Chapter 3: Refuge Environment and Management

In this chapter

3.1 Refuge Environment

3.1.1 Geographic/Ecosystem Setting

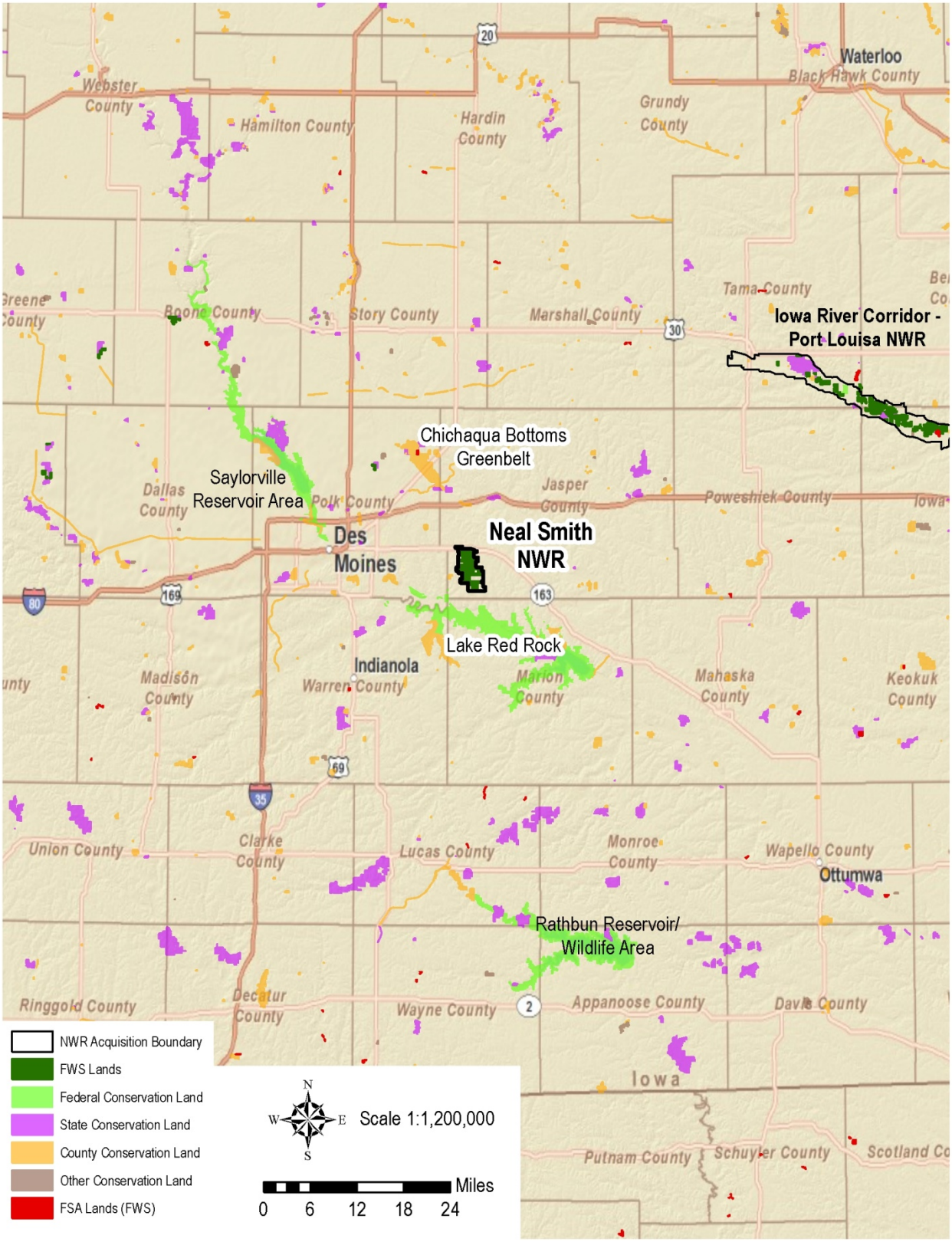
Ecological Land Classification
Neal Smith National Wildlife Refuge (NWR, Refuge) lies within the Prairie Parkland (Temperate) Province as defined by Bailey's ecological classification system, developed by Bob Bailey and others in the U.S. Forest Service. The Prairie Parkland (Temperate) Province covers an extensive area from Canada to Oklahoma, with alternating prairie and deciduous forest. Summers are usually hot, and winters are cold. Vegetation is characterized by intermingled prairie, groves, and strips of deciduous trees. The prairies seem to be areas that have not yet become forested, either because of frequent fires or because the last glaciation was too recent for final successional stages to have been reached. Due to generally favorable conditions of climate and soil, most of the province is cultivated, and little of the original vegetation remains (Bailey, 1995).

In Bailey's classification system, sections are subdivisions of provinces based on terrain features. The Refuge lies within the Central Dissected Till Plain Section, which includes southern Iowa and portions of Illinois, Missouri, Kansas, and Nebraska. Key characteristics include:

- Moderately dissected, glaciated, flat-to-rolling plains that slope gently toward the Missouri and Mississippi River valleys.
- An estimated 60 percent of the land surface was tallgrass prairie, with bur oak and white oak savannas interspersed. Upland forest (white oak-shagbark hickory) occurred on more dissected land, grading into bottomland forests and wet bottomland prairies along rivers.
- A well-developed dendritic drainage network is carved into the land surface. Natural lakes and ponds are rare or non-existent. Many streams now are straightened by channelization and silted-in from agricultural run-off. A few bottomland wetlands have been preserved from drainage enterprises.
- Fire and grazing by herds of bison and elk were the most important disturbance regimes in creation and maintenance of this landscape.

Other Conservation Areas
Chichaqua Bottoms Greenbelt is a 9,100-acre wildlife area along the Skunk River in Polk County that contains county, state, and federal lands (figure 3-1). It is managed by the Polk County Conservation Board and includes dry, mesic, and wet prairies; floodplain wetlands, pothole marshes, wooded oxbow wetlands, and riparian woodlands. Much of the wildlife habitat has been restored and protected through the Wetlands Reserve Program administered by the Natural Resources Conservation Service.

Figure 3-1: Conservation Lands in the Area of Neal Smith NWR



Lake Red Rock is a flood control reservoir project and conservation area located about 3 miles south of the Refuge along the Des Moines River. At 52,800 acres, it's the largest contiguous public land mass in Iowa. Lake Red Rock conservation lands are managed by multiple agencies including the U.S. Army Corps of Engineers, Iowa Department of Natural Resources (DNR), and Marion County Conservation Board. Habitats include open water, forested corridor, wetland, prairie, savanna, and some fields and cropland.

Neal Smith NWR and Lake Red Rock are located within the boundary of the Des Moines Recreational River and Greenbelt, a 410,000-acre open space corridor along the Des Moines River. Authorized by Congress in 1985 and administered by the Corps of Engineers, the purpose of the Greenbelt is to develop and manage natural resources, cultural features, outdoor recreation facilities, and environmental education programs in a manner that makes wise use of resources and attracts outdoor recreation use and economic development to the area.

The National Audubon Society has identified Neal Smith NWR, Chichaqua Bottoms Greenbelt, and Lake Red Rock as Important Bird Areas (IBA). Sites that meet IBA criteria are considered to be the most essential habitats for support of the most seriously declining species of birds. The Chichaqua–Neal Smith region has been designated as a Grassland Bird Conservation Area by the Iowa DNR, following guidelines established by Partners in Flight. Such conservation areas are identified throughout the Iowa Wildlife Action Plan as providing significant habitat protection and restoration potential for Species of Greatest Conservation Need.

Northern Tallgrass Prairie National Wildlife Refuge (NTGP) was established to provide a means of working with individuals, groups, and government entities to permanently preserve and restore native prairie and wetland remnants in western Minnesota and northwestern Iowa. The project presently includes about 2,800 fee-title acres and 2,400 easement acres in widely scattered tracts. All or portions of 37 Iowa counties lie within the NTGP project area. One 192-acre tract on Neal Smith NWR has been purchased through the NTGP program. This tract, known as the Southeast Unit of the NTGP is managed as part of Neal Smith NWR and will be restored to prairie and savanna habitats as appropriate.

3.1.2 Physical Environment

Geology

Landforms of Iowa (Prior, 1991) divides Iowa into eight landforms based on glaciation, soils, topography, and river drainage. Neal Smith NWR is located in the Southern Iowa Drift Plain landform region (figure 3-2), which covers most of the southern half of Iowa and contains all or part of 66 counties, including Jasper County. This region was created by repeated glacial expansion and retreat, wind-deposited loess, and erosion.

The glaciers that created the Drift Plain are hundreds of thousands of years older than those that created the Des Moines Lobe to the north. Consequently, this terrain has had much more time to be reshaped by erosion, resulting in a landscape characterized by steeply rolling hills interspersed with generally level hilltops and valley bottoms. The flat hilltops are remnants of the old glacial plain. The region is heavily dissected by drainage systems such as the Walnut Creek basin. The Southern Iowa Drift Plain contains some of the most productive agricultural land in the world.

The current Refuge landscape consists of loess and alluvium over glacial till and bedrock. Loess, a fine, ash-like, wind-deposited material, typically occurs on uplands. Alluvium, found on valley bottoms, is eroded material from upland areas. The loess deposits tend to be thinner on valley slopes where they

have been subject to erosion than on the ridgetops. Although the underlying bedrock is generally buried to a considerable depth by glacial till and loess, narrow outcrops of sandstone occur in a few locations.

Figure 3-2: Landforms of Iowa

Topography

The Refuge landscape has been molded by the erosive activities of Walnut Creek and its tributaries. Elevations within the Refuge range from a low of approximately 785 feet above mean sea level along Walnut Creek near the southern boundary to a high of approximately 930 feet above mean sea level at several locations on the ridgetops that occur at the periphery of the Refuge.

The majority of the Refuge consists of relatively level 0 to 5 percent slopes (approximately 43 percent) and gently sloping 5 to 9 percent slopes (approximately 41 percent). Approximately 15 percent of the Refuge consists of moderately to steeply sloping land (10 to 20 percent slopes). These slopes, which are associated with stream valleys, tend to face east or west along Walnut Creek and north or south along its tributaries.

Soils

Refuge soils formed as a result of the interaction of climate with the growth of tallgrass prairie and deciduous trees in loess, glacial till, and alluvial deposits. Decomposition of the deep fibrous root systems of grasses and forbs over many centuries produced the rich, black organic soils characteristic of tallgrass prairie. Soils formed under deciduous trees are generally lighter in color and more acidic than soils formed under tallgrass prairie. Based on interpretation of the soils data for the 1992 Master Plan, the majority of Refuge soils were formed under tallgrass prairie (62 percent) and oak savanna (36 percent); a much smaller portion of the Refuge (less than 2 percent) formed under deciduous woodlands. However, soil is just one factor in determining historic distribution of vegetation types;

geomorphic setting (slope, aspect, etc.), rainfall, and fire regime also affect the distribution of vegetation over time.

Approximately 60 percent of Refuge soils are subject to moderate erosion. These soils are located on valley slopes, which are subject to water erosion and on flatter ridgetops, which are more prone to wind erosion. Agricultural development during the last 150 years may have resulted in the erosion of up to six feet of topsoil from some upland areas, thus, accounting for the thin and weakly developed soil profiles currently encountered in the upland areas. Some of the soil has been deposited in lowland areas, creating soil levels higher than historic levels in these areas.

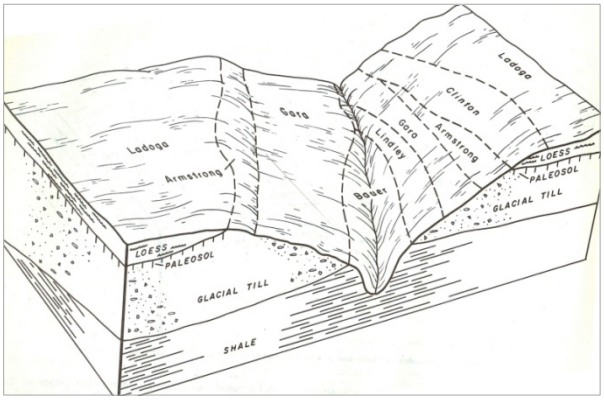
Soils can be grouped into soil associations, which are landscapes that have a distinctive pattern of soils in defined proportions. They typically consist of one or more major soils and at least one minor soil (table 3-1). Soil associations provide a general understanding of the soil types in a particular survey area and are useful for comparing different parts of the Refuge. Neal Smith NWR contains four soil associations: Tama-Killduff-Muscatine, Downs-Tama-Shelby, Otley-Mahaska, and Ladoga-Gara (U.S. Department of Agriculture, 1979).

Table 3-1: Major soil series and attributes

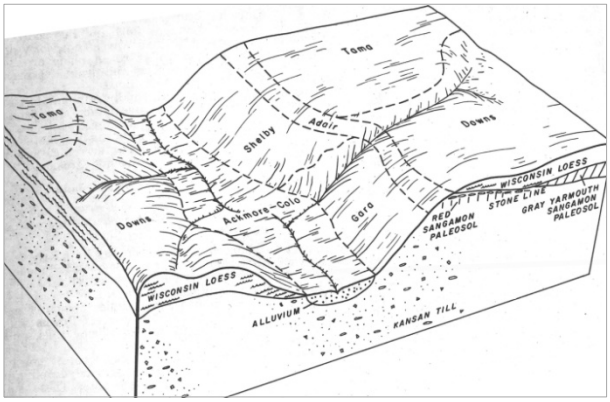
Major Soil Series	Drainage	Texture	Slope	Location	Conditions of Formation
Tama	Well drained	Silty clay loam	0 to 4 %	Convex ridgetops and side slopes	Formed in loess under grass
Killduff	Moderately well drained	Silty clay loam	5 to 18 %	Convex side slopes near threads of drainageways	Formed in loess under grass
Muscatine	Somewhat poorly drained	Silty clay loam	0 to 2 %	Broad upland divides	Formed in loess under grass
Downs	Well drained	Silt loam	0 to 18 %	Convex ridgetops and side slopes	Formed in loess under deciduous trees and tall prairie grasses
Shelby	Moderately well drained	Loam	9 to 25 %	Convex side slopes next to drainageways	Formed in glacial till under prairie grasses
Otley	Moderately well drained	Silty clay loam	2 to 14 %	Ridgetops and side slopes	Formed in loess under grass
Mahaska	Somewhat poorly drained	Silty clay loam	0 to 2 %	Upland divides	Formed in loess under grass
Ladoga	Moderately well drained	Silt loam	2 to 14 %	Convex ridgetops and side slopes	Formed in loess under deciduous trees and tall prairie grasses
Gara	Moderately well drained to well drained	Loam	9 to 40 %	Convex side slopes	Formed in glacial till under a mixture of prairie grass and timber

Within each association, individual soil series typically can be arranged based on slope position as illustrated in the diagrams (figure 3-3). Soil series information is needed to make decisions on specific tracts, because the soils within an association ordinarily vary in slope, depth, stoniness, drainage, and other characteristics that affect their management.

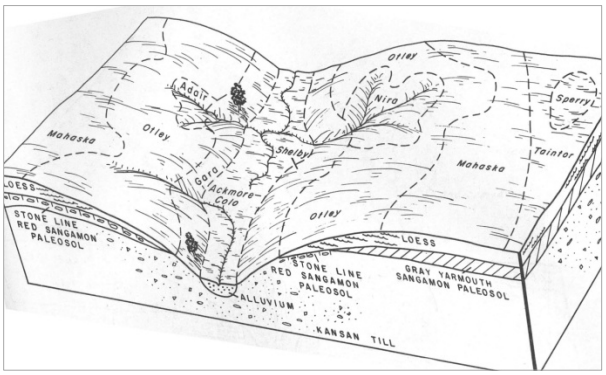
Figure 3-3: Soil Associations



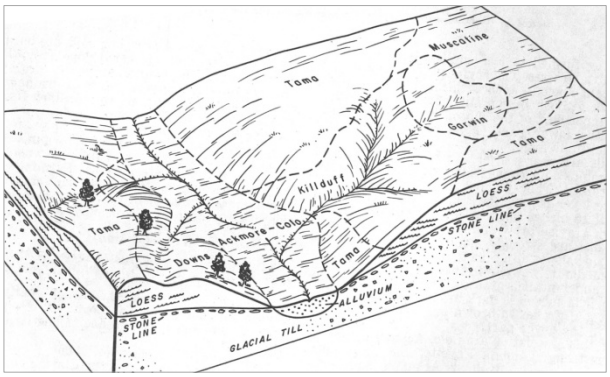
Ladoga-Gara



Downs-Tama-Shelby



Otley-Mahaska



Tama-Killduff-Muscatine

(Diagrams from U.S. Department of Agriculture, 1979)

Climate

The climate of central Iowa, classified as humid continental, is characterized by warm, humid summers and cold, relatively dry winters. Average temperatures typically range from 72 °F in the summer to 22 °F in the winter. Approximately 70 percent of the average annual rainfall (32 inches in Jasper County) falls between April and September. The typical seasonal snowfall is approximately 27 inches. The amount of precipitation is a primary factor in the historic dominance of tallgrass prairie in the region: drier areas to the west support midgrass or shortgrass prairie, while deciduous forest is the native vegetation typically occurring in moister regions to the east. Prevailing winds in the region are from the northwest in the winter and from the southwest in the summer. The typical growing season begins sometime after the first week in April and lasts until the middle of October, with about 165 growing days.

Climate change

Iowa's annual average temperature has increased since 1873 at a modest rate, but seasonal and day-night changes have been proportionately larger. Temperatures have increased six times more in winter (0.18 °F/decade) than in summer (0.03 °F/decade), and nighttime temperatures have been increasing more than daytime temperatures. Iowa now has a statewide average of five more frost-free days per

year than 50 years ago and eight to nine more than at the beginning of the 20th century. Higher winter and spring temperatures seem to be causing earlier and more protracted snowmelt and a reduced probability of spring flooding (Iowa Climate Change Impacts Committee [ICCIC], 2011).

Precipitation in Iowa has gradually increased over the last 100 years, although year-to-year variability is high. Eastern Iowa has a higher upward trend than the statewide average. Most of the precipitation increase has come in the first half of the year and less in the second half, leading to wetter springs and drier autumns. Trends toward more precipitation and changed seasonality, as well as higher increases in eastern Iowa, are projected to continue. Growing evidence points to stronger summer storm systems in the Midwest due to warming temperatures and increasing humidity levels. The increased number of large summertime rain events, increased soil moisture, and other factors seem to be leading to increased summer flooding. This new pattern of seasonal flood occurrence in Iowa is expected to continue (ICCIC, 2011).

Predictions of continued increases in temperature and precipitation may cause accelerated growth of woody vegetation, which could eventually allow oak savannas to expand into non-wooded areas (if they are not cropped). Increased rainfall could make prescribed fire more difficult to implement, allowing fire intolerant species to more rapidly invade grasslands and savannas. Monitoring climate change effects on the Refuge will require a cadre of varying expertise. In the short term it will be difficult to determine or predict what the impacts of climate change will be on management of the Refuge. However, continuing to restore a healthy, resilient ecosystem in the face of current uncertainty will help wildlife and plants adapt to the changing climate over time.

Water and Hydrology

The Refuge is located within the 30.7-square mile Walnut Creek watershed, which lies within the Des Moines River drainage basin. The acquisition boundary for Neal Smith NWR encompasses about 44 percent of the watershed (figure 3-4). From its headwaters, located two to three miles north of the Refuge, Walnut Creek flows south approximately ten miles to its confluence with the Des Moines River at the upper end of the Red Rock Reservoir. The approximately 6.5-mile stretch of Walnut Creek within the Refuge boundary bisects the Refuge from north to south and is fed by numerous tributary streams that generally flow in an east-west orientation (figure 3-4).

Stream flow increases substantially from north to south, with flows in the southern portion of the Refuge averaging about three times greater than flows in the northern portion of the Refuge. Typically, volume has been greatest in the spring following heavy rains, decreasing throughout the summer, although this pattern could be altered as climate change progresses. Walnut Creek changes from an intermittent stream north of the Refuge to a perennial stream sustained by groundwater discharge, subsurface tile drainage, and tributary inflows as it flows south through the Refuge. Groundwater seeps are located on the Refuge where the upland mantle of loess has thinned and groundwater discharges at the contact between the loess and exposed paleosols or glacial till.

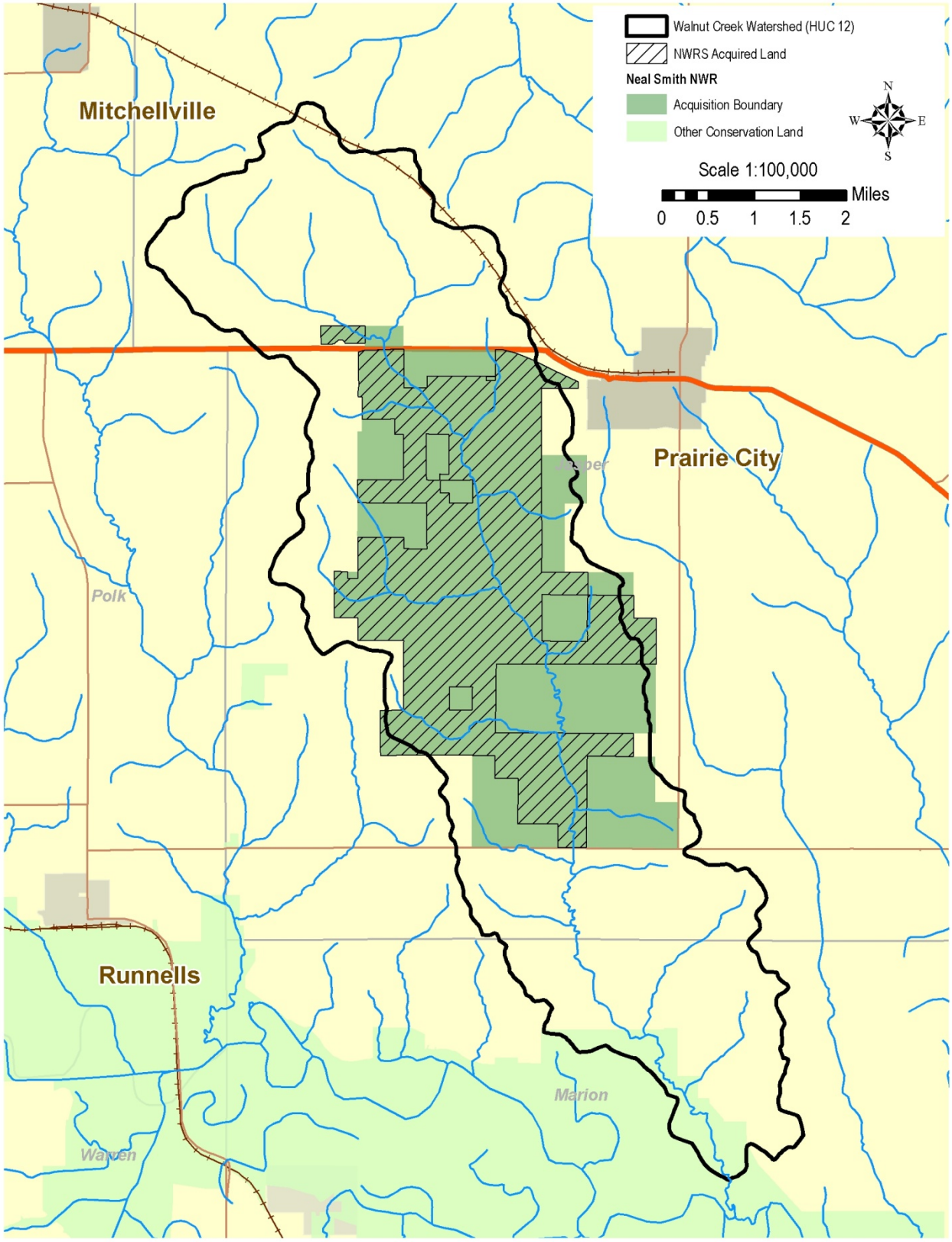
Water Quality

Water quality in Walnut Creek varies with changes in discharge and runoff and is typical of many warm water streams in Iowa. A Walnut Creek water quality monitoring program was established in 1995 in conjunction with habitat restoration efforts on the Refuge. Because the Walnut Creek watershed was intensively farmed in the past, the restoration of Neal Smith NWR provides a valuable opportunity to study sediment transport and nutrient cycling in a modified stream and monitor how quickly water quality can be improved by land management changes.

Sediment moves very rapidly downstream in the watershed in response to precipitation and snowmelt. Approximately 10,000 to 20,000 tons of sediment is transported each year in the Walnut Creek channel. The majority of highly erodible land occurs within the Refuge area whereas the headwaters area, above the Refuge, is the more gently sloping portion of the basin.

In addition to sediment, Walnut Creek is affected by agricultural non-point-source water pollutants including nutrients, pesticides, and animal waste. Between 1995 and 2005, nitrate concentrations significantly decreased in the Walnut Creek watershed as acreage of row crops decreased. Phosphorus concentrations varied between 0.06 mg/l and 0.2 mg/l but did not statistically change between 2001 and 2005. Herbicide detection frequencies were greater than 70 percent. Fecal coliform bacteria were detected frequently above water quality standards of the Environmental Protection Agency, with highest counts often occurring between May and October during high stream flow periods associated with rainfall runoff (Schilling et al., 2006).

Figure 3-4: Walnut Creek Watershed



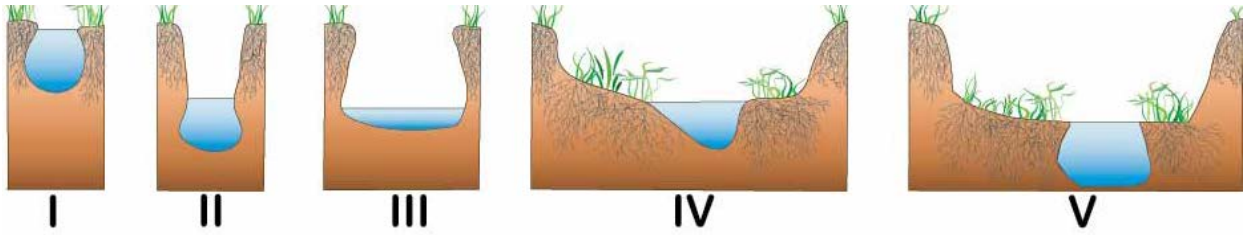
Hydrologic Alteration

Walnut Creek Floodplain

As tallgrass prairie was converted to agriculture, most of the natural meanders in Walnut Creek were straightened and deepened, and subsurface drainage tiles were installed throughout the watershed. These measures had the desired effect of moving water off crop fields and down Walnut Creek more efficiently, thereby increasing farm productivity. However, the increased volume and velocity of water in the straightened creek also caused significant channel scouring. Today the channel is incised as much as ten feet in many places, the groundwater table is lowered near the channel, and Walnut Creek is disconnected from its historic floodplain. As a result, floodplain soils are drier, particularly near the stream, and native vegetation has been overtaken in many locations by a monoculture of invasive reed canarygrass. Although much of the main stem of Walnut Creek has been straightened, an 840-acre Refuge inholding (surrounded by U.S. Fish and Wildlife Service [FWS, Service] fee title lands) includes a reach of the creek with meanders largely intact. This reach has retained some of the original geomorphology, but the hydrology is still altered; the area is a bottleneck for large volumes of water and sediment moving down the ditched portions of the creek.

The creek has benefitted from reduced human disturbance and is slowly moving toward a new state of equilibrium as it attempts to balance parameters such as slope, sediment loads, water volume, and channel geometry. Given current trends, the creek will eventually restore many of its natural functions. The incision of the creek bed has largely stabilized, and the channel is gradually widening as the stream banks collapse (Schilling et al., 2011). This is a natural process resulting from the channel encountering more resistant layers of alluvium and till, and probably aided by conversion of former agricultural fields to native prairie on the Refuge and widespread use of conservation tillage on farmland upstream. As the channel widens, slope of banks will decrease, terraces and channel meanders will begin to emerge, and floodplain vegetation communities will become established (figure 3-5). The “new” floodplain will be connected to the stream stage but the abandoned floodplain will continue to be largely unsaturated. The new floodplain could be populated by pre-settlement vegetation (sedge meadow), whereas the old floodplain terrace could be populated by floodplain savanna. The time needed for these changes to occur naturally is unknown but would be on the order of decades to centuries (Schilling et al., 2012).

Figure 3-5: Stream Channel Evolution



(From MN Dept. of Natural Resources, 2010.)

I. A properly shaped stream in equilibrium and connected to its floodplain prior to disturbance.
II. Channel incision from ditching or by a headcut originating in a channelized reach due to increased slope and flow.
III. Channel widening as the channel begins to meander again.
IV. A more properly shaped stream as it evolves to re-establish equilibrium and rebuild a new floodplain.
V. A new, properly shaped channel in equilibrium with a lowered floodplain.

Subsurface Drainage System

The subsurface drainage system in the Walnut Creek watershed follows the natural branched drainage pattern of the land. Typically, a perforated tile line was buried under each ravine to sufficiently dry these

low areas enough for farmers to drive across and plant. The tile lines lower surficial groundwater levels by draining water out of the soil column above and adjacent to the tile. The diameter and length of tile lines varies depending on location and the amount of water each was designed to carry. Many of the small tributary streams in the watershed originate from tile drains. The system has not been mapped but is extensive—more than 50 outlets have been found on the Refuge along Walnut Creek and throughout several of its tributaries.

The branched drainage system of Walnut Creek is fairly common in the Southern Iowa Drift Plain but unusual in many other places (Schilling et al., 2012). Watersheds in the Des Moines Lobe and other recently glaciated areas are typically drained by pattern tile systems laid out in a dense grid designed to lower entire surficial groundwater tables below the root zone for increased crop yields. The extent, volume, and water quality concerns of pattern tile drainage are much more significant than for branched tile. However, although downstream impacts of Walnut Creek tile drainage on the Iowa and Mississippi River systems are small when compared with pattern tile systems, local impacts to habitat restoration on the Refuge are of concern.

State Highway 163 runs east-west through the Walnut Creek watershed. Refuge lands lie almost entirely south of the highway. Tile lines originating in the upper watershed, north of Highway 163, do not pull water from Refuge uplands; they empty directly into the creek before reaching the Refuge. Tile lines located south of the highway do affect many prairie, savanna, and upland sedge meadow sites on the Refuge by reducing the amount of available water in the soil. Reducing or eliminating the subsurface drainage system south of the highway would restore more natural water flow to the Refuge uplands, likely resulting in more diverse and sustainable native plant communities.

Breaking, plugging, or complete removal of tile lines also has the potential for undesired effects: plugs might create overly wet conditions in adjacent areas as water continues to discharge above the plug; breaking the tiles might allow some continued drainage and potential headcutting at the break points; and full removal has the potential for increased erosion in some areas. Headcuts will always be a concern in the highly erodible soils found on and near the Refuge, but as Walnut Creek continues moving toward a new state of equilibrium, active erosion and headcut risk will decrease dramatically over time.

Nonetheless, restoring the hydrology of upland areas on the Refuge should be fairly straightforward, especially after the techniques have been mastered. The real challenge may be in locating the tile lines and addressing segments outside the Refuge boundary. Some tile lines lie completely within the Refuge boundary, but many are thought to originate on private agricultural lands up-gradient of the Refuge. Breaking, plugging, or removing these tiles only within the Refuge boundary would not be enough to restore local hydrology; off-Refuge portions would remain intact, continuing to discharge groundwater onto Refuge lands and possibly backing water onto adjacent private property.

3.1.3 Biological Environment

Vegetation

Historic Ecosystem

At the time of European settlement, prairie covered 28.6 million acres in Iowa (Smith, 1998). Oak savannas covered 11 to 13 million acres in the Midwest (Nuzzo, 1985) and about 2.4 million acres in Iowa (Smith, 1998). According to 1846 General Land Office survey records, the land cover of the current Neal Smith NWR at the time of European settlement consisted of tallgrass prairie in the northern half,

extending into the southwestern and southeastern portions of the Refuge; a lobe of oak savanna extended from the south along Walnut Creek to the center of the Refuge.

The pattern of vegetation across the landscape was dependent on a complex combination of environmental factors such as climate, topography, hydrology, grazing, and soils; combined with the effects of fire either caused naturally by lightning or deliberately set by humans. Fire was an important factor in the ecology of the ecosystem, promoting deep-rooted herbaceous plants, reducing litter build-up, and suppressing the growth of woody vegetation. Bison and elk provided essential functions such as grazing and other disturbances that, together with fire, maintained the diverse and dynamic nature of a system dominated by herbaceous vegetation. As these environmental factors varied over time and space, so too did the distribution of vegetation communities. The landscape was a mosaic of prairie flowing to oak savanna and sedge meadow with no abrupt edges between them.

Tallgrass prairie is dominated by grasses and forbs. Typically there is little cover of woody vegetation, although some shrub species are appropriate. Plant species are adapted to sunny conditions. Spring-blooming species are smaller in stature with each successive wave of bloom coming on taller plants until late summer and autumn, when tall forbs bloom amidst warm season grasses. Several hundred plant species are adapted to prairie conditions with variation in moisture regime and soil type.

Oak savanna is characterized by spreading, open-grown oak trees. The scattered trees or groves of trees typically have a canopy ranging between 10 and 70 percent. On the Refuge, bur oak (*Quercus macrocarpa*) is the dominant tree species interspersed with red oak (*Quercus rubra*), black oak (*Quercus velutina*), shagbark hickory (*Carya ovata*), and bitternut hickory (*Carya cordiformis*). Sapling and pole trees help maintain a subcanopy layer and replace mature overstory trees that age and eventually drop out of the canopy. Historically, trees probably were denser in wet areas and along north and east slopes.

The mosaic of open, closed, and partially shaded areas created by the trees provide for a unique mix of herbaceous understory plants—sun-loving prairie species, shade-adapted forest species, and savanna-specific species can all be found in oak savanna. Shrubs may or may not be present depending on fire frequency. Savanna fires are often slow and creeping, compared to raging prairie fires. Historically, oak savanna represented a dynamic ecotone between prairie and forest, slowly expanding and contracting as climate and fire regime shifted over thousands of years.

Sedge meadow is a very shallow wetland community characterized by hydric soils and dominated by a variety of sedges. Sedge meadows occur along a gradient from mesic tallgrass prairie to wet prairie to sedge meadow to wetland. They require moisture close to the surface for an extended period during the growing season. The plants require full sun and frequent fire. In addition to sedges, sedge meadows contain prairie cordgrass, rushes, and some forbs. Sedges often form tussocks, creating unique habitat for wildlife. Sedge meadows are a unique mix of aquatic and terrestrial ecosystems, with fluctuating water levels.

European Settlement

The tallgrass prairie ecosystem was quickly settled and cleared as European-Americans arrived in the Midwest in the mid-1800s. Oaks provided firewood and building material. When settlement began it was believed that the best soil for farming was under wooded areas so many were rapidly cleared for agriculture. The rich prairie soils were soon discovered and quickly plowed as the state was settled. By the late 1800s, most of the prairies had been plowed or heavily grazed, and today less than one percent of tallgrass prairie remains east of the Missouri River, and less than 0.1 percent in Iowa (Smith, 1998).

Only 0.02 percent of midwestern savannas remain, with the rest destroyed or severely degraded (Nuzzo, 1986). Noss et al. (1995) classified tallgrass prairie east of the Missouri River and on mesic sites throughout their range and all midwestern oak savannas as critically endangered. Savannas are the biome with the greatest conservation risk on Earth (Hoekstra et al., 2005).

Populations of wildlife that depended on tallgrass prairie habitats declined quickly as the land was settled and many species disappeared from the area. It is estimated that there were 50–75 million bison present in North America at the time Europeans arrived. The last of the bison (*Bison bison*) were extirpated from Iowa in 1863, and elk (*Cervus elaphus*) were gone by the early 1870s (Dinsmore, 1994). Many species of grassland birds also showed precipitous declines in numbers. The last nesting population of Greater Prairie-Chickens in southern Iowa disappeared in the 1950s, prior to their reintroduction in 1987.

Neal Smith NWR

The entire Walnut Creek watershed and surrounding area were heavily impacted by agriculture. Most prairie and savanna were converted to croplands; lands less suitable for crops were used for grazing livestock or logging. Fire was actively suppressed. Consequently, all of the pre-settlement natural communities were eliminated, degraded, or considerably disturbed. When the Refuge was established, cropland occupied about 69 percent of the approved boundary, grazed pasture occupied approximately 17 percent, and about 7.5 percent had been converted to grassland dominated by non-native brome under the Conservation Reserve Program (CRP). Scattered untilled remnants of native vegetation also remained. Figure 3-6 illustrates current Refuge land cover.

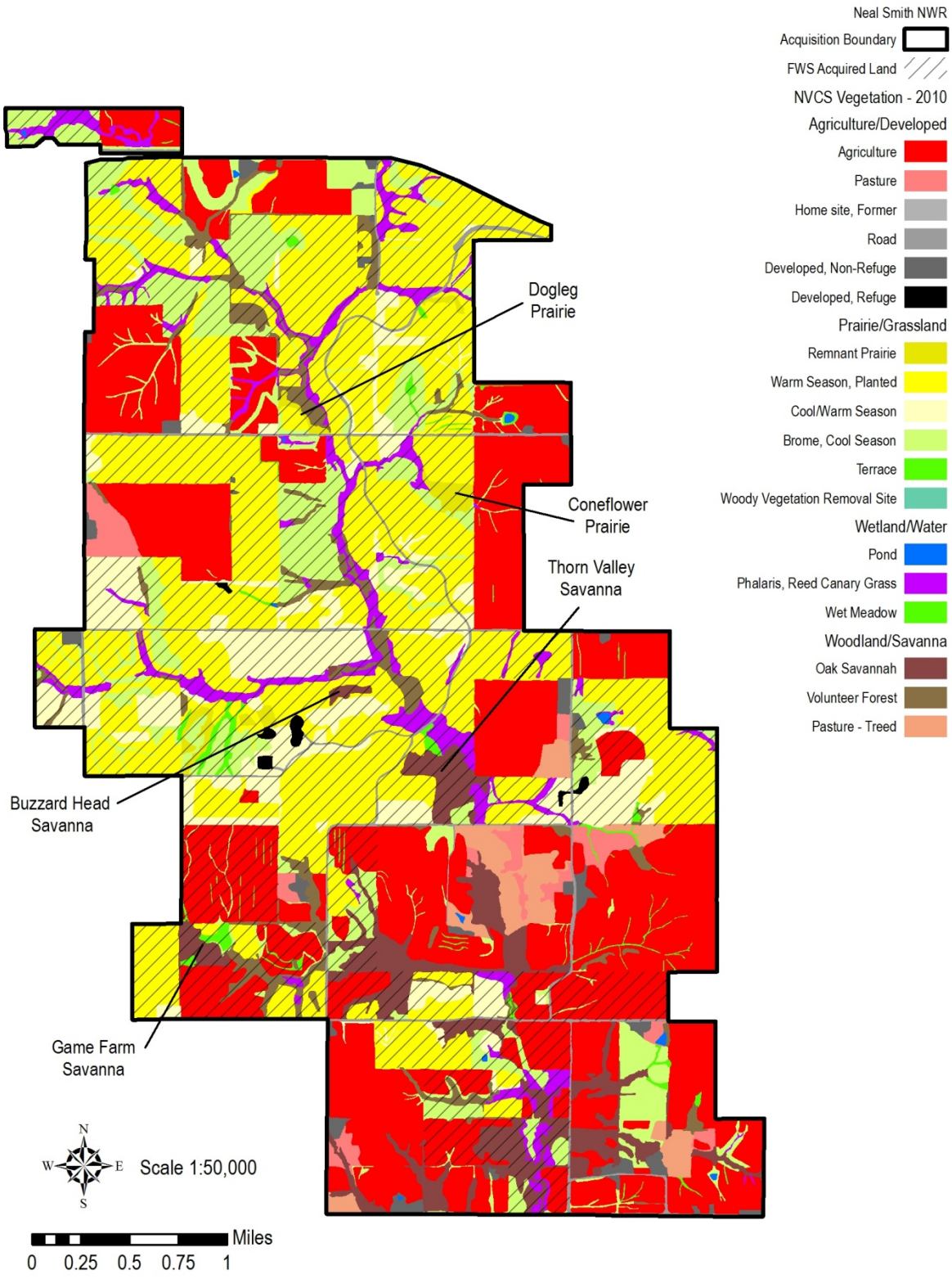
Reconstructed prairie

About 3,400 acres of former cropland have been planted with native prairie species. Prairie reconstructions on the Refuge are of varying quality, from very diverse to those dominated by a few species, primarily warm season grasses including big bluestem (*Andropogon gerardii*), Indian grass (*Sorghastrum nutans*), and little bluestem (*Schizachyrium scoparium*). Native cool season graminoids (grasses and sedges) and forbs are under-represented throughout the Refuge. Some units have very low densities of forbs and some are beginning to be invaded by woody vegetation. Non-native invasive species are present in many locations.

Many plants that are associated with high quality prairie [such as lead plant (*Amorpha canescens*), prairie lily (*Lilium philadelphicum*), and New Jersey tea (*Ceanothus americanus*)] are beginning to be observed on the Refuge despite having been planted a decade or more ago. These and other species are indicators of a maturing prairie and testimony that ecological restoration is a long-term process.

The 2,500 acres of reconstructed prairie classified as *"Warm Season"* on the 2010 vegetation map (figure 3-6) are dominated by warm season grasses and native forbs but may contain up to 20 percent cover of non-native grasses (mostly brome) and non-native forbs. Units classified as *"Cool/Warm Season"* (675 acres) have more than 50 percent cover of non-native grasses, especially brome. This category is typical of younger plantings and areas that have been grazed or mowed.

Figure 3-6: Current Land Cover, Neal Smith NWR



Crop fields and old pasture
About 600 acres of Refuge land are still being farmed to prevent weed encroachment until they can be planted to prairie. Another 700 acres are categorized as *"Brome (Cool Season)."* Most of these units were planted for pasture or through the CRP prior to Refuge ownership. They are dominated by smooth brome and other non-native cool season grasses [timothy (*Phleum pretense*), Kentucky bluegrass (*Poa pratensis*), etc.].

Prairie and savanna remnants
About 90 acres of remnant tallgrass prairie and 150 acres of oak savanna remnants are found on the Refuge. When fire was suppressed, non-fire-tolerant woody species began encroaching, eventually forming an overly dense canopy that favors shade-tolerant understory species at the expense of prairie and savanna specialists. Native herbaceous plants that remain often are limited to spring-blooming species that complete much of their life cycle before the trees leaf out. Non-native plant species, both woody and herbaceous, are invading many remnants. Oak regeneration in savannas has been limited by shady conditions, competition with faster-growing trees and shrubs, and browsing by white-tailed deer.

Sedge meadow
Dominant native plants found in sedge meadows include prairie cordgrass, sedges, and rushes. Native forbs occur occasionally. Sedge meadows are located in floodplain depressions associated with Walnut Creek and its tributaries as well as in upland seeps and ravines. In the floodplain, invasive reed canarygrass has become a tenacious competitor due to hydrologic alteration. About 330 acres of low-lying Refuge land are classified as *"Phalaris (Reed Canarygrass)"* on the 2010 vegetation map (figure 3-6). These areas are dominated by greater than 75 percent reed canarygrass. One ten-acre sedge meadow on the Refuge is the subject of an ongoing reconstruction and research program.

Sedge meadows on upland areas near seeps and ravines often still retain some diversity. Seasonal variations in wetness in these locations make it difficult for many invasive plants to survive, including reed canarygrass, although seeps are vulnerable to cool season exotics like smooth brome. Ravines drain surface runoff into Walnut Creek; many probably contained seeps prior to being tiled and sedges sometimes still survive in these areas. Subsurface drain tiles have reduced the level of soil saturation in seeps and ravines and reduced the quality and diversity of the sedge meadows found there.

Volunteer Woodland
About 220 acres, primarily along Walnut Creek, are currently woodlands that have grown in since European-American settlement. Another 185 acres of trees have been removed since the Refuge was established. Although the trees are primarily native species, they are fire-intolerant and did not occur in these locations in the 1840s. Oak woodland did exist in some parts of southern and eastern Iowa prior to European settlement but not on the Refuge. Evidence indicates that current-day Refuge woodlands are actually overgrown savanna, prairie, or sedge meadow, the result of fire suppression, not historic ecological processes. For example:

- Mature oaks in the Refuge woodlands have widely spreading branches indicating that they grew in strong sunlight.
- There is no ecological relationship between the overstory and understory species in Refuge woodlands indicating that the understory species are present as a result of disturbances in the natural ecological processes.
- The General Land Office (GLO) survey notes make no mention of trees north of the current Visitor Center site.

Ponds

Farm ponds existed on some Refuge lands at the time of purchase, created by previous landowners as a water source for livestock or to reduce soil erosion. Some were silted-in and abandoned at the time of Service acquisition. Most of the dams have been removed so the ponds no longer hold water. Such ponds did not exist in the pre-settlement ecosystem, and their modest wildlife habitat benefits can be replaced by restoration projects that are more appropriate for the ecology of the area.

The 1992 Master Plan called for creation of six small impoundments and moist soil units within the riparian corridor. The purpose was to create marsh habitat to increase the value of the Refuge for wildlife, provide educators with the opportunity to teach the public about wetlands and wildlife, and enhance the visual and biological diversity of the Refuge. The created wetlands would have required dikes, water control structures, and intensive management. However, as a result of the National Wildlife Refuge System Improvement Act of 1997 (Improvement Act) and subsequent policy on biological integrity, diversity, and environmental health, National Wildlife Refuge System (NWRS, Refuge System) priorities began to favor management that restores or mimics natural ecosystem processes and functions. The created wetlands identified in the Master Plan were not constructed.

Wildlife and Fish

Birds

More than 200 species of birds now use the Refuge, including more than 80 species during breeding season. Many bird species that had been extirpated from the area due to habitat loss have returned as the ecosystem undergoes restoration.

Birds began showing up in Refuge prairies soon after plantings began, and as the Refuge has grown the number of grassland bird species has increased. Henslow's Sparrow (*Ammodramus henslowii*) was first found on the Refuge in 1999 and is now ubiquitous in the unburned prairies and grasslands each year. Several other species of grassland birds including Sedge Wren (*Cistothorus platensis*), Field Sparrow (*Spizella pusilla*), Grasshopper Sparrow (*A. savannarum*), Dickcissel (*Spiza Americana*), Bobolink (*Dolichonyx oryzivorus*), and Eastern Meadowlark (*Sturnella magna*) also are common on the Refuge during the breeding season. Western Meadowlark (*S. neglecta*) is found in a few locations including one pair in the bison and elk enclosure most years. Upland Sandpipers are present in small numbers in most years, and fledglings have been confirmed. The Northern Bobwhite (*Colinus virginianus*) is present in small numbers, although some of these birds may be captive-reared birds released for hunting from a nearby game farm. Short-eared Owls (*Asio flammeus*) and Northern Harriers (*Circus cyaneus*) are now consistently seen during winter and migration. Swainson's Hawks (*Buteo swainsoni*), Smith's Longspurs (*Calcarius pictus*), and Le Conte's (*A. leconteii*) and Savanna Sparrows (*Passerculus sandwichensis*) use the Refuge regularly during migration.

Another group of birds on the Refuge uses shrubs for feeding and nesting, including Bell's Vireo (*Vireo bellii*), Gray Catbird (*Dumetella carolinensis*), Brown Thrasher (*Toxostoma rufum*), Yellow-breasted Chat (*Icteria virens*), and Orchard Oriole (*I. spurius*). Others—such as Loggerhead Shrike (*Lanius ludovicianus*), Willow Flycatcher (*Empidonax traillii*), Eastern Kingbird (*Tyrannus tyrannus*), Vesper Sparrow (*Pooecetes gramineus*), Field Sparrow (*Spizella pusilla*), Lark Sparrow (*Chondestes grammacus*), and American Goldfinch (*Carduelis tristis*)—use scattered shrubs surrounded by grasslands. Loggerhead Shrikes are sometimes present on the Refuge in small numbers. American Tree (*Spizella arborea*) and Harris' Sparrows (*Zonotrichia querula*) and Northern Shrikes (*L. excubitor*) are also present in this habitat during migration and winter.

Red-headed Woodpeckers (*Melanerpes erythrocephalus*) are found in oak savannas on the Refuge. Northern Flickers (*Colaptes auratus*) frequently forage in prairies but use trees for nesting. Eastern Towhees and Field Sparrows use shrubs in oak savanna areas.

Waterfowl may occur on the Refuge more frequently as habitat conditions in sedge meadows and savannas improve.

Mammals

By the end of the 19th century at least 13 mammals were extirpated from Iowa including bison, pronghorn (*Antilocapra americana*), elk, mountain lion (*Felis concolor*), porcupine (*Erethizon dorsatum*), gray wolf (*Canis lupus*), wolverine (*Gulo luscus*), lynx (*Lynx canadensis*), fisher (*Martes pennant*), black bear (*Ursus americanus*), beaver (*Castor canadensis*), river otter (*Lutra canadensis*), and white-tailed deer (*Odocoileus virginianus*). The last three have been reintroduced into the state and the populations are rebounding. Black bears are sighted occasionally in Iowa but have not shown a substantial comeback, which is likely the result of a lack of suitable habitat.

More than 40 mammal species, including the federally endangered Indiana bat (*Myotis sodalis*) have been documented on the Refuge. White-tailed deer, eastern cottontail (*Sylvilagus floridanus*), thirteen-lined ground squirrel (*Citellus tridecemlineatus*), and raccoon (*Procyon lotor*) are the most frequently seen mammals on the Refuge. Badgers (*Taxidea taxus*) and bobcats (*Lynx rufus*) have also been found. Bison and elk have been reintroduced to a 700-acre fenced enclosure. The Refuge has suitable habitat to support the spotted skunk (*Spilogale putorius*), although the species is thought to be extirpated from the state. Although somewhat outside its present range, the white-tailed jack rabbit (*Lepus townsendii*) could potentially occupy grazed areas of the Refuge in the future. Franklin's ground squirrel (*C. franklini*) is another species formerly occurring in the area that could be re-established on the Refuge.

Reptiles and Amphibians

The 1992 Master Plan appendices list four turtles and 15 snakes likely to occur on the Refuge. Most of these species have broad distributions and are common in Iowa. At least three species of grassland-associated reptiles might reoccupy the area if suitable habitat were available. Two of these species [western slender glass lizard (*Ophisarius attenuates*) and speckled kingsnake (*Lampropeltis getula holbrooki*)] are currently listed as endangered in Iowa. The ranges of both species extend to near the Refuge. The other, the northern prairie skink (*Eumeces septentrionalis*), is reasonably common in suitable habitat (sand prairies) in Iowa, but such habitat currently is greatly restricted and not present on the Refuge. All three of these species might naturally recolonize the Refuge if suitable habitat is available. Fox (*Elaphe vulpine*) and bull snakes (*Pituophis catenifer*) (as well as many others) are also declining and are present in suitable habitat on the Refuge.

Eastern Gray Treefrog

Amphibian surveys documented nine species on the Refuge in 2004 including the tiger salamander (*Ambystoma*

tigrinum), eastern gray treefrog (*Hyla versacolor*) and Cope's gray treefrog (*H. chrysoscelis*), American toad (*Anaxyrus americanus*), American bullfrog (*Ranus catesbeiana*), Blanchard's cricket frog (*Acris crepitans blanchardi*), western chorus frog (*Pseudacris triseriata*), northern leopard frog (*Rana pipiens*), and pickerel frog (*R. palustris*). A narrow-mouthed salamander (*Ambystoma texanum*) was captured in a pitfall trap as part of a ground invertebrate sampling project in 1994. The most common frogs and toads detected on annual nocturnal call surveys are eastern gray tree frog, American toad, Blanchard's cricket frog, and western chorus frog. None of the amphibians present on the Refuge are on the federal or Iowa lists of threatened or endangered species, although Blanchard's cricket frog is listed as a species of greatest conservation need in the Iowa Wildlife Action Plan. Additional species that may occur include the plains leopard frog and green frog (*R. clamitans*). The spring peeper (*P. crucifer*) is found in nearby counties and its range is expanding in Iowa.

Invertebrates

Nearly 90 butterfly species have been documented on the Refuge, including the regal fritillary (*Speyeria idalia*), which has been the subject of Refuge reintroduction and research efforts. Baseline sampling in remnants on the Refuge identified 426 moth species. At least 29 species of ants have been documented from the Refuge, including *Formica montana* and *Formica exsectoides*, two species that build large mounds. Five species of native earthworms have been documented on the Refuge. Prairie crayfish (*Procambarus gracilis*), which engineers the prairie by building burrows, is found throughout the Refuge.

Fish

Thirty-one species of fish from eight families were collected from Walnut Creek between 1995 and 2005, but the overall number of fish collected was low. The fish community was dominated by minnows (Cyprinidae), most of which are considered abundant-to-common in Iowa streams. Sunfishes (Centrarchidae) were often found in Walnut Creek, but in small numbers. Seven species of suckers (Catostomidae) were collected, generally in fairly low numbers. Gizzard shad comprised a large proportion of the Walnut Creek fish population in 1998 and 1999 but were found in relatively low numbers in other years. During all years, species tolerant of degraded environmental conditions made up a large proportion of the Walnut Creek fish community. Less tolerant species were sporadically found. The diversity of fish collected from Walnut Creek can vary dramatically and is heavily influenced by its proximity to the Des Moines River. The dominant resident fish species are likely populations that have relied historically on Walnut Creek for shelter and food while the infrequent species are likely just transients (Schilling et al., 2006).

Little is known about the historic fish assemblage of Walnut Creek. At least two species listed as threatened in Iowa [western sand darter (*Ammocrypta clara*) and blacknose shiner (*Notropis heterolepis*)] once were found in this region, although Walnut Creek does not appear to have suitable habitat for either. The Refuge is within the historic range of the endangered Topeka shiner (*N. topeka*), but the species has not been found in Walnut Creek, and the Refuge does not contain designated critical habitat. The damming of the Des Moines River to create Red Rock Lake influences habitat in Walnut Creek and allows access to the creek by warm-water species that would not be present otherwise.

Threatened and Endangered Species

Federally endangered Indiana bats (*Myotis sodalis*) migrate from central Missouri to southern Iowa during the spring months to raise their young. Jasper County is near the northwestern edge of the species' range. Two monitoring seasons (1992 and 1993) on the Refuge resulted in successful mist-netting of lactating females and juveniles from one localized area just north of Thorn Valley Savanna. A third monitoring season resulted in capture of one adult male. The Refuge follows Service guidelines for

tree-cutting and burning to protect roosting Indiana bats. Savanna restoration will likely improve Indiana bat habitat by developing more desirable flyways and thus, better forage conditions under an open canopy. The species prefers large dead trees with loose bark during breeding season.

In 1994, seeds of the federally threatened prairie bush clover (*Lespedeza leptostachya*) were sown on the Refuge. No plants have been observed as yet on this 35-acre site. Seeds and/or seedlings may have perished, but it is also possible that the seeds are still lying dormant in the soil. Some species of the genus Lespedeza require seed scarification to begin the germination process, but it is uncertain whether or not prairie bush clover is one of those species.

In 2001, seedlings of the federally threatened western prairie fringed orchid (*Platanthera praeclara*) were transplanted to two sites on the Refuge. The plants were the result of a project instigated by Dr. Margaret Fromm, the only individual who had successfully propagated the species from seed in the lab. Seedlings existed as a single green shoot or leaf per plant. Though the shoot stayed green on some orchid plants, others could not be found again later in the year. In subsequent years the plants have not been observed in the area where transplanting took place.

3.1.4 Socioeconomic Environment

Population, Income, Employment, and Demographics

The Refuge lies in the southwest quadrant of Jasper County. Jasper County is primarily rural in nature. Polk County includes the city of Des Moines, located about 18 miles west of the Refuge. The Des Moines metropolitan area (population 500,000) is one of the fastest growing regions of the state. The town of Prairie City (population 1,400) lies just northeast of the Refuge boundary.

The area population increased by 12.8 percent from 1995 to 2005, compared with a 3.4 percent increase for the State of Iowa and an 11.4 percent increase for the United States as a whole. Per capita income in the area increased by 8.6 percent over the 1995-2005 period, while the State of Iowa and the United States increased by 14.6 and 13.2 percent respectively (Carver and Caudill, 2007; figure 3-2).

Table 3-2: Changes in population, employment, and income 1995-2005

County	Population		Employment		Per Capita Income	
	2005	*% change 1995-2005*	*2005*	*% change 1995-2005*	*2005*	*% change 1995-2005*
Jasper	37,500	6.0%	18,700	1.4%	$28,622	1.5%
Polk	401,800	13.5%	323,300	12.5%	$39,215	14.5%
Area Total	**439,300**	**12.8%**	**342,000**	**11.8%**	**$33,919**	**8.6%**
Iowa	2,965,500	3.4%	1,968,200	9.6%	$31,670	14.6%
United States	266,278,400	11.4%	174,249,600	17.0%	$34,471	13.2%

(From: Carver and Caudill, 2007)

The median household income in Jasper County in 2009 was $48,439 with ten percent of residents living below the poverty level. The population is about 97 percent white (U.S. Census Bureau *Quick Facts*). Manufacturing is the largest category of private sector employment in Jasper County, followed by retail trade, leisure/hospitality, and education/health services (Iowa Workforce Development http://iwin.iwd.state.ia.us/iowa).

Refuge Economics
Neal Smith NWR affects the local economy through the visitor spending it generates and the employment it supports. The Refuge currently supports 10.5 full-time permanent employees and receives about 160,000 visitors each year, many of whom visit the Refuge multiple times during the year. About 14 percent of visitors come from Jasper County, 24 percent from the Des Moines metropolitan area, 36 percent from other parts of Iowa, and 22 percent from other parts of the United States. Neal Smith NWR was one of the sample refuges investigated in a national study of the economic benefits to local communities of national wildlife refuge visitation (Carver and Caudill, 2007). This study found that, in 2006, resident and non-resident visitors to Neal Smith NWR spent about $2.3 million with non-residents accounting for about 90 percent of total expenditures. When this spending had cycled through the economy, Refuge visitation had generated $982,200 in job income, 36 jobs, and about $325,400 in total tax revenue for local communities.

3.1.5 Cultural Resources

Area History (from Hudak et al., 1991)
Pre-History
Archeological records show evidence that nomadic hunter-gatherers were present in Iowa from the earliest generally accepted cultural period, the Paleo-Indian tradition, that began about 12,000 years before present (yrs BP). Archeologists hypothesize that these hunter-gatherers roamed widely through the post-glacial boreal forest of the Midwest in search of mastodon, wooly mammoth, and other resources.

The Archaic tradition evolved as the climate grew warmer and drier, and the cool moist boreal forest gave way to deciduous forest and savanna. People became more sedentary, exploiting deer, elk, and smaller mammals for food, as well as birds and plant resources. There is consistent evidence of ongoing trade and other forms of interaction during this period. Prairie vegetation moved into the region during the middle Archaic (8,000–5,000 yrs BP), and bison became a dependable resource. Late Archaic sites are well represented in central Iowa, including sites in Saylorville Reservoir.

Cooler moister conditions subsequently re-emerged. As deciduous forest expanded once again, bison herds likely moved farther west, although other resources were still plentiful. During this time, people of the Woodland tradition developed pottery manufacture, construction of burial mounds, experimentation with cultivated plants, and habitation in small villages. The middle Woodland tradition (2,500–1,500 yrs BP) is well represented in the archeological record of central Iowa.

Several new cultural traditions emerged in the Midwest as shorter climatic intervals (~400 years) oscillated between wet and dry periods. The people of the Oneota tradition (950–200 yrs BP) were the primary inhabitants of the tallgrass prairie. Archeological sites west of the Mississippi River generally offer large numbers of bison bone, suggesting that the animals were located nearby and were intensively sought by these people. Almost all Oneota villages offer evidence for intensive gardening of corn, beans, and squash. The Oneota culture is regarded as the traditional culture of the Winnebago, Ioway, Oto, and Missouri Indians. Oneota cultural remains from central Iowa are sufficiently distinctive that they are referred to in the literature as the Moingona phase.

Native American History
Prior to 1821, the Ioways and Missouris were in control of the lower and central Des Moines River Valley. The prehistoric remains of these tribes are well represented in the nearby Red Rock Reservoir

area. It is possible that the ancestral Ioway, Missouri, and/or Oto lived in large villages very near the Refuge area as early as A.D. 1000. Their hunting grounds, collecting locations, campsites, and gardens were probably located in the Walnut Creek drainage although there is little specific documentation in the historic record.

The Sauk Indians, led by the famous warrior Black Hawk, soundly defeated the Ioways in a battle fought near Iowaville in 1821. The Ioways vacated the area soon thereafter and ceded all their Iowa lands to the U.S. Government in the early 1830s. Shortly after the battle, the Sauk and Fox moved into the central Des Moines valley and became the principal Native Americans in residence there until they ceded all Iowa territory and left for reservations to the west.

The Sauk and Fox lived in several villages simultaneously that fluctuated in size depending upon the fortunes of the village leader. In the early 1840s Poweshiek's village was located less than 20 miles north of the Refuge on the South Skunk River, and Keokuk's village was located immediately south of the Refuge along the Des Moines River (now Lake Red Rock).

The Sauk and Fox were involved in numerous treaties with the U.S. Government to cede their lands. In an 1842 treaty, they ceded their last claim to Iowa land in exchange for a reservation in Kansas, then to the present-day reserve in Oklahoma. Part of the Meskwaki tribe, however, separated from the larger group, returned to Iowa, and purchased land in Tama County where they still maintain the Meskwaki Settlement today.

The historic record contains few specific references to Native American use of the Walnut Creek drainage but one early settler, William Edward Pulver, told the story of the "Johnnie Green Indians" in a 1935 article in the Newton Daily News. Johnnie Green was a Potawatomi, yet he was the leader of a band of Meskwaki. Pulver probably saw Green and his band along Walnut Creek in the early 1860s when he was a small boy:

> *"I remember seeing the Indians ride past our house wrapped in their bright blankets and I have been with Lute Hayes in their camp about two miles east of here, where they built a dam in the creek to wash their clothes, in the Dan Hayes timber. They were called the Johnnie Green Indians as that was the name of their chief. They left here and went to Kansas, then later moved to Tama. It was their custom to return each year to camp for a time in the timbers near their graveyard on the Billy Hayes farm. There are some fourteen or more graves that lay on a hillside just east of a small creek east and a little north of the barn as it now stands, the location being R 21 W, Township 78 N, Section 21. There are also several Indian graves just south of the school house."*

Euro-American Settlement

Jasper County was created in 1840 even before there were any permanent residents. Settlement began in 1843, and by 1846 permanent white settlement was sufficient to merit establishment of formal county government. Newton City (later shortened to Newton) was named county seat.

With rapid increased settlement in the interior of Iowa came calls for a state capital that was more centrally located than Iowa City. Many frontier communities dreamed of capturing the prize, and the political pressure was intense. A three-man commission examined a series of locations in 1847 before settling on an uninhabited site two miles south and east of present-day Prairie City. Word of the selection touched off a frenzy of speculative lands sales, and central Iowa suddenly was *the* place to be. However, legislators in Iowa City were less than thrilled with the location, so in 1848 they repealed the

earlier act that provided for a new capital location. The capital of Iowa was moved to Des Moines in 1857.

By the summer of 1847, there was evidence of various settlement activities in southwest Jasper County. The map prepared by surveyor Samuel Jacobs showed four sets of cultivated fields, what may have been an Indian trail running east-west across the center, and a portion of the old Territorial Road from Oskaloosa to Fort Des Moines crossing the northeast corner of the township. Jacobs described the landscape:

> *"Township 78 Range 21 W 5th Meridian has a rolling surface and a good second rate soil. In the southwestern part of the township there is a body of generally good timber, about equal in area to ten sections, consisting of oak, hickory, elm, lind, walnut, etc. The remainder of the township is rolling prairie. It is well watered and being rapidly settled."*

Prairie City was founded in 1851 and soon became a stop along the old Territorial Road. Jasper County acquired rail service in 1865 when the Des Moines Valley Railroad reached Monroe. Prairie City emerged as the dominant community in the Walnut Creek area when it gained rail service in 1866.

Farms and communities developed rapidly, fueled by the developing agricultural economy. In Jasper County and elsewhere, settlers initially favored farm sites combining timberland and open prairie land, preferably near a stream. Such sites offered wood for fuel and building purposes, a water source, and prairie for pasture and (relatively) easy planting. But as settlement increased, virtually all available land was soon snapped up without regard for the proportions of timber and prairie on them.

Livestock and corn were dominant in Iowa, but some areas developed additional agricultural specialties. In the Prairie City area, commercial potato production was very important during the late 19th century. The area was termed the "Potato Metropolis," and one 1891 account estimated that the total harvest that year alone would easily reach 100,000 bushels. The Dowden potato digger was invented and manufactured in Prairie City, and the company touted its "potato harvesters, shoveling boards, potato cutters, potato sorters, etc." Many prominent root cellars on area farmsteads persist as a visual reminder of this era.

Refuge Cultural Resources

In 1991, the Service sponsored a cultural resources investigation of the Refuge to guide development of the 1992 Master Plan and to formulate a predictive model to identify areas of high cultural resources potential for use in future planning (Hudak et al., 1991).

The investigation team identified and evaluated seven prehistoric sites, two reported historic Indian burial locations, a reported Indian camp area, and all standing farmsteads located on the Refuge. None of the prehistoric sites were considered significant. No surface evidence of the reported burial areas or camping site was found, probably due to the effects of cultivation and erosion. Additional non-destructive testing was recommended should ground-disturbing activities become necessary. The farmsteads have been greatly altered over the years and it is unclear at present whether any are eligible for the National Register of Historic Places.

Two soil groups found in alluvial fans and valley bottoms were identified as having the potential to contain additional cultural resources. Cultural resources in the lowlands may now be deeply buried.

Uplands on the Refuge show little or no promise for either surficial or buried archaeological sites because of extensive erosion.

Cultural Resources 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 regarding not only human interactions with each other, but also with 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 National Historic Preservation Act of 1966, of identifying historic properties (cultural resources that are eligible for listing on the National Register of Historic Places) that may be affected by our 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.

The Archaeological Resources Protection Act of 1979 (ARPA), Section 14 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 (not just sites meeting the criteria for the National Register) on federal land 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 relating to cultural resources are to be 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 administered lands, by monitoring archaeological investigations by contractors and permittees, and by reporting ARPA violations.

3.2 Refuge Management

3.2.1 Biological Program

Introduction
At Neal Smith NWR, management emphasis is placed on restoring the tallgrass prairie ecosystem, including native wildlife, plants, and ecological processes. Tallgrass prairie, oak savanna, and sedge meadow vegetation communities are being restored or reconstructed. The prescribed fire program is approximating a historic burn regime. Bison, elk, and the regal fritillary have been reintroduced on the

Refuge. Many grassland bird species and other wildlife have returned to the Refuge as habitat conditions have improved.

The benchmark reference period for ecosystem restoration on the Refuge is the 1840s when permanent European settlement was beginning in central Iowa. This period was chosen because GLO survey notes and maps from that era provide one of the earliest detailed records of landscape conditions in central Iowa. However, it is understood that some of the flora and fauna of that time period may no longer exist today, and other irreversible changes have occurred so that it will be impossible to restore the entire historic conditions. We also are faced with the effects of climate change creating uncertainty about future precipitation and temperature patterns. Habitat restoration to date has focused on reconstructing native prairie plant communities on former agricultural lands and restoring biological diversity on prairie and savanna remnants according to the best science available.

Refuge staff developed an ecosystem summary table for Neal Smith NWR (Appendix G: Summary of Refuge Ecosystems); three vegetation communities are named: tallgrass prairie, oak savanna, and sedge meadow. Also included are aquatic and aerial ecosystems. Table columns list characteristic plant species, wildlife species, natural processes, and limiting factors/threats. Plant and wildlife species listed aren't considered more "important" than other species, but they are considered representatives of a high quality ecosystem, specializing in those communities. It is considered that if these species are present, then other more generalist species should be present, too.

Vegetation

Tallgrass Prairie Reconstruction

Habitat work in the early years following Refuge establishment focused on planting and maintaining native prairie species on former agricultural fields. The new Refuge was controversial, and quickly, planting many fields was perceived to be critical in gaining credibility and support at all levels both within and outside the Service. About 1,100 acres were planted from 1993 to 1995. Today that total is about 3,400 acres (figure 3-6). Each planting is a unique prescription derived for the specific site conditions using the plant species available at the time.

Seed sources and mixes

Development of seed sources was a complicated business when the Refuge began. Only seed from a 38-county "local ecotype zone" was to be used for Refuge plantings in order to maintain a high degree of ecological integrity. By using local ecotype seed, the environmental pressures that influenced presence and development of species, genetic, and community characteristics would most effectively be captured. The local ecotype zone lies primarily within the Southern Iowa Drift Plain, but because the Refuge lies near the northern end of the landform, additional counties were added that were likely to have contributed to plant genetic exchange via wind, water, or animal movement.

The Refuge had a large and immediate need for native prairie seed in the early years, but local remnant prairie seed sources were small, scattered, and mostly unknown to the conservation community. Businesses supplying an appropriate seed product did not exist. Over time a greater diversity and quality of seed became available as suppliers adapted to this new market and as Refuge plantings began producing harvestable seed, but in the initial years the majority of seed available was big bluestem (*Andropogon gerardii*), and Indian grass (*Sorghastrum nutans*). Now volunteers, school groups, interns, and staff collect a wide diversity of native seeds on the Refuge. Species not present in high quantities or difficult to collect on the Refuge can be purchased from several local seed vendors.

Purple Prairie Clover

Early plantings included some areas with concentrations of highly diverse seed mixes, some areas with good diversity in a matrix primarily of available grass, and some plantings that were admittedly dominated by big bluestem and Indian grass, with the intent of future species enrichment. To date, such enrichment has been minimal due to time and funding constraints.

Meanwhile, Refuge staff began using Canada wild rye as a nurse crop for prairie plantings, because it establishes easily, competing with weeds as other native species become established but declines in vigor within five years. This built-in obsolescence holds the place for future infusion of diversity without the intense competition of warm season grass species. Inclusion of Canada wild rye as a native nurse crop became standard practice relatively early in Refuge development. Canada wild rye is still used on the Refuge in this way and the practice has been widely adopted by other prairie restoration programs.

Refuge greenhouse facilities and production plots provide the opportunity to establish plants without competition before planting them out. Plant species diversity has been increased by transplanting plugs into specific areas. Certain seed is hard to obtain and/or very expensive, so the greenhouse is used to provide better germination success. Some plants do not establish easily or quickly from seed but do so from a greenhouse started plant. Other species are grown in the greenhouse, so they can be planted in specific areas where seeding hasn't been very successful, such as near the Visitor Center. The greenhouse is used for environmental education and stewardship activities in addition to improving plant diversity.

With more options for obtaining greater quantities of seed of specific species, planting prescriptions no longer need to be dominated by warm season grasses. Current plantings may contain 250 or more species, although the precise number of total species planted is difficult to assess. Small samples of each lot of machine-harvested seed are tested to provide an idea of at least the most abundant species in the mix for development of reasonable planting prescriptions.

Site selection

A variety of factors are considered when selecting planting sites in any given year. A priority in the early years of reconstruction was to concentrate plantings in the core of the Refuge to serve a two-part goal of ecological restoration and development of an area near the Visitor Center where visitors could experience prairie and that was convenient for Refuge interpretive and education programs. Similarly, a high priority was placed on planting near the location of the entry road. When roads or buildings were constructed, planting the area of disturbance was of utmost importance.

Planting crop fields has been a higher priority than planting areas with existing perennial vegetation, such as former CRP lands and pastures. The Refuge has attempted to take proportionate amounts of cropland from each cooperating farmer in any given year, which was a big influence in the early years when many acres were planted. The relationship of a site to remnant natural communities or high

densities of invasive species like reed canarygrass has been considered. Later priorities included seeding along drainage areas, roadsides, and smoothed fencerows that had been included in the initial plantings.

Site preparation and planting
In general, agricultural fields are kept in Roundup Ready® crops until Refuge staff is ready to plant them with prairie seed. This reduces invasive species problems. Crop fields are rotated annually between corn and soybeans, with the final crop usually consisting of soybeans. The presence of terraces and trees in a unit requires more preparatory work and has delayed planting in some areas more recently. Subsurface drain tiles were not removed in most areas that have been planted to native species.

Early plantings were experimental and included several methods of seed delivery using drills and various broadcast seeders, but the most common method was a no-till drill. Later, broadcast seeding became a routine practice. Observations and research indicate better results using broadcast seeding in terms of invasive species suppression, forb establishment and earlier blooming, establishment of relatively more conservative species, and more even species distribution, so that is the approach now used. Broadcast seeding is also esthetically more pleasing, because it does not result in obvious rows of plants as drilling does.

Generally for the first two years after planting, the field is mowed two to three times during the growing season to prevent early successional non-native species from going to seed. After three or four years the planting may be burned. It typically takes at least three years for a prairie planting to develop a fuel matrix sufficient to carry fire.

Results
Since the Refuge was established, almost 3,600 acres of prairie has been planted into former agricultural land. Tallgrass prairie reconstruction at this scale had never been done previously. Returning perennial vegetation to the land has provided benefits to the wildlife and hydrology on the Refuge. Native warm season grasses and many native forb species established readily. Other species have been slow or difficult to establish. Prairie reconstructions on the Refuge vary in diversity of vegetation, from highly diverse to those dominated by a few species that are primarily native warm season grasses. Native cool season graminoids (grasses and sedges) and forbs are under-represented throughout the Refuge. Some units have low densities of forbs, and most units would benefit from the addition of more species. Non-native invasive species are present in many locations. Terraces, gullies, trees, roads, fences, and drain tiles should be removed before planting. This has not always happened; removal is still needed on some previously planted sites.

Many factors affect the outcome of prairie reconstruction efforts on the Refuge. Differences in diversity and development of planted sites can reflect differences in seed mixes; timing and method of planting; frequency and seasonality of burning, mowing, and spraying; and effects of bison and elk in the fenced enclosure. The large-scale spraying of herbicides to treat invasive species, particularly Canada thistle, has probably contributed to the low diversity of native plants in some areas. Weather patterns such as temperature and rainfall are very important in determining what species and how many seeds will survive, and which invasive species might become a problem. Sorting out the nuances that result in a particular planting outcome at any given time is difficult. However, research efforts on the Refuge are addressing some of these issues.

Restoration of Remnant Habitats

In the first 15 years or so after Refuge establishment, the focus of habitat work was on planting native prairie vegetation on former cropland. Work on most remnants was deferred. On those remnants that did receive attention, it was minimal. Prioritization of restoration on remnants was focused primarily on degree of visibility to the public and on public use. Thus, Thorn Valley and Buzzard Head savannas were selected early-on for restoration activities, because both have foot trails and are used for interpretive and environmental education activities.

In general, remnant native vegetation communities on the Refuge (figure 3-6) are in a degraded condition as evidenced by relatively low native species diversity compared to historic conditions and/or the presence of non-native plants. Nevertheless, they are notable for their wildlife benefits, seed source potential, and as focal points for native community reconstruction and restoration. Several of the remnants contain species unique to that site, so taken together the diversity of remnants is higher. Development and maintenance of these sites is accomplished by prescribed burning, planting, grazing, and mechanical and chemical control of undesirable plant species.

Most remnants don't have the more aggressive invasive plants that are targeted for eradication by the Refuge and there has been tolerance for many non-aggressive invasive species, knowing most will succumb through time to good management including prescribed fire. Also, there is a difference between invasive species and opportunistic native species. Some tree species are not invasive but need to be removed if they are not appropriate in fire-dependent systems like prairie or savanna. Black locust and European silver poplar, however, are non-native and aggressively invasive so require more intensive and focused control efforts.

Tallgrass prairie

There are 12 known prairie remnants on the Refuge, totaling about 90 acres. Each of the remnants is unique, composed of different sets of plant and animal species. The degree of degradation is also unique with some sites being overgrown with woody vegetation and others more open but threatened with invasive forbs and grasses. Most remnants have had little management except for burning. Remnants are usually burned at the same time as the burn unit that surrounds them, if there is enough fuel to carry fire.

Some tree removal has occurred on the Dogleg (15.7 acres) and Coneflower (11 acres) remnants. Trees are cut, stumps are treated with herbicide to prevent re-sprouting, and felled trees are moved outside the remnants to a designated area. Heavy equipment is used only when the ground is frozen and snow-covered to prevent damage to understory plants, root systems, and soil structure. Some woody species have been mowed using a brush cutter. In Coneflower, sweet clover has been mowed and hand-pulled and, in June 1994, fifty-three species of native grasses and forbs were sown there. Downy gentian (*Gentiana puberulenta*) and prairie phlox (*Phlox pilosa*), among others, are now thriving and are indicators of increasing natural community quality.

Oak Savanna

About 150 acres of remnant oak savanna remain on the Refuge, with additional remnants within the Refuge acquisition boundary. Fire-intolerant woody species have been removed in portions of the Thorn Valley, Old Game Farm, and Buzzard Head savannas to begin opening up the canopy. Fire has been attempted in these and other savannas with some success.

Most of the savanna restoration work has been focused in Thorn Valley (39 acres) where results have been encouraging. Fire has been attempted here most years and in some years has been quite successful but is restricted to the period between September 15 and April 15 due to the possible presence of Indiana bats. Oak seedlings are now scattered throughout the areas where the canopy has opened up and saplings are found around the southern and western edges. The understory is recovering and herbaceous savanna species are now present. Invasive bush honeysuckle (*Lonicera* sp.) is present. Black locust (*Robinia pseudoacacia*) along the west edge has been sporadically treated with herbicide.

Thorn Valley Savanna

In Old Game Farm savanna (22 acres), in the southwest corner of the Refuge, resprouting of cut woody vegetation has created a dense thicket in one area. Prescribed fire is not always successful due to tree density and difficulty in getting a fire to carry under typical conditions. Due to its history as a game farm, this savanna includes invasive species that are not found in most areas of the Refuge, including Japanese raspberry (*Rubus parvifolius*), autumn olive (*Elaeagnus umbellata*), Russian olive (*Elaeagnus angustifolia*), and black locust. They persist despite sporadic herbicide treatment.

Buzzard Head savanna (11 acres), located inside the loop of the Tallgrass Trail, has young oak trees and many larger fire-intolerant woody species. Tree and brush clearing was not always followed up with stump treatments, resulting in dense shrub thickets. The most recent efforts have concentrated on removing brush and trees on the west end of the remnant. Hoary puccoon (*Lithospermum canescens*) was recently discovered here, making it the only known population on the Refuge, and indicating sun-loving native species still persist in these remnants despite neglect.

Sedge Meadow

Sedge meadow remnants are found in several small areas on the Refuge. Many are surrounded by prairie plantings or prairie remnants and are generally burned with the unit. One area near Thorn Valley savanna has been the focus of a reconstruction effort. This area was formerly dominated by reed canarygrass. It was burned and sprayed, and planted with sedge meadow seeds, greenhouse-grown plants, and plants rescued from a bulldozed fen. Burning has continued almost annually. The area is also the site of a hydrology research project. Research results indicate three zones of vegetation that correspond to three hydrologic zones.

Research indicates that the zone next to the stream supports a few forbs, a tallgrass component, and reed canarygrass. Soil moisture in this zone is affected by stream elevation. Hydrologic study revealed that the near-stream floodplain groundwater drains into the deeply incised stream and creates dry soil conditions adjacent to the channel. Until stream hydrology is normalized, this zone will remain drier than it was historically and drier than other parts of present-day sedge meadows.

Soil moisture in the middle zone is affected both by upland groundwater tables and stream elevation. Reed canarygrass is especially dense and tenacious here. Data indicate wide fluctuation in groundwater in response to rainfall with a rapid rise followed by a rapid fall. Water is poorly drained in the middle zone until the near zone has sufficiently drained into the incised stream.

The zone farthest from the stream has the most stable groundwater table during rain events and excellent restoration potential. It supports a diversity of sedge meadow species with some reed canarygrass mixed in. Groundwater fluctuation in this zone is buffered by distance from the incised stream and proximity to the savanna. A fair amount of water is thought to enter the sedge meadow from the adjacent savanna.

Management Tools

Prescribed Fire

Fire has shaped prairies for centuries and is critical to restoration of the ecosystem. Prairie and savanna species evolved with fire, and it is crucial to their long-term survival. Prescribed fire is used to prevent woody species from overtaking the prairie and to reduce invasive species. Fire removes dead plant material, allowing additional heat and light to reach the soil and stimulating the growth of native prairie and savanna plant species. Fire is also used in cool season non-native grasslands to prepare the site for prairie reconstruction. Frequent-to-annual burns are most effective in increasing overall plant diversity and in gaining control of woody and invasive species.

Prescribed Fire

Fire improves habitat for many species of wildlife by maintaining grassland vegetation and allowing easier access to forage or prey. Some grassland species prefer recently burned areas that begin the season with little above-ground vegetation or litter, and plant height changes dramatically during the growing season. Others prefer standing dead plant material in the spring. The downside of prescribed fire is that it may have detrimental effects on some invertebrate populations, destroys early nests of ground-nesting birds, and temporarily reduces cover for some wildlife species. Frequent fire eliminates the litter layer that is important to some wildlife such as small mammals. Careful use of prescribed fire includes leaving unburned refugia for vulnerable species and those species requiring a litter layer.

The Refuge has been using prescribed fire as a management tool since 1993 to emulate historic disturbance regimes. Refuge files from 1993-2000 document 5,452 acres that were burned during 69 prescribed burns (table 3-3). In recent years the Refuge typically has burned 2,000 acres or more per year. Factors that influence which units are burned each year include presence of certain invasive species, time since last burn, management or research activities, and condition of the planting.

Table 3-3: Prescribed burn history 1993–2010

Year	Number of Burns	Acres Burned
1993	3	58
1994	6	280
1995	2	218
1996	5	805
1997	6	268
1998	10	356
1999	6	868
2000	21	2453
2001	7	813
2001	8	1717
2003	8	854
2004	12	2018
2005	15	3130
2006	14	2738
2007	7	1342
2008	21	2977
2009	17	1878
2010	20	2721

Variability in timing of prescribed fire promotes diversity of plant species. Fall burning promotes forbs and favors a more competitive prairie community, and spring burning can be very effective in controlling certain invasive species. Weather and vegetation conditions generally allow for a longer burn window in spring than in fall or summer. Although summer burning requires specific weather conditions that do not commonly occur, it may promote forbs over warm season grasses and can be useful in controlling some invasive species. Suppression of cool season invasives can be achieved by spring burning and woody species can be effectively limited by summer burns. Invigoration of natural communities resulting from frequent fall burns can also suppress invasives.

The majority of burns on the Refuge to date have been in spring, though a limited fall burn program was initiated in 1999, and summer burns have been conducted recently in the bison and elk enclosure as part of the patch burn grazing regime. More extensive summer and fall burn seasons are difficult to implement due to staffing shortages and weather conditions. However, intensive use of an expanded burn season is especially important at Neal Smith NWR because of many abnormally wet springs in recent years, often prolonged and cool. Such conditions favor rampant expansion of cool season invasive species and encroachment of trees, especially in a landscape in the early stages of ecological recovery. Creative and persistent use of prescribed fire in spring, summer, fall, and even winter if conditions permit, would enhance the ability to achieve habitat goals and objectives on the Refuge.

Grazing

Bison and elk have been reintroduced to emulate the role of grazers in the pre-settlement ecosystem. Grazing by native ungulates undoubtedly played an important role in maintaining the tallgrass prairie. Bison grazing has been correlated with increased plant species diversity and richness in prairies. Removal of dead plant material through burning and grazing increases primary productivity in prairie (Knapp et al., 1999). Grazing is an important ecological process in prairies but little is known about its effects on reconstructed prairies.

Most of the 700-acre bison/elk enclosure was planted between 1992 and 1996, at which time the first bison were reintroduced to the Refuge. The vegetation had little time to become established and was in a state of change. Some areas were planted after bison and elk were present and other areas still have not been planted with native prairie species and are dominated by non-native smooth brome (*Bromus intermis*). Until 2007, about half of the enclosure was burned each spring, alternating halves between years.

In 2007, the Refuge began using more varied patch burn grazing to manage the prairie in the enclosure. Patch burn grazing uses prescribed fire in widely spaced small patches to create shifting areas of intense bison grazing rotated across the landscape over several years (Fuhlendorf and Engle; 2001, 2004). This regime is thought to emulate the patchy mosaic of evolutionary grazing distribution across the tallgrass

prairie. Under patch burn grazing, the enclosure is divided into twelve burn patches, but the bison still have access to the entire enclosure. About one-third to one-half of the enclosure is burned each year, with two to six different patches burned in different seasons each year depending on burning conditions and vegetation condition.

Patch burn grazing is used on the Refuge to stimulate native vegetation and reduce non-native invasives and residual standing dry matter. Bison prefer to graze in recently-burned areas, attracted to the nutritionally high quality new growth. Research on the Refuge (Kagima, 2008) provided evidence that the spatial distribution of the mixed sex/age bison group is positively correlated with fire and higher proportions of native plants, despite the abundance of exotic plant species in the landscape. They also have a strong preference for grasses over forbs (Plumb and Dodd, 1993), so intensive grazing in the burned areas reduces competition from the dominant grasses, giving forbs a better chance at survival.

Patch burn grazing is expected to increase plant diversity in the enclosure as well. Grazing creates microsites throughout the bison and elk enclosure that, when coupled with seed additions, increases diversity and the presence of rare forb and grass species (Martin and Wilsey, 2006). In general, the more time that has passed since burning, the more detritus is present, and the less grazing occurs. Plants that thrive with fire and grazing grow well in the more recently burned patches, and plants that take longer to recover grow more successfully in the patches with the longest time since burning. Grazing is dispersed throughout the enclosure over several years but concentrated within individual seasons. This creates more spatial and temporal heterogeneity on the prairie.

Bison stocking rate is important in a patch burn grazing regime. Too many bison will overgraze burned patches while too few will allow grasses to grow beyond the stage of high quality forage. An optimum bison herd size to promote native vegetation under the current program has not been established. Ongoing monitoring of the effects of the Refuge patch burn grazing program will continue.

Bison affect the prairie in other ways, creating bare areas by rubbing and wallowing. Their grazing and rolling also may affect seed dispersal of native plant species; ongoing research is investigating.

The effects of elk grazing on tallgrass prairie are not well-understood, although their foraging habits are different from bison so their effects are expected to be different as well. The Refuge elk herd spends noticeably less time out on the prairie and more time in wooded areas than the bison. Elk consume more woody vegetation, so they may be important in controlling woody species. Although there are very few studies of elk food habits in prairie systems, the limited information that exists indicates that forbs and browse play an important role in Great Plains elk diets during the fall and winter (Wydeven and Dahlgren, 1983). Due to the small number of elk relative to bison in the enclosure, they have less impact on the vegetation.

Use of grazing as a management tool is currently limited to the 700-acre fenced enclosure. Doubling the size of the enclosure would be possible based on the current land ownership pattern; the 1992 Master Plan recommended a 2000-acre enclosure when land acquisition is complete. Non-native grazers such as cattle, sheep, and goats have not been used to manage prairie on Neal Smith NWR.

Farming

Farming is used as a tool to manage the land until sufficient quantities of native local ecotype seed can be secured and staff is available to plant and maintain a new planting. Currently there are 543 acres in

six management units being farmed on the Refuge by three farmers. In any given year, about 50 percent of the farmed area is planted to corn and about 50 percent is planted to soybeans.

Only "no till" farming practices are allowed. Planting of genetically-modified corn is allowed on Refuge cropland tracts as a place holder to reduce weed infestations until the site is planted to prairie. Under current FWS Region 3 policy, use of glyphosate-tolerant crops is allowed for a maximum of five years after a site is acquired by the Service. Application of anhydrous ammonia is allowed in the spring; no fertilizer application is permitted in the fall. All fields with streams and/or gullies are required to have a 100-foot-wide buffer strip on each side planted with perennial vegetation.

Only glyphosate (Roundup®) herbicide has been allowed without first obtaining written permission from the Refuge. Other herbicides may be permitted under the following conditions:

- There is a documented need from a crop scout;
- the herbicide is listed on the Region 3 Herbicides List; and
- the farmer obtains written permission from the Refuge.

A Special Use Permit that defines terms and conditions is issued to each farmer annually. Farmers pay rent each year and provide pesticide use data and crop yield information to Refuge staff. Pesticide data are used to insure appropriate use and efficacy and in preparation of the Refuge Pesticide Use Report. Crop yield data are compared to the Cash Rental Rates Survey prepared by Iowa State University Extension and is used to set the rental rates for the next crop year. The Refuge may remove tracts from the farm program prior to drafting the next year's agreements.

Invasive Plants

Invasive plants can out-compete native species and cause their displacement, sometimes altering habitat structure and ecosystem processes. Even if the native species are not completely eliminated, the ecosystem often becomes much less diverse. A less diverse ecosystem is more susceptible to further disturbances such as diseases and natural disasters. Invasive plants degrade, change, or displace native habitats and thus are harmful to fish, wildlife, and plant resources. Wildlife species are adapted to the native plants of an area and are much better served by them for food and cover than by most introduced plants. Control of invasive plant species on the Refuge can be time-intensive. Methods include herbicides, mowing, prescribed burning, and hand cutting or pulling.

Sericea lespedeza

Considerable effort was invested in avoiding introduction of the biggest invasive plant threats such as spotted knapweed (*Centaurea* sp.), sericea lespedeza (*Lespedeza cuneata*), purple loosestrife (*Lythrum salicaria*), garlic mustard (*Alliaria petiolata*), and leafy spurge (*Euphorbia esula*). Nevertheless, two sericea lespedeza plants were found within a few years of the initial prairie plantings on the Refuge. One plant, located within the bison and elk enclosure, was thought to have been eliminated by bison grazing. Since then, however, sericea lespedeza has been found to be widespread in the enclosure, so grazing apparently does not eliminate it. The other initial sighting, outside the bison and elk enclosure, could not be relocated later for chemical treatment, and sericea lespedeza has since become widespread in that area. In 2006, sericea lespedeza was discovered again in several more plantings. The practice of harvesting areas of the Refuge and planting the seed in newly retired crop fields exacerbated spread of this species.

Sericea lespedeza can quickly change a landscape by displacing native vegetation. It is a deep-rooted perennial that cannot be pulled out of the ground once it is established. Even young seedlings may have deep roots before they are of noticeable size. Mature plants can reach five feet or more in height, producing large quantities of seed that can remain viable for 20 or more years. Sericea lespedeza is also known to produce chemicals that inhibit the growth of neighboring plants.

The species generally emerges on the Refuge in late May, blooms in September, and sets seed in October. Plants stay green later in the season than native warm season grasses, making it easier to detect in the fall. However, fall herbicide treatment is less effective than earlier treatments, and seed may already be viable by the time plants are easiest to see. Summer mowing may reduce seed production but does not affect the plant's survival. Because of its high tannin content, the plant is not very palatable, so livestock and native ungulates avoid it if possible. The species is adapted to fire. Seed scarification stimulates germination, and fire does not damage established plants. Chemicals are the only effective method of killing sericea lespedeza.

Sericea lespedeza has been promoted for use in wildlife food plots and for cover. However, its negative attributes overwhelm its few benefits. The exclusion of other plant species by sericea can result in monocultures, reducing the diversity of plant foods and cover needed to support a variety of wildlife. Northern Bobwhites occasionally consume the seeds, but they obtain little nutrition from them. Cover provided by sericea in the summer can be beneficial to Northern Bobwhites, but this benefit is eliminated when sericea is dormant.

For the past several years, interns, volunteers, and staff have been walking a grid pattern through management units, locating sericea lespedeza plants, marking them with GPS, and spot spraying them. Because most of the plants are isolated individuals or small patches, broadcast spraying has not been used. Larger patches are sprayed with a UTV-mounted sprayer. Marked locations are re-visited in following years to re-spray if necessary. Plants found after seed set are clipped and removed if possible. Sericea lespedeza has been found at low levels in most plantings that have been searched.

More recently, dogs have been used to locate sericea lespedeza plants in management units that have not yet been searched. Using smell, the dogs have a high success rate in locating low densities of the plant in a relatively short period of time, freeing the use of interns, volunteers, and staff to direct their efforts toward more treatment. Repeated use of dogs over time will assist the Refuge in quickly determining the success of treatments, locate new infestations, and identify areas without sericea lespedeza for harvest sites.

Because of the severity of the threat this species presents, staff is identifying sites on the Refuge that show no sign of sericea lespedeza. Seed will either be hand-collected or machine-harvested on sites believed to be sericea-free. As planting efforts increase, the Refuge must work to clear more areas of sericea for seed harvest or else purchase additional seed.

Other Invasive Species

White and yellow sweet clovers (*Melilotus* spp.) are mowed while blooming, generally in June. These biennial species can be controlled by preventing seed production through early season mowing. Eventually the seed bank can be depleted if the plants are consistently mowed every year. The seeds respond to fire by germinating, so burning is often followed by a flush of sweet clovers. Although they are not as much of a biological threat to the prairie as sericea lespedeza is, sweet clovers are widespread and very visible so are also an aesthetic issue.

Refuge staff also puts considerable time into spraying Canada thistle (*Cirsium arvense*), usually during bud stage. Currently, large patches are treated using a Patriot sprayer to apply the herbicide Milestone®. The operator locates the patches from the spray rig, but locations are not tracked from year-to-year to determine success. This method undoubtedly kills many of the native forbs, too, though it is more selective than some other herbicides. Research is underway on the Refuge to determine which native species might be resistant to some of the more selective herbicides. In 2009, smaller patches of Canada thistle in some of the most diverse plantings were sprayed using a smaller spray rig mounted on a UTV. These patches were marked into GPS and will be re-visited for further treatment if necessary. Some patches of Canada thistle have also been mowed prior to seed set.

Black locust (*Robinia pseudoacacia*) is present on the Refuge in several of the plantings and has invaded some remnants. Many of the locations are former home sites or along the edge of the Refuge near neighboring residences. Black locust is a clonal species, so the entire clone must be killed. Attempts to control it have been sporadic, but much has been learned and efforts are more consistent with added interns in recent years. In some years black locust was mowed, followed by treatment of resprouts with a bud inhibitor, hand cut followed by stump treatment with triclopyr, or basal bark treatment with triclopyr. However, if the entire clone was not treated the roots would survive.

A more complete table of invasive species that have been managed on the Refuge is included in Appendix I. Most of the species not already mentioned above are small or isolated populations that do not take as much time to manage, or they are widespread persistent species that are kept in check with prescribed fire. There are many other non-native species on the Refuge that do not pose much of a threat and have not had nor are likely to receive much management. A prioritized list of invasive plants that need management attention on Neal Smith NWR will be developed in a step-down management plan following approval of the CCP.

Wildlife

Birds

Grassland-dependent birds are adapted to the diverse vegetation structure that historically was maintained by frequent disturbances from fire and grazing. Habitat needs vary by species. Some prefer tall vegetation with a dense litter layer, while others prefer shorter patchier vegetation. Most grassland birds prefer areas with little to no woody vegetation and at least low to moderate forb cover. Reestablishing diverse native plant communities and historic fire, grazing, and hydrologic regimes on the Refuge will create a sustainable mosaic of habitat types that meets the needs of grassland birds and other wildlife. Many birds of the tallgrass prairie ecosystem have returned to the Refuge in response to restoration efforts.

Henslow's Sparrow was first detected on the Refuge in 1999 and is now quite common in prairie units that have not been burned for one year or more. Other grassland birds present during breeding season include Sedge Wren, Dickcissel, Eastern Meadowlark, and Bobolink. Sedge Wren prefers tall grass, especially in low wet areas of the Refuge. Dickcissel and Eastern Meadowlark are found in all types of grassland. Upland Sandpiper and Grasshopper Sparrow use the short vegetation found in areas that are grazed or dominated by shorter grass species such as little bluestem or smooth brome. Management for more areas of short vegetation likely would increase numbers of these species but would also reduce habitat for birds such as Henslow's Sparrow that prefer taller vegetation.

Northern Harrier usually is present fall through spring, with an occasional bird seen during the summer. Short-eared Owl also is present in small numbers from fall through spring. Both require large areas of grassland. Expanding the area of prairie and removing trees may provide sufficient habitat for these species to nest. Smith's Longspur is a migrant found for brief periods in spring and fall using short, sparse vegetation in recently burned areas and newly planted prairie that has been mowed. Le Conte's Sparrow is present on the Refuge in tall grass during migration, particularly in the fall.

The Greater Prairie-Chicken (*Tympanuchus cupido*) requires a large home range and a variety of grassland habitat conditions to meet its life cycle needs. The Iowa DNR has had some success in reintroducing Greater Prairie-Chicken on grasslands in southern Iowa. Both Missouri and Illinois have been able to maintain small populations on fairly small isolated grasslands although they have required intensive management including additional reintroductions to maintain genetic diversity. Greater Prairie-Chicken populations in some locations have experienced declines associated with competition from Ring-necked Pheasants (*Phasianus colchicus*). The sizeable Ring-necked Pheasant population found on Neal Smith NWR and adjacent lands may limit success in reestablishing this species. The Refuge is working with Iowa DNR to determine if reintroduction is feasible and, if so, to develop a strategy for success through partnerships.

The Northern Bobwhite needs sparse vegetation with some tall grasses and shrubs. The Refuge is in the northern edge of its range and the habitat looks suitable throughout portions of the Refuge. Intensive agriculture on the surrounding landscape may prevent movement of these birds into the area, so reintroduction may be necessary to restore a viable population. Other birds that use Refuge habitats with a shrub component include Bell's Vireo, Gray Catbird, Brown Thrasher, Yellow-breasted Chat, Orchard Oriole, Loggerhead Shrike, Willow Flycatcher, Eastern Kingbird, Vesper Sparrow (*Pooecetes graminius*), Field Sparrow, Lark Sparrow (*Chondestes grammucus*), and American Goldfinch. Species that benefit from Refuge savannas include Red-headed Woodpecker, Northern Flicker, Eastern Towhee, and Field Sparrow.

The Service developed *Birds of Conservation Concern 2008* to identify species that represent the Service's highest conservation priorities because they are rare or declining. The list encompasses three geographic scales— The North American Bird Conservation Initiative (NABCI) Bird Conservation Regions (BCR), FWS Regions, and National—and uses assessment scores from the North American Landbird Conservation Plan, the U.S. Shorebird Conservation Plan, and the North American Waterbird Conservation Plan. Eleven species of the tallgrass prairie ecosystem are considered Birds of Conservation Concern for the portion of BCR 22 that lies within the Service's Midwest Region, where Neal Smith NWR is located: Upland Sandpiper (*Bartramia longicauda*) Short-eared Owl, Red-headed Woodpecker, Northern Flicker, Loggerhead Shrike, Bell's Vireo, Field Sparrow, Grasshopper Sparrow, Henslow's Sparrow, Smith's Longspur, and Dickcissel. The species that Neal Smith NWR could be the most influential in meeting regional population objectives are Red-headed Woodpecker, Henslow's Sparrow, and Dickcissel (Will, 2012; personal communication). Appendix H contains a table that summarizes the current status of species selected as Birds of Special Consideration for Neal Smith NWR.

Restoration activities consider potential negative impacts to birds and avoid them, if possible. Tree cutting and brush clearing take place outside of the nesting season, between September 15 and March 30. Most spring burning takes place before May 1 to minimize destruction of grassland bird nests.

Bison and Elk

The historic ecological role of bison and elk cannot be fully replicated on the Refuge. Herds historically were free-ranging and migratory, for example, but now must be confined within Refuge boundaries and carefully managed. The appropriate role of captive bison and elk on national wildlife refuges is still evolving and has been discussed within the Service since before the Refuge was established. Ultimately, the 1992 Final Environmental Impact Statement and Master Plan did support bison and elk reintroduction at Neal Smith NWR (then known as Walnut Creek NWR) "to best achieve the biodiversity, environmental education, and interpretation and recreation goals" of the new Refuge.

In August 1996, new Service policy (Service Manual, 701 FW 8 Fenced Animal Management) specifically authorized five Refuges to "preserve and promulgate" remnant herds of nationally and/or historically significant animals. Walnut Creek NWR was approved for reintroduction of bison and Rocky Mountain elk. The policy requires each Refuge to develop a herd management plan that describes objectives relating to the specific population(s) and the relationship of the management of the species with other objectives.

The Fenced Animal Management Plan (FWS, 2002) for Neal Smith NWR outlined a program designed to restore Refuge bison and elk herds as nearly as possible to the condition that existed prior to Euro-American settlement. Neal Smith NWR was described as unique in managing its herds to perpetuate habitat, rather than using habitat management to perpetuate the species. The bison and elk are limited to a 700-acre fenced enclosure but are treated as wild animals as much as possible and managed with minimal interference.

Bison

The Fenced Animal Management Plan recommended an "ecological" carrying capacity of 35 animal units for bison (based on a conservative estimate of 1,500–2,000 pounds/acre of available forage, a moderate grazing rate of 35 percent, and a correction factor of 30 percent for soil/slope conditions). This carrying capacity was thought to ensure a herd size that would survive drought or severe winter conditions without overgrazing the prairie. Herd reductions would be made each year as needed to prevent habitat damage while allowing the bison to continue playing a vital role in prairie establishment and ecology.

Bison were introduced to the Refuge between 1996 and 1998. During that time, 30 bison were transferred to the Refuge from Fort Niobrara NWR, Wichita Mountains NWR, and the National Bison Range. By the end of the spring 2001 calving season, the Neal Smith herd numbered 68. In October 2001, the herd size was reduced to 33 by donating animals to other programs. Additional bison were culled in 2003 and 2004 to maintain population numbers between 35 and 40 animals.

Meanwhile, the U.S. Department of the Interior and the Service began moving toward more cohesive management of federal bison herds as one resource to better conserve and protect the genetic diversity of the wild species on a national scale. The majority of bison in the United States currently exist in private herds that often have high rates of hybridization with domestic cattle. This makes Service bison herds with low hybridization especially valuable for long-term conservation of the species. As part of this program, the existing Neal Smith bison were transferred to Native American tribes in Iowa and North Dakota, because they represented a gene pool well established in other Service herds. In December 2006, a herd of 39 animals with high genetic uniqueness was brought in.

By November 2010, the herd had grown to 85 animals. Thirteen bison were relocated, bringing the herd size down to 72 animals as of March 2011. After another year of births and deaths in the herd, in

November 2011, another 16 bison were relocated to bring the population down to 71 animals. While the current herd size is being held at approximately 70 animals, the optimum herd size has not been determined, but is one that will promote the growth and diversity of the prairie and maintain bison body condition and health without supplemental food. Monitoring of plant biomass is not currently occurring within the enclosure, although one study in 2002-2003 calculated above-ground productivity at 4,000 to 7,000 pounds/acre/year, depending on the year and the calculation method used (Martin et al., 2005). This production rate is much higher than the estimate used to develop the Fenced Animal Management Plan in 2002.

Seven national wildlife refuges participate in the national FWS bison genetics program. These seven smaller herds are managed genetically as a single large metapopulation of about 1,400 animals total. Each animal undergoes genetic testing and receives a microchip implant for identification. Maintaining the genetic foundation broadly across several locations reduces the risk of total loss of genetic resources from a natural event or other disaster. In addition, exchange of animals between the participating Refuges ensures that the diversity of the metapopulation is maintained.

The genetics program does not affect habitat management within the bison/elk enclosure. Refuge staff decides how many animals to transfer based on habitat quality. Selection of which animals to excess or move to other Refuges is done by the FWS Wildlife Health Office in Bozeman, Montana and is based on presence of rare alleles and other genetic factors, sex, and age class. Herd management includes an annual roundup to take genetic samples and microchip calves, do health screenings on a random sample of adults, assess condition of animals, and remove or exchange animals.

The bison get their water from streams running through the enclosure, and mineral blocks are provided primarily to prevent bison from being attracted to road salt on vehicles. Domestic animal practices such as vaccination, feeding, and individual animal treatment are avoided. However, confinement to small areas, dense animal aggregation, and repetitive use of select forage all enhance transmissible parasites and diseases so in addition to disease testing during the roundup, occasional testing for parasites is done and herd treatment takes place if necessary. Additional actions are taken to inhibit the spread of parasites within the enclosure. Refuge staff monitors the herd weekly (when conditions permit) to assess herd health and condition. In isolated cases when an animal is determined to be suffering, it is euthanized. Dr. Tom Roffe of the Wildlife Health Office advises Refuge staff on herd health issues.

Routine supplies cost about $2,000-$3,000 annually for mineral blocks, biological sampling, microchips, and other supplies. Roundups involve considerable staff time for one day each year and some preparation time to maintain the handling facility. Regular monitoring and occasional maintenance of water gaps and cattle guards is necessary to prevent escape.

Elk

Elk were introduced onto the Refuge in 1998 and 1999 by transferring ten Rocky Mountain elk from Fort Niobrara NWR. No additional animals have been brought in since then. Because of difficulties in managing elk in captivity, the target herd size is 15. Five animals were culled in 2006 when numbers had grown to 21. Since then, elk have died at about the same rate that calves are born. Herd size in spring of 2011 was 16.

Inbreeding is a concern with such a small number of animals and the benefits of their grazing on overall habitat diversity in the enclosure are probably small due to the small number of elk. Refuge staff conducts weekly health monitoring, but because of their habits the elk are difficult to observe. A study

of habitat use and diet of bison and elk in the enclosure was conducted in 2006-2007 (Kagima, 2008). Tranquilizers are necessary to handle them, and darting is difficult and dangerous for staff and could be fatal for the elk, so research involving marking or tracking animals is not conducted. Live elk are not handled, and management focuses on morbidity and mortality.

Chronic Wasting Disease (CWD) is a significant threat to the long-term viability of elk on the Refuge. Deer are free-ranging on the Refuge, so if CWD shows up in Iowa's deer population it could be transmitted to the elk herd. If CWD were found on or near the Refuge, the elk would likely need to be eliminated. Elk are regulated through the Iowa Department of Agriculture and cannot be transported on or off the Refuge unless they are in the Iowa CWD program. Neal Smith NWR does not participate in this program because of its intensive livestock approach and lack of deer-proof fencing on the Refuge.

The Refuge adopted a CWD contingency plan in 2005. The Refuge plan accepts many measures identified in the state plan, which includes strategies for 1) surveillance and detection, 2) communication and education, and 3) containment and eradication; and includes provisions for destroying the elk herd upon request by the Iowa DNR if CWD is found on or near the Refuge. As of January 2012, all states bordering Iowa had found at least one CWD-infected animal, but no cases have yet been documented in Iowa.

Indiana bat

The Indiana bat, a federally listed endangered species, was first documented on the Refuge in 1992 through a bat mist-netting project. Indiana bats were found to be present in the Thorn Valley savanna and north along Walnut Creek. In 1992 and 1993 there was evidence of a maternity colony (adult female with enlarged mammae and juveniles). In 1995, the last time Indiana bat surveys were conducted, only a single adult male was captured. This male was radio-tagged and found to be using red elm snags and live shagbark hickory trees as roost sites. Roost surveys found up to two to three bats emerging from these trees, consistent with a male Indiana bat roost. The Refuge has conducted Endangered Species Act Section 7 consultation with Ecological Services and follows seasonal tree clearing and burning restrictions to protect any maternity roosts that may be present.

Regal Fritillary

The regal fritillary is a rare butterfly closely associated with high quality prairies whose obligate larval host plants are prairie violet (*Viola pedatifida*) and bird-foot violet (*Viola pedata*) (Shepherd and Debinski, 2005). Iowa State University was the principal investigator in a research project designed to reintroduce the regal fritillary to the Refuge and to explore certain relationships that this species has to fire including success of its host food.

Prairie violet plots have been established in each of four areas on the Refuge to provide larval food. In the summer of 2000, gravid female regal fritillaries were introduced in cages over prairie violets to maximize probability of successful egg-laying. Independent of reintroduction attempts, two wild butterflies (one male and one female) were observed on the Refuge in 2000. Adult regal fritillaries were sighted across the Refuge during the summers of 2002–2010. Though the butterfly is vulnerable to fire, especially during the larval period, the prairie violet is invigorated by fire and tends to decline in periods when fire is absent from the landscape. Regal fritillaries continue to persist on the Refuge as do the violets where they were planted.

Monitoring and Research

Monitoring

Twenty-five permanent plant transects were established on prairie and savanna remnants throughout the Refuge in 1994 under the direction of Dr. Darryl Smith. Fifty randomly located 0.1-meter plots were surveyed along each transect. Species diversity, cover, and frequency data were recorded in each plot. Transects were permanently marked using metal conduit and drawn on a topographic map. More than sixty vegetation survey transects were established on planted prairie sites in late summer of 1997 using the same methods. These data have not yet been analyzed. Follow-up monitoring began in 2008, with a few different transects sampled each year. Data will be analyzed using the Floristic Quality Assessment technique (Swink and Wilhelm, 1994).

The Refuge has conducted breeding season bird point counts almost every year since 1994. Over 120 randomly selected points were established and almost evenly divided between riparian, crop, woody, and grassland sites. Eighteen of the points are in the bison and elk enclosure. The observer stands at each point for ten minutes and documents birds heard and seen within 0–25, 25–50, and >50 meter distances of the point. Recently this was modified to include distance bands of 50–100 meters and > 100 meters. The observer also records whether the birds were first detected in the first five minutes or the last five minutes. Recently this was modified to record the minute the bird was first detected. Each point is surveyed once per year. The surveys were originally conducted to collect baseline data on birds and look for population trends during the early stages of prairie reconstruction (Thomas, 1999). This study found increases in grassland birds such as Dickcissel and Grasshopper Sparrow during the first few years after Refuge establishment.

In 1998, a recommendation was made to change the protocol to conduct the counts only one time at each point, rather than three times as the original protocol established. This recommendation was followed. Another recommendation was made to continue conducting point counts in crop fields, despite changes in vegetation from crop to grassland. For unknown reasons this recommendation was not carried out, and the number of points in each vegetation type was kept fairly constant, with points dropped as crops were planted to prairie vegetation and new points added in crop fields. This has made it difficult to detect changes in the bird populations on the Refuge in a straightforward manner. Analysis of data is being initiated to try to detect population trends. Recently an analysis was carried out examining the bird species composition in prairie plantings of different ages (Olechnowski et al., 2009). This study found that the bird species found in certain areas of the Refuge were related to the age of the planting. For example, Henslow's Sparrows were found in more established plantings, while Killdeer, Horned Lark, and Vesper Sparrow were most abundant in the first year after planting. Dickcissels peaked in abundance the second year after planting.

A Christmas Bird Count circle includes the entire Refuge and the count is conducted annually to monitor winter bird populations. This count has not occurred long enough to get trend data, but data are submitted to National Audubon Society to contribute to the national database. Some monitoring of birds has also been carried out during spring and fall migration. Smith's Longspurs have been detected during spring and fall using Refuge areas that were recently burned or planted and mowed.

Nocturnal frog and toad call surveys are done in coordination with the Iowa DNR's wildlife diversity program and contribute to monitoring long-term trends state-wide. The surveys were originally conducted by volunteers between 1997 and 1999. Since 2006, the surveys have been conducted annually by the Refuge biologist. The most common frogs and toads detected on annual nocturnal call surveys are eastern gray tree frog, American toad, Blanchard's cricket frog, and western chorus frog. The

northern leopard frog has rarely been detected. Bullfrogs were detected in areas that are no longer monitored, and no suitable habitat occurs on the current survey route.

In 1994, baseline surveys were conducted across the Refuge on birds, medium-sized mammals, and Orthoptera (grasshoppers and katydids). Remnants were surveyed for butterflies, moths, ants, and ground-dwelling invertebrates (Klaas and Bishop, 1995).

The National Oceanic and Atmospheric Administration operates a meteorological station on the Refuge as part of the U.S. Climate Reference Network (USCRN). The USCRN consists of more than 100 stations in the United States installed for the express purpose of detecting climate change. In addition to temperature and precipitation, these stations also monitor solar radiation, surface temperature, and surface winds. Data is transmitted hourly via satellite to the National Climate Data Center. Measured elements are being expanded to include soil moisture, soil temperature, and relative humidity.

Research

Neal Smith NWR was home to the Service's Land Management Research and Demonstration Program (LRMD) for over ten years. The LMRD supported research to increase understanding of effective prairie, savanna, and sedge meadow restoration techniques. Major studies in 2009 included use of herbicides to control Canada thistle and the relationship of avian diversity to changes in vegetative structure in restored tallgrass prairie and savanna. Additional studies relate to climate change, carbon sequestration, and impacts to vegetation and hydrology due to changes in weather patterns. Outreach programs on the Refuge included: research symposia, field days, brown bag specials, student science innovations, interpretive and environmental education programs, and volunteer involvement in science.

While the program has been beneficial, regional reorganization has caused the Tallgrass Prairie and Savanna LMRD site to be phased out in 2012. Some research pertaining specifically to Neal Smith NWR prairie and savanna restoration and bison/elk management will continue through the Refuge biological program. A list of LMRD-related publications from 2001 through 2011 is included in Appendix K.

3.2.2 Visitor Services Program

The Visitor Services program has been a significant component of management since the Refuge was established. Early planning documents all described the importance of the new Refuge as a major center for environmental education, interpretation, and wildlife-oriented recreation in central Iowa. To enhance the program, state-of-the-art facilities were constructed. The entire Refuge was intended to serve as an outdoor laboratory and classroom; it was designed to impart an awareness and appreciation of "the value of wildlife and wildlands" and to teach visitors about the natural and cultural history of the ecosystem and the process of native habitat reconstruction. Much of that original vision has now been implemented.

In 2010 and 2011, a National Visitor Survey was conducted by the FWS Division of Visitor Services and Communications and the U.S. Geological Survey's Fort Collins Science Center. The goal was to provide refuge managers, planners, and visitor services specialists with reliable baseline data about refuge visitors and their experiences, both at a national level and at a field station level. Neal Smith NWR was one of the participating field stations. The data provides insight into visitor characteristics, primary activities, and average expenditures. Visitor satisfaction was measured in four categories: recreational activities and opportunities, information and education provided at the Refuge, services provided by employees or volunteers, and how well the Refuge was conserving fish, wildlife, and their habitats. In

each category, more than 90 percent of visitors expressed satisfaction with Neal Smith NWR (Sexton et al., 2011).

Neal Smith NWR has been known as the Neal Smith National Wildlife Refuge and Prairie Learning Center since building construction was completed in 1996. The use of the name Prairie Learning Center has been confusing to many visitors who are not certain they are at the Refuge when visiting, or ask directions to the Prairie Learning Center. This confusion also has affected public understanding of Refuge purposes, so "Prairie Learning Center" is being dropped from the name. The large building that houses the exhibits, bookstore, and administrative areas is now referred to as the Neal Smith National Wildlife Refuge Visitor Center.

Guidance for authorizing public uses on national wildlife refuges is provided in the Improvement Act, which states that "Compatible wildlife-dependent recreation is a legitimate and appropriate general public use of the System . . . through which the American public can develop an appreciation for fish and wildlife." The Improvement Act specifies hunting, fishing, wildlife observation and photography, and environmental education and interpretation as priority public uses. These six activities, when determined to be compatible, are considered legitimate and appropriate uses of Refuge System lands that should receive priority consideration in refuge planning and management. Compatibility determinations are the responsibility of the Refuge Manager with concurrence by the regional office supervisor. Compatible uses are those that will not materially interfere with or detract from the fulfillment of the mission of the Refuge System or the purposes of the Refuge.

Welcome and Orientation

Refuge visitation has averaged about 160,000 people annually during the years 2007 through 2009 (tables 3-4 and 3-5). For most, the visit begins with a drive along the winding entrance road that meanders through the rolling topography (figure 3-7) and is designed to provide a sense of immersion in the landscape. The experience provides a dramatic contrast to the agricultural lands surrounding the Refuge and visually introduces visitors to the beauty and diversity of prairie, savanna, and riparian plants and wildlife.

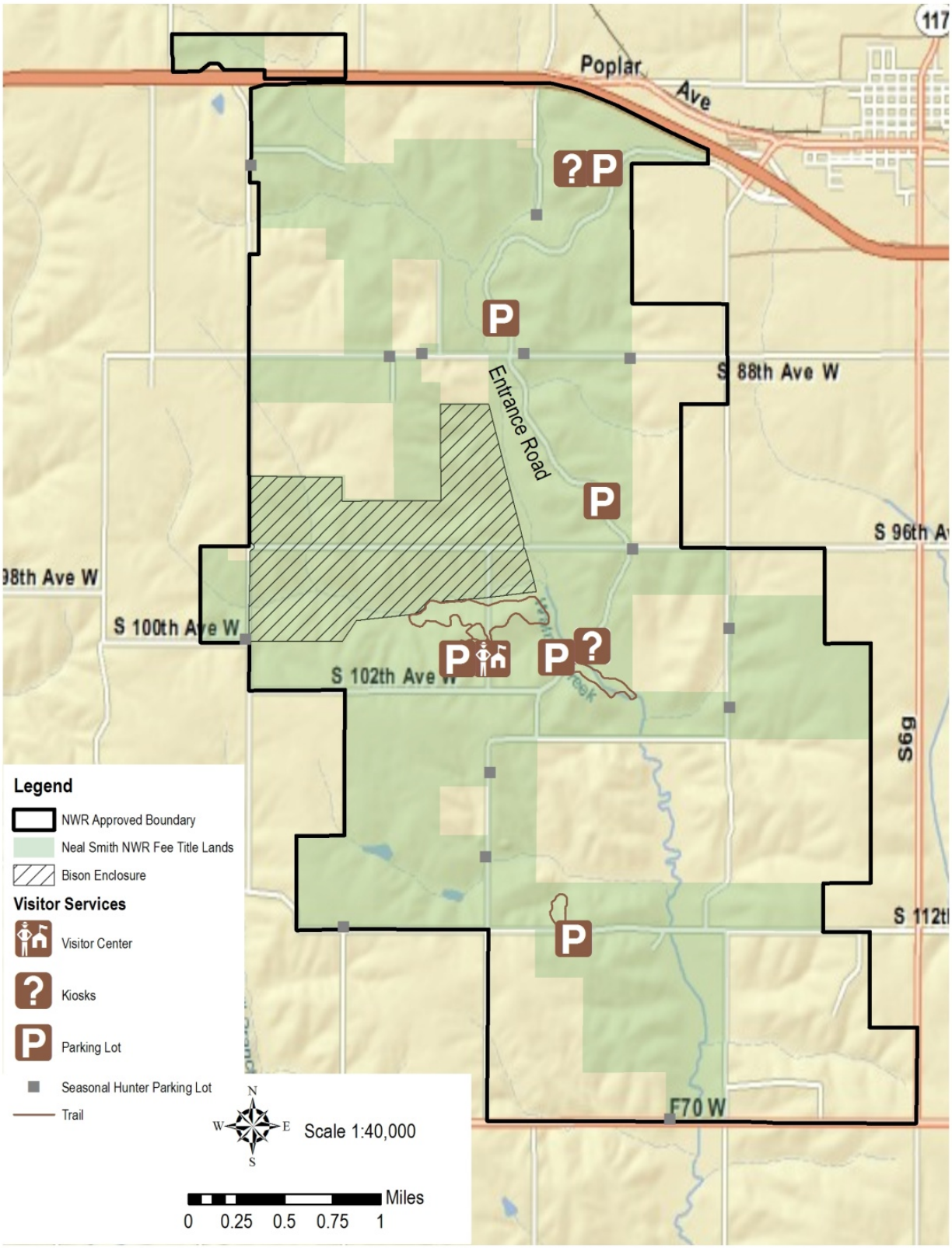
Table 3-4: Visitor numbers

	2009	2008	2007
Trails	44,000	18,000	19,500
Visitor Center	25,000	22,500	24,000
Bison and Elk Enclosure	88,500	105,500	149,500

Table 3-5: Where do visitors come from?

Locations	Percentage of Visitors
Jasper County	14%
Des Moines + suburbs	24%
Other Iowa	36%
Other United States	22%
Other countries	3%
Unknown	1%

Figure 3-7: Current Visitor Services Facilities, Neal Smith NWR



The 4.5-mile entrance road leads to the Visitor Center. The site of the Visitor Center provides good views of the Refuge and offers the opportunity to explore and discover the incredible diversity of the tallgrass prairie ecosystem firsthand. The building itself is designed to blend unobtrusively into the surrounding landscape. The 40,000 square foot Visitor Center includes 13,000 square feet of exhibits, multi-purpose meeting rooms, theater, laboratory-classroom, and bookstore, as well as Refuge offices and research facilities. The Visitor Center desk is staffed seven days/week by volunteers who are available to welcome and orient visitors to the Refuge.

Neal Smith NWR Visitor Center

Wildlife Observation and Photography

The opportunity for wildlife observation and photography are huge draws for visitors. The bison and elk are very popular with visitors and are the primary reason many people come to the Refuge; they are also a critical component of Refuge biological and environmental education programs. Birding also is popular, although most birders come from outside the local area. Five trails and an auto tour loop are available for exploration, and all are open from daylight to dusk.

Foot Trails

Overlook Trail is a short, quarter mile paved loop adjacent to the Visitor Center. It has interpretive signs and is accessible under the Americans with Disabilities Act. It passes through prairie plantings and offers panoramic views of the Refuge. Portions of prairie along the trail have been adopted and are maintained by volunteers from the community. Bison and elk can sometimes be spotted in the distance.

Tallgrass Trail is two-mile asphalt loop that branches off from the Overlook Trail. Its long gradual slopes pass through reconstructed prairie, along a prairie/savanna remnant in the process of being restored, and down to the lowlands along the creek. This trail has an interpretive brochure and benches about every third of a mile. Like the Overlook Trail, it offers scenic views and occasional sightings of bison and elk. Since this trail parallels the south fence of the bison enclosure, it provides one of the best chances to see bison close up while travelling by foot.

Savanna Trail is a half-mile gravel loop that allows visitors to meander through a mature oak savanna that is in the process of being restored and to view a sedge meadow under restoration near Walnut Creek. The Savanna Trail is located east of the Visitor Center near the main entrance road. The site includes a visitor parking lot.

Basswood Trail, located in the southern end of the Refuge, has a mowed grass surface. The half-mile trail is mostly wooded and located in the open hunting zone. The site includes a hunter and visitor parking lot.

Native Trails are mowed firebreaks that allow the visitor opportunities to walk along the perimeter of the Refuge to view the prairie from other vantage points. Over 49 miles of firebreak are available on the Refuge, outside the bison enclosure.

Volkssport Trail is an officially designated ten-kilometer trail listed with the American Volkssport Association that incorporates some trails, firebreaks, and county roads.

Auto Tour Route

The four-mile Auto Tour Route is the most popular visitor attraction. Its gravel surface mostly follows county roads and passes through the 700-acre bison/elk enclosure. Many visitors come to the Refuge just to see the herds. For safety reasons, visitors are asked to remain in their vehicles at all times inside the bison/elk enclosure. An interpretive audio CD is available for loan or purchase when the Visitor Center is open.

Bicycle Trail

Visitors enjoy bicycling along the entry road, but there is no shoulder so safety has been a concern. In 2010, the Refuge received a grant from the Paul S. Sarbanes Transit in Parks Projects (a Federal Transit Authority program) to engineer and design a bike/pedestrian trail that will connect Prairie City with the Neal Smith NWR Visitor Center. The trail will follow the entry road, reducing habitat fragmentation while safely allowing visitors the opportunity to reduce their carbon footprint, exercise, and experience the prairie outside of their vehicles. Prairie City currently has a one-mile bike/pedestrian trail that includes a parking lot, restroom, and kiosk just to the northeast of the Refuge. Jasper County Conservation Board has completed more than half of a trail connecting Prairie City and Monroe Iowa. When completed, this trail will add access by bicycle to the Refuge from the town of Monroe.

There are plans for a 100-mile loop trail from Des Moines to Lake Red Rock (a U.S. Army Corps of Engineers facility), with the Refuge trail being a spur. In the future, there is a possibility of extending the Refuge trail to the south, creating two 50-mile loop trails for those desiring a shorter excursion.

Other Access

Some visitors explore the Refuge away from the designated roads and trails. Although demand for such experiences is low at present, this activity is expected to increase. Some visitors walk along fire breaks while others (mostly hunters and birders) venture off into the unbroken prairie. Snowshoeing and cross-country skiing are allowed on- and off-trail in winter; snowshoes in adult and child sizes are available for loan when snow depth is six inches or more. Foot access to the bison/elk enclosure is not allowed. Horses are allowed on county roads only. Other requests for off-trail access are handled on a case-by-case basis with consideration for visitor safety and wildlife disturbance.

Environmental Education and Interpretation

The Refuge provides a wide variety of environmental education and interpretation programs for a wide range of audiences. Teacher training, the Partner Schools program, and ranger-led stewardship activities are the heart of the environmental education program. New twice-monthly interpretive programs are now being developed and presented by staff in an effort to provide more opportunities for visitors to explore the tallgrass prairie and oak savanna ecosystem.

Since 2007, the Visitor Services program has focused more effort on training teachers to lead their own groups and less on ranger-led environmental education programs. Teacher training is an effective way to reach more students when Refuge staff time is limited. A 200-unit teacher-training curriculum on prairie

and oak savanna—called Project Bluestem—has been developed by Refuge staff, the Friends of Neal Smith NWR, and educators from around the state. The K–12 interdisciplinary program is available electronically and is designed for Refuge or school-site learning. The original authors of the Project Bluestem Curriculum (PBS) wrote in their introduction that the PBS curriculum should be constantly "changing, improving, and growing." Neal Smith NWR recognizes the importance of these commands and has worked to uphold them by reviewing and revising the curriculum with the most current philosophies and methods of environmental education. Recently, Neal Smith NWR has adapted and created six new lessons for each grade level K–5; three for the fall season and three for the spring season. These new lessons will be added to the original Project Bluestem Curriculum. Teacher workshops are held at the Refuge in the summer and are usually well-attended. A new rotation of teacher workshops is currently being developed.

The Partner Schools program uses the environment and the outdoors to teach science, math, social studies, English, and art. It provides a multidisciplinary standards-based curriculum that includes hands-on experiences with plants and wildlife to immerse students in nature throughout the seasons. The program typically involves the entire student body. Ideally, Refuge staff visits each school three to four times per year and each class visits the Refuge three to four times per year. While the program reaches a wide audience of students, the emphasis is on diverse youth. The Refuge currently partners with five area schools; additional schools would like to participate and will be accommodated when and if staffing and resource levels are able to meet the requests.

Through this interaction, students are able to gain both hands-on and minds-on learning experiences on a repetitive basis, allowing more in-depth understanding of America's wildlife resources and the role that the Service plays in their management and protection. A growing volume of new research may be accessed at http://www.peecworks.org, the Place-Based Education Evaluation Collaborative website. Previous research and the findings from the Prairie Science Class (Prairie Wetlands Learning Center in Fergus Falls, Minnesota) evaluations demonstrate that integrated learning using authentic field-based experiences makes sense, with positive outcomes for both students and partnering organizations such as the Service.

Research also substantiates that maintaining a smaller teacher to student ratio is one of the most effective ways to increase academic achievement. For this reason, Neal Smith NWR has recently moved from having 100 students on a field trip at time to usually 50 students at a time. Even with these restrictions, staff still lead nearly 5,000 students in environmental education and stewardship programs at the Refuge each year and teach another 2,500 students during off-Refuge programs. The Refuge is also involving teachers and students in research-based programs such as hands-on field work, monitoring, and data collection, and designing their own research proposals. Neal Smith NWR partners with many surrounding institutions of higher learning including Central College, Des Moines Area Community College, Simpson College, Wartburg College, and Iowa State University to provide their students with hands-on, career-related work. School groups are at the Refuge every weekday in September, October, April, and May and most weekdays the rest of the year.

The Refuge sponsors eight special events each year including celebrations for Earth Day, International Migratory Bird Day, National Wildlife Refuge Week (Ding Darling Day), Monarch Madness, Public Lands/Buffalo Day, stewardship days, butterfly counts, and the Christmas bird count. Other interpretive programs include prairie walks, winter adaptation hikes with snowshoes, beginning birding classes, and preschool and family programs. Most activities are scheduled on Saturdays and Sundays. Public interest in these events and programs is strong. An activity guide is made in-house and distributed each season

and includes information about interpretive programs and special events. On the weekends, Neal Smith NWR also offers ranger-led badge programs for Boy Scouts and Girl Scouts of various ages.

Non-personal interpretation on the Refuge includes the Visitor Center exhibits, multi-media presentation, trail brochures, interpretive signs and kiosks, and an interpretive audio CD for the auto tour route. A butterfly garden with walkways has been established next to the Visitor Center.

Hunting and Fishing
About two-thirds of the Refuge is open for deer, squirrel, rabbit, pheasant, and quail hunting. The bison/elk enclosure and the area surrounding the Visitor Center are closed to all hunting. Shotgun, bow, and muzzleloader deer hunts are available. Drive hunting for deer is also currently allowed. Special youth and disabled hunter deer seasons are currently not open on the Refuge. There are 15 temporary parking areas available on the Refuge during hunting season. Non-toxic shot is mandatory. The use of dogs is allowed only for upland game birds during the state-approved season. Hunter registration is not required.

Walnut Creek and a few tributaries are the only areas within the Refuge with perennial waters. Even so, water depths are very shallow in the summer and winter months, supporting minnows and other small fish not suitable for angling. Peak water flow occurs after spring rains when flood conditions sometimes make Walnut Creek inaccessible. Therefore, fishing is not a recreational activity that is conducted on Neal Smith NWR.

Other Recreational Uses
Other recreational activities include:

- Horseback riding is allowed on county roads only.
- Dogs allowed for pheasant hunting only.
- Berry and morel collecting are allowed.

Activities not allowed on the Refuge include:

- No shed antler collection.
- No ATVs or snowmobiles.
- No camping/picnicking/fires, but lunchroom and outdoor lunch area are available for visitor use.

Volunteers, Partnerships, and Community Outreach
Refuge programs are supported by many dedicated volunteers. They staff the Visitor Center and bookstore, lead environmental education and interpretive programs, and assist with special events. Volunteers help with invasive species control, greenhouse operations, hand harvest of seed, the prescribed fire program, and many other activities. In 2010, volunteers contributed more than 13,000 hours to the Refuge.

The volunteer group Friends of Neal Smith NWR (Friends) was established in 1993. In addition to supporting the activities listed above, the Friends group pays for the quarterly *Prairie Wind* newsletter and maintains the *tallgrass.org* website to communicate current news and event information. The Friends group has joined the local business association and provides up to four annual $1,000 college scholarships to local graduating high school seniors who are pursuing a higher degree in a natural

resources field. The group also provides funding for a 12-week Prairie Builder intern program. Since 1999, over 65 interns have received a combined total of more than $150,000 in stipends.

In 2008, the Friends group and the Iowa Natural Heritage Foundation (INHF) acquired 840 acres of land within the Refuge acquisition boundary. Of particular importance was a large tract of land containing remnant oak savanna and the only remaining unchannelized section of Walnut Creek. The Friends and INHF jointly committed $2.7 million to purchase and hold the land until Service acquisition funds become available.

In 2004, Refuge staff assisted Prairie City with a successful $600,000 grant application that included construction of a bike trail, entry plaza with native plantings, and a bison sculpture. Another $10,000 grant for interpretive kiosks was funded with assistance from Refuge staff. The Refuge was a partner in developing interpretive panels for the kiosks that were installed in 2009. The Refuge continues to be an active member of the Prairie City Business Association.

3.2.3 Administration

Facilities

The 40,000 square-foot Visitor Center was built in the mid-1990s using existing green technology (including geothermal heating and cooling). The building serves as Refuge headquarters and includes offices, exhibits, bookstore, research lab, greenhouse, and meeting rooms. A maintenance shop, vehicle and seed storage buildings, greenhouse, and small outdoor amphitheater are located nearby.

The Refuge uses a constructed subsurface flow wetland to treat effluent leaving the septic tank. This system offers an environmentally compatible alternative to a septic drain field, which studies had shown to have severe limitations in the area proposed for the Visitor Center. Through a series of physical, chemical, and biological processes, the three-cell wetland naturally breaks down the effluent as it passes through the porous rock medium and over plant roots and stems on which bacteria, algae, microflora, and fauna are present. The wetland is monitored and operated by Refuge staff to meet permit discharge requirements. Weekly inspections and monthly water sample testing are required. Frequent vegetation control within the cells and surrounding area is necessary to keep the wetland functioning properly. The water quality of the wetland discharge has consistently been better than the permit requires.

A 4.5-mile paved entry road leads from Highway 163 to the Visitor Center, and a paved parking lot is available for visitors and staff. The Refuge is crisscrossed by county roads, both paved and unpaved. About 30,000 linear feet of eight-foot-high, high-tensile woven wire fence surround the bison and elk enclosure, and two cattle grates have been installed, one at each end of the enclosure.

Conservation Easements

When the Farm Services Agency (FSA), formerly known as the Farmers Home Administration, acquires property through default on loans, it is required to protect wetland and floodplain resources on the property prior to public resale. The Service assists the FSA in identifying important floodplain and wetland resources on these properties. Once identified, the FSA assigns a perpetual conservation easement to the property and transfers management responsibility to the Service as part of the Refuge System.

Neal Smith NWR manages 21 FSA conservation easements located in 10 central Iowa counties and totaling approximately 700 acres. All easement properties are inspected, have management plans, and are posted with signs indicating the properties are under conservation easements. Widely dispersed easements have proven difficult to adequately manage with limited Refuge staff. Easements need regular inspection and management to prevent encroachment and resource degradation. The Refuge visits and inspects easements each year, notifying the owners of the upcoming visit as well as any violations that may be found afterwards.