CHAPTER 4—Affected Environment

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Grasslands characterize much of the Karl E. Mundt National Wildlife Refuge.

This chapter describes the Complex's environmental resources that may be affected by the implementation of the CCP. It describes the physical environment and biological resources of Complex lands as well as its fire and grazing history, cultural resources, visitor services, socioeconomic environment, and operations.

4.1 Physical Environment

Located in southeastern South Dakota, the Lake Andes National Wildlife Refuge Complex includes two refuges and 85 waterfowl production areas (within one wetland management district) scattered throughout 14 counties (Aurora, Bon Homme, Brule, Charles Mix, Clay, Davison, Douglas, Gregory, Hanson, Hutchinson, Lincoln, Turner, Union, and Yankton). Complex staff manage thousands of noncontiguous tracts of Federal and private land totaling 110,925 acres: 21,193 acres of refuges and waterfowl production areas and 89,732 acres of conservation easements (figures are current as of September 2010). The geology, topography, soils, and climate of Complex lands are discussed below. Unless otherwise noted, information in this section has come from Bryce et al. 1998.

Geology and Topography

The Lake Andes Refuge is situated in a partially buried bedrock valley (Kume 1977). All Complex lands are part of the Northern and Northwestern Glaciated Plains, whose landscape was created by the most recent continental glaciation event, the Late Wisconsin, which occurred 25,000–20,000 years ago. Glaciation left the landscape rich in moraine and numerous wetlands. The Complex consists of grasslands; riparian forests; upland habitat; native prairie; and temporary, seasonal, and semi-permanent and permanent wetlands.

The majority of the Complex's waterfowl production areas and grassland and wetland easements fall within the Southern Missouri Coteau and Southern Missouri Coteau Slope ecoregions. The Southern Missouri Coteau ecoregion, the southern fringe of continental glaciation, exhibits gentle undulations in topography, smaller areas of wetland density, and more stream erosion. The Southern Missouri Coteau Slope ecoregion has a good amount of rock-free loess. The remaining waterfowl production areas and easements exist in the eastern portion of the Lake Andes District within the James River Lowland ecoregion. This ecoregion exhibits a flat to gently rolling topography, high density of wetlands, and warmer temperatures.

Karl E. Mundt Refuge in Gregory County is the only part of the Complex that lies west of the Missouri River. As such, the landscape of the refuge differs from that of the other Complex lands. This area falls in the Southern River Breaks ecoregion characterized by more temperate conditions with heavily wooded deciduous forests. The topography is characterized by dissected hills and canyons with slopes of high relief

bordering the Missouri River and its alluvial plains. Cretaceous Pierre Shale is the primary surface geology.

The Complex lies within the westernmost extent of continental glaciation (Pre-Late Wisconsin Glaciation and Late Wisconsin Glaciation). The melting ice from this glacial stagnation and retreat formed most of the prairie potholes found throughout the Complex. The geological materials underlying the Complex lands consist of Wisconsinan glacial till and loess over Cretaceous Pierre Shale (exposed bedrock is present throughout the city of Lake Andes and along the bluffs of the Missouri river) and sandstone of Niobrara Formation (primary bedrock of the Complex lands in the eastern portion of the Lake Andes District) (Johnson and Higgins 1997).

Soils

Soils differ in the four ecoregions—the Southern Missouri Coteau, Southern Missouri Coteau Slope, James River Lowland, and the Southern River Breaks—in which Complex lands lie. The main soil series in the Southern Missouri Coteau ecoregion are Eakin, Highmore, Java, Beadle, Dudley, DeGrey, and Zahl. These soils are deep and moderately to well drained and formed in silty and/or clayey material over glacial till with permeability ranging from slow to moderate.

The main soil series in the Southern Missouri Coteau Slope ecoregion are Highmore, Mobridge, Houdek, and Ethan. Deep, well drained soils formed in loamy glacial till, silty glacial drift, or silty alluvium on uplands. Permeability ranges from moderate to moderately slow.

The James River Lowland ecoregion is made up of the Beadle, Dudley, Hand, Bonilla, Houdek, and Prosper soil series. These soils are generally deep, moderately to well-drained, loamy, or silty soils on uplands. These soils range in permeability from very slow to moderate.

The Southern River Breaks ecoregion mainly consists of the Tuthill, Sansarc, Okaton, and Manter soil series. With the exception of Manter (a deep soil), these soils are generally shallow, well drained and formed in clayey shale residuum on uplands. Permeability ranges from slow to moderately rapid.

Climate

Relative to the rest of the Northern and Northwestern Glaciated Plains, the southern location of the Complex results in milder winters with longer, warmer summers. Temperatures range from -16 °F to 104 °F and average 51 °F. Annual rainfall varies from 17 inches to 24 inches while annual evaporation can amount to 36 inches, resulting in some years of marginal to poor wetland conditions. Precipitation on Karl E. Mundt Refuge averages 20–22 inches, and average snowfall is 60 inches.

4.2 Water Resources

Surface water

Lake Andes and the Missouri and James Rivers are the primary sources of water supply for the Complex. Two roadway dikes separate Lake Andes into the North Unit, Center Unit, and South Unit. Lake Andes has a drainage area of about 230 square miles. Andes Creek flows into the North Unit and is the largest contributor of inflow into the Lake Andes Basin. The remaining units receive inflow from several unnamed tributaries. Tributaries to Lake Andes are ephemeral (Sando and Neitzert 2003). The water level of Lake Andes is solely dependent on watershed runoff, thus fluctuations between flooding and a completely dry lake bed are common.

Agriculture is widespread throughout fourteen-county region of the Complex. Unfortunately, some agricultural activities—especially feedlot operation and crop production—cause nutrient enrichment, siltation, and algal growth that, together with other causes, have impaired the quality of water basins, streams, and Lake Andes over the years. Poor water quality significantly degrades the quality of fish and wildlife habitat in the lake. Complex staff is participating in meetings with CMCLRO and supporting and guiding its efforts to improve water quality and quantity in Lake Andes. CMCLRO seeks to improve water quality through the following actions:

1. Sediment removal. CMCLRO seeks to remove sediments from Lake Andes that are laden with high levels of nitrogen and phosphorus—nutrients that lead to frequent algae blooms that cloud the water and block sunlight penetration to a degree that many species of aquatic plants cannot grow. When the algae decompose, the oxygen content of the lake water is reduced to a level at which sport fish species and other aquatic animals and plants cannot survive.
2. Supporting soil conservation practices. CMCLRO is supporting ongoing government efforts to clean up the Lake Andes watershed through cost-shared, voluntary soil conservation practices (for example, planting buffer strips to reduce agricultural runoff, fencing livestock out of seasonal drainages, cost-sharing agricultural waste containment systems).
3. Controlling the rough fish population. CMCLRO intends to remove carp and bullhead species of rough fish that persist in oxygen-poor waters. The feeding behaviors of these fish agitate the water to the degree that sunlight penetration is blocked, thereby reducing aquatic vegetation.

Groundwater

The Lake Andes Basin and Choteau Creek Basin reach across the following counties: Aurora, Charles Mix, Gregory, Davison, Douglas, Hutchinson, and Bon Homme (Sando and Neitzert 2003).

The Dakota Aquifer, one of the classic artesian aquifers, covers most of central North America and is part of the Great Plains Aquifer System (Bredehoeft et al. 1983). The Dakota Aquifer in southeastern South Dakota consists of Dakota Formation overlain by Cretaceous shales (Gosselin et al. 2003).

In 1985, an artesian well was placed 960 feet into the Dakota sandstones of the Dakota Aquifer. This free-flowing well drains groundwater into Owens Bay. When first installed, this well pumped 900 gallons per minute (gpm). Today, this rate has decreased by about 70 percent to 250 gpm.

Wetlands

Wetlands are lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface (Cowardin et al. 1979). Wetlands are extremely productive and important as breeding and nesting habitat for migratory birds and as wintering habitat for many resident wildlife species.

Wetlands are classified using a number of attributes including vegetation, water regimes (the length of time water occupies a specific area), and water chemistry. Prairie potholes are described using the following nontidal water regime modifiers (Cowardin et al. 1979):

- Temporarily flooded: surface water is present for brief periods during the growing season. The water table usually lies below the soil surface most of the season, so plants that grow in both uplands and wetlands are characteristic.
- Seasonally flooded: surface water is present for extended periods especially early in the growing season, but is absent by the end of the season in most years.
- Semi-permanently flooded: surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land surface.
- Permanently flooded: water covers the land throughout the year in nearly all years. Vegetation is composed of obligate hydrophytes, such as cattails.

Even though drainage and other wetland-decimating factors have taken their toll, wetlands are still a prominent feature of the landscape within the Complex. Wetlands on the Complex range from temporarily flooded to permanently flooded. Surface hydrology of these wetlands is influenced by a combination of precipitation, surface runoff, surface water, and groundwater inputs.

Water rights

The following is a summary of water rights associated with Complex lands:

- Lake Andes holds water rights filed April 22, 1940, for a total of 20,534 acre-feet, of which 13,721 acre-feet are for storage and 6,813 acre-feet are for seasonal use.
- Owens Bay Well holds water rights filed July 6, 1956, for 2.22 cubic feet per second (cfs) from the Dakota Sandstone artesian aquifer to be stored in Owens Bay.
- Varilek Waterfowl Production Area holds water rights filed December 27, 1988, for 139 acre-feet of storage.
- Sherman Waterfowl Production Area holds water rights filed December 27, 1988, for 271 acre-feet of storage.
- Broken Arrow Waterfowl Production Area holds water rights filed October 7, 1985, to impound 131.2 acre-feet of storage from Joubert Drain through the means of Dam #7.
- Roth Waterfowl Production Area holds water rights filed July 30, 1997, for 323 acre-feet of storage and 212 acre-feet of seasonal use.
- The Lake Andes District holds 904 wetland easement contracts protecting 37,985 acres of naturally occurring wetlands.

4.3 Vegetation Communities

Vegetation communities associated with the Complex's wetland, upland, and riparian areas are discussed below. Figures 15–18 show the various land cover types found on and around Complex lands.

Wetlands and associated vegetation communities

Wetlands throughout the Complex provide both resting cover and food resources for migratory birds. Substantial emergent and submergent aquatic vegetation occurs in freshwater wetlands. Sago pondweed, coontail, and duckweed occur in the deeper, more permanently flooded zones, while cattail, bulrush, bur-reed, and smartweed grow in shallow areas that may go dry due to a drawdown. Poor water quality is a limiting factor for aquatic vegetation in individual wetlands scattered throughout the Complex. The poor quality can lead to algae blooms, reducing sunlight penetration and thus restricting growing potential for aquatic plants.

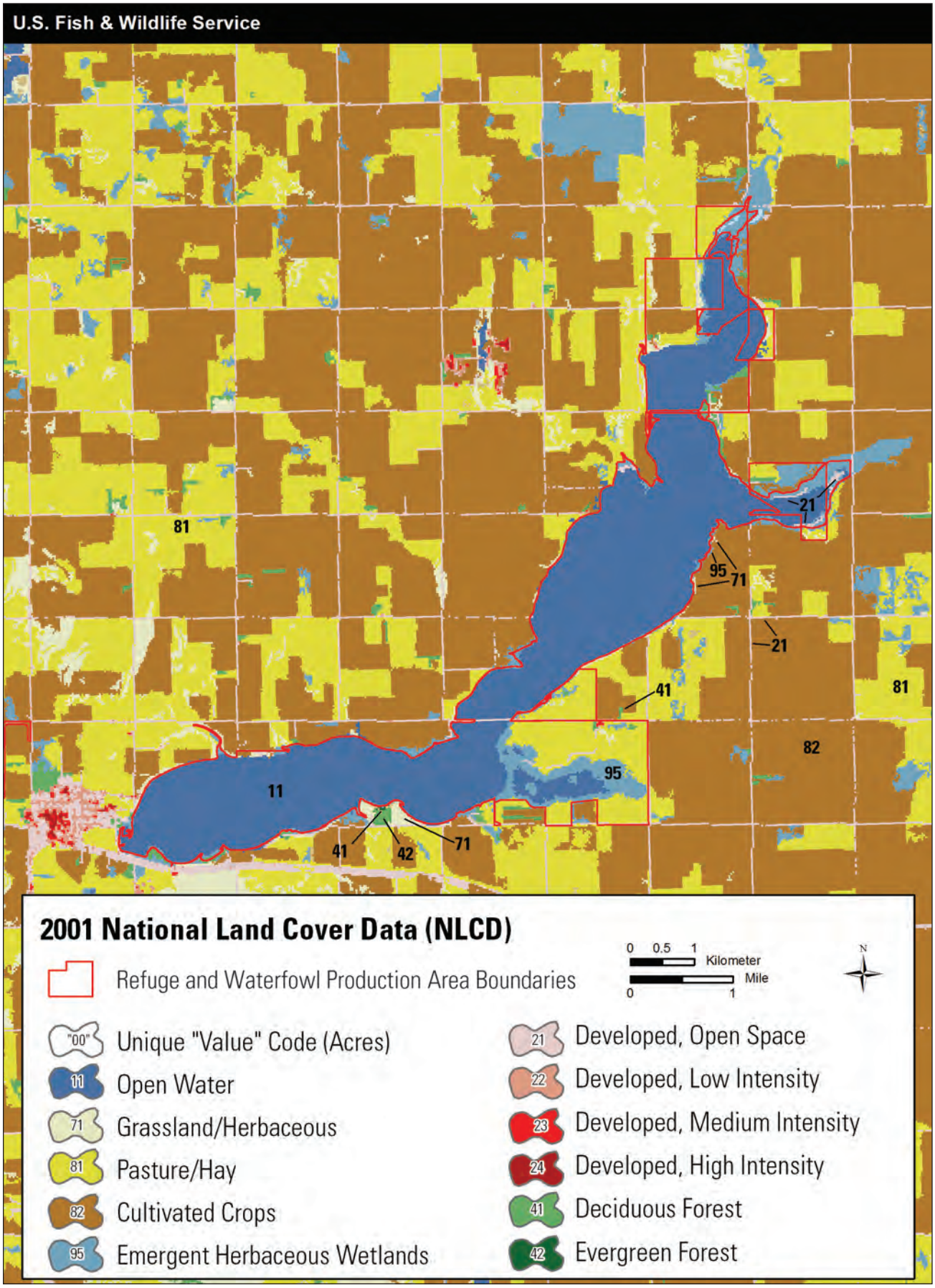

Figure 15. National Land Cover Data for the Lake Andes National Wildlife Refuge, South Dakota.

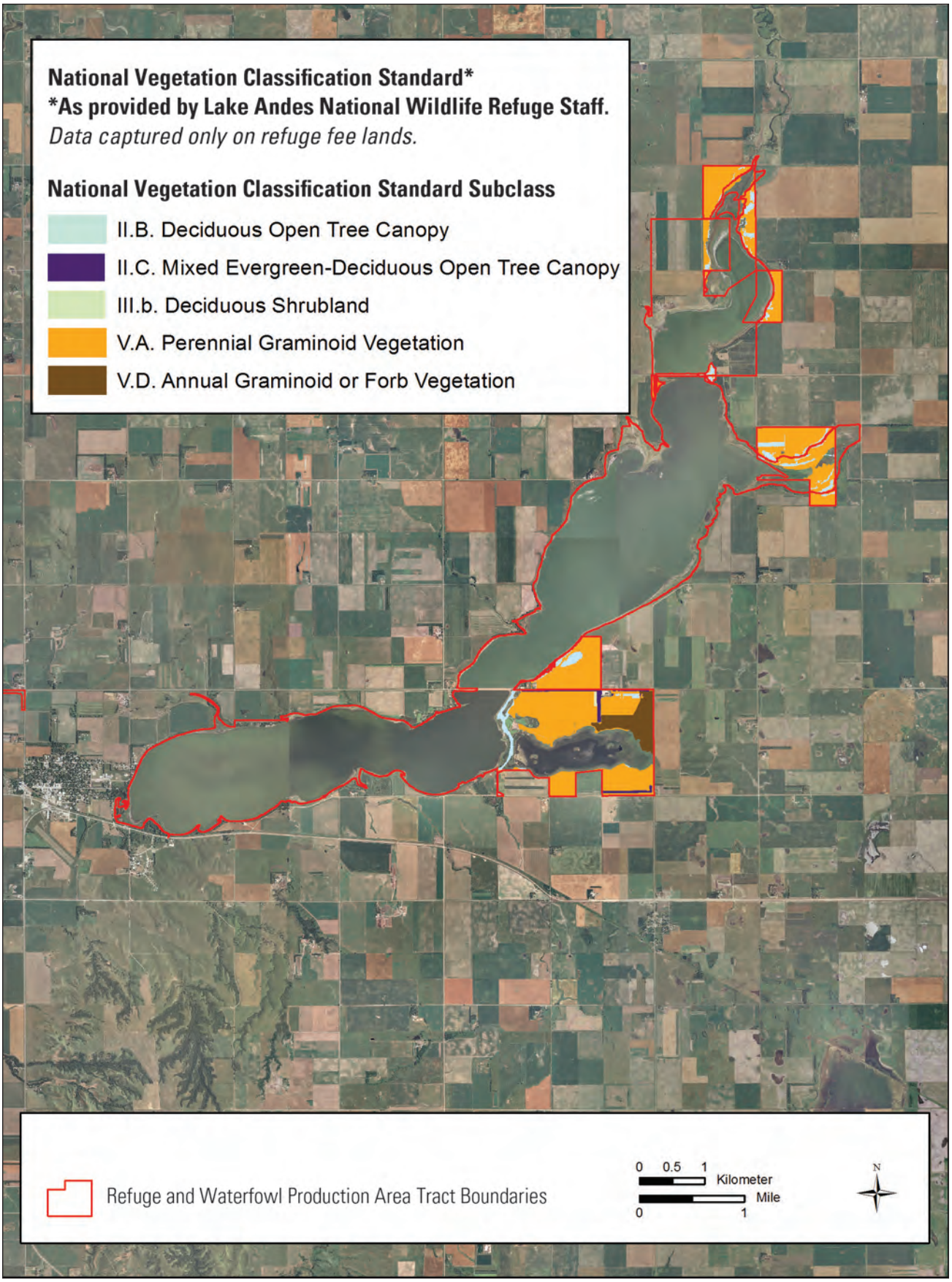

Figure 16. National Vegetation Classification Standard vegetation on the Lake Andes National Wildlife Refuge, South Dakota.

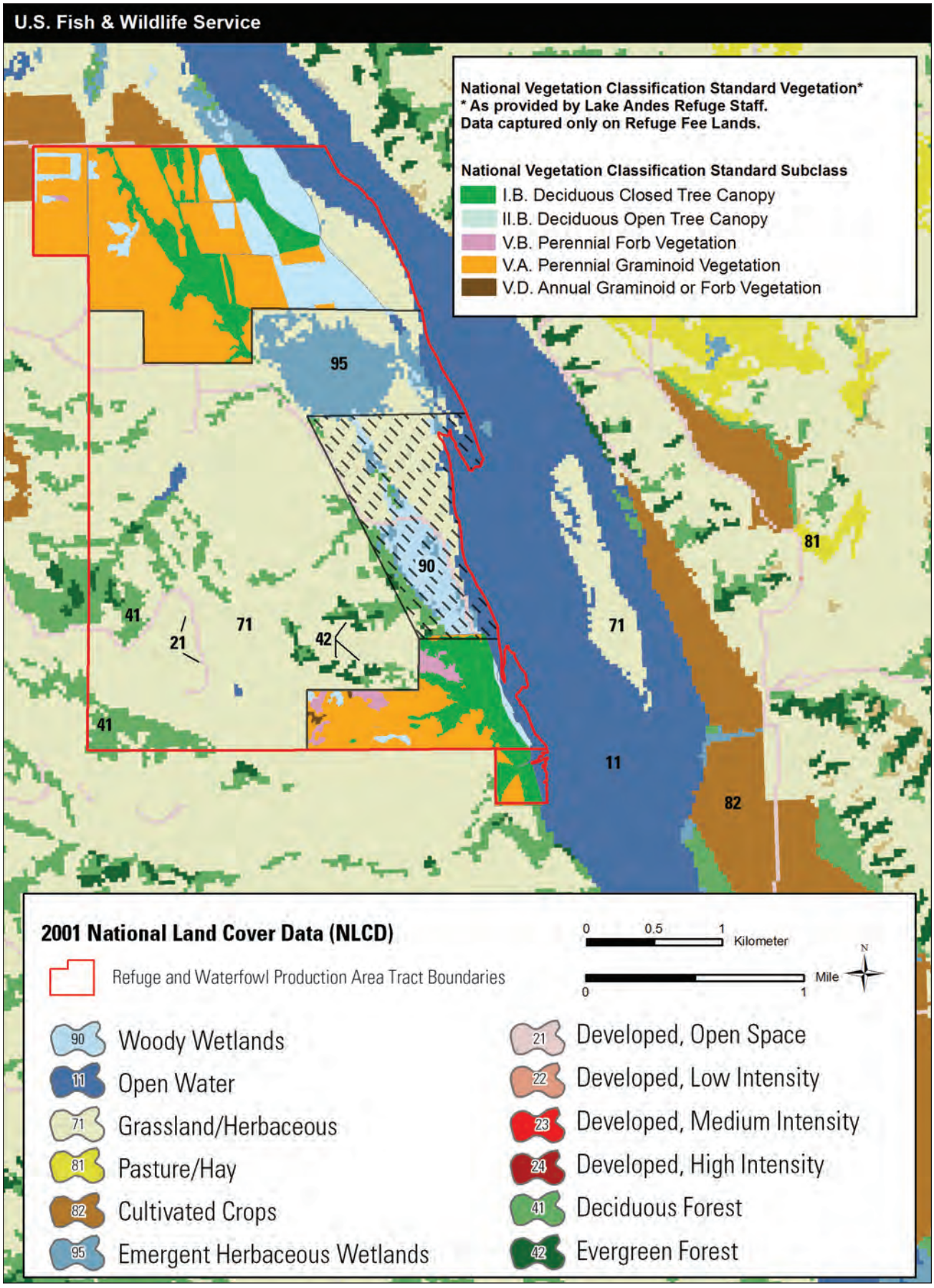

Figure 17. National Land Cover Data for the Karl E. Mundt National Wildlife Refuge, South Dakota.

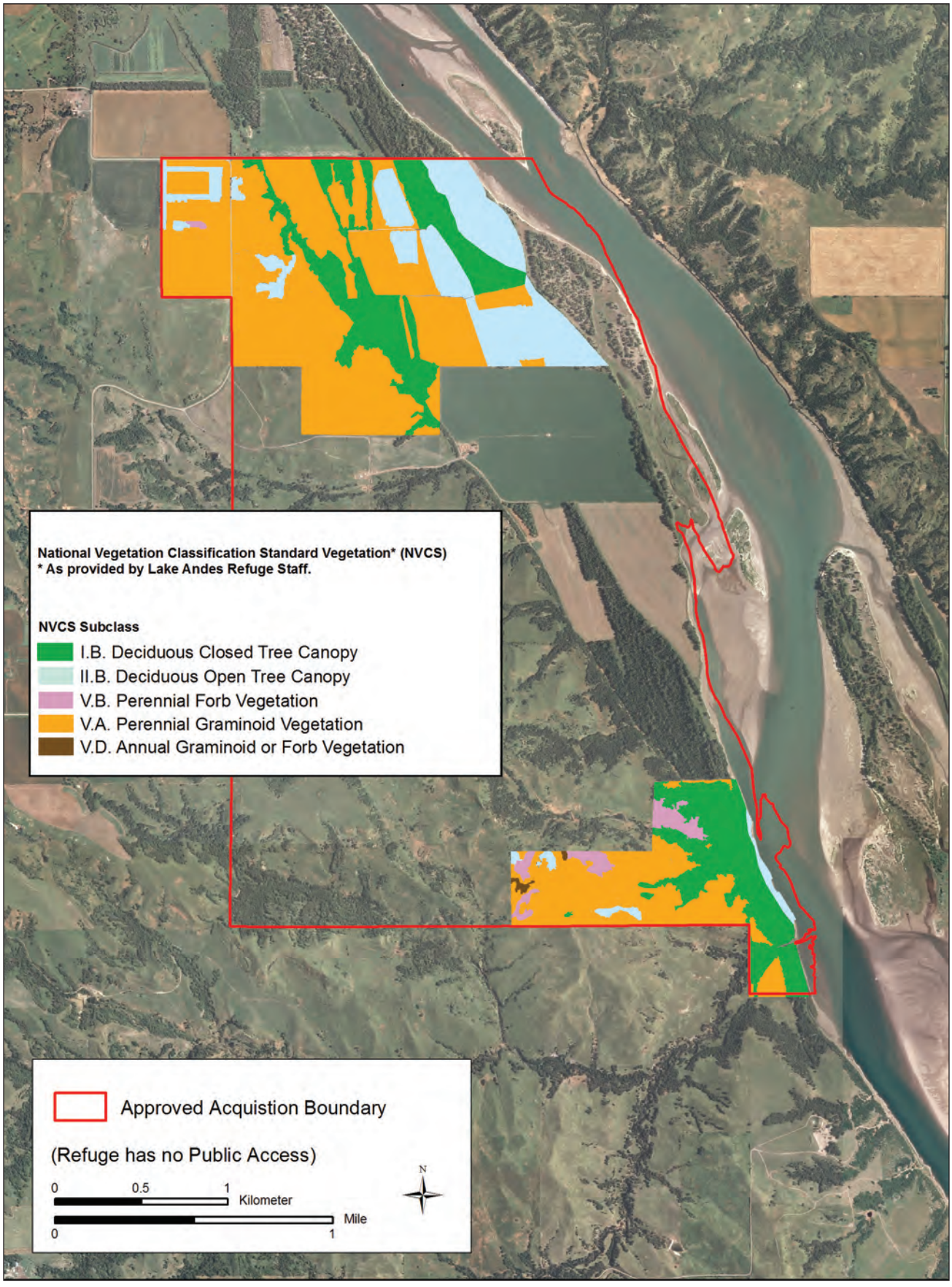

Figure 18. National Vegetation Classification Standard vegetation on the Karl E. Mundt National Wildlife Refuge, South Dakota.

Most palustrine basins exhibit concentric zones of vegetation that are dominated by different plant species (Kantrud et al. 1989). The terms commonly used in reference to these zones are, in decreasing order of water permanency, deep marsh, shallow marsh, and wet meadow (Kantrud et al. 1989). The water regime in a deep marsh zone is usually semi-permanent. Dominant plants include cattail, bulrush, submersed or floating plants, and submersed vascular plants, but this zone also may be devoid of vegetation if bottom sediments are unconsolidated. Shallow marsh zones are usually dominated by emergent grasses, sedges, and some forbs, but submersed or floating vascular plants also may occur. Wet meadow zones also are typically dominated by grasses, rushes, and sedges, whereas submersed or floating plants are absent.

Management of wetlands in the Complex where facilities have been developed (Owens Bay and Broken Arrow Waterfowl Production Area) simulates natural (that is, historic) wet–dry cycles by raising and lowering water levels to meet specific management objectives. This encourages emergent and submergent aquatic vegetation growth, increases invertebrate biomass, improves water clarity, breaks down and cycles accumulated nutrients in bottom sediments, and augments control of common carp. Extensive mudflats are created when wetlands are in the initial drawdown phase. Mudflats provide optimal feeding opportunities for migrating shorebirds, wading birds, and other waterbirds.

The wetland easement program has provided perpetual protection for 37,985 acres of wetlands on private lands in the wetland management district. A current total of 54 FmHA easements protect 3,834 acres of wetlands. This has secured a landscape-level habitat base for migratory birds. While normal farming practices may have essentially erased some of the smaller, temporary, and seasonal wetland basins, most of the habitat that has been protected remains intact.

Uplands and Associated Vegetation Communities

Upland vegetation is essential in providing nesting habitat for migratory and resident bird species. Upland habitats also provide necessary habitat requirements for resident wildlife throughout the year. The Lake Andes District holds 199 grassland easement contracts, providing perpetual protection for 38,103 acres of privately owned grasslands within the district. The program continues to expand the acreage protected annually.

The Complex currently uses a variety of management techniques to maintain and enhance upland habitat conditions on fee-title uplands including the use of prescribed fire, grazing, haying, native grass seeding, and invasive species management.

During the 1930s, large fields formerly planted to crops were planted with nonnative grasses including smooth brome, crested wheatgrass, and Kentucky bluegrass species to minimize soil erosion.

In the early 1970s, habitat management techniques were developed to provide dense nesting cover for waterfowl. Several areas on the refuge were planted to grass species such as tall and intermediate wheatgrass, sweet clover, and alfalfa. These fields initially provided good cover for nesting birds; however, over time they deteriorated and were prone to invasion by Canada thistle and other problem species (for example, smooth brome). The Complex has begun the process of restoring these grasslands to native grasses and forbs. The native grass restoration process generally involves cropping the field for 3 or more years to eliminate exotic cool-season grass seeds and rhizomes, control Canada thistle and other noxious weeds, and prepare a seedbed for planting native grass seed.

Uplands were historically composed of warm-season grasses characteristic of the short-grass prairie to the west and the cool- and warm-season grasses characteristic of the tallgrass prairie to the east (Samson et al. 1988); thus, the area represented a zone of ecotonal mixing that included a diversity of short grass, intermediate grass, and tallgrass species (Bragg and Steuter 1996). The most common mixed-grass prairie grass species within the Complex include western wheatgrass, slender wheatgrass, witchgrass, blue grama, sideoats grama, needle and thread, Indiangrass, switchgrass, big bluestem, little bluestem, and Canada wildrye. Smooth brome and Kentucky bluegrass are nonnative, invasive species that are dominant throughout many Complex lands. Chemical, mechanical, and biological control of these species is of high priority. Common upland forbs include American licorice, annual sunflower, Canada goldenrod, curlycup gumweed, heath daisy, hemp dogbane, leadplant, Maximilian sunflower, meadow anemone, Missouri goldenrod, showy milkweed, silverleaf scurfpea, smartweed, stiff goldenrod, stiff sunflower and woolly verbena. Prairie rose and prickly rose are the most prevalent shrubs found throughout Complex uplands.

South Dakota upland plant associations are shown in appendix F.

Riparian Areas and Associated Vegetation Communities

The riparian areas of the Complex fall mostly within the Karl E. Mundt Refuge, located along the Missouri River. The broken topography of the river breaks provide valuable riparian habitat. Draws and northern aspects are heavily wooded with deciduous forests that provide essential roosting and nesting sites for bald eagles and many other migratory birds.

Cottonwood forests were historically a major component of the floodplains of the Missouri River. Floods

supported a healthy ecosystem by offering moisture to sustain trees and wetland plants, depositing sediment and nutrients to enhance soils and providing seedbeds for establishing new cottonwood stands. The use of flow-regulating facilities (for example, levees and dams) has led to major cottonwood declines with existing cottonwood stands aging and being replaced by later-successional species. Bald eagles are highly dependent on mature cottonwoods for roosting and nesting. A cottonwood restoration plan is essential for the restitution of riparian diversity and habitat for bald eagle and other migratory bird species.

Dominant trees of the riparian woodlands include prairie cottonwood, green ash, American elm, box elder, hackberry, peach-leaved willow, bur oak, white mulberry, common hackberry, and honey locust. Russian olive and eastern red cedar are invasive tree species that are beginning to dominate the landscape. The presence of these species can reduce the integrity of the riparian habitat. Emphasis is placed on the eradication of these species on Complex riparian lands.

Common shrubs include roughleaf dogwood, riverbank grape, woodbine, narrowleaf willow, and sandbar willow. Riverbottom grasses and forbs are primarily Canada wildrye, prairie sandreed, big bluestem, switchgrass, dogbane, milkweed, white snakeroot, Downy brome, sand dropseed, sedge, ragweed, sweetclover, and prairie cordgrass. Canada thistle has infested almost all riparian margins in eastern South Dakota, including those that lie within the Complex. Leafy spurge and musk thistle are also becoming widespread invaders in these areas. This is particularly troublesome because invasive plants in riparian areas provide a constant supply of seed to downstream areas through water movement. Chemical, mechanical, and biological control of Canada thistle and other herbaceous weed infestations are of high priority.

Dominant plants of the uplands of riparian areas include switchgrass, big bluestem, little bluestem, sideoats grama, western wheatgrass, green needlegrass, silver buffaloberry, and yucca. Invasive species such as Canada thistle, musk thistle, and leafy spurge are also invading these uplands and are being targeted with control methods.

4.4 Wildlife

Mammals

A total of 57 mammals have been recorded in South Dakota (appendix G); of these, 48 mammal species have been recorded on the Complex. Representative species include coyote, red fox, white-tailed jackrabbit, white-tailed deer, thirteen-lined ground squirrel, badger, raccoon, mink, muskrat, striped skunk, deer mouse, masked shrew and meadow vole.

Birds

Numerous bird species occur in South Dakota (appendix G); more than 220 bird species have been documented throughout the Complex. There are 85 bird species known to breed within the Complex, 13 of which are waterfowl species. The six most abundant of the breeding duck species include mallard, blue-winged teal, northern pintail, gadwall, American widgeon, and northern shoveler. When habitat conditions are favorable, breeding duck densities exceed 60 pairs per square mile in several portions of the Complex. The Service began conducting annual breeding waterfowl population surveys throughout North Dakota, South Dakota, and northeastern Montana in 1987, focusing on 13 duck species that are the primary breeding species in the Plains and Prairie Pothole Region. Based on survey data, a strong positive relationship exists between wetland condition (that is, wet area or number of wet ponds) and both breeding pairs and duck recruitment.

Twenty-eight species of shorebirds have been documented throughout the Complex. Three shorebird species are regular breeders on Complex lands: killdeer, spotted sandpiper, and upland sandpiper. Regionally rare species such as marbled godwits are commonly observed on the Complex. A number of songbirds migrate through or nest on the Complex. Declining species, such as grasshopper sparrow, bobolink, western meadowlark, and dickcissel, are commonly observed on Complex grasslands.

The Karl E. Mundt Refuge was established after discovering nearly 300 endangered bald eagles—the largest population of wintering bald eagles at that time—spending the winter below the Fort Randall Dam. In 1992, the refuge became the site of the first successful nesting attempt in South Dakota in over a century. Since that time more than 30 eaglets have been recruited to the population from the refuge. Beginning with that first nest 10 years ago, the bald eagle nesting population in South Dakota has expanded to more than 20 active nests. The high recruitment rate and the close proximity of nests on the refuge are testimony to the quality of the habitat.

Fish

Most of the wetlands on the Complex are too shallow to support a fishery. However, there are wetlands in the Schaeffer Waterfowl Production Area and Scheffel Waterfowl Production Area in Bon Homme County that are typically deep enough to support a fishery. These wetlands are regularly stocked for fishing.

Historically, Lake Andes was one of the best bass fishing lakes in South Dakota. It was a well-stocked fishery supporting species such as northern pike,

largemouth bass, yellow perch, bluegill, black crappie, walleye, and channel catfish. Today, the lake suffers from low dissolved oxygen levels and high concentrations of algae. The poor water quality of Lake Andes has reduced the high species richness that once characterized the lake. Carp and black bullhead are the only species that can tolerate the poor quality of the lake. These species are further degrading the water quality through their aggressive feeding behavior that agitates the water to the degree that sunlight penetration is blocked, which impairs aquatic vegetation growth.

Threatened and Endangered Species

Endangered whooping cranes sometimes use Complex lands for feeding and resting during their spring and fall migrations. Additionally, there are two federally delisted species commonly observed on Service lands within the Complex. Recently delisted from the endangered species list, bald eagles and peregrine falcons frequently use the Complex lands. Bald eagles regularly use the mature cottonwood habitat of Karl E. Mundt Refuge for roosting and nesting. Peregrine falcons benefit from the abundance of prey such as small birds and ducks.

The American burying beetle, which was listed as an endangered species in 1989, has recently been discovered inhabiting Gregory County; however, none have been documented on the Karl E. Mundt Refuge, which lies within Gregory County, nor on any other unit of the Complex.

4.5 Cultural Resources

Historical Resources

The Complex's early 20th century history is tied to the Works Progress Administration, which was the program responsible for building the two roadway dikes that split Lake Andes into three separate units. These dikes are considered historical resources.

Many of the old homesteads that existed on Lake Andes Refuge, Karl E. Mundt Refuge, and several waterfowl production areas have been removed. Prior to any groundbreaking activities, such as removing these homesteads, the Complex staff complies with Federal and State laws and regulations, specifically Section 106 of the National Historic Preservation Act of 1966. Under these provisions, local archeologists inspect and record the area of interest to determine if the groundbreaking disturbance would affect any historical properties.

4.6 Visitor Services

The Complex offers a variety of recreational opportunities to local residents and other visitors centered on the wildlife resources. Opportunities on the Complex include wildlife-dependent and wildlife compatible uses legislated by Congress and outlined in the Improvement Act. These uses include hunting, fishing, wildlife observation, wildlife photography, environmental education, and interpretation.

Hunting

The Center Unit of Lake Andes and all waterfowl production areas are open to hunting for white-tailed deer, ring-necked pheasant, and other State game. The peak period for hunting is during ring-necked pheasant hunting season in the fall. An estimated 15,000 hunting visits occur on the Complex each year—about 81 percent of all visitations to the Complex. It is estimated that total expenditure by hunters at the Complex is about $570,400 per year (BBC Research & Consulting 2008).

Fishing

Fishing is permitted year-round on the Center and South Units of Lake Andes and on the wetlands of Schaeffer and Scheffel Waterfowl Production Areas in Bon Homme County. The water level of the lake and wetlands are highly dependent upon surface runoff. Thus, cycles of wet and dry periods commonly affect fishing opportunities.

The wetlands at Schaeffer and Scheffel Waterfowl Production Areas are typically deep enough to support a fishery and are regularly stocked with yellow perch. The poor water quality of Lake Andes today (low dissolved oxygen levels and high algal growth) can only support carp and black bullhead during dry cycles.

An estimated 741 fishing visits occur each year on the Complex. The expenditure from these visits has been estimated to generate about $12,800 per year (BBC Research & Consulting 2008).

Environmental Education and Interpretation

Complex staff members provide educational talks and tours for schools and other groups upon request. Informational brochures and Complex maps are available at the Complex headquarters and at information kiosks located outside of the headquarters and at the beginning of the nature trail. Throughout the Atkins Wetland Interpretive Trail interpretive signs illustrate the importance of conserving wetlands and restoring native grasslands. An estimated 1,058 environmental education and interpretation participants visit the Complex each year.


USFWS

Lake Andes National Wildlife Refuge Headquarters

WILDLIFE OBSERVATION AND PHOTOGRAPHY

The Complex provides great opportunities for viewing and photographing wildlife, particularly views of migrations of waterfowl, shorebirds, and neotropical birds. Ducks and geese begin concentrating in large numbers in October, and numbers generally peak in December. The abundance and variety of wildlife species combined with relatively low visitation provides many opportunities to view wildlife close up.

Lake Andes Refuge offers a 1-mile foot trail that winds around the Prairie Ponds (four small ponds about 1–4 acres in size) and runs along Owens Bay. The trailhead is next to the Complex headquarters, and an observation platform provides an elevated view of the ponds, which are managed to provide attractive habitat for migratory birds during spring and fall migration. Waterfowl, shorebirds, grassland birds, and white-tailed deer are common along this route.

The 1-mile Atkins Wetland Interpretive Trail offers self-guided opportunities to observe 160 acres of wetlands and native prairies on the Atkins Waterfowl Production Area. Interpretive signs along the trail present information about the importance of conserving wetlands and restoring native grasslands as well as describing some of the birds visitors may encounter. The trail leads to an overlook where visitors can admire native prairies. Waterfowl, grassland birds, and white-tailed deer can easily be spotted on this trail.

There are an estimated 2,800 wildlife observation and photography visits to the Complex each year. Total expenditure by these non-consumptive recreational activities—including environmental education and interpretation—is estimated to be $36,800 per year (BBC Research & Consulting 2008).

4.7 Fire and Grazing History

Prior to European settlement, wildfires along with grazing (primarily by bison, prairie dogs, and insects) and drought were the primarily ecological disturbances that revitalized grasslands. Ignitions for these wildfires were caused by both lightning and Native Americans, with most wildfires likely occurring during the summer and fall. Depending on weather conditions, a wildfire could burn thousands of acres, creating a mosaic of burned, unburned, and grazed areas. Historical fire frequency was probably highly variable but has decreased since settlement (Umbanhowar 1996); however, little information is available on the pre-settlement occurrence of fire within the Complex area. For the mixed-grass prairie, fire return interval evidence seems to point to about every 5–10 years on the moist portions of mixed-grass prairie and around 25 years on dry portions (Frost 1998, Wright and Bailey 1982). In general, where precipitation is limited, such as in the western and central grasslands, a long-term decline in grass production occurs when burning is more frequent than every 5–10 years. This fire frequency may be best for natural fire management of grasslands, such as the short- or mixed-grass prairies, although fire exclusion may be best for other purposes (Bragg 1995). Tallgrass prairie tends to have a quicker fire return interval than mixed-grass prairie. Science seems to indicate roughly a 3- to 7-year fire return interval for most of the tallgrass prairie.

After settlement by Europeans, wildfires were suppressed. Today, most local fire departments and area farmers and ranchers still aggressively suppress wildfires. It has also been the policy on Service lands within the Complex to aggressively suppress wildfires.

The Complex uses prescribed fire to simulate the historical influence fire had on plant communities. Burning removes layers of residual cover; this action can reduce plant species diversity and increase a wildfire's resistance to control. Even though prescribed burning can occur at any time of year, most prescribed fires are currently applied in April and May, depending on the prescribed fire's objectives and the associated impact(s) on flora and fauna. The Complex's use of this tool is limited by many factors including plan development, staff availability, and weather. Because of these limiting factors, prescribed fire is rarely used on Complex lands. Since 2001, the Complex has treated about 3,800 acres with prescribed fire.

Although prescribed burns are infrequent on the Complex, air quality is still an issue when burns do occur. The National Ambient Air Quality Standards include maximum allowable pollution levels for particulate matter, ozone, sulfur dioxide, nitrogen dioxide, lead, and carbon dioxide. Particulate matter is a measure of tiny liquid or solid particles in the air that is respirable in the lungs. Carbon from automobiles and diesel engines, prescribed fire activities on Complex lands, and dust associated with wind-blown sand and dirt from roadways and fields contribute to particulate matter.

Similar to fire, grazing greatly influences the structure and composition of grassland communities. Most plant species have developed growing points located at or near the ground surface, which allows the plant to be clipped off without killing it.

Complex staff works with cooperators to mimic grazing disturbances such as grazing by bison. Grazing is generally conducted during the spring and early summer for about 6 weeks, and again in the fall in upland habitats, to stress exotic cool-season grasses and favor native warm-season grasses and forbs. In this instance, overgrazing is beneficial as it damages invasive grasses to the point where native seeds have a better chance to grow with less competition.

4.8 Socioeconomics

The 14-county area of the Lake Andes National Wildlife Refuge Complex is home to over 154,000 persons. Since 1990, the population has grown by 1.1 percent per year (BBC Research & Consulting 2008). This 14-county area employs over 70,000 workers mostly in trades, transportation, utilities, government, education and health services, and manufacturing (BBC Research & Consulting 2008).

The Complex employs six full-time equivalent (FTE) employees and one part-time employee, for a total of 6.7 FTEs (appendix E). The most current budget totaled $687,400, of which about $544,000 went toward salaries. A report titled "Banking on Nature" evaluated the impacts of refuges on local economies. Lake Andes National Wildlife Refuge Complex was estimated to generate about $620,000 per year in total visitor expenditures (BBC Research & Consulting 2008).