3 Refuge Resources and Description

This chapter describes the characteristics and resources of the Medicine Lake NWR Complex. It specifically addresses physical, biological, cultural, and socioeconomic resources, as well as recreational opportunities.

3.1 Physical Environment

The refuge complex is located in northeastern Montana, and includes the 31,660-acre Medicine Lake NWR (figure 6, chapter 2) and the Northeast Montana WMD (figure 8, chapter 2). The refuge and WMD are bounded on the south by the Missouri River, on the north by Saskatchewan, Canada, and on the east by North Dakota. The refuge complex lies within the highly productive Prairie Pothole Region (figure 3, chapter 1) of the Northern Great Plains and has topography typical of the glacial drift prairie, with relatively gentle rolling plains and numerous shallow wetland depressions. The 800-acre Lamesteer NWR (figure 7, chapter 2), located in Wibaux County, Montana, is a limited-interest easement refuge, and the third component of the refuge complex.

For Service administrative and planning purposes, the refuge complex is considered within both the main stem Missouri ecosystem and the Missouri/Yellowstone/Columbia rivers (MOYOCO) ecosystem (figure 4, chapter 1). Vegetation is primarily the wheatgrass-needlegrass association of the mixed-grass prairie (Coupland 1950, Kuchler 1966), but transitions into short-grass prairie, mostly grama-wheatgrass association, in western portions of the refuge complex.

Historically, this area was a treeless expanse of prairie, with plants kept in relatively short stature by frequent fires and grazing by native mammals, most notably bison (Coues 1878, Murphy 1993, Bragg 1995). In 1805, the explorer Captain William Clark wrote in his journal that the southern end of the Big Muddy valley was "a beautiful and extensive valley as far as can be seen." Clark wrote that he saw "only a single tree in this fertile valley" (Moulton 1986). Other early explorers also describe a "barren" landscape, with little or no woody vegetation (Cooper 1869, Coues 1878, Preble 1910). Trees and shrubs were restricted to draws and other fire sheltered areas. These prairies supported an estimated 5- to 10-year fire return interval (Wright and Bailey 1982, Murphy 1993, Bragg 1995). Climatic variation and periodic rest from wildland fires and grazing resulted in a mosaic of vegetation types across the landscape at any given time.

Settlement of the area by Europeans during the early 1900s brought extreme changes that impacted the vegetation. These changes included suppression of wildland fires, extirpation (or wiping out) of bison and their replacement by domestic livestock, and the tilling and farming of the prairies. Settlers also planted trees as windbreaks, and introduced exotic plants to the landscape. Approximately 60 percent of this area is now cultivated, primarily for small grains, with recent increases in oil seed crops such as safflower and canola (figures 6, 7, 8, chapter 2). About 25 percent of the cropland base is enrolled in the conservation reserve program. The land use for noncultivated areas is primarily livestock grazing and hay production.

The Northeast Montana WMD encompasses a total of 11,791 acres in 44 waterfowl production areas that range in size from 4 to 2,012 acres. An additional 8,588 acres of privately owned wetlands are protected from drainage, burning, leveling, and filling by perpetual wetland easements. Perpetual grassland easements protect 10,968 acres from cultivation.

The WMD lies within the Williston Oil Basin, which was one of the most active oil regions in the lower 48 states during the early 1980s. Oil exploration and development is widespread throughout the area. Recent advances such as horizontal drilling and 3-D seismic technology resulted in renewed oil exploration activity in the mid-1990s. The majority of waterfowl production area tracts were acquired without mineral rights. Reservations for development of the subsurface minerals were retained by the owners or their assigned third party. For this reason, seismic exploration and oil well development is common in waterfowl production areas.

Climate

The climate of the region is continental and characteristic of the northern Great Plains, with cold winters, hot summers, and peak rainfall during the early-to-mid growing season. Weather is often extreme and variable, with periodic drought, severe blizzards, great fluctuations in temperature both annually and daily, and frequent strong winds. The growing season is usually 110 to 125 days long, with

about 80 percent of annual precipitation occurring during this time. Annual precipitation averages 13 inches (1911–2000), but fluctuates greatly.

For example, at Medicine Lake NWR, 1 year in 10 has average precipitation of less than 9.5 inches or more than 19.1 inches (Richardson and Hanson 1977). Total annual snowfall averages 27 inches (1911–2000). Evapotranspiration losses from water areas are about 50 inches per year. Average daily minimum and maximum temperatures are minus 4 degrees Fahrenheit in January and 85 degrees Fahrenheit in July.

Global Warming

The U.S. Department of the Interior issued an order in January 2001 (DOI 1999) requiring federal agencies under its direction that have land management responsibilities to consider potential climate change effects as part of long-range planning endeavors.

A Department of Energy report, "Carbon Sequestration Research and Development," (DOE 1999) concluded that ecosystem protection is important to carbon sequestration and may reduce or prevent loss of carbon currently stored in the terrestrial biosphere. The report defines carbon sequestration as "the capture and secure storage of carbon that would otherwise be emitted to or remain in the atmosphere."

The increase of carbon dioxide (CO_2,) within the earth's atmosphere has been linked to the gradual rise in surface temperature commonly referred to as "global warming." Carbon sequestration constitutes the primary climate-related effect to be considered in comprehensive conservation planning for Refuge System units.

Vegetated land is a tremendous factor in carbon sequestration. Large naturally occurring communities of plants and animals that occupy major habitats—grasslands, forests, wetlands, tundra, and desert—are effective both in preventing carbon emission and in acting as biological "scrubbers" of atmospheric CO_2.

One Service activity in particular—prescribed burning—releases CO_2 directly into the atmosphere from the biomass consumed during combustion. However, there is no net loss of carbon because new vegetation quickly germinates and sprouts to replace the burned-up biomass. This vegetation sequesters an amount of carbon approximately equal to the amount emitted into the air (Dai et al. 2006).

Several other effects of climate change may need to be considered in the future:

- Habitat available in lakes and streams for cold-water fish such as trout and salmon could be reduced.
- Forests may change, with some plant species shifting their range northward or dying out, and other trees moving in to take their place.
- Ducks and other waterfowl could lose breeding habitat because of stronger and more frequent droughts.
- Changes in the timing of migration and nesting could put some birds out of synchronization with the life cycles of their prey.

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Wildfires may affect air quality in the short term but the prairie ecosystem eveloved with fire.

Air Quality

A recently initiated monitoring program will provide an air-quality assessment, though air quality is believed to be good due to the refuge complex's remoteness from significant industrial or urban pollution sources. The Medicine Lake Wilderness is a Class I Air-Quality Area, and receives special protections against air pollution under the federal Clean Air Act. The refuge is a member of the IMPROVE (Interagency Monitoring of Protected Visual Environments) network, a cooperative program of federal and state agencies whose primary purpose is to protect visibility in Class I areas and to characterize regional haze.

Geology and Soils

The plains landscape of northeast Montana was shaped by repeated advances and retreats of glaciers. Prominent landforms are the Missouri Coteau and associated prairie potholes, the Big Muddy Creek channel, and the Medicine Lake-Dagmar channel (explanations follow). Elevation in Sheridan County ranges from 1,933 to 2,600 feet (Richardson and Hanson 1977).

The northeast corner of the refuge complex experienced at least 3 episodes of glacial advances (Heidel et al. 2000), with the most recent leaving the distinctive, hummocky, collapsed glacial moraine known as the Missouri Coteau. This steep, irregular terrain produced a high density of wetland basins of assorted shapes and sizes, known as "prairie potholes." Outwash channels fringe the glacial sediments. Here, bedded glacial sediments lie in low points of the topography in closed-basin watersheds, and form some of the most extensive alkali lake systems in Montana (Heidel et al. 2000). Soils over much of the moraine deposits are mapped as Zahill-Williams-Dimmick association, and are characterized as well-drained to poorly drained clay loams, loams, and silty clays, with sand and gravel layers in the outwash deposits (Richardson and Hanson 1977).

The present-day Big Muddy Creek is a narrow (approximately 20 to 30 feet wide) perennial prairie stream, the largest in Sheridan County. These floodplain soils were formed primarily from glacial outwash and alluvial deposits, are moderately to poorly drained, and are saline or salt-affected in many locations. Numerous wetlands were formed from shallow depressions, oxbow cutoffs, and a high water table from underground aquifers. Big Muddy Creek has its headwaters in Saskatchewan and the northwestern corner of Sheridan County, and flows southward through the refuge complex into the Missouri River. The broad 1- to 3-mile-wide valley is a major outwash channel formed by a glacial front more than 12,000 years ago (Clayton et al. 1980), and is bordered by pre- and postglacial terraces.

Another major outwash channel is the Dagmar Channel, which runs southwest–northeast from Medicine Lake through the Lake Creek drainage. This broad channel is now nearly filled with glacial outwash and alluvium, but is believed to have been the pre-glacial route of the Missouri River into Hudson Bay.

Medicine Lake is a large (8,218-acre) shallow lake filling this ancient valley. The lake was designated a National Natural Landmark by the National Park Service in 1980 to recognize the area's "exceptional value as an illustration of the nation's natural heritage."

To the southeast of the lake are large sand deposits that formed as the wind scoured sand out of the lake bed. Gentle sand plains and small ridge systems developed parallel to the prevailing northwest wind, with resulting choppy sand dunes ranging between 20 and 40 feet in height. This area, known as the Medicine Lake Sandhills, comprises over 20 square miles, and is 1 of the most extensive sandhills formations in Montana.

Soils in the Medicine Lake area include the Blanchard association throughout the sandhills, composed of well-drained and droughty, fine and loamy sands, and the Lihen-Parshall association throughout the gentle sand plains, composed of well-drained, loamy, fine sands and fine sandy loams. The Dagmar channel area has the contrasting McKenzie association, with poorly drained, silty, clay loams in lowlands (Heidel et al. 2000).

An extensive aquifer system underlies the eastern portion of the refuge complex, including the refuge. This system is referred to as the Clear Lake Aquifer, and is composed of several buried glacial outwash channels and the buried ancestral Missouri River channel (Reiten 2001). The aquifer extends northeast and southwest for approximately 40 miles, with 28 miles in Montana and the remaining 12 miles in North Dakota. The width of the aquifer ranges from more than 3 miles wide east of Medicine Lake to 0.6 miles at its narrowest in North Dakota.

3.2 Biological Resources

The refuge encompasses 31,660 acres in Sheridan and Roosevelt counties, and includes about 13,010 acres of open water and marsh, 14,890 acres of native prairie and 3,760 acres of previously cultivated lands now maintained mostly in perennial grass plantings. Most of the surrounding private land is intensively farmed for small grain.

The refuge consists of 2 noncontiguous tracts. The main tract includes the 8,218-acre Medicine Lake, 5 smaller lakes, and numerous potholes. The smaller tract to the south contains the 1,280-acre Homestead Lake. Within the main tract of the refuge, the 11,360-acre Medicine Lake Wilderness was established by Congress in 1976. This area includes the main water body of the lake, the islands within, and the 2,320-acre Sandhills Unit, with rolling hills, native grass, brush patches, and a few relic stands of quaking aspen.

Four locations on the refuge were designated as research natural areas in 1972. They include Bruce's Island (367 acres), Big Island (251 acres), Teepee Hills (95 acres), and Homestead (39 acres).

Within the Northeast Montana WMD, most (40 of 44) of the waterfowl production areas are located in Sheridan County, with 3 in Daniels and 1 in Roosevelt County. They generally have a significant wetland component, interspersed with native prairie and perennial grass plantings in the uplands.

Located 160 miles south of Medicine Lake NWR, Lamesteer NWR was established in 1941 as an easement refuge. However, the Service purchased from the landowner only about 2 of the 800 acres to construct a dam and for the rights to hunt and trap the land. Only water management and facilities maintenance rights currently are covered by the easement. The refuge consists of about 110 acres of marsh habitat, 350 acres of grassland, and 340 acres of cropland.

Water Resources and Associated Wetlands

Wetlands in the refuge complex are diverse in size and type (figure 10). On the refuge, wetland types include: lakes (11,430 acres), semi-permanent wetlands (1,470 acres), seasonal wetlands (464 acres), temporary wetlands (660 acres), and river (46 acres).

The Big Muddy Creek runs along the western boundary of the refuge. A diversion canal was constructed to bring Big Muddy Creek waters into Medicine Lake. A dam adjacent to the Homestead Unit allows a diversion of Big Muddy Creek into Homestead Lake. The Lake Creek drainage originates in North Dakota and flows southwest into the refuge, receiving inflow from ephemeral creeks and overflows from numerous lakes. Water is also provided to the eastern refuge water units from Cottonwood and Sand Creeks and eventually flows into Medicine Lake and Big Muddy Creek. The Homestead Unit receives water from Big Muddy Creek on the western boundary and spring season flows from Lost and Sheep Creeks to the east.

The watershed for Medicine Lake is approximately 2,447 square miles, 214 square miles of which are in Canada. This includes the Big Muddy Creek and the tributaries that feed it. Elevation of the drainage varies from 2,910 mean sea level (msl) at the highest point to 1,920 msl at the confluence with the Missouri River.

The waterfowl production areas in the refuge complex contain 3,841 acres of wetlands ranging from small temporary areas that hold water for only a few weeks, to large permanent lakes. Waterfowl production areas are concentrated in the Missouri Coteau, Prairie Pothole Region of northeast Sheridan County. The outwash terrain around Westby and the collapsed moraine landscape around Comertown contain a particularly high density and diversity of wetlands. The Westby area has some of the most extensive alkali lake systems in the state of Montana.

Eighty percent of the refuge complex water comes by way of snowmelt from the watershed. Although spring and summer rains contribute to the water supply, most rain is absorbed in the soil or lost through evapotranspiration. Significant runoff from rainfall can occur if the soil is frozen or an extremely heavy rainstorm occurs.

Montana water law dates back to territorial days and is based on the doctrine of "prior appropriation." Under this doctrine, the first landowner to put water to beneficial use has the most senior right. When adequate water supplies are available for all users, the issue of water rights is minor. However, when water resources are limited, it becomes an important issue.

On November 7, 1936, the Bureau of Biological Survey filed Notices of Appropriations of water for use on the refuge. Table 5 indicates sources and water appropriations by stream.

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Habitat management contributes to the preservation of unique flora that attracts butterflies to the refuge complex.

Place Holder for Figure 10 habitat

Habitat disturbance on Medicine Lake National Wildlife Refuge.

11x17 map

In 1970, an additional appropriation of 300 cubic feet per second was made on Sheep Creek for Homestead Lake. The only total water volume stated in any filing for Medicine Lake was in the appropriations for Big Muddy Creek, which was 55,000 acre-feet.

As a result of 1979 Senate Bill 76 and a 1979 Montana Supreme Court order, every person claiming ownership of a state-based water right from before July 1, 1973, had to file a statement of claim before January 1, 1982, or risk losing the water right. (Small livestock water claims, domestic claims for groundwater, and instream flow claims were exempted from this requirement.) Thirty claims were filed for a total of 146,715 acre-feet of water. Included were applications for refuge complex stream diversions, water wells, and small ponds. The claims are supplemental to each other, because the bulk of the water is retained in lakes, where the total capacity, at desired management levels, is approximately 108,811 acre-feet. No final action has been taken by the Montana Water Court on any of the water rights claims the Service submitted for the refuge.

There have been numerous filings for water rights on Big Muddy Creek, and several are senior to the refuge. By law, these senior water right holders have a right to water coming down the creek. Once they have had an opportunity to take their share of the water, the refuge can take its share. In the past there has not been a problem with senior water right holders, and there has been enough water to fill their needs. The Assiniboine and Sioux Native American tribes hold a senior downstream right to the Big Muddy Creek, known as the "Fort Peck Compact." However, with the exception of the irrigation of 523 acres of tribal lands, the tribal right is subordinate to the refuge's rights. In addition, there are junior water right holders upstream of the refuge that cannot divert if the refuge's senior rights are not whole and the refuge needs water. In dry years, the refuge sends letters to junior users, requesting they refrain from taking water until refuge needs are met. In every year that letters have been sent, the junior water right holders upstream have been cooperative in respecting the refuge's request.

The Clear Lake Aquifer underlies much of the refuge complex, and the Sheridan County Conservation District (SCCD) manages a reserved water right for irrigation from this aquifer (Reiten 2001). Precipitation recharges the aquifer, and the amount and distribution of recharge are beginning to be understood, including water losses from the aquifer. Water evaporates from the aquifer system, where it reaches the surface at sloughs and lakes. Groundwater is consumed by some plants, called "phreatophytes," whose roots can tap the water table.

The effect of irrigation pumping on aquifer levels is more understood through monitoring of wells and documenting use. In 2005, documented water use was approximately 3,881 acre-feet of water extracted from the Clear Lake Aquifer (Reiten 2006). This is the twelfth-highest reported usage in the past 26 years, in a year with heavy summer rains, hail damage to some crops under irrigationsystems, and a cooler-than-normal average temperature, resulting in lower water demand (Reiten 2006).

The SCCD has managed a moderate growth of irrigation development so that any evidence showing over-allocation of water resources can be evaluated before the development has an impact on other water resources. The refuge is a voting member on a technical oversight committee that evaluates water resource data before approving permit applications for drilling new wells.

Water Quality

Agriculture is the most extensive land use in the Big Muddy watershed. Fifty-three and 43 percent of the acreage is classified as range land and dry land agriculture, respectively (SCCD 2006). Another 3 percent of the land is used for irrigated agriculture. Less than 1 percent of the watershed is mapped for urban land use.

The SCCD conducted a study of Big Muddy Creek in 2000 to assess the general conditions of the creek. Thorough analysis of inorganic constituents

Table 5. Water Appropriations by Streams at Medicine Lake NWR

Source	*Amount in cubic feet per second (cfs)*
Big Muddy Creek (to Medicine Lake)	1,200 cfs
Big Muddy Creek (to Homestead)	50 cfs
Cottonwood Creek	100 cfs
Sand Creek	75 cfs
Lost Creek	25 cfs
Sheep Creek	20 cfs
Lake Creek	100 cfs

and measurable total maximum daily load in the creek water still need be addressed (total maximum daily load, or TMDL, is a standard set by the Environmental Protection Agency of the maximum amount of pollutant that a water body can receive and meet water quality standards). At all sampling sites, flow measurements are being performed to evaluate flow alterations to the drainage. Monitoring of the Big Muddy Creek also includes nutrients, salinity, total dissolved solids (TDS), chlorides, suspended solids (SS), temperature, pH, and metals, which are listed under TMDL parameters for Big Muddy Creek (SCCD 2006; USFWS 2006d).

Flows in the Big Muddy Creek are primarily from groundwater recharge. Likely impacts to water quality are the result of crop production, grazing, and improper disposal of oil field exploration and production wastes.

Vegetation

Approximately 40 percent of the landscape in the 3-county refuge complex remains in native prairie, with most used as livestock pasture or hay land. On the refuge, about 14,000 acres is native mixed-grass prairie, of which approximately 3,600 acres were farmed or otherwise disturbed before the Service acquired the land in 1935 (figure 10).

Most of these acres have been replanted since the 1960s as dense nesting cover (DNC), a mixture of several tame wheatgrasses and legumes that is particularly attractive to nesting waterfowl. Old shelterbelt plantings of trees and shrubs, such as cottonwoods, junipers, Russian olives, and green ash, are scattered throughout the refuge complex, although most have succumbed to drought over the years. Today, the only tree plantings that are maintained are the windbreaks at the refuge headquarters. In the WMD, the 44 waterfowl production areas contain about 5,500 acres of planted tame grasses and 3,400 acres of native prairie.

The native mixed-grass prairie is dominated primarily by western wheatgrass, needle and thread, and blue grama, but plant associations fluctuate greatly in time and space with annual moisture, slope, aspect, and soil type. Grasses are interspersed with a diversity of forbs and patches of low shrubs, especially in the sandhills where chokecherry and snowberry patches are common on slopes and flats between dunes. Subirrigated, wet meadow areas are dominated by prairie cordgrass, switchgrass, western wheatgrass, rushes and sedges, and abundant forbs. More than 42 plant associations have been identified and described for Sheridan County (appendix H, Heidel et al. 2000). Herbaceous groups make up the majority of these, but 2 woodland and 7 shrub land groups were also identified.

Of the herbaceous types, more than 20 are wetland plant associations. Hard stem bulrush is the most prevalent deep-marsh emergent on Medicine Lake NWR and the WMD wetlands, and is well adapted to the area's brackish water. Alkali bulrush dominates the wetlands with higher dissolved salt levels, while cattail species are locally abundant in fresher basins. Common, shallow-marsh, emergent plants include smartweeds, spikerushes, and sedges. Whitetop is a common dominant in seasonal wetlands in the Missouri Coteau, but is rare in the refuge complex.

Wetland margins (riparian zones) exhibit the greatest diversity of grasses, sedges and rushes, and forbs. Species composition is influenced largely by water quality, water permanence, and soils. Sago pondweed is probably the most abundant submerged aquatic, but other species of pondweeds, water milfoil, and common bladderwort are also common.

For management purposes, upland vegetation of the refuge complex is summarized in the following 6 groups:

Sparse Mixed-grass Prairie

Dominant grasses are needle and thread, blue grama, threadleaf sedge, and prairie Junegrass. Prairie muhly grass is a codominant in some settings. Other less-dominant grasses include western wheatgrass and prairie sandreed. Clubmoss is common. The Big Muddy headwaters area also might host the little bluestem-prairie muhly association. Sparse mixed-grass prairie is found in well-drained upland sites, especially hilltops and glaciated areas, and includes thin, hilly, shallow-to-gravel and thin-breaks range sites.

Mixed-grass Prairie

Dominant grasses are needle and thread, western wheatgrass, and blue grama. This is a prevalent upland type that includes silty and shallow-to-gravel range sites. Mixed-grass prairie is found on slopes and wetter sites than sparse prairie.

Northern Mixed-grass Prairie

Dominant grasses are thick-spike, northern porcupine grass (often on north-facing slopes),

Mixed-grass Prairie

Dominant grasses are needle and thread, western wheatgrass, and blue grama. This is a prevalent upland type that includes silty and shallow-to-gravel range sites. Mixed-grass prairie is found on slopes and wetter sites than sparse prairie.

Northern Mixed-grass Prairie

Dominant grasses are thick-spike, northern porcupine grass (often on north-facing slopes), western wheatgrass, and green needlegrass. Blue grama grass drops out, and upland sedge cover is generally low. Needle and thread is codominant in

some associations. Big and little bluestem may be present but probably do not codominate in well-developed plant communities. The northern mixed-grass prairie includes silty and clay range sites, and is prevalent in the Prairie Pothole Region and some of the outwash channel areas of the landscape.

Sand Prairie

Dominant grasses are prairie sandreed and needle and thread, with blue grama, threadleaf sedge, sand dropseed and sand bluestem grasses common. Western wheatgrass is among the codominants in swales and on gentle plains. The sand prairie includes sandhills and sandy range sites. Sand blowouts (small active nonvegetated areas of moving sand) are often dominated by an Indian ricegrass–scurf pea association, commonly with less than 5 percent vegetation cover.

Wet Meadow

Dominant grasses are prairie cordgrass, northern reedgrass, and sedges and rushes, as well as switchgrass, mat muhly, clustered field sedge, slender and western wheatgrass, and sometimes codominant little bluestem. Tall forbs (wild licorice, sow thistle, dock) are abundant even if they do not dominate in natural conditions. Wet meadows are found in subirrigated, overflow, and dense-clay range sites. Monotypic stands of western wheatgrass (without other upland grasses) are wet meadow features on dense clay, as found in the Big Muddy floodplain.

Saline Lowland

Dominant grasses are alkali grass and salt grass. Slender and western wheatgrasses, mat muhly, foxtail barley, sedges and rushes, and greasewood are also found in saline lowland and dense-clay range sites.

Plants of Special Concern

Fifteen plant species of special concern have been identified in the refuge complex (Heidel et al. 2000). The Medicine Lake sandhills harbor 5 plant species of special concern, at least 3 of which—Schweinitz' flatsedge, Fendler cats eye, and plains phlox—have their highest known numbers for the state in this area.

Five Montana wetland plant species of special concern have been found in the Missouri Coteau area of the refuge complex. Four occupy the dynamic wetland edge: many headed sedge, chaffweed, pale spike lobelia and northern blue-eyed grass. Two woodland plant species that are on the state watch list, lavender hyssop and common agrimony, are found in the Big Muddy headwaters area.

Integrity of native vegetation has been compromised by the planting and subsequent spread of exotic invasive plants. Crested wheatgrass dominates much of the refuge grasslands. It was planted extensively on retired cropland in the 1930s and 1940s, and has subsequently spread to many areas beyond the original seeding. Smooth brome is another introduced grass that is prominent in more mesic (moderately moist) sites throughout the refuge complex, and quackgrass and Kentucky bluegrass are present to a lesser degree. Russian olive, an exotic invasive tree originally planted in shelterbelts, has become established in native prairie throughout the refuge complex.

Four state-listed invasive plants are found in the refuge complex. Leafy spurge infests approximately 50 acres, mostly in the sandhills, the Big Island on Medicine Lake, and the Parry waterfowl production area. Canada thistle is widespread, especially in low-lying and disturbed areas, and infestations fluctuate with precipitation. Small (<0.1-acre) patches of spotted knapweed and dalmation toadflax on the refuge and Carlson Waterfowl Production Area are being intensively managed for eradication.

Grasslands in the refuge complex are maintained and enhanced with prescribed grazing and fire, haying, and rest. These management tools mimic the natural processes (naturally caused fires and grazing by bison) that historically maintained vegetation on the northern Great Plains, by removing accumulations of litter, increasing native plant vigor, inhibiting many exotic plants, and fostering plant-soil feedback mechanisms, such as fast and slow nutrient cycling (Wright and Bailey 1982, Higgins et al. 1989, Braff and Steuter 1996).

Wildlife

Wildlife of the refuge complex is typified by a rich fauna of native prairie and wetland associated species. Although most of the larger native

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The refuge supports a variety of prairie communities.

mammals, such as bison, elk, gray wolf, and grizzly bear, were extirpated from the area, many other wildlife species historically found in the area are still present today. Species lists and scientific names for birds, mammals, amphibians, reptiles, and fishes are found in appendix H.

Birds

The refuge complex provides breeding and migration habitat for a diverse group of bird species. In fact, the refuge complex has been designated 1 of the top 100 Globally Important Bird Areas in the United States by the American Bird Conservancy (ABC) (Chipley 2001). The refuge complex bird list includes 283 species, of which 126 are documented breeders, 5 are introduced species, 1 is extinct, and 2 extirpated from the area (appendix H). These species are listed as endangered or threatened under the federal Endangered Species Act. Twenty-seven species are Service nongame migratory bird species of conservation concern (USFWS 2002, table 6), and 20 of those breed within the refuge complex. Historically, the bird community of Northeast Montana was composed of prairie nesting species. Endemic chestnut-collared longspur, Baird's sparrow, Sprague's pipit, and lark buntings were among the most common songbirds, and ground nesting ferruginous hawks, burrowing owls, short-eared owls, northern harriers, and Swainson's hawks dominated the raptor community (Coues 1878, Allen 1874, Preble 1910, Murphy 1993). Sharp-tailed grouse and mourning doves were common upland game birds (Allen 1874, Preble 1910).

The changes wrought by agriculture and human settlement greatly decreased the abundances of most native prairie-nesting species, while fostering some increases in tree-nesting species such as great-horned owls, red-tailed hawks, black-billed magpie, crows, and many nonendemic songbirds (Houston and Bechard 1983, Murphy 1993, Igl and Johnson 1997).

The refuge complex is central to the breeding ranges of the passerine birds (or songbirds) endemic to the northern Great Plains, many of which are experiencing alarming population declines (Sauer et al. 1997). From 1995 to 2000, the most abundant breeding passerines in refuge grasslands were grasshopper sparrow, Baird's sparrow, chestnut-collared longspur, and Savannah sparrow. Western meadowlarks, clay-colored sparrows, lark buntings, Sprague's pipits, and bobolinks were also common.

From 1998 to 2000, waterfowl production areas in Sheridan County hosted similar large bird communities, except that Sprague's pipits were far more abundant than on the refuge (USFWS 2000c). The composition of these prairie songbird communities is similar to the historic descriptions for the area (Coues 1878, Allen 1874, Preble 1910), except that McCown's longspur is not commonly found here now, but breeds further west in Montana.

All of these species are showing continental declines, mostly due to loss of native grassland habitats. Many are also "area sensitive," meaning they disappear from an area once grasslands are fragmented to less than a minimum size. Much of the reason these species still occur in high numbers in northeast Montana may be the relatively intact nature and size of remaining prairie areas.

The importance of this area to breeding and migrating waterfowl has long been recognized and was the primary reason for the purchase of the refuge in 1935. The density of breeding duck pairs is highest in the Missouri Coteau and the refuge complex (figure 11). Most common nesting ducks are mallard, gadwall, northern pintail, northern shoveler, blue-winged teal, and lesser scaup, with a total of 14 species breeding locally.

Although the density and diversity of nesting waterfowl is outstanding, more remarkable are the area's high rates of success for nesting birds and recruitment (successful reproduction), which are among the highest recorded in the Prairie Pothole Region. Unlike more intensively farmed areas of the region, this area retains extensive contiguous tracts of publicly and privately owned grasslands, and has a predator community composed primarily of coyotes, rather than red foxes, raccoons, and striped skunks. Nest success thus is relatively high. Recorded nest success on refuge grasslands from 1975 to 1999 averaged between 35 and 40 percent (the typical range is between 12 and 78 percent). Nest success on islands and predator-excluded peninsulas averaged 56 percent and 64 percent, respectively, from 1990 to 1999, compared to a typical range of between 38 and 83 percent.

Recruitment rates for mallards (0.97 female ducklings fledged per nestling hen), and likely other dabblers, are the highest of any WMD lands in the Prairie Pothole Region (USFWS 1996), and make it an important "source" breeding area. Up to 40,000 ducks have been produced annually on the refuge complex. A breeding population of Great Plains Canada geese, previously extirpated from this area, was reestablished on the refuge from a captive flock in the 1940s. More than 300 pairs now breed in the refuge complex. Spring and fall migrations bring thousands of waterfowl to the refuge, mostly ducks, Canada and white-fronted geese, and tundra swans, with a smaller number of snow geese.

Refuge wetlands provide habitat for many colonial-nesting waterbirds, including western and eared grebes, California and ring-billed gulls, double-crested cormorants, great blue herons, and American white pelicans. The large pelican colony on Big Island and Bridgerman Point has been in existence since at least 1939, and is one of the largest colonies in the United States, with about 3,000 to 5,000 nests each year.

Table 6. Bird Species of Conservation Concern for the Medicine Lake NWR Complex, based on National Bird Conservation Initiative (NABCI) planning efforts (Landbird Plan, Shorebird Plan, Waterbird Plan, NA Waterfowl Management Plan). Status B= Breeding, M= Migration, No=Not found. Abundance A = Abundant, C= Common, U= Uncommon, O = Occasional, R= Rare. (Source)

Bird Species	*Status MDL*	*Abundance MDL*	*Other conservation status (state,Service, other)*
greater sage-grouse	No	—	PIF Watch List
greater prairie-chicken	Extirpated	—	PIF Watch List
Swainson's hawk	B	C	PIF Watch List
short-eared owl	B	U	PIF Watch List
red-headed woodpecker	B	O	PIF Watch List
willow flycatcher	B	U	PIF Watch List
Sprague's pipit	B	C	PIF Watch List
Baird's sparrow	B	A	PIF Watch List
Nelson's sharp-tailed sparrow	B	U	PIF Watch List
McCown's longspur	B	O	PIF Watch List
dickcissel	B	R	PIF Watch List
sharp-tailed grouse	B	C	
northern harrier	B	C	
ferruginous hawk	B	U	
golden eagle	B	U	
prairie falcon	B	U	
black-billed cuckoo	B	R	
burrowing owl	B	U	
northern flicker	B	C	
loggerhead shrike	B	U	
horned lark	B	A	
brown thrasher	B	C	
clay-colored sparrow	B	A	
lark bunting	B	C	
grasshopper sparrow	B	A	
Le Conte's sparrow	B	U	
chestnut-collared longspur	B	A	
western meadowlark	B	A	
black-billed magpie	B	U	
sedge wren	B	O	
piping plover	B	U	Federally threatened
mountain plover	No	—	
American avocet	B	A	
upland sandpiper	B	C	
long-billed curlew	B	U	
Hudsonian godwit	M	R	
marbled godwit	B	A	
American woodcock	No	—	

Table 6. Bird Species of Conservation Concern for the Medicine Lake NWR Complex, based on National Bird Conservation Initiative (NABCI) planning efforts (Landbird Plan, Shorebird Plan, Waterbird Plan, NA Waterfowl Management Plan). Status B= Breeding, M= Migration, No=Not found. Abundance A = Abundant, C= Common, U= Uncommon, O = Occasional, R= Rare. (Source)

Bird Species	*Status MDL*	*Abundance MDL*	*Other conservation status (state,Service, other)*
Wilson's phalarope	B	C	
migrant shorebirds	M	A	
least tern	No	—	Federally threatened
whooping crane	M	R	Federally endangered
least bittern	No	—	Federally threatened
western grebe	B	A	
Franklin's gull	B	A	
black tern	B	U	
horned grebe	B	C	
American bittern	B	U	
yellow rail	B	R	
king rail	No	—	
lesser scaup	B	A	
mallard	B	A	
northern pintail	B	A	

Place Holder for
Figure 11 duck pair
11x17 map

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Water quality is important to piping plovers and other wetland birds.

Other marsh-nesting birds breeding in the refuge complex include American bittern, rails (Sora, yellow, and Virginia), and terns (black, common, Caspian, and Forster's). A large (40-60 acre) breeding colony of Franklin's gulls is located on Manning Lake, an expansive, temporary and semipermanent wetland complex in the floodplain of Big Muddy Creek, on the Fort Peck Indian Reservation. Annual nest surveys from 1997 to 2000 revealed 1,500 to 6,000 gull nests. Other colonial waterbirds nesting within this colony include white-faced ibis, black-crowned night-heron, black and common tern, and eared grebe.

Especially in drier years, when low water levels leave large areas of exposed shoreline, concentrations of thousands of migrating shorebirds are found throughout the refuge complex. Thirty-five species of shorebirds have been observed in the refuge complex, and 12 species breed there. Several upland-nesting shorebirds are common breeders in native prairie habitats: marbled godwit, willet, upland sandpiper, and Wilson's phalarope (table 6). American avocet, killdeer, spotted sandpiper, and piping plover are the most common wetland breeders.

Sharp-tailed grouse are one of the few native prairie birds that are year-round residents. They breed commonly throughout the refuge complex with at least 30 leks (or "dancing grounds" for bird display and courtship behavior) in the refuge complex, and approximately 20 are located in waterfowl production areas in Sheridan County. Leks on the refuge annually averaged 11 displaying males from 1990 to 1999.

Table 7 lists land birds in the Prairie Pothole Region that are of regional importance to the Service.

Several nonnative bird species introduced from other countries, including house sparrow, European starling, and rock dove, have spread to Montana. Some nonnative bird species, such as ring-necked pheasant and gray partridge, were introduced early in the twentieth century as game birds for hunting. Both species are native to Asia, and have adapted well to North America. Ring-necked pheasants

Table 7. Land Birds of Regional Importance to USFWS in the Prairie Pothole Region (Birds of Conservation Concern, 2002)

Species
American bittern
northern harrier
Swainson's hawk
ferruginous hawk
peregrine falcon
yellow rail
solitary sandpiper
willet
upland sandpiper
long-billed curlew
marbled godwit
sanderling
white-rumped sandpiper
chestnut-collared longspur
buff-breasted sandpiper
black-billed cuckoo
Wilson's phalarop
burrowing owl
short-eared owl
red-headed woodpecker
loggerhead shrike
Sprague's pipit
grasshopper sparrow
Baird's sparrow
Henslow's sparrow
Le Conte's sparrow
Nelson's sharp-tailed sparrow
McCown's longspur
Hudsonian godwit

and gray partridge are managed by Montana Fish, Wildlife, and Parks because they are considered nonmigratory game birds.

Avian Diseases

Avian botulism has affected waterbirds in the complex since the refuge was established. The summer outbreaks vary from none to thousands of mortalities. No preventative measures for botulism have been developed. More recently, birds in the complex have been affected by West Nile virus. It was first detected in the pelican breeding colony in 2003, and has been present there in varying degrees every year since. Swainson's hawk nestlings also tested positive for West Nile virus in 2004. The magnitude with which the virus affects other species is unknown. West Nile virus monitoring and research began in 2003 and is ongoing, in cooperation with the U.S. Geological Survey and Montana State University. Sampling for avian influenza was initiated as part of a national effort in 2006.

Mammals

Many of the large mammals native to northeast Montana were extirpated from the area during late 1800s and early 1900s by bounty hunters and settlers. Wolves, elk, bison, swift fox, and grizzly bear were abundant in this area when the Lewis and Clark expedition traveled through in 1805. Lewis and Clark killed the first grizzly bear of their expedition 25 miles south of Medicine Lake near Culbertson, Montana (Moulton 1986).

With European settlement and agricultural development came an increase in sheltered spots, such as abandoned buildings, shelterbelts, culverts, and rock piles. These new den and hibernation sites, coupled with decreases in large predators such as wolves and coyotes, fostered increases in midsized mammals such as red fox, raccoon, and skunk. These species had historically been excluded or kept in low numbers by wolves and coyotes. Swift fox were declared extinct in Montana in 1969, but the refuge complex is within their historic range. Swift fox have been reintroduced in Saskatchewan and on the nearby Fort Peck Indian Reservation. They have re-established populations in some prairie areas, and are expanding their range. One sighting was reported in the refuge complex, in northern Sheridan County (Montana Natural Heritage Program, unpublished report, 1999).

Thirty-eight species of mammals have been observed in the refuge complex in recent years, according to information in refuge files (appendix H). White-tailed jackrabbit, beaver, muskrats, and many small mammals are common. Richardson's ground squirrels are an important species, providing a prey base for other prairie species, such as ferruginous hawks and badgers, and burrows for burrowing owls and various reptiles and amphibians. Little is known about the distribution of bat species within the refuge complex. White-tailed deer have increased with agricultural development and are now abundant. Mule deer and pronghorn antelope are sighted occasionally in or around the refuge complex, and are more common in the western portion of the WMD. Pronghorn numbers have declined dramatically on grasslands.

Amphibians and Reptiles

At least 17 species of amphibians and reptiles are found within the refuge complex (appendix H), although little inventory work has been done, according to the limited information in refuge files. Tiger salamanders, northern leopard frogs, and chorus frogs are the most common amphibians. Painted turtles and garter snakes are the most common reptiles. The smooth green snake, locally common, is found nowhere else in Montana. Western hog-nosed and smooth green snakes, and northern leopard frogs are considered state species of special concern. (Montana Natural Heritage Program and MFWP 2006). While northern leopard frogs are

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White-tailed jackrabbit is common on the refuge complex.

experiencing widespread declines in other parts of Montana and North America, they remain relatively abundant in the refuge complex.

Fishes

More than 26 species of fish have been documented as occurring within the Big Muddy Basin in the refuge complex (appendix H; Brown 1971, Holton and Johnson 1996). On the refuge, fewer fish were present before the development of water management facilities, because wetlands periodically dried up completely.

After installation of refuge dikes and water control structures, more permanent water was maintained. Fish gained access to the refuge water units by migrating from the Big Muddy Creek and other tributaries. Most common species were fathead minnow and carp.

Several attempts were made over the years to establish a fishery, and stocking northern pike to control large numbers of carp was successful in the late 1960s. An exceptional northern pike fishery developed in Medicine Lake, and the refuge became well-known. However, little reproduction occurred, and restocking was required annually. The fishery was eliminated during the drought of the late 1980s and early 1990s due to low water levels and winterkill in succeeding years.

The return of high water flows in 1993 and 1994 again brought forage fish back into the refuge. White pelicans, great blue herons, grebes, and other birds feed extensively on these fish. Stocking of northern pike resumed in 1996, and the northern pike fishery is again well-established at Medicine Lake. Few, if any, fish inhabit wetlands in waterfowl production areas, since the basins are not deep enough for fish to survive the winter.

Invertebrates

The diversity of invertebrates in the refuge complex has not been quantified. Refuge wetlands produce huge numbers of invertebrates such as midges, dragonflies, amphipods, copepods, and water boatmen. Prairies and tame grasslands produce large numbers of insects (notably grasshoppers, leafhoppers, butterflies, beetles), and spiders. These invertebrates are the food base for nearly all breeding bird species. Two butterfly species of special concern, Ottoe skipper and tawny crescent, have been collected in the refuge complex (Heidel et al. 2000). In recent years the butterflies and moths have been surveyed, and a species list has been started.

Threatened and Endangered Species

One migrant bird species, the whooping crane, and two breeding bird species, the piping plover and least tern, found in the refuge complex are listed as threatened or endangered under the Endangered Species Act. Endangered whooping cranes occasionally migrate through the refuge complex, using area wetlands and grain fields for foraging.

Endangered interior least terns nest on islands and gravel bars in the Missouri River, the southern boundary of the refuge complex.

A significant portion of the threatened Great Plains population of piping plover breeds in the refuge complex. A network of closed alkali lake basins in the northeast part of the refuge complex typically supports 85 percent of Montana's breeding plover population and 5 to 10 percent of the entire Great Plains population. This population was listed as threatened in 1985.

Plovers nesting in northeast Montana have the highest breeding recruitment of the Great Plains population, due largely to the relatively intact wetland-prairie refuge complexes found in the area (Murphy et al. 2000). Comprehensive surveys of breeding adults have been conducted annually since 1988. Breeding populations have averaged approximately 153 adult plovers with 60 breeding pairs. About 60 percent of the plovers nest on private and state land, and about 40 percent on waterfowl production areas and the refuge. In 1991, a peak number of 276 adults with 95 pairs was found in the refuge complex.

Plovers in the refuge complex typically nest along the shorelines of shallow, semipermanent, "hypersaline" to "eusaline" wetlands, or water with salinity of 30 to 40 parts per thousand due to land-derived salts (Cowardin et al. 1979) that are generally associated with the Missouri Coteau. Beaches with some gravel or scattered cobble are preferred. Plovers increasingly use waterfowl production areas and the refuge for nesting during periods of severe drought, as additional shoreline is exposed, and the more shallow alkali lakes go dry. Between 28 and 34 pairs nested on the refuge from 1990 to 1993, the last sustained drought period. Twenty-one alkali lakes and wetlands in the refuge complex have been identified as critical habitat for breeding piping plover (70 FR 57637).

Recruitment has averaged approximately 1.1 fledglings produced per nesting pair, a higher rate than most other areas, but still only approximately the level needed to maintain a stable population. Since 1996, the refuge complex has participated in a larger cooperative recovery effort with The Nature Conservancy, Montana Fish, Wildlife, and Parks, the North Dakota Game and Fish Department, and private landowners to increase fledging rates throughout the Missouri Coteau. Use of wire mesh cages and temporary electric fencing to exclude predators has increased recruitment to more than 1.4 fledglings produced per pair.

One endangered fish species, the pallid sturgeon, occurs in the Missouri River along the southern boundary of the refuge complex. No threatened or endangered plants are found in the refuge complex.

3.3 Cultural Resources

Cultural resource files indicate that 57 acres of Medicine Lake have been archaeologically surveyed for cultural resources. Historic structures in the refuge complex also were partially described in a regionwide report on Roosevelt-era public works projects in 2001. Several of the known sites on the refuge were reported by refuge staff.

Although few datable artifacts have been found on the refuge, archaeological resources investigated outside the refuge can be used to make inferences about the people who have lived at Medicine Lake for the past 11,000 years. Until the last 150 years, the region was occupied predominantly by Native Americans whose economy was based on hunting large animals. By the mid-eighteenth century the influx of nonnative peoples significantly began to alter this traditional way of life and to reshape the landscape of the region. Evidence of both the prehistory (pre contact) and the history (post contact) is found in the archaeological sites and historic buildings on the refuge.

Occupation of the region began with the Paleo-Indian Period approximately 11,000 years ago and extended through the late Prehistoric Period to about A.D. 1700. During most of this time, the population consisted of nomadic hunters primarily exploiting bison. Archaeologically, prehistoric plains hunters are distinguished through projectile points (spear and arrowheads), some of which represent technological shifts. This shift represents the use of spears, then atlatls (spear throwers), and finally the bow and arrow. Few artifacts have been found that directly link specific cultures to refuge lands.

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Refuge lands include a stone structure dating from the 1930s.

However, archaeological sites and surface finds provide evidence that prehistoric people inhabited the refuge. At this time, nine campsites with stone tool scatters, stone circles or tipi rings, and bison bones have been documented.

Tipi Hills, one example of these occupations, has evidence of at least 15 stone circles. These were recorded by refuge staff, who submitted the site for listing on the National Register of Historic Places. The remaining 8 recorded prehistoric sites consist of isolated or small groupings of tipi rings or stone cairns. These sites have not been evaluated for listing on the National Register, and should be protected from disturbances until further work demonstrates their potential for research. Sites with surface indications, such as tipi rings and cairns, are more easily identified than those without stone features. The refuge staff believes that many more sites are located on the refuge. On the basis of what is known about archaeological sites outside the refuge, there is potential for sites representing the habitation of early plains hunters that predate the use of tipis.

The presence at various times of historic Native American tribes in the area is well-documented, and includes predominantly various bands of the Arapaho, Assiniboine, Blackfeet, Cheyenne, Crow, and Gros Ventre (also called the Atsina or White Clay People). Because some of these people still live nearby, it is probable that they have interests in traditional uses of the refuge. No traditional cultural properties have been identified within the refuge complex, though the Little Rocky Mountains Traditional Cultural Property used by the Assiniboine and Gros Ventre tribes is located in nearby Phillips County.

The historic period began with the appearance of Euro-American explorers, horses, and associated trade goods in the area about A.D. 1700, although permanent settlement did not occur until the late 1800s. Horses and guns were the major trade goods that influenced the lives of the native peoples. Horses were introduced by the Spanish and initially arrived through trade from the Southwest. Guns were initially obtained through trading with the Hudson's Bay Company which was extending its influence from Canada to the area. The combination of guns and horses made bison hunting more effective. However, it also increased competition for territories in which trappers could obtain furs and hunters could hunt the migrating bison. Conflicts among the native groups increased, resulting in shifting control of these resources.

Although the fur trade brought the early settlers into contact with the native people, these were not well-documented until the Lewis and Clark expedition passed through the area in 1805, and the explorers made notes in their journals. On April 29, 1805, near present-day Culbertson, Montana, Lewis

and another expedition member wounded 2 grizzly bears. Lewis wrote: "We fell in with two brown or yellow bear; both of which we wounded; one of them made his escape, the other after my firing on him pursued me seventy or eighty yards." Lewis later notes, "Game is still very abundant. We can scarcely cast our eyes in any direction without perceiving deer, Elk, Buffaloe or Antelopes."

Lewis and Clark stayed on the Missouri River and made a small excursion up Martha's River (later called Big Muddy Creek) a short distance, but did not venture as far as the refuge. Later explorers of the region included American Fur Company trader Alexander Culbertson (1809-1879), who founded Fort Benton and was the first white American to live among the Blackfeet Indians; German explorer Prince Maximilian (1782-1867); Swiss painter Karl Bodmer (1809-1892); and American ornithologist and painter John James Audubon (1785-1851). Most of the early explorers avoided the area north of the Missouri drainage, mainly due to the adversarial relations with the native tribes, fuel and water shortages, and the preference for river travel rather than overland passage.

An early writing from this period (1855) by fur trader and chronologer of Native American life of the region, Edwin Thompson Denig, indicated that the territories around Medicine Lake were occupied in particular by the Assiniboine Tribe (Denig 2000). Other tribes known to be present in the area include the Blackfeet, Cree, and Gros Ventre.

By the late 1800s, settlers were slowly moving into the region and leaving their mark on the landscape. Most of the early evidence for this period relates to homesteading and agriculture. Among the more common site types are farmsteads, homesteads, dugouts, small rural communities, bridges, schools, and railroads. The remains of several of these homesteads are found on the refuge. Two examples are the Erickson Place and the Bock House. The Bock house was determined to be eligible for the National Register, while the Erickson Place was found not eligible for the National Register.

The establishment and early success of the refuge is tied to the Civilian Conservation Corps (CCC) and Works Progress Administration (WPA) programs of the mid-1930s. President Franklin D. Roosevelt created these programs during the Great Depression as a means to employ people to work in forests, parks, rangelands, and wildlife refuges.

WPA crews were at Medicine Lake from 1936 to 1938 and again in 1941. The CCC crews arrived at the refuge in 1937 and stayed for 4 years. During this short period, much of the infrastructure for the refuge was established, including most of the major wetlands. Projects completed on the refuge include: planting more than 18,000 trees and shrubs, installing telephone lines and fences, constructing roads, establishing trails and recreation areas, and building residences, barns, sheds, a fire tower, water control structures, and other outbuildings.

Many of these are still standing and in use, and several are eligible for the National Register of Historic Places. In 2001, the Service documented many of the public works buildings in the refuge complex, but some of the larger projects of the period, such as the Muddy Creek Diversion and other water control structures have not been documented. The Service developed a memorandum of agreement with the Montana State Historic Preservation Office to replace the water control structure from Dam 4 (Medicine Lake). The terms of this agreement required the Service to completely document the structure using historic plans because preservation was not an option.

3.4 Wilderness Management

Congress designated approximately 11,360 acres of Medicine Lake as wilderness by public law 94-557 (90 Stat. 2633) on October 19, 1976. This includes Medicine Lake and the 2,300-acre Sandhills Unit (figure 9, chapter 2). Four natural areas for research encompassing 762 acres were designated in 1972. The Service is guided in its management of the wilderness area by the Wilderness Act of 1964 and the Service's wilderness policy (USFWS 2001b). This policy describes how the refuge manager preserves the character and qualities of designated wilderness while managing for the establishing purposes of the refuge. As described earlier, the refuge must meet stringent air-quality standards.

3.5 Visitor Services

Medicine Lake NWR and the Northeast Montana WMD provide the public many opportunities to observe and experience the numerous wildlife resources of the area.

General Visitor Services

The refuge has several access points (figure 12), which make it difficult to estimate with certainty the total number of visitors. Annual visitation is estimated at 16,000 visits. This number is based on the number of people who stop into the refuge complex office and sign the visitors' registration, along with staff observations of the number of visitors to the refuge complex during the year.

Most of the refuge complex visitors can be grouped into 4 categories: hunters and anglers, wildlife observers and birdwatchers, school groups, and day visitors looking for a scenic drive or diversion from a trip.

The refuge complex office is open Monday to Friday, 7:00 am to 3:30 pm. Information and accessible restrooms are available during these hours, and are available 7 days a week at the Environmental Education Area.

Facilities

Most of the refuge complex's current visitor service facilities are found on the refuge. The WMD has no visitor services facilities except for parking lots that are next to county or township roads. A few vehicle trails traverse some waterfowl production areas, but these existed before Service ownership, and have not been improved.

The current refuge road system consists of 50 miles of designated roads; 31 miles are classified as administrative roads, and 19 miles are classified as open public roads. A 14-mile auto tour route, Wildlife Drive, is located on the refuge. This route is passable by passenger vehicles approximately 8 months of the year, and often is open at other times of the year, depending on weather conditions. The 2.3-mile entrance road is an improved all-weather gravel road from Montana State Highway 16 to the refuge complex office. The county administers an additional 8 miles of roads transecting the refuge.

All other public roads are only seasonally passable, are not improved, and are maintained on a periodic basis. Four-wheel-drive or high-clearance vehicles are recommended. Seasonal closures are imposed. For protection of habitat, vehicles are allowed only on established open roads and must be parked in designated locations.

A 99-foot-high observation tower is located at the refuge complex office site. It provides visitors a unique vista to the western half of the refuge. It is open most of the year, but closes when climatic conditions prohibit climbing the 135 steps to the top.

The Environmental Education Area is located off of Montana State Highway 16. A 0.25-mile road leads to a mowed grass loop with benches, interpretive signs, lake access, and an outdoor restroom.

Three kiosks exist on the refuge to provide the public general information and direction, interpretation, and brochures. They are located at the entrance to the Environmental Education Area off of Montana State Highway 16; at the junction of Wildlife Drive and the headquarters access road; and at the junction of East Lake Highway and Lakeside Road. New interpretive exhibits were installed at the visitor center in 2007.

The Pelican Overlook site is located at the end of the 1.2-mile vehicle trail leading to Bridgerman Point. An elevated platform overlooks a breeding colony of pelicans, cormorants, and herons. All-season fixed binoculars are provided on the deck for observation. The colony is protected from mammal predators by a 6-foot-high electric fence.

Interpretive signs are located at various locations along the Wildlife Drive. Many of these depict wildlife management activities that change annually, thus the signs are moved to correspond with current activities at a specific location.

Compatible Wildlife-Dependent Recreation

The refuge complex offers visitors a wide selection of self-guided and dispersed recreation opportunities. The 1997 Improvement Act states that public use of a refuge may be allowed only where the use is "compatible" with the Refuge System mission and the purpose for which the refuge was established. The Act also sets forth a current standard by which the Secretary of the Interior shall determine whether such uses are compatible. The term "compatible use" means an existing or proposed "wildlife-dependent recreational use" or any other use of a refuge that, in the professional judgment of the Service, would not materially interfere with, nor detract from, the fulfillment of the System's mission or the purpose of the refuge. Hunting, fishing, wildlife observation, photography, environmental education, and interpretation are the priority general public uses of the Refuge System.

Before a new use is allowed on a refuge, the Service must determine that the use is compatible and not inconsistent with public safety. To determine if a new use is compatible, a refuge must estimate the time frame, location, and purpose of each use. Furthermore, the refuge staff must identify the direct and indirect impacts of each use on refuge resources, and evaluate the use relative to the refuge's purpose.

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A favorite location for viewing wildlife is Pelican Overlook.

Place Holder for
Figure 12 public

11x17 map

Wildlife Observation and Photography

Wildlife observation is one of the most popular public use activities within the refuge complex. Most wildlife observation occurs on the refuge along the Wildlife Drive, which begins Montana State Highway 16 along the north shore of Medicine Lake. Wildlife Drive traverses various habitats, from freshwater to alkaline wetlands, and native prairie to planted tame grass. All of these habitats and the wildlife that occupy them can be viewed from a vehicle. A favorite location is Pelican Overlook, which has an observation platform that allows viewing of the refuge complex's 10,000-bird white pelican colony.

Hunting

Hunting seasons occur between September 1 and late December. Hunting is permitted for select game species, according to state regulations. The most common species hunted are white-tailed deer, ducks and geese, ring-necked pheasant, sharp-tailed grouse, and Hungarian partridge. Other species in the refuge complex that are open to hunting under state regulations include red fox, coyote, white-tailed jackrabbit, coots, and mourning doves. A special hunting season for white-tailed deer and upland game birds opens every year on November 15 for the Homestead and Lake Creek areas of the refuge (figure 12). These areas are closed before November 15 to protect populations of migratory birds that congregate in these areas for rest and feeding before continuing their fall migration. By November 15th, these units are usually frozen, and migratory birds have continued on their migration, so other hunting can take place.

Certain areas are closed to hunting to protect refuge facilities and to provide resting and feeding habitat for migratory birds (figure 12). Areas closed to hunting are clearly posted with signs.

All waterfowl production areas are open for the hunting of any game species legal to hunt in Montana.

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Hunting is a popular refuge use.

There are an estimated 7,200 hunter visits on refuge lands each year, totaling about 45 percent of annual visits. Actual harvest numbers are unavailable for the refuge complex. Refuge staff observes a small number of waterfowl hunters each year. Staff estimates the number of hunter visits for deer at fewer than 50. The MFWP annual report for upland bird harvests for all of Sheridan County in 2003, the latest year for which numbers are available (MFWP 2003), estimated 21,786 hunter visits and 26,648 birds harvested for all upland game species. The refuge probably accounts for a small percentage of the total number of hunter visits and harvest. In 2003, for Sheridan County, pheasants accounted for 14,947 birds harvested and 9,637 hunter visits (MFWP 2003).

Fishing

Fishing takes place primarily on Medicine Lake. Although fishing does occur on Lake 12 and Gaffney and Swanson lakes, (figure 12), the fish populations are low or nonexistent, thus these lakes are rarely used for fishing. Due to the wilderness status of Medicine Lake, power boats are not allowed, nor are powered augers during the ice-fishing season. Canoes and rowboats are permitted on Medicine Lake, but few people use them because of the high winds that can arise at any time, creating safety concerns.

Eight public access points for fishing are located around Medicine Lake. The most-used areas are those off of Montana State Highway 16 and along the Environmental Education Area shoreline. Most fishing is done from the shore. Winter ice fishing is very common with the aid of an icehouse. These temporary shelters, in essence hard-sided, tent-like structures, must be hand-pushed or dragged out onto the ice and removed before ice-out in the spring. They are allowed only near the Highway 16 bridge and refuge headquarters. Northern pike is the only game species available to the public, and is a much sought-after species. Due to the lack of available fishing lakes in northeastern Montana, Medicine Lake is a popular place for anglers. Fishing within the refuge complex is subject to state regulations. Refuge-specific regulations are included in the state fishing regulations, which are updated every 2 years.

Environmental Education

Environmental education usually is conducted while touring the refuge with school, scout, and civic groups. The complex staff conducts off-site programs when their schedules allow. These programs are very popular with various groups. However, some requests for educational programs and technical assistance must be denied due to staffing limitations.

Figure 13. Medicine Lake National Wildlife Refuge and surrounding counties Source: Microsoft MapPoint North America

Interpretation

The refuge complex office contains indoor exhibits that include a wall mounted map, a touch table, several archaeological and historic pieces, and several bird and mammal mounts. Interpretive signs and information kiosks are situated at various locations along Wildlife Drive.several bird and mammal mounts. Interpretive signs and information kiosks are situated at various locations along Wildlife Drive.

3.6 Current Socioeconomic Conditions

The Medicine Lake NWR is located in Roosevelt and Sheridan counties in northeastern Montana, near the borders with Canada and North Dakota. It includes 2 tracts of land that contain Medicine and Homestead lakes. Neighboring Daniels County is also included in the study area because it experiences public use related to the greater Northeastern Montana WMD that contains the Medicine Lake NWR. This 3-county study area is shown in figure 13.

Population

The 3-county district encompassing Medicine Lake NWR is gradually declining in population. The population of Montana, by comparison, has increased at a steady pace since 2000 (figure 14). The gradual loss of residents affects the socioeconomic conditions of the area (figures 14, 15, 16). In the future, the population of the 3-county study area is expected to remain stagnant, while the population of Montana experiences steady growth.

Employment

The study area employs people primarily in service, retail, and public administration jobs. Education was the largest employer, employing 23 percent of the workforce, followed by public administration (18

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The refuge provides outstanding opportunities to view birds and other wildlife.

percent), health care and social services (14 percent), and retail trade (12 percent). The agriculture industry in the study region is very small, employing only about 1 percent of the workforce. Figure 15 shows employment by sector in the study area.

The civilian workforce for the 3-county district remained stagnant at approximately 5,400 people between 2001 and 2005. Estimates from the year 2005 calculated the unemployment rate for Roosevelt County at 6.4 percent, Sheridan County at 3.6 percent, and Daniels County at 3.5 percent. These compare to a statewide unemployment level of 4 percent (DOL 2005).

Figure 16 illustrates the aging population of the 3-county district. In 1990, about 32 percent of the population was between 35 and 64 years, while that same demographic constituted 40 percent of the population in 2005. The median age for the 3-county district increased by about 2 years in the 5-year period from 2000 to 2005.

Federal Employment

Current federal employment at Medicine Lake NWR includes 9 permanent full-time employees and between 7 and 10 seasonal employees (April through September). Medicine Lake NWR had a budget of approximately $900,000 in FY 2006. The combined annual salaries of employees is $423,000. Medicine Lake NWR does not collect any fees for recreational use of its facilities, and does not directly generate any basic local revenue.

Activities

There are many recreational opportunities at Medicine Lake NWR, including hunting, fishing, wildlife observation, photography, and hiking.

Hunting represents about 45 percent of visitation (7,200 hunter days). Approximately one-third of the Medicine Lake NWR is open to hunting of waterfowl, upland game bird, and deer. The most popular animal hunted in the NWR is the ringed-neck pheasant. The major hunting season for all species is September through mid-December, with the greatest spike in visitation occurring in October. On November 15, an additional two areas of the refuge are opened for late-season hunting of upland game bird and deer.

Fishing is a popular activity in the refuge complex, representing about 10 percent of visitation. The popular ice fishing season extends from November through February, and the spring fishing season spans March through May. It is estimated that about 95 percent of all visitation for fishing takes place from November to May.

Wildlife viewing represents about 45 percent of visitation to the refuge. The most popular season for wildlife observation is during the spring migration, which lasts from April through June.

Visitation Levels

The refuge complex records about 16,000 visitor days per year. Visitation is heavily concentrated during hunting season in the fall and wildlife viewing season in the spring.

Only an estimated 15 percent of visitors live in the 3-county Medicine Lake region. Local residents do not comprise a significant proportion of the visitors who come to the refuge for hunting and wildlife viewing. The only activity in the refuge that attracts a large following of local residents is fishing.

Visitor Spending

Off-site spending by visitors helps support local lodging and retail establishments in surrounding towns. Very little lodging is available in the area surrounding Medicine Lake. In Sheridan County, the towns of Medicine Lake (2 miles from the refuge) and Plentywood (28 miles north of the refuge) each

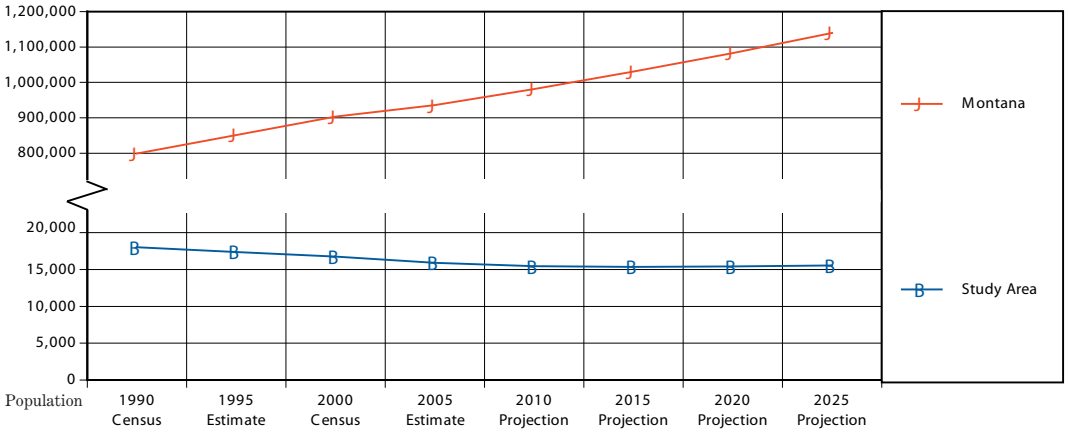

Figure 14. Montana and 3-county study area by population age
Source: U.S. Census Bureau and NPA Data Services, Inc.

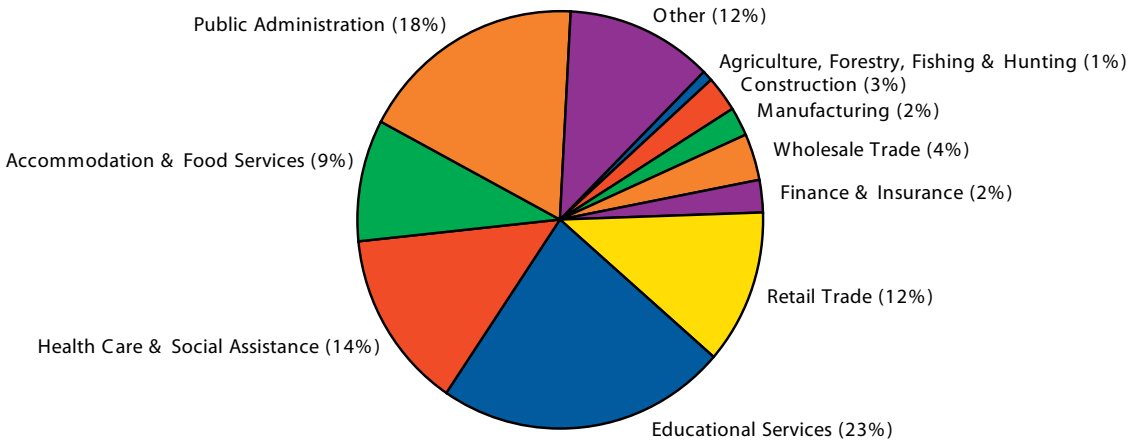

Figure 15. Area employment distribution, 2004
Source: U.S. Census Bureau, 2005 Quarterly Workforce Indicators

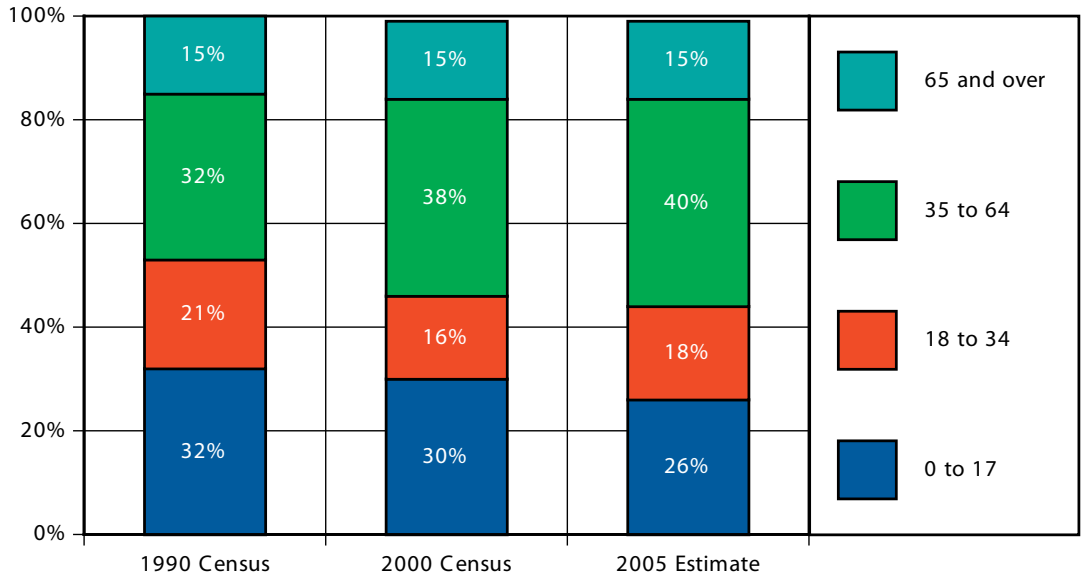

Figure 16. 3-county study area age composition
Source: U.S. Census Bureau

have one motel. Culbertson, 30 miles south of the refuge in Roosevelt County, has two motels. The lack of lodging is said to be an issue in the area, and all motels are regularly booked well in advance during the peak hunting seasons.

The lack of motel lodging has led many residents to begin renting out their homes, primarily to hunters in the fall hunting seasons, for about $100 per night for up to 4 people and $150 per night for 4 to 6 people.

Baseline Economic Activity

The Medicine Lake NWR affects the local economy through the visitor spending it generates and the employment it supports. According to the Service's "Banking on Nature 2004" study (Caudill et al. 2005), 16,000 visitor days supported $192,600 in direct local spending. Assuming a 2.5 percent annual rate of inflation, Medicine Lake NWR in 2006 contributed an estimated $202,350 in visitor spending to the local economy.

Medicine Lake NWR currently supports 9 full-time permanent employees and between 7 and 10 seasonal employees whose average tenure is 4 months per year. This equates to about 12 full-time-equivalent (FTEs) staff positions. In 2006, the combined salary of these employees was $423,000, or $35,250 per FTE.

Using the U.S. Bureau of Labor Statistic's Consumer Expenditure Survey data for individuals in this income category, and considering the commercial offerings in the study area, this study assumes that 79 percent of annual income is spent locally. Medicine Lake NWR Complex therefore brings $332,500 to the local economy in employee spending.

Combining visitor and employee spending, the total economic activity generated by Medicine Lake NWR in local economy is estimated at $535,000 for 2006.

3.7 Reasonably Foreseeable Activities

Oil and gas development is a reasonably foreseeable activity that occurs on or adjacent to the refuge complex that is independent of the actions identified in this CCP. These activities potentially can affect refuge complex resources in different ways, and refuge staff spends considerable time working with oil and gas development companies to limit adverse effects to wildlife resources. These activities are discussed in detail in the following sections.

Oil and Gas Development within Medicine Lake NWR

The Montana Minerals Management Bureau is responsible for leasing, permitting, and managing agreements related to extractions of oil and gas, metals, nonmetals, coal, sand, and gravel on 6.2 million acres of school trust lands and approximately 1,800 acres of other state-owned lands throughout Montana. The state owns the mineral rights on several school trust lands within the refuge complex boundaries, including several tracts that fall within the Medicine Lake wilderness area.

In FY 2006, record-high oil and gas prices resulted in a significant increase in leasing activity on state lands (Montana Trust Land Management Division 2006a). The primary mineral resources that are feasible for development are oil and gas (table 8). In December 2006, 2 tracts on the Medicine Lakebed were offered for lease and sold (Montana Trust Land Management Division 2006b). These are within the wilderness boundary, located under Bruce's Island (figure 17). It is not known when these resources would be extracted or from where, but horizontal or directional drilling will be used. The state has placed a "no surface occupancy" stipulation on this lease, and therefore no above-ground disturbance or infrastructure will be permitted.

Oil and Gas Development within the Wetland Management District

The Northeast Montana WMD is located in the Williston Oil Basin. The Williston Oil Basin is Montana's top oil producing area, accounting for 81 percent of all oil produced in the state (Montana Oil and Gas Conservation Division, 2000). The overlap of oil production activities has created concerns for the WMD (figures 18a and 18b). The majority of the waterfowl production areas were purchased without underground mineral rights, and perpetual wetland and grassland easements do not prevent oil exploration or drilling activities. The Williston Oil Basin was first discovered in North Dakota in

Table 8. Mines and Oil and Gas Wells within Refuge Complex, May 2007

	WMD Total	*MDLNWR*	*MDLWPAs (Fee)*	*Approved Acquisition Boundary*	*Proposed Acquisition MDLNWR*
Mines	157	0	0	0	0
Oil/Gas Wells	2,236	4	19	0	0

1951, but the first oil boom in this area did not occur until the early 1960s, when several large fields were developed. A second oil boom occurred in the 1970s, when deeper oil formations were targeted.

Renewed oil exploration activity began in the mid-1990s with the advent of horizontal drilling and 3-dimensional seismic technology (USFWS 2006d). In addition to concerns associated with oil drilling, the Williston Oil Basin produces some of the most saline water in the United States (saline or brackish water called "produced water" is generated during oil drilling). In fact, the oil field brines produced from within the Williston Oil Basin can be up to 10 times saltier than seawater (Reiten, 2002).

The majority of the waterfowl production areas occur in the eastern portion of Sheridan County, which also contains the largest concentration of oil wells. Approximately 900 oil wells have been drilled in Sheridan County, and over half of these are located in the eastern third of the county (Reiten and Tischmak 1993). In addition to oil wells and their associated tank batteries, Sheridan County also has a large number of oil and produced-water pipelines (Montana Oil and Gas Conservation Division 2000). Spills from produced-water lines are common, and impacts to wetlands in the area are visually evident (USFWS 2006d).

Adverse effects from environmental contaminants generated in conjunction with oil exploration and production include drilling muds, produced water, and production activity wastes. Congress exempted these wastes from the more stringent requirements of the hazardous waste management provision of the Resource Conservation and Recovery Act (RCRA).

USFWS

Oil exploration occurs in wetland production areas.

Consequently, reserve pits, re-injection wells, and well-site abandonment procedures are less stringent than they otherwise would be (USFWS 2006d).

The dominant waste product from the oil production process is produced water. Contaminants in produced water vary by region, depth-to-production zone, and age of the well. Frequently occurring production- water contaminants include oil, trace elements, radionuclides, additives, and salt. In the Williston Oil Basin, drilling wastes and initial production fluids are placed into reserve pits. Until the late 1970s these reserve pits were unlined; although they now are required to be lined, the linings do not prevent the migration of contaminants into nearby wetlands (USFWS2006d).

The influx of salts from produced waters to wetlands can impact waterfowl and shorebirds dependent on these systems in several ways. Invertebrate populations can shift so that an important food source is eliminated from the wetlands. Waters can become directly toxic, and birds' feathers can be degraded by salts.

Concerns over potential loss of wetland resources led to an investigation by the Service's Environmental Contaminants Program in conjunction with the refuge staff and the Montana Bureau of Mines and Geology, the SCCD, and others, of the number of waterfowl production areas impacted by oil field waste, to determine the nature and extent of oilfield exploration and production waste impacts (USFWS 2006d). The investigation will determine which wetlands contain potentially toxic concentrations of ions and co-occurring contaminants from oil exploration and production activities. It will also provide tools for the Service to use for determining whether wetlands considered for protection have good water quality and are not impacted by oil field wastes. A final report is expected in August 2008. The report will include additional recommendations to address contaminant issues disclosed in the investigation. Another investigation will be evaluating oil field waste impacts to Big Muddy Creek for future total maximum daily load development.

Operation and maintenance of oil and gas wells throughout the Northeast Montana WMD require companies to have access roads and utility lines. Refuge staff spend considerable time, equal to about three-quarters of 1 full-time position, working with oil and gas companies to limit the impact of roads and other utility lines on the WMD.

Place Holder for
Figure 17 oil
11x17 map

Place Holder for
Figure 18a oil west
11x17 map

Place Holder for
Figure 18b oil east
11x17 map

3.8 Lamesteer NWR

Lamesteer NWR is an unmanned "satellite" station to Medicine Lake NWR. The condition of Lamesteer dam, information about other water resources, upland habitat, and migratory bird resources specific to Lamesteer NWR are discussed below.

Condition of Dam

The Lamesteer dam is classified as an intermediate size, low hazard dam (USFWS 2005). An intermediate-size dam is defined by the Service as having a storage capacity ranging from 1,000 acre-feet to 50,000 acre-feet. The storage capacity of the Lamesteer dam is about 1,470 acre-feet. The dam was last inspected in 2005. A low hazard classification means that there does not appear to be a potential for "lives in jeopardy" in the downstream flood path.

Hydrologic and hydraulic analyses conducted by the Service confirmed that no permanent-living structures exist in the downstream floodplain, and property damage from failure of the dam would be minimal (USFWS 2005). The overall safety classification of the dam is considered "poor," and corrective actions to resolve the deficiencies in the dam were recommended. The "poor" classification was based primarily on the absence of low-level outlet works, the deteriorated condition of the service spillway walls, the low areas of the dam crest, and uncontrolled seepage areas located at the toe of the dam (USFWS 2005).

Recommendations in the last inspection report (USFWS 2005) included a range of maintenance priorities, such as removing Russian olive trees and other shrubs, establishing a vegetation control program for the dam crest and slopes up and down stream, and continual monitoring. Recommendations also included construction projects, such as filling and compacting low areas on the dam crest, installing a low-level outlet works to provide a means to lower the reservoir, and repairs to the spillway wall. The total cost for all repairs and construction were estimated at $950,000 (appendix J).

Adjacent Water Resources

The Lamesteer reservoir measures about 70.48 acres (surface area). Figure 19 shows other water resources within a 25- to 50-mile radius of Lamesteer NWR. Within 25 miles of the refuge, there are approximately 127 lakes, ponds, and stock tanks, totaling 1,179 acres. Within a 50-mile radius, there are approximately 425 lakes (or 3,980 acres of lakes). The majority of other water resources near Lamesteer NWR are in eastern Montana.

Habitat

As explained in chapter 2, the Service does not control any of the uplands surrounding Lamesteer NWR. Almost all of the adjacent uplands are croplands (figure 7).

Migratory Bird Resources

MFWP conducted an avian inventory of shallow wetlands in eastern Montana in 2006 and found 28 bird species at Lamesteer NWR. None were uncommon species or species of concern (table 6), and most are considered abundant or common. The agency did not find any breeding birds or nests at Lamesteer NWR during the survey period (MFWP 2007).

USFWS

Lamesteer NWR does not possess the same habitat value as other parts of the refuge complex.

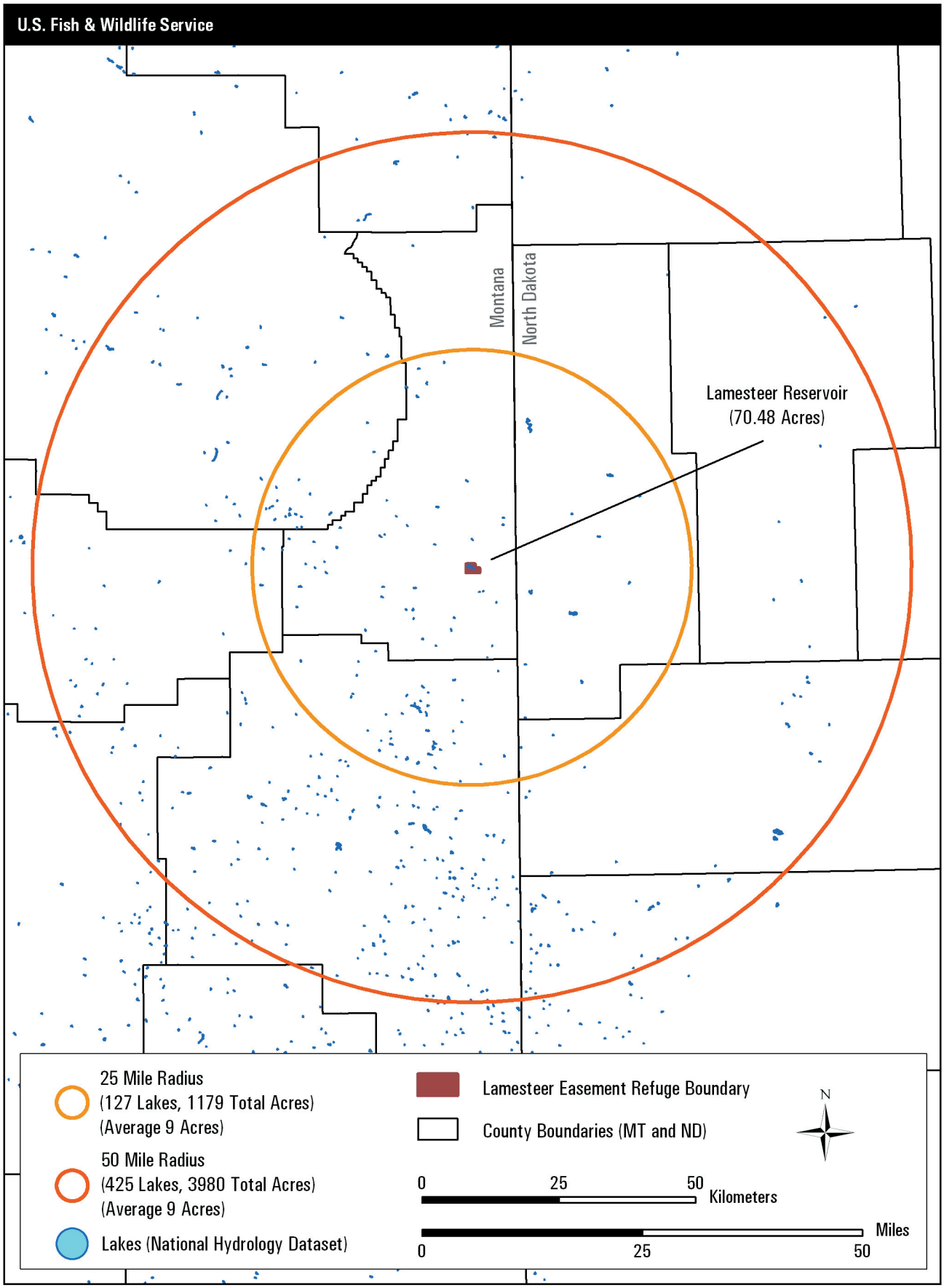

Figure 19. Water within a 50-mile radius of Lamesteer National Wildlife Refuge