3 Affected Environment

Gary Eslinger/USFWS

Native Prairie Clover and Coneflowers

The three refuges lie within the Souris River basin, which extends from north-central North Dakota to southeastern Saskatchewan and southwestern Manitoba.

The J. Clark Salyer NWR is the largest of the three refuges, at 58,700 acres. Upper Souris NWR covers 32,092 acres and Des Lacs NWR covers 19,500 acres. The Souris River basin is in the eastern, mesic (moist) subregion of the northern mixed-grass prairie, principally within the *Agropyron–Andropogon–Stipa* (needlegrass–bluestem–wheatgrass) vegetation association (Kuchler 1964, Coupland 1992, Bragg 1995). However, the contemporary landscape is dominated by annually tilled cropland (figure 3).

In the late 1880s and early 1890s, Government Land Office officials surveyed the basin's vast prairie to guide forthcoming settlement by Euro-American homesteaders. The surveyors may have unknowingly encountered one of North America's most botanically diverse native grasslands, encompassing more than 750 plant species. Although characterized by cool-season, mid-height grasses, the prairie was mixed grass, because it also included widespread tall-grass and short-grass prairie elements. These mainly were big bluestem communities on low, moist sites and blue grama–threadleaf sedge communities on higher, relatively dry sites such as sandy or elevated ridges and southwest-facing slopes.

Like other northern mixed-grass prairie, the prairie in the Souris River basin evolved with interacting grazing and fire disturbances (Higgins 1986), as well as marked climatic variability (Bragg 1995). Through the mid-1800s, the Souris River basin was a significant, year-round range for bison (Hanson 1984) and experienced roughly a 5-year fire return interval characteristic of the region (Bragg 1995). These major, frequent disturbances ended by the early 1900s. Bison had been extirpated, and Euro-American homesteaders who settled in the basin suppressed fires (Grant and Murphy 2005). Before settlement, trees mainly had been restricted to green ash–American elm woodland along the Souris River and on some steep north slopes of adjoining major coulees (ravines). Bur oak and quaking aspen brush had occurred on steep, fire-protected scarps in the sandhills of present-day J. Clark Salyer NWR. However, without frequent fire and grazing disturbances, tree and shrub cover significantly

increased throughout much of the area (Grant and Murphy 2005).

The Souris and Des Lacs rivers are perennial, exhibiting many old oxbows, meander scars, and channel relicts. Prior to settlement, numerous riverine and palustrine (nonflowing, such as ponds and marshes) wetlands were maintained by periodic overbank flooding. With settlement of the region, the Souris and Des Lacs rivers were significantly modified (1) by drainage and channelization, and (2) by construction of many low-head dams along the river to regulate flooding and restore wetlands or augment wetland management on the three refuges. Because of these changes, few natural riverine wetlands remain on the Souris River basin refuges.

Environments and natural resources of the Souris River basin refuges are described in the following sections:

- physical attributes
- biological attributes
- cultural resources
- special management areas
- visitor services
- socioeconomic environment

PHYSICAL ATTRIBUTES

This section describes the climate, physiography, geology, soils, and water resources of the Souris River basin refuges.

Climate

Area climate is semi-arid to subhumid continental, with average monthly temperatures ranging from 5°F in January to 68°F in July (USFWS, unpublished data). There are significant daily and annual temperature fluctuations and precipitation is erratic. Average annual precipitation (1898–2002) is 16–17 inches, most falling as rain during April–September.

The National Climate Data Center has entered into a long-term agreement with the Service to install and operate one of the National Oceanic and Atmospheric Administration's U.S. Climate Reference Network meteorological stations at the Des Lacs NWR. The station will provide data on long-term climate change in the northern Great Plains, as one of a series of meteorological stations. The station will be located at the northwest end of the refuge, 2.2 miles south of Canada and will operate by 2006.

Physiography, Geology, and Soils

The physiography (mainly soils and topography) of each refuge was uniquely shaped by ice flow associated with the Wisconsin lobe of the Laurentide Ice Sheet during the end of the Pleistocene Epoch (Bluemle 1991).

The Des Lacs River and upstream portion of the Souris River (encompassing Des Lacs and Upper Souris NWRs) were formed by catastrophic meltwater release from two large glacial lakes about 10,000 years ago. River channels at Des Lacs NWR and Upper Souris NWR were spillways from these glacial lakes and thus the refuges (especially Des Lacs NWR) are characterized by steep, high-relief valleys roughly 0.7 mile wide and 165 feet deep (Lord and Kehew 1990). Soils at Des Lacs NWR and Upper Souris NWR are mostly well drained, level to steep loams formed in glacial till.

The Souris Lake Plain characterizes the downstream portion of the Souris River drainage (east of Minot, North Dakota, including J. Clark Salyer NWR), and is the remnant of Glacial Lake Souris (Lord and Kehew 1990). The contemporary Souris Lake Plain is a flat, deltaic outwash plain, bordered to the south and east by sandhills formed from wind and wave action of historic Glacial Lake Souris. Soils are mostly well drained, level to hilly sandy loams.

Water Resources

All three refuges are within the Souris River basin, an area encompassing about 24,600 square miles, of which 5,500 square miles are in the United States (adapted from Laubhan et al. 2003). The United States portion of the basin is located within the "Central Lowland Province" and is bounded by the Souris River (east) and the Missouri Coteau (south and west).

The Souris River, the main watercourse in the basin, originates near Weyburn in southeastern Saskatchewan and enters the United States in the northwest corner of Renville County, North Dakota. It flows southeast to Velva, North Dakota, then turns north and enters Manitoba northeast of Westhope in Bottineau County, North Dakota. The river, which is perennial, discharges into the Assiniboine River, which discharges into the Red River at Winnipeg. The Des Lacs River, a perennial stream that originates in southeastern Saskatchewan about 2 miles north of the international boundary, is the primary tributary of the Souris River.

Prior to settlement, the Souris River valley supported numerous riverine and palustrine wetlands. The Souris River in many areas was broad and deep with a gentle current, according to a review by

Laubhan et al. (2003). The riverine system apparently was very dynamic, characterized as sinuous and prone to overbank flooding, a view supported by current aerial photos and satellite imagery that reveal numerous relict meander scars, oxbows, and abandoned channels within the valley.

Darla Leslie/USFWS

Ducks settle in a wetland at Upper Souris NWR.

With settlement by Euro-Americans, the Souris and Des Lacs rivers were significantly modified by drainage and channelization; this was most evident at J. Clark Salyer NWR, where major stretches of the river were dredged and channelized to promote cultivation. River flows were unregulated until the 1930s, when numerous low-head dams were constructed to regulate flooding or to increase wetland management capability at the three refuges.

BIOLOGICAL ATTRIBUTES

This section describes the environment, vegetation, and characteristic wildlife of the following contemporary habitats of the Souris River basin refuges:

- drift prairie
- prairie slope
- prairie parkland
- sandhills
- old cropland
- coulee woodland and coulee woodland edge
- riparian woodland
- meadow
- wetland
- islands

Acreages of these habitats at the refuges are displayed in figure 9, and their general spatial distributions are shown on habitat maps for Des Lacs NWR (figure 10), J. Clark Salyer NWR (figure 11), and Upper Souris NWR (figure 12).

Detailed information about biological resources of the Souris River basin refuges are found in several appendixes:

- plants (appendix D)
- plant group types (appendix E)
- birds (appendix F)
- birds of conservation concern (appendix G)
- mammals (appendix H)
- reptiles and amphibians (appendix I)
- fishes (appendix J)

Drift Prairie

The upland habitat type most commonly shared by the Souris River basin refuges is drift prairie, collectively comprising about 12% of these refuges (figure 9). Due to its level, relatively rich loams, drift prairie has been destroyed through conversion to agriculture more than other northern prairie types, and remnant tracts appear to be particularly vulnerable to invasion by smooth brome and Kentucky bluegrass (Murphy and Grant 2005). As such, drift prairie could be considered an endangered resource.

Physical Environment

Drift prairie is defined as native ("unbroken") sod in relatively deep (5- to 6-inch surface, 10- to 12-inch subsurface), level to gently rolling (<5% slope), loam soils typical of the extensive Drift Plain physiographic region (Bluemle 1991).

There are roughly 3,300–9,500 acres of drift prairie per refuge (figure 9). Drift prairie on Des Lacs NWR and on J. Clark Salyer NWR consist of 15- to 20-mile long, 0.2- to 1.2-mile wide tracts along the east and west sides of impoundments of the Des Lacs or Souris rivers (figures 10 and 11). Compared to these extensive, relatively flat tracts, drift prairie at Upper Souris NWR typically occurs in isolated, gradually sloping patches, interspersed with extensive prairie slope and coulee woodland habitat. Drift prairie tracts on all three refuges are (1) bordered by cropland (dryland farming for small grains and oil seeds); (2) annually grazed, privately owned drift prairie (40–640 acres); and (3) former cropland seeded to varied mixtures of native and introduced grasses and forbs, both on and off the refuges.

Drift prairie tracts at Des Lacs NWR and J. Clark Salyer NWR have similar management histories (Murphy and Grant 2005):

- From refuge establishment in the mid-1930s through the late 1960s, drift prairie at both refuges typically was grazed season-long by cattle at light- to moderate-stocking rates of 0.3–0.7 animal unit months (AUMs) per acre.

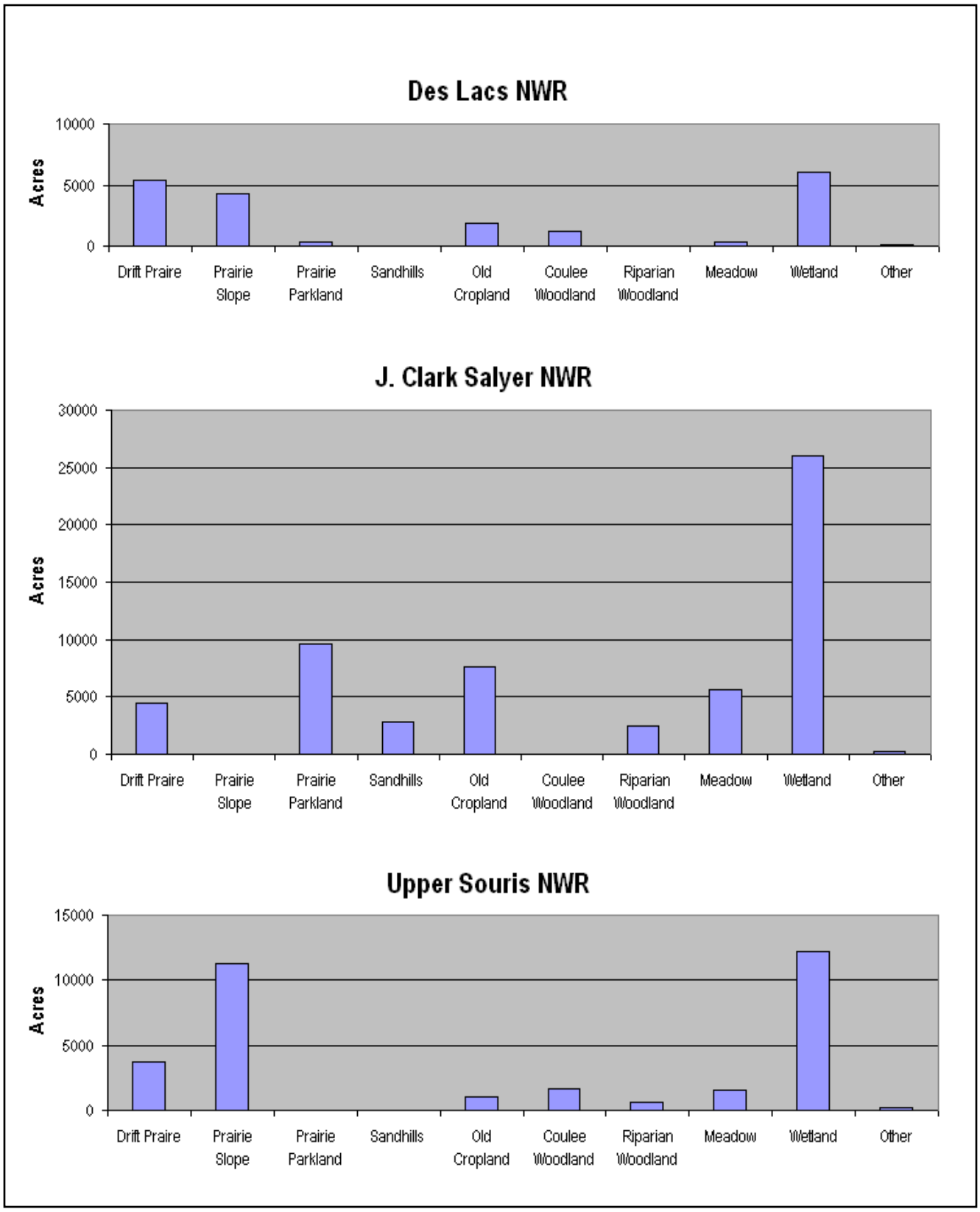


Figure 9. Contemporary habitat coverage for the Souris River basin refuges, North Dakota.

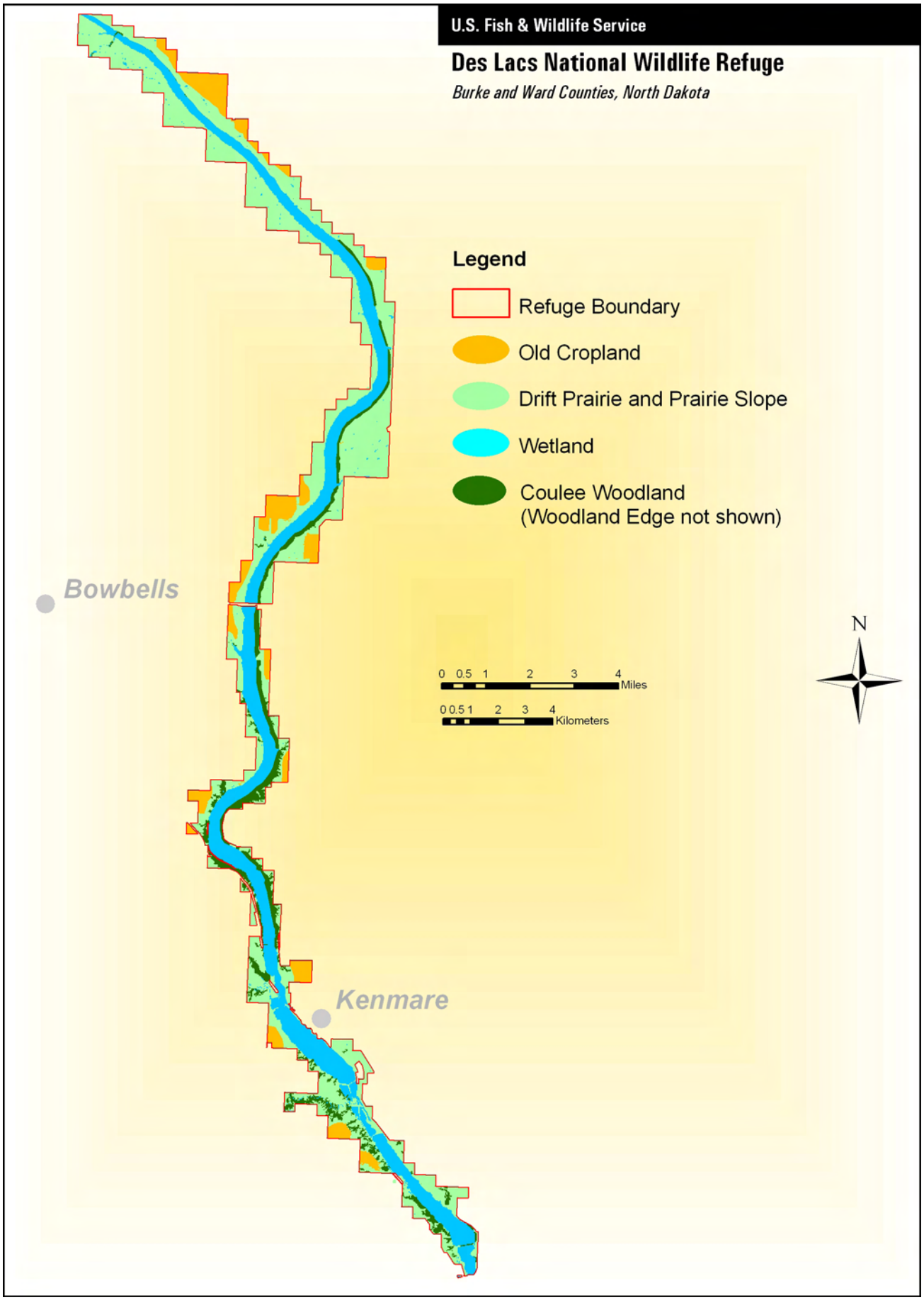


Figure 10. Habitats at Des Lacs NWR, North Dakota.

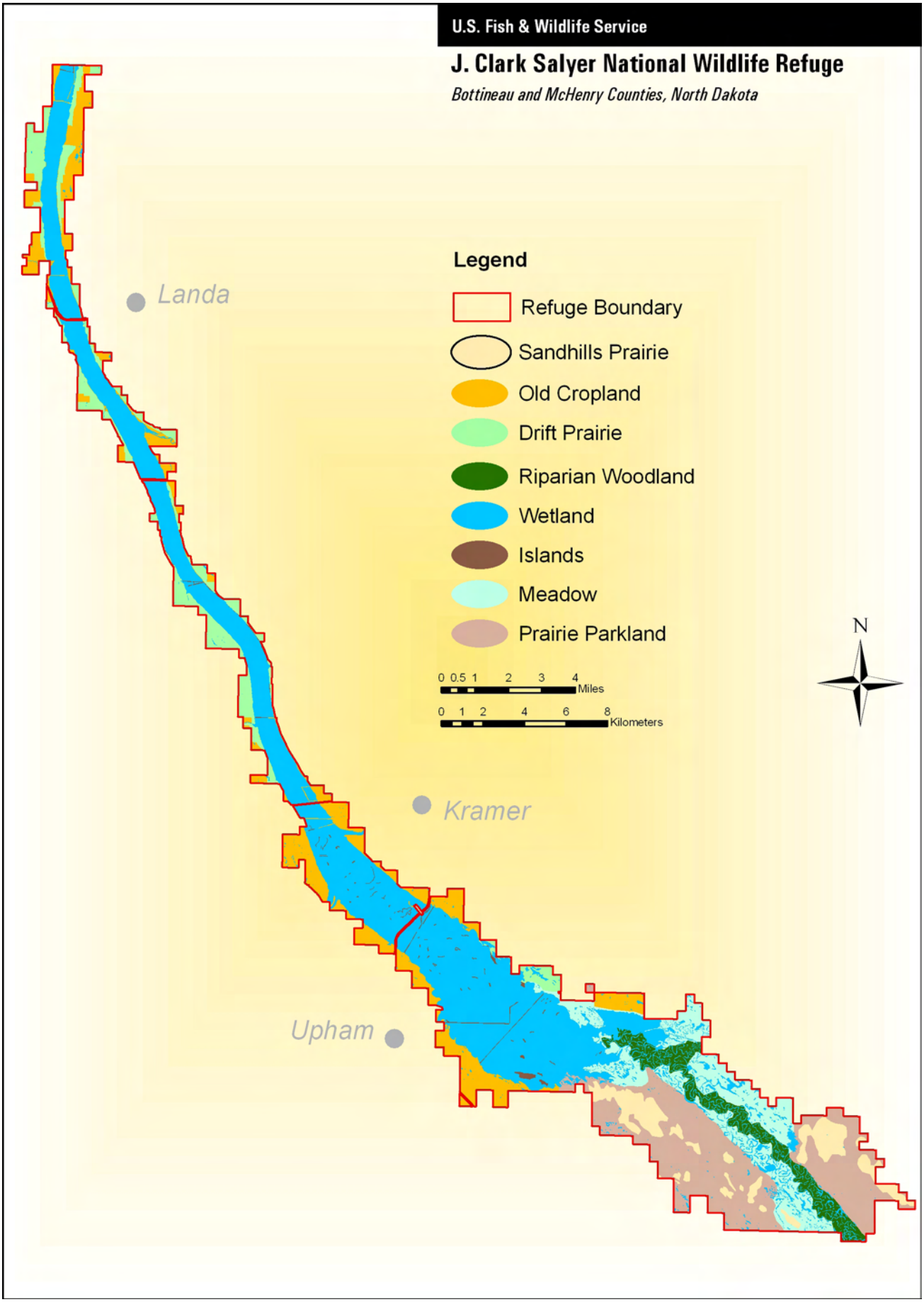


Figure 11. Habitats at J. Clark Salyer NWR, North Dakota.

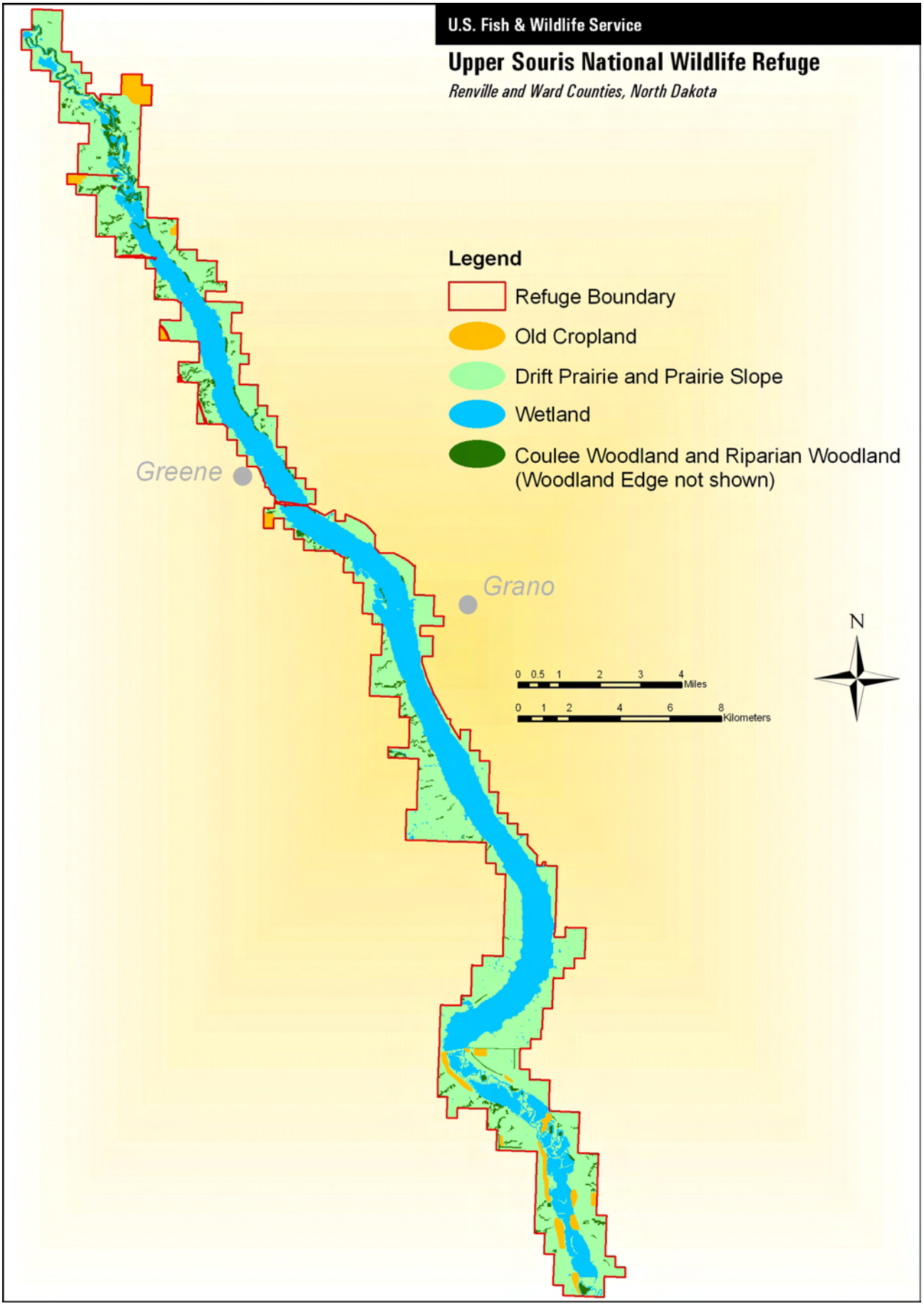


Figure 12. Habitats at Upper Souris NWR, North Dakota.

However, at Des Lacs NWR, years of grazing often alternated with years of rest. During the early 1970s to early 1990s, drift prairie at both refuges was rested with increasing frequency to emphasize dense, undisturbed nesting cover for prairie ducks. About one-third of the prairie at Des Lacs NWR was grazed at moderate stocking rates under rotation prescriptions during an average of two May–September seasons. At J. Clark Salyer NWR, grazing was limited to few drift prairie tracts.

- Tracts totaling roughly two-thirds of the drift prairie at each refuge were prescribe burned (spring or late summer), usually just once, during this 20-year period. Only since the early 1990s has prescribed fire been used widely and frequently, especially at Des Lacs NWR, where nearly all drift prairie management units have received multiple (two to four) burn treatments.

USFWS

The management history of drift prairie at Upper Souris NWR is vaguely similar to that at Des Lacs NWR and J. Clark Salyer NWR through the 1960s, but not afterward, as follows:

- Drift prairie at Upper Souris NWR was idle from the late 1930s through the mid-1940s, and then grazed heavily through the mid-1950s. Light, season-long grazing and rest prevailed through the early 1970s. This was followed by rest-rotation grazing, then twice-over rotation grazing (late spring and fall grazing periods) through the mid-1980s. Since then, a once-over grazing treatment with moderate stocking rates and grazing periods has been applied annually to each upland management unit.
- Almost no prescribed burning has occurred on drift prairie at Upper Souris NWR. Since the mid-1990s, an average of only about 800 acres of upland habitats of all types has been burned annually.

Characteristic Vegetation

Parallels in management of the drift prairie at Des Lacs NWR and J. Clark Salyer NWR through the early 1990s are reflected by strikingly similar patterns in composition of the contemporary vegetation (Murphy and Grant 2005):

- The drift prairie flora at both refuges is badly degraded by introduced plant species, especially the widespread invasion by smooth brome and Kentucky bluegrass, although this varies among management units. Vegetation dominated by introduced species occurs frequently (average frequency of occurrence is >60%), while intact assemblages of native vegetation occur infrequently (3–6%).
- Smooth brome-dominated types occur almost twice as frequently as Kentucky bluegrass-dominated types (at Des Lacs NWR, 40% versus 22%; at J. Clark Salyer NWR, 32% versus 18%). Vegetation dominated by introduced, weedy forb species occurs less frequently (2% at Des Lacs NWR; 12% at J. Clark Salyer NWR). Such vegetation includes leafy spurge (about 80% of weedy forb types), sweetclover (10%), and Canada thistle (10%).
- Vegetation dominated by low shrubs, principally western snowberry, occurs fairly frequently (22% at Des Lacs NWR; 17% at J. Clark Salyer NWR), probably greater than it did under a natural, historical disturbance regime; for example, an estimated 5% low shrub cover occurred on pristine mixed-grass prairie in northwestern and north-central North Dakota (U.S. Soil Conservation Service 1975). Snowberry probably was more prevalent on the refuge drift prairie 20–30 years ago (U.S. Fish and Wildlife Service [USFWS], unpublished refuge narrative reports), but has been largely replaced by smooth brome. The relatively cool, moist sites typically occupied by snowberry appear most vulnerable to smooth brome invasion (Romo et al. 1990).
- Smooth brome poses a particularly serious management problem on the drift prairie. Because it seems more difficult to control than other introduced cool-season grasses (Murphy and Grant 2005), smooth brome more significantly alters the quality and structure of a prairie (Blankespoor 1987), and can alter the soil environment to further its own invasion (Jordan et al., unpublished data).

The plant community of Upper Souris NWR's drift prairie is also badly invaded by introduced plant species and low shrub cover. Intact native, herbaceous vegetation occurs as infrequently as on the drift prairie at the other two refuges. However, differences in makeup of plant species that are invading the drift prairie at Upper Souris NWR

predictably reflect the refuge's longer grazing history and relative lack of fire, as follows:

- Intact assemblages of native herbaceous vegetation compose <5% of the prairie, similar to the other two refuges.
- Kentucky bluegrass-dominated types occur much more frequently (42% frequency) than smooth brome-dominated types (13%), versus greater frequency of brome than bluegrass types at the other two refuges.
- Low shrub-dominated types are more prevalent (27% frequency) than on drift prairie at Des Lacs NWR and J. Clark Salyer NWR.
- Vegetation dominated by introduced, weedy forb species occurs infrequently (<1%) on drift prairie at Upper Souris NWR. Leafy spurge accounts for 90% of this cover.

Characteristic Wildlife

The degraded condition of the drift prairie vegetation has important implications for grassland-dependent bird species. Populations of grassland birds are experiencing the most rapid declines of any group of bird species in North America (Peterjohn and Sauer 1999). Refuges in the northern Great Plains potentially serve an important role in maintaining representative, grassland bird communities. However, the diversity of grassland-breeding birds is significantly diminished on refuge drift prairie (Murphy and Sondreal 2003; Grant et al. in press).

Species characteristic of the contemporary drift prairie are Savannah sparrow, clay-colored sparrow, and bobolink; less common are sharp-tailed grouse, grasshopper sparrow, and (in relatively wet years) Le Conte's sparrow (figure 13).

Most bird species characteristic of northern mixed-grass prairie are uncommon or absent, for example, marbled godwit, horned lark, western meadowlark, Sprague's pipit, chestnut-collared longspur, and Baird's sparrow (Stewart 1975). The latter three species, which are endemic to the northern Great Plains, were considered the most common breeding birds across the North Dakota–Canada border of the Souris River basin in the 1870s (Coues 1878). Burrowing owl and ferruginous hawk also were characteristic of this northern mixed-grass prairie, but have not been recorded as breeding at the refuges for decades.

The communities of grassland bird species that are uncommon to absent on the refuges' drift prairie require shorter, sparser, more herbaceous prairie vegetation than that available. In particular, Sprague's pipit is associated with native bunchgrasses and avoids broad-leaved, introduced grasses such as smooth brome (Wilson and Belcher 1989, Madden et al. 2000, Nenneman 2003a, Grant et al. 2004a).

Dave Menke/USFWS

The Savannah sparrow is a common species at the refuges.

Losses of plant and bird species diversity are not the only consequences when introduced plants invade northern prairie. Nutrient pools, energy flows, soil invertebrate and mycorrhizal relationships, and the water cycle also can be altered significantly (Bragg and Steuter 1995, Christian and Wilson 1999, Seastedt 1995, Wilson 2002). Regardless of vegetation conditions, some species such as northern harrier may avoid narrow tracts of drift prairie bordered by cropland simply because they need broader grassland tracts (Johnson and Igl 2001). For example, territories of the harrier may cover 250–500 acres (Bildstein and Gollop 1988).

In an adjacent, rolling to hilly region of northern mixed-grass prairie known as the "Missouri Coteau," habitat and species diversity of grassland birds has been largely restored by applying multiple prescribed burns (Madden et al. 1999). A recent study of relationships between bird species abundances and fire history at Des Lacs NWR suggests, however, that habitat and birds may not respond similarly to reintroduction of fire to drift prairie (Ludwick and Murphy 2006). The three endemic, historically common, songbird species (Baird's sparrow, chestnut-collared longspur, and Sprague's pipit) continue to be rare or absent on drift prairie at Des Lacs NWR regardless of fire history. Abundances of common bird species appear uninfluenced by fire, perhaps because smooth brome is so pervasive and has a pronounced influence on habitat structure for at least several bird species. Greater treatment frequency and integration of alternate tools, chiefly livestock grazing, could possibly improve the structure to attract a broader mix of grassland songbirds, including endemic species.

Still, the quality of grassland habitat for grassland birds is not necessarily reflected simply by bird abundance. Often there are tradeoffs to consider when reintroducing major habitat disturbances such as fire and grazing; short-term losses should be weighed against net gains over longer periods. For example, management treatments might influence the survival of grassland bird nests, directly through

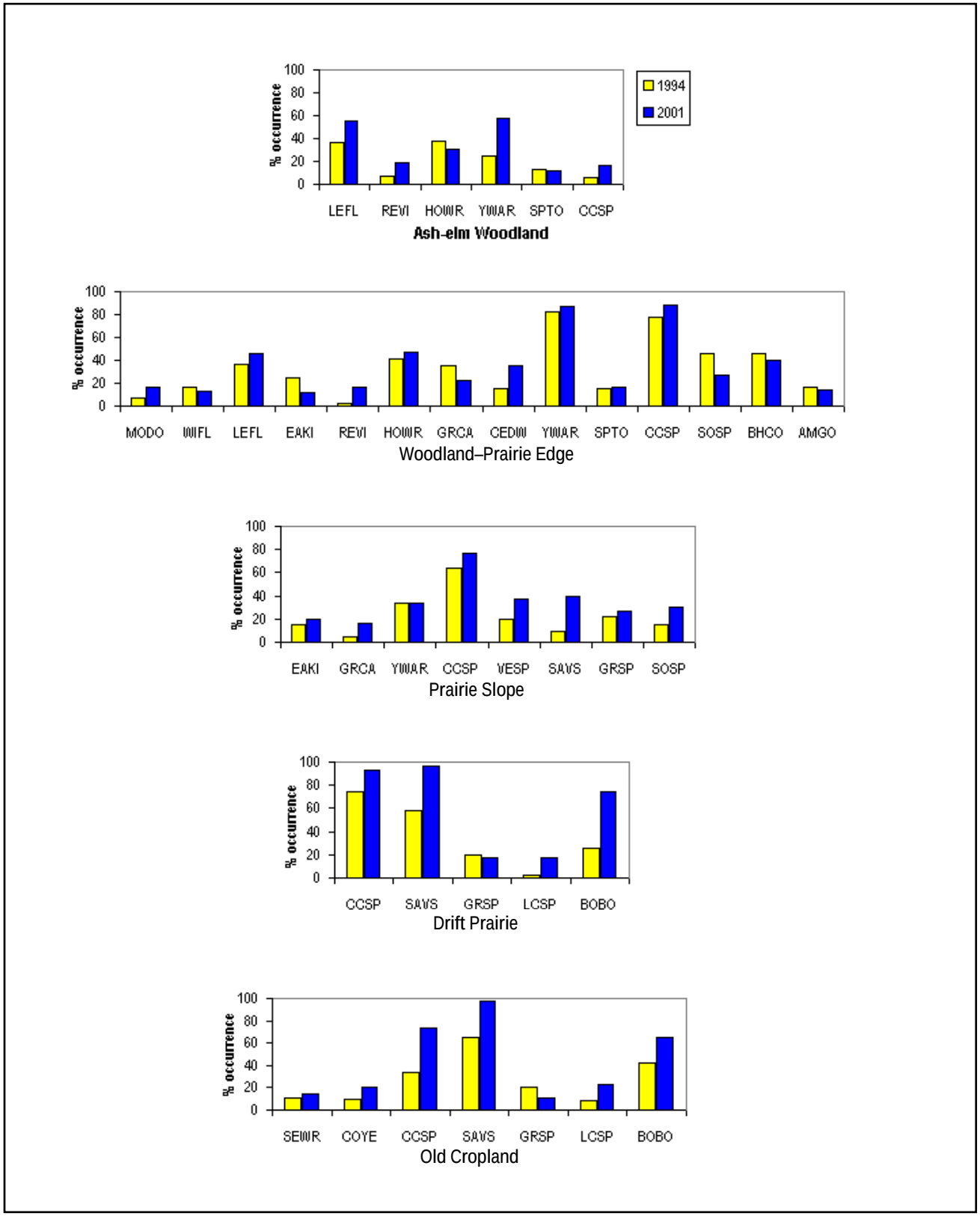


Figure 13. Frequency of occurrence of common breeding bird species in major upland habitats at Des Lacs NWR, North Dakota, following several dry years (1994; yellow bars**) and wet years (2001;** blue bars**).**

Species include: American goldfinch (AMGO), bobolink (BOBO), brown-headed cowbird (BHCO), cedar waxwing (CEDW), clay-colored sparrow (CCSP), common yellowthroat (COYE), eastern kingbird (EAKI), grasshopper sparrow (GRSP), gray catbird (GRCA), house wren (HOWR), least flycatcher (LEFL), Le Conte's sparrow (LCSP), mourning dove (MODO), red-eyed vireo (REVI), Savannah sparrow (SAVS), sedge wren (SEWR), song sparrow (SOSP), spotted towhee (SPTO), vesper sparrow (VESP), willow flycatcher (WIFL), and yellow warbler (YEWA). Modified from Murphy and Sondreal (2003).

livestock trampling, or indirectly via increased predation or brood parasitism rates, when nest site vegetation is modified by fire or grazing. These potential management influences have been assessed recently on drift prairie on the refuges. The density of songbird nests declines during the first growing season following a prescribed fire. However, no strong relationship was detected between the survival of nests of three grassland songbird species and the time since the last fire (1, 2, 3, or >4 years) at J. Clark Salyer NWR, except that parasitism of nests by brown-headed cowbirds was greater during the first growing season following a fire for Savannah sparrows and may have decreased nest survival (Grant et al., in review). The probability of Savannah sparrow nests surviving at Des Lacs NWR declined when cattle were present at moderate stocking densities, but no such relationship was evident for clay-colored sparrow nests in the same management units (Kerns 2005). Cattle trampling accounted for only 1% and 3% of all nest failures for the two species, respectively.

The quality of drift prairie as habitat for grassland birds also may be influenced by occurrences of trees and tall shrubs. Historically, the drift prairie landscape of the Souris River basin was open and treeless, but trees appeared and increased across much of the area during the 1900s (Grant and Murphy 2005). Trees and tall shrubs effectively fragment this landscape, rendering it unsuitable for most grassland bird species (Grant et al. 2004a).

There are almost no trees or tall shrubs on the contemporary drift prairie at J. Clark Salyer NWR. Most drift prairie at Des Lacs NWR and Upper Souris NWR has either (1) widely scattered, stunted trees or tall shrubs, or (2) borders of natural woodland or planted tree and shrub shelterbelts. Some drift prairie tracts in the northern half of Des Lacs NWR also have one to several groves of quaking aspen and are more aptly classified as aspen parkland habitat. Much of the tall, woody cover at Des Lacs NWR currently is being reduced by prescribed fire, however. An analysis of recent data from the refuge suggests that the survival of clay-colored sparrow nests declines with increasing amounts of surrounding tree and tall shrub cover, but survival of Savannah sparrow nests appears unaffected (Murphy et al., unpublished data). Tall woody cover on the drift prairie at Upper Souris NWR—where prescribed fire has not been applied frequently or extensively and trees and tall shrubsare much more widespread—is likely to reduce the occurrence and productivity of at least some grassland songbird species.

Many duck species use drift prairie at the refuges as nesting cover. For example, blue-winged teal, gadwall, mallard, northern shoveler, and northern pintail nests composed 95% (in decreasing order) of duck nests discovered at J. Clark Salyer NWR during 1998–2003. Nesting density and nest success varies among years and among the refuges. Ducks nest at greater densities on the drift prairie at J. Clark Salyer NWR than on drift prairie at the other refuges. Regardless, the density and fate of duck nests in northern prairie may be affected by grassland management practices such as prescribed fire and grazing (for example, Kruse and Bowen 1996). On drift prairie at J. Clark Salyer NWR during 1998–2003, duck nest densities were reduced during the first growing season following a fire, but recovered 2–3 years postfire. Nest survival for mallard and gadwall was greater during the first post-fire growing season than in subsequent years, but was unaffected by fire for other duck species regardless of how recently fire had occurred (Grant et al., unpublished data). The density and survival of nests of prairie ducks are believed to be greatest on rested grasslands (Naugle et al. 2000).

Beginning in 1970, rest (nondisturbance: no grazing, haying, or fire) was emphasized as a management approach to increase densities of duck nests in uplands at the Souris River basin refuges. In the short term (2–20 years), greater vertical structure may be maintained in northern grasslands that are rested. The structure of such idle vegetation is believed to be more important than plant species composition when the management goal is waterfowl production (Schranck 1972, Naugle et al. 2000). However, management that emphasizes rest has long-term implications for prairie duck nesting habitat that often are overlooked in short-term management studies, because continuous idling without periodic defoliation disturbance fails to promote long-term grassland health (Naugle et al. 2000). With extended rest, introduced grasses, especially smooth brome and Kentucky bluegrass, may more rapidly displace native vegetation (Murphy and Grant 2005). Of particular concern is replacement of western snowberry communities (see previous) by smooth brome, which is less attractive to ducks, short-eared owls, northern harrier, and grassland songbirds. Monotypic stands of smooth brome and Kentucky bluegrass are less attractive to upland-nesting ducks than other types of grass–forb cover (Kemner and Higgins 1993, Nenneman 2003a). Duck nest survival, although highly variable among years, can decrease for grasslands idled >5 years (Miller 1971).

Conspicuously absent from the refuges' drift prairie is the Richardson's ground squirrel, which typically occupies open, heavily grazed grasslands. Historically, its colonies extended across the northern Great Plains north and east of the Missouri River (Jones et al. 1983). Burrows created by Richardson's ground squirrel continue to be key nest site habitat for burrowing owls in most of North Dakota, a state where the owl's breeding population is declining (Murphy et al. 2001). The ground squirrel occurs on some annually grazed, privately owned drift prairie

tracts adjacent to the refuges and could colonize the refuge drift prairie where the height of vegetation was reduced by burning and frequent grazing.

Other vertebrate fauna characteristic of the contemporary refuge drift prairie include chorus frog, plains garter snake, masked shrew, meadow vole, thirteen-lined ground squirrel, deer mouse, and meadow jumping mouse (Eddingsaas et al., unpublished data). Coyote, white-tailed jackrabbit, and northern pocket gopher are less common.

Thirteen-lined Ground Squirrel
© Cindie Brunner

Prairie Slope

Prairie slope occurs at Des Lacs NWR, at Upper Souris NWR, and minimally at J. Clark Salyer NWR. Prairie slope, especially the southwest-facing slopes, supports some of the most pristine native flora in the Souris River basin and is thus a highly valued resource.

Physical Environment

Prairie slope is defined as native sod hillside that covers at least a 25-foot elevation gain and generally is characterized by a 25–60% slope. Such slopes typify the transition from the level Drift Plain down to the valley floor at Des Lacs NWR and at Upper Souris NWR. At J. Clark Salyer NWR, prairie slope is poorly developed, and the transition from drift prairie to valley floor instead is represented by very short hillsides.

Prairie slope accounts for 22% of the total area of Des Lacs NWR (figure 9). Slopes on the southern half of the refuge cover a 100- to 170-foot rise; slopes on the northern half are shorter, covering only a 50- to 70-foot rise from the valley floor to the Drift Plain. Soils on the refuge's slopes are thin ("A" horizon, 1–4 inches deep), well-drained loams formed in glacial till. For at least 60 years, prairie slope at Des Lacs NWR had been managed mainly by rest—there had been occasional light grazing by cattle and perhaps a single prescribed fire, a history identical to that of the adjoining, level drift prairie (Murphy and Grant 2005).

At Upper Souris NWR, prairie slope is the most widespread upland habitat, comprising 35% of the refuge (figure 9). Physical characteristics of prairie slope at the refuge are roughly similar to those of this habitat at Des Lacs NWR, except that slopes are more gradual at Upper Souris NWR. Since the mid-1900s, prairie slope at Upper Souris NWR generally has been managed along with adjoining drift prairie by light grazing interspersed with long periods of rest and little or no fire.

Characteristic Vegetation

Slope aspect (the direction toward which it is oriented) can have significant implications for plant species composition. At Des Lacs NWR, it is important to distinguish between southwest-facing prairie slope and northwest- to southeast-facing prairie slope (aspect, 180–270° versus 280–170°). Southwest-facing prairie slope at the refuge supports some of the most pristine native flora in the Souris River basin and thus is a highly valued resource. The steep southwest aspect fosters a hot, arid, sunlight-rich environment for plant growth. This favors many xerophytic (dry-site loving), native plant species, but is hostile to most introduced plant species such as smooth brome. Competition is fierce among individual plants for crucial resources in the thin soils, especially for moisture. Compared to the refuges' drift prairie, litter apparently accumulates slowly on southwest-facing prairie slope, and the native-dominated plant community may remain relatively stable over decades with little management intervention. Native, warm-season grasses are far better represented among the flora of southwest-facing prairie slopes at Des Lacs NWR than they are in northwest- to southeast-facing slopes and drift prairie. This provides a broader overall plant phenology and thus more effective competition against introduced cool-season grasses.

More intact assemblages of native plant species, especially grasses, sedges, and forbs, characterize prairie slope at Des Lacs NWR. For example, an average of about two-thirds of the southwest-facing prairie slope is noninvaded, native herbaceous vegetation, compared to only 6% on the adjoining drift prairie (Murphy, Whipp, and Muscha; unpublished data). Dominant grasses and sedges of southwest-facing slopes in the refuge include the following species (from upper to lower slopes):

- blue grama
- threadleaf sedge
- plains muhly
- needle and thread
- prairie sandreed
- prairie Junegrass
- native bluegrasses (two species)
- green needlegrass

native wheatgrasses (several species)
sideoats grama
little bluestem
porcupine grass
Kentucky bluegrass
big bluestem
smooth brome

Tall shrubs and trees occur infrequently on southwest-facing slopes; these mostly are chokecherry, Saskatoon serviceberry, and stunted green ash trees.

Northwest- to southeast-facing slopes at Des Lacs NWR are relatively cooler, darker, and moister than southwest-facing slopes. These areas tend to be more successfully invaded by introduced plants (for example, smooth brome) and native woody plant species (Murphy, Whipp, and Muscha; unpublished data). Much of this slope is woodland edge habitat, distributed mainly along the west side of the river valley (described and discussed in more detail under "Coulee Woodland and Coulee Woodland Edge" habitat).

Prairie slope at Upper Souris NWR are less pristine than those at Des Lacs NWR. This is probably due in part to subtle contrasts in their general management history, but also to differences in the steepness of slopes at the two refuges. Frequent light grazing by cattle, interspersed with long periods of rest and little fire, tend to further the spread of introduced cool-season grasses (especially Kentucky bluegrass), plus hasten invasion by low shrubs, tall shrubs, and trees. The average frequency of vegetation dominated by Kentucky bluegrass and woody plants is 32% and 28% respectively, versus about 20% for each plant group type at Des Lacs NWR.

Regardless, native herbaceous vegetation is more intact on prairie slope than on adjoining drift prairie at Upper Souris NWR (13–15% pristine native vegetation on prairie slopes versus <5% on drift prairie).

In contrast with Des Lacs NWR, plant species composition on southwest-facing slopes at Upper Souris NWR appears to be quite similar to that on the refuge's northwest- to southeast-facing slopes. This may be partly because Kentucky bluegrass is a significant invader of upland native prairie at Upper Souris NWR regardless of aspect. For example, plant communities characterized solely by native herbaceous vegetation make up 15% and 13% respectively, of southwest-facing and northwest- to southeast-facing slopes; vegetation dominated by Kentucky bluegrass makes up 33% and 31%. During sampling of prairie slope vegetation, scattered patches of tall woody vegetation (such as chokecherry, Saskatoon serviceberry, northern hawthorn, and green ash saplings and trees) generally were avoided, such that woody cover probably is much more prevalent on northwest- to southeast-facing slopes at Upper Souris NWR than conveyed here.

Characteristic Wildlife

Several more songbird species are commonly found on prairie slope than are found on drift prairie (figure 13), although the overall density of songbirds probably is less on prairie slope. At Des Lacs NWR, southwest-facing prairie slope is the most important habitat for vesper sparrow and grasshopper sparrow. Upper slopes are about the only place on the refuge where the endemic Sprague's pipit currently occurs, albeit uncommonly. Most common bird species on southwest-facing prairie slope (such as vesper sparrow and song sparrow) are associated with the sparse, widely scattered, tall woody vegetation.

No corresponding data are summarized for the breeding bird community of prairie slope at Upper Souris NWR, but the general makeup of the bird community probably is similar to that on prairie slope at Des Lacs NWR. There likely is potential for a significant amount of breeding habitat for Sprague's pipit if upper prairie slopes are restored at Upper Souris NWR.

Prairie Parkland

Prairie parkland occurs only at J. Clark Salyer NWR, occupying about 16% of the refuge (figure 9).

Physical Environment

Prairie parkland is an island of mixed-grass prairie and woodland habitat occurring within the Souris Lake Plain physiographic subregion (Bottineau, McHenry, and Pierce counties). The Souris Lake Plain is a flat, deltaic outwash plain, bordered to the south and east by sandhills formed from wind and wave action of historic Glacial Lake Souris (Bluemle 1991). Soils are mostly sand, gravel, and clay; water drainage is good in sandy soils but poor near the Souris River. The water table is close to the surface in sandy soils, especially during years of above average precipitation.

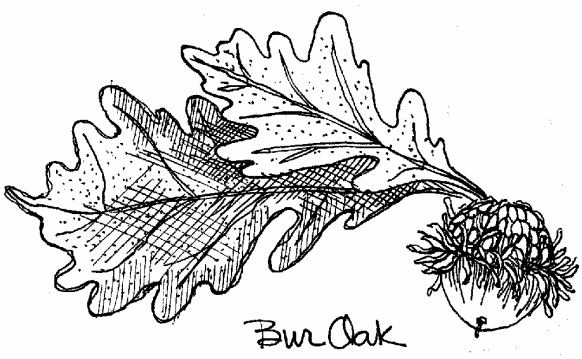
Lands in and adjacent to J. Clark Salyer NWR constitute one of the largest, contiguous patches of northern mixed-grass prairie remaining in North America (about 1 million acres). The refuge is bordered to the south mainly by native rangeland. Some cropland (dryland farming for small grains), hay land (seeded alfalfa and native meadows), and Conservation Reserve Program (CRP) lands seeded to grasses and forbs border the refuge to the west and east.

Characteristic Vegetation

Aspen–oak woodland accounts for 38% of the contemporary prairie parkland. Low shrubs and tall shrubs collectively account for about 10% cover, with

the remainder (52%) occurring as grasses, upland sedges, and forbs. About 15% of these grass–forb communities are in pristine condition; 28% are partially degraded (where native plants occur codominant with introduced plants), and 33% are badly degraded by invasive plants, being dominated by introduced species of grasses and forbs. Kentucky bluegrass is the dominant invasive plant, accounting for about 28% of the grass–forb cover. Other, introduced plant species include smooth brome (3% cover), leafy spurge (<2% cover), yellow sweetclover (<1% cover), and crested wheatgrass (<1% cover).

Native prairie is a mix of warm- and cool-season grasses and forbs. Dominant cool-season grasses include prairie Junegrass, western wheatgrass, porcupine grass, green needlegrass, and various species of upland sedges. Warm-season grasses include sand bluestem, little bluestem, blue grama, prairie sandreed, and sand dropseed. Grasslands are interspersed with low (<3 feet) shrub dominated by western snowberry and meadowsweet, plus tall (>3 feet) shrub dominated by chokecherry and willow. Quaking aspen and bur oak are the dominant tree species in woodland. Woodland understory shrubs include western snowberry, chokecherry, Saskatoon serviceberry, and redosier dogwood. Ground cover is dominated by poison ivy, wild sarsaparilla, false Solomon's seal, and various species of grasses and sedges.



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Expansion of aspen–oak woodland into native prairie remains the most serious threat to the prairie parkland. Prior to settlement, the extent of this woodland was limited, occurring as stunted groves of quaking aspen and bur oak along fire-protected scarps of sandhills or near wetland margins. The extent of aspen–oak woodland has doubled since 1938 and now account for almost 40% of the prairie parkland landscape (Grant and Murphy 2005). Aspen–oak woodland initially increased due to fire suppression, extirpation of bison and elk, and annual cattle grazing at low to moderate stocking rates (reviewed in Grant and Murphy 2005). Long-term rest (that is, limited grazing and burning) is implicated in more recent expansion of this woodland.

Kentucky bluegrass is the most widespread introduced grass in the prairie parkland, occurring codominant with native grasses and forbs. Kentucky bluegrass increases under prolonged rest or with grazing in northern prairie, but generally decreases with fire (reviewed in Murphy and Grant 2005). From 1890 to 1960, the prairie parkland was annually grazed, season-long, at light to moderate stocking rates (0.3–0.7 AUM/acre). Beginning in 1970, the extent, frequency, and intensity of grazing were reduced to emphasize nesting cover for waterfowl and sharp-tailed grouse. Since 1890, natural fires were suppressed; cultivation and road building helped limit the spread of fires. Prescribed fire was used opportunistically from 1960 until 1990, with one or two burns applied on a few prairie parkland management units. Since 1992, prescribed fire has been used with greater frequency; one to four burns have been applied to control woody vegetation and Kentucky bluegrass at each of several units ranging from 300 to 1,200 acres.

Leafy spurge, an introduced forb, is an aggressive invader of prairie on sandy soils and poses a significant long-term threat to prairie parkland. Leafy spurge spreads into prairie parkland mainly from sandhills, where it is a more serious problem. Biological control with flea beetles (*Apthona* spp.) has not been effective on sandy soils characteristic of the prairie parkland.

Characteristic Wildlife

Changes in vegetation of the prairie parkland since the 1870s have implications for the diversity and abundance of breeding birds, especially grassland-dependent species. These species were historically the most important bird guild in the region (Coues 1878). Grassland species characteristic of the contemporary prairie parkland include sharp-tailed grouse, vesper sparrow, clay-colored sparrow, Sprague's pipit, upland sandpiper, and grasshopper sparrow (Grant et al. 2004a, in press). Less common are blue-winged teal, mallard, northern pintail, horned lark, eastern kingbird, common nighthawk, and (in wet years) bobolink. Several species characteristic of the region are rare or absent, for example, Savannah sparrow, chestnut-collared longspur, western meadowlark, and Baird's sparrow.

Invasion of prairie by aspen woodland profoundly changes the breeding bird community of the prairie parkland. As woodland expands, edge and woodland bird species displace grassland birds (figure 14).

- Occurrence decreases markedly for 11 of 15 grassland bird species (including three species endemic to the northern Great Plains—Baird's sparrow, chestnut-collared longspur, and Sprague's pipit) as percent woodland, tall shrub, or brush cover increases (Grant et al. 2004a).

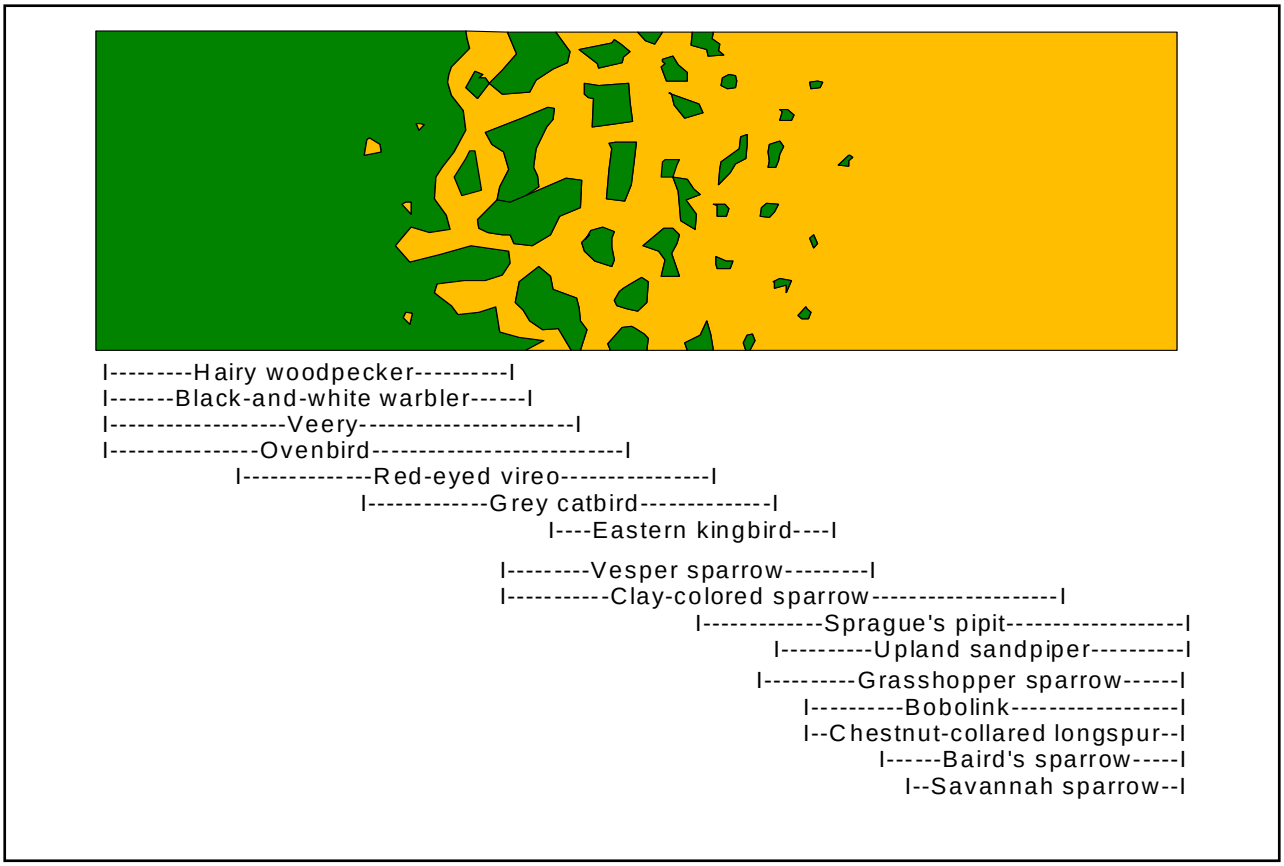

Figure 14. Distribution of breeding songbird species in relationship to the proportion of woodland (in green) **and grassland** (in yellow) **within prairie parkland at J. Clark Salyer NWR, North Dakota.** (Large aspen–oak woodland patches are represented at the far left and large, treeless grasslands are represented at the far right.)

Effects are intensified as the height of woody plants increases from low shrubs to tall shrubs to trees. Prairie parkland becomes largely unsuitable for nine grassland bird species as woodland cover exceeds 25%.

- Except for clay-colored sparrow, vesper sparrow, Sprague's pipit, and upland sandpiper, few grassland bird species nest in prairie parkland (Grant et al., in press). Contrary to expectations, nest predation and brood parasitism rates are lower near woodland edges than for nests placed far from woodland, at least for clay-colored and vesper sparrows (Grant et al., in press).
- Sharp-tailed grouse also use prairie parkland habitat for nesting and brood rearing and for winter food and cover. However, when woodland cover increases above a certain threshold, grouse will abandon lek sites (spring dancing grounds) where males gather to display to and breed with females (Berger and Baydack 1992, Hanowski et al. 2000). At least 10–12 historical leks have been abandoned at J. Clark Salyer NWR since 1950 because of woodland expansion (Grant and Hammond, unpublished data).
- Several grassland bird species (for example, chestnut-collared longspur, horned lark, and Sprague's pipit) are particularly sensitive to the quality of remaining prairie. Their occurrence declines when nonnative plants, especially smooth brome, replace native grasses and forbs (Wilson and Belcher 1989, Madden et al. 2000, Grant et al. 2004a).

At least 50 breeding bird species are associated with aspen–oak woodland at J. Clark Salyer NWR (Grant and Berkey 1999). Large woodland patches support more diverse bird communities than smaller or more isolated woodlands, especially area-sensitive, forest-interior species. Large contiguous patches of aspen woodland account for a significant portion of the contemporary prairie parkland landscape; restoration of these heavily invaded sites (former grasslands) is no longer feasible.

Woodland contributes to local avian diversity and may provide habitat for forest species that have shown regional or continental population declines such as red-eyed vireo, rose-breasted grosbeak, veery, and ovenbird. Large (40- to 500-acre) woodlands provide suitable habitat for area-sensitive woodland bird species, while also meeting the requirements of habitat generalists such as

brown thrasher, catbird, yellow warbler, and American goldfinch. The converse is not true; small woodland patches do not support the high number or diversity of bird species that large woodland patches do. Of the more than 50 bird species recorded in aspen–oak woodland, none appears restricted to small patches and most use the edges of larger woodland patches. These findings suggest that small woodland patches may be removed (for example, for grassland restoration) without adversely affecting overall use of woodland by forest birds. Meanwhile, removal of the small patches significantly improves availability of habitat for several species of grassland songbirds (Grant and Berkey 1999).

The species makeup of mammal communities also changes with the transition from open grassland to the grassland–woodland edge to woodland interior habitats. The meadow vole, thirteen-lined ground squirrel, plains pocket mouse, short-tailed shrew, western jumping mouse, masked shrew, arctic shrew, and pygmy shrew prefer open prairie habitat, while the deer mouse, red-backed vole, fox squirrel, snowshoe hare, red squirrel, and raccoon prefer woodland and woodland edge habitat (Kadrmas 2005). The relative abundance of small mammal species can fluctuate significantly from year to year, even from month to month (for example, increased juvenile dispersal during late summer), or following a disturbance such as fire.

Gary Eslinger/USFWS

White-tailed Deer

Large mammals such as moose, white-tailed deer, coyote, and red fox are more flexible in their selection of habitats and can range widely, rarely restricted to a certain habitat type. Other important vertebrates include chorus frog, wood frog, and plains garter snake.

Sandhills

The sandhills cover about 5% of J. Clark Salyer NWR (figure 9).

Physical Environment

The sandhills occur within flat sandy plains occupied by more extensive prairie parkland. Embedded in this plain are a series of northeast- to southwest-oriented sand ridges with relief of 50–80 feet. These ridges were formed from wind and waves acting on sediments deposited on the floor of Glacial Lake Souris (Bluemle 1991). Soils are mostly sand and gravel. Management history and surrounding land use are similar to descriptions for the prairie parkland.

Characteristic Vegetation

The sandhills' prairies are a mix of warm- and cool-season grasses and forbs. Dominant cool-season plants include prairie Junegrass, green needlegrass, and various species of upland sedges. Warm-season grasses include sand bluestem, little bluestem, blue grama, prairie sandreed, and sand dropseed. Grasslands are interspersed with low (<3 feet) shrub dominated by western snowberry and Woods' rose, and tall (>3 feet) shrub dominated by chokecherry, hawthorn, and Saskatoon serviceberry.

North and east aspects of sand ridges are often dominated by bur oak. Aspen woodland has invaded the transition from oak to prairie at the toe of these slopes and occurs as stunted or widely scattered woodland patches. Woodland and tall shrub cover is extensive in some areas.

The contemporary composition of the sandhills is woodland (20% cover), tall shrub (12% cover), and low shrub (8% cover), with the remainder occurring as grasses and forbs. The extent of aspen woodland has increased since refuge establishment and is now twice that of bur oak woodland (13% versus 7%). Some of the best representative examples of northern mixed-grass prairie are found growing on sandy soils and harsh sandhill aspects. About 35% of the grass–forb cover is in pristine condition (having no introduced species and relatively little native, woody vegetation). However, about 20% of the grass–forb cover has been replaced by invasive, introduced plants, primarily leafy spurge and to a lesser extent, Kentucky bluegrass. Only 5% of the grass–forb vegetation is partially degraded by invasive plants. This suggests that once invasion has occurred, especially by leafy spurge, native grasses and forbs are quickly and completely displaced.

Less than 1% of the sandhills are unvegetated. Early descriptions and aerial photographs from 1938 suggest that sand blowouts were more common than today. Heavy disturbance by grazing and wallowing bison, and later by cattle, likely maintained many of these blowouts, especially on south- and west-facing aspects.

As in the prairie parkland, encroachment by trees and tall shrubs poses a serious threat to the sandhills. Changes in the extent of aspen–oak woodland and rationale for these changes are similar to descriptions for the prairie parkland.

Leafy spurge is the most serious long-term threat to the integrity of the sandhills. Leafy spurge currently dominates 17% of the nonwoodland cover. Biological control using flea beetles (*Apthona* spp.) has yet to be effective on sandy soils characteristic of the sandhills. Furthermore, vehicle access to the sandhills is limited, rendering efforts to control leafy spurge using chemicals unrealistic. Soil disturbance by cattle and fire can hasten the expansion of leafy spurge, potentially limiting the use of these tools to control expansions of woody vegetation and Kentucky bluegrass.

Gary Eslinger/USFWS

Sandhills in Fall

Gary Eslinger/USFWS

Black-billed Magpie

Characteristic Wildlife

The contemporary bird community of the sandhills includes grassland species that tolerate trees and tall shrubs. Important species include clay-colored sparrow, vesper sparrow, and Sprague's pipit. Conversely, other grassland bird species such as upland sandpiper and grasshopper sparrow are intolerant of tall, woody vegetation and thus avoid much sandhill habitat on the refuge (Grant and Berkey 1999).

Woodland edge and shrubland species include black-billed magpie, black-billed cuckoo, brown thrasher, and lark sparrow. Black-and-white warbler and orange-crowned warbler have an affinity for bur oak and are commonly found in closed-canopy stands on the northeast aspect of sand ridges (Grant and Berkey 1999). Resident forest species (such as hairy woodpecker and black-capped chickadee) and Neotropical migrant forest species (such as red-eyed vireo, rose-breasted grosbeak, veery, and ovenbird) use larger woodland patches.

Important small and mid-sized mammals of the sandhills include masked shrew, pygmy shrew, red-backed vole, meadow vole, deer mouse, Franklin's ground squirrel, thirteen-lined ground squirrel, northern pocket gopher, porcupine, and North American badger (Kadrmas 2005).

Old Cropland

Old cropland occurs at all three Souris River basin refuges, roughly covering 10%, 13%, and 5% respectively of Des Lacs NWR, J. Clark Salyer NWR, and Upper Souris NWR.

Physical Environment and Characteristic Vegetation

Old cropland includes areas cultivated before refuge establishment, usually on the Drift Plain, into which perennial grasses and forbs have been seeded to provide relatively tall, dense cover mainly for nesting by mallards and other ducks. The general term "seeded herbaceous cover" includes old cropland areas into which dense nesting cover or native grass mixtures were known to have been seeded at least once during the past 25 years.

Old cropland also includes previously cultivated tracts allowed to revert to herbaceous cover ("go-back" prairie). These reverted areas of old cropland are particularly extensive at J. Clark Salyer NWR. However, distinguishing go-back prairie from badly degraded drift prairie can be difficult based on plant species composition. Signs of soil surface disturbance or other physical evidence of tillage often are subtle. Definitive inventories generally have not been completed.

Typically, introduced species of grasses and forbs are used to reseed old cropland—intermediate wheatgrass, tall wheatgrass, and alfalfa or sweetclover or both (Duebbert et al. 1981, Higgins and Barker 1982). This seed mixture commonly is referred to as "dense nesting cover" (DNC). DNC is relatively inexpensive to establish, but has a limited lifespan—providing cover attractive to nesting ducks for perhaps only 6–8 years after seeding (Higgins

and Barker 1982). Stand structure and vigor often can be rejuvenated and the life of the stand extended several years through periodic hay harvest, prescribed burning, or grazing. Regardless, stands of DNC respond less favorably to management treatment about 12–15 years after establishment. Typically, these areas are then cultivated and farmed for 2–3 years, then reseeded. For this reason, stands of introduced cover are considered semipermanent (Higgins and Barker 1982).

Nearly all old cropland at Des Lacs NWR is under the typical DNC rotation of seeding–managing–farming–seeding. Roughly one-half of old cropland identified on the Drift Plain at J. Clark Salyer NWR has been seeded during the past 25 years into DNC, or (more recently) native grasses, or both. Most old cropland at Upper Souris NWR was seeded into DNC 15–25 years ago. During the same time, other old cropland on the refuge was seeded into native grasses. Regardless of whether native grasses were "interseeded" or seeded into cultivated seedbeds, old cropland at Upper Souris NWR now is covered by invasive, introduced grasses and native grass species are no longer evident.

Stands of native grasses are expensive to establish in old cropland, mainly due to seed costs, but they have the advantage of being permanent if successfully established. In the early 1980s, native grasses were seeded into some old cropland areas at Upper Souris NWR, and were "interseeded" into several DNC areas at the refuge. Regardless of seeding history, native grass species are no longer evident on these areas. In recent years at J. Clark Salyer NWR, warm- and cool-season native grasses sometimes have been seeded into old cropland instead of introduced plant species typically used in DNC.

On the Souris River basin refuges, seeded herbaceous cover, whether composed of DNC or native species, tends to be rapidly degraded by undesirable, introduced plant species (especially smooth brome, quackgrass, Canada thistle, and leafy spurge). Smooth brome, in particular, becomes pervasive and significantly compromises stand structure. Management treatments that discourage undesirable, introduced cool-season plants (such as smooth brome) also tend to discourage the desirable, seeded, introduced cool-season grasses due to closely overlapping phenology. Application of herbicides to control noxious weeds (for example, leafy spurge and Canada thistle) can significantly reduce cover of alfalfa and sweetclover. Seeded stands dominated by warm-season grasses, typically big bluestem, switchgrass, and Indiangrass, may provide considerably broader latitude for control of undesirable cool-season plants. For example, prescribed fire ineffectively controls smooth brome in cool-season-dominated grasslands when few (<20% cover) warm-season plants are available to compete (Willson and Stubbendieck 2000). When warm-season plants are more common, however, smooth brome can be reduced by late spring burning when brome is most actively growing.

Characteristic Wildlife

Cover provided by plants seeded in old cropland generally is taller and denser than that on native sod at the Souris River basin refuges. However, this cover may not necessarily provide more secure nest site habitat for prairie ducks. At Des Lacs NWR during 2001–2003, the average annual success of duck nests discovered in DNC was similar to that in drift prairie (annual range 12–20% versus 12–34% [Mayfield estimate; Johnson 1979]).

Survival of nests in DNC at Des Lacs NWR was within an estimated 15–20% considered necessary to maintain stable duck populations in the region (Cowardin et al. 1985). The variety of duck species that nest in DNC was less than in drift prairie, however; an average of five and seven species were represented annually in the two habitats at Des Lacs NWR. Mallard nests composed most nests found in the seeded cover (annual average 60%) and other species were uncommon (<15% each). During the same years, nests of three species were common in drift prairie: mallard, gadwall, and blue-winged teal (35%, 23%, and 20% respectively of all nests discovered).

Savannah sparrow, clay-colored sparrow, and bobolink are abundant breeding birds in DNC and probably in all seeded herbaceous cover in old cropland at the refuges, similar to characteristic breeding birds of the contemporary drift prairie (Murphy and Sondreal 2003; Grant, et al.; unpublished data). DNC at the refuges also is important breeding habitat for sedge wren, Le Conte's sparrow, and Nelson's sharp-tailed sparrow; the relatively rank, dense cover apparently imitates the native wet meadow vegetation that attracts these species (Murphy and Sondreal 2003). DNC and other seeded herbaceous cover at the refuges may be a preferred nesting site and foraging habitat of the short-eared owl and northern harrier; their main prey, the meadow vole, appears to be common to abundant in this habitat most years.

Herbaceous cover seeded in old cropland can increase grassland habitat diversity at the refuges by providing a unique tall-grass prairie component. This may be increasingly important as vegetation height and density are reduced on much of the drift prairie. This reduction occurs through more frequent and intensive management treatments to effectively restore that prairie and address needs of a broader suite of grassland birds. Establishment of stands of native warm-season plants in old cropland should provide more flexibility for managing invasive plant species, better complement the Refuge System's goals for biological diversity and ecological integrity,

and reduce erosion potential and sources of introduced plant species invasion (for example, by sweetclover) into native sod.

Coulee Woodland and Coulee Woodland Edge

Coulee woodland and coulee woodland edge occurs only at Des Lacs NWR and Upper Souris NWR (about 9% and 6% respectively; figure 9).

Physical Environment and Characteristic Vegetation

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Coulee woodland and coulee woodland edge includes partially to mostly wooded drainages of intermittent stream tributaries. It also includes any partially to mostly wooded, east- to north-facing , native sod hillside of the river valleys. In coulee woodland, the uppermost vegetation strata is dominated (>50% canopy cover) by trees, primarily green ash. Woodland edge is coulee that is sparsely wooded with trees, mostly green ash (5–50% canopy cover, usually <20%), plus associated chokecherry and other tall shrub. Coulee woodland and coulee woodland edge are characteristic of the west sides of steep-walled valleys, especially the southern half of Des Lacs NWR and most of Upper Souris NWR. Slopes at these sites at Des Lacs NWR typically are 25–60% and are less steep at Upper Souris NWR.

Coulee woodland at Des Lacs NWR occurs as a narrow (<300 feet wide), relatively linear habitat, typically with about 250–350 trees per acre and 55–60% canopy cover (from 1995 random plot data in Nenneman et al. 2003). Stands generally are 65–80 years old. Green ash is the overwhelmingly dominant overstory tree (Nenneman and Murphy, unpublished data). Historically, American elm codominated this woodland in the Souris River basin (Grant and Murphy 2005). However, elm occurred on only 56% of coulee woodland plots sampled at Des Lacs NWR in 1995, and these trees were dead and dying, apparently from Dutch elm disease. Ten years later, no viable mature elm remains and almost no young elm is found in the understory. With the change to dominance by a single-tree species, structure of coulee woodland will be further simplified and value of the habitat for some species of woodland-breeding birds may be altered. Other coulee woodland trees include boxelder and quaking aspen (28% and 3% frequency, respectively). No bur oak occurs at Des Lacs NWR even though it is common about 25 miles downstream near the confluence with the Souris River. Bur oak occurs infrequently at nearby Upper Souris NWR.

Principle understory shrubs in Des Lacs NWR woodland include chokecherry, Saskatoon serviceberry, and green ash saplings (>75% frequency each; Nenneman and Murphy, unpublished data). Shrub density typically is 600–1,000 stems per acre. Frequency of occurrence for the introduced tall shrub, common buckthorn, was 25% in 1995 (Nenneman and Murphy, unpublished data) and appears to have increased markedly since (Robert Murphy, wildlife biologist, Des Lacs NWR, personal observation). Left unchecked, this aggressive, weedy shrub may pose a serious threat to the native plant diversity and wildlife habitat value of coulee woodland, just as it has degraded native woodland, pasture, fens (alkaline bogs), and prairie in many midwestern states (Grace et al. 2001).

Ground cover averages 90% in coulee woodland at Des Lacs NWR and is dominated by native woodland sedges, Kentucky bluegrass, smooth brome, wild sarsaparilla, and western snowberry (Nenneman and Murphy, unpublished data). Leafy spurge rarely occurs.

Woodland edge at Des Lacs NWR is not just the broken-canopy transition between woodland and open prairie. More often, it is broad, grassy slopes of moderate to steep grade. Vegetation is scattered patches of tall shrub and young or stunted trees that emanate from subtly low, relatively moist areas and shallow drainages. This woody cover can sometimes spread into adjoining drift prairie. Tree canopy typically covers only 8–15% of woodland edge areas (Murphy et al., unpublished data). Typical tree and shrub densities are 40–70 stems per acre and 1,100–2,000 stems per acre, respectively. Green ash trees and snags (dead, tall woody stems) usually occur (69% frequency for each).

Shrubs common in woodland edge at Des Lacs NWR include green ash saplings, chokecherry, Saskatoon serviceberry, and round-leaved hawthorn (25–56% frequency). Each of four species of introduced tall shrub—common buckthorn, Tartarian honeysuckle, Russian olive, and caragana—occur infrequently (4–8% frequency). Woodland edge vegetation is otherwise badly degraded; invasive grasses, mainly smooth brome and Kentucky bluegrass (30% frequency) and low shrubs (27% frequency) account for most cover. Leafy spurge occurs more than twice as commonly in woodland edge (10% frequency) than in other habitats. Intact assemblages of native vegetation rarely occur (3%).

Equivalent descriptive data for coulee woodland habitat at Upper Souris NWR have been collected recently but are not summarized. Distribution (site type), species composition, and structure of coulee

woodland on the refuge appear generally similar to the respective attributes of coulee woodland at Des Lacs NWR. Coulee woodland edge is similarly pervasive on northwest- to southeast-facing slopes at Upper Souris NWR but also remains unquantified except for the herbaceous and low-shrub stratum. In this layer, vegetation dominated by native low shrub, especially western snowberry, is prevalent (30% frequency), just as at Des Lacs NWR. Unlike at Des Lacs NWR, however, this layer is otherwise composed chiefly of native-dominated and Kentucky bluegrass-dominated vegetation (24% and 31% respectively at Upper Souris NWR), rather than smooth brome-dominated vegetation (12%).

Characteristic Wildlife

The breeding bird community of coulee woodland at Des Lacs NWR is characterized by least flycatcher, house wren, and yellow warbler, which are abundant (figure 13). Red-eyed vireo, spotted towhee, and clay-colored sparrow are common. Two forest-interior species, veery and ovenbird, are found in the most mature stands. Cooper's hawks are common, with a nest area occurring about every mile along the southern half of the refuge (Nenneman et al. 2002). Northern goshawk and pine grosbeak are among migrant bird species that often overwinter in coulee woodland (Des Lacs NWR Christmas bird count, 1939–2004 data).

Characteristic small mammals of coulee woodland at Des Lacs NWR are deer mouse and red-backed vole (Eddingsaas et al., unpublished data). Eastern cottontail and moose are uncommon and local in distribution, while the white-tailed deer is common and widespread.

Lee Karney/USFWS

Song Sparrow

Because of its structural diversity, it is unsurprising that woodland edge provides habitat for more breeding bird species than other habitats at Des Lacs NWR (figure 13). Woodland edge is the most important habitat at Des Lacs NWR for willow flycatcher, song sparrow, and brown-headed cowbird; the cowbird occurs more than twice as frequently here than in any other habitat (Murphy and Sondreal 2003). Besides brown-headed cowbird, however, the only other grassland bird species common in this habitat is clay-colored sparrow.

Almost no woodland cover existed at present-day Des Lacs NWR in the 1800s, but woodland had developed by the time the refuge was established (Grant and Murphy 2005). The area covered by woodland increased significantly through the late 1960s but appears to have nearly reached its potential extent.

Today, most areas covered by coulee woodland at Des Lacs NWR may be overwhelmingly difficult to restore back to prairie. However, these areas probably could continue to provide modest habitat for forest-interior bird species without hindering widespread improvement in grassland bird habitat elsewhere at the refuge (Grant and Berkey 1999). In contrast, coulee woodland edge is a widespread habitat type at the refuge that, in the absence of fire, would continue to fragment drift prairie and some prairie slope. None of the breeding bird species that are common in this edge habitat is of management concern, whereas 11 grassland bird species that occur or used to occur at Des Lacs NWR are species of concern.

Conversion of woodland edge habitat to open prairie at Des Lacs NWR could be done through repeated prescribed fire. This conversion would negligibly influence continental population trends of woodland bird species, while helping reverse population declines of grassland bird species (Murphy and Sondreal 2003). Reduction of woodland edge may also help reduce cowbird parasitism rates among grassland bird nests.

The breeding bird community of coulee woodland at Upper Souris NWR likely is similar to that in the same habitat type at Des Lacs NWR. However, the bird community at Upper Souris NWR could be more diverse because some of its coulee woodlands at the refuge are broader, which may provide habitat for additional forest-interior species (for example, great crested flycatcher). Data on abundance of breeding birds and of other vertebrate species specific to coulee woodland and to coulee woodland edge at the refuge are available but not summarized. Unlike Des Lacs NWR, coulee woodland was evident in the 1800s along the river valley of present-day Upper Souris NWR, although its extent has increased markedly since (Grant and Murphy 2005).

Riparian Woodland

Riparian woodland occurs only at J.Clark Salyer NWR and at Upper Souris NWR (5% and 2% of refuge area, respectively; figure 9).

Physical Environment

Riparian woodland occurs within about 0.5 mile of the Souris River and is most extensive on the southern one-half of J. Clark Salyer NWR and the upper one-third of Upper Souris NWR. Woodlands extend downstream from Upper Souris NWR and terminate 1 mile west of Willow Creek at J. Clark Salyer NWR. These woodlands are associated with the meandering river, its numerous oxbows, and abandoned channels.

At least 1,000 acres of riparian woodland at Upper Souris NWR were permanently lost in the late 1930s when water was impounded behind Lake Darling dam. Riparian woodland is periodically inundated by overbank flooding of the Souris River. Soils are alluvial, mainly silty clay loams that are poorly drained.

Characteristic Vegetation

Riparian woodland has not been extensively inventoried at J. Clark Salyer NWR; quantitative and qualitative data are derived from less than 10 survey plots variously located in the riparian zone (Nenneman et al., unpublished data). Extensive inventories have been recently completed at Upper Souris NWR but the data have not been summarized.

Green ash is the dominant tree species of riparian woodland. American elm was once codominant with green ash, but Dutch elm disease has all but eliminated elm from riparian woodland. Furthermore, recent flooding (1997–2001) significantly reduced the density of large elm snags. Bur oak, boxelder, eastern cottonwood, and balsam poplar also occur. Understory shrubs include redosier dogwood, chokecherry, and various willow species. Ground cover comprises various forb, grass, and sedge species. Woodland cover is mostly continuous, with the forest canopy broken only by the meandering river channel and its numerous oxbows.

An extended hydroperiod associated with construction and operation of numerous dams along the Souris River has likely contributed to observed changes in extent and composition of wet meadow and riparian vegetation at the refuges. Green ash and American elm mortality occurred north of Lake Darling when the maximum operating elevation of the lake was raised 1 foot to 1,597.0 feet above mean sea level. Loss of these species is linked to increases in depth and duration of surface flooding (Fredrickson 1979, Fredrickson and Batema 1992).

Characteristic Wildlife

Breeding birds have not been inventoried in riparian woodland at J. Clark Salyer NWR. Inventories have been recently completed at Upper Souris NWR, but the data have not been summarized. Based on qualitative observations and data from related systems, riparian woodland is important for forest-interior migratory birds such as northern waterthrush, ovenbird, veery, red-eyed vireo, and American redstart (Rumble et al. 1998, Grant and Berkey 1999, Murphy and Sondreal 2003).

Gary Kramer/USFWS

Black-crowned night-heron (above) and great blue heron colonies are found in riparian woodland.

Other characteristic vertebrates include red squirrel, red-backed vole, masked shrew, raccoon, moose, wood frog, chorus frog, and leopard frog.

Meadow

Meadow is a transitional habitat on the Souris River basin refuges, where it supports some water-loving plants and is sometimes temporarily flooded. In addition, meadow supports vegetation characteristic of relatively moist areas of uplands. Meadow on the refuges generally is not classified as wetland in broad inventories based on remote imagery (for example, Habitat and Population Evaluation Team [HAPET]; Cowardin et al. 1979); this may partly be an artifact of the particular imagery used and its interpretation.

Meadow occurs at all three refuges but is uncommon at Des Lacs NWR (<1% of area versus 9% of J. Clark Salyer NWR and 6% of Upper Souris NWR; figure 9).

Physical Environment

The Souris River is "under-fit" relative to the size of the river valley (1–2 miles wide at J. Clark Salyer NWR). The river is sinuous and meandering, with numerous oxbows and abandoned channels. Prior to settlement, the Souris River valley supported numerous riverine and palustrine marshes maintained by periodic overbank flooding of the river. Extensive meadows that occurred on the northern one-half of J. Clark Salyer NWR and much of Upper Souris NWR have been lost—initially during the early 1900s due to extensive drainage and channelization, and later during the 1930s as water was impounded in several large reservoirs following refuge establishment.

Contemporary meadows at J. Clark Salyer NWR and Upper Souris NWR occur along both banks of the river within a seasonally inundated zone that includes riparian woodland habitat. This zone is bounded by prairie parkland at J. Clark Salyer NWR and by drift prairie and prairie slope at Upper Souris NWR. Soils are alluvial, silty clay loams that are poorly drained. Meadows extend south and west of J. Clark Salyer NWR in McHenry County and are especially extensive around Towner, North Dakota. Meadows in private ownership are used for winter livestock forage (hay land) and are bordered mainly by native rangeland.

Meadow is limited in area at Des Lacs NWR, occurring in small (<40-acre), isolated, often long, narrow patches. Meadow occurs at the mouths of major coulees or on the periphery of riverine wetland units along the southern one-third of the refuge. Meadow is uncommon on the refuge because of the valley's relatively narrow, steep profile.

Characteristic Vegetation

A variety of native sedges, rushes, and grasses dominate meadow sites including the following principal species: slim sedge, wooly sedge, and fescue sedge, prairie cordgrass, northern reedgrass, Baltic rush, common spikerush, and fowl bluegrass.

Oxbows, meander scars, and old channels support wetland plants tolerant of deeper water such as cattail, three-square bulrush, giant bur-reed, slough sedge, and American mannagrass.

Low shrubs include western snowberry, meadowsweet, and Woods' rose. Tall shrubs include several willow species and aspen. Near the river channel, meadow includes edges of riparian woodland where dominant species are green ash, American elm, bur oak, boxelder, and balsam poplar.

Willow shrubland and aspen woodland have expanded significantly since 1900 and now occupy 15–20% of the meadow zone (Grant and Murphy 2005). The herbaceous component of the contemporary meadow vegetation is composed of pristine native assemblages (37%), partially degraded native assemblages where native plants occur codominant with introduced plants (10%), and assemblages that are severely degraded (mostly by quackgrass [18% of all cover], reed canarygrass [8% cover], Kentucky bluegrass [7% cover], Canada thistle [<4% cover], or leafy spurge [<1% cover]).

Expansion of tall shrubs and trees is the most significant threat to meadows. The open, herbaceous character of meadows was historically maintained by fire, periodic spring flooding, and year-round grazing by bison and elk (Hanson 1984). During the 15-year interim between the extirpation of bison and beginning of settlement (about 1875–1890), early ranchers used meadows for open range and as hay land for winter livestock forage. Beginning in 1890, Euro-American settlers suppressed natural fires, and extensive cultivation and road building limited the spread of fires once started. On poorly drained soils, willow and aspen can quickly invade sedges and grasses in the absence of fire or grazing (Ewing 1924, Buell and Buell 1959, Coupland 1961).

Since 1900, the hydroperiod and hydrograph of the Souris River have been altered, first by drainage and channelization, and later by construction of dams along the entire river. Changes in the peak and duration of spring river flows have likely affected historical soil moisture levels in meadows, which could have affected establishment and expansion of tall shrubs and trees (Laubhan et al. 2003).

Beginning in the 1880s, annual clipping (haying) largely replaced fire and grazing as the principal defoliation disturbance. Recurrent clipping of woody sprouts appears effective in limiting the expansion of willow and aspen into meadows.

Rapid invasion of meadow by trees and shrubs during the 1960s and 1970s appears to correspond with several years of high to extreme flooding (1956, 1960, 1969, and 1974–76), as the Souris River overflowed its banks and inundated adjacent meadows. Access to meadows was limited for several consecutive years, allowing woody plants to expand beyond control through use of conventional haying equipment. (Grant and Murphy 2005.)

Characteristic Wildlife

Use of meadows by breeding songbirds, waterfowl, or other waterbirds has not been systematically assessed. Qualitative observations suggest that meadows are important to upland nesting ducks (mallard, blue-winged teal, gadwall, and northern shoveler), shorebirds (willet and Wilson's phalarope), and grassland songbirds (bobolink, Nelson's sharp-tailed sparrow, Le Conte's sparrow, Savannah sparrow, and sedge wren), especially during dry years. Use shifts to wetland-associated bird species during years when meadows are flooded during much of the summer (for example, sandhill crane, sora rail, yellow rail, Wilson's snipe, marsh wren, red-winged blackbird, and redhead).

Based on data collected for birds breeding in drift prairie and prairie parkland, the occurrence of important open-meadow bird species, such as Savannah sparrow, Le Conte's sparrow, bobolink, and sedge wren will decline as trees and shrubs expand (Grant et al. 2004a). Conversely, extensive stands of willow and aspen are used by yellow warbler, common yellowthroat, alder flycatcher, willow flycatcher, clay-colored sparrow, and gray catbird.

Dave Menke/USFWS

Common Yellowthroat

Other characteristic vertebrates include beaver, muskrat, red-backed vole, meadow vole, deer mouse, masked shrew, raccoon, moose, wood frog, chorus frog, leopard frog, and tiger salamander.

Wetland

Few natural riverine wetlands remain at the Souris River basin refuges. This section focuses on the contemporary riverine lakes and marshes, which account for 35–40% of collective habitat acres of the refuges (figure 9).

International Agreements

All of the Souris River basin refuges have certain physical and legal constraints affecting their water management capabilities. All three refuges hold state-based water rights, administered by the state of North Dakota.

Des Lacs NWR holds a declaration of filing dated September 1, 1934. The water rights filed with the North Dakota State Engineer on August 25, 1937 claimed a total of 65,000 acre-feet. The primary water management constraints on Des Lacs are physical: the low gradient of the Des Lacs River and the small size and inconsistent elevations of the water control structures limits water management capability. Currently, senior water right holders do not directly impact Des Lacs NWR.

The 1909 Boundary Waters Treaty Act governs the apportionment of waters between the United States and Canada. This act generally specifies that Canada is entitled to 50% of the water originating in the Canadian portion of a river basin, and that the United States is entitled to 50% of the natural flow that would have occurred at the border. The Souris River is unique in that it arises in Saskatchewan and North Dakota (Long Creek), flows through Saskatchewan, enters North Dakota, and then flows north into Manitoba. In 1959, an interim operating agreement was adopted by the respective countries giving Saskatchewan the right to store and use 50% of the flows originating in Canada, and apportioning the remainder to North Dakota. In addition, North Dakota had to supply a minimum of 20 cubic feet per second (cfs) to Manitoba from June 1 through October 31, unless certain drought conditions existed. The International Souris River Board of Control oversaw the apportionment.

The governments of the United States and Canada entered into the "Agreement between the Government of Canada and the Government of the United States of America for Water Supply and Flood Control in the Souris River Basin" (referred to as the "International Agreement") on October 26, 1989 (the complete agreement is in appendix K). To offset evaporation from two large reservoirs constructed in Saskatchewan, Saskatchewan's apportionment would now be 60% of the natural flow, depending on the elevation of Lake Darling on October 1 of a given year. This language was modified in 2001. The current language gives the United States 50% of the first 40,500 acre-feet (50,000 cubic decameters) that occurs prior to May 1, and then there is a 50:50 or a 60:40 split between the countries depending on the elevation of Lake Darling on June 1 of each year.

The operation of the Lake Darling Dam is under the control of the Service for runoff events with less than a 10-year exceedance probability. For flood events with greater than a 10-year exceedance probability, the USACE assumes operational responsibility for Lake Darling. The Service operates the dam at the direction of the USACE. Saskatchewan Watershed Authority operates the dams in Canada and coordinates dam operation with the Service, the USACE, and the North Dakota State Water Commission.

USFWS

Lake Darling

In addition to the flood control project, there are senior water right holders in North Dakota, and an agreement with the Eaton Irrigation Project for water supply. Management at Upper Souris NWR must accommodate senior water right holders and the Eaton Irrigation District. These operations are

coordinated with the North Dakota State Water Commission. The Service and the Eaton Irrigation District have applied for prescriptive water rights through a state process; none of these water right applications has been finalized. The disposition of the water right claims has the potential to impact water management on the Des Lacs NWR and Upper Souris NWR.

The water resources division of region 6 of the Service helps fund gauging stations on the Souris River that are used in determining apportionment, meeting water quality mandates set by the International Agreement, and helping in water management. In addition, Service employees of the water resources division have a role on the International Souris River Board and participate in subcommittees of the board. The water resources division is also working with the North Dakota State Water Commission on the processing of the prescriptive water right applications. Changes in refuge operations that might have water right implications or be affected by the International Agreement are coordinated through refuge staff consultation with the division of water resources.

Physical Environment

Almost all wetlands occur as riverine lake and marsh units that are impounded behind low-head dams and, thus, have potential for water level management. The degree to which these can be successfully managed differs markedly among and within refuges.

Natural wetlands not impounded by dikes and dams occur within other habitat types (for example, drift prairie, parkland, and meadows), especially at J. Clark Salyer NWR. These natural wetlands are generally managed in concert with the surrounding upland matrix in which they occur. Constructed ponds such as dugouts (cattle water sources) and wetlands created by damming intermittent streams compose a small component (<200 collective acres) of the Souris River basin refuges (figure 15).

Much of this section is adapted from a recent biological assessment of the Souris River basin refuges by Laubhan et al. (2003). The Souris River basin encompasses about 24,600 square miles, of which 5,500 square miles are in the United States.

The Souris River is perennial and originates in Saskatchewan. The river flows south to Velva, North Dakota, and then turns north, entering southern Manitoba northeast of Westhope, North Dakota. The Des Lacs River is a major tributary, entering the Souris River northwest and west of Minot. Des Lacs NWR and Upper Souris NWR are contained within steep, high-relief (0.7 mile wide and 165 feet deep) river valleys (Lord and Kehew 1990), with numerous intermittent drainages extending several miles from the respective rivers.

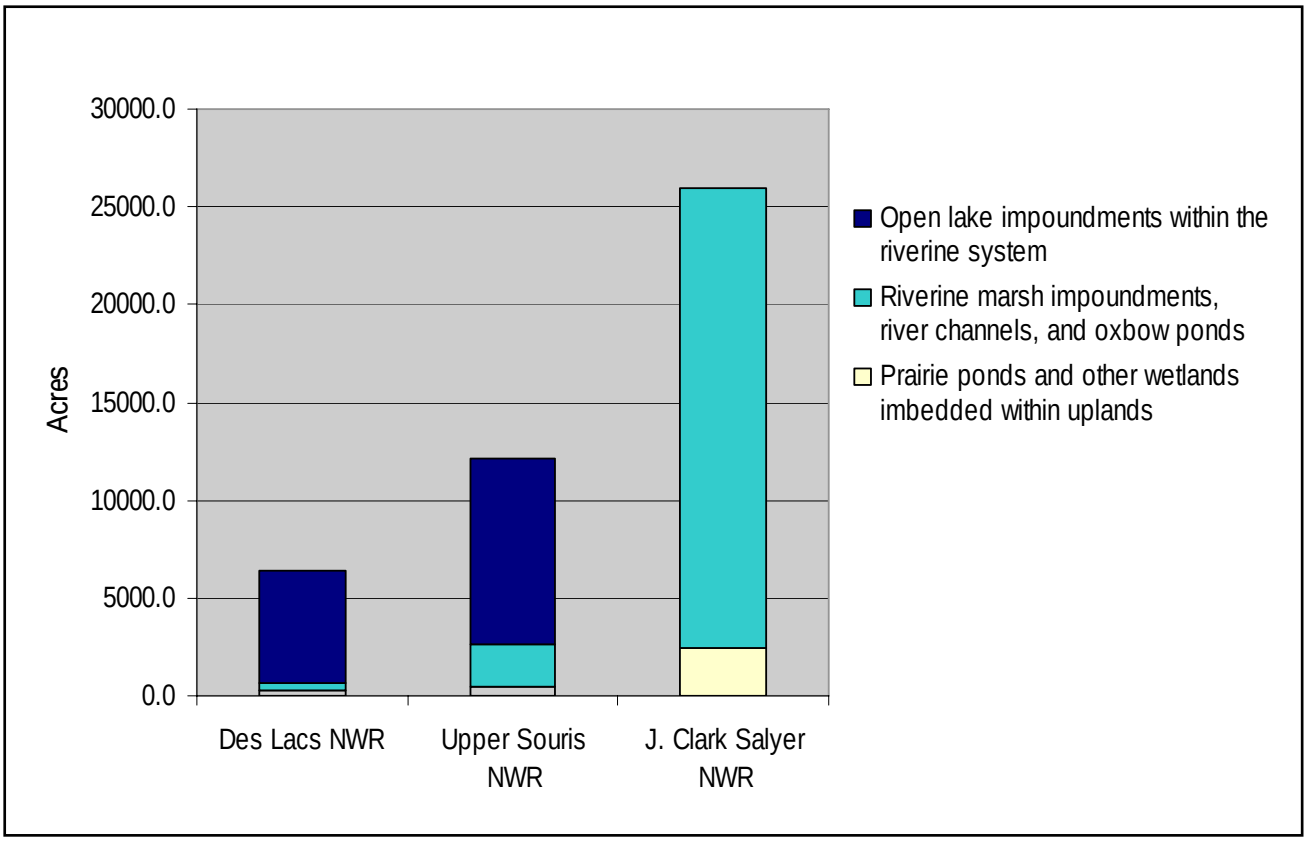

Figure 15. Extent of three wetland types at each of the Souris River basin refuges, North Dakota.

The downstream portion of the Souris River drainage, including J. Clark Salyer NWR, lies within the Souris Lake Plain physiographic subregion, a flat, deltaic outwash plain, bordered to the south and east by a series of sandhills. The Souris River is "under-fit" relative to the width of the valley floor, which exhibits many old oxbows, meander scars, and channel relicts.

Prior to settlement, the Souris River valley contained numerous riverine and palustrine marshes, maintained by periodic overbank flooding of the Souris River. With Euro-American settlement of the region, drainage significantly modified the Souris and Des Lacs rivers. This was most evident at J. Clark Salyer NWR, where stretches of the river were dredged and channelized to promote cultivation. River flows were unregulated until the 1930s. At this time, numerous low-head dams were constructed along the river to regulate flooding and carry out wetland management to benefit waterfowl at the three refuges. Because of these changes, few natural riverine wetlands remain at the Souris River basin refuges (excepting meadows on the southern one-half of J. Clark Salyer NWR).

Wetlands of Des Lacs NWR

Des Lacs NWR extends from the Canada border to 8 miles south of Kenmare, North Dakota. The refuge includes 5,695 acres of open water and 350 acres of emergent marsh along a 28-mile reach of the Des Lacs River (figure 15). The river's name was derived from the French, "Riviere des Lacs," literally, a "river of lakes." The floodplain of the present-day refuge historically included a series of three large basins that functioned at times like dynamic prairie lakes. At other times, it functioned like a broad, slow-moving river, overflowing into adjoining and downstream marshes and meadows.

Dikes were constructed in the 1930s to create eight impoundments. Maximum water depths in impoundments range from 5 to 12 feet; maximum storage capacity of all impoundments is 53,879 acre-feet. Each dike is equipped with water control structures to permit water level manipulations. However, control is limited for several reasons, as follows:

- The source of water is unregulated runoff from the surrounding watershed (350 square miles of which only 43% contributes runoff to the river). Water enters different refuge impoundments via five primary coulees on the west side of the refuge valley. Most runoff occurs during March and April, but severe summer thunderstorms also can contribute large volumes of water to refuge impoundments.
- Although the timing and amount of runoff received are not controlled, the construction of railroads on both sides of the floodplain has altered surface inputs to the impoundments. Historically, surface water transported by coulees to the river was unobstructed and entered the floodplain at various sites and velocities. In contrast, water from coulees obstructed by the railroad grade must now pass through ditches and culverts, which function to stabilize the location and restrict the velocity of water entering impoundments.
- Dikes were constructed perpendicular to the floodplain; thus, upstream impoundments can only be dewatered by transferring water through downstream impoundments. This challenge has been alleviated to some extent by constructing bypass channels around some impoundments (for example, impoundments 6 and 7). Finally, water movement is restricted by an area of higher elevation (1,777.6 feet above mean sea level) in the middle impoundment (impoundment 4, also known as Middle Des Lacs Lake) that creates a hump or "hinge-point" in the system. Surface water inputs from coulees north of this hump flow north, whereas surface inputs from coulees south of the hump flow south. Consequently, drainage of northern impoundments 1, 2, and 3 is difficult. Changing the elevation of the dikes is not possible due to potential damage to the railroad grade. Therefore, refuge personnel have attempted to achieve more control by constructing a new structure that prevents water in impoundment 4 from flowing north.

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Aerial View of Unit 6 (upper third of photograph) at Des Lacs NWR

The local water board has proposed altering flood control protocols to evacuate water from the Des Lacs River to the Souris River in spring. Although this may improve the ability of refuge staff to achieve water levels more desirable for plant production, it may imply that an additional purpose of the refuge is flood protection.

Wetlands of J. Clark Salyer NWR

J. Clark Salyer NWR extends from Canada south for about 50 miles along the Souris River in Bottineau and McHenry counties, North Dakota. The refuge includes 23,525 acres of impounded riverine marshes and 2,474 acres of river, oxbows,

and prairie marshes (figure 15). The watershed contributing to the refuge covers about 9,000 square miles, of which only 40% contributes runoff to the river.

During the early 1900s, attempts to farm and harvest hay from the area that is now the refuge were difficult due to frequent flooding. Therefore, previous landowners dredged channels to improve drainage. Following purchase by the Refuge System in 1935, the Service completed additional earthwork. This included construction of levees across the Souris River floodplain to retain water in five major impoundments, mainly to increase waterfowl production.

During the 1950s, and again in 1991–92, the heights of original levees were increased up to 2 feet to improve wetland management and as a mitigation measure for the Souris River Flood Control Project. Each dike was equipped with control structures to enable management of water levels. The addition of heated radial gates (around 1990) has provided more flexibility in discharging water from impoundments during winter. Flows exceeding 3,000–3,500 cubic feet per second are discharged over spillways constructed as part of the levee design. Maximum water depths in pools vary, but range from 4–6 feet.

Gary Eslinger/USFWS

Dam 1 at J. Clark Salyer NWR

The types of prior land modifications at J. Clark Salyer are similar to those already mentioned for Des Lacs NWR and Upper Souris NWR. In general, the construction of levees to impound and manage water has converted a dynamic lotic (flowing) system to a less dynamic lentic (nonflowing) system. The ability to manage this altered system is constrained by the existing physical infrastructure. During periods of high river flows, the river often transports a large volume of water. These flows must pass through refuge impoundments, but the channel capacity often is not sufficient to transport the water quickly or efficiently. Thus, marsh habitat within impoundments often becomes flooded for extended periods. Although this occurred naturally, upstream disturbances and increased runoff from wetland drainage have significantly altered the time and duration of these flows.

Another potential long-term change occurring in marshes at the refuge is increased deposition of sediment. Although the river potentially can transport large sediment loads into the marshes, drainage of numerous wetlands in surrounding agricultural land may elevate sediment loads (for example, Brander drain, Boundary Creek drain, Oak Creek drain, and White Spur–Stone Creek drain). A determination of sediment accretion rates is currently being made, but results are not available for inclusion in this draft CCP and EA. Based on qualitative sampling in 2003–2004 and on data collected for Sand Lake NWR, South Dakota (Gleason et al. 2003), it seems likely that accumulated sediments have significantly degraded the long-term productivity of refuge marshes and may continue to do so.

Wetlands of Upper Souris NWR

Upper Souris NWR follows a 35-mile reach of the Souris River in Renville and Ward counties, North Dakota. Wetland habitats total about 12,175 acres (figure 15), including the following:

- 9,575-acre reservoir, Lake Darling
- 58 acres of river
- 2,127 acres of riverine marshes with riparian woodlands
- 472 acres of dugouts, ponds, oxbows, and prairie marshes

The watershed for Lake Darling is 9,450 square miles, of which only 35% contributes runoff to the lake. The primary management objective for Lake Darling is to provide water, particularly during drier years, to marshes at J. Clark Salyer NWR located 237 river miles downstream. However, the reservoir also provides the water supply for downstream marshes at Upper Souris NWR. In addition, the reservoir provides 100-year flood protection for Minot, North Dakota (population 33,000).

In addition to Lake Darling, there have been numerous smaller impoundments created both above and below the reservoir by constructing earthen dikes equipped with water control structures. Some of these impoundments (pools A, B, C, 87A, 96A, and 96B) are located adjacent to the Souris River and pump stations are used to supply water. The Souris River runs through the remaining impoundments (Pools 41, 87, and 96). Water management capability varies among impoundments. Pools A, B, C, 87A, 87B, 96A, and 96B are isolated from the river and can be effectively managed. Many pools require that in-stream pools be lowered before they can be drained.

Sanford Rostad/USFWS

Pool C at Upper Souris NWR

Lake Darling is part of the Souris River Flood Control Project, which includes three dams in Saskatchewan. Collectively, these structures provide 100-year flood protection for Minot, North Dakota. An international agreement and an agreement with USACE stipulates that the Service will control discharges from Lake Darling dam unless the magnitude of the flood exceeds a 10-year event. In addition, drawdowns of Lake Darling are mandatory, to prepare for floods up to a 100-year event.

The construction of Lake Darling Dam and other dams on the river have resulted in numerous effects on natural resources, both positive and negative. Compared to pre-dam conditions, flows in the river have been greatly altered. Peak flows have been lowered, whereas the duration of low and moderate flows has increased. Flow releases to benefit different natural resource components often conflict, particularly during periods of extreme or extended drought and flood, as follows:

- Although the international agreement states that flood control dams are to be operated in a manner that mimics natural conditions to the extent possible, the timing of flow releases from upstream dams in Saskatchewan is often later than historical river flows.
- Management of Lake Darling is further constrained by an agreement to supply irrigation water (10,000 acre-feet) to the Eaton Irrigation District, and by minimum flow requirements at the international boundary near Westhope, North Dakota.
- Additionally, the capacity of the channel and structures in Minot to readily pass high flows complicates releases of water from Lake Darling. Subsequently, the water level in Lake Darling can fluctuate above desired levels.

Siltation rates probably vary among refuge wetlands. All drainages except the 12-mile-long Mackabee Coulee are short (<2 miles long). Much incoming silt carried by the Souris River appears to be trapped in pool 41 above Lake Darling. Lake Darling appears to receive some siltation from erosion of high banks surrounding the reservoir that occurs from wave action when the lake is high.

The Wetland Cycle

There have been no formal surveys of marsh vegetation at the Souris River basin refuges since the 1940s and 1950s, except for a recent study of sago pondweed at Des Lacs NWR (Euliss et al. 2003).

The impact of altered river flows has influenced sediment distribution, water quality, and plant community dynamics. The purpose of levee construction at all three refuges was to restore and enhance previously degraded wetlands. At the time of refuge establishment in the 1930s, lack of water was considered the primary limiting factor (Henry 1939, Steenis 1939). This is not surprising given this was the Dust Bowl era and human developments and agriculture had disrupted floodplain functions.

Installation of water control structures indicate that the need for water removal was necessary, but engineers of the original structures may not have considered the need for complete dewatering of refuge impoundments. Although successful in providing resources for wildlife, the construction of in-stream obstructions in the floodplains of both rivers, coupled with human disruptions to the floodplain, started to change fundamental wetland processes. The frequency and magnitude of different flow events changed (for example, minimum flows increased and peak flows decreased) and the channels of both rivers started to become laterally stabilized and entrenched. As a result, the frequency, duration, and extent of flooding were altered and likely became less dynamic. For example, compared to historical conditions, the areas impounded by levees obviously were designed to flood with greater frequency and for longer durations. In addition, changes in runoff and flow impacted sediment transport and deposition. In combination, these two factors are important in the creation and loss of riverine wetlands.

The levees constructed at each refuge created new, permanent areas of high- and low-flow velocities. This often has numerous impacts that affect long-term productivity of riverine systems. For example, the rate and number of new wetlands that are formed is reduced because scouring and deposition occurs repeatedly in the same areas. The creation of new wetlands is important because initially they tend to support annual plants and invertebrates capable of rapid colonization. Thus, they are important in providing wetland diversity needed for survival of many wetland-dependent species such as amphibians, reptiles, and birds. In addition, the location of sediment accumulation tends to become more stationary. As sediment depth increases, numerous

factors critical to proper wetland function often are impacted, including soil properties, nutrient cycling, invertebrate egg banks, seed banks, and plant community composition. Eventually, wetlands that are sediment traps tend to become dominated by a reduced diversity of plants and invertebrates capable of tolerating a rather constant set of abiotic conditions.

Data collected at J. Clark Salyer NWR between 1940 and 1960 suggest that many of the above changes started to create new management challenges as the drought ended and a wet period began. In a report covering the period 1946–56, it is stated that "annual floods prevented the attainment of complete plant succession from marsh to dry-land species which had been desired at higher elevations" (Hammond, no date). This report further states that areas (primarily sloughs and oxbows) at elevations below 1,415 (elevation datum not provided) were never exposed during this period and that most had "silted in greatly" during the years of high water levels.

In 1951, a refuge report on marsh and waterfowl management at Lower Souris NWR (later renamed J. Clark Salyer NWR) states that "sediment accumulation in open water bay sloughs, channels, borrow pits, and all open water areas not covered by sod, or exposed to periodic drying or wave action, had developed a deep muck bottom" (Hammond [no date]). This report also mentions that periodic drawdowns were being conducted, but implies that success was dependent on time and magnitude of river flows. Other conditions that had developed by this time included concern regarding the extensive expansion of cattail, river bulrush, and common reed (anonymous 1962), as well as relationships between algal blooms, pondweed production, and botulism (Hammond 1961, 1962). Similar records were not located for Des Lacs NWR and Upper Souris NWR. However, many of the same challenges likely occurred at all three refuges, because a river flows through impoundments at each refuge and individual impoundments cannot be independently flooded or dewatered.

Since the 1950s, there have been numerous, additional disturbances within the Souris River basin that have further altered the dynamic flow regimes once characteristic of the Souris and Des Lacs rivers. This includes additional dams and an international agreement that regulates river flows and water quality, along with continued human development. An example of an altered flow regime is where the average annual runoff at Sherwood, North Dakota, was 73,170 acre-feet between 1929 and 1968, but increased to more than 208,000 acre-feet (184%) between 1969 and 1975 (Ulrich and Pfeifer 1976). Although such increases are due in part to precipitation cycles, another cause has been major land use changes in the watershed (Ulrich and Pfeifer 1976). For example, wetland drainage and conversion of grasslands to cultivated cropland has likely increased runoff contributed by watersheds.

Given the history of changes and current conditions within the Souris River and Des Lacs River watersheds, one of the challenges that must be addressed if management goals are to sustain long-term productivity is the ability to manage water to promote natural marsh cycles. Short- and long-term hydrologic conditions affect many abiotic factors. Water fluxes affect nutrient cycling by determining the type and quantity of nutrients that enter and exit wetlands and influencing decomposition rates (Livingston and Loucks 1979). Hydroperiod affects water quality and soil conditions (Mitsch and Gosselink 2000). These abiotic conditions in turn influence biotic components including the composition, distribution, and productivity of wetland vegetation (van der Valk and Welling 1988, Squires and van der Valk 1992) and invertebrate community composition and structure (Kadlec 1982). Ultimately, vertebrate use of wetlands is directly and indirectly affected by hydrology (Weller and Spatcher 1965, Weller and Fredrickson 1974, Laubhan and Roelle 2001).

Currently, refuges have difficulty removing water from impoundments and drying soils sufficiently to (1) promote establishment of annual vegetation, or (2) control the encroachment rate of perennial vegetation such as cattail and bulrush. Therefore, vegetation tends to cycle rapidly between open water and dense stands of perennial emergents. The root of this problem may be the inability to reliably dewater impoundments during the growing season because of the following:

- The volume of water entering the refuge is frequently outside the control of the refuges.
- Water entering the refuge cannot be diverted from marshes because the river flows through each impoundment.
- Management actions such as drawdown of one impoundment constrains management options at other impoundments.

All three refuges have attempted to dewater impoundments and, when accomplished, the seed bank responds in large portions of many impoundments. This suggests that the seed bank is still viable. However, the ability to reliably conduct complete drawdowns at the correct time is limited. Consequently, maximum productivity potential of impoundments is often not attained. Upper Souris NWR appears to have the greatest capability to control water during the growing season, but only in a few impoundments (collectively <2,000 wetland acres). In contrast, J. Clark Salyer NWR and Des Lacs NWR often attempt to dewater select impoundments, but success is hindered by the inability to move flows through impoundments without unintended flooding of marsh substrates.

The importance of dewatering and drying soils described above is based on an important paper describing a model of wetland plant succession that was developed by van der Valk (1981). According to this model, wetland plants can be divided into groups based on life span (annual, perennial with limited life, or perennial with unlimited life), propagule longevity (short or long), and requirements for propagule establishment (drawdown, surface water). Annual plants generally have long-lived propagules that are contained in the seed bank and, following a drawdown, production of seeds can be large. However, if the wetland remains saturated or flooded for more than a year, the abundance of annuals typically decreases because they are incapable of germinating in water. In contrast, perennial vegetation tends to increase because these species can propagate by rhizomes as well as seeds, and can tolerate deeper water. Through time, particularly under stable water regimes, perennial plants capable of reproducing by rootstocks (such as cattail and bulrush) will begin to dominate the wetland plant community. In many cases (such as the Souris River basin refuges), dense, monotypic stands of robust vegetation develop throughout the basin and a decline in productivity eventually occurs.

In northern temperate wetlands, the feeding and house-building activities of herbivores such as muskrats and beaver are extremely important at this stage in the cycle. These activities, in conjunction with water level fluctuations, function to create openings in the marsh and facilitate the production of annuals when the next drawdown occurs. At the Souris River basin refuges, however, the inability to conduct complete drawdowns appears to create conditions that either facilitate the creation of large open water bodies or cause rapid recolonization of perennial vegetation. Thus, marshes often do not exhibit the critical dry portion of the marsh cycle that facilitates oxidation of soil and stimulates annuals to germinate.

Characteristic Wildlife

The importance of the Souris River basin refuges for waterbirds has been widely recognized since acquisition of the areas. For example, following impoundment development in the 1930s, the waterfowl response at J. Clark Salyer NWR was tremendous. During the first 3 years of management, nests of 22 species were documented for the first time at the refuge. By 1939, a total of 112 nesting species had been documented (Henry 1939).

Currently, the refuges provide food and breeding habitat for thousands of migrating and nesting waterfowl. J. Clark Salyer NWR, in particular, has developed into one of the most important duck production areas in the United States. The refuge also provides habitat for numerous other bird species including shorebirds, grebes (five species), and wading birds. Based on the most recent bird list available, the refuge has documented 160 nesting species.

Donna Dewhurst/USFWS

Green-winged Teal

The American Bird Conservancy recognizes all three refuges as "Globally Important Bird Areas." In addition, J. Clark Salyer NWR has been designated as a regional shorebird site in the "Western Hemisphere Shorebird Reserve Network." Lake Darling is designated critical habitat for the federally threatened piping plover.

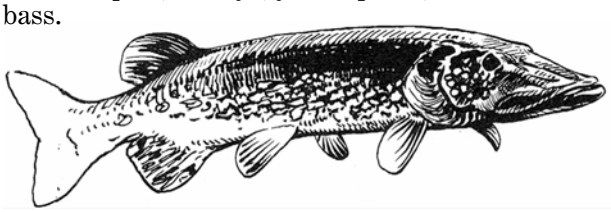
The Souris River basin refuges support high densities of dabbling and diving duck species, especially during years with favorable wetland conditions. J. Clark Salyer NWR and the upper end of Lake Darling at Upper Souris NWR are especially important as a molting refuge for dabbling ducks. The Souris River basin is within the core breeding range of most dabbling duck and several diving duck species, including mallard, northern pintail, gadwall, American wigeon, green-winged teal, blue-winged teal, northern shoveler, redhead, canvasback, lesser scaup, and ruddy duck.

The Souris River basin provides significant breeding and migration habitat for more than 200 other bird species. Important wetland species that breed in the area include Franklin's gull, yellow rail, piping plover, Wilson's phalarope, marbled godwit, American avocet, American bittern, and five species of grebes.

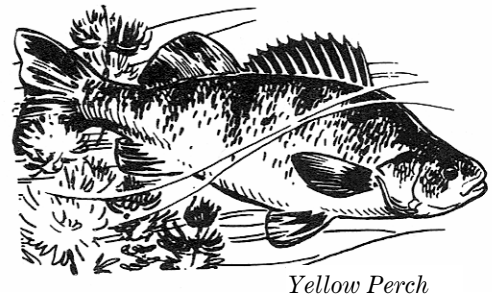
Wetlands in the region also provide important migration habitat for the following:

- waterfowl such as tundra swan and snow goose
- waterbirds including sandhill crane
- shorebirds such as Hudsonian godwit, American golden-plover, white-rumped sandpiper, and buff-breasted sandpiper

Other important vertebrates include muskrat, mink, painted turtle, snapping turtle, chorus frog, and tiger salamander. In addition, Lake Darling at Upper Souris NWR supports a fishery that includes northern pike, walleye, yellow perch, and smallmouth bass.



Northern Pike
Bob Hines/USFWS



Yellow Perch
Bob Hines/USFWS

Islands

All three Souris River basin refuges have islands.

Physical Environment

Construction of artificial islands is a management technique used in the Prairie Pothole Region to overcome the loss of upland nesting habitat.

Eight 0.5-acre islands were created in the early 1990s at Des Lacs NWR (four in each of 115-acre impoundment 6 and 400-acre impoundment 7 [lower Des Lacs Lake]). The latter were improperly designed and became mostly to completely submerged during reflooding of the pool in the mid-1990s.

At J. Clark Salyer NWR, more than 50 nesting islands, ranging in size from 0.6 to 3.0 acres, were constructed in the 1930s, 1950s, and 1970s. Islands were constructed in four large (4,000- to 5,000-acre) impoundments (pools 320, 326, 332, and 341) and in hay meadows east of the Rubble Masonry Unit. Additionally, a 7-acre natural island (Ding Island) is located in pool 320. All islands were constructed using a dragline or bulldozer or both to borrow fill adjacent to the site. Many islands were rehabilitated in the 1990s and were riprapped with fieldstone to reduce erosion.

At Upper Souris NWR, 28 islands have been constructed. Islands average about 0.6 acre each and are found in six impoundments (41, C, 87A, 87B, 96, and 96B). The two largest islands (2 acres each) are located in pools C and 96.

Characteristic Vegetation

The makeup and density of plant cover varies significantly among islands. The average cover on islands at J. Clark Salyer NWR follows:

- 18% low shrubs (western snowberry and Woods' rose)
- 38% introduced grasses (mainly smooth brome and Kentucky bluegrass)
- 23% tall, weedy forbs (stinging nettle, mustard, Canada thistle, and absinth wormwood)
- 9% leafy spurge
- the remainder is bare ground, rock, or emergent vegetation such as common reed and cattail

Low shrubs attractive to ducks as nest sites have been hand-planted and may need to be periodically replanted because of flooding or due to clipping by meadow voles during winter. Planted stands of DNC (wheatgrasses, alfalfa, and sweetclover) are short-lived (7–10 years), and often invaded by smooth brome, Kentucky bluegrass, and weedy forbs. Over time, grazing by Canada geese can shift island cover from grasses to weedy forbs.

The makeup and density of plant cover on islands at Des Lacs NWR and Upper Souris NWR is roughly similar and as variable.

Wildlife Use of Islands

Waterfowl use of nesting islands at J. Clark Salyer NWR has been intensively studied (Hammond and Mann 1956, Duebbert 1966, Aufforth et al. 1990, Willms and Crawford 1989). However, most of these studies were conducted over 2 years on a subset of islands. In 1992–94, a more comprehensive study was conducted on 30 nesting islands located in impoundments 320, 326, and 332 and under variable water levels (Grant and Shaffer, unpublished data). Gadwall was the most common nesting duck, accounting for 50–60% of nests. Gadwall, mallard, and blue-winged teal accounted for 90% of all waterfowl nests in this and previous island studies at J. Clark Salyer NWR. Less common were Canada goose, northern pintail, northern shoveler, lesser scaup, American wigeon, redhead, canvasback, and ruddy duck. Double-crested cormorant, American avocet, and ring-billed gull nest on islands occasionally.

Nests on islands at Des Lacs NWR are mostly of mallard, gadwall, and Canada goose. Canada geese

have been observed nesting on islands at Upper Souris NWR.

Nest densities are higher on islands that have (1) predators controlled; (2) a large, surrounding, open-water barrier; and (3) extensive cover of low shrubs or leafy spurge (Grant and Shaffer, unpublished data). Nest survival can be greater than 75% (apparent survival), especially following winter drawdowns in conjunction with predator removal. Deep water and an extensive unvegetated barrier around an island discourage mammalian predators from reaching islands. Mink are a significant predator of island-nesting ducks and can seriously impact nest and hen survival (Grant and Shaffer, unpublished data). Once nesting begins, mink are especially difficult to remove by trapping. Striped skunk, raccoon, and red fox also cause nest losses but are more readily controlled. Gulls occasionally prey on eggs and ducklings.

Islands are expensive to build ($30,000 per acre) and maintain. Long-term maintenance costs were not factored into original construction; island repairs and rehabilitation have significantly inflated the cost-to-benefit ratio of island construction. Many islands that were built at J. Clark Salyer NWR in the 1930s during impoundment construction are rarely used by nesting waterfowl because they fail to deter predators that come from the mainland. These islands are perennially surrounded by dense stands of emergent vegetation, occur in shallow water, or are too close to the mainland.

Cultural Resources

The Service is responsible for managing archaeological and historical sites found on refuge lands.

Prehistoric Background

Because of the limited nature of the archaeological work that has been conducted to date, much of the understanding of the area's prehistory is drawn by inference from surrounding areas. This document gives details of the various cultural traditions and complexes that are present or potentially present within the Souris River basin, particularly that portion of the Souris River valley in North Dakota upstream of the city of Minot.

Artifactual evidence exists for the presence of prehistoric peoples in and near the Souris River valley in North Dakota from Paleo-Indian times (9500–5500 BC) to early historic times. The Paleo-Indian tradition is characterized by a variety of hunting and gathering adaptive strategies, each with a strong focus on big game. Due to the limited amount of archaeological excavations in this area however, evidence for the presence of particular cultural complexes and traditions comes primarily from a small number of surface-collected diagnostic artifacts.

Rhoda Lewis/USFWS

Remains of a Prehistoric Campground in the Souris River Basin

Ethnographic (descriptive of cultures) accounts indicate that the Assiniboine, Sioux, Mandan, Hidatsa, Plains Ojibwa, and Atsina peoples all made use of the Souris River region of North Dakota for hunting or trade route purposes. Although the area has a rich cultural heritage, few sites have been formally identified.

The Souris River basin refuges are within a relatively unresearched archeological area in northwestern North Dakota. The closest site to be excavated is about 40 miles west of the northern boundary of Des Lacs NWR at Long Creek near Estevan, Saskatchewan, in Canada. Excavation at Long Creek was sponsored by the Saskatchewan Museum of Natural History in 1957 and was reported in 1960 (Wettlaufer and Mayer-Oakes 1960). The Long Creek site revealed occupation by as many as nine separate cultures dating back to 3043 BC ±125 years. Because of the near proximity of the Long Creek site and the then-interconnecting of the Souris and Des Lacs rivers and the Long Creek flowage, it is reasonably safe to assume that at one time or another all of the nine cultures were present in the Des Lacs River valley.

Historical records indicate that the last inhabitants of the Des Lacs River valley, before Euro-American settlement, were the southern Assiniboine tribes, who now reside in Canada. Many known sites exist at the Des Lacs NWR where Native Americans occupied the area either in permanent or transient camps and more may be present but undiscovered. Sites commonly contain tipi rings and one site contains several turtle effigies with what are apparently rock-lined fire pits in the center. During drought years when water levels in the Upper Des Lacs Lake recede, large quantities of bison bones are visible on the beaches and shoreline adjacent to one site.

Early Exploration

Among the earliest accounts located for the Souris River region is an article that recounts a journey by Alexander Henry in the summer (June 14–August 9) of 1806 (Billeck 1990). Gough (1988) bases the article on a transcription of Henry's 1,642-page journal. The general route traveled was from the confluence of the Assiniboine and Souris rivers to near the confluence of the Knife and Missouri rivers. On the outbound portion of the trip, Henry headed southeast and crossed the Souris River valley to near present-day Minot, North Dakota. On the return portion of the trip, the Souris River was crossed near present-day Verendrye and again at Willow Creek.

Billeck (1990) indicated that at least part of the Souris River area was a buffer zone, which is a contested area between Native American tribes. In this case, the buffer zone separated the Assiniboine and Sioux. Buffer zones are characterized as supporting higher game populations because the area was not settled and was exploited only by hunting parties at high risk (Hickerson 1965). Henry's journal frequently mentions the abundance of game. For example, on August 1, 1806, Henry describes "thousands of buffalo [American bison]" while overlooking the Souris River valley from the Missouri Coteau. On August 3, 1806, Henry crossed the Souris near Verendrye and reported the river was "well stocked with red deer, moose, deer, antelope [pronghorn], and buffalo."

The first accounts of Euro-American contact with Native Americans occurred in 1738 when Verendrye traveled between Fort LaReine on the Assiniboine River to the Missouri River (probably near either present-day Bismarck or Minot, North Dakota) (Robinson 1966, Schweigert 1990). Organized fur companies such as North West Company, Hudson's Bay Company, and American Fur Company and independent trappers traded with Native American tribes between 1780 and 1850. However, major trading posts apparently were never established in the middle Souris River region of North Dakota (Schweigert 1990). Similarly, between the 1850s and 1880s, there were several military and civilian expeditions through the area, but again settlements were not mentioned (Schweigert 1990).

Although speculative, the journal kept by settler Henry A. Boller suggests that he and his party crossed the Des Lacs River at a point south of the southern end of Middle Des Lacs Lake and camped at the Assiniboine encampment approximately 5 miles east of the river valley. Whatever the case may have been, it is certain that Boller traveled through the Des Lacs River valley in 1858, several decades before the rapid and widespread settling of the area by Euro-Americans.

Boller's accounts of his journey to the Des Lacs River valley paints a picture of a vast and continuous landscape devoid of trees, but alive with life. Shortly after departing Fort Atkinson, Boller characterizes their route as "uninteresting ... high rolling prairie, totally destitute of timber." Again, making reference to an unforested landscape, Boller notes that out of necessity of "there being no wood within miles," he and his party were "busied in collecting dry buffalo chips" to provide fuel for their evening campfires.

Although Boller continued to characterize his route to the Des Lacs River valley as "a most barren and uninteresting country," the wildlife seemed to be overly abundant. Boller notes that the "buffalo were plenty ... wild fowl were present in countless numbers ... plenty of ducks could be obtained with but little trouble ... [wolf] forms could everywhere be seen sneaking over the adjacent hills." Again, in reference to the abundance of bison in the area, Boller noted that the country "abounded in innumerable lakes or ponds of stagnant water, and all more or less highly flavored with buffalo urine." Boller also made special mention of a grizzly bear that was sighted "a short distance from the line of march."

Boller's first and only reference to the presence of trees came on his party's approach to the Des Lacs River. It seems, however, that these trees did not make a big impression on Boller as they were not mentioned again in his journal. Boller described the trees as "a dark line" that "marked [their] approach to a running stream, the River of Lakes." From his brief description, the trees appeared to be no more than in a narrow line along the river edge. Boller also enthusiastically mentions that the river "had a hard rocky bottom, making a very good crossing," which according to Boller was "a wonder in this part of the country."

After crossing the river and "toiling up the steep and stony bluffs on the opposite shore ... reach[ing] a broad plateau", Boller's party was "strung out over the prairie" with "the conical skin lodges [of the Assiniboines] ... now plainly in sight, not more than five miles off." Boller describes the Assiniboines encampment as "in the middle of an open plain without a stick of timber in sight ... large bands of buffalos were in plain sight from the encampment ... the whole country seemed fairly alive with moving herds ... the proximity of the herds and the abundance of meat in the camp [made] the [Assiniboines] dainty in their selections."

Alexander Henry's 1806 journey from Fort Souris across the Souris River valley and Missouri Coteau to villages on the Upper Missouri River brought him into the vicinity of the Des Lacs River valley, thus providing another invaluable early description of the area's landscape. On reaching the Des Lacs

River valley, most likely near the confluence of Des Lacs and Souris rivers, Henry described a landscape of "steep hills ... covered with huge stones" and "low valleys in continual succession ... there [was] no wood of any kind" (Coues 1897). After continuing his trek across the valley, Henry and his party soon spotted a "cluster of wood at the N. extremity ... of a long lake running N. and S." (Coues 1897). According to Henry, this came as a surprise to his guide, "who said he never knew of any wooded lake in this plain" (Coues 1897). Henry also noted the "thousands of buffalo which covered the plains" (Gough 1988).

Early Settlement

The first settlements began to appear in the early 1880s. The town of Scripton (near Velva) was established in 1882 and settlement of the Souris Valley upstream from Minot occurred in 1883. These initial settlers were ranchers that claimed lands in the Souris and Des Lacs river valleys for exclusive use by cattle and forage production (Stammen 1978).

A lignite mine was established near Burlington at the mouth of the Des Lacs River; by 1883, 12,000 pounds of lignite had been excavated. The 1885 Census of Dakota Territory listed 31, 257, and 800 people living in what would become Renville, Ward, and McHenry counties, respectively (Schweigert 1990). In Ward County, 600 head of cattle and 1,093 acres were planted to crops in 1884, and census records indicate there were 280 farms in McHenry County.

In 1886, extension of the Great Northern Railway from Devils Lake to Minot (Robinson 1966) was initiated. Following completion, the area was more accessible for settlers and both the Souris and Des Lacs river valleys filled with people. In 1893, the Soo Line was established from Minot north to Portal at the Canada border, part of which runs through present-day Des Lacs NWR for 12.6 miles. The Great Northern Railway extended a track that ran parallel to the Souris River from Granville to Sherwood. In 1905, the Soo Line constructed a rail from Oslo, Minnesota, to Kenmare that crossed the Souris River south of Greene (Schweigert 1990).

Towns developed at regular intervals along these lines and, by 1905, nearly every quarter section (160 acres) of land in north-central North Dakota had been claimed. At this time, Minot had a population of about 10,000.

The Des Lacs River area was part of a vast cattle range that extended from Texas to the Canada border. Thousands of acres were ranched, as the lush prairie grasses of the area provided excellent pasture for finishing of cattle. In 1894, more than 125,000 head of cattle were trailed overland from the Chinook and Malta, Montana, area for shipment at Spiral, a major cattle-shipping center located a few miles northwest of the Des Lacs NWR headquarters along the Soo Line. Sheep were grazed in the hills and coulees in the areas to the west and southwest.

The first major influx of Euro-Americans into the Des Lacs River area began in the early 1890s near the present city of Kenmare. However, evidence indicates that a rancher settled the area in 1864 and the first lignite coal mine opened in 1880. Accounts left by one early rancher, Andrew McBride, relates that in 1892 there were only three other settlers within a 20-mile radius of his homestead, located at the southern end of Middle Des Lacs Lake. The coming of the railroad in 1893, however, opened up the area to settlement, although the development of town sites and the arrival of immigrants did not begin until after 1896.

The land in Kenmare was first opened to homesteaders in July 1896 and was incorporated as a village in 1901. In 1897, Kenmare took on the appearance of a booming frontier town with 1,200 cars of settlers arriving and the establishment of livery stables, restaurants, saloons, and other area businesses. The area was also a trade center for grain shipping and the terminal point for a short-lived river barge business. Navigation of the Upper Des Lacs Lake was begun in 1903 in a sternwheeler; barges were used to ship grain to a point near Kenmare to be unloaded and shipped via the Soo Line railroad. In 1904, records show that A.A. Robinson hauled about 200,000 bushels of grain on the boat to a site near Kenmare and loaded it onto the Soo Line Railroad.

The 1890s marked the beginning of a major transformation of the landscape in the Des Lacs River valley. Decades of activities associated with Euro-American settlement has resulted in dramatic changes in the composition and abundance of the area's native fauna (for example, bison were extirpated) and flora (for example, increases in woody and brushy vegetation). Fortunately, detailed records were taken of the vegetation and wildlife of the Des Lacs River valley, particularly near Kenmare, in the early years of settlement.

George K. Dike came to the Des Lacs River valley area in September 1895. Dike's survey notes

described a prairie country, although noting the occurrence of trees and brush in coulees and along lakeshores. The photographs of E.H. Gross corroborate Dike's surveys and provide convincing evidence of the scarcity of trees in the Des Lacs River valley, especially near Kenmare, in the early 20th century. Vernon Bailey's field reports (1913) of the flora and fauna of the Kenmare and Des Lacs River valley area from July 1913 also suggested a prairie landscape, but included areas of dense woodland. According to Bailey (1913), the Kenmare area in 1913 was "rolling prairie ... [with] numerous coulees ... many of [which were] densely wooded or full of brush." He also noted the deliberate planting by farmers of trees such as boxelder and willow as windbreaks (Bailey 1913).

Although the landscape was being rapidly modified by agricultural and mining activities during the early 1900s, the bird fauna still appeared to be thriving in the Des Lacs River valley. According to Bailey's field notes, ducks, especially northern pintail, mallard, blue-winged teal, and northern shoveler, were abundant, as well as many other waterbird and shorebird species (Bailey 1913). More importantly, however, were Bailey's numerous accounts of species sensitive to woody growth and other invasive vegetation. This suggests that the grasslands surrounding the Des Lacs River valley in the early 1900s were of higher quality than those of today. The prairie-adapted species documented by Bailey (1913) included the northern harrier (common), Swainson's hawk (common), ferruginous hawk, greater prairie chicken (common), upland sandpiper, burrowing owl, short-eared owl (common), Baird's sparrow (common), and grasshopper sparrow (common). Conversely, certain species that were not very common during Bailey's survey in 1913 (such as the ring-billed gull, double-crested cormorant, and American white pelican) are currently common and abundant at the refuge.

Civilian Conservation Corps and Works Progress Administration

The election of Franklin Roosevelt as president in 1932 unleashed a host of programs aimed at stemming the Great Depression cycle. These programs were meant to build the nation's infrastructure to support the failing economy and to overhaul the methods that had lead to the disastrous conditions.

Roosevelt was a strong advocate for conserving natural resources and felt strongly that the federal government should take an active role in the nation's economy. His somewhat romantic sentiment was turned into several broad-brush executive orders to create work programs with a strong central conservation ethic. Five days after taking the oath of office, President Roosevelt called a conference with the secretaries of Agriculture, Interior, and War. The president discussed his ideas for recruiting 500,000 men to work in the nation's forests and eroded farmland.

The CCC was legislated, followed several months later with an executive order setting up the development of the Works Projects Administration (later renamed Works Progress Administration). Both programs contributed to the Depression-era development of the Souris River basin refuges. The men labored for months and years to build the headquarters, roads, dams, and recreation facilities that survive today and are an integral part of the refuges.

Camp Des Lacs was located at Kenmare, North Dakota. The camp was part of the 797th Company of the CCC; its official army name was Camp Sam G. Anderson. Camp Des Lacs was one of four CCC camps operating under the U.S. Bureau of Biological Survey, in the restoration and development of four migratory waterfowl refuges in the northwestern part of North Dakota. The camp was established to carry on the restoration and development of the Des Lacs and Lostwood migratory waterfowl refuges.

The CCC built almost all the present-day patrol roads, dams, and spillways at Des Lacs NWR. Several structures still remain including the cinderblock residence, cold storage building, well house, Tasker's Coulee picnic shelter, and Northgate rubble dam. In addition, the CCC built fences, planted trees, and transplanted emergent vegetation.

The 796th Company of the CCC was assigned to Camp BF-1 (known as Camp Maurek, located at Upper Souris NWR) and Camp BF-5 (known as Camp Heintzelman, located at Mohall). The camps operated from May 1935 to October 1941. A Works Project Administration workforce was employed at the Upper Souris NWR from December 1936 to November 1939, and for a short time in 1940.

At Upper Souris NWR, the CCC laborers helped build miles of truck roads, diversion ditches, spillways, waterfowl-nesting islands, and fish-spawning habitat. Crews from the CCC and Works Progress Administration cleared the area to be flooded by Lake Darling of fence materials, farm buildings, and trees that lined the river channel. Contractors built dams 83 (Lake Darling), 87, and 96. The CCC crews assisted by building spillways, culverts, bridges, and water control structures using quality masonry in which local fieldstones were incorporated. (Speulda and Lewis 2003).

The 766th Company of the CCC was assigned to Camp BF-4; after temporarily locating near Bottineau, the company was moved to a location west of Kramer. The camp was commonly known as Camp Ding, after J. Ding Darling. The CCC were stationed at the refuge from 1935 to 1942.

At J. Clark Salyer NWR, the company built dikes and miles of roads and fences; collected wildflower, grass, tree, and shrub seeds; planted trees; and installed many other wildlife habitat facilities. A Works Progress Administration workforce was also employed at the refuge from 1936 to 1941 and assisted the CCC with their projects.

Historical Sites

There are a limited number of sites at J. Clark Salyer NWR eligible for listing in the Register of Historical Sites. They are dams 1, 320, 326, 332, 341, and 357. There are many farmstead sites at the refuge but the exact locations are unknown at this time.

Special Management Areas

There are several, officially designated, special management areas in the Souris River basin refuges:

- The American Bird Conservancy recognizes each of the three refuges as a globally important bird area. The important bird area program, initiated by BirdLife International in Europe during the mid-1980s, was developed to recognize and support sites significant to bird populations. Based on the criteria developed by BirdLife International, an important bird area must maintain and support one or more of the following: (1) species of concern (for example, threatened and endangered); (2) restricted-range species; (3) species vulnerable because of population concentration; and (4) species vulnerable because they occur at high densities due to their congregative behavior.
- The auto tour route at the Des Lacs NWR is designated as a national scenic backway. The route starts at the south end of the refuge on the east side of the lake and proceeds north 6.5 miles to a point just south of Kenmare. The route then proceeds through Kenmare for 2.2 miles. The backway starts again on the south end of Boat Dock Road, 1 mile north of Kenmare. The route then proceeds north 5 miles on the west side of Upper Des Lacs Lake, until it exits the refuge and joins into Ward County Road 1.
- The Munch's Coulee Hiking Trail at Des Lacs NWR was designated as a national recreation trail in June 2005. The trail is located adjacent to the Lower Des Lacs Lake, situated just off the national scenic backway. The trail has an accessible hard-surfaced lower section that is 0.25 mile long. The foot trail is a loop on top of the bluffs overlooking the river valley.
- J. Clark Salyer NWR has been designated as a regional shorebird site in the Western Hemisphere Shorebird Reserve Network.


USFWS

Munch's Coulee Hiking Trail at Des Lacs NWR

- Lake Darling at Upper Souris NWR is designated critical habitat for the piping plover, a shorebird listed by the Service as threatened in the northern Great Plains.

Visitor Services

Each of the Souris River basin refuges supports a variety of the priority public uses identified in the Improvement Act.

Des Lacs NWR

The Des Lacs NWR provides visitors opportunities for five of the six priority public uses identified in the Improvement Act. Fishing is not allowed as there is no sustainable fishery population. Most activity centers on hunting and wildlife observation. Yearly visitation is approximately 11,000.

Hunting

The hunting program provides opportunity to hunt deer, turkey, pheasant, gray partridge, sharp-tailed grouse, cottontail, snowshoe hare, and fox. Many hunters request waterfowl hunting and are referred to other public lands or to private lands, as waterfowl hunting is not permitted at the refuge. A hunting "tear sheet" provides information, regulations, and a map for a variety of game seasons. Some aspects of the hunting program follow:

- Turkeys are hunted in the spring and fall.
- Upland game is permitted in late-November to early January annually, after deer rifle season closes and waterfowl have generally migrated out of the area.
- Deer hunting is permitted for archery, rifle, and muzzleloader hunters in accordance with state seasons. Archery season opens in early September, rifle season in early November, and muzzleloader season in early December. No special regulations exist except to have a unit tag. Youth deer hunting is allowed and

encouraged at the refuge during the September season.

- The Canada Goose Trail, White-tailed Deer Trail, and Boat Dock Road to Highway 52 are open for game retrieval access with vehicles during rifle deer season. Deer hunters are able to retrieve game during designated times posted at these locations, to encourage hunters to walk to access more remote areas of the refuge.
- Requests for accessible hunting permits (to shoot from vehicles) are evaluated for hunters with disabilities and are generally allowed.
- The use of dogs is permitted for upland game hunting only.
- No field trials or shooting ranges are permitted at the refuge.

Fishing

Fishing does not occur at the refuge.

Wildlife Observation and Wildlife Photography

An auto tour route is part of a system of North Dakota's scenic backways and byways. The route traverses 14 miles along Upper Des Lacs, Middle Des Lacs, and Lower Des Lacs lakes and includes driving through Kenmare. Thirteen interpretive panels are located along the auto tour route and overlooks are available at Middle Des Lacs and Lower Des Lacs lakes. The direction of travel is two-way and the route is generally open from April through November. The auto tour route is not maintained during winter months. The refuge, Ward County, and Kenmare Park Board rotate summer road maintenance annually, as agreed upon through a memorandum of understanding.

Four nature trails are available at the refuge:

- Canada Goose Trail—7.5-mile nature trail is open to hiking and bicycling, and one-way vehicle traffic for 17 days in mid-September annually
- Munch's Coulee Hiking Trail—1-mile nature trail loop is open to hiking with an accessible section
- White-tailed Deer Trail—1-mile nature trail is open to hiking
- Tasker's Coulee has informal mowed nature trails

A viewing and photography blind to observe displaying sharp-tailed grouse is available in the spring. Spotting scopes and binoculars are available for visitors. An all-weather binocular is mounted on the observation deck at headquarters and provides visitors with an excellent view of the Middle Des Lacs Lake and wildlife. A paved overlook with interpretive panels is located adjacent to the headquarters area.

Tasker's Coulee has tables, a CCC-era covered shelter, accessible restrooms, and informal mowed trails. The boat dock day use area has a boat ramp, tables, and vault toilets. Nonmotorized boats are allowed.

Environmental Education and Interpretation

Videos and trunks are available for loan. Binoculars, dip nets, spotting scopes, and microscopes are available for use. Refuge staff have developed a curricula on fire ecology of the northern Great Plains, which is available for use in schools. Small-group environmental education programs are provided on request to Boy Scouts, Cub Scouts, and other groups. Environmental education duties are currently shared among the staff.

Visitor exhibits are available at refuge headquarters and focus on early history of the area, habitats and waterfowl production, grassland birds, grebes, sharp-tailed grouse, and butterflies.

Gary Eslinger/USFWS

Monarch Butterfly on Switchgrass

A general brochure is available and provides information about refuge wildlife and habitats and visitor opportunities. The Souris River basin refuges' bird list and the brochure for the auto tour route describe refuge wildlife.

The refuge staff hosts a variety of special events:

- "Green Wing Day" promotes youth hunting safety and conservation
- National Wildlife Refuge Week
- "Eco-Ed Days" promotes conservation and resource management for fifth- and sixth-grade students
- "Haunted Hayride"

The refuge also assists with the annual Kenmare Goosefest celebration in October.

A number of community groups and individuals (including Natural Resource Conservation Service [NRCS], Ducks Unlimited, and Kenmare Association of Commerce) participate in the planning and implementation of special events. Other community groups have donated equipment and personnel for various special events.

J. Clark Salyer NWR

J. Clark Salyer NWR provides visitors wildlife-dependent activities including hunting, fishing, wildlife observation, wildlife photography, environmental education, and interpretation. Yearly visitation is approximately 15,000.

Hunting

The refuge is open for the hunting of waterfowl, white-tailed deer, turkey, sharp-tailed grouse, gray partridge, ring-necked pheasant, and fox. A hunting brochure provides information, regulations, and a map for a variety of game seasons. Some aspects of the hunting program follow:

- There are nine designated public hunting areas that are open for the hunting of waterfowl and upland game birds, which follow the state-designated hunting seasons.
- Most of the refuge, with exception of specific closed areas, is open to deer hunting with archery, muzzleloader, and rifle equipment following state seasons.
- Late-season hunting for upland game bird and for fox is allowed after the close of the deer firearm season.
- The portion of the refuge south of the Upham–Willow City Road is open for hunting turkey, grouse, and partridge during state seasons.

Fishing

Fourteen public fishing areas cover the entire length of the refuge. All of these locations are open to bank fishing and several allow limited nonmotorized boat fishing. Fishing is allowed along the entire length of Souris River Canoe Trail. All areas are open to winter ice fishing following state regulations.

Wildlife Observation and Wildlife Photography

There are numerous opportunities for these activities, many opportunistic and some formalized. The self-guided Scenic Trail, Grassland Trail, and Souris River Canoe Trail cover prairie, forest, wetland, and hardwood bottomland habitats. Wildflowers, songbirds, waterfowl, and waterbirds are seasonally abundant.

A photography blind is placed near a sharp-tailed grouse dancing ground each spring and visitors can reserve its use.

Environmental Education

The refuge conducts an extensive operation for the banding of waterfowl each autumn. The project requires a lot of time and staff to accomplish the banding of 4,000–5,000 ducks. Volunteers from universities and local schools provide a substantial amount of time toward this operation. Their assistance with collecting, handling, marking, and releasing thousands of birds could not be accomplished without their help. This activity not only provides the refuge with adequate staff to get the work done, but it provides a wonderful outdoor classroom for students from elementary school to college to learn about national wildlife refuges and wildlife resources.

In addition to the above activity, minimal opportunities are provided to educate the public because of the lack of funding and trained staff. There are more than 60,000 residents and more than a dozen schools within commuting distance of the refuge. Videos and trunks are available for loan as well as binoculars, dip nets, and spotting scopes for specific groups and organizations.

Interpretation

Two interpreted auto tour routes are open to the public:

- The 22-mile Scenic Trail begins at the refuge headquarters and traverses wetland, grassland, and woodland habitat from pool 326 to the south boundary and back to Highway 14. A brochure provides interpretation of eighteen stops along the route. The brochure includes information on wildlife, habitat, management techniques, and history. The direction of travel is two-way. The route is generally open from April through November, but is not maintained during winter months.
- The 5-mile Grassland Trail is located along the northern shoreline of pool 341 on the west side of the refuge. It moves through mixed-grass prairie habitat and meanders down to the shoreline of the marsh. The trail is interpreted through a leaflet that provides information on seven stops along its route. This unimproved one-way trail begins off the Newberg Road and exits at the Shevelo Road; it is open from April to November.

The Souris River Canoe Trail is designated as a national recreation trail. The canoe trail traverses bottomland hardwood forest habitat within the Souris River floodplain. It can be paddled as a 5½- or 13-mile trip. The 5½-mile route travels from Johnson Bridge to Thompson Well and takes 2–3 hours to complete. The 13-mile route travels from Johnson Bridge to dam 1 and takes 5–7 hours to float. Numbered markers are located at each mile along the river. An interpretive brochure provides a

map and information about the habitat and wildlife a visitor will encounter.

Thompson Well is an historical stop along the Scenic Trail that has drinking water from a hand-pumped well, a shelter, accessible restrooms, and a portable dock for access to the Souris River Canoe Trail. The Sandhills Walk, also along the Scenic Trail, is an area designated for hiking into the unique sandhills, containing bur oak forest with shrub and grassland understory.

A two-tiered viewing platform and an accessible observation deck provides visitors with an excellent view of marsh habitat and associated wildlife at pool 326. A paved walkway with interpretive panels leads to the observation point located adjacent to the headquarters area. Spotting scopes and binoculars are available for visitors.

A viewing and photography blind to observe displaying sharp-tailed grouse is available in the spring.

Visitor exhibits at refuge headquarters focus on early history of the area, habitats, and wildlife. Brochures are available and provide information about wildlife, habitats, and visitor opportunities.

Upper Souris NWR

Upper Souris NWR provides visitors with a full complement of wildlife-dependent activities including hunting, fishing, wildlife observation, wildlife photography, environmental education, and interpretation.

Yearly visitation is approximately 60,000–70,000 with a peak of 150,000 visitors. In 2004, the following percentages of visitation were estimated for each wildlife-dependent activity:

- 3% of visitors participated in hunting
- 78% of visitors participated in fishing
- 9% of visitors participated in wildlife observation and wildlife photography
- less than 1% of visitors participated in environmental education activities
- 8% of visitors participated in interpretive activities

Hunting

Hunting, particularly for white-tailed deer, is very popular. Deer hunting with archery equipment begins in early September, followed by rifle and muzzleloader seasons.

Several areas are open to hunting sharp-tailed grouse, gray partridge, and ring-necked pheasant. To reduce waterfowl disturbance, upland bird hunting is open during different times of the fall and at different areas of the refuge.

A hunting brochure is available that provides information, regulations, and a map.

Bob Savannah/USFWS

Fishing

Fishing is allowed year-round, with visitors permitted to drive on the ice covering Lake Darling to fish. Lake Darling is a magnet for anglers looking to catch walleye, northern pike, perch, and smallmouth bass.

There are 2 boat-fishing areas at Lake Darling and 13 bank-fishing areas scattered along the lake and the Souris River. There are four boat-launching facilities. Boat fishing is allowed from May 1 through September 30.

A fishing brochure containing information, rules, and a map is available.

Wildlife Observation and Wildlife Photography

There are numerous opportunities for these activities—many are opportunistic and some are formalized.

The Prairie–Marsh Scenic Drive is open to vehicles during the summer and early fall. Numbered signs along the drive correspond to points of interest that are described in the tour brochure available at the beginning of the drive. Visitors are welcome to walk around the coulees, roads and prairie-covered hills in the immediate vicinity of the scenic drive. This is an excellent place to observe wetland and grassland animals and plants—the area has spectacular summer-long blooms of native wildflowers.

Photography blinds are placed at three sharp-tailed grouse dancing grounds (leks) each spring and visitors can reserve the use of these blinds at no charge. The peak time for active dancing occurs at

sunrise. Another blind placed at the end of Pelican Nature Trail is available year-round. Visitors are welcome to hide in this blind and let the wildlife come to them.

Five nature trails beckon visitors to get out of their vehicles and explore the refuge. All trails present opportunities for observation and photography. These trails are for walking and are less than 2 miles long. One trail is almost flat and is hard-surfaced, making it wheelchair-accessible. Other trails require some stamina to climb up and down the hills. Some trails have interpreted stops and benches for relaxing.

Canoes are permitted on two Souris River canoe trails and on Lake Darling from May 1 through September 30. Canoeing can be a very quiet way to sneak up to wildlife such as the colorful wood duck and capture an unforgettable picture. It is a convenient way to view a beaver lodge and get a closer look at its inhabitants.

Environmental Education

There is a growing need for environmental education as people move from rural to urban areas and lose their connection to the land. There are more than 60,000 residents and more than a dozen schools within commuting distance of the refuge. One of the largest potential audiences is the Minot Air Force Base (12 miles east of refuge headquarters).

The refuge has a diversity of habitats and wildlife that can be used to teach environmental education. However, only minimal opportunities can be made available yearly because of a lack of trained and available staff.

In the past, the refuge has sponsored "Migratory Bird Day," "Zoo Day," "Special Fishing Day," wildlife refuge week activities, and "Envirothon." The latter is a national scholastic competition among high school students that also teaches environmental principles. Teams compete and broaden their knowledge of the environment.

USFWS

Students learn aquatic sampling at the "Envirothon" hosted by Upper Souris NWR.

Interpretation

Visitors have access to a wide array of interpretive media that describe refuge management, wildlife, wetlands, grasslands, Neotropical birds, history, fishing, and hunting.

Interpretive panels are found at two visitor kiosks, along an auto tour route and a walking trail, at road pull-offs, and at refuge headquarters. Interpretive exhibits at refuge headquarters focus on the CCC and historical trade routes. In 2006, two new kiosks with interpretive signs will be completed.

The Prairie–Marsh Scenic Drive will be improved by adding new interpretive stops, redesigning the trails brochure, and paving the road surface. This 12-stop interpreted drive will give visitors a first-class look at prairie habitats and marsh habitats that support a diversity of wildlife.

The Theodore Roosevelt Nature and History Association has generously cooperated with the refuge to provide visitors a chance to purchase wildlife and habitat books and games for all ages (sales area is open 8 a.m.–4:30 p.m. weekdays). Profit from the sale of items is returned to the refuge for biology and visitor service programs.

SOCIOECONOMIC ENVIRONMENT

The local and regional demographics—that is, statistical data about the population—are described below for the communities in the five-county study area pertaining to the Souris River basin refuges.

Population

Table 2 shows population estimates and trends for the regional area and communities near the refuges. In 2000, the five counties in the study area accounted for approximately 12% of North Dakota's total population (U.S. Census Bureau 2000). From 1990 to 2000, North Dakota's overall population increased by 0.5%. Ward County was the only county within the study area to increase its population (1.5 %), over the same period. The other four counties all had negative population growth rates—ranging from a decrease of 25.3% in Burke County to an 8.3% decrease in McHenry County, over the same period.

Bowbells in Burke County and Kenmare in Ward County are the centers of visitation activity associated with the Des Lacs NWR, as follows:

- Kenmare, a community of 1,081 residents, offers world-class upland hunting as well as abundant opportunities for hunters to bag white-tailed deer and pronghorn. Goose hunting is also a popular hunting activity in and around Kenmare as reflected in its

Table 2. Local and regional population estimates and characteristics for the five-county study area, North Dakota.

Area	Population in 2000		% Population Change 1990–2000
	Number of Residents	Persons per Square Mile	
Bottineau County	7,149	4.3	-10.8
Burke County	2,242	2.0	-25.3
McHenry County	5,987	3.2	-8.3
Renville County	2,610	3.0	-17.4
Ward County	58,795	29.2	1.5
Five-county Area Total	76,783	—	—
North Dakota Total	642,200	9.3	0.5

Source: U.S. Census Bureau (2000).

nickname, the "Goose Capital of North Dakota" (city of Kenmare). Kenmare residents are also proud of the birding and ecotourism opportunities provided by the refuge (city of Kenmare).

- Bowbells, a town of 406, is another popular destination for hunters. Its abundant wildlife provides thrills for hunters of a variety of game, from waterfowl to pheasant to big game. Fishing at the Northgate Dam recreation area gives anglers the opportunity to land trout, walleye, largemouth bass, and bluegill (city of Bowbells). Farmers in the area produce flax, canola, peas, barley, oats, sunflowers, durum, and hard red spring wheat (city of Bowbells).

The towns of Newburg, Bottineau, and Westhope in Bottineau County and the towns of Upham, Towner, and Granville in McHenry County are the principal communities near the J. Clark Salyer NWR. These six communities surrounding the refuge are relatively small, with populations ranging from 88 in Newburg to 2,336 in the county seat of Bottineau (U.S. Census Bureau 2000). Descriptions of four of these communities follow:

- The town of Upham is located on the western side of the refuge and hosts the refuge headquarters. In 2000, the population of Upham was 155 residents (U.S. Census Bureau 2000).
- The town of Westhope has 533 residents and is northwest of the refuge near the Canada border.
- Towner (McHenry County seat) is a small community on the southern end of the refuge with a population of 574 (U.S. Census Bureau 2000). The only tree nursery in the state is located in Towner.
- Granville has 286 residents and is also on the southern end of the refuge (U.S. Census Bureau 2000). Granville is home to Big Sky Buffalo Ranch, which houses "Mystical," an albino bison bull.

Carpio and Minot in Ward County and Tolley and Grano in Renville County are the primary local communities surrounding the Upper Souris NWR. Ward County is the fourth most-populated county in the state, with a population of 58,795 residents. The bulk of these residents are concentrated in the county seat of Minot, home to 36,567 people. Community descriptions follow:

- Minot was nicknamed the "Magic City" some 100 years ago because "when the railroad arrived, the city sprouted up like magic" (Minot 2005). Minot is home to the Minot Air Force Base, which houses the 5th Bomb Wing and the 91st Space Wing, as well as Minot State University.
- Carpio is a small town composed of 148 residents, located southwest of the refuge on the Des Lacs River.
- Tolley and Grano are small communities located along the north central portion of the refuge. In 2000, Tolley's population was 63 and Grano's was 9 (U.S. Census Bureau 2000).

In 2000, four out of five counties in the study area consisted of a higher percentage of white persons not of Hispanic or Latino origin than the North Dakota state average of 92.4%. Ward County exactly matched the state average and McHenry County had the greatest percentage, 98.7%. Ancestry patterns were similar across counties, with heavy German and Norwegian influences (U.S. Census Bureau 2000).

The state percentage of residents from Hispanic or Latino descent was 1.2%, and all five counties were similar to this estimate. Likewise, the Asian population of the five counties was similar to the state average of 0.6%. North Dakota's American Indian population compiled 4.9% of the state total.

All five counties were below this average, with Ward County having the highest American Indian or Alaska Native population, consisting of 2.1% of the county's residents. Ward County had a greater percentage of its population that comprises Black or African Americans, with 2.2%, compared to the state average of 0.6%. The four other counties closely resembled the state average (U.S. Census Bureau 2000).

Approximately 83.9% of North Dakota residents 25 years and older were high school graduates. The five counties were all similar to the state average in this category, ranging from 76.9% in McHenry County to 87.4% in Ward County. The percentage of residents 25 years and older who held a bachelor's or advanced degree ranged from 12% in Burke County to 22% in Ward County. The state average was 22% (U.S. Census Bureau 2000).

Employment and Income

Employment estimates for the five-county study area are shown in table 3. Agriculture composes a substantial percentage of employment in all counties. As a percent of a county's total jobs, farm employment ranges from 36.1% in McHenry County to 3.4% in Ward County (U.S. Department of Commerce 2002).

Ward County is the most populated in the study area, which explains its role as the economic hub for northern North Dakota, in addition to its relatively lower dependence on farm employment. The city of Minot, located in Ward County, hosts a diverse range of corporate offices for such companies as ING and Choice Hotels International, as well as Minot State University and Minot Air Force Base (Minot Chamber of Commerce 2005).

The services and government sectors are also key employers in the five-county region. As a percentage of total nonfarm employment, the service sector ranged from 22% in Renville County to more than 35% in McHenry County. Government employment composed nearly 20–25% of all nonfarm employment in all five counties, with Renville County having the greatest percentage, 28%.

U.S Census Bureau (2000) data for median household income, unemployment and percentage of persons below poverty in 1999 are shown in table 4 (U.S. Census Bureau 2000). The median household income for the five-county study area is below the state and national averages. Also, the percent of unemployed of all counties is below the state and national averages. The percent of population below the federal poverty line is an indicator of the economic distress within a community. Bottineau, Renville, and Ward counties are below the state average of 11.9% of persons living in poverty and the national average of 12.4%. Both Burke and McHenry counties are above both the state and national averages for this category.

Table 3. Employment for the five-county study area, North Dakota (2000).

	Percent of Total Employment				
	County				
Industry	*Bottineau*	*Burke*	*McHenry*	*Renville*	*Ward*
Farm Employment	22.5%	31.5%	27.9%	36.1%	3.4%
Nonfarm Employment	77.5%	68.5%	72.1%	63.9%	96.6%
Agricultural services, forestry, and fishing	D[1]	D	D	D	0.8%
Mining	3.8%	5.2%	6.0%	D	0.8%
Construction	D	D	3.2%	8.2%	5.0%
Manufacturing	2.5%	D	2.3%	D	2.2%
Transportation and public utilities	6.1%	10.2%	D	D	5.1%
Wholesale trade	4.1%	5.9%	6.6%	6.6%	4.5%
Retail trade	17.8%	16.1%	13.4%	11.2%	19.3%
Finance, insurance, and real estate	7.5%	6.4%	6.2%	5.8%	7.1%
Services	31.3%	25.8%	35.7%	21.9%	29.8%
Government (federal, state, and local)	18.5%	21.6%	20.2%	28.2%	25.5%
Total Full- and Part-time Employment	4,501	1,701	1,600	2,873	40,144

Source: U.S. Department of Commerce (2002).
[1]*D—not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.*

Table 4. Income, unemployment, and poverty estimates for the five-county study area, North Dakota.

Area	*Median Household Income (1999)*	*Percent Unemployed (2000)*	*Percent of Persons Below Poverty (1999)*
United States	$41,994	4.1%	12.4%
North Dakota	$36,604	3.0%	11.9%
Bottineau County	$29,853	2.7%	10.7%
Burke County	$25,330	1.5%	15.4%
McHenry County	$27,274	2.9%	15.8%
Renville County	$30,746	1.1%	11.0%
Ward County	$33,670	2.7%	10.8%

Source: U.S Census Bureau (2000).