

Chapter 3: Refuge Environment and Current Management

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Introduction

This chapter first describes the geographic setting for DeSoto and Boyer Chute National Wildlife Refuges (NWRs, refuges), and then introduces the diversity of resources associated with the refuges under four broad categories: physical environment, habitat, wildlife, and people. A general description of the resource and the current refuge management of that resource are provided for each topic. The description of current management provides a reference for the management direction and values leading up to the development of the comprehensive conservation plan (CCP).

Geographic Setting

Refuge Sketch and Local Context

A description of each refuge is provided separately below as well as a section on easements administered by the refuges.

DeSoto National Wildlife Refuge

DeSoto NWR was established in 1958 and is located approximately 15 miles north of Omaha, Nebraska in Washington County, Nebraska and Harrison and Pottawattamie Counties, Iowa (figure 3-1). It lies midway between the towns of Missouri Valley, Iowa and Blair, Nebraska and straddles just over three river miles (641.1 through 644.7) of the Missouri River. For ease of reference and discussion in this CCP, portions of the refuges have been divided into management units and a naming convention applied as depicted in figure 3-2.

Figure 3-1: Regional Location of the Refuges

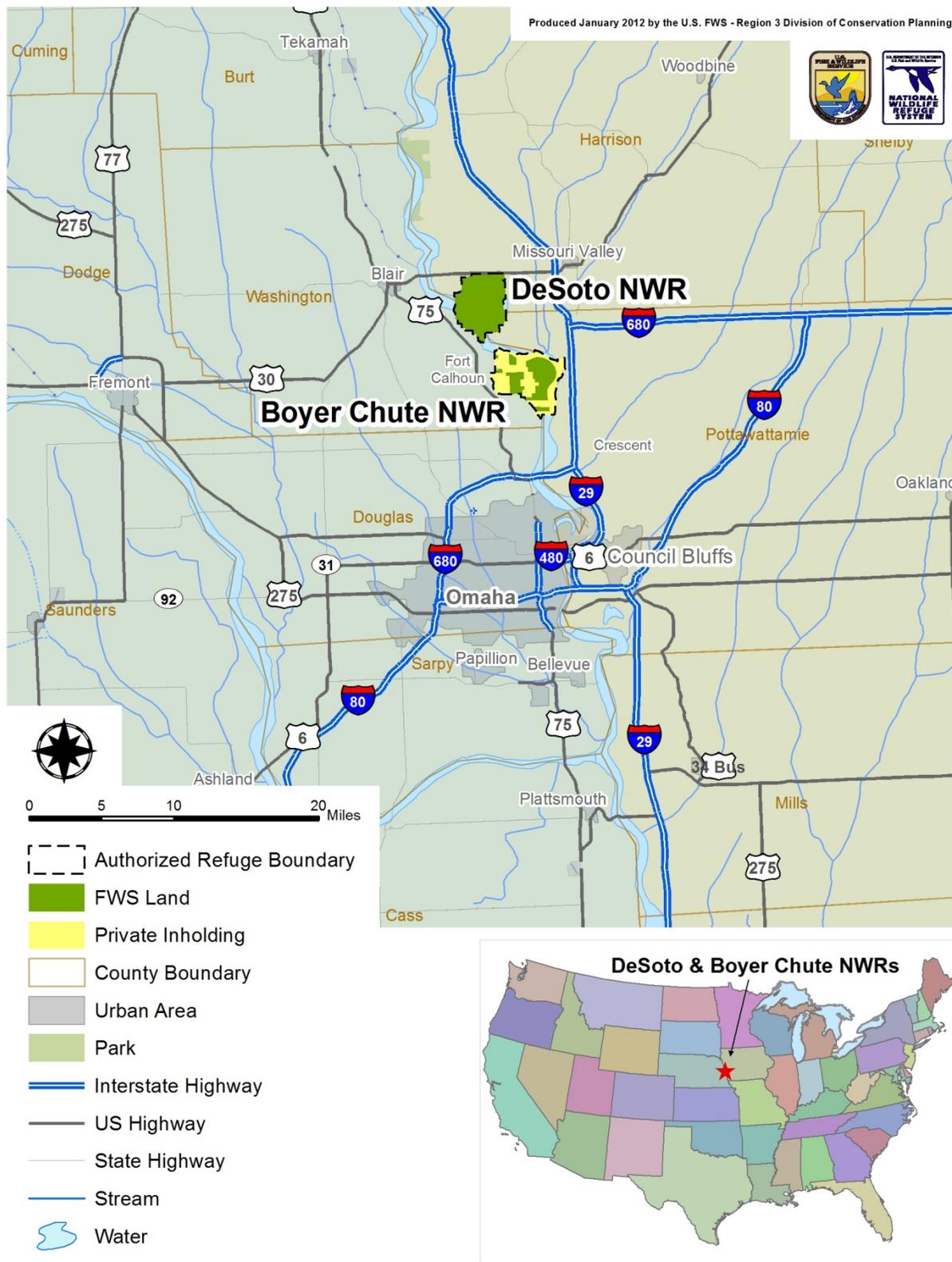
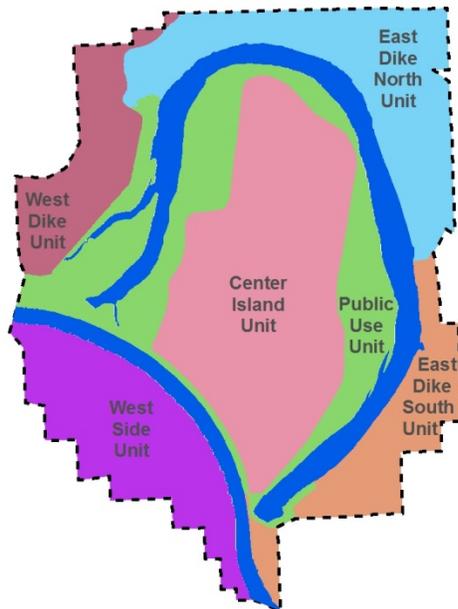


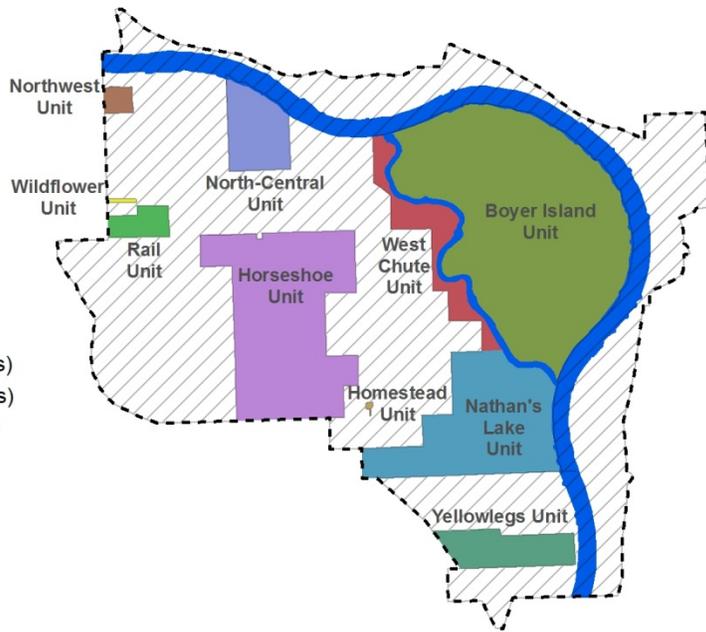
Figure 3-2: Refuge Management Units

Produced April 2013 by the U.S. FWS - Region 3 Division of Conservation Planning



DeSoto NWR

- Center Island Unit (2,120 acres)
- East Dike North Unit (1,192 acres)
- East Dike South Unit (682 acres)
- Public Use Unit (1,528 acres)
- West Dike Unit (641 acres)
- West Side Unit (1,037 acres)



Boyer Chute NWR

- Homestead Unit (2 acres)
- Horseshoe Unit (895 acres)
- Boyer Island Unit (1,731 acres)
- Nathans Lake Unit (645 acres)
- Northcentral Unit (204 acres)
- Northwest Unit (31 acres)
- Rail Unit (68 acres)
- West Chute Unit (206 acres)
- Wildflower Unit (5 acres)
- Yellowlegs Unit (186 acres)

--- Authorized Refuge Boundary

▨ Private Inholdings

Water



0 0.5 1 2 Miles



Comprised of approximately 8,365 acres, DeSoto NWR is situated entirely within the historic floodplain of the Missouri River resulting in essentially flat topography and elevations ranging from 987 to 1,014 feet above mean sea level (MSL). Although the majority of the refuge is now protected from the river by a levee, DeSoto NWR's landforms, soils, and oxbow lake are all a direct result of the natural fluvial processes of meandering, deposition, and scouring carried out by the Missouri River for countless millennia. The oxbow bend that created DeSoto Lake began as a slight curve in the river and grew steadily larger over time as the outside of the river channel was eroded and undercut by the stronger outer current, and deposition occurred on the inside of the curve where the current is weaker. DeSoto–Bertrand Bend was well on its way to cutting itself off from the main channel and forming an oxbow lake, when in 1959–1960 the U.S. Army Corps of Engineers (USACE, Corps) excavated a cutoff channel and constructed levees from the dredge spoil to separate the new 7.5-mile DeSoto Lake from the primary channel of the Missouri River.

About half of the land comprising the refuge was cleared for agriculture in the 1940s and 1950s prior to refuge establishment. In 1958 when DeSoto NWR was established, its primary purpose was to provide for the needs of migratory birds (see Refuge Purposes in chapter 2). Early management emphasized providing sanctuary and food for migratory waterfowl by raising crops on refuge land through cooperative agreements with local farmers. In addition, 350 forested acres on the center island were cleared of trees, and shorelines were opened up to attract more geese. The refuge farming program has been slowly reduced since the 1970s in favor of native habitats such as wetlands, grasslands, and bottomland forests. DeSoto NWR remains an important stopover for migratory waterfowl during their spring and fall migration between the Arctic nesting grounds and the Gulf Coast wintering areas. A variety of ducks and geese migrate through the area; records show that in some years as many as 500,000 birds stop at the refuge to rest. Also, mature cottonwood gallery forest on the refuge is an important habitat for migratory raptors; records show that over 280 Bald Eagles have been seen on the refuge during the winter months. The natural regeneration of these bottomland forests has declined substantially since the 1950s with the reduction of natural flood cycles.

DeSoto offers a number of wildlife-dependent recreation opportunities including hunting, fishing, and wildlife observation. The refuge also has an outstanding environmental education program that emphasizes partnerships with local schools, is based on local curricula, and offers students successive opportunities to visit and learn. DeSoto NWR is nationally renowned for its archaeological museum collection and associated cultural history interpretation. The number of visitors has always been high at the refuge, averaging just under 200,000 in the 1960s, nearly 350,000 in the 1970s, almost 400,000 in the 1980s, and just shy of 300,000 in the 1990s. In the 2000s the number of visitors has averaged just under 250,000 annually. Changes in visitation over the decades have been attributed to changes in compatible public uses, the establishment of fees, occasional flood events, and fluctuations in wildlife populations.

Due to the historically dynamic nature of the Missouri floodplain, little early archeological evidence has been discovered on the refuges. The earliest known historical records are from the European colonization time period, including those of Native Americans, explorers, trappers, and frontier settlements in the area. Lewis and Clark are believed to have camped overnight on or near DeSoto NWR on August 3, 1804. Their stay in the area also includes the famous “Council Bluff” meeting with the Native Americans held only a few miles to the southwest of the refuge (just west of Boyer Chute NWR). A unique and popular facet of DeSoto NWR's history is the story of the Steamboat Bertrand. In April of 1865 the Bertrand cargo vessel was heading up the Missouri River from St. Louis to the goldfields of the Montana Territory when it hit a partially submerged snag on the DeSoto Bend and sank. The ship remained lost and buried for 103

years until two Omaha salvors rediscovered the steamboat's hull and cargo in 1968 under 28 feet of earth. The time-capsuled cargo of over 200,000 items was carefully excavated and preserved and has been housed since 1981 in the refuge's Visitor Center as one of the Nation's premier collections of Civil War-era artifacts.

Boyer Chute National Wildlife Refuge

Boyer Chute NWR was authorized in 1992 in an ongoing effort to recover, restore, and safeguard fish and wildlife habitat along the Missouri River corridor. The refuge is located just east of the farming community of Fort Calhoun, Nebraska and 15 miles north of Omaha, Nebraska. The authorized boundary resides along an eight-mile stretch of the Missouri River (river miles 631.8 to 640.2) in the wide, fertile floodplain of the Missouri River Valley on former river meanders in Pottawattamie County, Iowa and Washington County, Nebraska (figure 3-1).

By comparison to other national wildlife refuges, Boyer Chute NWR is a relatively new and a relatively small refuge, having existed for 20 years and incorporating just over 4,000 acres of managed land. Its combined acreage of separated units equates to approximately 40 percent of the total proposed acquisition boundary. The fragmented land status combined with a passive and gradual process of land acquisition poses challenges for management.

Boyer Chute NWR conserves a number of landscape features unique to large river systems including chutes, backwaters, side channels, islands, pools, sloughs, and sandbars as well as floodplain wetlands, prairies, shrublands, and forests. To every extent possible, management efforts on the refuge seek to restore or rehabilitate habitats and landforms that have been virtually erased by a century and a half of human-induced change in the Missouri River valley. Riverine, wetland, woodland, and grassland habitats are managed to provide habitat for a number of species, including three federally threatened or endangered species. Located on the edge of the central flyway, the refuge serves as a seasonal resting area for waterfowl and is a nesting area for a variety of migratory grassland, wet meadow, and wetland-dependent birds. It is also the year round home for many resident wildlife species. Refuge backwaters provide spawning, nursery, and food production areas; while the rivers, chutes, and side channels provide habitat for numerous aquatic species including the endangered pallid sturgeon. Boyer Chute NWR has documented over 200 bird species, 35 mammal species, 30 reptile species, 10 amphibian species, and over 60 fish species. Appendix B contains these and other species lists.

The refuge also provides unique opportunities for wildlife-dependent recreation along the Missouri River to approximately 25,000 visitors each year. The refuge offers activities such as wildlife observation and photography, environmental education and interpretation, and fishing and hunting to the small communities near the refuge as well as to the Greater Omaha–Council Bluffs Metropolitan Area.

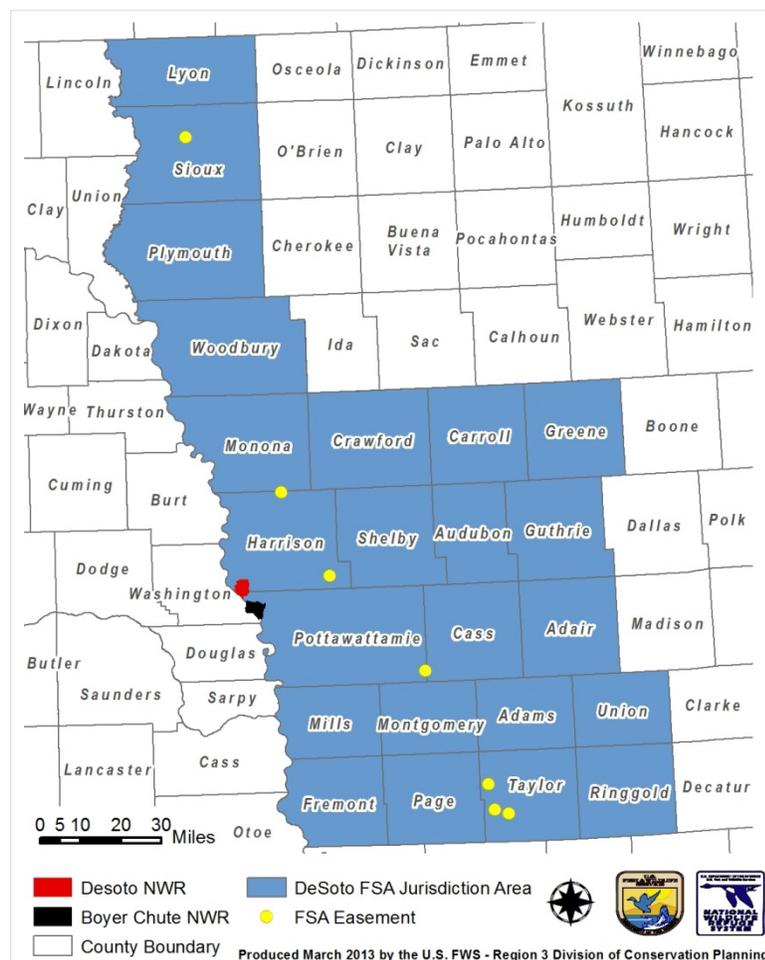
Other Units Administered: Conservation Easements

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

agreement between the FmHA and the U.S. Fish and Wildlife Service (FWS, Service) authorized the Service to be the easement manager and to protect these lands for conservation, recreational, and wildlife purposes. The “Service Easement Manual” (U.S. Department of the Interior 2005) states that, “The agreed upon purposes of this easement are the preservation and maintenance of the wetland and floodplain areas existing as of the date of this conveyance as well as protection and enhancement of plant and animal habitat and populations.” Farm Service Agency (FSA; previously known as FmHA) easements are administered by the Service as part of the National Wildlife Refuge System (NWRS, Refuge System) pursuant to the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd et. seq.), and thus they are subject to compatibility regulations and other relevant Refuge System policy.

DeSoto NWR has jurisdiction over the FSA easements in 23 western Iowa counties (figure 3-3). Within these counties, the refuge is responsible for the oversight and management of seven easement properties with a combined total of 177 acres.

Figure 3-3: Farm Service Agency Easements Administered by DeSoto NWR



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

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

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

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

Ecosystem Setting

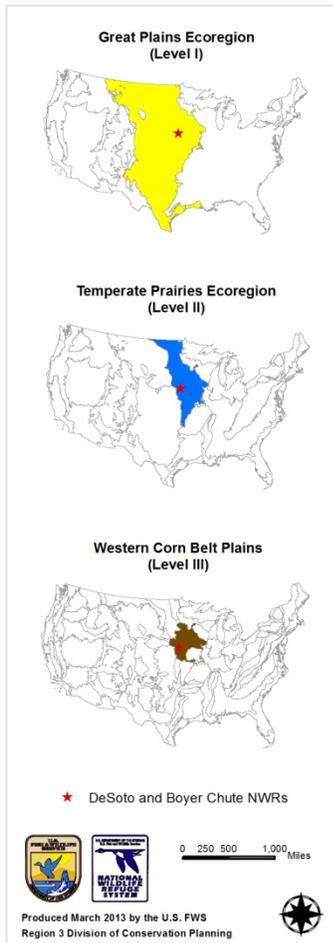
Ecoregional Context (Omernik/EPA)

North America has been classified into ecological units of varying scales using a number of different hierarchical systems. The different systems all use biotic and abiotic criteria to delineate areas of geographic similarity, with the intention of providing a framework for research and management of natural systems. Factors such as geology, vegetation, climate, soils, hydrology, land use, and wildlife are used in a system originally devised by James Omernik (Omernik 1987, 1995), and which was subsequently adopted, adapted, and further refined by the U.S. Environmental Protection Agency's (EPA's) Western Ecology Division (EPA 2000). Understanding a refuge's context within the broader physiographic region provides insights into opportunities, challenges, and other management implications.

At the highest of four levels in the Omernik/EPA hierarchy, the North American continent is divided into 15 Level I ecoregions that provide a broad continental perspective. Biophysical characteristics combined with human-related activities define the geographic dimensions for these ecoregions. The refuges are located within the **Great Plains (Level I) Ecoregion**, which paints a wide north-south swath down the center of the continent from north-central Canada to northeastern Mexico (figure 3-4). Covering over 1.3 million square miles, the region is characterized by minimal topographic relief, predominantly grassland vegetation, and sparse tree coverage. Well suited to agriculture, the soils of this region are threatened by reduced nutrient levels, increased salinity, and erosion. High winds and periodic severe droughts and frosts are also important climatic factors. Biologically, this region was once covered with specialized grassland plant and animal communities driven by fire, grazing, and climatic conditions. Rainfall increases from west to east across the region, defining the prairie types in the past, and defining predominantly agricultural zones today; what existed as short-, mid-, and tallgrass prairie zones now correspond with the rangeland, wheat belt, and corn/soy belts that now cover this landscape. Wetlands are concentrated in the post-glacial northern Great Plains, the Nebraska sandhills, and the seasonal playas of the southern United States. These wetlands provide important breeding, staging, and nesting habitat for migratory birds in the central flyway. This ecoregion was once able to support vast numbers of migrating mammals; now many of the species that once flourished in this ecoregion are vulnerable, rare, threatened, or endangered. Widespread conversion of prairies to agricultural production have made this region is one of the largest, and most productive farming and ranching areas on earth. In addition to farming,

mining and oil/gas extraction are important economic activities (Commission for Environmental Cooperation 1997, 2011).

Figure 3-4: Ecological Context, EPA Levels I, II, and III

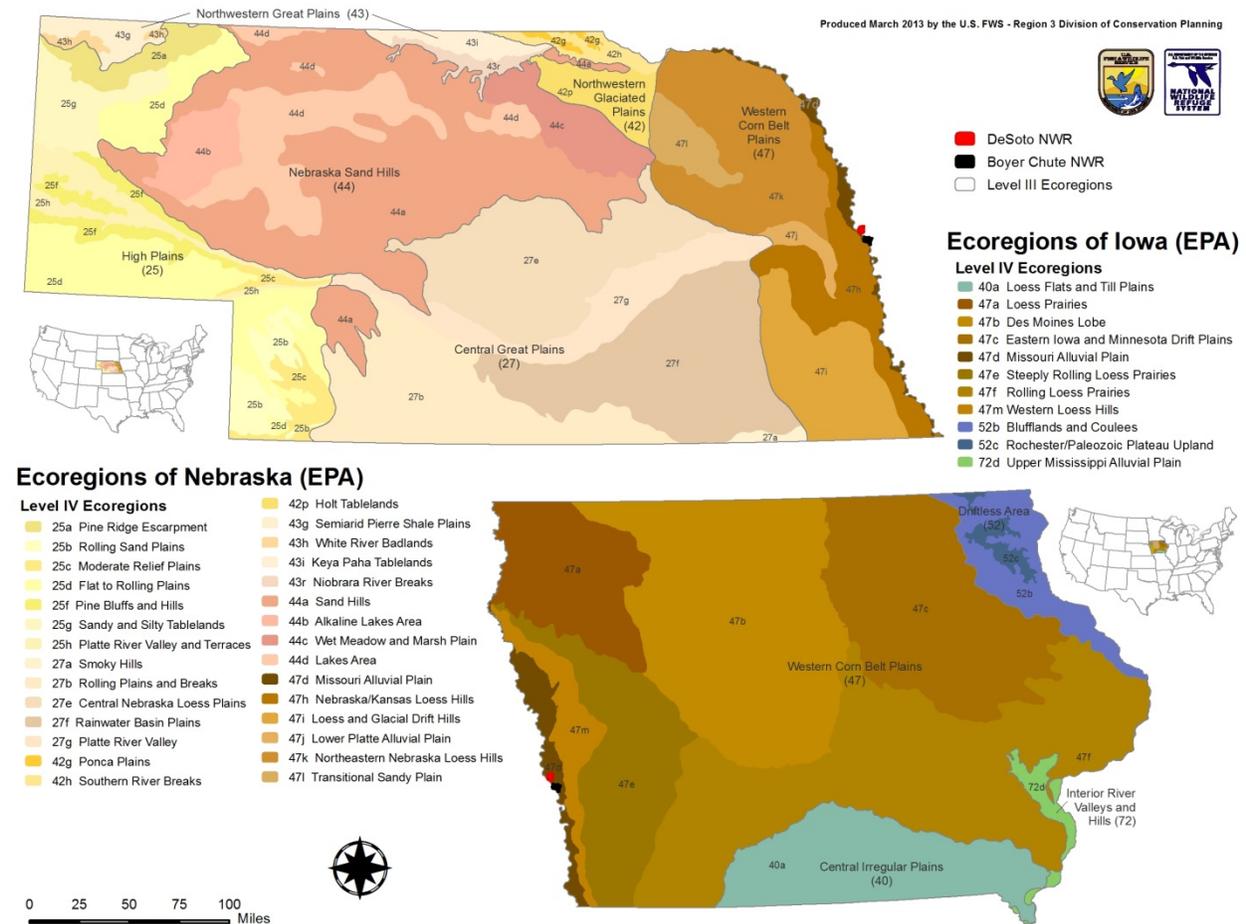


Level II of the Omernik/EPA hierarchy contains 52 regions based on physiography, wildlife, and land use. They are used to provide a national or sub-continental perspective nested within the Level I regions. The refuges lie in the **Temperate Prairies (Level II) Ecoregion**, (figure 3-4). This ecoregion is composed of irregular plains that were once tallgrass prairie and aspen parkland but are now used predominantly for agriculture. Past glaciations have left their mark on the terrain leaving moraines and numerous small lakes and wetlands. Most areas have calcareous soils; some southern areas have a loess substrate.

Level III of the Omernik/EPA hierarchy for North America has 194 regions, 104 of which are in the continental United States. DeSoto and Boyer Chute Refuges are located within the **Western Corn Belt Plains (Level III) Ecoregion**, which extends from southern Minnesota through central and western Iowa, eastern Nebraska, and the northern corners of Missouri and Kansas (figure 3-4). Hot summers and cold winters typify this severe, mid-latitude, humid continental climate. The land surface is characterized by level or gently rolling glacial till and loess plains covering shales, sandstones, and limestones. Mollisols and Alfisols are the predominant soils. The growing season typically ranges from 140–200 days, and precipitation ranges from 24–32 inches per year. Once dominated by tallgrass prairie and sparse oak-hickory woodlands, the overwhelming majority of the region has now been converted to highly productive soy and corn croplands, with some rangeland areas. Much of the original hydrology has been modified for agriculture, which has contributed to a number of environmental concerns, including surface and ground water contamination from soil erosion, fertilizer and pesticide applications, as well as livestock concentrations (Wiken et al. 2011).

The most site-specific scale in this hierarchy developed to-date is Level IV. The refuges are located in the **Missouri River Alluvial Plain (Level IV) Ecoregion**, which is comprised of the large, wide, alluvial valley of the Missouri River bordered by deep loess bluffs that straddles Nebraska and Iowa (figure 3-5). This region is distinguishable from adjacent Level IV regions because of the consistent, level river plain composed of deep, silty, clayey, and sandy alluvium. Extensive cropland has been developed in this region because of the rich soils but is constrained by flooding and high water tables. The Missouri River once meandered freely across this floodplain-centered region, but it has now been restricted by channelization efforts, levees, and dams (Chapman et al. 2001). The floodplain forest and tallgrass prairie native to this ecoregion have been extensively replaced by agricultural croplands.

Figure 3-5: Ecological Context, EPA Level IV



Missouri River Basin

Both refuges lie entirely within the floodplain of the Missouri River Valley on former river meanders. The lands that comprise Boyer Chute NWR’s authorized boundary are predominantly on the west bank of the current Missouri River channel, whereas the majority of DeSoto NWR’s lands are on what is now the east bank (figure 3-6). Both refuges hug the western edge of the floodplain, with the south and west boundaries of Boyer Chute NWR formed by the bluffs that delimit the edge of the floodplain. The floodplain valley is approximately 4 miles wide at the southernmost end of Boyer Chute NWR; it expands to about 7 miles in width between the refuges and grows to nearly 12 miles wide at the northern edge of DeSoto NWR. The Missouri River Valley continues to widen north of the refuges.

To understand why DeSoto NWR, Boyer Chute NWR, and other conservation lands in the Missouri River Valley merit protection, one must first understand the history of the larger Missouri River ecosystem. The Missouri River system is a national resource of substantial ecological importance with a long history of human interaction and change. As the longest river in the United States, the Missouri River drains approximately one-sixth of the U.S. land surface. The Missouri River flows 2,341 miles from its headwaters in Montana to the Mississippi River confluence in St. Louis, Missouri (figure 3-7). It drops from an elevation of approximately 14,000 feet above mean sea level (MSL) at its headwaters in Montana, to 405 feet MSL at its

mouth in St. Louis. DeSoto and Boyer Chute Refuges are at approximately 990 feet above MSL. The basin drains an area of 529,350 square miles, overlaps 10 states and one Canadian province, and is home to about 10 million people (MRNRC 1998). The lands and waters of the basin host abundant and diverse resident wildlife and serve as important stopover sites for great numbers of migratory birds in the central flyway.

Broadly speaking, the Missouri River is divided at Sioux City, Iowa—above which semi-natural stretches of the river are punctuated by large hydro-electric dams—and below which the channel has been engineered for navigation. Only three national wildlife refuges have been established on the banks of the channelized third of the river that flows 735 miles between Sioux City, Iowa and St. Louis, Missouri. Two of these, DeSoto NWR and Boyer Chute NWR, are located side-by-side 15 miles north of the Greater Omaha–Council Bluffs Metropolitan Area, or approximately 75 miles downriver from the last large dam. The third is Big Muddy National Fish and Wildlife Refuge, in the state of Missouri. The closest Service landholdings to DeSoto and Boyer Chute Refuges are a part of the Rainwater Wetland Management District (WMD) 75 miles to the west, the Iowa WMD 75 miles to the east, Squaw Creek NWR 100 miles downriver, and Lake Andes NWR Complex 200 miles upriver.

DeSoto and Boyer Chute Refuges provide sanctuary for wildlife in a vast agricultural landscape. The wildlife, habitats, and recreation opportunities associated with this big river system are unique and important. The refuges play a role in a much larger effort to rehabilitate the Missouri River ecosystem and provide opportunities for the public to increase their understanding and appreciation of this ecosystem.

Figure 3-6: Lower Missouri River Floodplain

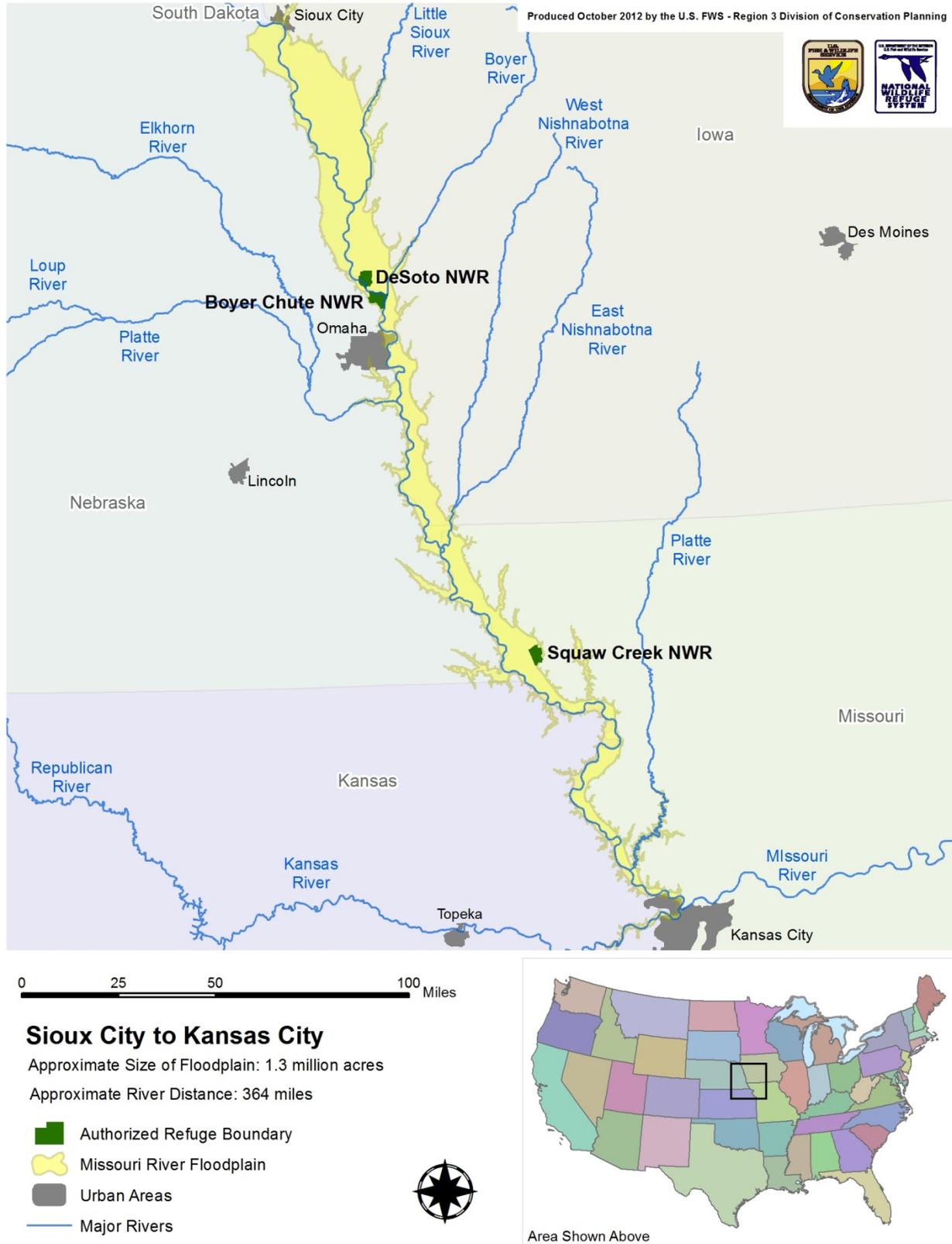


Figure 3-7: The Missouri River Basin



- Missouri River Watershed
- State Boundaries
- Lakes
- Rivers
- DeSoto & Boyer Chute NWRs
- Major Dams
- Cities



The history of the Missouri River as a part of the United States began when the Missouri River Basin was acquired from France on April 30, 1803 as a part of the Louisiana Purchase. The first federal exploration of the new territory occurred between 1804 and 1806, led by army officers Meriwether Lewis and William Clark. Subsequent exploration and navigation of the Missouri River included the adventures of John J. Audubon, Prince Maximilian, John C. Fremont, and Major Stephen Long. The first steamboat traveled the river in 1819, and the first federal improvement of the river began in 1824 with the removal of snags. Between 1820 and 1837, natural meandering and migration of the river in the area that now contains the present-day refuges moved the main channel three miles eastward from the Fort Calhoun bluffs near Fort Atkinson to its present location. Steamboat travel increased on the river and reached its peak in the 1880s but was quickly superseded by trains in the 1890s. A series of legislative acts followed, greatly changing the system dynamics and use of the Missouri River. The natural processes of this river system and the resulting landscape patterns changed dramatically over the 20th century as a result of two major anthropogenic factors: dam construction on the upper two-thirds of the Missouri River, and channelization on the lower 735 river miles below Sioux City, Iowa. The legislation with the greatest impacts on the hydrology and natural resources of the system include the following acts (USACE 2006):

The Rivers and Harbors Act of 1912: Authorized the Corps to create a six-foot navigation channel from St. Louis to Kansas City, Missouri.

The Flood Control Act of 1944: Authorized the development of the main stem of the Missouri River by the Corps according to the “Pick-Sloan Plan.” This plan called for a complete treatment of the river for flood control, navigation improvement, hydroelectric power generation, and the provision of water for irrigation, municipal use, and industry. Although not implemented in its entirety, it led to the creation of hundreds of miles of levees south of Sioux City, Iowa and six main stem dams above Sioux City. The dam construction era started in 1946 with Garrison Dam in North Dakota (excluding the Fort Peck Dam, which was completed in 1937, prior to the “Pick-Sloan Plan”) and was complete by the mid-1960s. The southernmost main stem dam, Gavins Point, located west of Yankton, South Dakota was completed in January of 1957.

The Rivers and Harbors Act of 1945: Authorized the Corps to secure a 9-foot deep by 300-foot wide navigation channel along the 735 river miles from St. Louis, Missouri, to Sioux City, Iowa, as a part of the “Missouri River Bank Stabilization and Navigation Project (BSNP).” This navigation channel was officially completed in 1981 and has been maintained to the present day.

Before the 20th century, the Missouri River flooded annually on a cycle that included a March/April rise caused by rain and melting snow on the Great Plains and then a higher June flood pulse when the Missouri River filled with runoff from Rocky Mountain snowmelt. In summer and fall the river discharge declined, reaching a low point in late December. Fall rains sometimes prompted a slight rise in the river during October or November. This annual cycle of rising and falling water levels, and the associated sediment flow and deposition within the floodplain, once created some of the Nation's most outstanding wetland and bottomland habitats.

In accordance with the “Pick-Sloan Plan,” six large dams were constructed on the Missouri River reaches in South Dakota, North Dakota, and Montana. This greatly changed both the flow regime of the river and the quantity of sediment transported to downstream reaches (National Research Council Panel 2002). Numerous Rivers and Harbors Acts have kept the Corps

working to create and maintain a channel that meets minimum navigation requirements for barge traffic below Sioux City, Iowa. The dams and channelization have brought with them socio-economic benefits such as recreation, power generation, irrigation, transportation, and water storage—but at a high cost to the natural resources of the ecosystem. In fact, “American Rivers” designated the Missouri River one of the most endangered river systems in the United States in 1997. On the landscape, the river’s channelization prompted the construction of levees and dikes, the armoring and stabilization of the river’s banks, the dredging of the navigation zones, and the confinement of the river to a single, stable channel. On the channelized stretches of the river the once broad river floodplain of 1.9 million acres with its mosaic of forests, shrublands, grasslands, and wetlands was reduced to a narrow, highly engineered, incised river course surrounded by agriculture, residential development, and industry. The channelization process eliminated 72 miles of river and nearly 354,000 acres of natural habitats, including the sandbar nesting areas required by bird species such as the federally endangered Piping Plover and Interior Least Tern. Channelization also virtually eliminated the backwater spawning habitat required for fish species such as the federally endangered pallid sturgeon. Additionally, these changes eliminated the cottonwood regeneration cycles that provide successional riparian forest stages important to raptors and passerine birds, and the backwater wetlands that provide food and resting areas for migratory birds in the central flyway (National Research Council Panel 2002). The Missouri River ecosystem currently hosts at least 60 mammals species, 301 bird species, 52 reptile and amphibian species, and 156 fish species (USACE 2006).

Today in terms of river miles, the Missouri River is 35 percent impounded, 32 percent channelized, and 33 percent unchannelized in inter-reservoir reaches (MRNRC 1998). Over the entire course of the Missouri River, forest and shrubland vegetation has declined by 47 percent since the late 1800s (Dixon et al. 2010). This same study analyzed the river reaches just south of Boyer Chute NWR (from Plattsmouth, Nebraska to Kansas City, Missouri) and found 70 percent of the land within a three-mile buffer of the river now in agricultural cropland, 9 percent forest, 7 percent grassland, 4 percent urban, and found that sandbar habitat had been nearly eliminated (Dixon et al. 2010).

Land Cover: Past and Present

Prior to European settlement the Missouri River meandered as a braided, dynamic series of channels, sandbars, backwaters, and sloughs across a wide floodplain. Even in the years between 1820 and 1890 the river channel migrated 5 miles eastward from the Fort Calhoun, Nebraska bluffs to its present location (USACE 1995). It is likely that the refuges were once covered by a shifting mosaic of bottomland forests, prairies, wetlands, and successional shrublands. The continual migration of the river channel would have removed the forest cover and periodically reset the succession cycle. Willows colonized bare islands and sandbars, to be succeeded by cottonwoods, which were later replaced by silver maple, box elder, red mulberry, and American elm.

Beginning in the late 1800s, lands in the river bottom were cleared for agriculture. This process increased in the 1940s and 1950s and is now characterized by agricultural land, altered hydrology, and scattered remnants of natural cover types.

Some of the earliest accounts of the vegetation and landscape in the area of the refuges comes from the journal entries of historical figures such as Captain Meriwether Lewis, William Clark, the Corps of Discovery, and surveyor William N. Byers.

The following edited excerpts describe the landscape and vegetation Lewis and Clark encountered from the Council Bluff and surrounding area (adapted from Lewis and Clark et al. 2002).

July 30, 1804

We proceeded on to a clear open prairie on the left shore, on a rise of about 70 feet higher than the bottom, which is also a prairie of high grass, plum bush, grape vine, and hazel. Both levels form bluffs to the river. The lower prairie is situated above the high water mark at the foot of the rising ground below the high bluff. We came to a small grove of timber at the foot of the rising ground between those two prairies.

Captain Lewis and I went up on the high bank and walked a short distance in the high prairie and observed the most beautiful prospects imaginable. This prairie is covered with grass 10 or 12 inches in height, soil of good quality, and the land rises another 80 or 90 feet about ½ a mile back and is a one continual plain as far as can be seen. From the bluff on the second rise immediately above our camp is visible a beautiful bottom interspersed with groves of timber. The river may be seen for a great distance both above and below meandering through the plains between two ranges of high land (70 to 300 feet), which appear to be from 4 to 20 miles apart, each bend of the river forming a point which contains tall timber, principally willow, cottonwood, some mulberry, elm, sycamore, and ash. The groves contain walnut, Kentucky coffee tree, and oak and in addition, hickory and linden.

August 1, 1804

The prairie, which is situated below our camp is above the high water level and rich, covered with grass from 5 to 8 feet high interspersed with copse of hazel, plumbs, currents (like those of the U.S.) raspberries, and grapes of different kinds, also producing a variety of plants and flowers not common in the United States.

The prairies produce the black currant common in the U.S., the goose berry common in the U.S., and two kinds of honeysuckle, one which grows to a kind of shrub common about Harrodsburg in Kentucky (coralberry/Indian currant/buck brush), the other is not large or tall and bears a flower in clusters short and of a light pink color, the leaves differ from any of the other kind in as much as the leaves are distinct and do not surround the stalk as all the other does (wolfberry/western snowberry).

August 4, 1804

Proceeded on, passed through between snags, which was quit across the river the channel confined within 200 yards, one side a sand point, the other a bend, the banks washing away and trees falling in constantly for 1 mile.

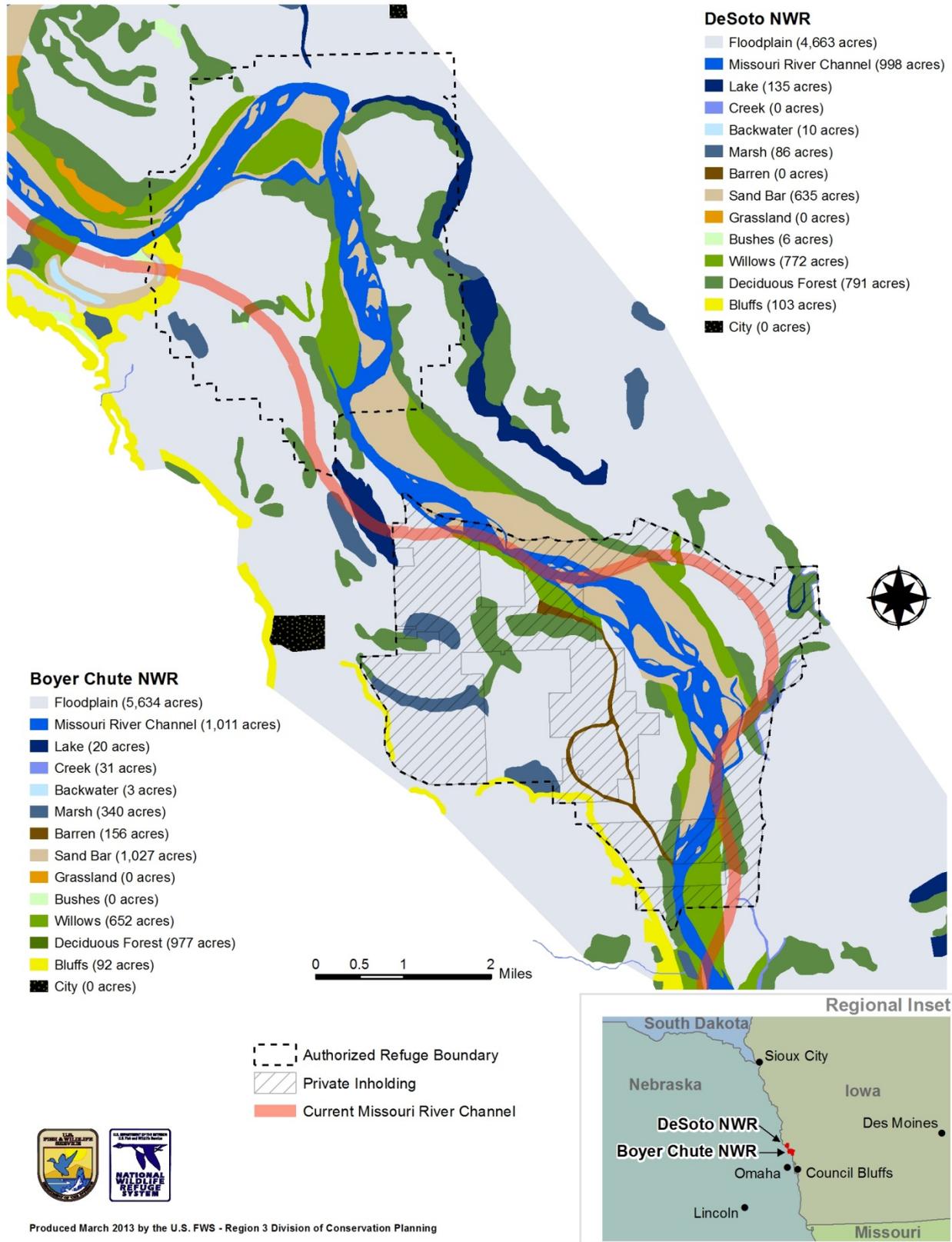
In 1856 William N. Byers, the first deputy surveyor of the Nebraska Territory, also gave a description of the Cabanne Post area six miles south of Fort Atkinson (just north of present-day Dodge Park) near Florence, Nebraska (Jensen 1998).

“Mostly level prairie-rolling . . . soil first and second rate clay and vegetable loam. The remainder of the township is mostly hilly & very broken, soil second rate – clayey. A good deal of this land is timbered with oak, walnut, elm, linn, ironwood, ash and hickory with a dense under growth of some wild plum, hazel, grape vines, & briars. Near the

river the land is level and wet, frequently swampy all subject to overflow. The growth is willows, cottonwood, grape vines, weeds and soil is first to third rate.”

Congress created the Missouri River Commission in 1884 and charged the five-member group with the development of the Missouri River Basin for river commerce, a task they undertook until the program ended in 1902. As a part of their charge, the Commission conducted an extensive surveying effort of the Missouri River in 1879 and 1894, including land cover and cultural features. Within this historical survey archive, the land that includes DeSoto and Boyer Chute Refuges is contained in the third of nine index maps, on plate XXIV. This plate shows a wider river channel, largely uninterrupted gallery forest of cottonwood and willow, small patches and strips of woodlands and forests scattered throughout the river terrace, regular sandbars and sand islands throughout the primary river channel, and a number of floodplain drainages and off-river wetland/open water areas. At the time of the survey, the main channel of the Missouri River coincided with the path of the existing Boyer Chute, and the DeSoto Bend oxbow just upstream and was not yet fully developed (figure 3-8).

Figure 3-8: Historic Land Cover (1894)

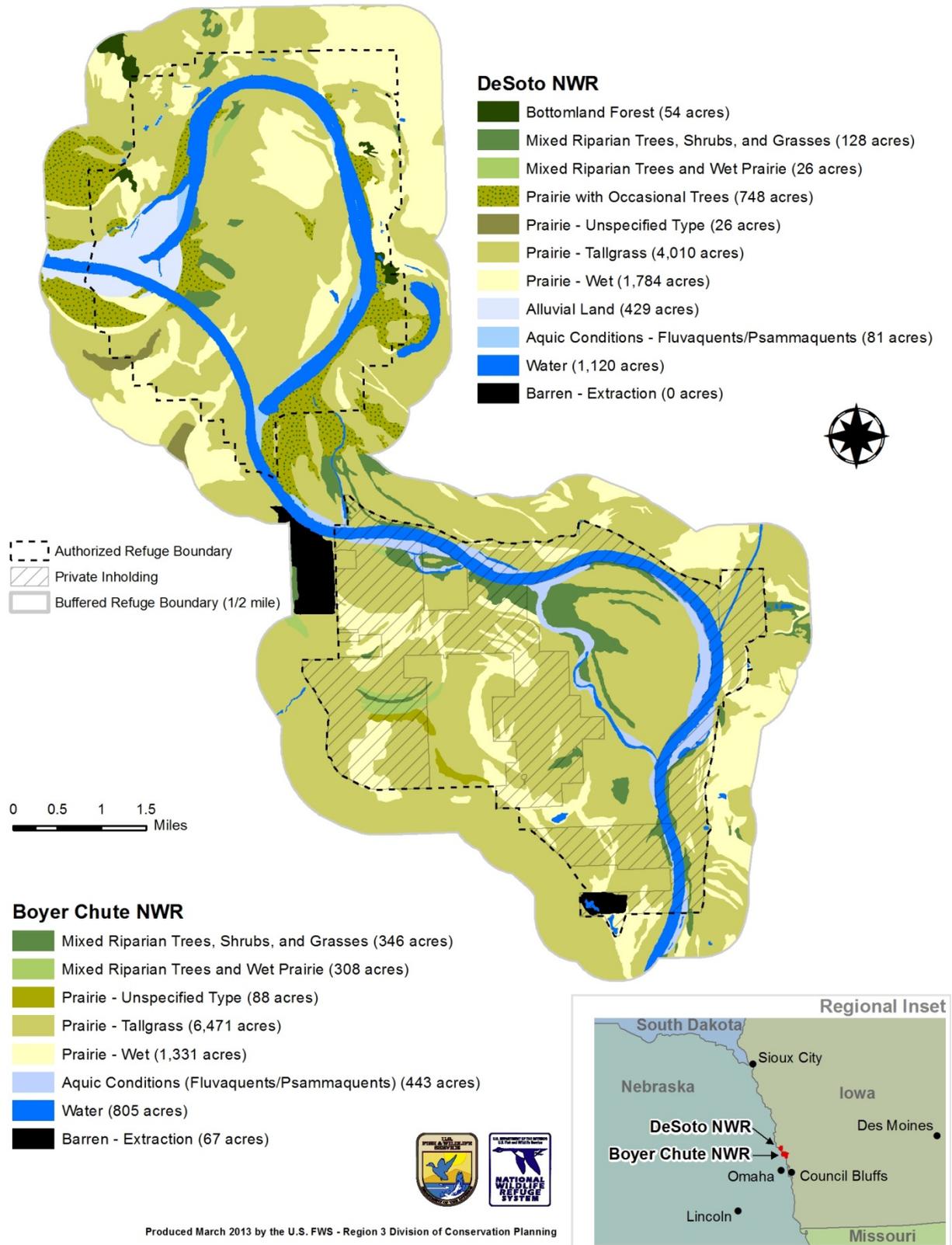


In addition to historic descriptions of the Missouri River landscape, information contained in soil surveys can be used to understand vegetation capacity in an area. The soils in a given locality are the result of the parent rock material, organisms, climate, and relief as they interact over time. These factors and the resulting soils determine, in part, which vegetation communities take hold in a geographic locale. Soil survey data collected over the past century by the U.S. Department of Agriculture's (USDA's) Natural Resource Conservation Service (NRCS) includes written descriptions of native vegetation, which can be linked to the primary soil unit and mapped. Figure 3-9 uses data from the Soil Survey Geographic database to display the potential natural vegetation at DeSoto and Boyer Chute Refuges.

Potential vegetation on DeSoto NWR based on soil data indicate that nearly half (48 percent) of the total refuge acreage is suited to mesic tallgrass prairie with little or no woody component. Common species include big bluestem, little bluestem, Indiangrass, switchgrass, western wheatgrass, sideoats grama, and others. Another 21 percent is wet prairie containing additional species such as Kentucky bluegrass, blue grama, and sedges. Just over 10 percent is suited to sparse cottonwood, willows, and sandburs. Only 1 percent is considered good forest land that might include oak species. The remaining areas of the refuge are either in an open water status (13 percent) or considered a undifferentiated bottomland soil with aquatic conditions (6 percent).

For Boyer Chute NWR, the interpretation of vegetation based on soils indicates that the majority (77 percent) of the refuge's soils are typically associated with prairie grass species absent any woody vegetation. Most of these prairie areas (82 percent) include a typical mix of tallgrass prairie species, while the remainder are considered wet prairies. Approximately 8 percent of the soils within the authorized boundary are suitable for a mixture of native grasses, sandburs, willows, and cottonwoods. According to this dataset, the remainder of Boyer Chute NWR (approximately 15 percent) is comprised of open water, saturated wetland soils, or contains gravel extraction operations.

Figure 3-9: Potential Vegetation Based on Soils

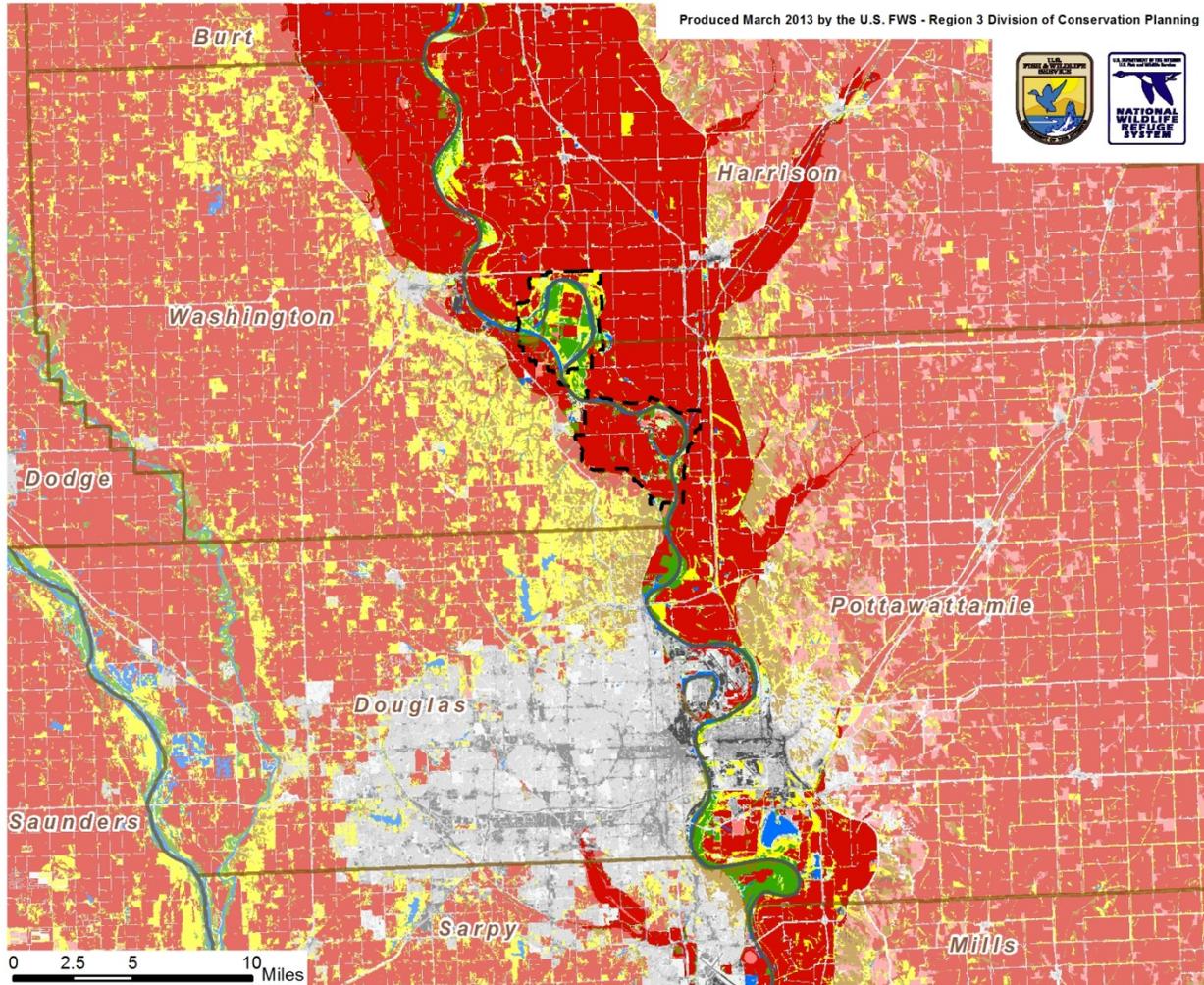


In 2010 the Corps completed a study comparing the composition, extent, and distribution of vegetation in the basin in 1892, the mid-1950s, and 2006. The study sampled 13 segments of the river, and only one of these occurred in the unchannelized section of the river below Sioux City, Iowa. Although segment 13 from Plattsmouth, Nebraska to Kansas City, Missouri (river miles 365.5 to 595.5) does not include the refuges, the development paradigm and land cover information are similar. The study indicates that in 2010, 70 percent of the floodplain was agricultural cropland, 9 percent forest, 7 percent grassland, and 4 percent urban. Most of the transition to agriculture and the decline in floodplain forests occurred before the mid-1950s, whereas much of the loss of shrubland (75 percent) and grassland (49 percent) occurred after the mid-1950s (Dixon et al. 2010).

A 21-class national land cover dataset developed by the Multi-resolution Land Characteristics Consortium using 2001 Landsat imagery was used to understand the geographic distribution of land use (U.S. Geological Survey [USGS] 2003). This imagery is medium resolution data with 30-meter pixels, so features less than 100 feet are generalized. However, across large areas this imagery is useful for understanding which parts of the landscape have retained natural cover types and which have been developed for human uses. Figure 3-10 shows the resulting imagery and depicts land cover emphasizing lands in the Missouri River floodplain. Cropland, pasture, and grassland now cover the vast majority of the region. The cities of Omaha and Blair in Nebraska and Council Bluffs and Missouri Valley in Iowa stand out due to their developed cover types. Forests, wetlands, and open water are all relatively minor components. The outline of the floodplain is accentuated in the figure by a white transparent mask over non-floodplain areas, and can also be discerned on the landscape by the abrupt change from the flat agriculture lands in the river valley to the mixed forest/grassland cover types on the bluffs.

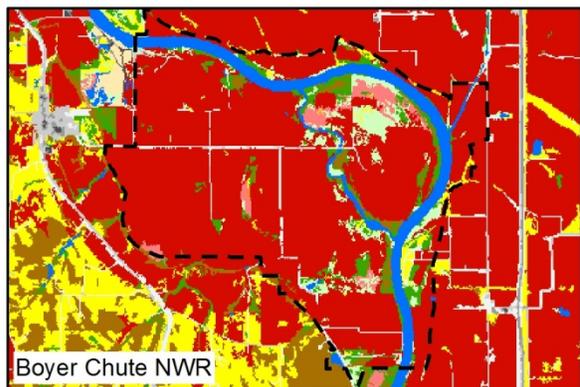
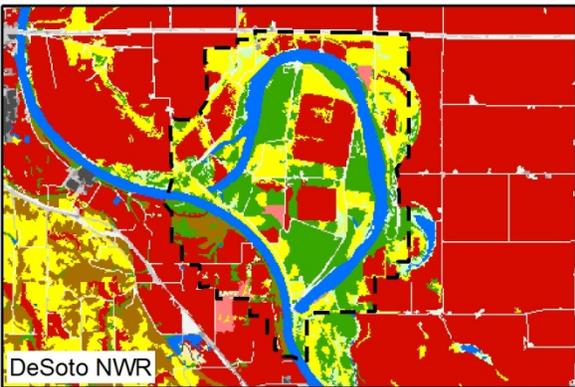
Close-ups of DeSoto and Boyer Chute Refuges are included in figure 3-10 to provide additional detail for the refuges. The limitation to using this data at a fine scale is fairly clear in the case of Boyer Chute NWR. The data does not accurately distinguish grassland areas of the refuge from surrounding cultivated cropland; some restored wetlands are also indiscernible. It does, however, portray the extent of the riparian forests and woodlands, show the limited coverage of successional shrublands, and illustrate the intensity of agricultural development. On DeSoto NWR the grasslands and forests are discernible, but few wetlands are visible, and much of the West Side Unit is shown as agriculture. Finer resolution and more accurate cover type assessment of lands owned and managed by the Service within the authorized refuge boundaries can be found in the Habitat section of this chapter.

Figure 3-10: National Land Cover Data in the Area of the Refuges



National Land Cover Data (2001) - Focus on the Missouri River Floodplain

- | | | | |
|-----------------------------|-------------------|---------------------|----------------------------|
| Open Water | Barren Land | Grassland | Authorized Refuge Boundary |
| Developed, Open Space | Deciduous Forest | Pasture/Hay | County Boundary |
| Developed, Low Intensity | Coniferous Forest | Cultivated Cropland | |
| Developed, Medium Intensity | Mixed Forest | Woody Wetland | |
| Developed, High Intensity | Scrub/Shrub | Herbaceous Wetland | |



Physical Environment

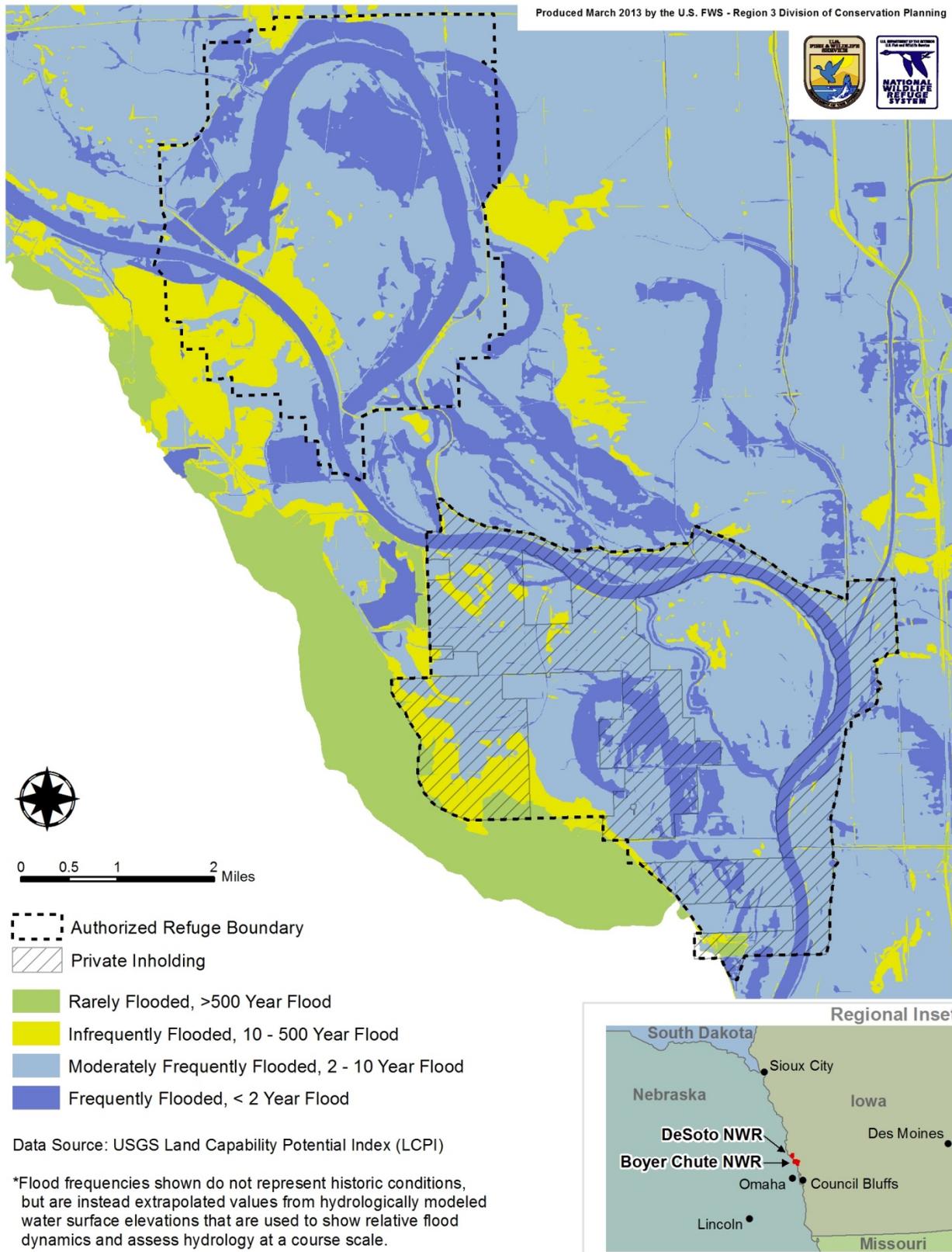
The Physical Environment section describes the abiotic resources associated with the refuges including topography, geology, climate, soils, water, and air. These underlying, non-living components of an ecosystem provide the stage on which wildlife, habitat, and people interact.

Topography and Geology

Contained entirely within the Missouri River floodplain, the land surface of the two refuges is relatively flat, and much of the refuge lands are within the 10-year floodplain level (figure 3-11). Elevation on DeSoto NWR ranges from 987 feet (301.1 meters) above MSL in low areas with ponds and in areas adjacent to DeSoto Lake, to 1,014 feet (309.2 meters) MSL on levees and roads. In Boyer Chute NWR's authorized boundary, elevations range from 976 feet (297.6 meters) MSL in lower wetland areas and drainage ditches, to 1,092 feet (332.9 meters) MSL on the small south-central points that rise onto the bluff (Jacobson et al. 2007). The elevation data show depressional areas of both refuges such as the wetlands on the outer rim of DeSoto Lake and Boyer Chute NWR's Mud Lake and Horseshoe wetland complexes.

The bedrock in the area of the refuges is made up of sedimentary deposits from the Late Carboniferous system, Pennsylvanian series, and Missourian stage sedimentary deposits. On the Nebraska side of the river, the bedrock is classified into the Kansas City group (Burchett 1959, 1986). This geologic formation underlies approximately 19 percent of Washington County and is located primarily in the southeast corner of the county. The group is made up of limestone and shale deposits and has an approximate maximum thickness of 200 feet. The limestones range in color from dark to light gray and brownish gray, and range in structure from very thin beds to massive, argillaceous and fossiliferous deposits with thin layers of chert, pyrite, and mica near the base. The color of the shales varies from shades of gray to greenish gray, red, and black and may be slightly sandy, calcareous, carbonaceous, fissile, and fossiliferous. On the Iowa side of the river, the bedrock underlying the refuges is considered to be part of the Bronson group (limestone, shale) and the Upper Cherokee group (shale, sandstone, limestone) both occurring in south-central and southeast Iowa (Witzke et al. 2010). In the Bronson group, sandstones and coals are uncommon, while marine fossils are prevalent. Ancient oceans expanded (producing limestone beds) and receded (producing shale beds) in cycles producing numerous layers of these sedimentary deposits. The Cherokee group contains alternating deposits of shale, clay, siltstone, lesser sandstone, thick coal beds, and minor but persistent limestone beds.

Figure 3-11: Extrapolated Flood Frequencies*



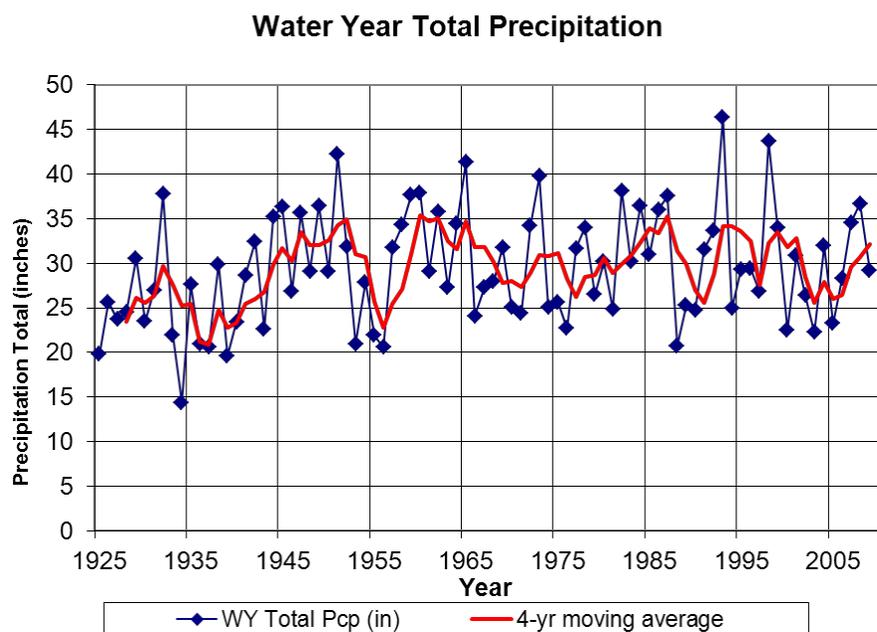
Climate

The refuges reside in a zone considered to have a humid continental climate, typical over large areas of land masses in the temperate regions of the mid-latitudes. The climate is typified by a zone of conflict between polar air masses pushing southward and tropical air masses pushing northward. Humid continental climates are marked by variable weather patterns and a large seasonal temperature variation. Summers are often warm and humid with frequent thunderstorms, and winters can be very cold with frequent snowfall and persistent snow cover.

Average annual precipitation is 26.5 inches. Rainfall during the warm season is 19.2 inches or 72 percent of total rainfall. The frost-free season generally falls between April 28 and October 11, and there is an average of 136 days per year below 32 °F. Annual average temperature is 49.3 °F. Summer average temperature is 75 °F with an average daily maximum temperature of 87 °F. Average winter temperature is 25 °F. Temperature extremes range from 113 °F to -28 °F. Average annual relative humidity is 68 percent. Evaporation from a Class A evaporation pan in Lincoln, NE (~70 miles southwest) averages 60 inches per year, 74 percent of which occurs between May and October. Sunshine occurs 64 percent of the total possible daylight hours. Average wind speed is 11 mph, and wind direction is predominantly north by northwest. Strongest winds occur in the spring, with area maximums at 109 mph.

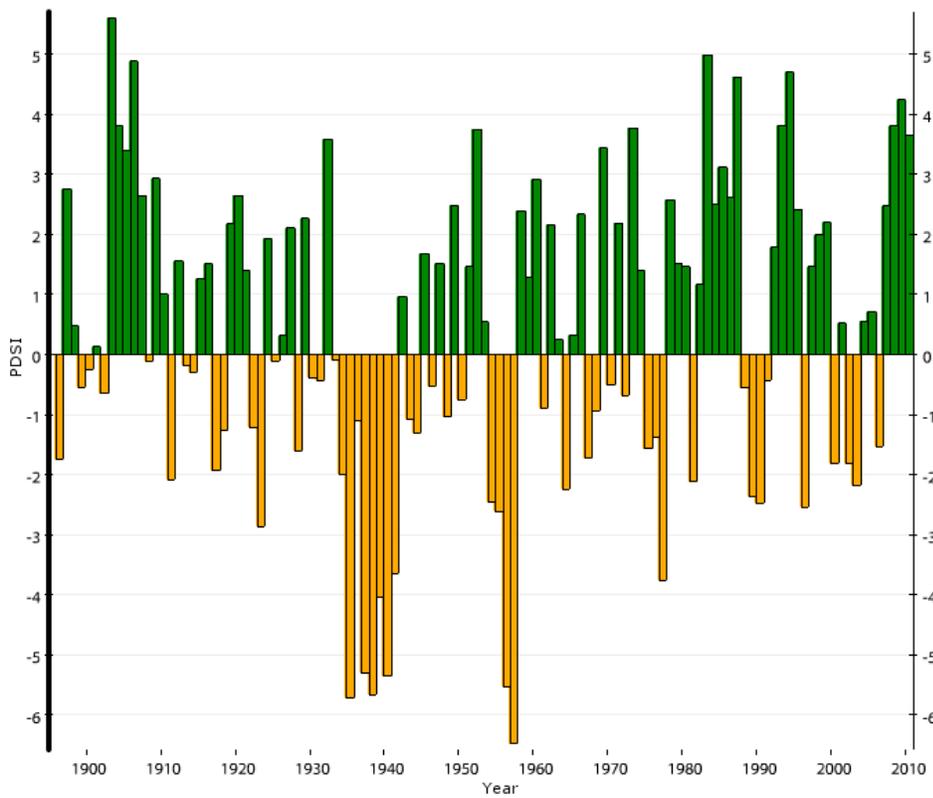
Precipitation data for the refuges is collected using the Parameter-elevation Regressions on Independent Slopes Model (PRISM), which uses point precipitation measurements, elevation data, and other spatial data sets to derive a continuous climatic data layer for the United States. PRISM data for the area of the refuges through 2009 indicates relatively consistent long-term trends (figure 3-12). Annual precipitation totals have roughly followed a 6–8 year cycle from wet to dry over the past 85 years, with the highest precipitation totals in 1993 and 2001 and the lowest totals in 1934 and 1939. On average, peak precipitation occurs during May and June, although monthly totals in certain years have exceeded 8 inches during April, May, June, July, and August over the last 34 years. After peak precipitation in early summer, the remainder of the year through December experiences a gradual decrease in precipitation (PRISM 2011).

Figure 3-12: Annual Precipitation in the Area of the Refuges (1925-2009)



Insight can be gained into the periodicity of annual wet and dry cycles over the long-term using the Palmer Drought Severity Index (PDSI). This index represents moisture conditions based on monthly temperature and precipitation data as well as the soil's water holding capacity at a location (Palmer 1965). A PDSI score ranging from 0.5 to -0.5 is within a normal range of variation. However, the scale extends to scores over 4 or under -4, which indicate wet and dry extremes respectively. The refuges fall into U.S. Climatological Division 25-06, East Central Nebraska, and 13-04, West Central Iowa. The annual PDSI calculations starting in the year 1895 are illustrated in figure 3-13 (NOAA, 2011). In general, dry weather runs in 10-year cycles on the prairie and severe drought in 20-year cycles (Zohrer 2006).

Figure 3-13: Palmer Drought Severity Index (PDSI) for the Refuges



Predicted Climate Change

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

Several examples of potential climate change impacts on wildlife have been identified. The following are just a few issues that may require further attention as climate change progresses (Green et al. 2000; Schneider and Root 2002).

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

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

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

A climate change study by Magness et al. (2011) on the NWRS gave DeSoto and Boyer Chute Refuges a low exposure rating estimating a 0.011 °C (DeSoto NWR) and 0.0019 °C (Boyer Chute NWR) rise in temperature per year based on historic rates of change between 1950 and 2006. The paper also indicated that DeSoto and Boyer Chute Refuges have a low sensitivity to climate change because they are not near the edges of the Temperate Grassland, Savanna, and Shrubland biome (Olson et al. 2001) and contain little critical habitat for threatened and endangered species. They also are considered to have a low adaptive capacity, because they contain little elevation change, a small latitude range, have very little of their watersheds permanently protected, and have a high watershed road density. Based on these conditions, the refuges' resilience and vulnerability to climate change were considered moderate.

Mitigation and Adaptation

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

There are many ways that refuges currently help mitigate the onset of climate change including increasing ecological resiliency and reducing environmental stressors. Refuges will also play a critical role in adaptation strategies in the future. Table 3-1 (next page) lists a number of examples in which refuges contribute to climate change mitigation and adaptation.

Table 3-1: Refuge Contributions to Climate Change Mitigation and Adaptation

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

Soils

Soils of the Missouri River floodplain are highly variable, ranging from light sandy soils that drain quickly to dense clays that are nearly impermeable to water. The soils of both refuges were recently formed from coarse to fine-textured alluvium (river-deposited sediments). The variation in local soil characteristics are a consequence of historic annual flood cycles and the continual migration of the pre-channelized river across the floodplain. The mouth of the Boyer River meets the Missouri River at the eastern edge of Boyer Chute NWR resulting in the accumulation of sediments and the formation of Boyer Island. Overall, the soils on both refuges are generally low-to-moderate in organic matter and are calcareous—ranging from neutral to moderate alkalinity. Available phosphorus is generally low, while available potassium is generally high. Permeability ranges from rapid to slow, depending on site-specific alluvium deposition history. Sand, loam, and clay layers vary over short distances; in some areas clays and loams form the upper layer of the soil and are underlain by fine sand and sandy loams. Other areas on the refuges contain soils consisting entirely of clay or entirely of sand. Still other areas have sandy loams over clay or clay loams.

Figures 4-14 and 4-15 provide additional detail on the extent and distribution of soils across the authorized refuge boundaries. The soil types with the greatest extent within the authorized boundaries for both refuges are either in the Albaton-Haynie-Sarpy association or are in the Onawa series. They are nearly level, except for short slopes along old channels and drainageways, and on a few ridges in the sandy areas. The three soils in the association are deep, nearly level, formed in alluvial bottomlands and differ primarily in their sediment type and the resulting drainage; Albaton is clayey and poorly-drained, Haynie is silty and well-drained, and Sarpy is sandy and excessively-drained. Onawa, the other soil series on the refuges with a large area of coverage, is very deep, somewhat poorly-drained alluvial soil with a layer of clay over loam (USDA NRCS 2011).

A number of soils have moderate (500–1,000 acres) and minor (200–500 acres) coverage on the refuges. Included are Cooper, Modale, and Merville (silt underlain by clay and somewhat poorly-drained); Grable (silt underlain by sand and well-drained); Sarpy and Wathena (sandy and moderately well-drained to excessively-drained); Onawet (silty clay loams and very poorly-drained); Forney and Luton (clay and poorly-drained); Percival (clay underlain by sand and somewhat poorly-drained); Omadi (loam and moderately well-drained); and Salix (a mix of silty clay loam and moderately well-drained) (USDA NRCS 2011).

The drainage classes associated with refuges' soil types are illustrated in figure 3-16. This information, in combination with the flood frequency map (figure 3-11), can be used to identify the wetland and upland restoration potential of sites across the refuges. On DeSoto NWR concentrations of well-drained soils form a band running diagonally northeast to southwest in the center of the refuge. These correspond with areas that are a part of the oxbow bend of the river and the island formed within the oxbow. Areas north of DeSoto Lake, and on the central portion of the West Side Unit have increased water retention and poorer drainage. The drainage on Boyer Chute NWR is a diffuse mosaic, with a higher concentration of well-drained soils in the east half (including Boyer Island) and large patches of poorly-drained soils that are remnants of previous Missouri River channel scars. The bluffs are evident on the refuge's western boundary as a solid band of well-drained soils.

Figure 3-14: Soil Types, DeSoto NWR

-  Authorized Refuge Boundary (8,365 acres)
-  Albaton and Sarpy soils (88 acres)
-  Albaton silt loam (54 acres)
-  Albaton silty clay (527 acres)
-  Albaton silty clay, 0 to 2 percent slopes (31 acres)
-  Albaton silty clay, occasionally flooded (705 acres)
-  Aquolls (4 acres)
-  Blake and Haynie soils (49 acres)
-  Blake silty clay loam (105 acres)
-  Blake silty clay loam, 0 to 2 percent slopes (39 acres)
-  Blencoe silty clay (15 acres)
-  Blyburg silty clay loam, rarely flooded (26 acres)
-  Cooper silty clay loam (23 acres)
-  Cooper silty clay loam, rarely flooded (96 acres)
-  Fluvaquents, sandy, frequently flooded (20 acres)
-  Fluvaquents, silty, frequently flooded (38 acres)
-  Forney silt loam, overwash, rarely flooded (92 acres)
-  Grable silt loam (21 acres)
-  Grable silt loam, 0 to 2 percent slopes (97 acres)
-  Grable silt loam, occasionally flooded (198 acres)
-  Haynie silt loam (94 acres)
-  Haynie silt loam, 0 to 2 percent slopes (71 acres)
-  Haynie silt loam, occasionally flooded (1,601 acres)
-  Keg silt loam (6 acres)
-  Kenmoor fine sand (54 acres)
-  Luton silty clay, rarely flooded (31 acres)
-  Luton silty clay, thin surface (151 acres)
-  Modale silt loam (71 acres)
-  Modale very fine sandy loam (11 acres)
-  Onawa silt loam (12 acres)
-  Onawa silty clay (504 acres)
-  Onawa silty clay loam, occasionally flooded (319 acres)
-  Onawa silty clay, 0 to 2 percent slopes (9 acres)
-  Onawa silty clay, occasionally flooded (339 acres)
-  Onawa-Haynie complex, occasionally flooded (140 acres)
-  Onawet silty clay, depressional, frequently flooded (26 acres)
-  Orthents, loamy (2 acres)
-  Percival silty clay (34 acres)
-  Percival silty clay, 0 to 2 percent slopes (45 acres)
-  Psammaquents, frequently flooded (17 acres)
-  Riverwash (429 acres)
-  Salix silty clay loam, rarely flooded (112 acres)
-  Sarpy fine sand, 0 to 3 percent slopes (152 acres)
-  Sarpy fine sand, 3 to 7 percent slopes (39 acres)
-  Sarpy fine sand, occasionally flooded (21 acres)
-  Sarpy fine sand, occasionally flooded (2 acres)
-  Sarpy fine sandy loam, 0 to 3 percent slopes (152 acres)
-  Sarpy loamy fine sand, 0 to 3 percent slopes (231 acres)
-  Sarpy loamy fine sand, occasionally flooded (151 acres)
-  Vore silty clay loam (21 acres)
-  Water (1,120 acres)
-  Wathena fine sandy loam, occasionally flooded (107 acres)
-  Woodbury silty clay (68 acres)

Produced October 2012 by the U.S. FWS - Region 3 Division of Conservation Planning

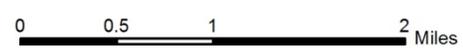
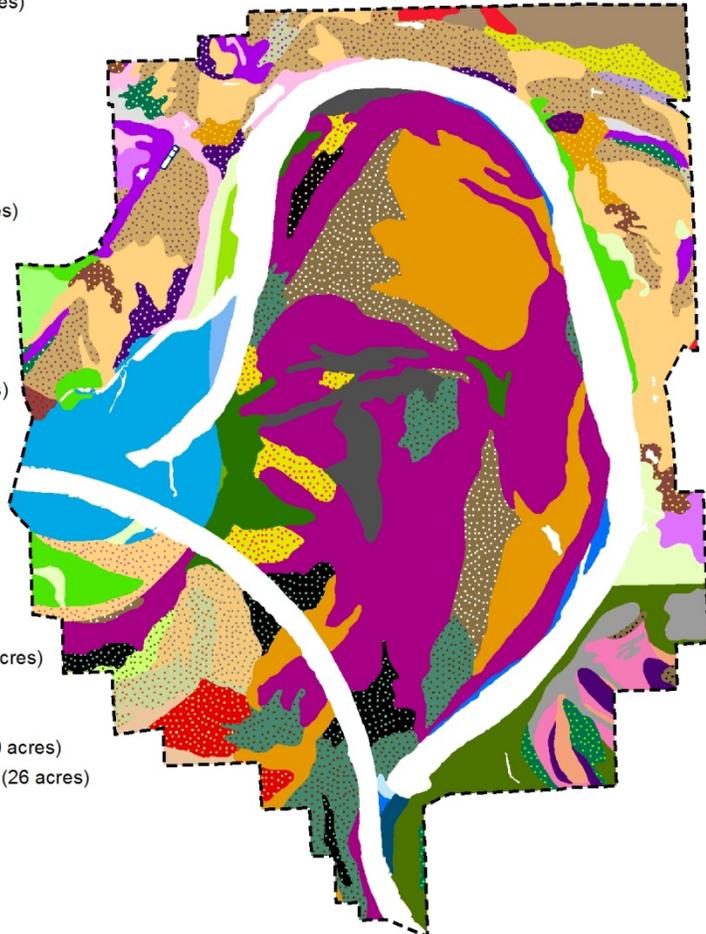


Figure 3-15: Soil Types, Boyer Chute NWR

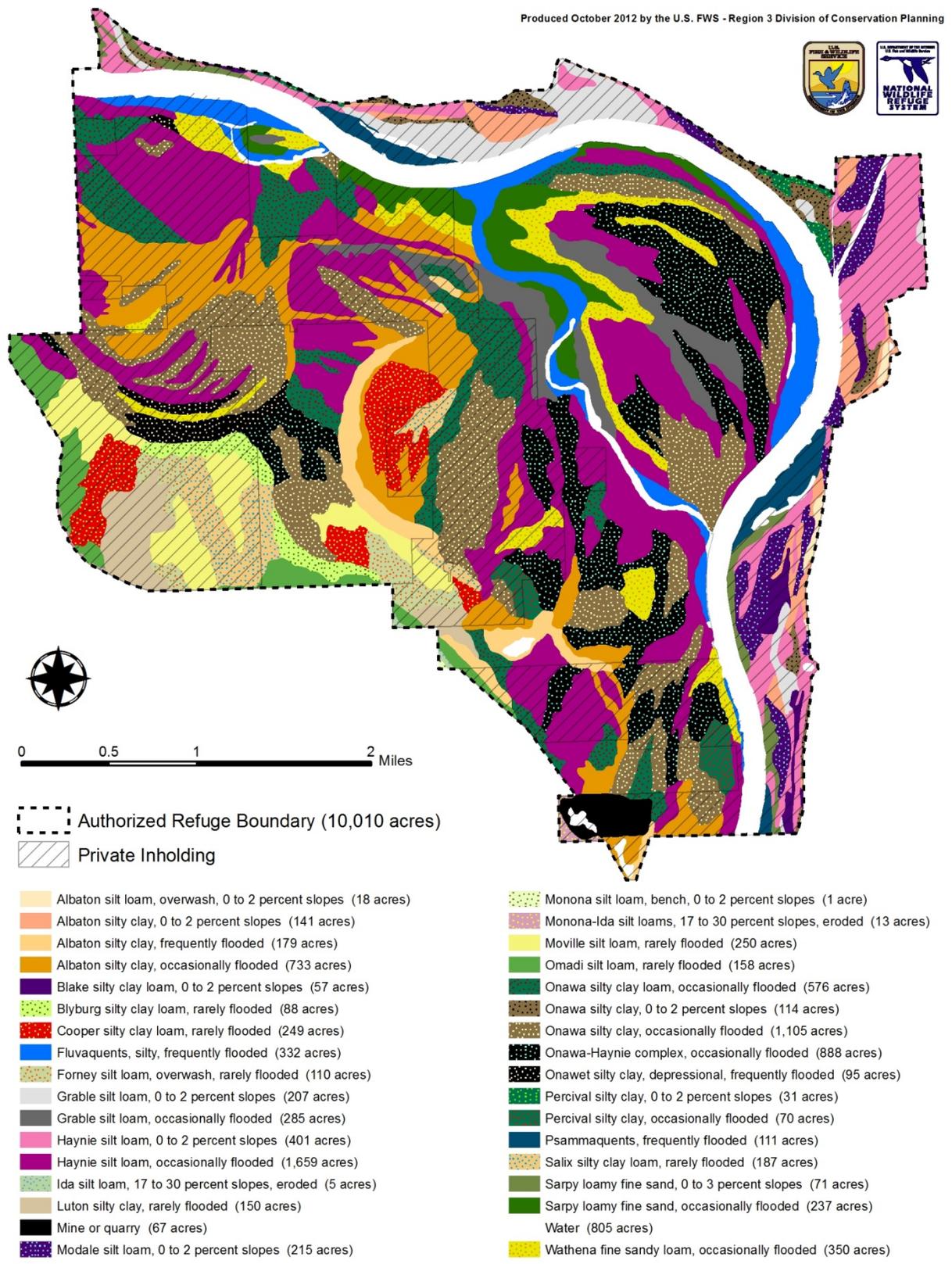
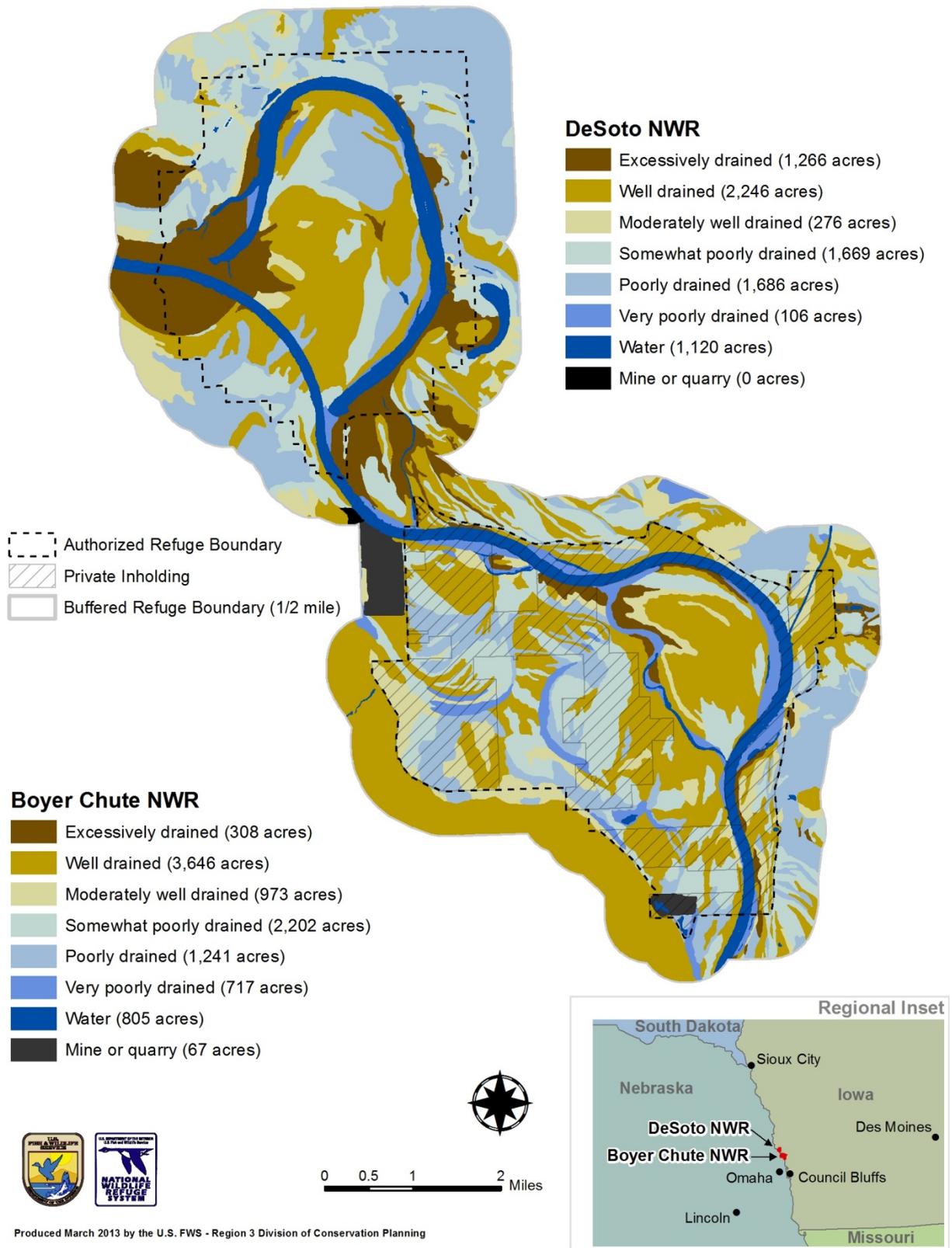


Figure 3-16: Soil Survey Drainage Classes



Water Resources

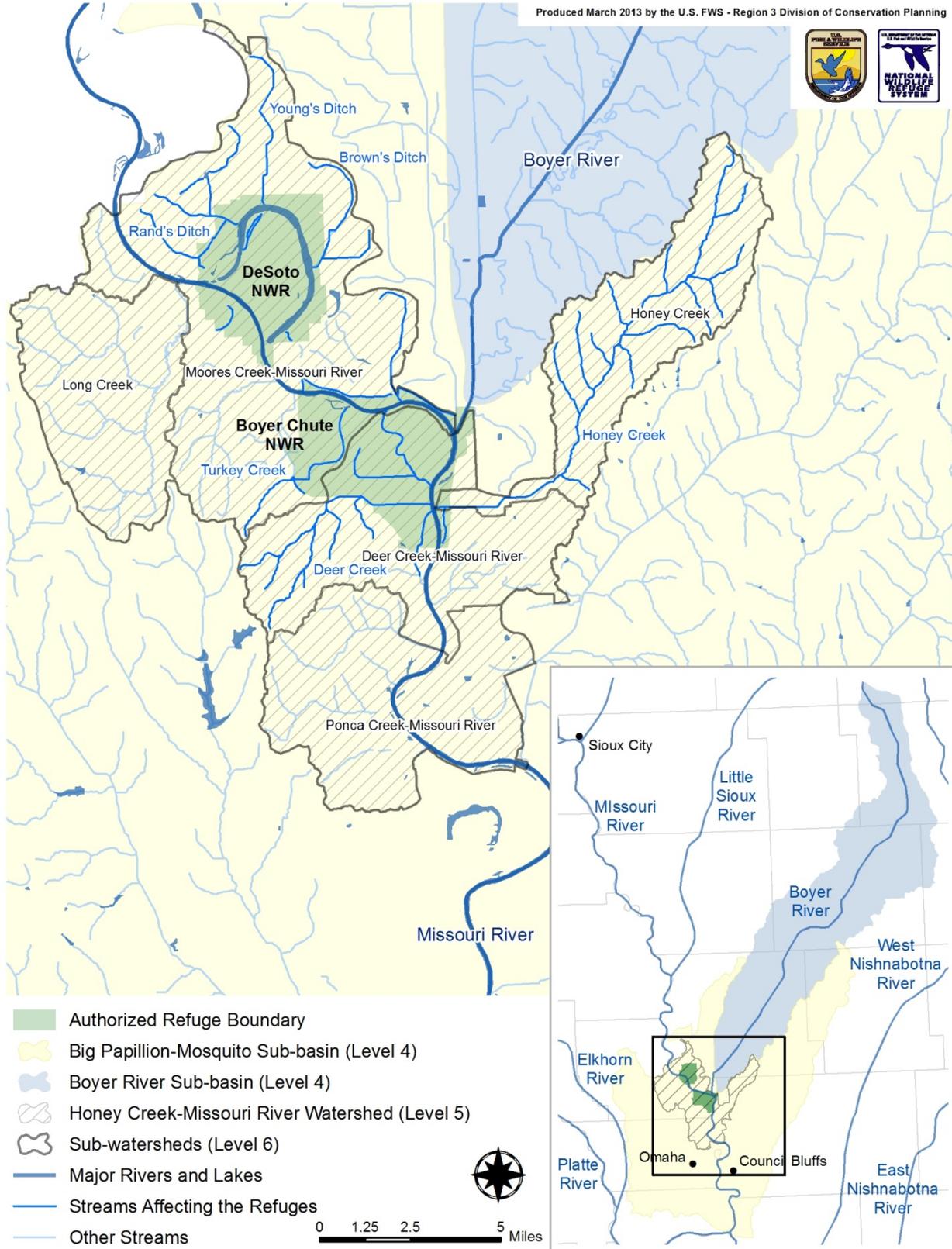
Refuge Hydrology

DeSoto and Boyer Chute Refuges are categorized within the hydrologic units of the USGS Hydrologic Unit Code (HUC) system as depicted in table 3-2:

Table 3-2: Refuge Hydrologic Unit Codes

HUC Level	Name	Sq. Mi.	HUC Number
1 Region	Missouri	529,350	10
2 Sub-region	Missouri-Little Sioux	9,140	1023
3 Basin	Missouri-Little Sioux	9,140	102300
4 Sub-basin	Big Papillion-Mosquito	1,160	10230006
5 Watershed	Honey Creek-Missouri River	182	1023000605
6 Sub-watershed (DeSoto NWR)	Moore's Creek-Missouri River	65	102300060504
6 Sub-watershed (Boyer Chute NWR)	Moore's Creek-Missouri River	65	102300060504
	Deer Creek-Missouri River	34	102300060505

Figure 3-17: Watershed and Hydrology of the Refuges

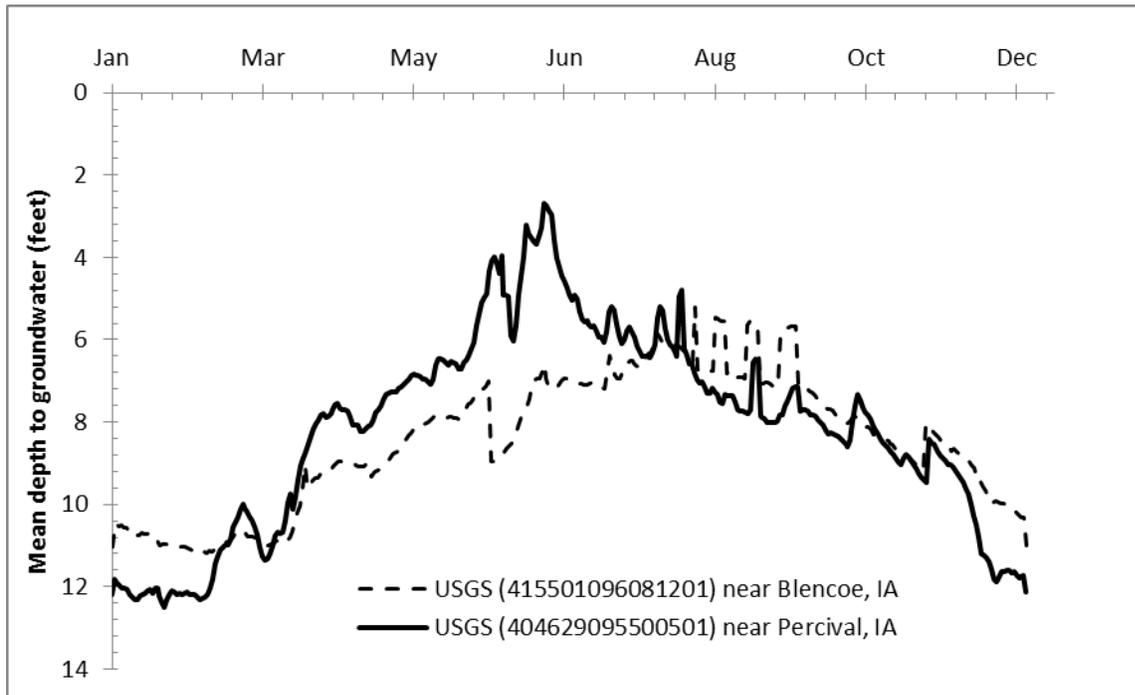


All of DeSoto NWR and the northwest portion of Boyer Chute NWR fall within the Moore's Creek – Missouri River sub-watershed (Level 6, HUC 12), while the southeast portion of Boyer Chute NWR falls within the Honey Creek – Missouri River sub-watershed (Level 6, HUC 12). Figure 3-17 depicts the drainage areas as well as the rivers, streams, and ditches associated with the refuges. The drainage basins associated with the refuges have relatively small upstream areas, and all water ultimately flows into the Missouri River. Boyer Chute NWR contains two additional drainage systems that flow in from the east (Iowa). These drainages travel only short distances through the authorized refuge boundary before emptying into the Missouri River. The bigger of the two is the Boyer River and its sub-basin, which has its own 1,089 square-mile watershed (Level 4, HUC 8), and the second is the Honey Creek sub-watershed (Level 6, HUC 12), which drains a 27 square-mile area.

The majority of the water that flows from the sub-watershed through DeSoto NWR on the east side of the Missouri River flows to DeSoto Lake. The drainage area for the lake is 12,563.46 acres (19.63 square miles) (Iowa Department of Natural Resources 2012), and contains three major drainage ditches: Young's, Brown's, and Rand's. There are also a few smaller, unnamed drainage channels and large areas of surface flow across the refuge. The flat topography of the floodplain and variable soils also afford natural ephemeral wetland areas. A number of old Missouri River channel scars on and adjacent to the DeSoto NWR retain water during flood stages. One of these on the south end of DeSoto Lake releases water south along the east edge of Wilson Island State Recreation Area before draining to the Missouri River. Another of these scars on the west side of the Missouri River takes on water from the main river channel during high water periods.

On Boyer Chute NWR, two streams flow eastward through the refuge from the bluffs on the western edge of the floodplain: Turkey Creek to the north and Deer Creek to the south. Both streams have been modified for improved drainage and are maintained by the Fort Calhoun Drainage District. Two water control structures were installed by the Papio-Missouri River Natural Resource District and one was installed by refuge staff to divert water to restored wetland basins on the refuge. High Missouri River flows can cause flooding on the refuge and turn the ditches and creeks into backwater areas. In more extreme high water conditions, the refuge may experience overbank flooding from the Missouri River. In other situations, the Missouri River may be acting as a hydraulic dam preventing drainage from other parts of the refuge. Seasonal groundwater levels can also impact the ability of surface water to drain off the refuge.

Water level data for the Missouri River is regularly collected by USGS gauges upstream of the refuges, at Boyer Chute, and at several groundwater monitoring sites located throughout the Missouri River floodplain. The Missouri River gauge upstream of the refuge in Decatur, Nebraska does not indicate many large fluctuations—not surprising considering modern regulation of Missouri River flows. A review of Missouri River water levels over the past 20 years shows that the regulated water levels of the Missouri River are relatively consistent. Notable exceptions include summer flood events in 1993, 1995, 1996, 1997, 2001, 2010, and 2011. Long-term data show that the Missouri River tends to crest and remain at higher water levels beginning in mid-March. Figure 3-18 uses data from USGS groundwater monitoring sites at Blencoe, Iowa (30 miles north of the refuges) and Percival (60 miles south of the refuges) to show floodplain groundwater trends. The available data spans the years from 1995–1996 and 2008–2011, and indicates a median depth to groundwater of approximately 10 feet. The graph also shows that groundwater response is approximately a month after the Missouri River peaks, water levels peak mid-summer and are relatively low from late-September through late-April, and a number of spikes suggesting water levels are especially responsive to rain events.

Figure 3-18: Groundwater Trends in the Area of the Refuges

Water Rights

The refuges have a system of ditches, creeks, wells, and water control structures for moving water within the refuges to fill the various impoundments.

Water law in the state of Nebraska is governed by prior appropriation water law, meaning that during shortages, water is appropriated to those individuals and entities that hold the oldest water rights. This is different than the neighboring state of Iowa, which governs its water law under riparian water law doctrine and allows equal rights to riparian land owners.

In accordance with Nebraska state water law, the Boyer Chute NWR maintains five surface water rights and has eight wells registered to account for water withdrawals and diversions used for habitat management on the refuge. The five surface water rights total 842.65 acre-feet per year, while the eight groundwater wells allow for the supply of significantly more water. Most of these rights are supplemental, meaning the water sources are commingled to supply the refuge needs for optimum operation. Currently, water management activities at DeSoto NWR do not require permitting under Iowa state water regulations (<25,000 gallons per day), and water is neither pumped nor diverted from the portions of the refuge located in Nebraska.

The main season of water use is from mid-March until early December. This varies with water conditions as determined by annual precipitation, snowmelt, and availability of water from creeks and supply ditches. Adequate water is important to provide spring and fall migration stopover habitat for migratory birds.

Water Contamination

Contamination of water resources on DeSoto NWR consists predominantly of sediment and agricultural runoff that enters the refuge via sheet flow (non-point sources), drainageways, and the Missouri River. Occasional flood events can also bring contaminants onto refuge lands and waters. Three drainage ditches (Young's, Rand's, and Brown's) drain neighboring agricultural fields, enter the refuge, and outlet into DeSoto Lake.

Groundwater samples on DeSoto NWR indicate elevated iron concentrations. Wetland units fed by groundwater sources incur iron flocculate, limiting primary productivity. Treatment methods are prohibitively expensive, and using alternative water sources is recommended.

Prior to the establishment of Boyer Chute NWR the Papio-Missouri River Natural Resources District retained Jacobson Helgoth Consultants, Inc. to do an environmental site assessment of the Boyer Island and West Chute units. They concluded, "No information was found which indicates that the properties have been affected by hazardous waste, PCBs [polychlorinated biphenyl], or other toxic substances or pollutants." Further, "With the exception of the small dump sites . . . no information was found which would indicate previous use for industrial, military or landfill purposes." The quality of groundwater and surface water are normal for the area. Water pumped from irrigation wells shows signs of considerable iron content. No known industrial or agricultural contaminants are known to exist. Other potential contaminant sources within the Boyer Chute NWR approved acquisition boundary are residential septic systems and agricultural non-point source runoff.

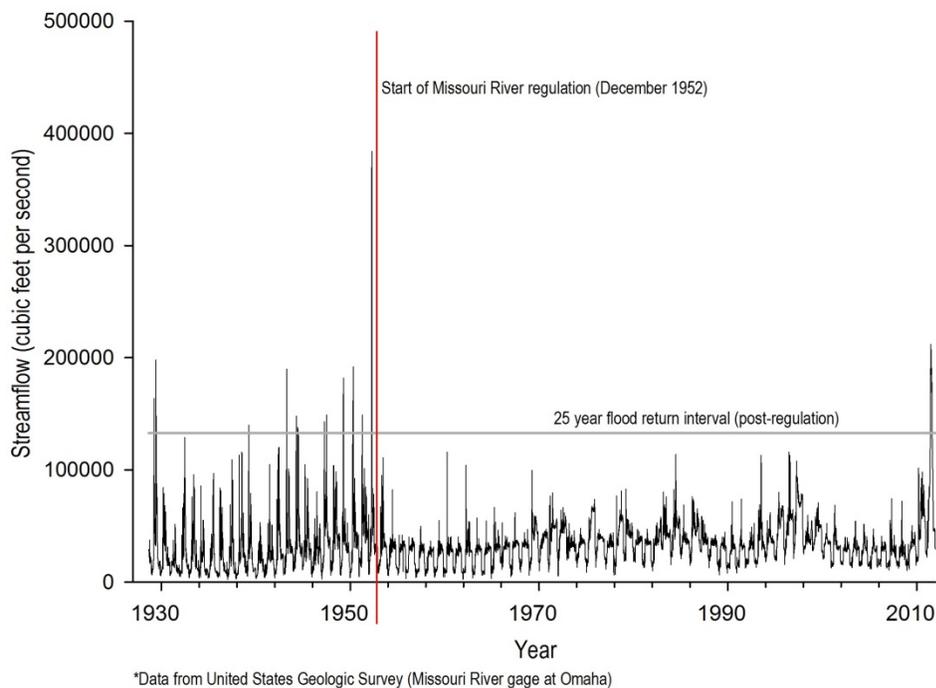
Treated sewage effluent from the Fort Calhoun Sewage Treatment Plant on the western boundary of the authorized refuge boundary previously flowed through the refuge, emptying into Turkey Creek and then entering the Missouri River. However, the Fort Calhoun Sewage Treatment Plant is no longer in service. Through a renewable 20-year inter-local agreement signed in July of 2007, Fort Calhoun, Nebraska opted to construct piping and conveyance facilities to transport its sanitary wastewater to a treatment facility in Blair, Nebraska.

Missouri River System

The Missouri River's impact on the floodplain landscape has been greatly reduced over the past century, yet it retains a role in reshaping the mosaic of habitats during floods. The river once played a much larger role, as the dynamic landscape of the Missouri River Basin continually reshaped its channel and floodplain through a never-ending process of creation and destruction, deposition and erosion. However, numerous Flood Control Acts and the Missouri River Bank Stabilization and Navigation Project were used to control erosion and protect land along the river. Over the past century, the Missouri River has been converted from a free-flowing river into a series of reservoirs and channelized waterways, effectively separating the river from its floodplain. Since 1890, the length of the Missouri River between Sioux City, Iowa and St. Louis, Missouri has been shortened by about 75 miles or almost 10 percent (USACE 2004). This vast engineering program has had devastating impacts on fish and wildlife populations and habitat. Roughly 168,000 acres of natural channel and 354,000 acres of associated floodplain habitat have been lost on the lower 730 miles of river. These accreted lands have since been developed for agricultural, residential, and industrial uses. The shallow water habitats essential to fish spawning and rearing of young have been reduced by 90 percent in some areas. In addition, islands and sandbars, important nesting habitat for migratory birds and other species, have been virtually eliminated. Moreover, riparian forest habitat has been reduced from 76 percent of floodplain vegetation in the 19th century to just 13 percent by 1972.

The flow cycles of the Missouri River have always varied seasonally and annually, but a substantial change occurred in December of 1952 with the beginning of flow regulation. Preregulation seasonal flow fluctuated more dramatically, with peak flows in the spring and lower flows the remainder of the year. In the post-regulation period spring flow starts early but are moderated to avoid flooding, water levels are then held artificially high and stable through the summer to late fall, finally water levels are drastically reduced during the winter (non-navigation) season. Figure 3-19 depicts the nature of the flow change from year-to-year. Before regulation the peaks were higher and the troughs lower, with a greater frequency of larger flood events. Aside from the 2011 flood year, post regulation has a much more stable and moderated trend.

Figure 3-19: Missouri River Mean Daily Streamflow at Omaha, Nebraska (1928-2012)*



In addition to flow volumes and timing, the sediment load was an important component of the historic Missouri River system. The river was a naturally turbid river, and continuous bank erosion and slack water deposition were common. Today, many of the native fish species in the Missouri River, including the pallid sturgeon, are specially adapted for life in turbid waters like those that were present in the historic river. The suspended sediment load in the river has decreased from 69 to 99 percent, depending on location and proximity to the main stem dams. Releases from Gavins Point Dam are cooler than historic river temperatures, free of sediment, low in nutrients, and saturated with dissolved oxygen. As distance increases from Gavins Point Dam the water temperature, turbidity, and nutrients increase from tributaries.

With the implementation of the Clean Water Act water quality in the Missouri River has improved over the last 30 years. Sources of pollution in the river include runoff of fertilizers,

pesticides, and herbicides from a predominantly agricultural watershed, as well as discharges from municipal wastewater treatment facilities and other urban industrial operations.

A U.S. Army Corp of Engineers (USACE, Corps) 2004 report on Missouri River stage trends indicates that there has been a downward trend/stage decrease on the Missouri River above Omaha, Nebraska (i.e., the channel has become deeper). This change is a result of a more linear channel, reduced sediment loads from upstream reaches, increased bed erosion, and a downward incision of the channel. In the absence of other factors, greater volumes of water would be necessary in the future to achieve the same levels of overbank flooding. The same study indicates that south of Omaha the stage has been increasing (i.e., the channel is becoming shallower). This shift is attributed to increased land surface runoff, tributary sediment inflows, and deposition within the main channel.

Current Management

Water quality management of the Missouri River is under the jurisdiction of the individual states through which the river passes.

The Nebraska Department of Environmental Quality (NDEQ) has placed the segment of the Missouri River between Sioux City, Iowa and Bellevue, Nebraska on the state's impaired waters list for 2010. This segment was listed as impaired for aquatic life, and a fish consumption advisory has been issued (NDEQ 2010). No information was available for the streams and ditches passing through the Nebraska side of the authorized boundaries.

The Iowa DNR has also placed the segment of the Missouri River between the water supply intake at Council Bluffs, Iowa (river mile 619) and the confluence with the Boyer River, which is just south of DeSoto NWR and includes the segment of the river that borders the Boyer Chute NWR backwater restorations, on the state's 2010 impaired waters list. This segment of the river is considered impaired for drinking water use because of arsenic levels (Iowa DNR 2010). The same 2010 data classifies the Boyer River from Dunlap, Iowa south as impaired due to the presence of *E. coli* (*Escherichia Coli*).

Air Quality

Greenhouse gasses, fine particles, ozone, air toxins, mercury, and lead are all airborne pollutants that affect human health and the health of natural ecosystems. The protection of air quality has been formally monitored and regulated since the passage of the Clean Air Act in 1970, and its subsequent revisions in 1977 and 1990 have intended to keep policy at pace with the evolving state of science and technology. The threats associated with global climate change have reinvigorated efforts to monitor both point sources of contaminants and non-point sources such as transportation and residential combustion. The EPA is responsible for establishing policy and guidance, which are used by the individual states to develop specific State Implementation Plans and Smoke Management Programs.

There is one air quality monitoring station for Washington County, Nebraska, located in Blair, which monitors for National Ambient Air Quality Monitoring Standards.

Criteria Air Pollutants

To protect public health, the Clean Air Act established concentration limits on six criteria air pollutants: carbon monoxide, nitrogen dioxide, ozone, sulfur dioxide, particulate matter, and lead. The 2002 National Emission Inventory (NEI) database documented 10 facilities in Washington County (of 492 in the State of Nebraska) whose emissions are estimated for one or more criteria air pollutants by state and federal agencies. The list includes a diversity of industrial businesses in Fort Calhoun and Blair, Nebraska including a power plant, a feed company, manufacturing enterprises, stone processors, and a number of construction companies. In 2002, the total quantity of criteria pollutants emitted yearly by these facilities was approximately 165 tons. Washington County's 2002 rank among Nebraska's 93 Nebraska counties for the criteria air pollutants was 15th for particulate matter (<2.5 micrometers), 19th for sulfur dioxide, 20th for ammonia, 22nd for particulate matter (<10 micrometers), 23rd for carbon monoxide, 28th for nitrogen oxides, and 32nd for volatile organic compounds. Overall, Washington County contributed 0.001 percent of the state's total annual point source criteria pollutant emissions, which in 2002 was 155,000 tons (EPA 2011).

Criteria air pollutant emission in Harrison County, Iowa is negligible.

Hazardous Air Pollutants

The NEI lists 188 hazardous air pollutants that are known to or suspected to cause serious health problems. The 2002 NEI identifies three facilities in Washington County, Nebraska that emit hazardous air pollutants. The three facilities include a landfill, a concrete company, and a manufacturing enterprise. In this list, the number of hazardous pollutant types emitted by each facility ranges from 9 to 28, and the combined emission volume of these point sources is less than 1 percent of the total estimated state emissions. 2002 data estimate that approximately 54,928,285 pounds of hazardous air pollutants are emitted yearly in Nebraska from all sources, point and non-point (EPA 2011). In 2002, the county ranked number 17 of all 93 Nebraska counties in the quantity of hazardous air pollutants emitted at 1.14 percent of the state total (EPA 2011).

According to 2002 data, there is only one site in Harrison County, Iowa that emits hazardous air pollutants. A manufacturing facility emits 21,500 pounds of mixed isomers annually. The county ranks 48 of 79 Iowa counties for its release of hazardous air pollutants.

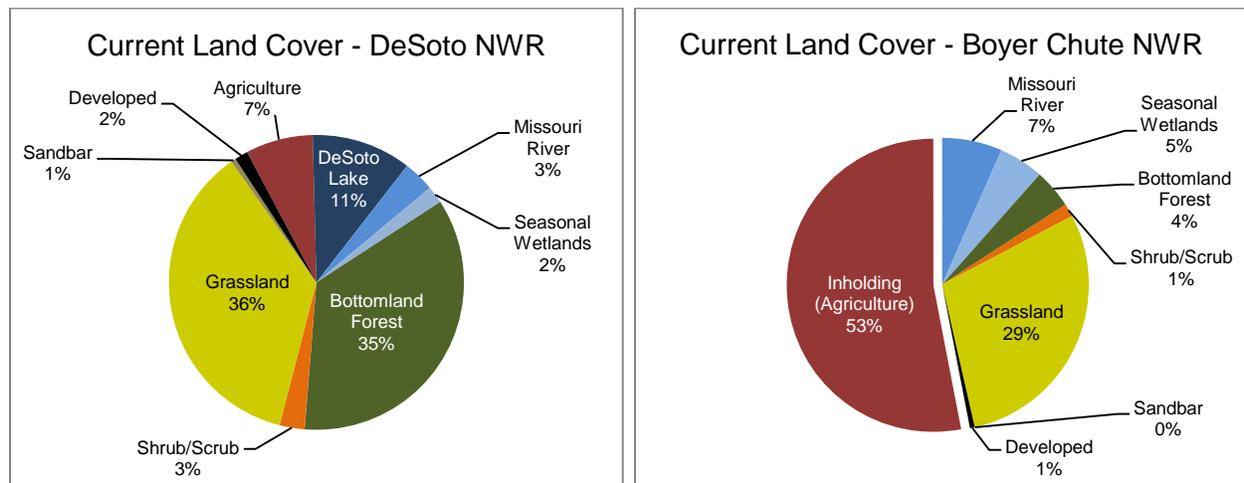
Current Management

Prescribed burning is the refuge management activity with the greatest effect on air quality. The management of smoke is incorporated into planning prescribed burns and, where possible, the suppression of wildfires. The areas surrounding the refuge are Class II air quality zones, or areas where moderate change in air quality are allowable. Class I areas, which allow no change from current air quality standards—such as federal wilderness or national parks, are not present. Wildland fires are expected to be of short duration with minimal effects on long-term air quality. Prescribed fire use on the refuge will not reduce long-term air quality and will adhere to all current air quality standards. Sensitive areas are identified and precautions are taken to safeguard visitors and local residents. Smoke dispersal is a consideration in determining whether a prescribed burn is within prescription guidelines. Generally, fine grass fuels and small burn unit sizes (80–600 acres) generate low volumes of smoke for short durations (four–five hours).

Habitat

Habitats on both refuges are completely contained within the Missouri River alluvial floodplain and are therefore a mixture of bottomland forest, open woodland, shrub/scrub, wet and dry prairie, seasonal wetland, and open water habitats (figure 3-20). Agriculture is also a managed cover type on DeSoto NWR. The land cover percentages documented in the 2001 DeSoto NWR CCP were slightly higher for forest (42 percent), much higher for agriculture (25 percent), and much lower for grassland (20 percent).

Figure 3-20: Current Land Cover Quantities on DeSoto and Boyer Chute Refuges



Past management of the refuges has favored mesic habitats generated by infrequent and low-severity flood conditions. However, approximately 95 percent of the surface area of both refuges was inundated during the 2011 flood. The post-flood vegetation response will vary from site to site, and the previously stable refuge habitats are likely to succeed and change over the next few years. Water has always been a primary driver in the succession of refuge habitats. Before the Missouri River was dammed and channelized, floodwaters and heavy sediment loads would continually shape and reshape this landscape, creating and erasing river system features that evolved through time from open water and wetland to upland and back again. Fire regimes and large herds of grazing animals were also historically important to changes in this river valley landscape. Today, many of these broader landscape processes have been reduced or eliminated from the system. The refuge incorporates prescribed fire into habitat management to simulate historic processes where possible. Aside from active habitat management conducted by refuge staff, many factors interact to shape the refuge vegetative communities including human-altered and remnant native hydrology; seasonal water tables, moisture regimes, and flood/drought cycles; and local relief and soil characteristics.

Habitat monitoring on both refuges consists of periodic onsite evaluations. Annual aerial photography missions have been scheduled to document habitat response to the 2011 flood, and ground truthing will be required to verify ground conditions. Water level monitoring on refuge wetlands and DeSoto Lake are taken at staff gauges periodically but not recorded.

The habitats at DeSoto NWR are approximately one-third grassland and one-third forest with the remaining third a mixture of open water, agriculture, and minor components such as shrub/scrub, developed areas, seasonal wetlands, and sandbar habitat. The grassland component is a mixture of mesic grasslands and wet prairie. Forests contain bottomland tree species, and density ranges from dense young stands, mature open savannas, to late successional cottonwood forest. The distribution of these cover types can be seen in figure 3-21.

Figure 3-21: Current Land Cover, DeSoto NWR

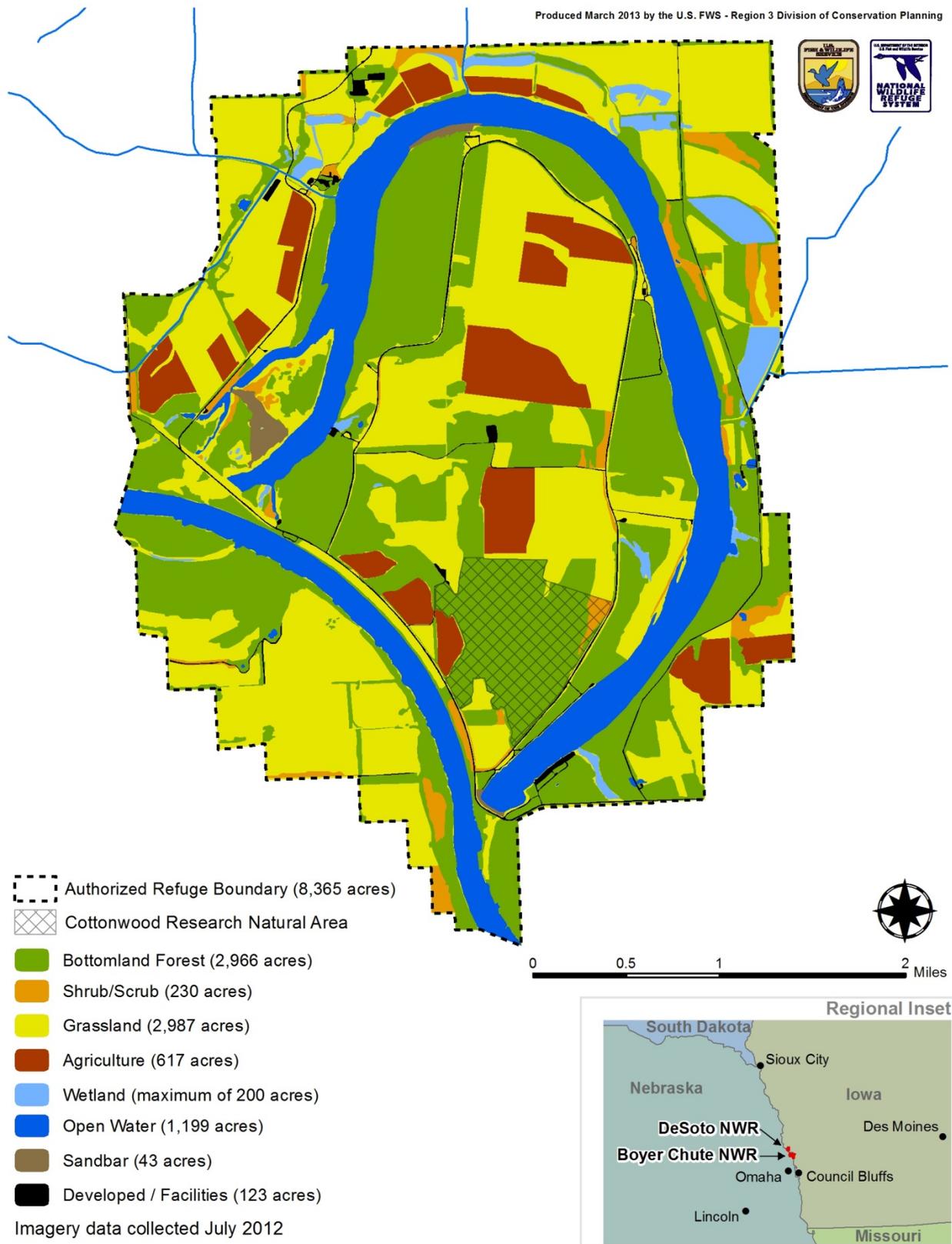
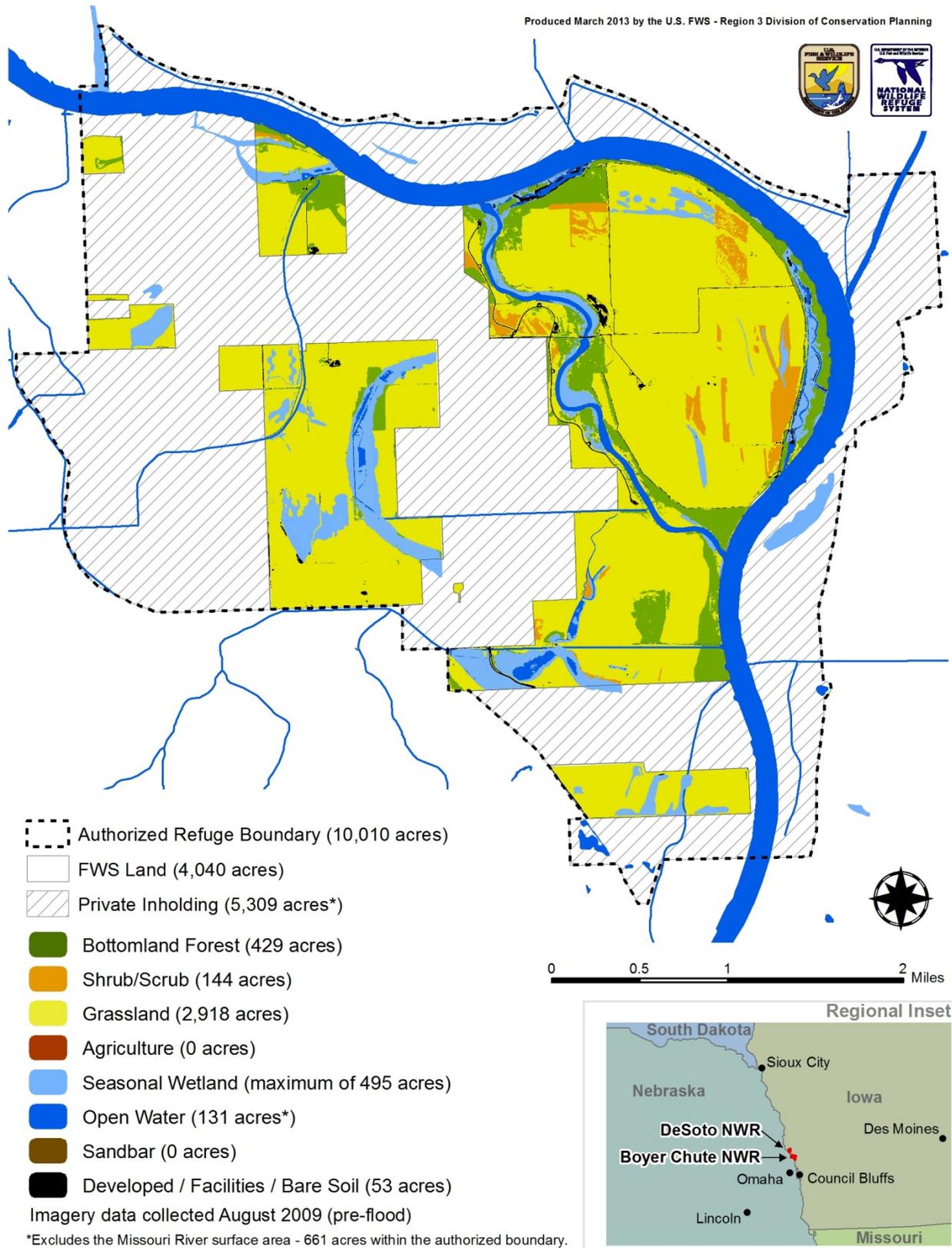


Figure 3-22: Current Land Cover, Boyer Chute NWR



Nearly all of the land that now comprises the authorized boundary for Boyer Chute NWR was farmed prior to the creation of the refuge in the 1990s. Restoration and rehabilitation of wetland and upland habitats have been and will continue to be an important part of refuge management activities. According to restoration records maintained by the refuge, habitat restoration has occurred on 2,350 grassland acres, over 370 wetland and riverine acres, and approximately 570 acres of woodland and shrubland.

In 2010 a mapping project conducted by the Region 3 Division of Conservation Planning, in coordination with refuge staff, classified the lands and waters of Boyer Chute NWR into cover types and general vegetation classes. The project used a mosaic of color-infrared image tiles flown in August of 2009. Image segmentation was used to classify one-meter cells into spectral categories, which were then associated with cover type classes equivalent to the formation level of the National Vegetation Classification Standard. Those areas in private ownership are predominantly agricultural cover types and were excluded from this analysis. Figure 3-22 illustrates and summarizes refuge vegetation based on the 2009 (pre-flood) land status. According to this data, over 60 percent of the refuge is classified as prairie, and when combined with wet meadow areas (10 percent), nearly three-quarters of the Service-owned lands fall into a mixed grassland and forb cover type. Wetlands and open water constitute approximately 12 percent of the refuge. Forests and open woodlands located primarily adjacent to waterways and wetlands constitute another 15 percent of the refuge. Finally, areas with some level of development such as buildings, roads, and parking lots, make up approximately 1 percent. This landscape has changed dramatically since the 2009 imagery was collected, including changes associated with major flooding in 2010 and 2011 and work done by the Corps to create shallow water habitat in the form of backwaters and side channels.

Missouri River Channel

The importance and potential of the Missouri River as a navigation channel was quickly recognized by early American explorers. By the mid-1800s, the river was already heavily traveled by steamboats and keelboats. As demand for commercial transportation grew in the second half of the 19th century, so did demand to “tame” the river by removing woody debris, snags, and other hazards to boat traffic. The first half of the 20th century was marked by intensive channelization of the river and the beginning of reservoir construction, including six major flood control dams in the Missouri’s upper reaches. These dams and channelization efforts did help reduce flooding but in so doing, altered the natural flood cycle and sediment transport on which the ecosystem depended. In 1997, the Missouri River was designated as the most endangered river system in the country (American Rivers 1997).

In the stretch of the Missouri River that passes by the refuges, the river runs at approximately 990.6 above MSL during normal flows, increasing to 994.2 MSL for the 10-year flood level, and 996.6 MSL for the 50-year flood elevation level. Normal flows from November through February are approximately 16,000 cubic feet per second (cfs) and 33,000 cfs between March and October each year.

DeSoto NWR originally contained approximately nine miles of the Missouri River’s channel. In 1960 this extent was reduced to slightly over three river miles (641.1 through 644.7) when the DeSoto–Bertrand Bend of the Missouri River was cut off and a new, shorter channel was excavated by the Corps. The new channel arcs southeast across the bottom of the refuge separating the West Side Unit from the rest of the refuge, it creates an island of Nebraska land on the east side of the Missouri River, and also forms a small pocket of Iowa land on the west

side of the river. The West Side Unit lies only 0.8 miles from the north side of Boyer Chute NWR's authorized boundary. A large extraction site, the Fort Calhoun Quarry (Martin Marietta Materials), lies between the refuges on the west bank. Although the precise surface acreage of the Missouri River channel changes slightly over time, recent estimates indicate that it spans approximately 286 acres of surface area within DeSoto NWR. Over time the Missouri River has incised its channel in the stretch passing through DeSoto and Boyer Chute Refuges.

The Missouri River runs just inside Boyer Chute NWR's authorized boundary on the north and east, including eight miles of river channel from river milepost 640 in the northwest to river milepost 632 in the southeast. Three major riverine feature restorations have been undertaken by the Corps on Boyer Chute NWR. The first is the Boyer Chute itself, a large side channel restored in 1994. A natural chute formed there long ago, but deteriorated after a river wall and shale dike were constructed across the upstream-end of the chute in 1937 as part of the Flood Control Acts and Missouri River channelization era. The chute closure was undertaken in 1937 to force water through the main river channel for navigation, and it gradually silted in over time forming a linear strip of seasonal and permanent wetlands in the footprint of the old chute.

In 2009–2010, the Corp restored two additional Missouri River aquatic habitat sites on Boyer Chute NWR. The first site is a side channel area called "Lower Calhoun Bend Side Channel" on the north end of the Boyer Island Unit. It was dredged to be a 2,700-foot long chute with a nine-acre main channel and two additional channels that form during high water (adding an additional two acres). The main channel was cut 76 feet wide and 5 feet below the construction reference plane. This feature was virtually erased by the flooding that occurred in 2011. The second site, Boyer Bend Backwater, is a 39-acre restoration on the east side of the Boyer Island Unit. The backwater averages 76 feet wide, and is nearly 6,900 feet (1.3 miles) long. The southern end remains open to the river, while the northern end is closed with rock. The rock closure includes a 30-inch diameter corrugated metal pipe to allow a trickle flow into the backwater. An additional 715 feet of backwater is included as an auxiliary connection to the river. The backwater cut through seven old river dikes, requiring the removal of 1,180 cubic yards of rock. Roughly four to seven acres of trees were removed for the excavation of the backwater and used in the construction of timber assemblages for fish habitat. This feature was also greatly altered by the 2011 floods but was in the process of being rehabilitated during the writing of this CCP.

Current Management

The Corps has primary jurisdiction over the main channel of the Missouri River. There are a number of wing dikes installed and maintained in the main channel to direct flow away from banks and side channels, and the sides of the river have been armored using rip-rap in sections (see figure 3-23). Six chevrons have been constructed by the Corps in the DeSoto NWR stretch of the Missouri River channel to create sandbar habitat and nine in the Boyer Chute NWR stretch. On the east bank of the DeSoto NWR stretch of the Missouri River, 12 sites have been de-armored to encourage bank erosion. Refuge management maintains a regular dialogue with the Corps regarding riverine restorations on the Lower Missouri River.

Wetlands and Open Water

DeSoto NWR has approximately 200 acres of seasonal wetland habitat and approximately 22 acres of ponds. This includes 170 acres in large, managed wetland complexes: Headquarters, Red Barn, Botos, Lone Tree, and Wood Duck. There are also a number of small sloughs,

channels, and shallow areas associated with DeSoto Lake (see figure 3-23). The refuge can actively manage the majority of these seasonal wetland acres by diverting or pumping water from DeSoto Lake, drainage ditches, and groundwater sources. Approximately 30 acres also occur as unmanaged wetlands, side-chutes, and drainage ditches on the refuge.

DeSoto NWR currently has a 12.2-mile levee system that is also depicted in figure 3-23. The 2011 floods impacted this levee system, and at the time of writing conversations were ongoing regarding the future of flood control infrastructure in the area.

Boyer Chute NWR contains approximately 460 acres of wetland/moist soil habitats and riverine features (figure 3-24 and table 3-3). Approximately 207 of these wetland acres allow some form of water level management, while the remaining wetland acreage is unmanaged and follows seasonal moisture trends. As mentioned in the previous section, three riverine features have been created by the Corps: Boyer Chute, Boyer Bend Backwater, and Lower Calhoun Bend Side Channel—the latter of which was erased by the 2011 floods.

The National Wetlands Inventory

The National Wetlands Inventory (NWI) is an extensive, ongoing survey by the Service of aquatic habitats across the United States. The NWI is based on interpretation of aerial photographs, not ground surveys, and its criteria differ somewhat from those used in jurisdictional wetlands delineations for permitting by the Corps under Section 404 of the Clean Water Act.

The existing NWI information indicates that DeSoto NWR has 1,680 acres of wetlands spanning 31 different types (figure 3-25). DeSoto Lake and the Missouri River account for approximately two-thirds (1,084 acres) of the total NWI acreage, forested wetland comprise another 385 acres, emergent wetlands are 200 acres, and ponds make up another 13 acres. The majority of the identified wetlands are clustered near the upstream-end of DeSoto Lake on the west side of the refuge.

The NWI for Boyer Chute NWR depicts the Missouri River channel, the Boyer Chute before its restoration by the Corps, a number of riparian woodland, shrubland, and emergent habitats along these major waterways as well as small lakes and ponds in the vicinity of the refuge (figure 3-25). The NWI information identifies 20 different wetland types spanning 1,350 acres within the authorized boundary of Boyer Chute NWR. Over half the acres (56 percent) comprise the Missouri River and the Boyer Chute. There are also 376 acres of forested wetlands, 170 acres of emergent wetlands, and just over 50 acres of ponds and lakes. Few seasonal wetlands, restored basins, or flood-prone areas are delineated, and the drainage modifications resulting from agricultural development prevalent throughout the area are not well documented in the NWI.

Figure 3-23: Water Resources, DeSoto NWR



Figure 3-24: Water Resources, Boyer Chute NWR

Produced March 2013 by the U.S. FWS - Region 3 Division of Conservation Planning

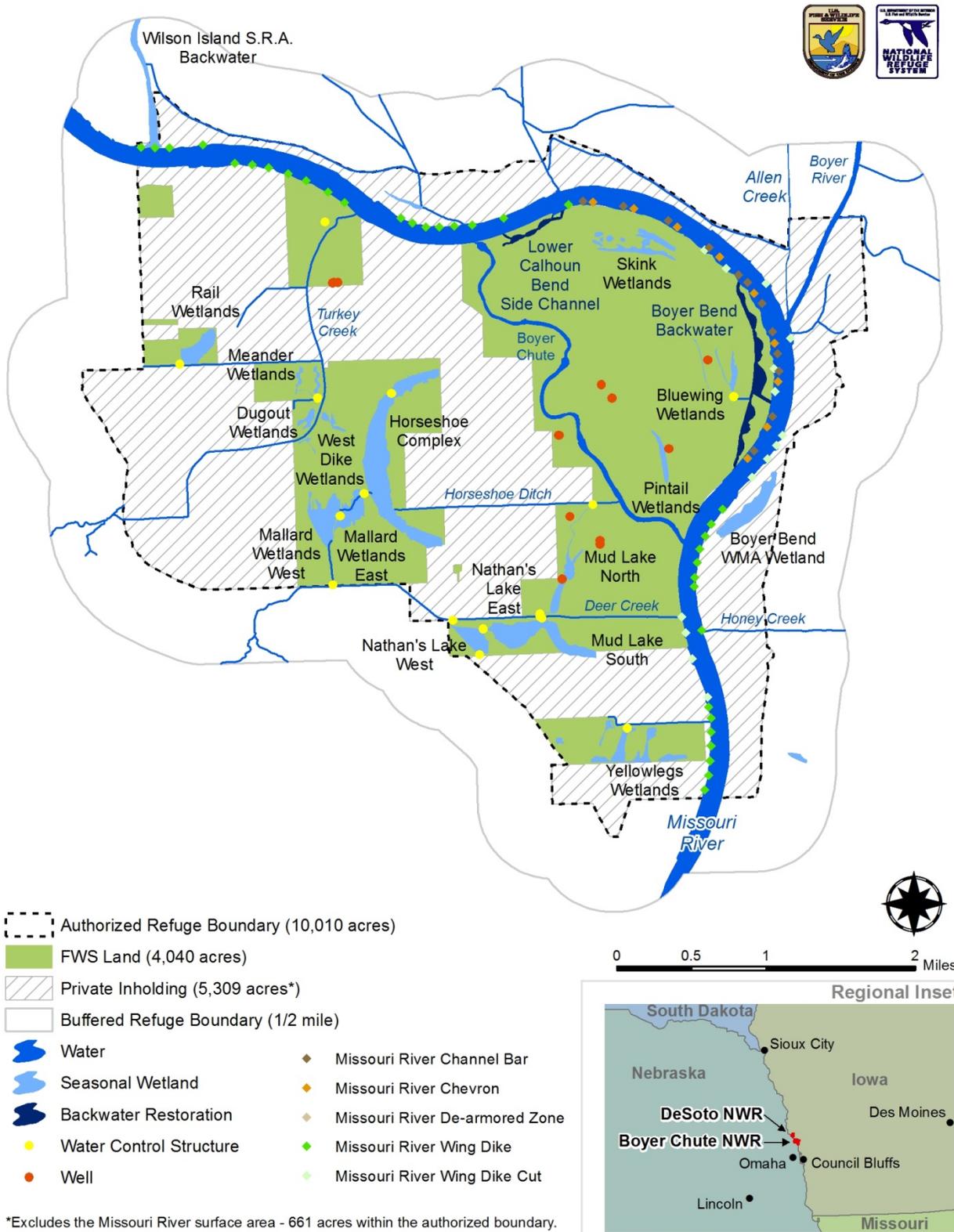


Figure 3-25: National Wetland Inventory

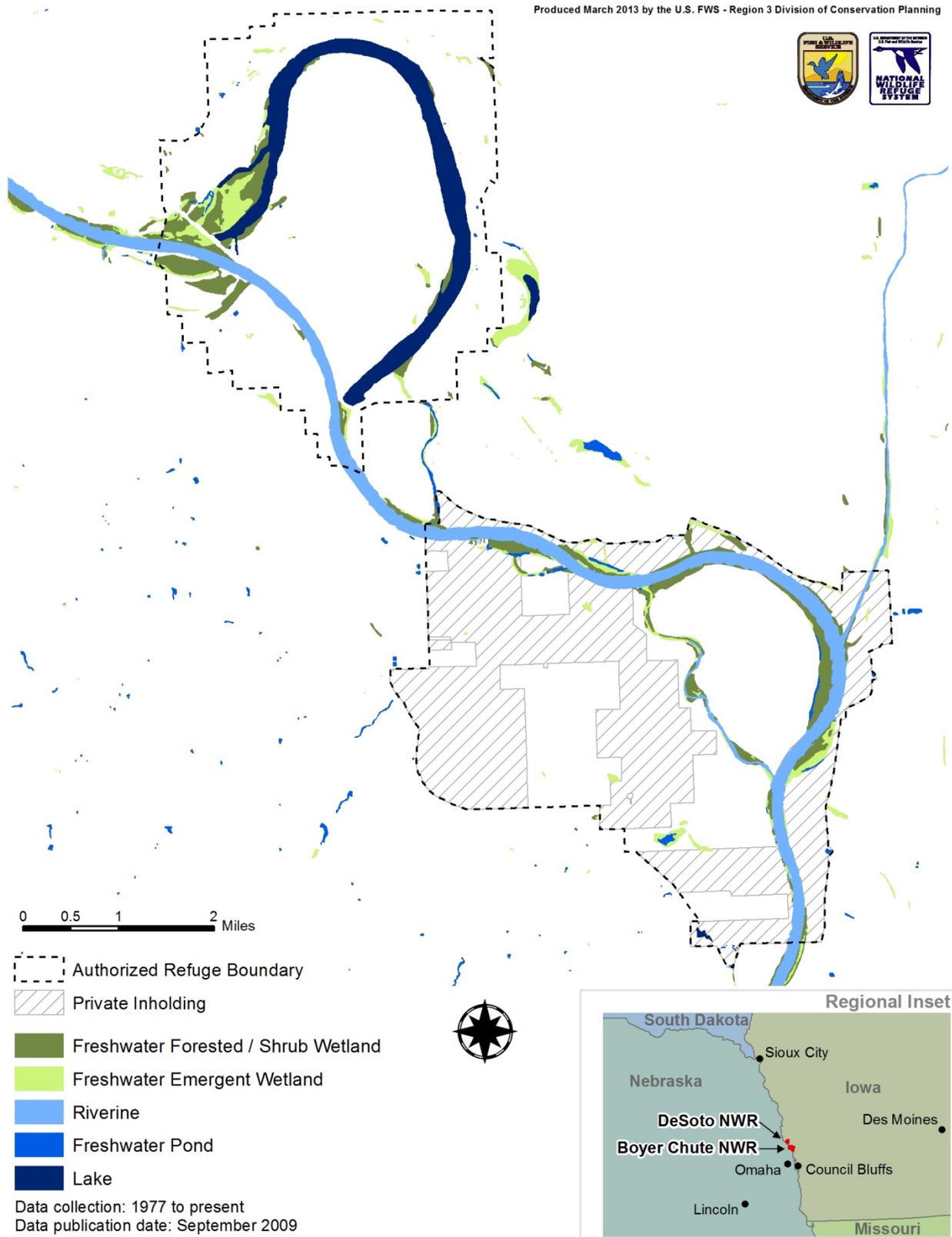


Table 3-3: Aquatic Habitat at Boyer Chute NWR

Feature Name	Management Capability	GIS Acres*
Bluewing Wetlands	Yes	7.5
Boyer Bend Backwater	-	36.6
Boyer Bend Wildlife Management Area (WMA) Wetland	-	30.0
Boyer Chute	-	57.4
Dugout Wetlands	-	4.2
Horseshoe North (north of water control structure)	Yes	15.4
Horseshoe South	-	91.2
Lower Calhoun Bend Side Channel	-	8.8
Mallard Wetlands East	Yes	18.6
Mallard Wetlands West	Yes	26.5
Meander Wetlands	Yes	5.2
Mud Lake North	Yes	15.2
Mud Lake South	Yes	19.3
Nathan's Lake East	Yes	27.9
Nathan's Lake West	Yes	16.5
Pintail Wetlands	Yes	7.1
Rail Wetlands	Yes	21.2
Skink Wetlands	-	21.9
West Dike North	-	3.7
West Dike South	-	1.1
Yellowlegs Wetlands	Yes	26.8
TOTAL ACRES	207	462

*All GIS acreages are approximate calculations of areal extent based on 2010 aerial imagery.

Current Management

Water control structures are used to manage water levels. Additional management actions include pumping water between units, disking wetlands, and prescribed burning. Water is typically pumped into units in the fall to provide stopover habitat for migratory waterfowl.

DeSoto NWR's wetlands consist of historic scours, side channels, oxbows, and natural depressions. Several factors have limited the size and extent of wetland habitats on the refuge in the past, including the following:

- Many wetland areas were modified to trap sediment in the past as a part of the Corps' Bank Stabilization and Navigation Project.
- Missouri River channel training structures and greater control of the river's water levels have virtually eliminated the natural overbank flooding that once occurred within the floodplain—along with the natural wetland complexes that were created and replenished by these flood events.

- DeSoto Lake's water levels have been maintained below certain thresholds to avoid drainage issues with upstream landowners.
- A number of restorable wetland areas have been left unrestored to facilitate the agriculture program.

DeSoto NWR has 170 acres of managed seasonal wetlands in five wetland complex management units. Each complex is comprised of a number of smaller sub-units. The wetlands are managed to provide a diversity of habitats and vegetation structure (forests, annual emergent vegetation, dense perennial vegetation, mudflats, and open water) for use by migratory birds. Refuge wetland complexes are illustrated in figure 3-23, and include:

- Headquarters (21 acres)
- Red Barn (34 acres)
- Botos (32 acres)
- Lone Tree (75 acres)
- Wood Duck (8 acres)

The Headquarters Complex has three sub-units connected by ditches and stop-log structures. Water is pumped from a well to feed this complex. The Red Barn Complex was created in 2004 and has two sub-units. Water is pumped into these units from two separate wells. The Botos Complex has four sub-units that are connected by stop-log structures. This complex is fed by the same well used for a portion of the Red Barn Complex. The Lone Tree Complex is composed of two moist soil units. The south unit has four cells interconnected by water control structures. Water is pumped into the south unit seasonally from a well at the southeast corner of the unit. The north unit consists of two cells interconnected by stop-log structures. The Wood Duck Complex is filled by a ditch system and/or water pumped from DeSoto Lake. Five of the wells that feed these wetland complexes were installed in 2003 and 2004, and electric pumps are used to extract groundwater. These seasonal wetland complexes are filled each spring and fall to accommodate migratory birds passing through the area. During the summer the water levels are drawn down to promote plant growth.

Climatic conditions and rain events largely dictate the water availability within most of Boyer Chute NWR's wetlands. Refuge staff work to maintain productive wetland habitat for waterfowl feeding and resting and for other wildlife by maintaining a healthy balance of open water and emergent vegetation. Periodic soil disturbance is used to stimulate annual forb germination. Water level management and herbicide application are also used to control undesirable emergent and aquatic vegetation such as river bulrush, cattails, and phragmites.

Boyer Chute NWR is able to manage water levels in 12 wetland units using 16 water control structures. Six of these wetland units (approximately 124 acres) use water-control structures to divert water from Deer Creek into the basins. In non-drought years there is adequate drainage in Deer Creek to supply the needed water to all six wetlands. The units that utilize Deer Creek diversion structures include:

- Mallard East (19 acres)
- Mallard West (26 acres)

- Nathan's Lake East (28 acres)
- Nathan's Lake West (17 acres)
- Mud Lake South (19 acres)
- Mud Lake North (15 acres)

Five additional wetlands encompassing approximately 76 acres also have water control structures to provide management capability but are entirely dependent upon precipitation or Missouri River flooding to supply water. These wetland units include:

- Rail (21 acres)
- Meanders (5 acres)
- Horseshoe North Impoundment (15 acres)
- Yellowlegs (27 acres)
- Bluewing (8 acres)

Water levels in the Bluewing wetland (8 acres) can also be managed by pumping water from a nearby well into the basin. A suction line can be dropped into the center-pivot irrigation well casing in the northwest portion of the wetland and a 6-inch trash pump can be used to add water to the area.

There also are a number of wetlands on the refuge in which climatic conditions largely dictate water availability because a direct water source is unavailable. Boyer Chute NWR has 232 acres of these unmanaged wetlands, including:

- Skink (22 acres)
- Pintail (7 acres)
- Dugout (4 acres)
- West Dike North (4 acres)
- West Dike South (1 acre)
- Boyer Bend Backwater (37 acres)
- Lower Calhoun Bend Side Channel (9 acres)
- Horseshoe Lake Complex – unimpounded areas (91 acres)
- Boyer Chute (57 acres)

The Boyer Chute, Boyer Bend Backwater, and Lower Calhoun Bend Side Channel have been designed to remain connected to the Missouri River. Their water levels are entirely dependent on Missouri River flows.

The Horseshoe Lake Complex is a large, drained wetland feature with very little active water management. Water exits the complex via an open ditch two-thirds of the way down the east side of the bend and ultimately discharges into the Boyer Chute. The southern tip of the

wetland complex (approximately 5 acres) is on private property. Restoration of this wetland complex is a high priority for the refuge.

There is one additional 30-acre wetland area not owned or managed by the Service but located within the authorized boundary, Boyer Bend WMA Wetland. This wetland is owned and managed by the Iowa DNR.

The Fort Calhoun Drainage District maintains an easement on Deer and Turkey Creeks, permitting access for maintenance.

DeSoto Lake

DeSoto Lake is a large, prominent, and central feature of DeSoto NWR. The surface area of the lake varies seasonally, but average total surface area ranges from 800–900 acres. The water volume has been estimated at approximately 6,390 acre feet. According to a 2006 USGS study, average water levels in the lake range from 986.5 to 989.5 feet above MSL, constituting a difference of 156.5 acres of surface area (Elliot et al. 2006). Multiple drainage ditches extend over 24 linear miles and drain 12,563.46 acres (19.63 square miles) of predominantly agricultural private land in the watershed before entering DeSoto Lake via three primary inputs (Iowa DNR 2012). Water levels in DeSoto Lake are influenced by four major factors related to precipitation in the watershed: runoff from the three aforementioned agricultural drainage ditches (Young's, Rand's, and Brown's Ditches) that release into the lake, Missouri River flows, sheet flow over the land surface, and local groundwater levels.

Bathymetric maps were created by the Service in 1967 using five-foot contour intervals, then again by the Iowa Conservation Commission in 1979 using four-foot contour intervals, and finally again in 2006 by the USGS. All work prior to 2006 did not document the survey density and/or water surface elevations and thus are of limited comparability with other studies. The 2006 study created high-precision maps of depth, elevation, and substrate condition based on a water surface level of 988.76 feet above MSL. Results indicate an average depth of 7.6 feet and a maximum depth of 21.98 feet. Overall, the west arm of the lake is substantially shallower (no point greater than 11.5 feet) than the central or eastern portions, and the deepest areas occur on the outside of the central and eastern sections, opposite sandbar deposition areas (see figure 3-26). These depth features are consistent with those found in other bends of the Lower Missouri River and are a legacy of the bend's previous riverine conditions. Substrate in areas under four feet is primarily soft silt and fine sand; clay is rare. A considerable amount of soft silt is located near ditch outlets. Assuming similar lake levels in 1979, comparison of the three lake bathymetry studies indicates an overall shallowing trend; maximum depth in 1967 was recorded as 34.9 feet, 26 feet in 1979, and 21.98 in 2006. According to these numbers, estimated sedimentation rates for the deepest parts of the lake from 1967–1979 were 8.9 inches per year, and from 1979–2006 were 1.8 inches per year (Elliot et al. 2006).

Figure 3-26: DeSoto Lake Bathymetry (2006)



Current Management

Past management of the DeSoto Lake prioritized open water habitat for the sport fishery. Walleye, channel catfish, flathead catfish, white bass, largemouth bass, and northern pike are typically stocked in the lake. The upper end of DeSoto Lake and a limited number of shoreline areas provide shallow water habitat conditions and cattail marshes. The central and lower portions of the lake are managed for open water habitat. DeSoto Lake has been managed without connectivity to the Missouri River throughout most of its history to maintain the stocked sport fishery. At times managed connectivity was created via water control structures on either end of the lake. At the time of writing, the fish passage barrier at the southern end of DeSoto Lake was not functional due to damage sustained during the 2011 flood. This lower end of the lake can also be opened and free-flowing to the Missouri River. When Missouri River levels are high and above the inlet elevation, lake management is designed to allow for water intake. Winter lake levels are maintained high to reduce fish kills; spring drawdowns are used to accommodate spring runoff from the watershed; and a fall drawdown occurs to provide food resources for waterfowl.

To improve the lake's fishery and reduce the rough fish populations the lake was drawn-down in 1985, treated with 9,000 gallons of Rotenone, and then re-stocked with sport fish. Additional improvements to the fishery have included installing an artificial aeration system with 16 helixers on the northeast side of the lake in 1985 to raise dissolved oxygen levels (damaged during 2011 flooding); providing additional cover, bottom structure, and habitat diversity in the form of rock jetties, underwater piers, and brush piles; armoring the banks of the lake to prevent erosion; and adding an electric fish barrier between the lake and the Missouri River (not functioning at the time of writing).

Lake management and monitoring continues to be conducted in coordination with the Service's Columbia, Missouri Fisheries Office, the Iowa DNR, and the Nebraska Game and Parks Commission (NGPC). The lake's fish monitoring program has included electroshocking and creel censuses. One additional method used to reduce the lake's rough fish population has been permitting private commercial harvesters to net buffalofish and carp. This activity has occurred between April and October with the year's take ranging from 7,000–18,000 pounds.

The three drainage ditches that terminate in DeSoto Lake are a substantial source of suspended sediment. There are pending water quality issues related to turbidity and algae, and the lake is currently listed as a state impaired water by the Iowa DNR under section 303(d) of the Clean Water Act. Watershed farmers are encouraged to put buffer strips of native vegetation along drainage ditches. Water from agricultural ditches is pumped into refuge wetlands to filter drainage when possible. Limited water quality monitoring is conducted in the lake.

Grasslands

Grasslands were a major component of the Missouri River floodplain ecosystem prior to large-scale conversion to agriculture. The extent and distribution of different grasslands types in the river valley varied over time in response to disturbance frequency and severity. Because the Missouri River valley at DeSoto and Boyer Chute Refuges is located in bottomlands between the tallgrass prairie ecosystem to the east and the shortgrass prairie ecosystem to the west, the refuges support native grass species that are found in tallgrass, shortgrass, and wet prairies.

Historically, uplands and well-drained areas of the refuges would have contained warm and cool season grasses with occasional forbs and shrubs. Northern tallgrass prairie remains an important habitat on the refuges. Tallgrass prairie was once the Midwest's largest and most biologically productive ecosystems, but it has been reduced to less than one-tenth of one percent of its original extent and has become functionally extinct due to fragmentation, fire control, and the extirpation of keystone species. Today's remaining prairie remnants are generally small, and woody encroachment further threatens the habitat quality.

Some of the native upland grasses found in the tallgrass prairies of the refuges include sideoats grama (*Bouteloua curtipendula*), little bluestem (*Schizachyrium scoparium*), switchgrass (*Panicum virgatum*), Canada wild rye (*Elymus canadensis*), big bluestem (*Andropogon gerardii*), sand lovegrass (*Eragrostis trichodes*), eastern gamagrass (*Tripsacum dactyloides*), Indiangrass (*Sorghastrum nutans*), buffalo grass (*Buchloe dactyloides*), blue grama (*Bouteloua gracilis*), green needle grass, (*Nassella viridula*), Virginia wildrye (*Elymus virginicus*), and western wheatgrass (*Pascopyrum smithii*).

Flood conditions like those experienced in the mid-1990s and 2010–2011 occur infrequently in modern times due to river regulation. This, combined with increased drainage systems for agriculture, have reduced the occurrence of wet prairies in the Missouri River floodplain. Nonetheless, in low areas or during prolonged or extreme precipitation events, ground and surface water levels can lead to saturated soil conditions and ephemeral wetlands. In these areas the prairie community may transition to include wet prairie species that can survive long periods of inundation such as prairie cordgrass (*Spartina pectinata*), sedges (*Carex sp.*), and switchgrass (*Panicum vergatum*).

DeSoto NWR supports approximately 2,987 acres of grasslands distributed throughout the refuge. The majority of the refuge's grasslands contain warm season grasses, but a number of areas have been planted to cool season grasses.

When established, Boyer Chute NWR's authorized boundary contained no virgin tallgrass prairie; all grasslands had been cleared and were being used for agriculture. However, native tallgrass prairie has been reestablished in many areas of the refuge. Grasslands and herbaceous vegetation now comprise approximately 2,918 acres of the refuge.

Current Management

Prior to flooding in 2010 and 2011, both refuges' grasslands were actively managed for upland (mesic) prairie species to support grassland birds. Grassland habitats were established and maintained through prescribed burns, mowing, haying, seeding (local ecotype), and hydrological restorations. Grazing has not been used on either refuge to date. Annual noxious weed inspections were conducted and treatments were applied as necessary. Post-flood upland grassland management will continue in many areas, but some grasslands on the refuges may shift to favor larger sedge meadow components as a result of the 2010 and 2011 floods. Grassland management is also guided by studies conducted on the refuges, such as work in the late 1990s (Van Dyke 2004) indicating that grassland birds respond better to burning than mowing and that they are sensitive to the shape and size of the management unit.

Grassland restorations take place during the dormant winter season or spring season and are typically performed using Truax drills and a broadcast seeder. The broadcast seeder is first used to disperse larger, coarse, combine-harvested grass seeds; the smaller forbs are then applied in a second seeding. Three different seed sources have been used in recent years for

grassland restorations: a standard commercial seed mix, a mix from Waterfowl Production Areas in the Rainwater Basin area of Nebraska (100 to 200 miles west of the refuges), and a local ecotype mix (collected within a 50-mile radius of the refuges). The local origin seed is sourced from two local vendors that have exclusive harvesting rights to a number of virgin prairies in Iowa.

An important component of grassland management is a prescribed fire program. Historically, fires served as large disturbance mechanisms in the tallgrass prairie, but historic fire intervals are unknown. It is estimated that fires occurred in one- to five-year intervals in eastern Nebraska (Schneider et al. 2005). Native Americans regularly burned the prairie to drive game animals, and lightning fires occurred frequently. Grasslands can burn whenever there are dry solids, even in mid-summer when foliage is green. Fires that occurred across the prairies in the past burned tens of thousands of acres at a time. The spread of these fires was affected locally by topographic relief and fuel quantities, the latter of which was affected by herds of American bison (*Bison bison*).

On the refuges, fire management for tallgrass prairie involves a 3- to 5-year cycle of prescribed burning. The refuges are a combination of Condition Class 3 lands, as defined in table 3-4, and native or restored lands more accurately classified into Condition Classes 1 and 2.

Table 3-4: Habitat Condition-based Fire Management Guidelines

Condition Class	Example Fire Regime Management Options
1	Fire regimes are within the historical range, and the risk of losing key ecosystem components is low. Vegetation attributes (species composition and structure) are intact and functioning within the historical range. Where appropriate, these areas can be maintained within the historical fire regime by treatments such as prescribed fire.
2	Fire regimes have been moderately altered from their historical range. The risk of losing key ecosystem components is moderate. Fire frequencies have departed from historical frequencies by one or more return intervals (either increased or decreased). This results in moderate changes to one or more of the following: fire size, intensity, severity, and landscape patterns. Vegetation attributes have been moderately altered from their historical range. Where appropriate, these areas may need moderate levels of restoration treatments, such as prescribed fire and mechanical treatments, to be restored to the historical fire regime.
3	Fire regimes have been substantially altered from their historical range. The risk of losing key ecosystem components is high. Fire frequencies have departed from historical frequencies by multiple return intervals. This results in dramatic changes to one or more of the following: fire size, intensity, severity, and landscape patterns. Vegetation attributes have been appreciably altered from their historical range. Where appropriate, these areas may need high levels of restoration treatments, such as mechanical treatments, before fire can be used to restore the historical fire regime.

Forests

The quantity, composition, and age structure of the refuges' wooded habitat-types have changed greatly over the past century. Historic accounts of the Lower Missouri River (circa 1892) estimate just under 20 percent of the floodplain was in forested and shrubland cover types (Dixon et al. 2010). Cottonwood, oak, black walnut, and hickory are mentioned in Lewis

and Clark's description of the area. Much of both refuges may historically have been bottomland forest, cottonwood parkland, and shrub/scrub habitats kept in a continual state of succession by the meandering and migration of the Missouri River channel. The Missouri River Valley was then a corridor of braided, sinuous channels, sandbars, backwaters, sloughs, and marshlands all connecting the river to its floodplain. Willows colonized bare islands and sandbars, to be succeeded by cottonwoods, which in the process of plant community succession were replaced by silver maple, box elder, red mulberry, and American elm. Today, cottonwood (*Populus deltoides*) is the dominant canopy tree in the forests and woodlands. On the refuges it is concentrated primarily along the banks of the Missouri River, Boyer Chute, DeSoto Lake, and in large blocks within the oxbow formed by DeSoto Lake. Reaching 100 feet or more in height, cottonwoods tower above all other trees in the floodplain. The majority of the existing cottonwoods appear to be between 50–100 years of age, and extensive mortality has been occurring in these stands for several years. One benefit of the older cottonwood stands is roosting and cavity nesting habitat for birds. Concerns have been raised regarding minimal regeneration of this species. Historically, flood pulses were important disturbance mechanisms for floodplain vegetation and new germination occurred in disturbed areas, but these events have been virtually eliminated since Missouri River flow regulation was stabilized circa 1952. The reduced frequency, or absence, of these flood pulses (and the sediment loads they once transported) has reduced or prevented the formation of the bare, moist, sand substrates required for recruitment seedbeds and the cyclic regeneration of cottonwood and willow stands.

Other common floodplain trees on the refuges include black willow (*Salix nigra*), sandbar willow (*Salix interior*), silver maple (*Acer saccharinum*), black walnut (*Juglans nigra*), boxelder (*Acer Negundo*), American elm (*Ulmus americana*), eastern red cedar (*Juniperus virginiana*), and the exotic Siberian elm (*Ulmus pumila*). Many cottonwood areas are being encroached upon by shade-tolerant species that are not flood dependent, including hackberry (*Celtis occidentalis*), red mulberry (*Morus rubra*), green ash (*Fraxinus pennsylvanica*), and most noticeably, roughleaf dogwood (*Cornus drummondii*). These species may result in greater mast production (fruit and nut) as they increase in prevalence.

According to aerial imagery from July of 2012, DeSoto NWR has approximately 2,966 acres of bottomland forest and open woodlands with an additional 230 acres of shrub/scrub habitat for a total of 3,196 total combined acres (see figure 3-21).

Vegetative analysis of the 4,040 acres at Boyer Chute NWR currently owned and managed by the Service estimates approximately 15 percent (573 acres) of the refuge is bottomland forest forests and cottonwood parkland (429 acres) or shrub/scrub habitat (144 acres) (see figure 3-22). The coarser-resolution 2001 National Land Cover Dataset (NLCD) (see figure 3-10) provides a similar estimate (approximately 528 acres). When the NLCD is expanded to the entire 10,010 acquisition boundary, the quantity of forest does not increase dramatically (approximately 790 acres), because the vast majority of non-Service lands in the authorized boundary have been cleared for agriculture (Homer et al. 2007). In fact, many of the larger cottonwood trees on the east side of the Boyer Chute were harvested just prior to purchase by the Papio-Missouri Natural Resource District.

Current Management

Forest management on both refuges is predominantly passive. A few sites have been disked, seeded, flooded, or burned in the past. Refuge staff has used numerous methods to increase the size and diversify the age structure of cottonwood stands. Attempts to plant new forest stands have been met with limited success due to dry soil conditions and deer depredation.

The most successful efforts at cottonwood restoration have been a result of natural reversion after large flood events. There is little or no tree harvest on the refuges. Moderate to high tree mortality is expected following the 2010 and 2011 floods and management will identify recruitment areas, allow natural regeneration, and support the establishment of new stands in appropriate areas.

Sandbar Habitat

Missouri River sandbar habitat is rare but essential for two federally listed species of bird. Least Terns and Piping Plovers have not been recorded nesting on DeSoto NWR since the 1970s. Historic sandbars on the refuge, including the old main sandbar (the spoil pile on the northwest, or inlet, arm of DeSoto Lake) and three sandy beaches adjacent to DeSoto Lake, have succeeded to other habitat types, and woody encroachment has been encouraged in certain areas to avoid wind erosion.

At times in the past sandbar habitat areas on DeSoto NWR were disked annually to remove encroaching vegetation. Despite these efforts, these areas were only marginally suitable for nesting birds because of vegetation establishment and easy access to ground predators like raccoons, skunks, and mink. However, these sandbar areas have been used by waterfowl for loafing and by nesting turtles.

In the past on Boyer Chute NWR no management effort has been directed to creating or maintaining sandbar habitat.

Current Management

Several new sandbars were deposited on both refuges after the 2011 flood, but the location of these features makes them undesirable for Interior Tern or Piping Plover habitat. They are located next to forested areas, and on DeSoto NWR they are far from DeSoto Lake. Ongoing inventories and monitoring will help determine the future management of these sites as sandbars or successional bottomland forest.

Agriculture and Cooperative Farming

Agriculture is the primary land use in the counties that surround the refuges. More natural habitat have been converted to cropland than to any other cover type, and much of this transition occurred by the middle of the 20th century.

Most of the land that comprises DeSoto NWR was cleared and used for agriculture in the 1940s and 1950s. In fact, an additional 350 acres of the refuge was cleared to plant crops in 1963–1964. At one time nearly half (3,714 acres) of DeSoto NWR was cultivated to provide food for migratory waterfowl with the rationale that cropland provided food, loafing areas, and cover for migratory birds and other wildlife. The cropped acreage has been reduced over time so that by the time the 2001 CCP was written just under 2,000 acres remained in cultivation. The 2001 CCP planned for the reduction of cropland on DeSoto NWR to 475 acres by 2016.

No farming occurs on any lands owned by the Service within the authorized Boyer Chute NWR boundary. However, most of the private land within the boundary is currently utilized for agricultural production.

There are a number of benefits and challenges associated with agriculture for the refuges due to their location in the Missouri River floodplain. For over a century levees and impoundments have been constructed to make farming possible on lands within the natural floodplain zone of the Missouri River. These lands offer highly fertile alluvial land with ready access to irrigation. However, yields are regularly reduced by flood events and seasonal high water tables. Agricultural use keeps otherwise marginal floodplain land values high, and engineered drainage alters local hydrology and natural drainage patterns. The land conversion also adversely impacts wildlife species by decreasing habitat availability, quality, and connectivity thereby increasing overall fragmentation of habitat. In addition, runoff from crop fields and pastureland contribute to non-point sources of pollution. Many agricultural processes can also lead to increased erosion, sedimentation, and eutrophication in the watershed lakes, ponds, wetlands, streams, and rivers. Many of these substances, such as organochlorines and organophosphates, are known to be toxic to fish and wildlife via direct exposure, bioaccumulation, and bio-magnification (Cox 1991).

Current Management

In 2012, 16 agricultural fields comprising approximately 617 acres of DeSoto NWR were farmed by three local cooperators. Farm field locations on the refuge remain fairly static, but crops types have a three-year rotation of corn, soybean, and wheat/clover. The refuge receives a 25 percent share, which provides additional food stores for migratory birds.

No agriculture has occurred on Service-owned land on Boyer Chute NWR since 2004; however, nearly all inholdings (5,309 acres, or 53 percent of the total authorized boundary) are farmed annually. Cooperative farming occurred on the refuge in the past as means to transition newly acquired lands from cropland to native cover types.

In 2011, the Midwest Region of the Service completed an environmental assessment (EA) for row crop farming and the use of genetically modified glyphosate tolerant (GMGT) corn and soybeans on refuge lands (FWS 2011e). Under the selected alternative, beginning in 2012, the use of farming on Refuge System lands in the Midwest Region can continue only in specified management situations: for achieving multiple objectives that include habitat restoration, habitat management, supplemental food for wildlife, and/or attracting wildlife for viewing and photography. In addition, the use of GMGT crops can be used only for habitat restoration. Similarly, the Service's ecological integrity policy specifies that GMGT crops cannot be used on refuge System lands unless they are "essential to the accomplishment of refuge purposes." If a refuge proposes the use of GMGT crops under any circumstances an approval process, including an eligibility questionnaire, is required to explain and justify the need. Currently, GMGT crops are not used on DeSoto NWR.

Special Management Areas

In 1972, Cottonwood Research Natural Area (RNA) was established alongside the Missouri River at the southeastern arm of DeSoto Lake (see figure 3-21). This 320-acre zone has an overstory of mature cottonwoods, a midstory of roughleaf dogwood, and an understory of poison ivy and horsetail species. The RNA has been used by Bald Eagles as a roosting site. No active management is conducted in this area. To date, no specific research has been conducted in this area.

Invasive Plant Species

Invasive species enter new areas and often cause harm to the environment, the economy, and in some cases human health. Invasive species are a growing challenge in wildlife and habitat management, because there are increasing numbers of invasive species, and because introductions occur across all habitats on land and water. The introductions are often irreversible, the controls for invasive species are often expensive and/or toxic, and invasive species often have negative impacts to native species in the form of displacement and competition.

In Washington County alone there are 84 invasive plant species documented by the Early Detection and Distribution Mapping System, a database maintained by the University of Georgia's Center for Invasive Species and Ecosystem Health (University of Georgia 2011). Many of these have spread to the refuges—including some that were introduced intentionally (i.e., smooth brome grass was planted as a ground cover by DeSoto NWR staff early in the refuge's history).

The following list includes some of the more common invasive species on the refuges:

- Canada thistle (*Cirsium arvense*)
- musk thistle (*Carduus nutans*)
- leafy spurge (*Euphorbia esula*)
- purple loosestrife (*Lythrum salicaria*)
- common reed (*Phragmites australis*)
- Siberian elm (*Ulmus pumila*)
- Chinese elm (*Ulmus parviflora*)
- tree of heaven (*Ailanthus altissima*)
- bull thistle (*Cirsium vulgare*)
- garlic mustard (*Alliaria petiolata*)
- white mulberry (*Morus alba*)
- reed canarygrass (*Phalaris arundinacea*)
- smooth brome grass (*Bromus inermis*)
- honeysuckle (*Lonicera sp.*)
- autumn-olive (*Elaeagnus umbellate*)
- cats claw vine (*Macfadyena unguis-cati*)
- cotoneaster (*Cotoneaster sp.*)
- crown vetch (*Coronilla varia*)
- dame's rocket (*Hesperis matronalis*)
- tall fescue (*Festuca elatior*)
- henbit (*Lamium amplexicaule*)

- common mullein (*Verbascum thapsus*)
- multiflora rose (*Rosa multiflora*)

Concentrations exist and vary by habitat; examples include garlic mustard and honeysuckle in forests, phragmites in wetlands and along water edges, reed canarygrass in wet meadows, and smooth brome in grasslands.

Current Management

Management for invasive species is achieved, where possible, through eradication, reduction, containment, and prevention. Invasive species are controlled in a variety of ways on the refuges, including prescribed burns, mechanical removal (e.g., plowing, manual removal), chemical applications (e.g., glyphosate), biological controls (e.g., the musk thistle seed head weevil), and flooding. In the wake of large flood events such as those in 2010 and 2011, the species, distribution, and severity of invasive species can change drastically. A few examples of treatments practices for some of the more common and problematic invasive plant species are described in the following paragraphs.

Thistles have been a primary invasive species management target because of their common occurrence in grassland restorations. The refuges use Aminopyralid (Milestone®) herbicide to eradicate Canada and musk thistles.

Smooth brome grass is found along many existing roads and trails on the refuges and often expands from these edges into restored grasslands. Both mechanical (plowing) and chemical (glyphosate) controls have been used.

Common reed (phragmites) is on the Department of Interior Species of Concern list, and genetic evidence has confirmed the existence of both native and introduced genotypes in North America. Several Phragmites clones have been discovered on the refuges, both native and exotic. Glyphosate herbicides have been used to control their spread. Mowing and prescribed burns are other tools that can be used to control this species.

Honeysuckle and autumn olive are invasive shrubs found throughout the refuges. On DeSoto NWR they are found near locations where they were planted as a landscape plant shortly after the establishment of the refuge (such as near the Visitor Center). Treatment includes mechanical removal (cutting) in the fall and chemical (glyphosate or 2 percent triclopyr) application.

There are concerns regarding the increase of reed canarygrass on the refuges following the 2011 flood.

Wildlife

The lands and waters of DeSoto and Boyer Chute Refuges host a diversity of wildlife, including over 250 species of birds, more than 60 fish species, 35 species of mammals, 30 species of reptiles and amphibians, and numerous invertebrates. Moreover, the refuges are well within the potential range of numerous additional species. Further wildlife inventorying and monitoring are likely to yield additions to the refuges' species lists (appendix B), and a changing climate may impact the ranges of the species that occur on the refuges. The refuges' wildlife inventory

includes a number of state and federally listed species such as the Interior Least Tern, Piping Plover, pallid sturgeon, and others.

As a part of comprehensive conservation planning, national wildlife refuges are charged with identifying their Resources of Concern—species or groups of species that are considered high conservation priorities for management. The process begins by compiling comprehensive lists of refuge species by taxa. These lists are then refined through a series of filters to arrive at a subset of potential focal species that the planning team evaluate for selection. The process is designed to be science-based, transparent, and well-documented. The final selections are species or groups of species chosen for their ecological significance, management implications, legal relevance, feasibility, and potential to enhance conservation partnerships. Table 3-5 summarizes the results of this process for DeSoto and Boyer Chute Refuges. Additional information on this process can be found in the introduction to appendix B.

Table 3-5: Potential Focal Species for Refuge Management

Landscapes	Habitat	Potential Focal Species	Other Benefitting Species*
Missouri River	Missouri River channel	[none selected, managed by the Corps]	gulls (m), terns (m), swallows (b), waterfowl (m)
Missouri River	secondary channel/backwater area	[same as wetlands]	[same as wetlands], plus Black-crowned Night-Heron (m, pb)
Missouri River floodplain	DeSoto Lake	[same as wetlands]	[same as wetlands], plus pelicans (m, sv)
Missouri River floodplain	wetlands	shorebirds (m), waterfowl/dabblers (m, wv) including Northern Pintail, marshbirds (m, b), and wading birds (m, b)	Mallard, Wood Duck, swallows (b, m), terns (m), gulls (m) including Franklin’s Gull (m, sv), secretive marshbirds (b, m) including Least Bittern (b, m)
Missouri River floodplain	bottomland mesic grassland	Eastern Kingbird (b)	Northern Harrier (m, b), Bobolink (b, m), wrens (m) including Sedge Wren (m, b), rails (m, b) including Yellow Rail (m), Dickcissel (b)
Missouri River floodplain	wet meadow	rails (m, b)	Yellow Rail (m), Sora and Virginia Rail (b, m), wetland sparrows (m) including Nelson’s Sparrow (m)
Missouri River floodplain	bottomland forest	Red-headed Woodpecker (b)	Rusty Blackbird (m, wv), Bald Eagle (b, m, wv), Mallard (m, b, wv); passerines (m)
Missouri River floodplain	cottonwood parkland	Red-headed Woodpecker (b)	Orchard Oriole (b), Bald Eagle (b, m, wv), other raptors (b, m, wv)
Missouri River floodplain	shrub/scrub	Black-billed Cuckoo (b)	Bell’s Vireo (b), warblers (m), vireos (m), and thrushes (m)
Missouri River	sandbar	Piping Plover (m, pb), Interior Least Tern (m, pb)	Hudsonian Godwit (m), terns (m), shorebirds (m), and gulls (m, wv)

*Abbreviation Key: (m) migrant, (b) breeder, (pb) potential breeder, (sv) summer visitor, non-breeding, (wv) winter visitor

According to the 2001 DeSoto NWR CCP, population objectives were set for snow geese (help reduce the mid-continent population by 5 percent annually) and deer (a maximum of 30–35 deer per square mile, or 330–380 wintering deer on the refuge). No population objectives have been established for Boyer Chute NWR.

Birds

The refuges provide habitat to many migratory and resident bird species (see appendix B for the refuges' bird list). A broad spectrum of birdlife is represented, from resident game birds such as quail, pheasant, and wild turkey to shorebirds, waterfowl, neotropical migrants, short distance migrants, resident songbirds, hawks, owls, and other raptors.

The Missouri River Valley is noted for its large-scale migrations of water birds and waterfowl including White Pelican, Double-crested Cormorant, Greater White-fronted Goose, Canada Goose, and a large percentage of the mid-continent Snow Goose and Ross's Goose populations (the latter species limited to a few hundred birds). Also included are several species of dabbling duck including the Mallard, Green-winged Teal, Northern Pintail, Blue-winged Teal, Ring-necked Duck, Lesser Scaup, Wood Duck, and Common Merganser. When the 2001 DeSoto NWR CCP was written, hundreds of thousands of snow geese were using DeSoto NWR for resting and feeding, primarily in November and December. Roughly 70,000 ducks, primarily mallards, stop at the refuges during the fall migration.

The Missouri River is a major raptor flyway for the eastern Great Plains, but most of the birds follow the eastern loess bluffs in Iowa southward. Detailed data for migratory raptors in this region can be derived from the Hitchcock Nature Center located five miles southeast of the refuges in Pottawattamie County, Iowa. Monthly tallies can be obtained from the Hawk Migration Association of North America. Dominant raptors utilizing this site and occasionally occurring on the refuges include Turkey Vulture, Broad-winged Hawk, Swainson's Hawk, Red-tailed Hawk, Northern Harrier, Osprey, Bald Eagle, Peregrine Falcon, and Merlin. Maintenance and restoration of riverside gallery forest offers shelter for migrant raptors. A number of Bald Eagle roosting sites are located at or near the refuges. Bald Eagles migrate across the refuges in late November and December; well over 250 have been observed on the refuges at one time.

A considerable number of shorebirds utilize the Missouri River Valley during spring and fall migrations, although species diversity is typically greatest in spring when suitable habitat is more readily available. The refuges have a low diversity of shorebirds species and a low overall quantity of shorebirds from what would be expected based upon refuges along the same general north–south valley alignment such as Squaw Creek NWR to the south (Missouri) and Big Stone NWR to the north (Minnesota). Lack of habitat for shorebirds may be the reason for this. A deficit of available habitat likely exists most years in mid-summer to late summer and autumn. Species that occur in moderate to large numbers in other sections of the Missouri River Valley include Black-bellied Plover and American Golden-Plover (mainly during spring for both species), Semipalmated Sandpiper, Least Sandpiper, White-rumped Sandpiper (mainly late spring), Pectoral Sandpiper, Dunlin, Stilt Sandpiper (more common in spring), Long-billed Dowitcher, Wilson's Snipe, Hudsonian Godwit, Buff-breasted Sandpiper, Red-necked Phalarope (mainly spring), and Wilson's Phalarope (mainly spring). Shallow water foraging areas and exposed flats attract the above species from April 20 to June 5 and from July 1 through the end of October.

Large numbers of Black Tern and Forster's Tern and the federally listed interior Least Tern utilize the Missouri River as a migration corridor to northern breeding grounds, especially in spring. Other species such as Franklin's Gull, Bonaparte's Gull, and Caspian Tern also utilize this stretch of river. All of these species seek roosting islands either in the main channel of the river or use adjacent marshes as resting areas during migration.

Three species of concern in the Midwest Region of the Service that are found in this area in good numbers are the Red-headed Woodpecker, Whip-poor-will, and Orchard Oriole. All three species utilize open, lightly grazed or periodically burned savanna habitat. The woodpecker and the oriole are also found in bottomland forest, especially cottonwoods. The woodpecker prefers older, mature cottonwoods with numerous dead branches and snags, while the oriole prefers younger, denser cottonwoods.

Streamside and upland thickets in this region also attract two species near the northwest portion of their breeding range—Bell's Vireo and Blue Grosbeak. Suitable habitat for both species includes dense and tall thickets that result from periodic burn regimes followed by a several-year burning moratorium.

The Missouri River Valley is a major flyway and stopover site for thousands of migrant swallows including all regularly-occurring eastern North American species. Tree snags near water, bulrush, native cattail, and other tall wetland grasses in ponded areas allow local populations of these birds to roost at night. Identification and protection of these roost sites in mid to late summer is beneficial to these bird populations.

Like other refuges situated along major migration corridors, the aerial habitat is considered a separate habitat in its own right providing a major foraging habitat for Whip-poor-wills, migrant waterfowl and water birds, shorebirds, raptors, and day-flying passerines such as swallows and Chimney Swift; as well as breeding birds with aerial courtship displays such as Red-tailed Hawk and American Woodcock. Future development of wind turbines and power lines on nearby bluffs could be a major hazard to some of these species.

DeSoto NWR has been recognized as an Important Bird Area (IBA) by the Audubon Society in both Iowa and Nebraska. Boyer Chute NWR was designated a Nebraska IBA in 2005. The IBA program identifies sites that are critical to the survival of bird species and promotes the conservation of these sites to maintain healthy bird populations. It is part of an international program overseen by National Audubon Society and BirdLife International in over 150 countries around the world.

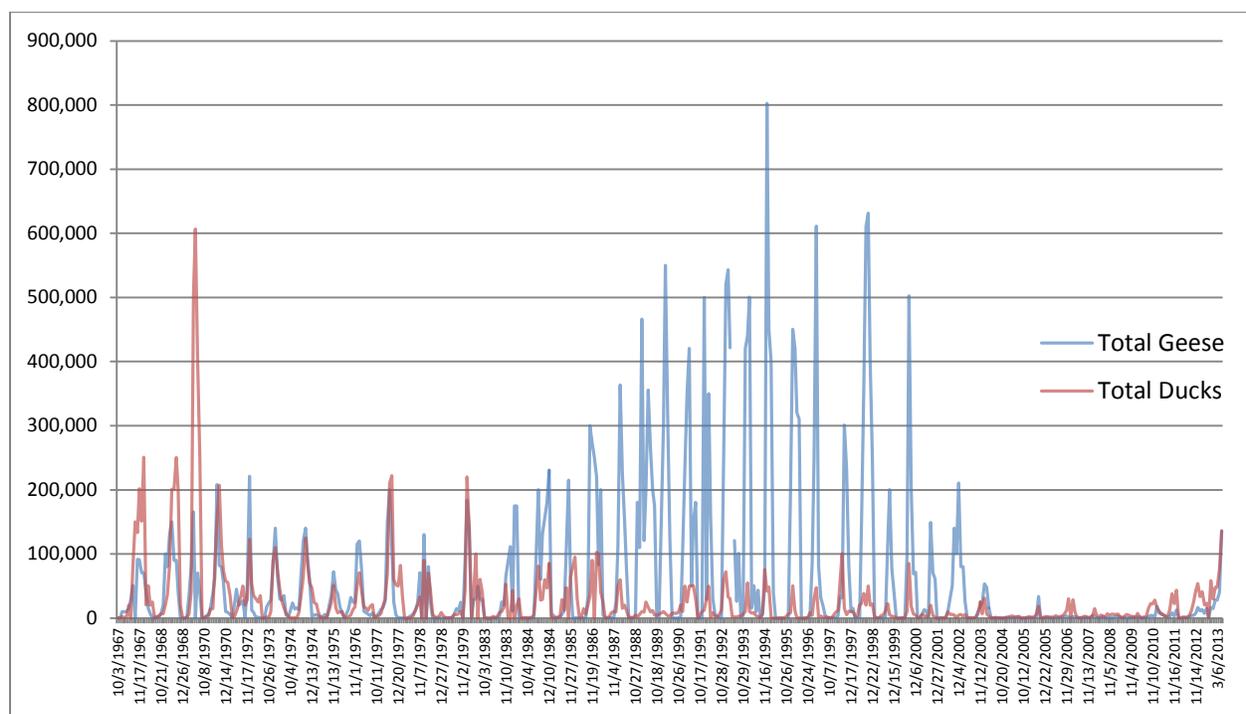
Current Management

The refuges' management for birds involves both habitat management and monitoring/survey efforts. Refuge habitat restorations have prioritized warm season, high diversity prairie and larger, unfragmented blocks of forest and grassland habitats. As a result, the refuges' grasslands and forests host substantial numbers of trust species and birds of conservation concern (McCarty and Wolfenbarger 2009).

Grassland habitats are actively managed for grassland birds such as Dickcissel, Loggerhead Shrike, Grasshopper Sparrow, Henslow's Sparrow, Bobolink, and Eastern Meadowlark. Grassland habitat management includes prescribed fire, mowing, seeding, and hydrological restorations. Annual Christmas and spring bird counts, weekly counts during migrations, and other periodic point counts are conducted.

The refuges currently contain nearly thirteen miles of Missouri River waterfront habitat (counting Service-owned lands only); full acquisition would result in over 22 miles of riverfront habitat. DeSoto Lake and Missouri River side channels, chutes, and backwaters also provide shoreline habitat. In addition, the refuges also contain permanent and seasonal wetlands, which are managed to provide productive habitat for migratory waterfowl, shorebirds, wading birds, and secretive marshbirds. Wetland water levels are adjusted, where possible, to maintain a balance of open water, emergent vegetation, and mud flat areas. Use of refuge wetlands by ducks, geese, coots, shorebirds, and wading birds is monitored weekly during both spring and fall migrations. Migratory waterfowl numbers have increased in recent years on both refuges (figure 3-27). Weather in recent years has played a role in the increasing migratory waterfowl numbers on DeSoto NWR. In addition, two management actions have been undertaken to support the increasing trend: an increase in wetlands and food on the refuge, and the establishment of the closed areas to provide refugia. Additional wetlands are being restored to attract greater numbers of migratory birds. Waterfowl counts are conducted weekly during the spring and fall migrations. Over twenty waterfowl species use the refuges as a stopover. Those in greatest abundance on the refuges include Mallards, Canada Geese, and Wood Ducks, with peak total waterfowl numbers during fall migrations ranging from 10,000 to 70,000 birds (28,000 in 2010 and 42,000 in 2011).

Figure 3-27: Migratory Goose and Duck Trends at DeSoto NWR, 1967-2013



Many of the monitoring efforts on the refuges have been conducted in collaboration with partner organizations utilizing volunteers. Boyer Chute NWR began breeding bird surveys in the late 1990s, which were replaced by the Monitoring Avian Productivity and Survivorship (MAPS) program when a banding station was established on the refuge in 2001. Christmas bird counts are conducted each year in December, and annual spring bird counts occur in May. Both have

been conducted regularly in cooperation with the Omaha Chapter of the Audubon Society. Both refuges have had Wood Duck nesting box programs in the past.

Mammals

At least 30 mammal species have been observed on the refuges with over twice that number of species unconfirmed but expected to occur based on their known breeding ranges (see appendix B for the refuges' list of mammals). A wide variety of mammals including white-tailed deer, bobcats, coyotes, red foxes, badgers, raccoons, opossums, skunks, muskrats, mink, beavers, squirrels, rabbits, woodchucks, and smaller species such as long-tailed weasels, gophers, mice, voles, and shrews can be found on the refuges. These species spend much of their time in uplands, but will use wetland and riverine areas as well for water, food, and shelter during dryer periods.

No federally listed mammal species have been confirmed on the refuges, but state listed species such as the spotted skunk, eastern pipistrelle, and southern flying squirrel have ranges that overlap the refuges. Bison and elk were once important keystone species of this prairie landscape but were extirpated in the early 1900s.

Current Management

The only mammal species that is actively managed and monitored on the refuges is white-tailed deer. When possible, aerial surveys are used to monitor the deer population. Flooding in 2010-2011 greatly reduced the area available to deer. The current deer population on the refuges is unknown because of the animal movement associated with the flood.

In order to maintain healthy habitats, the refuges have tried to manage for less than 20 deer per square mile. Excessive deer populations can also negatively affect plant communities on the refuges through selective over-grazing and reduced plant regeneration within the browse line. Few natural deer predators remain to keep deer populations in check, and deer herds can increase by 30 to 40 percent annually when protected and provided optimum habitat conditions (West Virginia DNR 1999). Optimum and maximum carrying capacity estimates for deer on the refuges vary, and habitat conditions themselves vary from year-to-year based on the dynamics of the floodplain. In general, abrupt declines in the local deer population can adversely affect the genetic structure of the herd. Conversely, when population levels exceed carrying capacity, deer become more susceptible to disease (e.g., hemorrhagic disease and chronic wasting disease), resulting in higher mortality.

Deer management is typically conducted through the refuge hunting programs. The hunting program provides the most effective tool for deer management on the refuges and facilitates the collection of harvest data. Managing for quality habitats and healthy wildlife populations through hunt programs supports the refuge goal of maintaining viable wildlife populations associated with tallgrass prairies and bottomland forests. Hunt programs also provide important recreation opportunities for the public.

Fish and Other Aquatic Species

The Missouri River Basin supports 156 native fish species, of which 33 are now listed by the states within the basin as rare, endangered, or threatened (Hesse et al. 1989). In addition to state listings, the pallid sturgeon has been federally listed as endangered since 1990. It is

estimated that both annual catch and species diversity of commercial fish in the Missouri River declined by over 80 percent between 1947 and 1963 (Funk and Robinson 1974). Much of this change is the result of modifications to the river channel and tributaries and land use changes in the drainage basin. Some of the system changes responsible for declining fish populations include the removal of snags, loss of floodplain connectivity, alteration of the hydrograph, loss of sediment transport, altered water temperature, fish bypass, and sport and commercial fish harvest (Hesse et al. 1993).

Of the 156 fish species in the basin, 92 species are found in the Lower Missouri River and are associated with the refuges—64 of which have been confirmed on the refuges (see appendix B for a complete list). The refuges have played a part in a larger, basin-wide effort to increase habitat for a variety of native fish species, including many species that have experienced drastic population declines over the past century. The restoration of floodplain wetlands and riverine habitats such as chutes, backwaters, side channels, and sloughs benefit species of concern like the pallid, shovelnose, and lake sturgeon; sturgeon and sicklefin chub; longnose and shortnose gar; blue and flathead catfish; sauger, burbot, paddlefish, blue sucker, and silvery minnow.

In addition to rare, declining, threatened, and endangered species, more common fish species, including game species, are present in the refuges' aquatic habitats. Channel catfish, bigmouth buffalo, and freshwater drum are examples of larger fish species that are well adapted to the backwaters, chutes, and side channels provided at Boyer Chute NWR.

Non-native fish such as common and bighead carp are also abundant in the Missouri River ecosystem. Large numbers of these exotic species can be seen in shallow backwaters and tributaries of the river. Refuge staff has noticed an increase in the number of Asian carp on the refuges, from just a few scattered sightings in the past, to large numbers in just about every shallow water habitat on the refuges.

Stocked game fish in DeSoto Lake include largemouth and white bass, black and white crappie, channel and flathead catfish, bluegill, walleye, and northern pike.

Current Management

The Corps is responsible for managing the Missouri River, with an emphasis on maintaining flows for navigational purposes. The biological opinion document for managing the Missouri River and associated listed species issued to the Corps by the Service in 2000, and its 2003 amendment, encourage flow enhancement, shallow water habitat restoration, unbalanced flow regulation, species propagation, monitoring, and adaptive management (FWS 2000a, 2003).

Reasons for listing the pallid sturgeon include habitat modification (loss, degradation, and contamination), lack of reproduction, commercial harvest, and hybridization. Beneficial management activities for the species include restoring braided channels, seasonal flow patterns, turbidity, and microhabitat diversity. Additional information on the pallid sturgeon and associated recovery efforts can be found in the Threatened and Endangered Species section of this chapter (FWS 2000a, 2003).

In collaboration with the Corps, habitat has been created on Boyer Chute NWR in the form of side channels, backwaters, and shallow water areas for pallid sturgeon and other riverine species. Nearly 60 acres of riverine habitat was created by the restoration of the Boyer Chute in 1994. In addition, the Corps restored approximately 45 acres of backwater and side channel habitat along the Missouri River on Boyer Chute NWR in 2009–2010. These restoration

activities have created spawning and nursery habitat as well as resting areas for native fish species. An additional benefit achieved by reconnecting wetlands and floodplain streams to the main river channel is increased sediment release into the river system. This influx raises water temperature, increases available food resources for aquatic invertebrates, and increases the overall biological productivity of these waters.

DeSoto Lake is an important part of DeSoto NWR's management for fish and aquatic species. In order to improve the lake fishery and reduce the rough fish populations, the lake was drawn-down in 1985, treated with chemicals (9,000 gallons of Rotenone), and then re-stocked with sport fish. Additional measures to improve the fishery have included an artificial aeration system with 16 helixers installed in 1985 to raise dissolved oxygen levels (damaged during 2011 flooding); providing additional cover, bottom structure, and habitat diversity (rock jetties, underwater piers, and brush piles); armoring the banks of the lake to prevent erosion; and adding an electric fish barrier between the lake and the Missouri River (also damaged during the 2011 flood).

Fish monitoring for DeSoto Lake includes electroshocking and creel censuses. Lake management and monitoring continues to be conducted in coordination with the Iowa DNR and Nebraska GPC, including stocking the lake with walleye.

In addition to the populations of fish and aquatic species associated with the Missouri River, riverine habitat restorations, and DeSoto Lake, additional aquatic habitat is provided by the refuges' wetlands and small open water basins.

Reptiles and Amphibians

Surveys have documented 24 species of reptiles and amphibians on the refuges, with over 60 total species expected to occur locally (see appendix B for the refuges' reptile and amphibian list).

On Boyer Chute NWR, surveys conducted throughout refuge wetlands by the University of Nebraska-Lincoln in the summers of 2004 and 2008 have confirmed nine amphibians species, and the refuge overlaps the ranges of at least 14 additional species. These species are all fairly common toads and frogs that are associated with off-river seasonal wetlands where fish predation is less of a concern. However, they also occur in riverine habitats including the Missouri River channel, Boyer Chute, and associated side channels and backwaters. Common amphibian species include gray tree frogs, leopard frogs, and cricket frogs.

Reptile species found on the refuges include six turtle species, eight snake species, and one species of skink. Common reptile species include snapping turtles, false map turtles, softshell turtles, bull snakes, and garter snakes.

Current Management

No routine management or monitoring of herpetofauna is currently conducted on either refuge.

Threatened and Endangered Species

There are a number of federally listed or state listed species of conservation concern that have ranges and habitats that overlap DeSoto and Boyer Chute Refuges. In the context of the Lower Missouri River ecosystem as a whole, three species of fish, one mussel, three mammals, two birds, one beetle, and five species of plant are considered federally endangered or threatened (NRCP 2002, FWS 2004, FWS 2011b, Whitmore and Keenlyne 1990). Table 3-6 summarizes species that are currently listed with a federal, state, or Lower Missouri River conservation status and that are associated with the refuges habitats. In the table, E indicates an *endangered* species, T indicates a *threatened* species, C indicates a *species of concern*.

Table 3-6: Refuges' Potential Species of Concern, including Conservation Status

Species Name	Scientific Name	Federally listed ¹	State listed in Washington Co., NE ²	State listed in Pottawattamie Co., IA ³	State listed in Harrison Co., IA ³	Lower Missouri River Ecosystem ⁴
Bald Eagle	<i>Haliaeetus leucocephalus</i>			C	C	
Barn Owl	<i>Tyto alba</i>			E	E	
Interior Least Tern	<i>Sterna antillarum</i>	E		E	E	E
Piping Plover	<i>Charadrius melodus</i>	T		E	E	T
Pallid sturgeon	<i>Scaphirhynchus albus</i>	E	E	E	E	E
Sturgeon chub	<i>Macrhybopsis gelida</i>		E			
Niangua darter	<i>Etheostoma nianguae</i>					T
Topeka shiner	<i>Notropis topeka</i>					E
Lake sturgeon	<i>Acipenser fulvescens</i>		T			
Pink mucket pearlymussel	<i>Lampsilis abrupta</i>					E
Indiana bat	<i>Myotis sodalis</i>	E				E
Gray bat	<i>Myotis grisescens</i>					E
Gray wolf	<i>Canis lupus</i>					E
Least shrew	<i>Cryptotis parva</i>			T		
Plains pocket mouse	<i>Perognathus flavescens</i>			E	E	
Southern bog lemming	<i>Synaptomys cooperi</i>				T	
Eastern massasauga rattlesnake	<i>Sistrurus catenatus catenatus</i>	C				
Great plains skink	<i>Eumeces obsoletus</i>			E		
Ornate box turtle	<i>Terrapene ornata</i>			T		
Western worm snake	<i>Carphophis amoenus</i>			T		
American burying beetle	<i>Nicrophorus americanus</i>					E
Dusted skipper	<i>Atrytonopsis hianna</i>			C	C	
Ottoo skipper	<i>Hesperia ottoe</i>			C	C	
Regal fritillary	<i>Speyeria idalia</i>			C		
Wild indigo dusky wing	<i>Erynnis baptisiae</i>			C		
Leonard's skipper	<i>Hesperia leonardus</i>				C	
Olympia marble	<i>Euchloe olympia</i>				C	

¹ FWS 2010a

² NGPC 2008

³ FWS 2007, FWS 2011a, Iowa DNR 2013

⁴ NRCP 2002, FWS 2004, FWS 2011b, Whitmore and Keenlyne 1990

Three federally listed species have been associated with refuge habitats in the past: pallid sturgeon, Interior Least Tern, and Piping Plover.

The pallid sturgeon was federally listed as endangered in 1990, can reach a length of up to six feet, can weigh as much as 80 pounds, and occurs in the Missouri, Mississippi, and Yellowstone Rivers. There are over 3,300 miles of riverine habitat in the pallid sturgeon's range, yet it is rarely encountered in the Lower Missouri River. This is primarily due to the loss of key backwater and side channel habitat required by the species.

The Interior Least Tern (*Sterna antillarum*) was federally listed as endangered in 1985. This species lives along large rivers and may sometimes be found hunting fish in shallow wetlands and along pond/lake shorelines. Terns nest from late April to August using barren to sparsely vegetated sandbars along rivers, sand and gravel pits, or lake and reservoir shorelines. They scrape a shallow hole in an open sandy area, gravelly patch, or exposed flat—preferably in the middle of a river far from predators—laying two to three eggs. They also often nest in small colonies of 2–20 pairs to provide increased protection from predators. The wide river channels dotted with sandbars that are preferred by the terns have been replaced by narrow forested river corridors. Recreational activities on rivers and sandbars can disturb nesting terns causing them to abandon their nests. Current estimates suggest 4,700 to 5,000 adult birds remain.

Piping Plovers (Northern Great Plains population) were federally listed as threatened in 1986. These birds make their nests on open, sparsely vegetated sand or gravel beaches adjacent to alkali wetlands and on beaches, sandbars, and dredged material islands of major river systems. They winter along South Atlantic, Gulf Coast, and Caribbean beaches and barrier islands, then arrive in their breeding grounds from mid-March through mid-May, remaining for three to four months per year. They lay three to four eggs in shallow scraped depressions lined with light colored pebbles and shell fragments; chicks hatch within 30 days. Small sand dunes, debris, and sparse vegetation provide shelter from wind and extreme temperatures.

Current Management

Throughout their combined histories, the refuges have undertaken efforts to support all three federally listed species historically associated with their habitats.

Boyer Chute NWR has worked with the Corps to help restore aquatic and riverine habitat types essential to the endangered pallid sturgeon. In addition to the Boyer Chute itself, two projects were completed along the Missouri River at Boyer Chute NWR in 2009–2010. These projects created nine acres of side channel habitat and 37 acres of backwater habitat. The chute and backwater habitat benefit many native fish species by providing warm water nurseries for young-of-the-year native fishes (such as chubs and minnows) and juvenile pallid sturgeon. These habitats may be critical to the early life stages of the pallid sturgeon and are thought to be essential to the success of the species. Research continues on the importance of chute and backwater habitats to larval pallid sturgeon during the drifting phase and downstream migration period that follows (FWS 2000a, 2003). In addition to providing nurseries, the development of these habitats offers multiple benefits to the ecosystem and its aquatic wildlife, such as improved water quality, enhanced water temperature diversity, potential spawning areas for native species, protection from high river velocities, and greater connectivity to the floodplain (Edwards 1983).

In 2004, the Service's Gavins Point Fish Hatchery released 52 pallid sturgeon into the Boyer Chute. Several of those pallid sturgeon have been recaptured at various locations in the region,

including (from north to south) Sandy Point Bend, DeSoto Cutoff, Boyer Bend, Bellevue Bend, Otoe Bend, and Upper Brownville Bend.

The historic presence of sandbar-nesting species such as the Interior Least Tern and Piping Plover was dependent on habitat provided by large, natural river dynamics that have been nearly eliminated in this portion of the Missouri River. Dams and channelization along the Missouri River, managed for barge traffic, disrupted these natural fluctuations and the sandbars disappeared. In 1890, sandbar habitat encompassed 35,273 acres along the Missouri between Nebraska and Iowa; in 1976 sandbars covered only 57 acres.

Piping Plover data in DeSoto NWR's files document an average annual peak migration population of 55 birds on the refuge from 1960–1970. Nesting records include a total of 45 nests and 135 young from 1963 to 1965, but there are no nesting records for the period from 1966 to 1970.

The annual number of migrating Least Terns observed on DeSoto NWR from 1960 to 1970 averaged 36 individuals. From 1972 to 1982 the average number observed declined to seven. Sources indicate that the last documented Least Terns to nest on the refuge did so in 1968 and 1973 (Kent and Dinsmore 1996, Iowa Ornithologists' Union 1968 and 1973).

Both species were observed on the spoil pile on the northwest, or inlet, arm of DeSoto Lake created in 1958–59 by cutting the new river channel, and the 1,800-foot strip of the former north swimming beach. Public access to both areas (just over 40 acres) was halted in 1988 to avoid disturbance and maintain the sites for these species. However, the last Piping Plover nest recorded on DeSoto NWR was found in 1977. As mentioned previously, the primary issue associated with the decline of these bird species is the loss and degradation of nesting sandbar habitats required by these species. The Piping Plover is also highly sensitive to disturbance. Ever since DeSoto Lake was separated from the Missouri River, vegetation has encroached onto the majority of the refuge's sandbars, and the habitat suitable for these two species has declined. Occasional development of the required breeding habitats for these species occurs after large flood events, and the renewed use of these habitats is encouraged by the refuges. However, maintaining appropriate conditions long-term through management prescriptions is prohibitively expensive and less effective than naturally created sandbar habitat. Unless the Missouri River channel is allowed to meander, the river flows are returned to historic regimes, and the river's sediment load increases, the habitat for these species will remain limited in Nebraska and Iowa. The refuges continue to monitor for the reoccurrence of these species locally—particularly following large-scale, landscape-modifying flood events.

As natural sandbar nesting habitat began to disappear in Iowa and Nebraska, the birds began to look elsewhere to nest, finding places like sand and gravel mining operations suitable. In Iowa, the Interior Least Tern is currently known to nest at only two sites—one near Council Bluffs and the other near Sioux City. Both sites contain fly ash deposits from power plants.

The refuges provide appropriate habitat and are within the expected range of other federally listed species in table 3-6, such as the Indiana bat and eastern massasauga, but there are no known confirmed observations of these species on the refuges.

Invasive Animal Species

Within the Missouri River, common, bighead, and grass carp are the most frequently encountered invasive fish species. Large numbers of Asian carp have been seen on the refuge in recent years. Because they are planktivorous and attain such a large size, these carp have the potential to deplete local zooplankton populations (Laird and Page 1996). A decline in the availability of plankton can lead to reductions in populations of native species including all larval fishes, some adult fishes, and the native mussels that rely on plankton for food.

Zebra mussels, an aggressively invasive bivalve, have shown up in the refuges' reach of the Missouri River in this past decade. Zebra mussels can decimate populations of native freshwater mussels, impact fisheries, clog water intake pipes, foul boat hulls, and disrupt aquatic ecosystems. Economic impacts of zebra mussels in North America during the next decade are expected to be in the billions of dollars (Missouri Department of Conservation 2010).

Current Management

Past management sought to control fish passage into DeSoto Lake—particularly non-native carp species, but flood damage to the lake's water control structures has reduced this management capability. Currently riverine fish can enter the lake through the refuge's water control structures. State partners conduct annual fisheries surveys to monitor carp populations in the lake.

Aside from invasive fish species, no other invasive or exotic animal species management is conducted at the refuges. The refuges remain actively engaged with partners working on aquatic species management in the Missouri River for fish, mollusks, and plants. Additional invasive animal species in the region, both aquatic and terrestrial, are being carefully monitored, including feral hogs, which have been sighted in both Nebraska and Iowa in recent years.

People

The People section of this chapter contains background on the various human dimensions of the refuges. Included are a portrait of the local communities, the diversity of public uses and visitor services available, refuge administration and infrastructure, support provided by partners and the public, and management of historic and cultural resources.

Socioeconomic Setting

In west-central Iowa, the entrance to DeSoto NWR is located less than 8 miles west of Missouri Valley, Iowa on U.S. Highway 30 and is only 6 miles east of Blair, Nebraska. The refuge is split between three counties: Washington County in Nebraska and Pottawattamie and Harrison Counties in Iowa. The entrance to Boyer Chute NWR is located three miles east of Fort Calhoun, Nebraska in Washington County. Some of the unacquired lands of the authorized refuge boundary also span Pottawattamie County in Iowa.

On the Iowa side of the Missouri River, the largest towns in Harrison County (population 14,928) are Missouri Valley (population 2,838) and Logan (population 1,534). Pottawattamie County to the south has a larger population of 93,158 because it contains the city of Council Bluffs (population 62,230). On the Nebraska side of the Missouri River, Washington County has a population of 20,234, which includes Blair (population 7,990) and Fort Calhoun (population 908).

Blair, the Washington County seat, is located 13 miles north of Fort Calhoun. Fifteen miles south of Boyer Chute NWR in Douglas County is Omaha, Nebraska, with a 2010 population of 408,958. Iowa has just over 3 million people, and Nebraska has approximately 1.82 million people of which approximately one-third live in the Greater Omaha–Council Bluffs Metropolitan Area. The Greater Omaha–Council Bluffs Metropolitan Area, contains almost 900,000, making it the 60th largest metropolitan area in the United States (U.S. Census Bureau 2010).

Development in the floodplain near DeSoto and Boyer Chute Refuges has come predominantly in the form of agriculture with only minor residential development. Development pressures in the area immediately surrounding the refuges have been low to moderate over the past half century, with Missouri Valley’s population decreasing by about 20 percent, Fort Calhoun’s population doubling over the past 50 years, and Blair’s increasing by 62 percent over the same time period (table 3-7).

About a dozen farmsteads are located within Boyer Chute NWR’s authorized boundary—primarily on the Nebraska side of the river. There are also three residential developments/trailer courts on the edge of the Missouri River within the authorized boundary—two on the Nebraska side and one in Iowa. In Nebraska, on the northwest corner of the refuge lies Desoto Park Estates, and to the southeast is the smaller development on North River Lane. Across the river in Iowa lies a dispersed housing development in the area of the Goosehaven Loop Road.

Table 3-7: Population Change over Time in the Cities and Towns near the Refuges

City	1960	1970	1980	1990	2000	2010
Missouri Valley, Iowa	3,567	3,519	3,107	2,888	2,992	2,838
Fort Calhoun, Nebraska	458	642	641	648	856	908
Blair, Nebraska	4,931	6,106	6,418	6,860	7,512	7,990
Omaha, Nebraska (City Only)	301,358	346,929	314,255	335,795	390,007	408,958

Demographics and Housing

The racial makeup of Harrison County is 98.3 percent White, 1.2 percent Hispanic, 0.4 percent American Indian, 0.3 percent Asian, and 0.2 percent Black or African American. The racial diversity increases very slightly in Washington County with 97.2 percent White, 2.1 percent Hispanic, 0.6 percent Black or African American, 0.3 percent Asian, and 0.2 percent American Indian. Douglas County, immediately to the south of Washington County and containing the city of Omaha, is 76.4 percent white, 11.6 percent Black or African American, 11.2 percent Hispanic, 2.7 percent Asian, and 0.7 percent Native American (U.S. Census Bureau 2010).

The average age of Harrison County residents is 42.9, with 75.9 percent over the age of 18 and 17.8 percent over 65 years of age. Females are in the slight majority at 50.6 percent. Washington County residents are slightly younger overall, with an average age of 40.8 years, 74.8 percent over the age of 18, and 14 percent over 65 years of age. Females are again in the slight majority at 50.2 percent (U.S. Census Bureau 2010).

Only 1.9 percent of Harrison County’s residents speak a language at home other than English, while 2.6 percent of Washington County’s population speaks a language at home other than English. The most abundant ancestral origins claimed by Harrison County residents include German (43.7 percent), Irish (19 percent), English (11.1 percent), and Danish (5.1 percent). Similarly, Washington County residents claim German (44.3 percent), Irish (15.8 percent),

Danish (12.7 percent), English (10.3 percent), Swedish (6.5 percent), and Czech (5.3 percent) origins.

In Harrison County 63.1 percent of men and 57.5 percent of women in the county are currently married, 24.8 percent of men and 18.3 percent of women have never been married, and 7.3 percent of men and 9.9 percent of women are divorced. In Washington County 62.4 percent of men and 59.1 percent of women in the county are currently married, 28.1 percent of men and 21.7 percent of women have never been married, and 6.7 percent of men and 8.7 percent of women are divorced (U.S. Census Bureau 2010).

In Harrison County, there are 6,096 occupied households of a possible 6,760 housing units (90.1 percent occupancy), with an average owner-occupied household size of 2.55 people. The numbers are slightly higher in Washington County, where there are 7,454 occupied households of a possible 8,270 housing units (90.1 percent occupancy), with an average owner-occupied household size of 2.68 people (U.S. Census Bureau 2010).

Employment and Income

In Harrison County, 67.3 percent of adults over 16 years of age are employed. The largest employment sectors include education and health care (22.3 percent), manufacturing (13.3 percent), and retail (10.4 percent), with 6.2 percent engaged in agriculture or forestry. Also, 14.9 percent are employed by the government and 10.4 percent are self-employed. The mean household income is \$62,488, and 6.2 percent of families have incomes below the poverty line (U.S. Census Bureau 2010).

Just over 69.4 percent of the population over age 16 in Washington County is employed. The largest employment sectors include education and health care (22.0 percent), manufacturing (11.2 percent), and retail (10.1 percent), with 4.3 percent in agriculture or forestry. Government employees make up 11.1 percent and 7.8 percent are self-employed. The mean family income is \$91,307, a third higher than in Harrison County, and only 2.6 percent of the population lives below the poverty line (U.S. Census Bureau 2010).

Education

Of Harrison County's residents, 91.2 percent of those over 25 years of age have completed a high school level of education, with 9.1 completing associate degrees, 15.9 having bachelor's degrees, and 3.4 percent with graduate or professional degrees. In 2010, a quarter of the population was enrolled in school (3,648), with 18.8 percent of those enrolled in post-secondary education (U.S. Census Bureau 2010).

In Washington County, 93.4 percent of those over 25 years of age have attained a high school diploma. Of this total, 9.0 percent have an associate degree, 27.4 have a bachelor's degree, and 6.6 percent have a graduate or professional degree. In 2010 over a quarter of the county population was enrolled in school (5,681), with 26.0 percent of those enrolled in post-secondary education (U.S. Census Bureau 2010).

Economic Value of the Refuge to the Local and Regional Economy

Visitors to DeSoto and Boyer Chute Refuges spend money on a wide variety of goods and services, including food, lodging, transportation, outdoor apparel, binoculars, cameras,

ammunition, and fishing tackle. Economic benefits also include annual payroll to 15 employees, tens of thousands of dollars' worth of materials and equipment, and services purchased from local vendors.

In 2006, DeSoto NWR was included in a national study of economic benefits provided to local communities by national wildlife refuges. The study found that there were 283,781 visits to the refuge in 2006, primarily associated with non-consumptive uses (261,581), fishing (20,000), and hunting (2,200). Most visitors were residents (64 percent). Visitors spent an estimated \$2.9 million related to recreation at the refuge (residents: \$1.9 million and non-residents: \$1 million). The final adjusted economic benefit provided by the refuge after the spending had cycled through the economy was \$2.6 million. This figure takes actual visitor expenditures and adds financial benefits to locals who earned income from the visitors' activities. Calculations predict that this economic activity also generated the equivalent of 52 jobs for the local economy. Spending on recreation in 2006 also generated \$364,500 in tax revenue. Finally, it is estimated that for every one dollar in budget expenditures at DeSoto NWR (\$1.5 million in the 2006 fiscal year), \$4.26 worth of recreation-related expenditures and net economic value were generated (Carver and Caudill 2007).

In 2004, Boyer Chute NWR was included in the national study of economic benefits provided to local communities by national wildlife refuges. The study notes that there were 22,044 visits to the refuge in 2004, primarily associated with hiking trails (16,816) and fishing (2,086). Visitors spent an estimated \$123,000 related to recreation at the refuge (residents: \$80,400 and non-residents: \$42,600). The final adjusted value after the spending had cycled through the economy was \$192,900. This figure takes actual visitor expenditures and adds financial benefits to locals who earned income from the visitors' activities. Calculations predict that this economic activity also generated the equivalent of three jobs for the local economy. Spending on recreation in 2004 also generated \$26,700 in tax revenue. Finally, it is estimated that for every one dollar in budget expenditures at Boyer Chute NWR (\$494,100 in the 2004 fiscal year), \$0.67 worth of recreation-related expenditures and net economic value were generated (Caudill and Henderson 2005).

The 2011 Nebraska Statewide Comprehensive Outdoor Recreation Plan provides additional information regarding recreation in the state (Nebraska Game and Parks Commission 2010). Nebraska has 2.4 percent of its total land and water base of 1,166,852 acres open to public recreation, with an additional 900,000 acres of privately-owned recreation lands and waters. Of the publicly available recreation lands, 51 percent are federally managed, 25 percent are managed by the NGPC, and 15 percent are enrolled in the Conservation Reserve Program. Recreation activities engaged in by Nebraskans that often overlap with national wildlife refuges include picnicking (77.4 percent), driving for pleasure (67.8), sight-seeing (66.7 percent), walking (65.3 percent), nature observation/photography (59.2 percent), and fishing (53.7 percent). Public use at the refuges currently accommodates a number of these activities.

The Iowa DNR estimates that nearly a quarter of the state population participates in hunting or fishing, that 1.3 million Iowans participate in wildlife-associated recreation annually, and that this recreation generates \$1.5 billion dollars annually—the equivalent of 16,000 jobs (Zohrer 2006).

Visitor Services

DeSoto NWR was established with the approval of the Migratory Bird Conservation Commission with the dual intention of providing for the needs of migratory birds and providing public recreation to local communities. Both refuges provide a number of facilities and opportunities for visitors, including all six of the priority uses established by the National Wildlife Refuge System Improvement Act of 1997: hunting, fishing, wildlife observation and photography, and environmental education and interpretation, as well as other wildlife-dependent recreation. DeSoto and Boyer Chute Refuges are open daily from sunrise to sunset. Following the 2011 floods, both refuges are managed out of DeSoto NWR.

DeSoto NWR has collected fees since 1987. Fees are collected as mandated by Congress under the Federal Lands Recreation Enhancement Act. At the time of writing, the entrance fee program was \$3.00 per vehicle and \$20.00 to 30.00 per commercial van/bus; federal Duck Stamps, Interagency passports and other such passes are accepted in lieu of the fee. A visitor survey conducted in 2011 shows 85 percent of the visitors surveyed feel the fee is about right; 13 percent feel it is too low or far too low; 88 percent agreed that the fee paid was justified by the value of the experience (Sexton et al. 2011). Boyer Chute NWR has no entrance fee, and there are no plans to collect a visitor fee.

For over two decades following its establishment, in addition to more traditional wildlife-dependent public uses, DeSoto NWR hosted diverse recreational activities such as picnicking, swimming, water skiing, and power boating. Many of these uses ended in the mid-1980s, well before the compatibility lawsuit against the Service in the 1990s questioned recreational uses that were not wildlife dependent. Visitation at DeSoto NWR has changed through time as a result of changes in recreation opportunities offered by the refuge, the addition of an entrance fees in 1987, and multiple years of flooding in the 1990s and in recent years. Just under 200,000 people visited the refuge annually in the 1960s. Annual visitation rose to nearly 350,000 in the 1970s, and then peaked in the 1980s at nearly 400,000 before decreasing to an annual average of 300,000 in the 1990s. In the late 2000s, average annual visitation hovered around 215,000, and then visitation dropped to record lows in 2010 and 2011 as a result of catastrophic flooding on the Missouri River, the closure of Wilson Island State Recreation Area, evacuation of the Steamboat Bertrand Museum Collection, and the seven-month closure of the refuge. The refuge and visitor center reopened to the public in January of 2012. In August of 2013, the Steamboat Bertrand Museum Collection was returned to DeSoto NWR. At the time of writing Wilson Island State Recreation Area remained closed. Table 3-8 shows DeSoto NWR's annual visitation counts over the past 10 years.

Visitation at Boyer Chute NWR began over Labor Day weekend in 1996. Since the refuge's inception, it has averaged just over 28,000 visitors per year. Similar to DeSoto NWR, visitation was greatly reduced in 2010 and 2011 due to long-duration, widespread flooding on the refuge. The history of visitation at Boyer Chute NWR appears in table 3-8 and is described in the sections that follow.

Table 3-8: Visitation at DeSoto and Boyer Chute Refuges

Fiscal Year	DeSoto NWR	Boyer Chute NWR	Comments
2002	176,009*	20,979	
2003	329,091*	16,375	
2004	362,427*	21,610	Last major snow goose migration
2005	216,000	25,439	
2006	253,510	26,141	
2007	211,263	27,286	
2008	191,639	26,936	
2009	254,770	29,582	
2010	175,445	15,000	Major flooding – Boyer Chute NWR and Wilson Island State Recreation Area
2011	146,250	16,868	Major flooding – both refuges
2012	128,890	11,250	Flood recovery – select area closures

*Data incomplete; this sum covers the months of January through September.

In 2011, DeSoto NWR was one of five refuges in the Midwest Region of the Service selected to take part in a visitor survey. Seventy percent of the original 203 participating visitors completed the survey. Widespread flooding in 2011 made it impossible to fully complete the second sampling period. Highlights of the results indicated that nearly 90 percent of visitors surveyed were familiar with the Service's conservation mission, half of surveyed visitors had come to the refuge on several occasions, and 63 percent were from communities in the area. Visitors indicated that the primary reasons for their visit were interpretation (28 percent), wildlife observation (15 percent), hunting (11 percent), and bird watching (10 percent); although they indicated that they engage in activities such as wildlife observation (61 percent), interpretation (45 percent), bird watching (44 percent), and auto tour driving (43 percent) while on the refuge. On average, visitors spend about \$35.00 per day in the local area. Nearly 90 percent of visitors were satisfied with the recreation opportunities, and approximately 95 percent were satisfied with the information, services, and overall conservation work done by refuge staff (Sexton et al. 2011).

Public Access and Facilities

Areas of DeSoto NWR open to the public from April 15 through October 14 include the area south of the headquarters and east of the entrance road, between the tour road and DeSoto Lake, and the area immediately surrounding the south end of DeSoto Lake near Wilson Island State Recreation Area. Only roads and trails in these public use zones are open the remainder of the year (October 15 to April 14). The area west of the Missouri River and the area southeast of DeSoto Lake are closed to the public except for the mushroom gathering season from April 15 through May 31. Finally, the areas of DeSoto NWR closed year round to visitors include the areas inside the tour road, north of the lake, and west of the entrance road. During the hunting seasons temporary access is permitted to some of these zones. Figure 3-28 depicts the visitor services infrastructure on DeSoto NWR.

DeSoto NWR provides a self-guided paved and gravel auto tour road through the refuge; bicycling is also permitted on the tour route. Kiosks and signs are located throughout the refuge for welcoming, orienting, and providing interpretive information to visitors. Information and orientation services are also available at the refuge headquarters near the north entrance to the refuge and at the Visitor Center.

Four satellite gravel parking lots with informational panels are maintained throughout the refuge for hunting access. Three wildlife observation trails are maintained: one at the Visitor Center (Visitor Center Trail) and two along the refuge tour route (Cottonwood Trail and Grassland Trail). Several accessible hunting blinds are available on the Center Island Unit. A covered environmental educational shelter is located at the Cottonwood trailhead; an environmental education gravel parking lot is maintained on the northeast corner of the refuge along U.S. Highway 30 to provide ranger guided school group access to the area. A large, accessible wildlife observation blind with two spotting scopes is located at Bob Starr Wildlife Overlook. Boating access to DeSoto Lake is provided at Middle Boat Ramp and hand-launch only access is available at the Steamboat Bertrand Discovery Site. Bank fishing is available seasonally along DeSoto Lake at Sandbar Chute, Bullhead Pond, Middle Boat Ramp, Lakeview Drive, Prairie Lane, Whitetail Drive, and the South Gate Area; an accessible fishing pier is located at the South Gate Area.

The Visitor Center at DeSoto NWR opened in 1981, with 26,000 square feet of space for the Steamboat Bertrand Museum Collection, interpretive exhibits, wildlife viewing galleries over DeSoto Lake, a theater, a small bookstore, an information desk, and numerous offices and meeting spaces. The building is maintained in good condition and has undergone major renovations over the past several years including new windows, a roof, lighting, and an entrance door. Additional repairs and modifications are being made to increase the building's ability to withstand future flood events. Annually 70,000 to 100,000 people visit the Visitor Center during open hours (9:00 a.m. to 4:30 p.m., seven days a week).

The Steamboat Bertrand Museum Collection has been housed in the DeSoto Visitor Center since the center was built in 1981. Flooding in 2011 caused the collection to be temporarily moved off-refuge. The Service is now conducting the first comprehensive inventory of the collection and is also in the process of updating the Visitor Center to better accommodate the collection and ensure a streamlined evacuation process should a future emergency arise. Curatorial staff are responsible for artifact loans, research and article publication, and technical assistance for inquiries from government agencies, museums, journalists, and researchers. Interpretation of the Steamboat Bertrand Discovery Site consists of a short trail leading from the parking lot to an observation platform, several interpretive panels, and a pond that formed at the completion of the Steamboat Bertrand excavation.

At Boyer Chute NWR (figure 3-29), all units are closed to the public except the West Chute and Boyer Island Units at the eastern end of County Road 34. All public use facilities are concentrated on these two units. The center of the south half of the Boyer Island Unit is also closed to the public. There is a heavy-duty bridge across the Boyer Chute that provides access to the Boyer Island Unit for both refuge staff and visitors. Its design has management implications, including safety concerns for boating in the chute, debris accumulation on the upstream side, and a reduction in the chute's ability to meander. Boyer Chute NWR allows mushroom gathering for personal use with no date restrictions in all open areas of the West Chute and the Boyer Island Units.

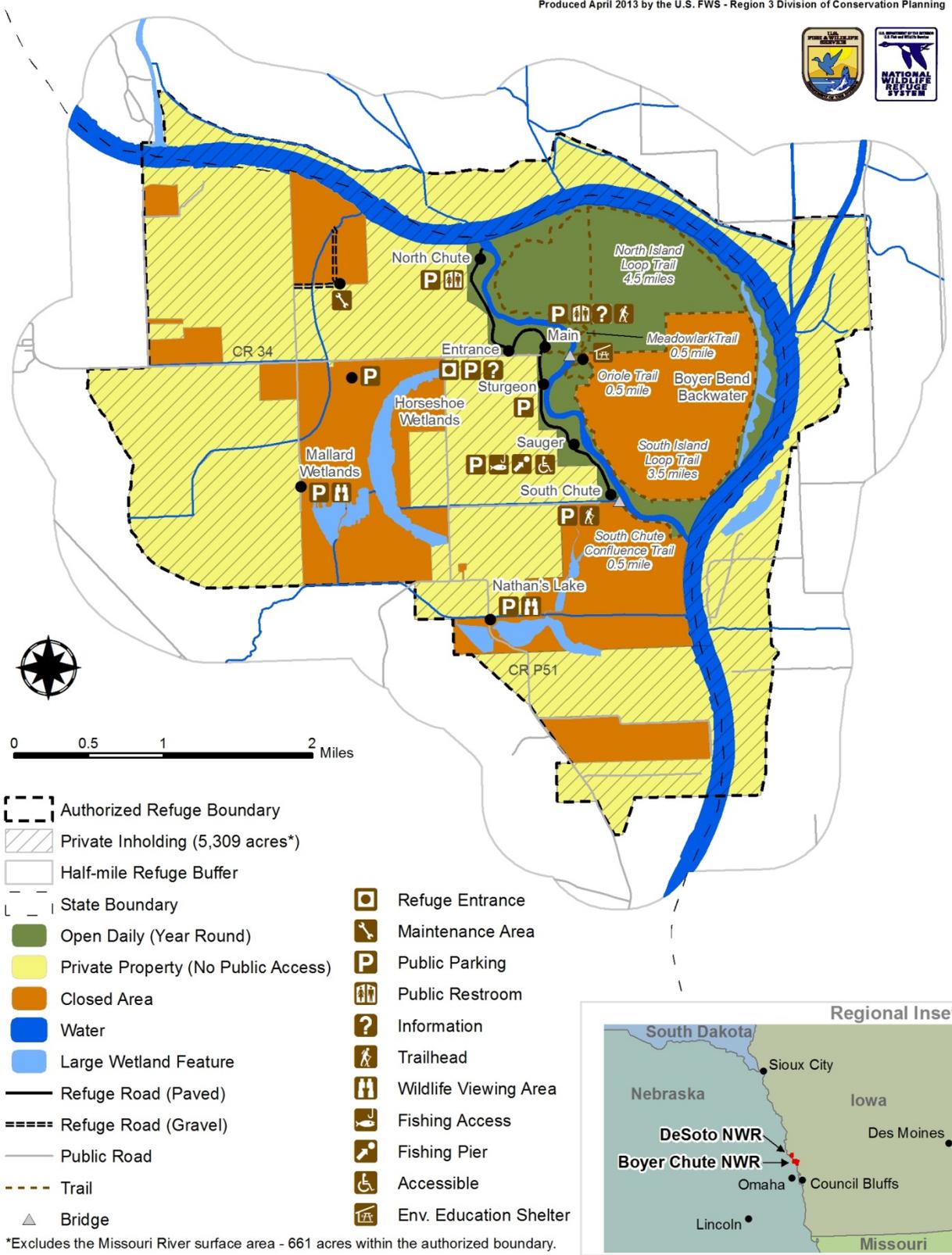
Boyer Chute NWR provides a self-guided, paved automobile tour road in the West Chute Unit. It also provides access to six parking areas and bank fishing opportunities along the chute, including one accessible fishing pier. Bicycling is permitted on the tour road. Informational and interpretive kiosks are located at the refuge entrance and at the main parking lot. There are approximately 10 miles of trails on the refuge. One of the five wildlife observation trails is located at the south end of the West Chute Unit tour road (South Chute Confluence Trail, 0.5 mile), and the other four are all located on the Boyer Island Unit [Oriole (0.5 mile), Meadowlark (0.5 mile), North Island Loop (4.5 miles), and South Island Loop (3.5 miles) Trails]. Several satellite gravel parking lots are maintained throughout the refuge for hunting access.

Boyer Chute NWR has a maintenance facility located at the intersection of Sands Lane and River Tree Road. The main shop building has three maintenance bays and was updated in 2009–2010. In addition to the main building, there are three pole sheds on the site used for equipment storage and general maintenance functions. Flooding in 2010 and 2011 has impacted the maintenance buildings and the use of this area.

Missouri River access is open to the public and managed by the Corps, not the refuges. There are no publicly accessible boat ramps to the Missouri River on either refuge, but access ramps can be found nearby in Blair, Nebraska and at Wilson Island State Recreation Area.

Figure 3-29: Current Visitor Services, Boyer Chute NWR

Produced April 2013 by the U.S. FWS - Region 3 Division of Conservation Planning



Public Use

Hunting

DeSoto NWR hunting opportunities include muzzleloader and archery deer, archery turkey, and special shotgun turkey hunts for youth and disabled hunters. Boyer Chute NWR has offered muzzleloader deer and waterfowl (shotgun) since 2004. State hunting license reciprocity exists for DeSoto NWR, which contains land in both Iowa and Nebraska but not on Boyer Chute NWR, because the refuge does not yet contain land on the Iowa side of the Missouri River. The refuge hunts are described in additional detail below and in figures 4-30 and 4-31.

Muzzleloader deer hunting is allowed at both refuges for managed, high saturation hunts. At DeSoto NWR this occurs in up to four hunt events annually, typically one of which is for bucks, the remainder are for antlerless deer; hunting zones vary between the two hunt types. At Boyer Chute NWR up to three antlerless muzzleloader deer hunt events occur annually on the five largest units: Boyer Island, West Chute, Nathan's Lake, Horseshoe Lake, and North-Central.

Archery deer hunting occurs at DeSoto NWR in the fall during the dates when Nebraska and Iowa have overlapping open seasons (early October to mid-January). This hunt is offered in two areas of the refuge: west of the Missouri River and the area southeast of DeSoto Lake.

Archery turkey occurs in the spring during the dates when Nebraska and Iowa have overlapping open seasons (mid-April to mid-May). This hunt is offered within two areas of the refuge: west of the Missouri River and the area southeast of DeSoto Lake.

Shotgun turkey hunting events occur on DeSoto NWR in April and May for youth and disabled hunters.

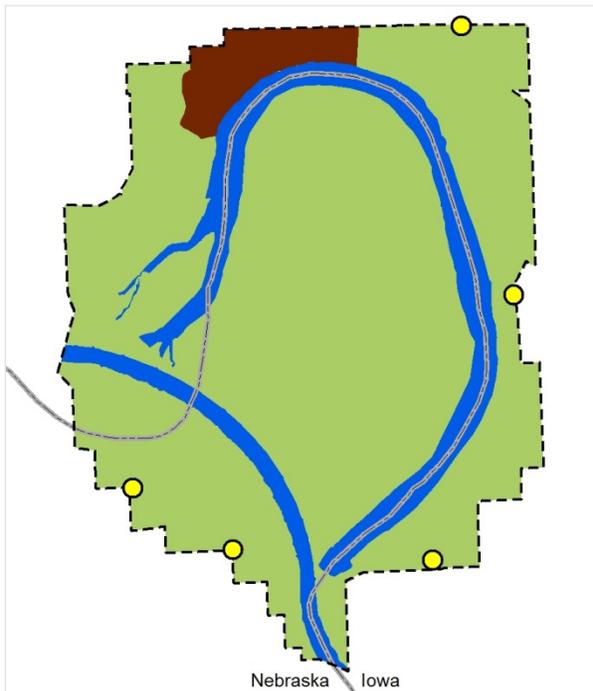
Waterfowl hunting (ducks, geese, and coots) has been allowed on Boyer Chute NWR in accordance with state and federal hunting regulations since the completion of the 2007 environmental assessment and follows the annual Service framework for the timing of migratory species hunting and the maximum allowable take. The area of the refuge designated for waterfowl hunting is defined as the immediate shoreline of the Missouri River, up to and including the high bank, and between both ends of the Boyer Chute (see figure 3-31). The majority of the hunters access the area by boat, but land access is also available. An estimated 20 waterfowl hunters use the refuge each season. DeSoto NWR does not currently have waterfowl hunting.

Small game hunting is not allowed on either refuge, although a fall youth pheasant hunt has been offered in the past on DeSoto NWR.

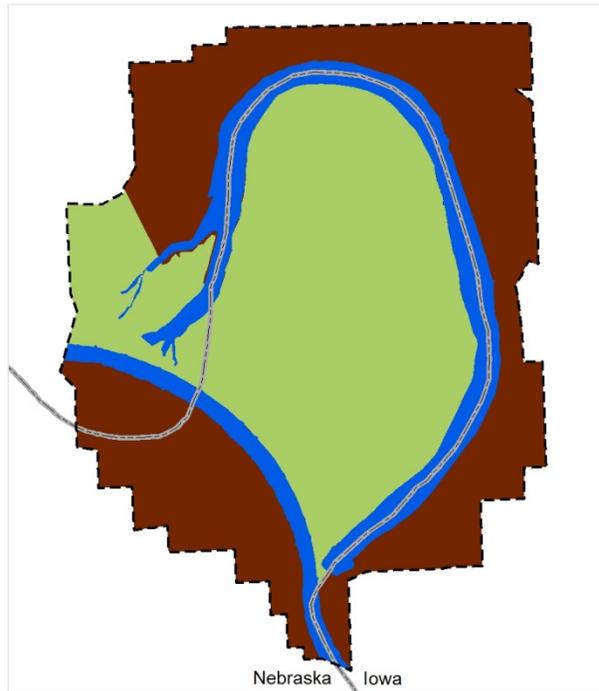
Trapping is not currently allowed on either refuge.

Figure 3-30: Hunting Program, DeSoto NWR

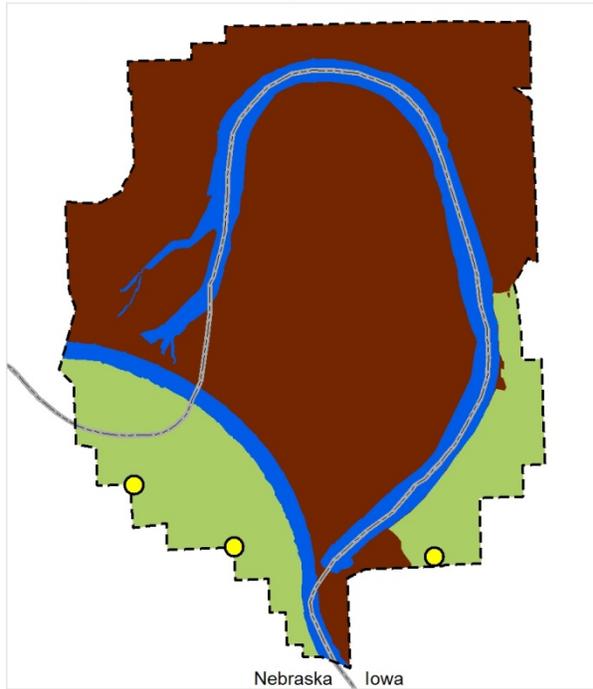
Muzzleloader Antlerless Deer



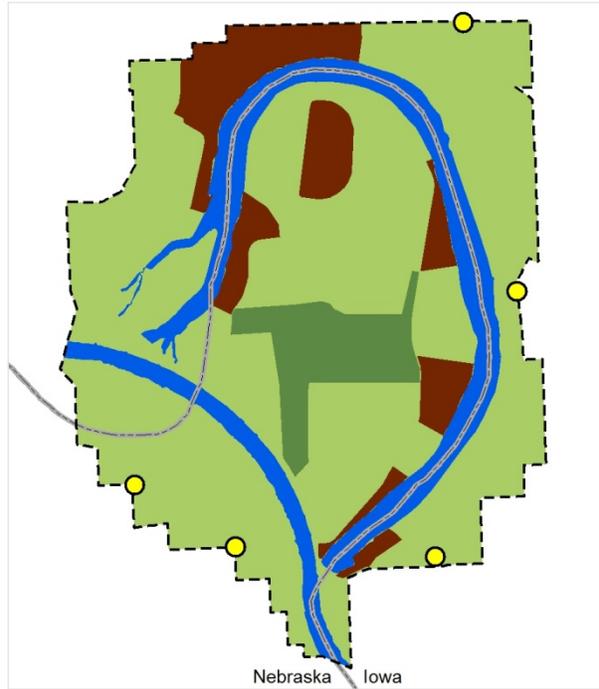
Muzzleloader Buck



Archery Deer and Turkey



Shotgun Special (Youth, Mobility Impaired)



- Authorized Refuge Boundary
- State Boundary
- Water
- Hunting Area
- Mobility Impaired Hunters Only
- No Hunting
- Hunter Parking

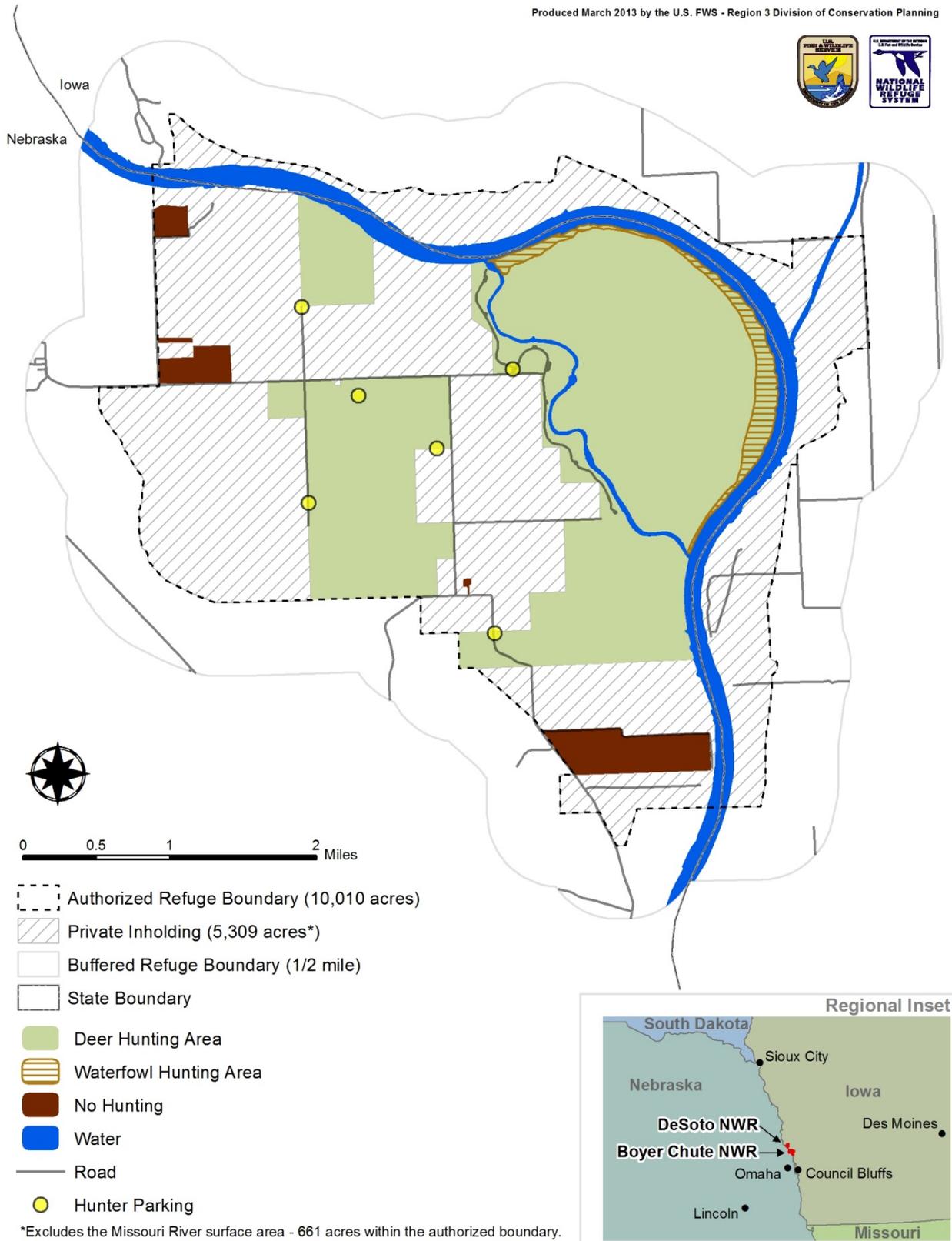


0 0.5 1 Miles



Produced March 2013 by the U.S. FWS - Region 3 Division of Conservation Planning

Figure 3-31: Hunting Program, Boyer Chute NWR



Fishing

DeSoto NWR provides anglers with opportunities to fish in DeSoto Lake from April 15 through October 14. In addition to bait and tackle, archery fishing for rough fish is permitted. Ice fishing on the lake is open from January 2 through the end of February. The lake supports a healthy fishery for bluegill, crappie, largemouth bass, white bass, and walleye. A number of fish habitat structures such as trees, rocks, and pallets have been added to enhance fish habitat. Motorized boating is permitted as long as visitors travel at no wake speeds (5 mph or less). The 2011 flood permanently damaged two DeSoto Lake boat ramps located at the Steamboat Bertrand Discovery Site and the South Gate. Hand-launch access remains available at the Steamboat Bertrand Discovery Site. In addition, a number of access points for bank fishing and one boat launch facility (Middle Boat Ramp) are available. Bank fishing locations include Sandbar Chute, Bullhead Pond, Middle Boat Ramp, Lakeview Drive, Prairie Lane, Whitetail Drive, and the South Gate Area. An accessible fishing pier is located at South Gate Area. No fishing is allowed in the small ponds dispersed throughout the refuge. Finally, boat fishing is permitted on the stretch of the Missouri River that passes through DeSoto NWR.

Boyer Chute NWR provides anglers with bank fishing opportunities along the Boyer Chute and the Missouri River and boat fishing on the Missouri River. In addition to bait and tackle, archery fishing for rough fish is permitted. Creel surveys indicate anglers catch a few shovelnose sturgeon as well as channel, blue, and flathead catfish; carp, skipjack herring, and drum are also caught. No off-river waters are open to fishing on the refuge, and ice fishing was permanently closed at Boyer Chute NWR in 2001 due to safety concerns on the Boyer Chute. There was an initial surge of interest in fishing in 1996 when the refuge opened, and then use stabilized in the early 2000s at 2,000 to 3,000 visits per year. Since 2005 use has hovered around 4,000 visits per year. Years with widespread flooding across the refuge (2010 and 2011) greatly reduce fishing visits and the refuge's ability to host and monitor fishing use. During normal river flows, light fishing occurs on weekdays, and larger numbers of anglers visit on weekends. Popular fishing spots include the north and south ends of the Boyer Chute, the area surrounding Boyer Chute Bridge, and the Sauger Pier. Litter associated with fishing can be problematic at times on the refuge.

Wildlife Observation and Photography

There are many opportunities to observe and photograph wildlife at DeSoto and Boyer Chute Refuges. Trails and public roads provide opportunities to see a diversity of big game, waterfowl, birds of prey, and songbirds in a floodplain landscape. The refuges provide thousands of acres of floodplain forests, prairies, and wetlands. These habitats benefit a broad diversity of wildlife including over 250 birds species, 35 mammal species, more than 60 fish species, and over 30 reptile and amphibian species. Large concentrations of waterfowl, primarily snow geese, once attracted great numbers of visitors to DeSoto NWR.

Visitors to the refuges may see Red-headed Woodpeckers, Barred Owls, Bald Eagles, Yellow-rumped Warblers, and Wild Turkey. Along the waterways, visitors may see Spotted Sandpipers, Great Blue Herons, Hooded Mergansers, and numerous species of waterfowl. The refuge habitats also attract mammals such as white-tail deer, beaver, muskrat, coyote, bobcat, badger, bats, and reptiles and amphibians including northern prairie skinks, softshell turtles, bull snakes, Woodhouse's toads, and leopard frogs. The species lists in appendix B provide additional information on wildlife that may be found on the refuges.

In addition to views from the observation galleries in the Visitor Center, DeSoto NWR visitors can enjoy the Steamboat Bertrand Discovery Site, three nature trails (Visitor Center, Cottonwood, and Grassland) extending a total of 1.76 miles, the Bob Starr Wildlife Overlook, the Missouri River Overlook, an auto tour route, and the South Gate Recreation Area. There are 11.5 miles of roads (10.9 paved, 0.6 gravel) available to the public year round, and an additional 7.0 miles of gravel roads open during non-migration periods.

Opportunities to observe wildlife are also abundant at Boyer Chute NWR. There are 2½ miles of paved roads that parallel the Boyer Chute with accessible parking areas, restrooms, and a fishing pier. Wildlife viewing is available from refuge roads, trails, and the Sauger Pier. On the West Chute Unit, the South Chute Confluence Trail runs a half-mile from the South parking lot to the Missouri River. There are also four trails on the Boyer Island Unit [Oriole (0.5 mile), Meadowlark (0.5 mile), North Island Loop (4.5 miles), and South Island Loop (3.5 miles)].

Visitation to the refuges continues throughout the winter season. At Boyer Chute NWR all available visitor facilities are open year round, sunrise to sunset. DeSoto closes approximately one-half of the refuge tour roads from October 15 through April 14 to provide refugia for migratory birds during the fall and spring migration periods. Weather permitting, visitors continue to participate in wildlife observation and photography throughout the winter at both refuges by driving and bicycling on tour roads, and snowshoeing and cross-country skiing on trails in open areas. DeSoto NWR is a popular destination for wildlife-dependent activities year round due to its well-maintained and plowed tour road and extensive Visitor Center featuring a theater, large wildlife viewing galleries, educational bookstore, public meeting space, natural history exhibits, and the Steamboat Bertrand Museum Collection display.

Environmental Education

DeSoto NWR operates a formal environmental education partnership with Blair Public Schools including an integrated curriculum developed with the school district for grades 3–12. The refuge is in the development stages of adding programs with other area schools, including an elementary school in Omaha. A number of other schools also utilize the refuges annually for self-guided or prearranged refuge staff-guided environmental education programs. DeSoto NWR hosts an average of over 5,000 student visits per year (5,951 in 2010; 6,321 in 2011; and 4,041 in 2012).

In partnership with staff at DeSoto NWR, Boyer Chute NWR hosts several environmental education classes each year. As part of the DeSoto NWR/Blair Public Schools Environmental Education Partnership, fifth grade students visit Boyer Chute NWR to study beavers and investigate signs of beaver activity on the refuge. As this partnership continues to grow it is likely that other grades from Blair Public Schools will visit the refuge. Other environmental education lessons are scheduled as requested.

Colleges and Universities periodically use the refuges for education and research, including Clarkson College, Creighton College, Dordt College, Drake University, Westmar College, the University of Nebraska, Iowa State University, Iowa Western Community College, the University of South Dakota, Morningside College, Hastings College, and Northwestern College.

Outreach and Programs

Onsite events hosted by DeSoto NWR in the past include Spring Migration Weekends/International Migratory Bird Day (IMBD) programs (February–March), Steamboat

Bertrand Days (April), National Volunteer Week/Earth Day/Spring Refuge Cleanup projects (April–May), Family Fishing Clinics (May–August), Teacher Workshop (June), Junior Refuge Manager programs (June–August), National Public Lands Day (September), National Wildlife Refuge Week/IMBD (October), Fall Migration Weekends/IMBD (November), Art-Of-The Wild wildlife art show (November), Backyard Bird Feeding programs (January–March), and wildlife-themed videos shown in the Visitor Center (weekends year round).

DeSoto NWR hosts weekend wildlife films, wildlife-related art exhibits, and winter and spring migration events. Online outreach efforts, including Facebook, facilitate public awareness of special wildlife viewing opportunities, programs, and exhibits available in the Visitor Center and refuge.

Events hosted by Boyer Chute NWR in the past included Bike to Boyer (2005–2010), National River Cleanup Week (2004–2007), National Trails Day (2007 and 2008), International Migratory Bird Day bird walk (2009), and Fontenelle Forest/Boyer Chute Butterfly Count (July). Since 2011, all refuge visitor services are based out of DeSoto NWR; public programs are intermittently scheduled at Boyer Chute or are included as part of programs (such as National Volunteer Week/Earth Day spring refuge cleanup projects, National Public Lands Day, and International Migratory Bird Day) being conducted and coordinated at DeSoto.

The refuges are also represented at outreach activities attended by staff. These events include Omaha's Henry Doorly Zoo (Earth Day) Party for the Planet (April), Nebraska Public Schools – Gifford Farm Park Family Nature Day (April), Omaha Public Schools Seventh Grade Career Day (April), University of Nebraska Medical Center's Nebraska Science Fest (April), Metro Omaha Resources for Exploring Nature (MORE) – Family Nature Nights (Spring/Fall), Wilson Island State Recreation Area Campfire Talks (June–September), and Omaha's Durham Museum – Teachers Workshop (October). Refuge-specific interpretive brochures and publications are sent to area tourism centers and are available for download from the refuges' website and Facebook pages.

Interpretation

Four primary interpretive themes form the foundation of interpretation and education on DeSoto and Boyer Chute Refuges. These themes offer visitors the opportunity to understand the natural and cultural resources of the refuges and the significance of these refuges nationally. The four themes are:

1. DeSoto and Boyer Chute Refuges provide sanctuary and a means of survival for migratory birds and other wildlife on the Missouri River floodplain by protecting, restoring, and enhancing diverse habitats that have largely disappeared from this important migratory bird corridor.
2. A mosaic of floodplain forest, grassland, wetland, sandbar, and riverine habitats are critical to the survival of diverse plant and animal life at the refuges—including rare, threatened, and endangered species such as the pallid sturgeon, Piping Plover, and Least Tern.
 - a. Innovative and science-based management techniques help preserve and restore native habitats and wildlife, especially migratory birds.
 - b. Wetlands are places of biological productivity, resilience, and beauty that provide resting and feeding areas for migratory birds, including Wood Ducks, Green-

winged Teal, Blue-winged Teal, Mallards, Great Blue Herons, egrets and many more.

3. Historic periods of exploration, settlement, and nation-building, including the passage of the Lewis and Clark Expedition (1804–1806) and Steamboat Bertrand (1865), heralded dramatic changes to the natural environment in the Missouri River Valley. These changes had substantial impacts on the wildlife and habitat in the Missouri River floodplain. Refuge resources and stories, such as those reflected by the Steamboat Bertrand Museum Collection, foster an appreciation for the impact of settlement in the Missouri River Valley and the refuges' role in conserving the river's unique natural history.
4. U.S. Fish and Wildlife Service staff and conservation partners work collaboratively in a dynamic and changing environment to understand, restore, and conserve biological communities on the refuges to benefit wildlife, and to promote an enduring appreciation for the refuges, the National Wildlife Refuge System, and Service trust resources.

In addition to the substantial interpretive facilities at the Visitor Center, DeSoto NWR also has kiosks with welcoming, orienting, and interpretive information located at the north and south entrances to the refuge, Visitor Center parking lot, and the Lewis and Clark Historic Campsite area. Informational and interpretive signs are located at the Middle Boat Ramp, Bob Starr Wildlife Overlook, Steamboat Bertrand Museum Collection and Discovery Site, Missouri River Overlook, and several additional locations along the refuge's tour road.

Natural resource interpretation provided at the kiosk and sign locations covers migratory birds and other wildlife, wildlife habitat, wildlife identification, wildlife conservation, threatened and endangered species, Missouri River channelization history, and recent habitat restoration efforts. Two major cultural themes are also interpreted throughout the refuge: the westward expansion of the United States (Lewis and Clark Expedition), and the mid-19th century Missouri River navigation and riverboat history (Steamboat Bertrand).

Boyer Chute NWR provides a self-guided, paved automobile tour road in the West Chute Unit, providing access to six parking areas and bank fishing opportunities along the chute including one accessible fishing pier. Bicycling is permitted on the tour road surface. Informational and interpretive kiosks are located at the entrance and at the main parking lot for the West Chute and Boyer Island Units. The kiosks are used to welcome and orient visitors as well as provide interpretation about the biological resources of the refuges and recent habitat restoration efforts including the Boyer Chute. One major cultural theme is interpreted—the westward expansion of the United States. Kiosk interpretive panels tell the story of Lewis and Clark's first meeting with Indian tribes in August of 1804, three miles west at the nearby "Council Bluff."

Refuge Administration

Both refuges are currently managed and staffed out of DeSoto NWR. The existing organizational chart identifies 21 positions, of which 16 are filled (see table 3-9). The 2001 DeSoto CCP requested an additional nine positions over the 19 positions that existed at the time to accomplish the objectives of the plan. Administration is split between the DeSoto NWR headquarters building, which houses most of the staff, and the Visitor Center, which houses the visitor services, law enforcement, and museum curatorial staff.

Table 3-9: Staffing on the Refuges

Position Category	No. of Employees
Manager	1
Wildlife Refuge Specialist	3
Administrative Officer	1
Museum Curation	2
Park Ranger	3
Law Enforcement	1
Maintenance	4
Student Trainee	1
TOTAL	16

The management of DeSoto NWR has been fairly stable since its creation in 1959. However, the management of Boyer Chute NWR has varied greatly over the 25-year lifespan of the refuge. The refuge was created as a unit of the Rocky Mountain Region of the Service (Region 6), but was managed by the Midwest Region (Region 3) until July of 2001. During the early 2000s the refuge was managed out of Region 6. Then in October of 2006, management was passed back to Region 3 of the Service and has remained there ever since. The refuges' close proximity and shared ecology, habitats, wildlife management, and publics make shared management more efficient.

The operations and maintenance budget for the refuges have fluctuated over the past 5 years (see table 3-10). The late 2000s saw a generally increasing trend, and then in the early 2010s budgets have been stable for Boyer Chute NWR and gradually decreasing for DeSoto NWR—the notable exception being 2012, which had a number of costs associated with 2011's catastrophic flooding.

Table 3-10: Refuge Operations and Maintenance Budgets

Fiscal Year	DeSoto NWR	Boyer Chute NWR
FY 2008	\$1,674,282	\$281,022
FY 2009	\$2,226,370	\$287,723
FY 2010	\$1,926,075	\$322,298
FY 2011	\$1,804,362	\$222,736
FY 2012	\$2,309,686	\$223,392
FY 2013	\$1,720,926 (estimated)	Funding moved to DeSoto NWR

Law Enforcement

Law enforcement on the refuges focuses on both protection and prevention. Protection seeks to safeguard the visiting public, staff, facilities, and natural and cultural resources from criminal action, accidents, negligence, and acts of nature such as storms. Incident prevention occurs primarily through the patrols and activities of law enforcement staff. Law enforcement includes verbal warnings, written notices, and warrant arrests; incidents reported include poaching, dumping, drug and alcohol use, vandalism, and auto accidents.

DeSoto and Boyer Chute Refuges share one Service law enforcement officer. As needed, the officer also assists other refuges in the Midwest Region. In addition, the refuges rely on assistance from the Iowa and Nebraska state conservation officers in the area and the Sheriff's Offices in Blair and Missouri Valley.

Refuge Support

To accomplish the conservation mission of the Refuge System, support from volunteers and partners is essential. External support is key to the success of many refuge programs.

Friends Group

The refuges share a single Friends Group: the Friends of Boyer Chute and DeSoto National Wildlife Refuge, a non-profit citizen group formed in 2003. At the time of writing, the Friends Group has approximately 55 members with about a dozen very active individuals. The goals of the Friends Group include providing awareness of the refuges and environmental education to residents of the surrounding communities, providing volunteers and support to refuge staff with environmental, educational, and wildlife-oriented projects, and raising funds for special refuge projects. At DeSoto NWR the Friends Group also manages and operates the Visitor Center's Eagle Emporium Bookstore.

Volunteer Program

Volunteerism on the refuges was relatively stable in the early 2000s but has declined in recent years due to the regularity of flood events, flood-related closures, and a reduction in the number of refuge events held throughout the year. Many volunteers work with the refuge as a part of the Friends Group or local birding groups. Refuge volunteers also assist with general maintenance, environmental education, and seed collecting activities. Table 3-11 tracks volunteerism on the refuges starting in 2000.

Table 3-11: Volunteerism at the Refuges

Fiscal Year	DeSoto NWR		Boyer Chute NWR	
	No. of Individuals	Hours Donated	No. of Individuals	Hours Donated
2000	84	4,168	14	292
2001	88	3,926	5	212
2002	137	5,962	20	4,010
2003	85	5,809	22	1,594
2004	106	5,952	60	2,151
2005	312	6,532	155	1,576
2006	562	5,202	46	1,043
2007	373	3,962	44	847
2008	343	4,222	33	781
2009	293	3,851	21	611
2010	369	4,933	22	563
2011	191	2,633	0	0
2012	262	2,262	50	180

Partnerships

Refuges staff frequently interact with many federal, state, county, and local governments in addition to a number of non-governmental organizations. In fact, it is through these partnerships that Boyer Chute NWR was created; collaborative efforts led to the initial land acquisition and numerous habitat restorations on the refuge.

In addition, there are a number of ongoing partnership activities throughout the Greater Omaha–Council Bluffs Metro Area. Examples include refuge participation in programs at the Omaha Zoo and Durham Museum, career days in metro area public schools, support of refuge activities by Bass Pro Shops®, interaction with the NGPC’s Omaha Visitor Center, and regular interaction with metro news and radio outlets.

The refuges meet annually with the Corps to discuss shallow water habitat restoration projects. Both refuges are in the path of the Lewis and Clark National Historic Trail and have camps from the expedition on or adjacent to refuge lands. An artistic monument has been constructed on Boyer Chute NWR as a part of the interpretation of this history. The refuges are also partners in a range of Missouri River Recovery Program initiatives and working groups. The refuges are involved in the Loess Hills Alliance through their private lands program, which has undertaken a number of restoration projects within the Loess Hills. Other examples of refuge partnerships include coordinating the refuge’s law enforcement program with the Washington County Sheriff’s Department, updating Nebraska legislators on Service programs and emerging issues, and the diversity of research projects coordinated with the University of Nebraska’s Omaha and Lincoln campuses.

A number of the refuge key partners are listed below and in appendix I.

- Papio-Missouri River Natural Resources District (PMRNRD)
- U.S. Army Corp of Engineers (USACE)
- Natural Resources Conservation Service (NRCS)
- National Park Service – Midwest Regional Office (NPS)
- Nebraska Game and Parks Commission (NGPC)
- Iowa Department of Natural Resources (Iowa DNR)
- Lower Missouri River Ecosystem Team
- Missouri River Natural Resources Committee (MRNRC)
- Ducks Unlimited (DU)
- Back to the River, Inc. (B2R)
- The Nebraska Land Trust
- National Audubon Society – Omaha Chapter
- The Nature Conservancy
- Washington County Highway Department
- Washington County Planning Department
- Pottawattamie County Conservation Board

- The Upper Mississippi/Great Lakes Joint Venture (UM/GL JV)
- University of Nebraska – Omaha (UNO)
- University of Nebraska – Lincoln (UNL)
- Fontenelle Nature Association
- Fort Calhoun Volunteer Fire Department
- Blair Community Schools
- Local landowners

Private Lands Program (Partners for Fish and Wildlife)

The Partners for Fish and Wildlife Program is a voluntary program that has been offered nationwide by the Service since 1987 to provide landowners with technical and financial assistance in restoring habitat and managing private property to benefit wildlife. Projects include wetland, upland, streambank, and aquatic habitat restoration. The program also strengthens relationships with federal, state, local, and private conservation partners.

DeSoto NWR currently maintains a coordinator position for the Private Lands/Partners for Fish and Wildlife Program it operates through DeSoto and Boyer Chute Refuges. Refuges staff assist with habitat restoration and enhancement projects in 28 counties along the Missouri River, 18 on the Iowa side (Lyon, Sioux, Plymouth, Woodbury, Monona, Crawford, Carroll, Harrison, Shelby, Audubon, Pottawattamie, Cass, Mills, Montgomery, Adams, Fremont, Page, and Taylor) and 10 on the Nebraska side (Burt, Washington, Dodge, Saunders, Douglas, Sarpy, Cass, Otoe, Nemaha, and Richardson). The refuges work with neighboring landowners and partners in the watershed to address water quality, drainage, and other hydrological issues. The refuges watersheds (see figure 3-17) are priority areas for targeting Partners for Fish and Wildlife projects. Along with wetland restoration projects, prairie restoration in the seven counties along the Missouri River containing the Loess Hills has been a priority of the upland habitat conservation program in recent years. As much as \$30,000 of Partners for Fish and Wildlife funds are allocated annually to restoring and enhancing wildlife habitat in the counties where the refuges work. Many of the habitat projects have been accomplished through coordination with Farm Bill programs operated by the USDA's Farm Service Agency and Natural Resource Conservation Service.

Historic and Cultural Resources

Native American History and Early Settlement

Human activity has taken place in western Iowa and eastern Nebraska, including the Missouri River Valley, for the past 12,000 years. Early peoples, called "Paleoindians" by archaeologists, were highly mobile and followed the migratory habits of the big game animals present at the end of the last ice age, such as mammoths and ancient bison. This cultural group is largely known by the large, chipped-stone spear points used to kill and butcher these animals. Paleoindian spear points that have been found include Clovis, Plainview, Folsom, Hell Gap, Agate Basin, Alberta, Scottsbluff, Eden, Frederick, Lusk, and Brown's Valley.

As the climate changed and became closer to what we experience today, the big game animals became extinct, and humans adapted; they became less mobile and used a much broader

range of plant and animals resources. These adaptive peoples, called “Archaic” by archaeologists, were foragers that, while still somewhat mobile, returned year after year to favorite hunting and gathering spots. They left behind a wide range of stone tools including smaller spear points and plant grinding implements.

By around 2,000 years ago, the introduction of new technologies from the East, such as clay pottery and the bow and arrow, set off a change in the subsistence and social structure of the people in western Iowa and eastern Nebraska. These peoples, called “Plains Woodland” by archaeologists, settled down in year round residences in small villages and utilized local resources. Because of their more stationary lifestyle they also started to develop designated burial sites in the form of earthen mounds.

As populations increased in these villages around 1,000 years ago, residents started to experiment with gardening and eventually added horticulture to their hunting and gathering activities. Transitioning into what archaeologists call “Central Plains Village,” these woodland peoples intensively planted and harvested corn, beans, and squash (introduced from the South) to supplement bison hunting and plant gathering activities. They built larger and more substantial lodges with a variety of storage and trash pits within the lodge floors. The St. Helena and Nebraska Phases of this period were centered along the Missouri River.

It is these Central Plains Villagers that European explorers encountered in the 1700s. Consequently, these are the earliest Native American groups for which there is ethnographic evidence of group identification and documentation of the tribes’ names. The area of the refuges was occupied by Siouan-speaking tribes, including the Omaha, Ponca, Oto, Missouri, Ioway, and Kansa. When Lewis and Clark passed through this area in August 1804 they met with the leaders of the Oto and Missouri just west of the refuge boundaries within the present day Fort Atkinson State Historical Park at the “Council Bluff” site. By 1820 the federal government established Fort Atkinson in the same area, the first fort west of the Missouri River. The fort was short-lived, however, and was abandoned in 1827. Since then the area has seen the rise of rural European-origin farmers taking advantage of the rich Missouri River bottom soils. A number of early farmsteads, including standing structures, are contained within the refuges’ authorized boundaries.

Although no evidence of Native American peoples has been found within the authorized refuge boundaries for either refuge, sites of the more recent Central Plains Village people have been found nearby. In fact, sixteen federally recognized tribes claim historic ties to the three counties that contain the refuges (appendix I). These tribes were invited to participate in the CCP process for the refuges.

The scarcity of evidence for pre-European human activity on the refuges is most likely due to active erosion and deposition of alluvial sediments from the Missouri River and its tributaries. As a result, while the potential for human activity is great, the tangible record of human occupation is sparse and not likely to improve. Even if ancient archaeological sites have survived years of sediment shifts, they are deeply buried and beyond the reach of ordinary Service activities. Such sites may turn up, however, during dredging activities along the Missouri River and its tributaries.

Harrison and Pottawattamie Counties in Iowa and Washington County in Nebraska contain numerous properties listed on the National Register of Historic Places (59 as of December, 2012). One is the Steamboat Bertrand Museum Collection and Discovery Site on DeSoto NWR; another is Fort Atkinson on the western border of Boyer Chute NWR. The remainder are

primarily homes, churches, schools, and other historic buildings in towns throughout the counties. Aside from the Historic Register sites, it is believed by some historians that additional steamboats may have been lost in the area of DeSoto/Bertrand Bend. In addition, the August 3, 1804 campsite of the Lewis and Clark expedition is believed to be located on DeSoto NWR, and two additional campsites from July 29 and 30, 1804 are thought to be located within or very close to the authorized boundary for Boyer Chute NWR (although not on Service-owned property). To date, no material artifacts have been recovered on the refuges from any Lewis and Clark campsites. DeSoto NWR contains 13 reported cultural resources sites. All of these sites are a part of the Western culture historic period, including two homestead sites. Just under 200 acres of DeSoto NWR have been subjected to archeological survey. This includes a survey conducted by Wichita State University in 1978 (the Blakeslee and King survey) at the location of the refuge's Visitor Center. At Boyer Chute NWR, the most recent archaeological survey was conducted in 2009 prior to the installation of the maintenance shop's geothermal wells. No evidence of archaeological resources was found at that time.

Steamboat Bertrand History

Over 400 steamboats were lost on the Missouri River during the early history of the United States, including the Steamboat Bertrand. DeSoto Visitor Center is home to a one-of-a-kind collection of civil war era artifacts that were excavated from the buried hull of the Steamboat Bertrand. On April 1, 1865, the Steamboat Bertrand was traveling up the Missouri River headed to the Montana goldfields when it hit a submerged log just below "DeSoto Landing" and sank with all of its cargo. Originally owned by J. J. Roe and Company, the 161-foot ship and its load of foodstuffs, clothing, and agricultural and mining supplies were on a two-month voyage from St. Louis, Missouri to Fort Benton in the Montana Territory. Rumor held that a wealth of mercury, whiskey, and gold were in the hull's contents, but these items were not found during the excavation, and it is now believed that the most valuable cargo was salvaged by the insurance company shortly after the steamboat sank (Petsche 1974).

A failed attempt to find the Steamboat Bertrand occurred in 1896. Finally, in 1968 the buried wreckage was discovered on DeSoto NWR beneath 28 feet of silt and clay by two modern salvors, Jesse Pursell and Sam Corbino, using a flux gate magnetometer. The iron-rich howitzer ammunition, iron plows, steel bar stock, and kegs of nails caused aberrations in the magnetic readings so a grid of holes were drilled and cargo materials were encountered in the core samples. In accordance with the Antiquities Act of 1906, the complete cargo (10,000 cubic feet) excavated during 1968 and 1969 were turned over to the Service for exhibition and preservation. The work was overseen by National Park Service archaeologists at the Midwest Archaeological Center in Lincoln, Nebraska. The hull of the ship was left in place once the cargo was removed (Petsche 1974), and the Steamboat Bertrand Discovery Site is state listed (25WN14) and has also been listed on the National Register of Historic Places (#69000138) since March 24, 1969. The well-preserved, time-capsuled artifacts include an array of tools, clothing, food, and equipment. Since 1981, the Steamboat Bertrand Museum Collection has been on display in the DeSoto Visitor Center. This 26,000 square foot facility contains numerous exhibits, a conservation lab, collection research area, and library.

In October of 1991, the Service signed an agreement with the Advisory Council on Historic Preservation, the Iowa State Historic Preservation Officer (SHPO), and the Nebraska SHPO that articulates conditions for the documentation, curatorship, and preservation of the Steamboat Bertrand Museum Collection. This agreement ensures compliance with Section 106 of the National Historic Preservation Act (NHPA).

Cultural Resource Management

Cultural resources (archaeological sites, historic structures, and Native American traditional cultural properties) are important parts of the Nation's heritage. The Service strives to preserve evidence of these human occupations, which can provide valuable information about interactions between individuals as well as between early peoples and the natural environment. Protection of cultural resources is accomplished in conjunction with the Service's mandate to protect fish, wildlife, and plant resources.

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

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

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

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