3 Refuge Description

John and Karen Hollingsworth/USFWS

The western meadowlark is a Neotropical migrant that nests in upland habitats at Arrowwood NWR.

Located in the glacial drift plain of east-central North Dakota, the Arrowwood NWR lies in the center of the Prairie Pothole Region. The 15,973-acre refuge occupies 14 miles of the James River Valley in Foster and Stutsman counties. The refuge is in the Central Flyway migration corridor and is an important stopover for many species of birds as they journey north and south during annual migrations.

This chapter describes the refuge's setting, as follows:

- physical resources
- biological resources
- cultural resources
- special management areas
- visitor services
- aesthetics
- socioeconomic environment
- staffing
- partnerships and other public outreach

3.1 Physical Resources

The climate, air, soils, minerals, and water resources at the refuge are described in this section.

Climate

The Arrowwood NWR has a continental climate characterized by relatively warm, short summers; long cold winters; and rapidly changing weather patterns. January is the coldest month and July is the warmest. The average growing season ranges from 98 to 106 days.

The average daily summer temperature is in the mid to upper 60s (°F), with the average high temperature in the upper 70s to low 80s. The average winter low temperature ranges from -1°F to -5°F. The coldest temperatures vary from -40°F to -60°F, with summertime highs up to 112°F. Annual temperature ranges can be as much as 150°F.

Average annual precipitation is 18.36 inches, more than half of which falls between May and July. Recorded amounts vary greatly, from less than 10 inches to more than 30 inches. The average annual snowfall ranges from 30 to 40 inches, but can vary from 7 inches to more than 100 inches. In the winter, snow and high winds bring frequent blizzard conditions to the area. The frost-free season generally runs from May 20 to September 15.

Air Quality

Visibility and clean air are primary resource values. Based on North Dakota's most current data, the state has relatively clean air. North Dakota is 1 of only 14 states to comply with all federal ambient air quality standards. The levels of ozone, sulfur, and nitrogen dioxide did not exceed federal or state standards at any monitoring site in 2004. In addition, levels of inhalable $PM_{2.5}$ and inhalable continuous PM_{10} did not exceed federal standards during the year.

Prescribed burning is the refuge management activity that has the greatest effect on air quality (find more information in the description of the fire management program in appendix F). The management of smoke is incorporated into planning prescribed burns and, to the extent possible, in suppression of wildfires. Sensitive areas are identified and precautions are taken to safeguard visitors and local residents. Smoke dispersal is a consideration in determining whether a prescribed burn is within prescription. Generally, the fine grass fuels and small burn size (80–600 acres) generate low volumes of smoke for short durations (4–5 hours).

Soils

Soils within Stutsman County have been inventoried and mapped, published copies of which are available. Arrowwood NWR contains soils formed in glacial drift. The advancing glacier picked up rocks and soil, ground and mixed them, and deposited the material as the ice melted from the receding glacier. Soils such as Barnes and Svea formed in unsorted material, or glacial till. Soils such as Bearden and Fargo formed in glaciolacustrine deposits, or glacial material deposited by water in glacial lakes. Other soils such as Divide and Sioux, were formed in glaciofluvial deposits or material deposited by glacial meltwater.

The soils in Stutsman County formed mainly under grassland vegetation. Grasses provide a plentiful supply of organic matter, which improves the chemical and physical properties of the soil. The fibrous roots of these grasses penetrate the soil to a depth of several feet, making it more porous and more granular. As a result of these changes in the soil, less water runs off the surface and more moisture is available for increased microbiological activity.

The slope of the soils range from level to very steep. The degree of slope and the shape of the surface affect each soil type through their effects on runoff and internal drainage. On Buse and other soils on steep slopes, much of the precipitation is lost as runoff. Vegetation is sparse, leaching is restricted, and profile development is slow. Svea and other soils in the lower areas receive runoff from the Buse and other soils because of their position on the landscape.

Soils formed in depressions vary widely in profile development, depending on the degree of wetness. Tonka soils, which are in shallow depressions, exhibit an advanced degree of horizonation (distinct horizons or layers) because of the alternate wet and dry cycles that occur in depressions. Because of increased moisture in the depressions, Tonka soils exhibit properties much like soils in areas of much higher precipitation. Southam soils, which are in deep depressions, are nearly continuously wet and have a thick surface layer and carbonates throughout. The horizonation in these soils is mostly the result of sedimentary processes resulting from the glacier and depositions within the James River floodplain.

Approximately 10,000–12,000 years have passed since the glacier receded from Stutsman County. In geological terms, the soils in the county and at the refuge are young.

Mineral Resources and Reserved Rights

During the withdrawal of lands establishing the refuge in 1935, and as additional lands were acquired, there were reservations of surface or subsurface mineral rights outstanding to third parties on lands acquired in fee title by the federal government. Later purchase of additional land tracts were subject to outstanding mineral rights and existing rights-of-way at the time of acquisition. These rights-of-way include four road easements to the state of North Dakota.

Water Resources

Figure 4 shows the water resources of Arrowwood NWR. The refuge has four major water impoundments, which cover 3,064 acres:

Arrowwood Lake (1,671 acres)

Mud Lake (359 acres)

Jim Lake (723 acres)

Depuy Marsh, which is comprised of two units: Depuy Marsh (230 acres) and North Depuy subimpoundment (81 acres)

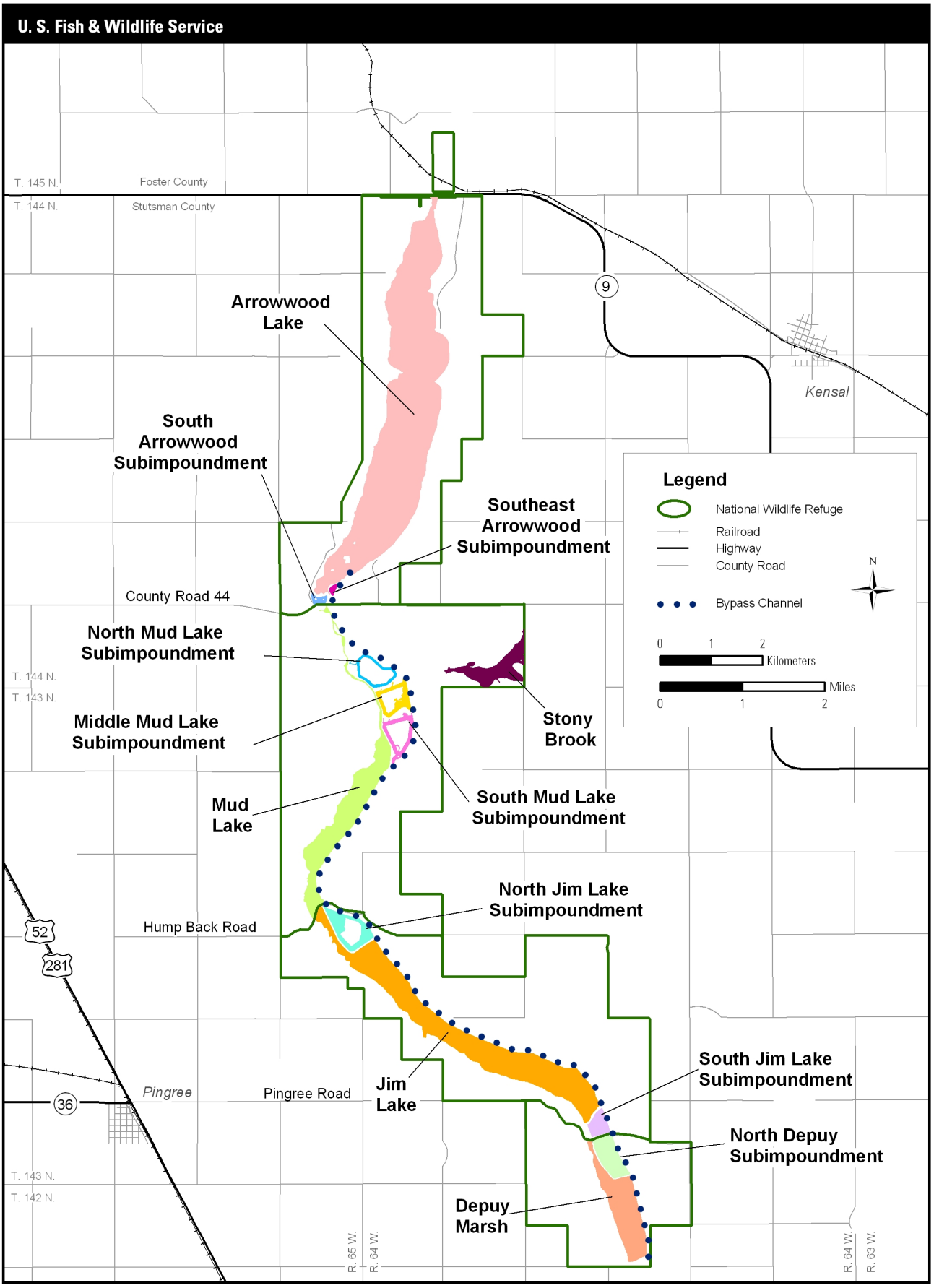

Figure 4. Water impoundments at Arrowwood NWR, North Dakota.

With completion of the Arrowwood NWR mitigation project, there are eight other managed water subimpoundments:

South Arrowwood (11 acres)

Southeast Arrowwood (6 acres)

Mud Lake North (28 acres)

Mud Lake Middle (47 acres)

Mud Lake South (44 acres)

North Jim Lake (69 acres)

South Jim Lake (37 acres)

Stony Brook (125 acres)

The three northernmost pools (Arrowwood, Mud, and Jim lakes) are natural lakes that were modified by the CCC with low-level dikes and water control structures to retain more water. Depuy Marsh, on the south end of the refuge, was also a CCC project to create additional wetlands. The Arrowwood NWR mitigation project constructed a bypass channel that starts at the south end of Arrowwood Lake. The channel runs along the east side of Mud Lake, Jim Lake, and Depuy Marsh to the southern boundary of the refuge. There is a water control structure located at the southern end of the channel that controls the water level in the channel. A second water control structure located at the head of the bypass channel controls the amount of water entering the channel. There are water control turnouts and outlets in each impoundment that allow water elevations to be controlled independently of other impoundments.

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The view looking north over Jim Lake shows the bypass channel hugging the eastern edge of the lake.

Based on historical runoff records, this system of water control structures and the bypass channel allows managers to reach target elevations an average of 7 out of 10 years. The other 30% of the time will be flood years when water levels overtop water control structures and dikes and the refuge would not be able to manage water until the Jamestown Reservoir level was lowered.

Hydrology

The James River, a tributary of the Missouri River, originates in central North Dakota. The headwaters flow generally eastward to the town of New Rockford and then southward to the South Dakota border. Arrowwood NWR is part of the upper James River watershed (figure 5). Most runoff occurs between March and July with very little runoff occurring between November and February, so average monthly stream flows vary widely throughout the year.

The upper James River watershed consists of a poorly defined series of small ponds and marshes. In the rest of the watershed, the 20- to 40-foot-wide river channel meanders across a flat-bottomed, steep-sided valley. The river valley varies from a few hundred feet to approximately 2 miles wide. Channel capacity varies from 30 cubic feet per second (cfs) in the upper reaches to 10,000 cfs in the lower reaches in South Dakota. In the headwaters of the James River, the maximum bankfull flow is 250 cfs with an average velocity of 0.87 foot per second. Rocky Run Creek, Kelly Creek, and Juanita Lake are the only tributaries to the upper James River. (Bureau of Reclamation 1997)

Winter snowmelt and spring rains often combine in March and April to form the runoff that replenishes refuge impoundments and wetland basins. Intense thunderstorms occur frequently in summer.

Water Quality

Before Arrowwood NWR was established, shallow, slowly draining wetlands served as natural wildlife areas in this flat terrain. The primary factors affecting water quality were hydrology and natural impediments to drainage. After construction of the dikes and water control structures, deeper and more permanent wetlands formed. The pools are eutrophic (depleted of oxygen by decay of organic matter) and highly productive. External nutrient inputs include agricultural runoff, bird droppings, decaying plants, and rough fish. At times, the refuge traps nutrients; however, during high-water events, the opposite is true and the refuge “exports” excess nutrients to Jamestown Reservoir.

Backwater effects of Jamestown Reservoir became apparent after the reservoir filled in 1965, resulting in further increases in refuge pool depths. In particular, flood control operations result in prolonged periods of high water at the refuge during the spring and early summer. This is undesirable since this period is critical for the establishment of submerged aquatic plants such as sago pondweed. High water, in combination with turbidity, limits light availability for plant growth. Blue-green algae usually dominate in years when submergent plants do not become well established.

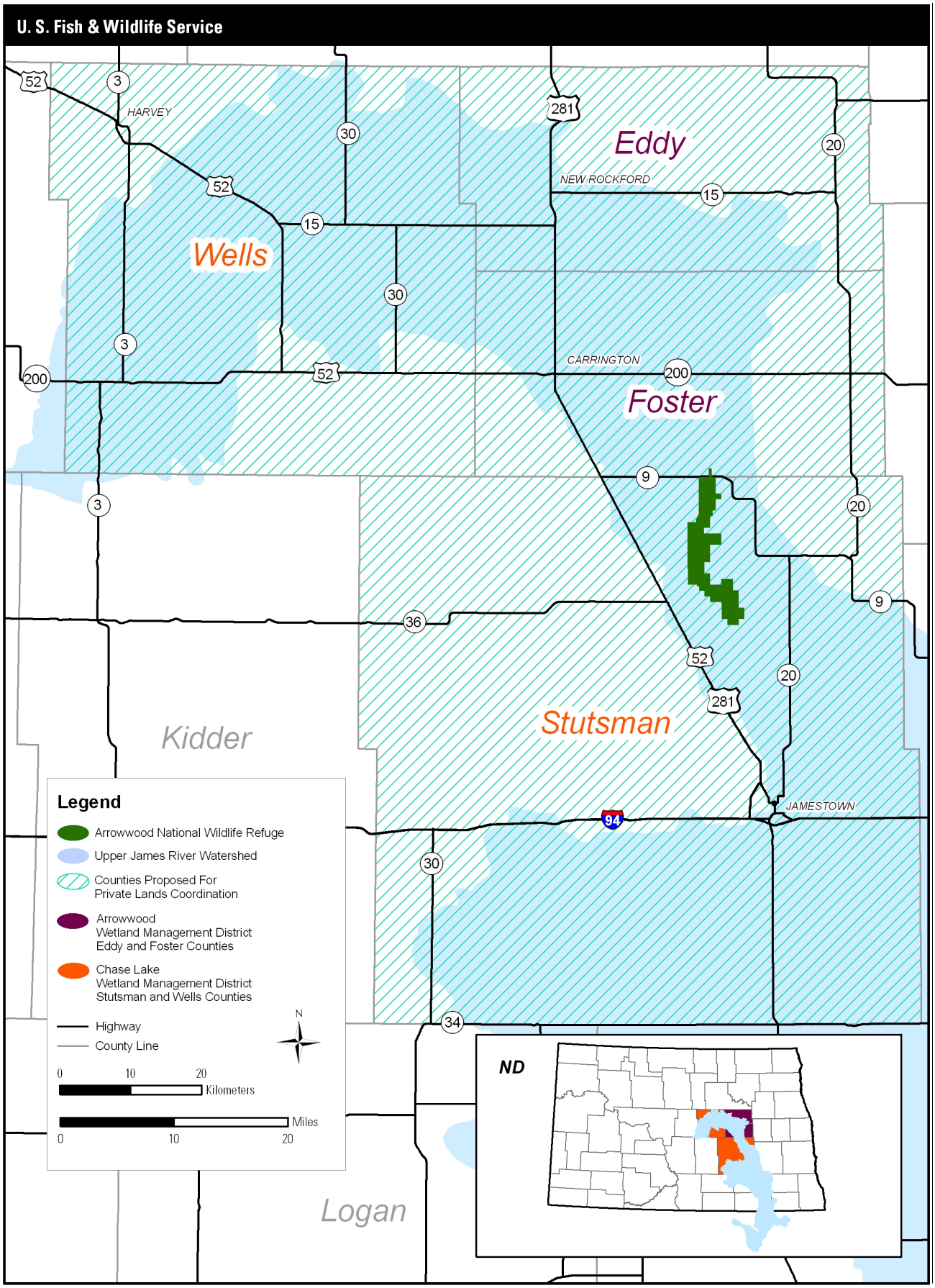

Figure 5. Upper James River watershed.

Water quality upstream of the refuge is determined in large part by land use practices as well as the flushing and hydrology of the watershed. Draining natural wetlands and channeling watercourses increase water quality degradation caused by row cropping and associated use of fertilizers and herbicides. Livestock confinement facilities that drain into the watershed are also responsible for lower water quality. Snowmelt and large rainfall events flush the watershed; however, periods with little or no flow are frequent, and the river may dry up entirely during a drought.

In 1997, Vice President Gore directed federal agencies to develop an action plan for clean water on the 25th anniversary of the 1972 Clean Water Act. The Clean Water Action Plan provided guidelines to restore and protect the water resources of the United States. One of the requirements of the Clean Water Action Plan was the North Dakota Unified Watershed Assessment (UWA). The UWA was issued September 25, 1998, and classified North Dakota's 50 hydrologic unit areas (HUA) into four categories, as follows:

Category I—watersheds in need of restoration

Category II—watersheds meeting goals, but needing action to sustain water quality

Category III—watersheds with pristine or sensitive aquatic systems on lands administered by federal, state, or tribal agencies

Category IV—watersheds with insufficient data to make an assessment

Nineteen data elements were used to categorize and rank each HUA. It was determined early in the evaluation that there were no watersheds in the state that met all of the goals of the Clean Water Act; therefore, all 50 HUAs were either classified as category I or IV. Eight were classified as category IV and the remaining 42 as category I. There were 14 HUAs identified as high-priority watersheds. The James River headwaters HUA was classified as medium priority for restoration and was ranked number 20 in the state.

As authorized under Title III Section 303(d) of the Clean Water Act, the Environmental Protection Agency (EPA) lists impaired waters of each state. These waters do not meet the water quality standards established for their intended purposes, which include public water supply; recreation; and fish, shellfish, and wildlife protection and propagation. Upstream of the refuge, the reach of the James River from the confluence of Big Slough downstream to the confluence with Rocky Run is listed as threatened for recreation because it exceeds standards for total coliform bacteria. At the refuge, the reach between Arrowwood Lake and Mud Lake is listed as threatened for fish, shellfish, and wildlife protection and propagation because it does not meet EPA standards for dissolved oxygen. Downstream of the refuge, the Jamestown Reservoir is listed as threatened for recreation due to excessive levels of nutrients.

Annual water quality patterns at Arrowwood NWR are typical of shallow lakes in the Prairie Pothole Region of North Dakota. The depth of the refuge pools and the resulting warm temperatures and light availability for photosynthesis are primary factors affecting productivity. Usually, highly productive summer conditions are followed by anoxic (absence of oxygen) winter conditions due to shallow depths and freeze out. During summer, respiration, photosynthesis, and mixing due to wave action can cause dissolved oxygen to fluctuate widely on a daily basis. During winter, limited photosynthesis and decaying organic matter under the snow and ice frequently deplete dissolved oxygen.

Concentrations of nutrients are similar to values reported from other refuges in North Dakota and South Dakota. Major constituents, chlorophyll, pH, conductivity, and dissolved oxygen show seasonal variations consistent with data reported from other prairie wetlands. An examination of trace elements in the water column revealed the presence of elements (arsenic, selenium, mercury, lead) that can, in high concentrations, cause reproductive problems in waterfowl. However, the concentrations of these elements at the refuge are low and should not pose a threat to aquatic biota.

Trace elements present in the sediments at the refuge are considered to be naturally occurring with the exception of arsenic. Elevated arsenic levels may be the result of treatments for grasshopper infestations during the 1930s. Although some persistent organic compounds such as pesticides have been detected in sediment samples from the refuge, the concentrations were within acceptable limits.

Water Rights

Water rights for Arrowwood NWR were filed September 1, 1934. These water rights provide 16,000 acre-feet annually or as much as it takes to fill the impoundments to spillway elevations. An additional water right of 10,000 acre-feet is allowed to maintain these elevations throughout the year.

3.2 Biological Resources

This section describes the existing habitat and wildlife at Arrowwood NWR. Figure 6 shows existing habitat conditions.

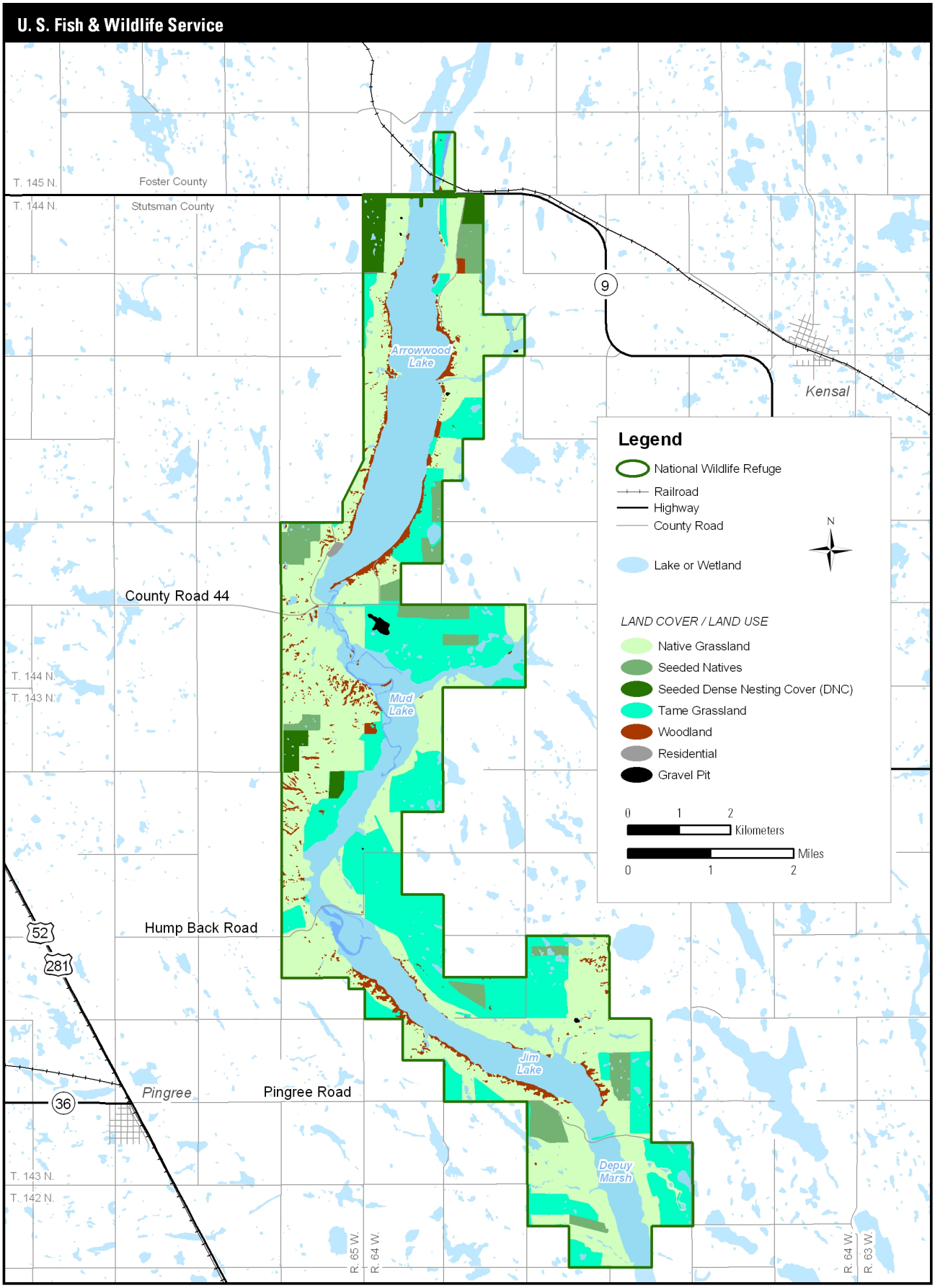

Figure 6. Habitats at Arrowwood NWR, North Dakota.

Habitat

The refuge provides, protects, and manages habitat for resident and migratory species, as well as federal- and state-listed threatened and endangered species. The refuge provides production habitat and resting and feeding areas for thousands of waterfowl and other migratory birds. The refuge historically has been particularly important as a major staging area in North Dakota with specific importance to fall populations of canvasbacks.

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Native forbs and grasses abound in the uplands.

The refuge contains approximately 6,000 acres of native prairie (unbroken sod); 5,340 acres of seeded grasses; 3,430 acres of enhanced wetlands; 420 acres of natural wetlands; 660 acres of wooded ravines and riparian woodlands; and 125 acres of planted trees (figure 6).

Upland vegetation makes up almost 12,000 acres of the 15,973-acre refuge. Deterioration of grassland habitats occurred for many years prior to and, in some cases, after acquisition by the Service. Many tracts have histories of tillage or overgrazing. Farming eliminated many native plant species. Even native grasslands that do not have farming histories face threats from the introduction of exotic plant species. In addition to tillage and overgrazing, many of the native plant communities were altered by other refuge management practices such as fire suppression or excessive rest, which provides exotic species an opportunity to outcompete native grasses. Many of these acres are invaded with nonnative plants such as smooth brome and Kentucky bluegrass, or invasive plants such as leafy spurge and Canada thistle. These nonnative species continue to alter the species composition and structure of grassland ecosystems, reducing their value as wildlife habitat. However, these sites still contain native plant seed sources and dormant native plants with the potential for tremendous biological diversity.

Nearly 90% of wetland habitats are contained within managed impoundments and pools. The remaining wetland acres are natural wetlands or wetlands created by low-head dikes on tributaries flowing into the refuge. The managed impoundments are natural riverine lakes that have been modified to enhance water management capabilities. The recent construction of the bypass canal and subimpoundments allow for the management of a variety of wetland habitats.

The prairie grassland and wetland complex habitats on and adjacent to the refuge provide nesting and feeding habitat for waterfowl in the spring and summer as well as important breeding habitat for a variety of other ground-nesting birds, especially the declining grassland-dependent songbirds. In addition, hundreds of thousands of birds passing through this area during spring and fall migration rely on these habitats for feeding and resting.

A list of refuge plant species is in appendix G.

Upland Vegetation

Uplands at the refuge are categorized as follows:

- native grass (within unbroken sod areas)
- "go-back" or old cropland from the 1930s allowed to naturally succeed
- seeded natives
- dense nesting cover (DNC), which is usually a mixture of introduced cool-season wheatgrass species, alfalfa, and sweetclover
- old DNC-seeded areas that are now predominately smooth brome and Kentucky bluegrass
- riparian habitat of native prairie interspersed with deciduous tall shrubs and trees, wooded ravines, and shelterbelts

Native Grassland

The refuge is comprised of 7,000 acres of native grasses (1,000 acres of which is "go-back"), 800 acres of seeded native grass species, and 660 acres within riparian corridors and wooded draws. The native prairie habitat is predominantly a cool-season, needlegrass-wheatgrass, mixed-grass prairie that primarily occurs on the steep bluffs on either side of the James River.

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Milkweed is one of the native prairie plant species.

Vegetation of the mixed-grass prairie is characterized by grasses and forbs ranging from 2 to 4 feet tall. Grasses are a mixture of western wheatgrass,

needlegrasses, blue grama, little bluestem, and upland sedges. Interspersed within the grasses are numerous species of forbs such as coneflowers, asters, and goldenrods; and patches of shrubs comprised of western snowberry, Woods' rose, silverberry, or mixtures of these species. The plant community is the transition zone between the wetter tall-grass prairie to the east and the drier short-grass prairie to the west.

The 660 acres of riparian floodplain and wooded draws are primarily associated with the James River valley and with lakeshores within the refuge. Tree species present include green ash, cottonwood, elm, chokecherry, and cedar. Shrubs and small woody species are present in the native and "go-back" areas and wooded ravines. Common species are western snowberry, prairie rose, and silver buffaloberry.

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Prescribed fire was used to remove litter, increase native vegetation, and improve habitat for ground-nesting birds in unit G21 at west Jim Lake.

Tame Grassland

Approximately 3,540 acres of the upland habitats are tame grasslands. About 400 acres have been recently seeded with DNC (a mixture of introduced wheatgrass species with alfalfa and sweetclover) and retain the seeded composition. The remaining 3,140 acres are old crop fields that were generally seeded to a mixture of introduced grasses and legumes in the 1970s and 1980s. These old crop fields are predominantly comprised of smooth brome, Kentucky bluegrass and in many cases, invasive plants, with little to no forb component remaining. DNC fields have proven very attractive to nesting waterfowl and have shown increased nest success within their confines.

DNC is very important to upland-nesting birds, especially ducks. DNC makes a major contribution toward achieving the waterfowl production objectives of the Arrowwood NWR Complex (Duebbert 1969, Duebbert and Lokemoen 1976, Higgins and Barker 1982). Some of these stands provide excellent nesting and winter cover. Many have declined in productivity due to the tendency of smooth brome to invade and dominate the stand and then to become sod-bound. DNC fields tend to become heavily infested with leafy spurge, Canada thistle, and other exotic and invasive plant species. An integrated approach to invasive plant control has been carried out to combat this problem.

Grazing, prescribed burning, haying, and cultivation have been the primary management tools used to achieve habitat objectives. Other than prescribed fire treatments, most management actions have been conducted under a special use permit with permittees selected through a bid process.

Woodland and Shelterbelts

Arrowwood NWR contains more than 125 acres in shelterbelts (planted tree rows) and old farmstead tree groves. The CCC and WPA planted most of these from 1937 through 1942 to control wind erosion and provide wildlife habitat. Species planted were chokecherry, caragana, Russian olive, cottonwood, boxelder, ponderosa pine, red cedar, American elm, and plum. Firebreaks have protected the shelterbelts. However, the shelterbelts have deteriorated with no other management such as pruning or replacement of dead trees. More than 30 of these plantings remain scattered throughout the refuge.

Tree plantings have significantly altered grassland habitats. The loss and degradation of native grasslands and habitat fragmentation have been implicated in the consistent decline of grassland bird populations (Samson and Knopf 1994, Herkert 1995, Bakker et al. 2002). In addition, the removal of trees may reduce avian predation on grassland-nesting species (Johnson and Temple 1990). Avian predators such as American crows and black-billed magpies prey on waterfowl eggs and use shelterbelts for nesting and food (Sargeant et al. 1993). Raptor species such as red-tailed hawk, Swainson's hawk, and great horned owl prey on adult ducks and ducklings (Murphy 1997). The removal of woody vegetation within grasslands likely reduces the cover and travel corridors for mammalian predators (Sovada et al. [in press]).

Wetland Vegetation

Wetland or aquatic vegetation consists of plants associated with wetlands or soil saturated for the majority of the growing season. The impoundments and pools contain sedges, smartweed, cordgrass, duckweed, reedgrass, cattails, and submergent plants such as sago pondweed. One of the most important aquatic food resources occurring at the refuge is the extensive beds of sago pondweed. Diving ducks, especially the canvasback, heavily use these beds. Good sago pondweed production occurs approximately 5 out of every 10 years.

Wetland plants affected by upland management are emergent vegetation along the upland–wetland edge. These include cattail, bulrush, and several species of moist soil plants such as smartweed. Substantial natural variation in submergent vegetation quantity and spatial distribution has occurred at the refuge since 1983. Emergent vegetation has remained relatively constant.

Impoundments and pools have been managed using the bypass channel system and water control structures. This manipulation of water levels has encouraged desirable plant growth and discouraged less desirable species.

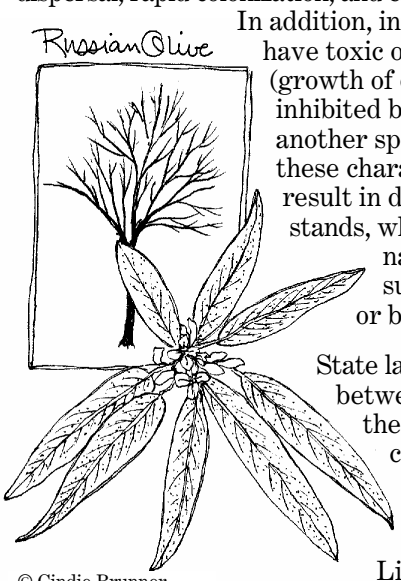
Threatened and Endangered Plants

The refuge has no documented threatened or endangered plant species; however, no formal surveys have been conducted.

Invasive Plants

"Noxious weeds" is a legal designation. In the North Dakota Noxious Weed Law and Regulations Guide, the North Dakota Department of Agriculture has identified noxious weeds as plants that are difficult to control, easily spread, and injurious to public health, crops, livestock, land, or other property. Many of the state-listed noxious weeds are also invasive species.

Invasive plants are introduced organisms that colonize and rapidly spread in native systems due to the absence of natural controls. Invasive plants often share characteristics including effective seed dispersal, rapid colonization, and expansion capacities. In addition, invasive plants can have toxic or allelopathic (growth of one species inhibited by chemicals of another species) effects. All these characteristics can result in dense single-species stands, which rapidly exclude native species or suppress crop yields or both.



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State laws, and agreements between the Service and the state, mandate the control of state-listed noxious weeds on Service-owned lands. Limited resources restrict the ability to control effectively all invasive plants at the refuge; therefore, priorities have been established to determine which species will be controlled first. These priorities are based the weeds' potential adverse effects to refuge grasslands, wildlife, and economic capital. The adverse effects are derived from the life history, species biology, and control techniques of the species. Those species selected as the highest priority for control are those known to be invasive in their characteristics and currently found in refuge habitats. The four priority invasive plant species are Canada thistle, absinth wormwood, leafy spurge, and Russian olive. Infestations of other invasive plant species are targeted for treatment immediately upon identification. Invasive plants are managed as described in the Integrated Pest Management Plan for the Arrowwood NWR Complex (IPM Plan) (USFWS 2005).

Smooth brome, Kentucky bluegrass, crested wheatgrass, and quackgrass are species of tame grasses that have been seeded on or adjacent to refuge lands. These grasses have been seeded by neighboring landowners for forage or in plantings through the Conservation Reserve Program (a U.S. Department of Agriculture [USDA] program that "idles" highly erodible land), or by the USDA for bank stabilization. In some cases, the Service has seeded some of these species on refuge lands for wildlife habitat. Although these grass species are invasive in their characteristics and can damage native prairie grasslands when they invade, they are not considered invasive plants or noxious weeds in the IPM Plan (USFWS 2005).

Significant infestations of invasive plants have resulted in more than a loss of habitat for wildlife and a decline in species diversity in prairie grasslands. For many years, invasive plant issues have been sources of contention between the Service, neighboring landowners, the state of North Dakota, and county officials. Invasive plants have not always been effectively managed at the refuge. Invasive plant control efforts were often cosmetic, shortsighted, and reactive; many times, control efforts used only one technique instead of an integrated approach designed to meet a habitat objective.

The refuge employs an integrated approach to more effectively control noxious weeds and invasive plants, to achieve management goals and refuge purposes. The "Upper James River Weed Management Area" partnership was developed to work cooperatively and apply for grants.

Cropland

Although the refuge has a long history of agricultural crop production, there is currently little cropland at the refuge. The process of reducing cropland acres began in 1995 and most fields were seeded to native grass by 2005. Cropland will only be used to rejuvenate old DNC or to replace DNC with native grasses.

John and Karen Hollingsworth/USFWS

Tundra swan.

Wildlife

An important stopping place for migratory birds, the refuge also hosts threatened and endangered species and other wildlife described in this section. Lists of refuge wildlife species are in appendixes H–K.

Invertebrates

Invertebrate production in refuge waters is excellent especially in low-water years. Production of chironomids (midges), corixids (water boatmen), notonectids, and many other aquatic species normally peak at the same time the majority of the waterfowl broods are hatching. These aquatic insects provide an important source of protein to waterfowl and other wildlife. Terrestrial invertebrates are also an important food source to wildlife at the refuge. There are no known endangered invertebrates at the refuge.

Amphibians and Reptiles

Tiger salamander, Great Plains toad, Dakota toad, leopard frog, snapping turtle, painted turtle, plains garter snake, and prairie skink are some of the common reptiles and amphibians that inhabit the James River watershed.

Several species of reptiles and amphibians have been documented at the refuge, but no formal surveys have been conducted. Tiger salamander, leopard frog, chorus frog, and two species of turtles are known to be present. There are only three species of snakes known to occur at the refuge—garter snake, red-bellied snake, and smooth green snake. Appendix I contains a list of potentially occurring amphibian and reptile species at the refuge.

Fish

The shallow nature of impoundments usually results in a winterkill of fish. However, in high-water years fish can move upstream from the Jamestown Reservoir. This can result in good populations of northern pike, walleye, yellow perch, crappie, smallmouth bass, and black bullhead, but also brings undesirable species such as bigmouth buffalo and carp. Fathead minnows and sticklebacks are also present. The fish provide a valuable food source for herons, grebes, mergansers, pelicans, and other fish-eating birds. Management efforts directed at sago production normally results in winterkill in all impoundments.

Common carp and bigmouth buffalo are always present in the James River and will enter refuge subimpoundments at every opportunity. Management of water levels on the refuge will minimize these undesirable species. Low water levels in the fall will cause winterkill of fish in most years. In addition, the electric fish barrier constructed as part of the Arrowwood NWR mitigation project (located between the refuge and Jamestown Reservoir) prevents fish from migrating from the reservoir into the refuge. The barrier is effective in normal and low water years but in high-flow years when the reservoir elevation exceeds 1,442 feet, water will overtop the barrier and fish will move into the refuge.

Birds

There are 266 species of birds that have been observed at the refuge (appendix J). Of these, 124 species are known to nest at the refuge. Spring and fall migrations find spectacular numbers of waterfowl passing through the area and the refuge is an important stop for many on the journey north or south. The James River serves as a major migration route and breeding ground for thousands of geese and ducks.

Dave Menke/USFWS

Gadwall.

Canada goose, snow goose, white-fronted goose, mallard, gadwall, blue-winged teal, American wigeon, lesser scaup, hooded merganser, redhead, and canvasback are common in the James River watershed.

Arrowwood NWR provides production habitat as well as resting and feeding areas for thousands of waterfowl and other migratory birds. The refuge is particularly important as a major diving duck staging area in North Dakota, with specific

importance to fall populations of canvasbacks. The refuge is a major waterfowl production area and provides wetland habitat for migratory waterfowl.

In addition to the waterfowl use of the refuge, other migratory and resident species inhabit the wetlands. Game and nongame species observed in the watershed include ring-necked pheasant, sharp-tailed grouse, gray partridge, mourning dove, upland sandpiper, bobolink, western meadowlark, and chestnut-collared longspur. Other bird species associated with riverine and wetland habitat found at the refuge include great blue heron, American bittern, American white pelican, red-winged blackbird, sora rail, American coot, Le Conte's sparrow, and sharp-tailed sparrow. Numbers of upland birds are cyclic, but good populations are normally present.

Mammals

Upland habitats are important to mammals at the refuge in many ways. White-tailed deer is the major big game species found in the James River watershed. Populations have increased statewide over the past 30 years and reached near record levels in the late 1990s.

ames R. Williams/USFWS

The eastern cottontail is common where sufficient woody vegetation provides adequate habitat.

Dave Menke/USFWS

Muskrat.

Major furbearers in the James River watershed include mink, muskrat, beaver, raccoon, red fox, and coyote. In addition, weasels, badgers, striped and spotted skunks, and jackrabbits inhabit the area. Appendix K contains a list of mammal species at the refuge.

Threatened and Endangered Wildlife

There are two federally listed threatened and endangered species known to occur at the refuge. The whooping crane is listed as endangered. The piping plover is a threatened species.

Whooping cranes migrate through the area but there have been only two confirmed sightings in recent years on or near the refuge. A lone whooping crane with a flock of sandhill cranes was recorded during the 2001 fall migration. A single whooping crane was sighted just west of Pingree, North Dakota, during spring 1997.

The piping plover has been recorded nesting at the refuge during years of low water; the bird prefers exposed gravel islands and shoreline habitat for nesting. Piping plovers have not been observed at the refuge since 1991. Because of its history of piping plover use, the refuge has designated critical habitat for piping plovers. The refuge participates in the "International Piping plover Breeding Census" conducted every 5 years.

The following species of special concern may be present at the refuge during certain times of the year:

- black tern
- ferruginous hawk
- Baird's sparrow
- loggerhead shrike
- northern goshawk
- Dakota skipper butterflies (periodic surveys of butterflies have been conducted since 1997; no Dakota skippers have been recorded)
- *Pyractomena sinuate* Green, a rare firefly (documented in 1991 by a professor from the University of Florida, Gainesville)

3.3 Cultural Resources

The built environment and archaeological remains on and near refuge lands represent the rich 10,000-year cultural heritage of the Arrowwood NWR. The varied habitats and resources of the refuge have attracted human settlement for more than 10,000 years. Until the last 150 years, the region was occupied by numerous groups of Native Americans who used a wide variety of adaptations to local resources, which included economies based on hunting, gathering, and horticulture (an early form of agriculture). The fur trade initiated contact between native peoples and Anglo visitors in the seventeenth century. By the mid-eighteenth century,

the influx of nonnative peoples significantly altered the traditional culture of the native people and reshaped the landscape of the region. Evidence of both the prehistory (pre-native contact) and the history (postnative contact) is found in the numerous archaeological sites and historic buildings on the refuge.

The refuge lies within the James River study unit of the "Archeological Components of the North Dakota Comprehensive Plan for Historic Preservation." Based on information provided in that document, the prehistoric occupation of the region began with the Paleo-Indian period (9500–5500 B.C.); and extended through the Archaic (5500–400 B.C.), Woodland (400 B.C.–A.D. 1000), and Plains Village (A.D. 1000–1780) periods. Archaeological evidence suggests that bison were a major component of the economies of the prehistoric residents, with dependence on this resource decreasing through time. The Paleo-Indian period was based on an economy that relied heavily on migratory, large-game animals; this required settlements to be highly mobile. The Archaic and Woodland periods were marked with increased specialization in a broader spectrum of local resources, which resulted in less need for mobile settlements. During the Plains Village period, people became more sedentary because plant husbandry required that crops be tended. The Plains Village lifestyle maintained bison hunting due to the lack of development of crops that would consistently produce in the short growing seasons of the area. A variety of archaeological sites and surface finds provide evidence for prehistoric occupation including stone tool and ceramic scatters, stone circles, burial mounds, villages, and bison kills.

Although there has been very limited cultural resource survey done at the refuge, evidence from the surrounding areas suggests that a common location for prehistoric sites is along the bluff edge overlooking the river valley. Many of these sites probably exist at the refuge; however, future archaeological knowledge should used to identify and protect these resources. No doubt, prehistoric archaeological sites that were below the bluffs in the river valley were covered with the deposition of sediments when water was dammed for the reservoirs in historic times.

Locations and items of traditional religious and cultural importance to Native Americans deserve special mention. The presence of several historic Native American tribes in the area at various times is well documented, predominantly various bands of the Lakota, Dakota, and Yanktonai Sioux. The name of the refuge, Arrowwood, comes from the fact that the Sioux gathered materials for bow and arrow manufacturing in this area from stands of oak and hackberry, which were not abundant outside the river valley. Sioux speakers named the area "Itazi paha koksj" meaning "the place for cutting bows" and they called the James River "san san san," meaning "white wooded river." There was a close relationship between native people and refuge lands in the past. Currently, the Spirit Lake Nation Indian Reservation and the Sisseton-Wahpeton Sioux Tribe of the Lake Traverse Reservation are near the refuge. Therefore, refuge lands likely support areas and resources that hold special meaning for these groups to preserve traditional religious or resource procurement activities.

The historical period began with the appearance of the Euro-American explorers and fur traders in the area about A.D. 1750, although extensive settlement did not occur until nearly 100 years later. In 1872, the Fort Totten Trail was constructed as a military route connecting Fort Seward in Jamestown to Fort Totten near Devil's Lake. The remains of the trail are still visible in the form of wagon ruts east of Jim Lake and in the Grasshopper Hills area. A fortified camp associated with the trail, complete with trenches and sod berms, lies near the north refuge boundary. Once the military was well established, the area became ripe for Anglo homesteading and agriculture. Many of these earlier settlers were of eastern European descent. Common site types associated with the establishment of farming communities are farmsteads, homesteads, dugouts, small rural communities, bridges, schools, and railroads.

The establishment of the refuge is directly 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 young men of ages 18–25 to work providing useful projects for society and income for the workers to send to their families. The men planted thousands of trees and shrubs at the refuge. The CCC and WPA built many low-level dikes and water control structures on the refuge between 1935 and 1942. Arrowwood, Mud, and Jim lakes were natural lakes enhanced by these projects, while Depuy Marsh is a constructed feature. In addition, infrastructure was constructed in the form of a residence, an equipment building, a barn, a root cellar (also referred to as an aquatic cellar), and a bunkhouse.

3.4 Special Management Areas

Arrowwood NWR meets the size, scientific, scenic, and ecological value criteria for wilderness. However, the refuge is impacted by roads, fences, and extensive human effects from grazing, agriculture, and wetland modifications that restrict it from being designated a wilderness area.

To be designated a wilderness area, lands must meet certain criteria (below) as outlined in the Wilderness Act of 1964:

- generally appears to have been affected primarily by the forces of nature, with the imprint of human work substantially unnoticeable
- has outstanding opportunities for solitude or a primitive and unconfined type of recreation
- has at least 5,000 acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition
- may contain ecological, geological, or other features of scientific, educational, scenic, or historical value

3.5 Visitor Services

The refuge offers a wide variety of year-round accessible recreational opportunities that are wildlife dependent. Hunting, fishing, wildlife observation, photography, and environmental education are popular activities.

The report, "Banking on Nature 2004: The Economic Benefits to Local Communities of National Wildlife Refuge Visitation" (Caudill and Henderson 2005), stated that Arrowwood NWR recorded 6,796 visitors in 2004. Residents accounted for 5,526 visits and nonresidents 1,270 visits. Visitors engaged in nonconsumptive activities 76% of the time, with hunting and fishing 19% and 5% of the time. In addition to the wildlife-dependent activities it provides, the refuge offers a scenic contrast to the agriculturally dominated landscape that surrounds it.

Hunting

Unlike most refuges in North Dakota, Arrowwood NWR has never been open to waterfowl hunting. Hunters are able to harvest waterfowl that leave the refuge to feed in surrounding crop fields; resident and nonresident hunters alike take advantage of this fact.

In 2004, there were approximately 1,125 deer-hunting visits. Hunters pursue deer with bows, muzzleloaders, and modern firearms. To maintain a safe, high-quality hunt, access is walk-in only unless a hunter has a documented disability and obtains a refuge permit that allows the use of a vehicle for hunting. Specified times have been established to allow hunters to retrieve harvested deer using vehicles. The entire refuge is open to hunting, except the closed zone around the headquarters and the Warbler Woodland Watchable Wildlife Area (figure 7).

The refuge is open to upland game hunting after the firearm deer season closes. Hunters can take ring-necked pheasant, sharp-tailed grouse, gray partridge, cottontail, and red fox.

John Stehn/USFWS

The refuge is well known for white-tailed deer hunting.

The hunting program is described in the compatibility determination in appendix L.

Fishing

The Service does not actively manage sport fisheries at refuges, including Arrowwood NWR, in the James River watershed. Managing for sport fisheries would conflict with the wildlife objectives for which the refuge was established. Sport fisheries would also create ideal habitat conditions for the survival of carp, which degrade wetland habitat for migrating and nesting waterfowl.

Fishing opportunities at the refuge are limited to extremely high-water years when the refuge is flooded. When water from the Jamestown Reservoir overtops the levees, fish can move upstream and populate the refuge. Fish species are typical of northern reservoirs with sport fish such as northern pike, walleye, yellow perch, crappie, and smallmouth bass. Abundant nonsport species include black bullhead, white sucker, carp, and bigmouth buffalo.

Public access is allowed to the sport fish resource when it is present. The spring and summer fishing season runs from May 1 through September 30. During that time, the following is allowed:

motorized boats, 25 horsepower and under, on Arrowwood and Jim lakes

nonmotorized boats on all refuge waters

bank fishing

Primitive boat launch facilities are located in the Warbler Woodland Watchable Wildlife Area and at the southwest corner of Jim Lake (figure 7).

Bow fishing for rough fish is permitted from May 1 through September 30 of each fishing year, in accordance with state regulations. Spear fishing is not permitted.

Arrowwood, Mud, and Jim lakes are open to winter fishing. Fish houses are allowed. Vehicles (no ATVs or snowmobiles) are allowed on the ice, but only on Jim Lake and only via the primitive boat launch. Fish houses must be removed no later than March 15. Portable fish houses can be removed daily and are allowed after March 15.

The fishing program is described in the compatibility determination in appendix M.

When needed to address the problem of carp and bigmouth buffalo, the refuge has issued a special use permit for commercial fishing to net these undesirable fish species. More information is in the compatibility determination in appendix N.

Wildlife Observation and Photography

Three county roads and one state highway cross the refuge and offer opportunities for wildlife viewing. The refuge is included in two of the birding routes described in the "Birding Drives Dakota" brochure and the number of nonresident birders has increased in recent years. The first half of the 5.5-mile auto tour route (figure 7) follows the river channel and provides access to a wildlife observation deck on the riverbank overlooking two managed wetlands. The second half of the tour route climbs to the top of the river bluffs and offers panoramic views of the valley and surrounding lands.

The Warbler Woodland Watchable Wildlife Area (figure 7) includes an interpretive nature trail, natural spring drinking water, a vault toilet, tables, and grills. The Centennial Overlook provides a panoramic view of Arrowwood Lake; in the spring and fall months, thousands of migrating waterfowl, shorebirds, and other waterbirds can be seen. The public can reserve two blinds set up each spring on sharp-tailed grouse leks, offering excellent viewing and photo opportunities.

Walk-in access is allowed everywhere except the closed area near the headquarters, which includes the shop, equipment storage areas, and residents' quarters. Nonmotorized biking is allowed on roads and service trails, but not allowed off-road. Horseback riding is allowed only by special use permit.

During the boating season, from May 1 through September 20, nonmotorized boats and canoes are allowed on all waters Boats with less than 25 horsepower motors are allowed on Arrowwood and Jim lakes.

The program for wildlife observation and photography is described in the compatibility determination in appendix O.

Interpretation

There is interpretive information for the auto tour route and nature trail. In addition, there are information kiosks at the entrance to the tour route, in the Warbler Woodland Watchable Wildlife Area, at the entrance to the grouse blind, and at refuge headquarters (figure 7). The refuge headquarters has a very small visitor contact area. The refuge staff is interested in increasing the size of the visitor contact area to provide interpretive information and brochures.

The interpretive program is described in the compatibility determination in appendix P.

Environmental Education

The refuge has both on- and off-site environmental education programs. Special events include participation with other refuges and conservation agencies in several water and river festivals, "JAKES (Juniors Acquiring Knowledge, Ethics & Skills) Day," "Refuge Night at the Redhawks," "Go Wild at the Mall," and "Refuge Day at the Zoo."

USFWS

Refuge staff demonstrate the benefits of wetland and riparian habitats.

The refuge hosts numerous elementary, secondary, and college groups; and scout groups for environmental education activities and tours.

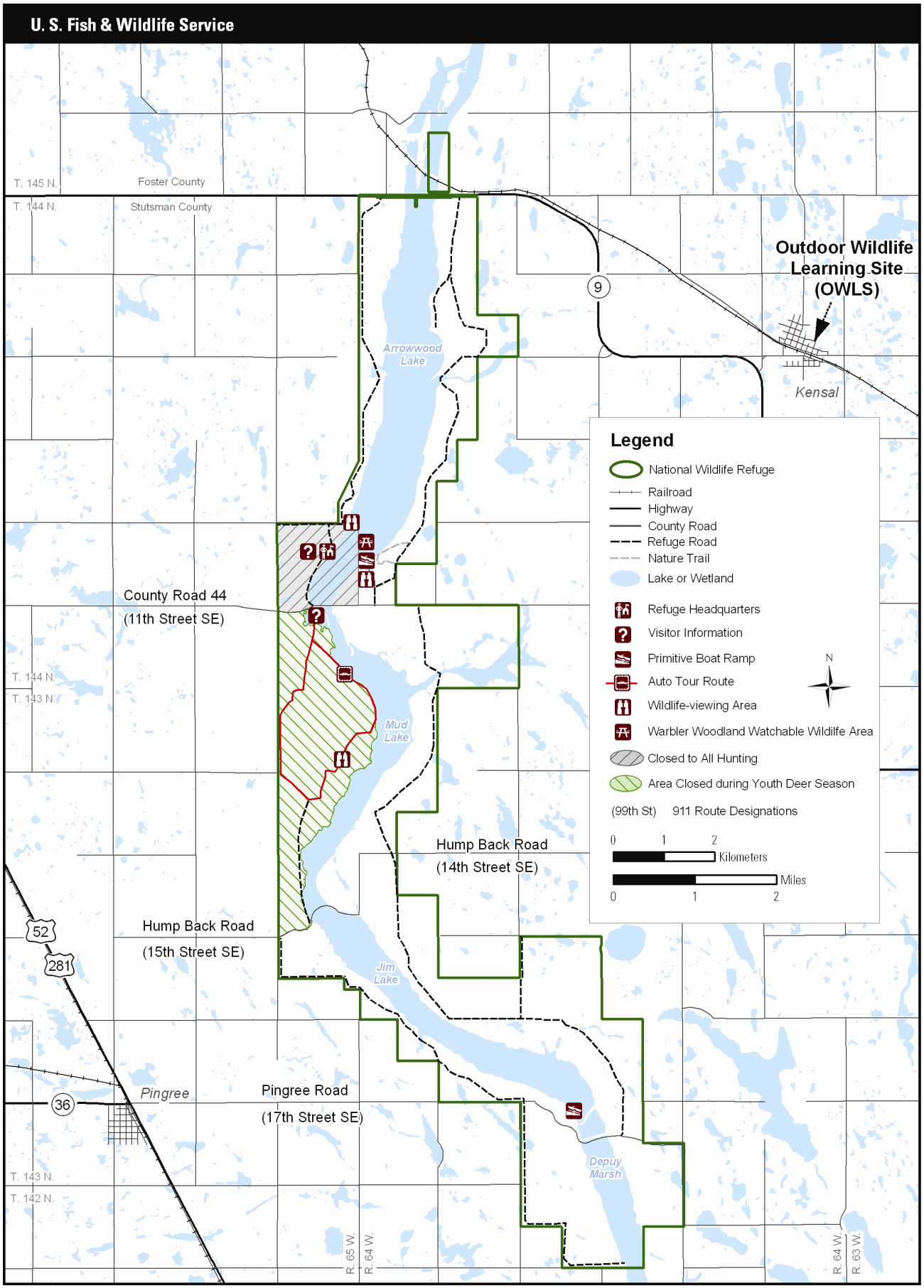

Figure 7. Public use areas at Arrowwood NWR, North Dakota.

Additionally, local third graders join the refuge for educational games and demonstrations during National Wildlife Refuge Week. The refuge is also a partner with the Kensal Public School and supports programs at the 1.5-acre Outdoor Wildlife Learning Site (OWLS).

The environmental education program is described in the compatibility determination in appendix P.

Other Recreational Uses

Refuge users are allowed to collect aboveground portions of commonly used edible plants such as berries, mushrooms, and asparagus for their personal use (see appendix Q). Trapping for recreational purposes is also allowed, under special use permit, on most areas of the refuge (see appendix R). The visiting public, under special use permit, can enjoy horseback riding on designated areas (see appendix S).

Compatibility Determinations

Compatibility determinations were approved for several uses in 1998. New compatibility determinations (listed below) have been prepared to update the 1998 determinations and to address public use at Arrowwood NWR:

- hunting (appendix L)
- fishing (appendix M)
- commercial fishing (appendix N)
- wildlife observation and photography (appendix O)
- interpretation and environmental education (appendix P)
- wild food gathering (appendix Q)
- recreational trapping (appendix R)
- horseback riding (appendix S)

3.6 Aesthetics

The NEPA requires agencies to consider aesthetic impacts to scenery, noise, and odor from proposed federal actions. The Service preserves and enhances aesthetic resources to the extent that refuge objectives can still be fulfilled. A natural undisturbed appearance is the visual standard that applies to refuge habitat rehabilitation and management projects. If this standard cannot be met, the Service takes actions to mitigate or diminish any negative impacts.

Service policy is to use the most natural means available to meet wildlife objectives. In situations where objectives cannot be met using natural processes, more intensive and artificial methods such as cropland management may be employed. The acreage cropped will be the minimum required to meet approved objectives. Service policy also states that the long-term productivity of the soil will not be jeopardized to meet wildlife objectives.

The following are examples of how the refuge carries out these policies:

- Borrow sites are reclaimed using pre-existing species.
- Old crop fields are being converted to various mixtures of grasses.
- Firebreaks are kept to the minimum necessary for safety and to meet prescribed fire management objectives; most firebreaks are being eliminated,
- Existing gravel pits are being reclaimed and no new gravel pits are being opened.

3.7 Socioeconomic Environment

This is a summary of the socioeconomic setting. The complete economic analysis is in appendix T.

Jamestown (Stutsman County) and Carrington (Foster County) are the primary communities near the refuge. According to “Tour North Dakota” (Central Dakota Tourism Partnership 2004), one of the greatest assets of the area is the quality of life enjoyed by its residents. In 2000, the population of North Dakota was 642,200 with an average density of 9.3 persons per square mile (U.S. Census Bureau 2002).

Stutsman County accounted for 3.4% of North Dakota’s total population in the year 2000, with a population of 21,908 residents averaging 9.9 persons per square mile (U.S. Census Bureau 2002). Jamestown, the county seat, is located in the south end of Stutsman County with a population of 15,571 people. Located in the valley where the James and Pipestem rivers meet, Jamestown offers a variety of recreational opportunities from summer activities such as fishing, hunting, and golfing to winter activities such as ice fishing, snowmobiling, and cross-country skiing (Jamestown, ND 2004).

Foster County, located just north of Stutsman County, is one of the smallest of the state’s 53 counties, 18 miles by 36 miles in size. Foster County accounted for 0.5% of North Dakota’s total population in the year 2000, with a population of 3,759 residents averaging 5.9 persons per square mile (U.S. Census Bureau 2002). Carrington, the largest town in Foster County, is commonly referred to as the “Central City” for its location central to the four major North Dakota cities of Bismarck, Fargo, Minot, and Grand Forks. With its outstanding leadership, community commitment, location, and updated infrastructure, Carrington has

been recognized as the most dynamic community in North Dakota with a population under 2,500 (Carrington, ND 2004).

While the state of North Dakota experienced a relatively low 0.5 % population increase from 1990 to 2000, Stutsman County's population increased by 3.0%, while Foster County's population decreased 6.0% over the same time frame. Approximately 78% of the Foster County population and 81% of the Stutsman County population 25 years and older have high school diplomas, while 20% were college graduates (U.S. Census Bureau 2002).

Based on population origin estimates from the 2000 census, 91.7% of the state's population was white persons not of Hispanic/Latino origin, 5.0% were American Indian and Alaska Native, 1.2% were Hispanic or Latino origin, 0.6% were Black or African American persons, and 0.6% of Asian decent. Population origins in Foster and Stutsman counties were similar to the state population (U.S. Census Bureau 2002). The predominant immigrant cultures in the region include Scandinavian, German, Ukrainian, and Icelandic (Central Dakota Tourism Partnership 2004).

The majority of Stutsman and Foster counties are rural with agriculture as the main industry (U.S. Department of Commerce 2002). Like most North Dakota communities, Jamestown and Carrington can trace their development to the arrival of the railroad (Central Dakota Tourism Partnership 2004). Agriculture formed the basis for the region's early economy and still is an important component today. According to the U.S. Department of Commerce (2002), total farm self-employment accounted for 8.3% of total employment in North Dakota (8.3% in Stutsman County and 13.8% in Foster County) in 2000. Besides agriculture, the other major local and state employers are service-related business, government, and retail trade.

Major employers in Jamestown include health providers, education, potato processing, and aerospace products manufacturing (U.S. Census Bureau 2002). Carrington's business community is diversified, including agriculture, manufacturing, financial, retail, and technology-based endeavors (Carrington, ND 2004). Carrington serves as the center of an important corridor of agribusiness (Dietz 2003). Carrington is home to state-of-the-art Dakota Growers Pasta Company, which markets premium quality pasta worldwide (Carrington, ND 2004).

Foster County per capita personal income was $25,138 in 2000, which very close to the state average of $25,109. Meanwhile, Stutsman County per capita personal income was $23,686, which was $1,423 lower than the state average (U.S. Department of Commerce 2002). Total personal income was $94 million in Foster County and $517 million for Stutsman County in 2000 (U.S. Department of Commerce 2002).

The communities and local governments near the refuge benefit economically from the presence of the refuge and the activities that occur there. In September 2005, the Service released the results of a report entitled "Banking on Nature 2004: The Economic Benefits to Local Communities of National Wildlife Refuge Visitation" (Caudill and Henderson 2005). Arrowwood NWR served as a sample refuge for this study, which resulted in the creation of economic models used to estimate the economic impact of refuge visitation nationwide. The report estimates that in fiscal year 2004, Arrowwood NWR recreational visitors spend $68,300, with the majority of that related to big game hunting ($46,200). When the total monetary value of this economic activity to the local area economy is considered, recreational visitation to the refuge generates $87,500 per year, which is enough to create two jobs (both part time and full time) with a combined income of $30,400.

3.8 Staffing

Staff located at the refuge headquarters has responsibility for the entire Arrowwood NWR Complex; however, for this document, the payroll expenditures are attributed entirely to Arrowwood NWR. Currently there are nine permanent employees and six temporary employees located at the refuge headquarters. Funding for employee salaries and benefits totaled $752,993 in fiscal year 2006. Table 1 shows the current refuge staff.

3.9 Partnerships and Other Public Outreach

The refuge has a long history of fostering partnerships that help the refuge accomplish its mission and goals. These partners include city, county, state, and federal agencies; nongovernmental organizations; conservation groups; and private citizens.

The refuge's partners have assisted in wildlife and habitat management, visitor services and recreational opportunities, and community outreach. Many of these relationships have developed into formalized partnerships with written agreements or understandings, while others remain more informal.

Existing Partnerships

The most significant partnership is with the Bureau of Reclamation for construction of the mitigation features authorized under the Garrison Diversion Unit Reformulation Act of 1986. Once completed, this

Table 1. Current staff at Arrowwood NWR, North Dakota.

Staff Group	*Position*
Management	Project leader, GS[1]-14* | Deputy project leader, GS-13* Refuge operations specialist, GS-7/9/11*
Biology	Wildlife biologist, GS-9/11*
Administration	Administrative officer, GS-11* Clerk (office assistant), GS-6*
Maintenance	Engineering equipment operator, WG[2]-10
Fire	Fire management officer, GS-11* Fire technician, GS-6/7*
Term[3], Temporary	Tractor operator (term), WG-6 Biological technicians (5), GS-3/4/5/6
Total Salaries and Benefits = $752,993	

[1]*GS=general pay schedule.*
[2]*WG=wage grade pay schedule.*
[3]*term=temporary time-limited position.*
**Staff with responsibilities for the entire Arrowwood NWR Complex.*

project will allow independent management of water levels in each of the refuge impoundments. An agreement that stipulates Reclamation will purchase necessary equipment and supplies and fund a position to operate and maintain the mitigation project features has been in effect for several years.

The refuge has worked closely with the Stutsman County Weed Board to combine resources, apply for grants, and cooperate on control actions. This arrangement has allowed both parties to purchase chemicals and insects for biological control at lower prices. In addition, this partnership has allowed county employees to assist with chemical application and map infestations on refuge lands. This partnership has expanded to three other county weed boards and extension offices, and several other partners. This partnership has received funding from the National Fish and Wildlife Foundation's "Pulling Together Initiative," for additional invasive species work within the Arrowwood NWR Complex.

"Birding Drives Dakota," a coalition of communities and agencies dedicated to the promotion of birding in North Dakota, is a new organization with which the refuge is collaborating. Some of the primary sponsors are Carrington Chamber of Commerce, Carrington Community Development Corporation, Carrington Convention & Visitors Bureau, Garrison Diversion Conservancy District, Jamestown Area Chamber of Commerce, Jamestown Promotion & Tourism, Jamestown Sun, and Northern Plains Electric Cooperative. Arrowwood NWR was a major contributor to the development of the "Birding Drives Dakota" pamphlet, which details six routes in and around Stutsman County where birders can expect to view North Dakota's abundant bird life. Additionally, the refuge was a major sponsor and organizer of the first "Potholes and Prairie Birding Festival," which has become an annual event to promote birding, other nature-based activities, and preservation of native grassland and wetland habitats.

The Northern Prairie Wildlife Research Center of the USGS is a valuable partner, providing the latest research information on wildlife issues. A current project includes long-term monitoring following completion of the study, "Role of nutrient manipulation and biological control insects on leafy spurge population regulation at Arrowwood and Tewaukon national wildlife refuges," in 2003.

The development of the OWLS at Kensal (figure 7) is the result of another partnership with the Kensal Public School and NDGF.

The refuge actively sought and fostered partnerships with organizations and individuals with whom a common goal is shared. Many individuals, groups, and organizations have contributed in important ways to the refuge, including the following groups:

- U.S. Army Corps of Engineers–Pipestem Dam
- NDGF
- Stutsman County Weed Board
- Foster County Weed Board

- North Dakota State University Extension Service
- Stutsman County Park Board
- Stutsman County Wildlife Club
- United Sportsman–Jamestown Chapter
- Dakota Anglers
- Tri-County Trap Club
- Ducks Unlimited
- Boy Scouts
- Girl Scouts
- 4-H

Potential Partnerships

Only with public support can the Service succeed in its mission. That support comes through outreach—fostering education and understanding, and communicating the importance of the Service commitment to protecting habitat on which wildlife depends. Outreach includes a broad array of activities and services focused on building relationships and communication. The Service is committed to getting its message to both traditional and nontraditional groups.

Existing Service private lands programs and the refuge's proposed watershed management (alternative 3 in chapter 4) correspond very well with programs offered by the Natural Resources Conservation Service (NRCS), NDGF, EPA, North Dakota State Health, and county water boards. A partnership to improve watershed health in the upper James River could include all these entities as well as others. The refuge is open to any partnership that will further the purposes, goals, and objectives of the Service, the refuge, or the Refuge System.

Additional partnerships can be forged with various universities to assist with research needs. Researchers from University of North Dakota and North Dakota State University have inquired into potential sites to initiate or expand current research.