particularly in Sherburne and Isanti Counties. Other projects include oak savanna restoration and stream bank stabilization projects. The number of wetlands and uplands restored in Morrison County since 2001 is summarized in Table 14.

In addition to numerous successful habitat restorations, this program has fostered excellent relationships between the Service and many local partners, hunt clubs, and private citizens. For larger projects, the Refuge typically seeks additional support from federal agencies, state agencies, counties, townships, non-governmental organizations such as Pheasants Forever, Minnesota Waterfowl Association, Ducks Unlimited, and private groups such as the Pinnacle Hunt Club and the Audubon Nature Center.

Landowners or administrators who benefit from this program must sign a Habitat Development Agreement (HDA) prior to any restoration work conducted on the property. The Agreement is a contract between the FWS and the cooperator, and states that the restoration must not be destroyed or damaged during the 10- or 15-year agreement

Table 14: Morrison County Private Lands Program Accomplishments

Year	Wetland Acres	Wetland Sites	Upland Acres	Upland Sites
2001	15	2	0	0
2002	128	11	60	4
2003	249	15	43	3
2004	216	10	0	0
2005	148	10	111	7
2006	241	7	102	10
2007	496	9	45	4
2008	307	6	0	0
2009	267	11	0	0
Total	2067	81	361	28

Table 15: Six-year Operations and Maintenance Budget

FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009
$125,629	$152,647	$120,507	$143,325	$119,437	$119,472

period. Otherwise, the cooperator is responsible for reimbursement of the federal funds obligated toward the project. Maintenance on projects is the responsibility of the cooperator.

Law Enforcement

Certain safeguards must be in place to protect visitors, visitor use areas, cultural areas, administrative zones, residential areas, wildlife habitat, and wildlife resources from criminal or negligent actions, as well as from acts of nature. Without a staff law enforcement officer on the Refuge, Crane Meadows NWR relies on assistance from the local state DNR conservation officer, the Morrison County sheriff's office, and law enforcement officers from other refuges brought in as needed. At the time of writing, both Tamarac NWR (3 hours northwest of Crane Meadows NWR), and Litchfield Wetland Management District (2 hours south of the Refuge) provide law enforcement officers as needed.

Overall, there are few problems or violations at the Refuge. Those that do occur are predominantly natural resource related, including illegal hunting and poaching, vehicular and ATV trespass, Farm Service Agency (FSA) easement violations, and dumping. In 2007 the only incidents reported were four easement violations. In 2008 there were 24 documented offenses related to trespass (10), easement violations (6), fishing (3), hunting (2), and other resource violations (3).

Staff and Budget

Administrative and operational staff for Crane Meadows NWR has changed little since the establishment of the Refuge in 1992. Its first manager arrived in September of 1992, and remained the only staff until a maintenance position was added in June of 1993. On January 1, 1994, Crane Meadows NWR was "complexed" with Sherburne NWR. As a part of this transition, management of both units was combined and oversight of Crane Meadows NWR moved to the headquarters at Sherburne NWR. With a small, federally-owned land base at Crane Meadows NWR and similar habitats and wildlife to Sherburne NWR, complexing the Refuges has provided Crane Meadows NWR with additional support from the larger staff at Sherburne NWR. For the next 10 years a maintenance position was the only staff position at Crane Meadows NWR. In October of 2004 a second position, a combined Refuge Operations Specialist and Private Lands Biologist, was added providing on-refuge management for day-to-day operations under the supervision of the complex manager. The two-person staff has continued to the present, with seasonal intern positions to help with busy summer schedules.

Crane Meadows NWR Staff, 2009:

- Private Lands Biologist/Refuge Operations Specialist
- Maintenance

The operating a maintenance budget for the Refuge over the last 6 years has slightly decreased overall. The budget history is displayed in Table 15.