

NEBRASKA

STATEWIDE FOREST RESOURCE ASSESSMENT & STRATEGY



NEBRASKA FOREST SERVICE

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EXECUTIVE SUMMARY

With more than 1.2 million acres of forestland and another 2.01 million acres of nonforestland with trees, Nebraska is rich in tree and forest resources. This document, the Nebraska Statewide Forest Resource Assessment & Strategy, represents the Nebraska Forest Service's first comprehensive geospatial assessment of the state's tree and forest resources. It provides unique insights and identifies strategic goals and opportunities for sustainably managing these resources.

This Assessment relies heavily on the input of our partners. To complete the Assessment, we bolstered our own forest resource data with publicly available data from a variety of sources, including the National Land Cover Dataset, U.S. Forest Service (USFS) Spatial Analysis Project, U.S. Census Bureau, Nebraska Game and Parks Commission, Nebraska Department of Roads and Nebraska Natural Resources Districts. We also received input from many partners. Combined, this information provided us with valuable insights about the nature, complexity and value of our forest resources and helped us identify priority forest areas across the state.

Using the information from the Assessment, we developed strategic goals based on national

objectives collaboratively crafted by both the National Association of State Foresters and the USFS State & Private Forestry Program. The strategic goals and actions identified in this document serve as a blueprint for focusing private, state and federal resources in areas of Nebraska where they will be most effective.

This is a living document. As new data becomes available it will be incorporated to provide an even clearer picture of Nebraska's tree and forest resources. Additionally, we invite readers and partners to help us make this document better by sharing their thoughts, ideas and perspectives.



CHAPTER 1: NEBRASKA STATEWIDE FOREST RESOURCE ASSESSMENT & STRATEGY—BACKGROUND

Nebraska boasts a diverse array of forest resources. From the ponderosa pine forests of the Panhandle’s Pine Ridge to the hardwood forests of the Missouri River bluffs, trees and forests play an important role in the lives of all Nebraskans and in the stability of ecological systems across the state and region.

Managed forests contribute millions of dollars every year to rural economies and produce a sustainable flow of economic and environmental benefits for all Nebraskans. Thousands of miles of agroforestry plantings, such as windbreaks and riparian buffers, increase crop yields, sequester carbon and protect precious water supplies. Woody biomass harvested from overly dense forestland provides carbon-neutral, clean-burning fuel for heating and cooling systems and industrial processes.

Urban and community trees clean our air, extend the life of roads, increase real estate values and save tax dollars by reducing the need for “hard” infrastructure. Trees save money on heating and cooling costs and preserve “The Good Life” in Nebraska by creating more beautiful, livable communities. In Nebraska, it is clear that trees can and do make a difference.

Yet energy security, climate change (fostering severe weather and drought), urbanization, invasive species, declining rural economies and catastrophic wildland fires either jeopardize our state’s trees and forests or provide opportunities for their rejuvenation. Whatever their impacts, these serious issues are complex, interrelated, defy single-remedy solutions and demand to be addressed now.

Fortunately, sustainably managing our tree and forest resources can play a huge role in addressing these issues. The Nebraska Forest Service (NFS) works closely with people, agencies and organizations across the state to tackle these issues head-on and carry out its mission of improving lives by protecting, preserving and enhancing Nebraska’s tree and forest resources. This Assessment will help NFS prioritize these efforts and define future directions for forestry programming statewide.

The 2008 Farm Bill, signed into law June 18, 2008, mandates that each state develop a comprehensive Statewide Forest Resource Assessment and Strategy to guide the long-term management of its forest resources. The Assessment provides an analysis of forest conditions and trends in the state, outlines

threats to our forest resources and identifies priority rural and urban forest landscape areas. The Strategy guides long-term investments of state, federal and other resources to manage priority forest landscapes (as identified in the Assessment) and focuses such investments where they can most effectively stimulate or leverage desired action and engage multiple partners.

NFS is required by state law (Section 85-161) to . . . “provide education and services to the people of Nebraska for the protection, utilization and enhancement of the state’s tree and forest resources. . . . The Nebraska Forest Service shall provide education and services covering all aspects of planting, protection, care and utilization of the state’s tree and forest resources and shall provide fire protection to all rural land in cooperation with the state’s rural fire districts...The Nebraska Forest Service shall work cooperatively with all federal, state and local entities to maximize services and funding.”

This document serves as a comprehensive guide for the improved and more focused management of Nebraska’s valuable forest resources. The strategies outlined in this document will focus on conserving Nebraska’s working forest landscapes, protecting Nebraska’s trees and forests from harm and enhancing public benefits from Nebraska’s trees and forests.

HISTORY & CULTURAL HERITAGE

Based on discoveries of stone tools and weapons, archeologists estimate humans arrived in Nebraska approximately 25,000 to 10,000 years ago. Before European settlers colonized the Midwest, Native Americans had inhabited the area for thousands of years. The Missouri, Omaha, Oto and Ponca tribes farmed and hunted along Nebraska rivers. Approximately 700 to 800 years ago, the Pawnee tribe established settlements along the Platte and Loup rivers where they farmed

corn (*Zea mays*), squash (*Cucurbita maxima*), beans and sunflowers (*Helianthus annuus*) and gathered wild turnips (*Sinapis arvensis*), grapes (*Vitis spp.*), plums (*Prunus americana*) and nuts. The Pawnee also hunted buffalo (*Bison bison*), elk (*Cervus canadensis*), pronghorn (*Antilocapra americana*), deer (*Odocoileus spp.*), rabbits, waterfowl and other game birds. Wandering tribes, such as the Arapaho and Cheyenne, lived in western and central Nebraska. By the late 1800s, Native American tribes had been decimated by introduced disease, as well as conflicts with settlers and the United States government, and were relocated to reservations. There are presently three reservations in Nebraska—the Santee Sioux, Omaha and Winnebago—all located in the northeastern part of the state.

During the 1500s and 1600s, France and Spain argued over which country had claim to the land in central North America known as “Louisiana.” In 1803, France sold the Louisiana Territory, which included present-day Nebraska, to the United States in the Louisiana Purchase.

Meriwether Lewis and William Clark were among the first Americans of European descent to visit Nebraska. From 1804 to 1806, their expedition traveled up the Missouri River and into the state’s eastern edge. The name “Nebraska” was taken from the Oto word “nebrathka” meaning “flat water.” The word “Nebraska” first appears in publications in 1842 when the “Nebraska River” is mentioned as the Oto name for the Platte River.

Beginning in the mid-19th century, wood- and coal-burning steamboats traveling the Missouri River brought people and much-needed supplies to Nebraska and territories beyond. These vessels played a vital role in the settlement and development of the western United States. They also used massive amounts of wood harvested from extensive riparian and adjacent bluff land forests that grew along the Missouri and navigable tributaries.

From 1847 through 1869, more than 400,000

people traveled across Nebraska on the Oregon and Mormon trails. These trails followed rivers and streams, in part because of the flat topography and because they provided the travelers with access to wood from riparian forests for fuel, building materials and to repair wagons.

Drawn by the promise of free land under the 1862 Homestead Act, many settlers traveled from the East Coast to claim a new life on the Plains. These early homesteaders fought drought, insects and countless other hardships to claim their 160 acres and, together, transform what was once described as a “Great Desert” into a prosperous state. Numerous “timber claims,” many of which still exist, were planted by these early settlers to secure their legal rights to their homesteaded lands. Settlers often planted trees grown from locally gathered seeds or seedlings to protect their homes and crops from the ever-present winds. Nebraska gained statehood on March 1, 1867, and the capitol was moved from Omaha to the city now known as Lincoln.

In the 1930s, both widespread drought and the Great Depression brought hardship to the state and initiated an outmigration from rural areas that continues to this day. The great drought of the 1930s stimulated the creation of national programs to plant windbreaks across the Plains to slow the wind and reduce soil erosion. Thousands of miles of windbreaks were planted during this period.

According to pollen records, much of Nebraska was covered by boreal white spruce (*Picea glauca*) during the Pleistocene period, approximately 10,000 years ago (Wright, 1970). Even today in the Sandhills, pieces of ancient wood are sometimes found buried deep under the sand. Remnant stands of paper birch (*Betula papyifera*) and quaking aspen (*Populus tremuloides*) remain today across portions of northern Nebraska, and additional evidence suggests that after the glacial period passed, the forests of the Rocky Mountains stretched

across Nebraska and may have connected with forests in the eastern United States (Bessey and Webber, 1889). Indeed, isolated stands of ponderosa pine (*Pinus ponderosa*) can be found in deep canyons in Custer, Loup and Garfield counties in west central Nebraska, even though these locations are more than 100 miles from the closest seed source (Schmidt and Wardle, 1986).

Nebraska’s history is steeped in trees and forests. Trees provided Native Americans with food, fuel and shelter, as well as protection for their animals. Early settlers often transported tree seedlings hundreds of miles to plant on treeless homesteads. They realized the value of trees on the harsh Plains for protection, wood products, conservation and beauty. They took great pains to plant and nurture the fragile seedlings.

Nebraska’s first recorded tree planting was by squatter G.B. Lore in 1853. Legal efforts soon followed to encourage the planting of trees.

The establishment of Arbor Day in 1872 was a reflection of both the official and popular fervor for tree planting in the state. Julius Sterling Morton, editor of the *Nebraska City News* and president of the state board of agriculture, introduced a resolution in 1872 establishing a tree planting day across the state to be known as Arbor Day. In 1885 the Nebraska Unicameral made Arbor Day a state holiday and set Morton’s birthday, April 22, as the official date. The idea was so popular that more than 1 million trees were planted throughout the state on the first Arbor Day. Today Arbor Day is celebrated in all 50 states, the District of Columbia and 33 countries.

Plantings increased under the Timber Culture Act of 1873, which offered free land to settlers if they planted trees as a part of their homestead (Schmidt and Wardle, 1986). Remnants of these homestead plantings remain today throughout Nebraska.

In 1902, the Charles E. Bessey Nursery was

established in north central Nebraska as part of the Dismal River Forest Reserve to provide tree seedlings for the “World’s Largest Man-Made Forest”: the USFS’s Bessey Ranger District near Halsey. Named for Charles E. Bessey, a horticulture professor at the University of Nebraska whose vision of a forest growing in the Nebraska Sandhills prompted its creation, the nursery is the oldest tree nursery within the USFS. Since 1926 the nursery has produced hundreds of millions of seedlings for conservation plantings in Nebraska, Kansas and South Dakota. The nursery and unique adjacent hand-planted forest are managed by the USFS.

the University of Nebraska’s athletic team.

Organized tree distribution began in Nebraska as far back as 1904, when Congressman Moses P. Kincaid introduced a bill (Kincaid Act) that authorized free distribution of trees west of the 100th meridian. The plan included the western half of Nebraska, generally west of present-day Cozad. Records show that almost 2 million trees were distributed from Bessey Nursery between 1912 and 1924.

The Clarke-McNary Act in 1924 authorized the Secretary of Agriculture to cooperate with states to procure, produce and distribute tree seeds and plants to establish windbreaks, shelterbelts and farm woodlots. In 1926, when the first plantings were made in Nebraska, 33,900 trees were distributed to 96 cooperators in 44 counties. In total, more than 100 million Clarke-McNary tree and shrub seedlings were planted for conservation purposes in Nebraska.

Nebraska’s state tree is the eastern cottonwood (*Populus deltoides*). This historically significant species served as a reference point for both Native Americans and settlers traveling to and through the area. It is the primary tree species harvested in the state.

In 1895, the Nebraska legislature declared Nebraska the “Tree Planter’s State” because Arbor Day originated here. In 1945 the state legislature changed the official state name to the “Cornhusker State,” after the nickname for



CHAPTER 2: METHODOLOGY

GEOSPATIAL ANALYSIS

To assess the forest-related conditions, trends, threats and opportunities within Nebraska, NFS identified priority forest areas within the state by using a GIS platform to combine maps representing nine of the 10 assessment objectives. The objectives used in this assessment, originally identified as part of the USFS's State & Private Forestry Redesign efforts, were deemed appropriate for Nebraska's conditions and are discussed in greater detail later in this document.

Multiple geospatial data layers were selected from the USFS's Spatial Analysis Project (SAP) and other sources to represent each objective (Table 1). All layers were equally weighted and used to create a composite map for each objective. These maps are discussed in Chapter 5. The nine composite maps were then analyzed using the 'Weighted Sum' geoprocessing tool provided by Environmental Systems Research Institute. Each composite map was sampled at 30-meter resolution to meet the federal guidelines set forth by the 2008 Farm Bill. Each composite map was then clipped to the state of Nebraska to maintain a constant geographic boundary.

After the composite maps were completed, NFS employees were given the opportunity to weight each objective (Table 2). The weighting was based on a percentage scale with a total of 100% for the nine objectives. Each objective's weight was calculated using the staff's rankings for each objective. A mean ranking for each objective was then calculated using staff rankings. Next the additive inverse was calculated, which gave the highest weight to the most important objective indicated by the staff. The sum of each objective was then added to determine each object's percentage contribution to the final composite map.

The final composite map (found on page 70) uses a presence/absence method to show the results of the nine weighted objective maps that were analyzed. Each 30-meter cell received a value representing the presence of each objective based on each respective inverse weighted sum. A cell that contains all of the objective features received a total of 1, identifying it as the highest importance, whereas a cell containing no features from each objective received a value of zero, representing the lowest importance.

Table 1. Objectives & Associated Data Layers

Theme	Objective	Data Layers
Conserve working forest landscapes	Actively and sustainably manage forests	riparian areas (SAP)
		agroforestry (SAP)
		private forestland (SAP)
		forest cover
		community forests
		land in forest stewardship plans
Protect forests from harm	Restore fire-adapted lands and reduce risk of wildfire impacts	wildfire risk (SAP)
		wildland-urban interface
	Identify, manage and reduce threats to forest and ecosystem health	potential forest health risk
Enhance public benefits from trees and forests	Protect and enhance water quality and quantity	priority watersheds (SAP)
		water quantity and quality by source (SAP)
		bodies of water
	Improve air quality and conserve energy	impervious surfaces
		change in housing density (SAP)
		canopy cover
	Assist communities in planning for and reducing wildfire risks	wildland-urban interface
		community wildfire protection plans
		wildfire risk (SAP)
	Maintain and enhance economic benefits and value of trees and forests	Data used in conjunction with this objective was not suited for geospatial analysis.
	Protect, conserve and enhance fish and wildlife habitat	threatened and endangered species habitat
		public lands
		Forest Legacy areas
		state wildlife action plan data
	Connect people to trees and forests and engage them in environmental stewardship activities	census data (population concentration)
recreation and trail networks		
hunting and fishing areas		
Manage and restore trees and forests to mitigate and adapt to global climate change	potentially affected forests	

Table 2. Objective Weights

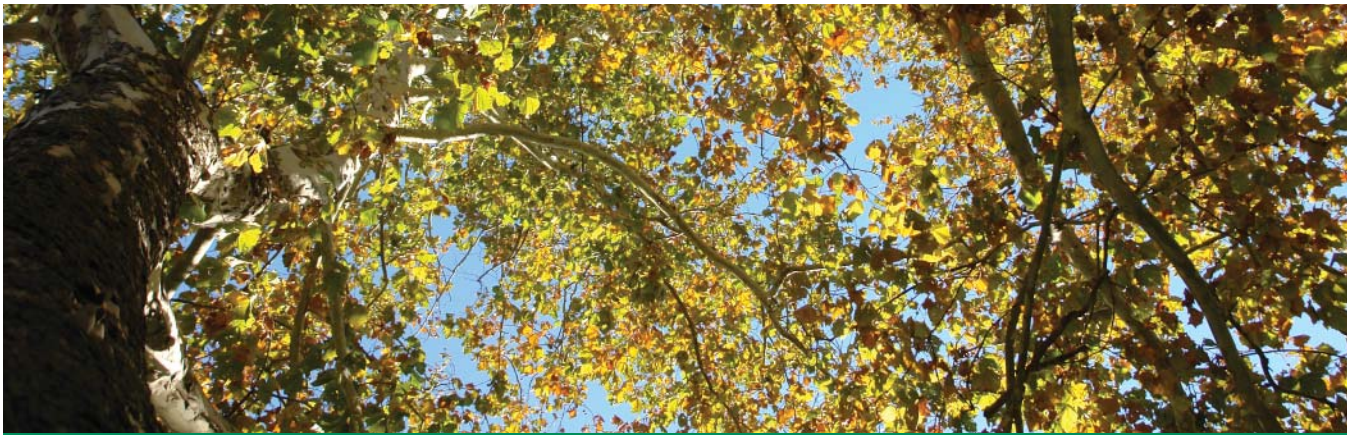
Objective	Weight
Actively and sustainably manage forests	0.1787
Restore fire-adapted lands and reduce risk of wildfire impacts	0.1185
Identify, manage and reduce threats to forest and ecosystem health	0.0013
Protect and enhance water quality and quantity	0.1310
Improve air quality and conserve energy	0.0784
Assist communities in planning for and reducing wildfire risks	0.1008
Maintain and enhance economic benefits and values of trees and forests	
Protect, conserve and enhance fish and wildlife habitat	0.0677
Connect people to trees and forests and engage them in environmental stewardship activities	0.1281
Manage and restore trees and forests to mitigate and adapt to global climate change	0.0668
TOTAL	1.00

PUBLIC REVIEW PROCESS

A draft of the Assessment and Strategy was made available for public review on the NFS website. Key stakeholder groups contacted for input were: Calamus Outfitters, Ducks Unlimited, Educational Service Units, Farmers Union, Fontenelle Forest, National Park Service, Natural Resources Conservation Service, Natural Resources Districts, Nebraska Alliance for Conservation and Environment Education, Nebraska Association of Resources Districts, Nebraska Audubon, Nebraska Cattlemen, Nebraska Corn Growers, Nebraska Department of Agriculture, Nebraska Department of Economic Development, Nebraska Department of Education, Nebraska Department of Energy, Nebraska Department of Natural Resources, Nebraska Environmental Trust, Nebraska Farm Bureau, Nebraska Forest Stewardship Coordinating Committee, Nebraska Game and Parks Commission, Nebraska Partnership for All-Bird Conservation, Nebraska State Museum, Nebraska State Technical Committee, Nebraska State Volunteer Firefighters Association, Nebraska Weed Management Association, Nebraska Wildlife Federation, Pheasants Forever, Inc., Ponca Tribe of Nebraska, Rainwater Basin Joint Venture of Nebraska, Sandhills Task Force, Santee Tribe, The Conservation Alliance of the Great Plains, The

Nature Conservancy, University of Nebraska, U.S. Department of Agriculture Animal & Plant Health Inspection Service-Plant Protection and Quarantine, U.S. Fish and Wildlife Service, USFS and Western Nebraska Resources Council.

A series of public meetings, held at six locations across Nebraska, provided stakeholders and the public with an additional forum for providing feedback.



CHAPTER 3: BENEFITS GENERATED BY NEBRASKA'S TREE & FOREST RESOURCES

Nebraska's trees and forests provide valuable benefits to citizens. Some of these benefits are tangible, such as reduced energy costs and income generation from traditional and specialty forest products. Other benefits, especially from community forests, such as reduced crime and increased worker productivity, are less tangible but, nevertheless, contribute in important ways to the high quality of life in Nebraska.

ENERGY EFFICIENCY & INFRASTRUCTURE SAVINGS

In landscape settings, strategically placed shade trees can reduce cooling costs 25-30%. Research in Sacramento, Calif., showed that three shade trees strategically planted around homes reduced air conditioning costs by 30% (Sacramento Tree Foundation, 2008). A 2001 study by American Forests found that the tree cover in metro Atlanta saved residents approximately \$2.8 million in energy costs (American Forests, 2008). A similar study from 1999 showed that trees in a 3.2-million-acre area around Houston provided \$26 million in annual benefits (American Forests, 2008). Additional research by the U.S. Department of Energy determined that strategic tree plantings

could reduce nationwide air conditioning use by at least 10% (Harden, 2006). The city of Los Angeles expects to achieve a \$2.80 return in energy savings, pollution reduction, stormwater management and increased property values for every \$1 it spends on trees (Harden, 2006).

Community trees also reduce the need for hard infrastructure by extending the life of roadways and reducing the need for stormwater treatment systems. Research in Modesto, Calif., revealed that the cost of maintaining a segment of unshaded street for 30 years was \$4,971, while the cost of maintaining a street segment with large-growing trees for the same time period was just \$2,071 (Center for Urban Forest Research). In Minneapolis, street trees provide an annual savings of \$9.1 million in stormwater treatment costs, while saving \$6.8 million in energy costs and increasing property values by \$7.1 million (McPherson, 2005). Metropolitan Washington, D.C.'s tree canopy reduces the need for 949 million feet of stormwater retention structures, a savings valued at \$4.7 billion (American Forests, 2008).

ENVIRONMENTAL BENEFITS & ECOSYSTEM SERVICES

Trees provide environmental benefits that improve the quality of life for people, plants and animals, whether they're planted in a city or a rural setting. These benefits can sometimes be quantified as ecosystem services.

“Ecosystem services” is a broad term that describes the benefits people obtain from ecosystems, such as food, water, wood and medicine. Ecosystem services also include benefits that are vital but harder to measure, such as carbon sequestration and storage, erosion control, pollination, nutrient cycling, soil formation, wildlife habitat and cultural services, such as recreation, ecotourism and educational and spiritual opportunities.

Water quality, air quality and carbon sequestration are three of the most commonly measured ecosystem services.

Water Quality

Trees and forests have a direct impact on water quality. In fact, Nebraska's 1.24 million acres of forestland (Meneguzzo, et al., 2008) and nonforestland with trees influence water quality and quantity on the surface and underground. In riparian areas, trees protect water quality by stabilizing streambanks and reducing sedimentation, the major cause of nonpoint water pollution in the United States (Welsch, 1991). As part of traditional agricultural systems, trees in riparian areas also filter agricultural runoff, preventing pollutants from entering rivers and streams. Municipalities substantially reduce water treatment costs when water supplies are buffered by trees.

Nebraska has more miles of rivers and streams than any other state in the United States. With most of these riparian corridors lined with forests, these areas substantially contribute to improved water quality.

Air Quality

Air pollution is a serious concern in many

metropolitan areas across the United States. Because trees remove pollutants from the atmosphere, including nitrogen dioxide (NO₂), sulfur dioxide (SO₂), ozone (O₃) and carbon monoxide (CO), they are an efficient, cost-effective means of improving air quality.

In Washington, D.C., trees remove 878,000 tons of pollutants annually at a value of \$2.1 million (American Forests, 2008). In much larger Atlanta, trees remove a staggering 19 million tons of pollutants annually at a value of \$47 million (American Forests, 2008).

Carbon Sequestration

Carbon markets have existed abroad for decades but are currently limited to voluntary markets in the United States. However, if legislation aimed at combating climate change is passed by Congress, domestic markets will expand.

Nebraska's forests provide emerging economic opportunities in the form of carbon credits, a commodity equated to one ton of carbon (C₂) that may be purchased by those wishing to reduce their carbon footprint. Nebraska's 1.24 million acres of forestland currently sequesters approximately 82.2 million metric tons (90.6 million tons) of carbon (Meneguzzo, et al., 2008). The soil and live trees (both above- and below-ground components) sequester 84% of this carbon, while the remaining 16% is sequestered in standing dead trees, the forest understory, downed dead trees and the forest floor (Meneguzzo, et al., 2008). Nebraska's community forests store 1.5 million tons of carbon at a value of \$31.9 million (Nowak and Greenfield, 2010).

SOIL & WATER CONSERVATION

Trees and shrubs are often intentionally planted in rural and agricultural areas to generate specific benefits. Nebraska has 423,098 acres of field and farmstead windbreaks and planted riparian forests providing enormous

environmental and economic benefits (NFS, 2010). Such agroforestry plantings reduce wind- and water-induced soil erosion, enhance water and air quality, create wildlife corridors across the landscape and help link rural areas to urban and suburban areas, protecting water quality from “forest to faucet.” These plantings also annually generate hundreds of millions of dollars of economic benefits by fostering higher crop yields, better survival, improved vigor during spring calving, reduced energy consumption on farms and acreages and the production of economically valuable products.

FOREST PRODUCTS

Nebraska’s forests are an untapped resource that can drive economic development if

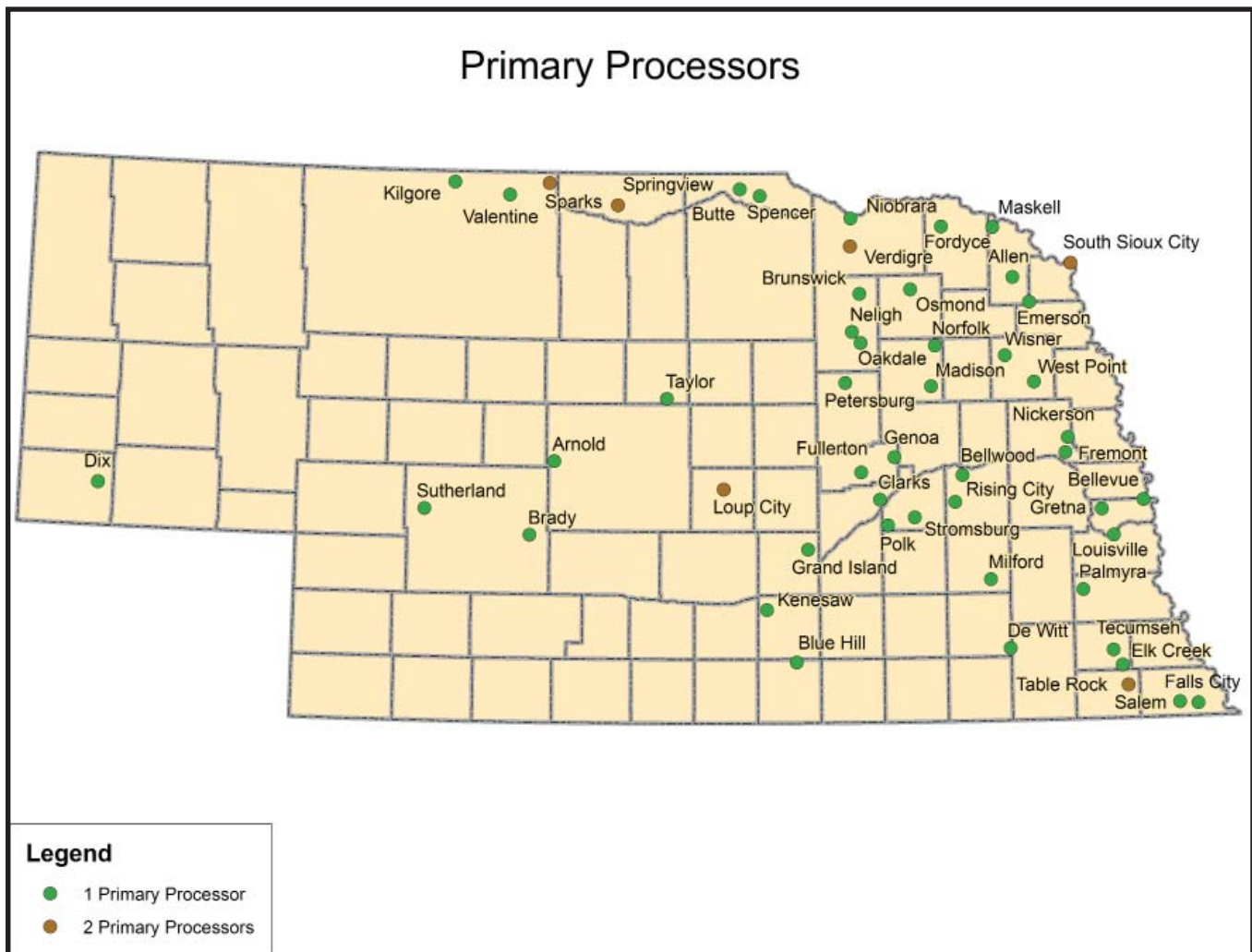
managed and utilized efficiently. From traditional forest products (e.g., timber) to emerging products such as nuts, medicinals and woody biomass, Nebraska’s forests offer opportunities to diversify farm and non-farm income, as well as revitalize struggling rural communities.

Traditional Wood Products

Nebraska’s forest resources contribute significantly to the state’s economy through the harvest and utilization of commodities, non-market environmental services, employment opportunities and wealth creation. Nebraska’s wood products manufacturing industry employs more than 2,200 workers with an output of \$286 million (U.S. Census Bureau, 2002).

The USDA Forest Service, Northern Research

Figure 1. Primary Processors



Source: Nebraska Timber Industry—An Assessment of Timber Product Output and Use, 2006

Station Resource bulletin NRS-28, “Nebraska Timber Industry—An Assessment of Timber Product Output and Use, 2006,” (Piva & Adams, 2008) summarizes the 2006 survey of all Nebraska sawmills and other primary wood products manufacturers.

The survey found:

- Nebraska’s primary wood-using industry includes 54 mills (49 sawmills and 5 mills producing other products) (Table 3).
- Nebraska’s primary wood-using mills (Figure 1) processed 5.1 million cubic feet of industrial roundwood in 2006, an 8% increase from 2000. However, industrial roundwood production decreased by almost 3%, from 6.3 million cubic feet in 2000 to 6.1 million cubic feet, mainly because South Dakota and Missouri imported less industrial roundwood from Nebraska (Figure 2).
- More than 90% of the industrial roundwood processed by Nebraska mills was cut from Nebraska forests. Cottonwoods account for almost 80% of the total volume processed.
- 59% of the industrial roundwood harvested was cottonwood. Ponderosa pine (23%) and eastern redcedar (*Juniperus virginiana*)(13%) were the other major species harvested (Figure 3).
- Nebraska sawmills processed 22.9 million board feet of saw logs in 2006, a decrease of 20% from 2000.
- Cottonwood and ponderosa pine account for 93% of Nebraska’s harvest.
- 74% of the 8.3 million cubic feet cut

Table 3. Lumber Production in Nebraska

Kind of Mill & Mill Size	1980	1993	2000	2006
Sawmills¹				
< 50 - 999 mbf*	35	13	11	11
1,000 - 4,999 mbf	7	10	5	3
> 5,000 mbf	-	2	2	2
TOTAL	42	32	32	49
Number of Other Wood Product Manufacturers ²				
	4	3	2	5
ALL PRODUCERS	46	35	34	54

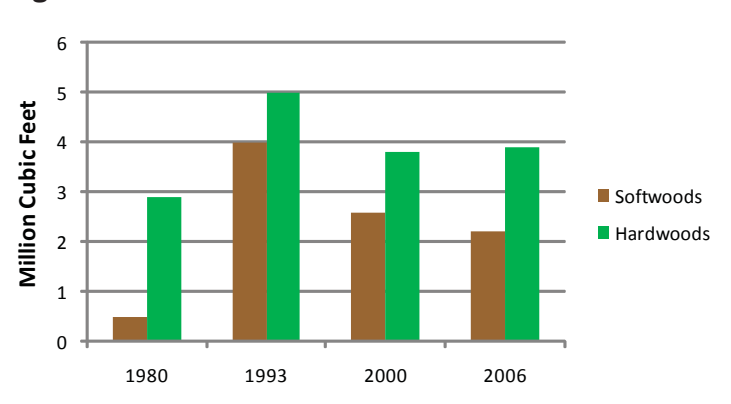
*mbf = thousand board feet. A board foot is a 1 ft. by 1 ft. by 1 in. piece of wood.

¹ Annual lumber production in thousand board feet, International 1/4 inch rule.

² Includes plants producing veneer, shavings, cabin logs, posts, etc.

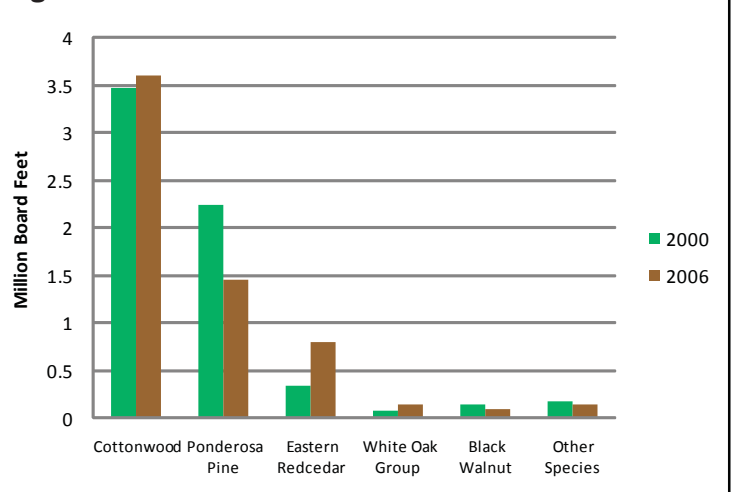
Source: Nebraska Timber Industry—An Assessment of Timber Product Output and Use, 2006

Figure 2. Industrial Roundwood Production



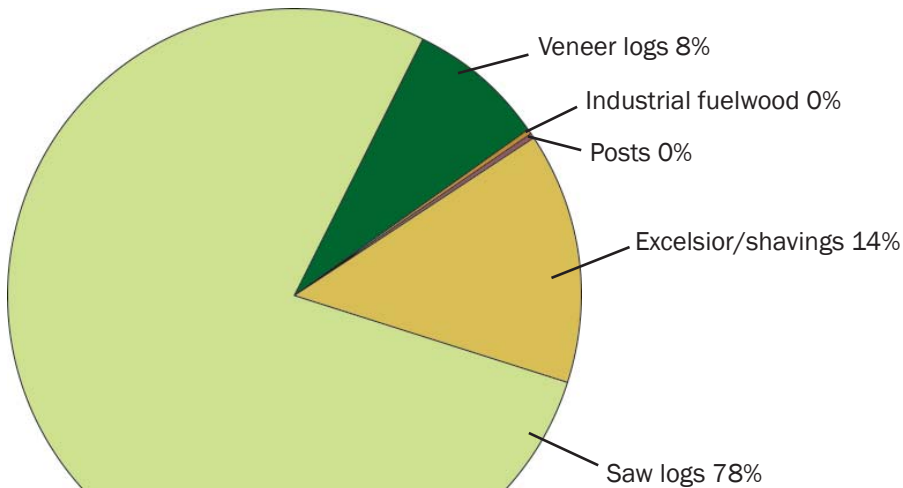
Source: Nebraska Timber Industry—An Assessment of Timber Product Output and Use, 2006

Figure 3. Industrial Roundwood Production



Source: Nebraska Timber Industry—An Assessment of Timber Product Output and Use, 2006

Figure 4. Industrial Roundwood by Product



Source: Nebraska's Forests 2005

during the harvest of industrial roundwood was used for primary wood products. The remainder (2.2 million cubic feet) was left on the ground as harvest residues (Figure 4).

- The 8.3 million cubic feet of total wood material removed during harvesting was less than 0.5% of the total live volume of trees in forestland.
- Nebraska's primary wood-using industries generated 72,000 green tons of wood residues (slabs, sawdust, bark, etc.); 89% of which were utilized for fuel, mulch, bedding, etc. The remaining 11% went unused.

Specialty Forest Products

Specialty forest products include a variety of forest-based products, such as medicinals, botanicals, food products, decorative florals, crafts, Christmas trees and specialty woods. While most specialty forest product markets are niche in nature, they can be incorporated into traditional agricultural and agroforestry systems. This allows producers to diversify income sources by growing a wider variety of crops.

In Nebraska, producers are finding success

with a number of woody floral cultivars as well as with commercial nut production. Nebraska also has a cottage industry of talented artisans who create novelty wood items and handcrafted wood furniture.

Woody Biomass

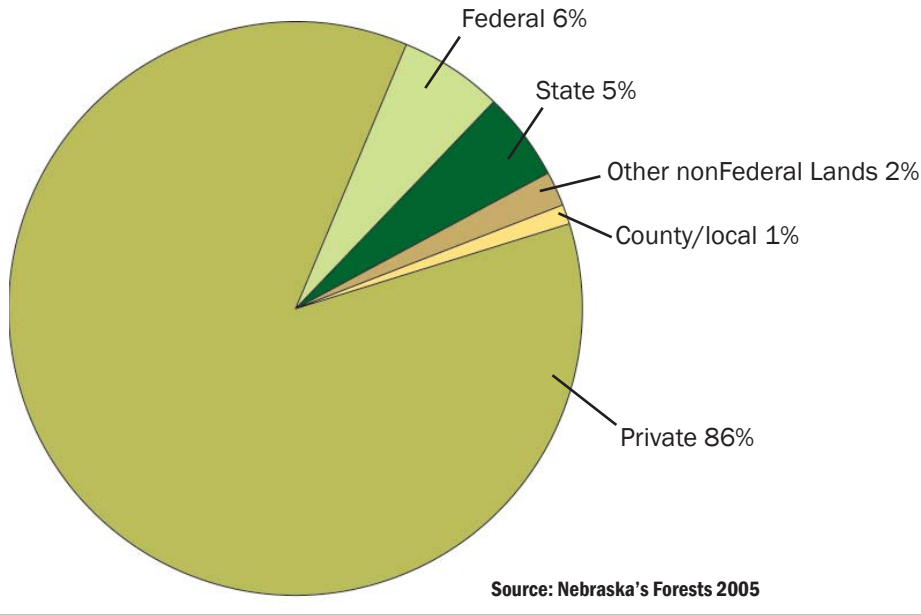
Woody biomass is a proven, reliable energy source for both heating and cooling, as well as industrial applications, electricity generation and ethanol production. Woody biomass is a near-carbon-neutral

energy source that can be used to co-fire coal-burning power plants, reduce air pollution and offset carbon emissions. For industrial applications, woody biomass can replace natural gas, increasing profitability and reducing net carbon emissions.

As an industry, woody biomass creates jobs and new sources of income. In 1991, Chadron State College installed a woody biomass heating system on its campus. With the addition of a wood-fired chiller in 2005, the college now uses 9,000 tons of woody biomass each year to heat and cool more than 1 million square feet of building space. This system has created at least six full-time, year-round jobs and generates more than \$1 million yearly in economic impacts to the area.

Other users of woody biomass include the Arbor Day Foundation's Lied Lodge in Nebraska City, which burns 3,500 tons yearly; a number of alfalfa dehydration plants that burn a total of 12,500 tons annually; and several forest product processing mills that consume 64,000 tons a year. The Nebraska College of Technical Agriculture in Curtis is in the process of converting to woody biomass thermal energy, and several other facilities are considering

Figure 5. Ownership of Live Biomass



cubic feet (Meneguzzo, et al., 2008). There is an estimated 36.7 million cubic feet (590,000 net air-dry tons) of woody biomass growing on 2.01 million acres of nonforestland with trees across the state (NFS, 2010). As these trees die or are trimmed and pruned, there is a tremendous volume of material left to decompose or be burned in waste piles. Eighty-six percent of live woody biomass in Nebraska grows on privately owned land (Figure 5). Table 4 shows the distribution of woody

switching to woody biomass as a primary thermal energy source.

Nebraska's forests produce 92 million cubic feet of net growth each year (Meneguzzo, et al., 2008; NFS, 2010). This is the equivalent of 1.47 million net air-dry tons of biomass per year. The total live-tree biomass on Nebraska's forestland is approximately 55.5 million

biomass by species.

Woody biomass utilization offers opportunities to produce renewable energy, develop bio-based businesses, generate energy cost savings and create new markets for Nebraska's low-value and waste wood resources. A recent study, the Nebraska Wood Waste Supply and Utilization



Table 4. Estimated Volume of Woody Biomass by Species on Nebraska's Nonforestland*

	Community & Rural Land (cubic feet)	Rural Land (cubic feet)	Community Land (cubic feet)
All Species	1,197,851,451	1,029,114,765	168,736,686
Redcedar/juniper spp.	104,679,072	99,922,733	4,756,338
Spruce spp.	6,826,779	134,636	6,692,143
Pine spp.	1,149,376	2,832	1,146,544
Ponderosa pine	16,355,515	15,676,071	679,444
Scotch pine	13,484,649	8,662,964	4,821,685
Unknown conifer	899,170	-	899,170
Maple spp.	2,490,979	37,874	2,453,105
Boxelder	19,681,365	18,815,638	865,727
Silver maple	36,515,083	14,144,474	22,370,608
Birch spp.	691,002	-	691,002
Hackberry spp.	78,128,686	55,767,826	22,360,859
Ash spp.	134,401,630	122,485,896	11,915,734
Honey locust spp.	30,976,600	24,681,327	6,295,273
Walnut spp.	3,649,265	1,124,073	2,525,193
Osage-orange	16,453,870	16,052,126	401,743
Apple spp.	2,735,117	252,735	2,482,382
Mulberry spp.	44,514,022	37,340,146	7,173,876
Cottonwood, poplar spp.	348,073,545	331,651,606	16,421,939
Cherry and plum spp.	15,308,859	14,615,034	693,825
White oak	39,428,806	26,116,997	13,311,809
Northern red oak	4,266,768	183,663	4,083,105
Willow spp.	56,101,791	55,166,341	935,451
Basswood spp.	6,646,095	727,083	5,919,012
Elm spp.	53,406,451	45,634,354	7,772,097
Siberian elm	136,747,213	120,601,811	16,145,402
Russian olive	8,631,554	8,551,995	79,559
Unknown hardwood	15,608,188	10,764,529	4,843,659

* Nonforestland is defined as less than 1 acre in size, less than 120 feet wide and less than 10% stocked.

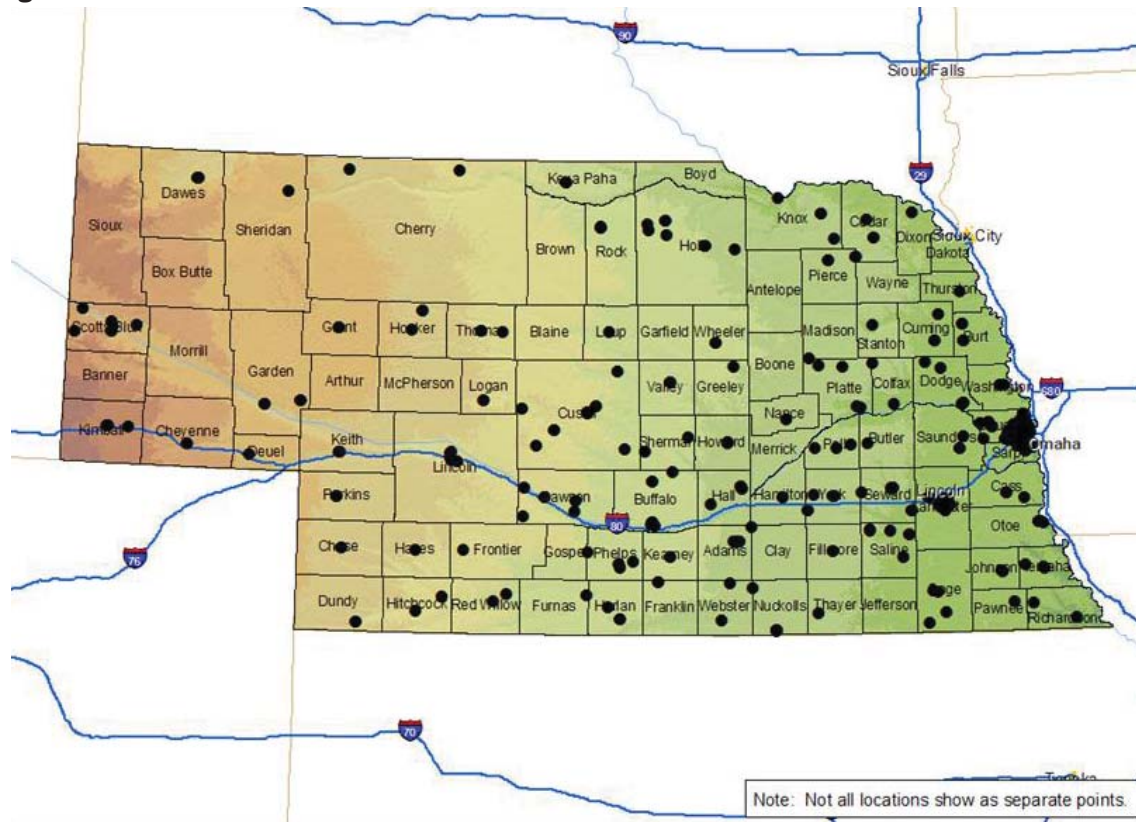
Source: Great Plains Initiative Inventory, 2008-2009

Assessment (Camas Creek Enterprises, 2008), was conducted at the request of NFS to determine the amount of wood waste currently produced and utilized in Nebraska and identify future woody biomass opportunities. For the study, 766 wood waste supply locations were surveyed to obtain data concerning wood waste produced and utilized from timber harvests,

forest improvement projects, manufacturing residues and community waste. The wood-waste utilization analysis focused on 422 non-wood-fired boilers that are 40 years and older and located at public institutions (Figure 6). Findings of the study included:

- There currently are 172,395 green tons of

Figure 6. Locations of Selected Public Institution Boilers 40+ Years Old



Source: Nebraska Wood Waste Supply and Utilization Assessment, 2008

Small-diameter branches left over from fuels treatment projects can be chipped and burned in woody biomass boilers. Photo: NFS.



processed wood waste generated annually in Nebraska (Table 5).

- If all wood waste associated with unprocessed forest biomass (e.g., timber harvests, forest improvement projects and range improvement activities) were utilized, another 270,523 tons could potentially be available (Table 6).
- There currently are eight commercial-scale wood-fired boilers in Nebraska.
- The wood waste generated from wood products manufacturers represents an important bioenergy feedstock source. A significant amount of this processed wood waste is currently used for landscape mulch or is discarded.
- Community wood waste is an important potential bioenergy feedstock source.
- The greatest concentration of wood waste supply exists in the same general

geographic areas where boiler conversion potential is the highest (Figure 7).

From 2005 through 2009 fuels treatment activities conducted on 442 acres of forestland in Nebraska’s Pine Ridge yielded considerable benefits for the area in the form of:

- 5,667 tons of woody biomass;
- \$231,000 in energy savings for Chadron State College, which used the biomass generated through the projects; and
- 418 man-days of employment (NFS, 2009).

Table 5. Green Tons of Processed Wood Waste Generated Annually

Source	Green Tons	% of Total
Commercial Logging and Fuels Management Contractors	11,500	6.7
Range Improvement Contractors	400	0.2
Primary Wood Products	71,972	41.7
Secondary Wood Waste	11,385	6.6
Municipal Waste Disposal Facilities	22,854	13.3
Tree Care Service	32,236	18.7
City Governments	12,542	7.3
Utility Companies	9,506	5.5
TOTAL	172,395	100

Source: NFS Wood Waste Supply & Utilization Assessment, 2008

Table 6. Processed & Unprocessed Wood Waste Supply by Major Category

Major Category	Green Tons	% of Total
Forest Biomass	110,028	40.7
Residual Byproducts	83,357	30.8
Community Wood Waste	77,138	28.5
TOTAL	270,523	100

Source: NFS Wood Waste Supply & Utilization Assessment, 2008

Figure 7. Wood Waste Supply Amounts/Boiler Conversion Potential

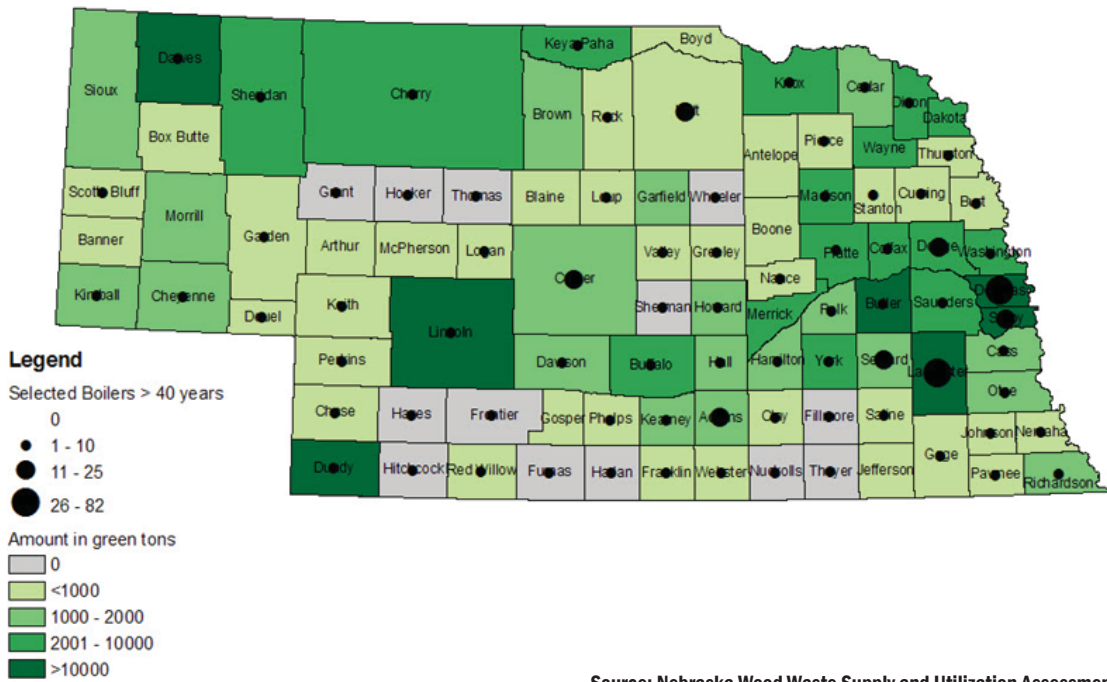


Figure 8. County-Level Wood Waste Supply Diversity

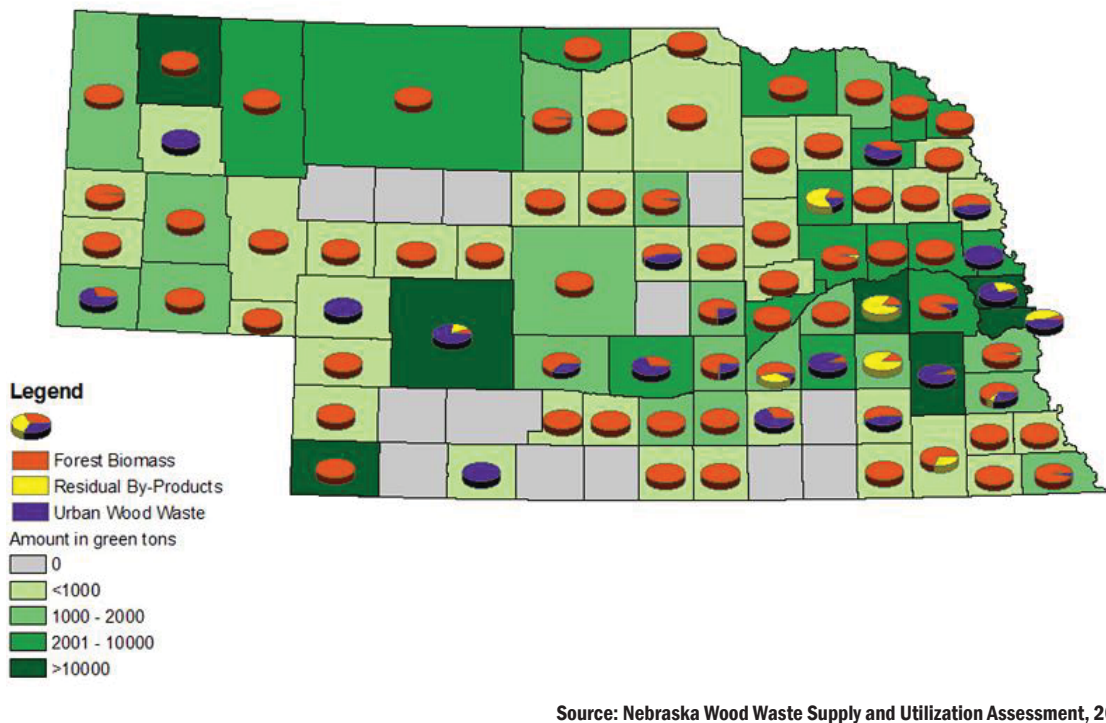
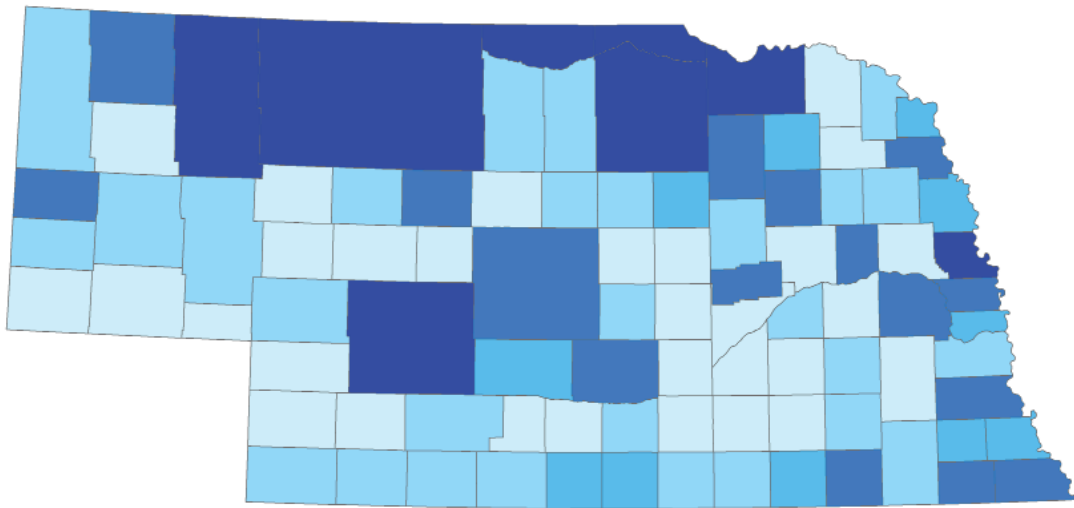
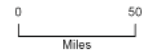
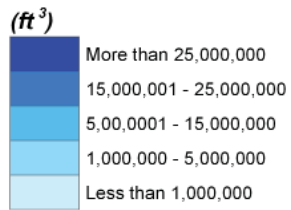


Figure 9. No-grade Live Volume on Forestland



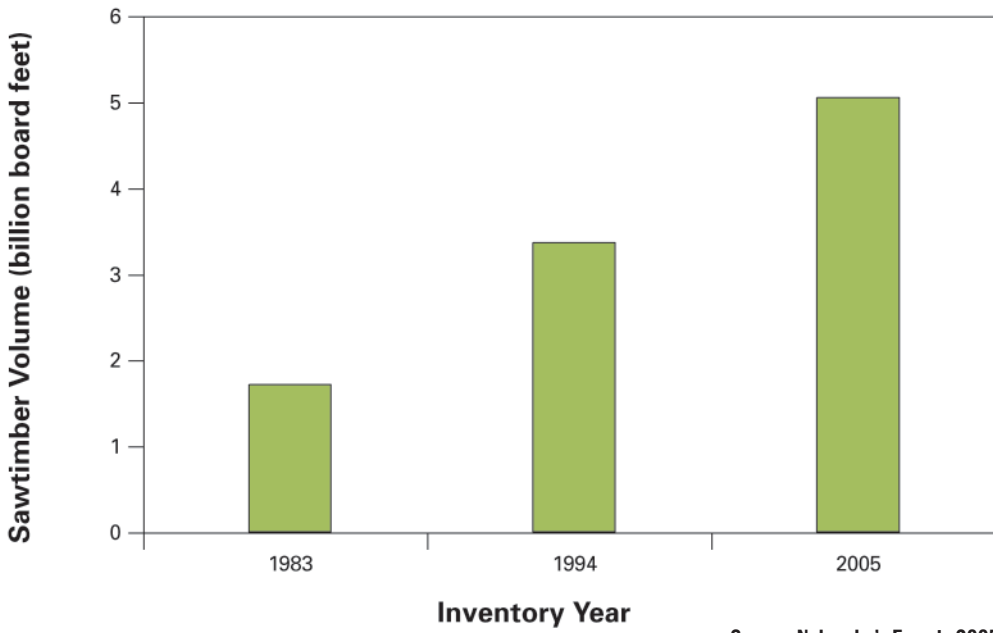
No-grade Live Volume on Forest Land



Projection: UTM Zone 14 N, NAD83.
Sources: U.S. Forest Service, Forest Inventory and Analysis Program, 2005 data. Geographic base data are provided by the National Atlas of the USA. FIA data and mapping tools are available online at <http://www.fia.fs.fed.us/tools-data>.
Cartography: D. Meneguzzo, August 2007.

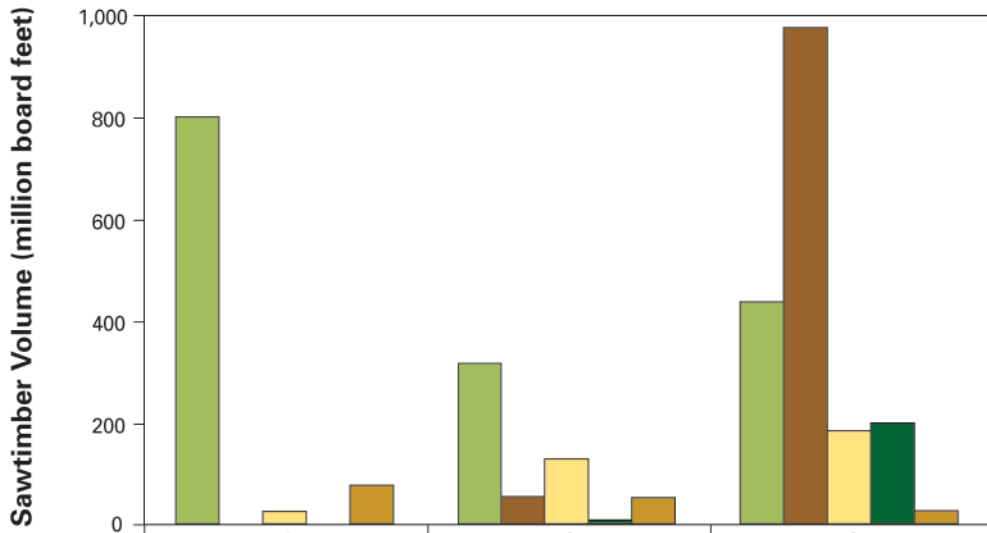
Source: Nebraska's Forests 2005

Figure 10. Sawtimber volume (billion board feet)



Source: Nebraska's Forests 2005

Figure 11. Sawtimber volume by major species (million board feet)



■ Cottonwood	798,245,000	314,511,000	436,105,000
■ Ponderosa pine	0	53,008,000	974,147,000
■ Bur oak	24,203,000	126,635,000	182,189,000
■ Eastern redcedar	0	7,419,000	197,291,000
■ American basswood	76,457,000	51,895,000	26,508,000

Tree Grade

Source: Nebraska's Forests 2005

SOCIAL BENEFITS

Community forest resources and their natural environments turn out to be particularly rich in the characteristics necessary for restorative and relaxing experiences (Kaplan, 1995). Just as the sound of running water or leaves blowing in the wind relaxes the mind and spirit, so does the view and experience of the community forest. These less tangible benefits of the community forest resource have been demonstrated and measured over the past several decades. Whether it's inspiration from

their beauty, a spiritual connection or a sense of meaning, people derive a sense of pleasure from trees (Lewis, 1996).

Researchers have demonstrated that exposure to green surroundings reduces mental fatigue and irritability associated with stress. The ability to concentrate is refreshed by views of the community forest, along with the ability and willingness to deal constructively with problems often associated with living in highly constructed environments. In a study conducted in a Chicago public housing development,

women who lived in apartment buildings with trees and greenery immediately outside reported committing fewer aggressive and violent acts against their partners in the preceding year compared to those living in barren but otherwise identical buildings. In addition, the women in greener surroundings reported using a smaller range of aggressive tactics against their partner during their lifetime (Kuo & Sullivan, 2001).

Trees add and define a neighborhood's sense of place. After natural disasters, people frequently express a sense of loss at the damage of their community's tree resources (Hull, 1992). When residential and public landscapes are constructed with greenery in mind, they become more attractive



Trees play an important role in creating a "sense of place" within communities, making them healthier and more liveable. Photo: NFS

and more comfortable, ultimately drawing people to them. Such settings create an environment that supports frequent and friendly interactions among individuals, establishing social ties and encouraging neighbors to help and protect each other. Healthy and diverse community forest landscapes help build stronger neighborhoods and, ultimately, communities. In a study conducted in a Chicago public housing development, residents of buildings with more trees and grass reported that they knew their neighbors better, socialized

with them more often, had stronger feelings of community and felt safer and better adjusted than did individuals of more barren but otherwise identical buildings (Kuo, Sullivan, Coley & Brunson, 1998).

There are many other social benefits of trees and community forests:

- People feel more comfortable and at ease in shaded, open areas of trees compared to areas of hardscapes and non-living things.



- People's preferences for locating areas of social interactions in calming, beautiful and nature-dominated areas revolve around the presence of community trees and forests.

- Trees and people are psychologically linked by culture, socialization, and co-adaptive history (Coder, 1996).

- Trees and views of greenery are linked to less domestic violence in the inner city and metropolitan areas.

HUMAN HEALTH BENEFITS

Trees play an important role in improving human health. Workers with views of nature report being more satisfied with their jobs and better overall health than co-workers who don't have views of nature (Kaplan & Kaplan, 1989). In hospital settings, natural

views from windows can shorten hospital stays and reduce the amount of medication required by patients (Ulrich, 1984).

There is considerable evidence that the restorative effects of nature scenes are measurable within just three to five minutes as a combination of psychological/emotional and physiological changes (Ulrich, 2002). Further laboratory and clinical investigations found that viewing nature settings can decrease blood pressure, heart activity, muscle tension and brain electrical activity (Ulrich, et al, 1991). Scientific studies have demonstrated increased feelings of pleasantness, calm and reduced negative emotions such as fear, anger or sadness when individuals experience or view trees or garden-like features. Natural scenes, such as those associated with the community forest landscape, can effectively sustain interest and attention and serve as a pleasant distraction that can diminish stressful thoughts.

Researchers also have made a connection between vegetation and increased concentration among children with Attention Deficit Hyperactivity Disorder (ADHD), as well as increased levels of self-esteem among pre-teen girls (Faber, Taylor, Kuo & Sullivan, 2001). Ultimately, such research findings demonstrate that adding trees and creating green landscapes where children spend a lot of time, such as near homes and schools, and encouraging kids with ADHD to experience natural landscapes may help supplement established treatments to improve children's functioning and overall health.

TOURISM & OUTDOOR RECREATION

Tourism and outdoor recreation in Nebraska are strongly associated with the state's forest resources. Across the state, trees create a mosaic that is visually attractive and offers many opportunities for outdoor enthusiasts. Some popular game species, such as wood duck (*Aix sponsa*), white-tailed deer (*Odocoileus virginianus*) and wild turkeys, are forest-



dependent. Additionally, many of the lakes and rivers that provide fishing and boating opportunities depend on forests for their water quality. In these areas, trees regulate water temperature and provide both habitat and food to wildlife and aquatic species. In 2006, fishing-related expenditures in Nebraska totaled \$181 million, and hunting-related expenditures totaled \$231 million (U.S. Department of Interior, et al, 2006). Wildlife watching, particularly birdwatching, is also popular in Nebraska. In 2006 wildlife watchers in Nebraska spent \$142 million on related activities (U.S. Department of Interior, et al, 2006).

There are multiple scenic byways stretching through portions of forested land. Nebraska's Highway 2 is considered one of the most scenic roads in the country. From Grand Island to the byway's western edge of Alliance, Highway 2 winds through remote and beautiful countryside. The area extending west from Grand Island to Kearney is also excellent for birdwatching, particularly sandhill cranes (*Grus canadensis*).

The Missouri River offers travelers a number of scenic drives, as well as abundant recreational opportunities, ranging from fishing to boating to hiking to birdwatching. Along the river, Fontenelle Forest, Indian Cave State Park and Schramm State Park provide habitat for many species of migrating woodland birds, such as

warblers, thrushes and tanagers (NGPC, 2005), and are popular spots for birdwatching.

From Omaha to South Sioux City, one can travel in Lewis and Clark's footsteps along Highway 75. This highway follows the Missouri River, a major source of commerce and recreation, and winds through an unspoiled land of lakes, rivers and scenic terrain. U.S. Highway 136, The Heritage Highway, stretches 238 miles from the Missouri River's wooded bluffs into central Nebraska, an area frequently featured in Willa Cather's novels. Nebraska Highway 12, the Outlaw Trail Scenic Byway, provides travelers a scenic drive from South Sioux City to Valentine.

A 59-mile stretch of the Missouri River, from Gavins Point Dam to Ponca State Park, is protected as part of the Wild and Scenic River System. This is one of two stretches of the river that remains unchannelized.

The Nebraska Game and Parks Commission manages 87 properties covering approximately 293,000 acres throughout the state. These state parks, state recreation areas and state historical parks offer visitors a variety

of educational opportunities and outdoor experiences. Many of Nebraska's parks are forested.

The National Park Service manages four properties in Nebraska: Agate Fossil Beds National Monument near Harrison; Niobrara Scenic River in north central Nebraska; Homestead National Monument near Beatrice; and Scotts Bluff National Monument near Scottsbluff. Again, forests are an integral part of most of these properties.

Once a military frontier fort, the Fort Niobrara National Wildlife Refuge was established on January 11, 1912, and sits on 19,131 acres along the Niobrara River in north central Nebraska. The property is managed by the U.S. Fish & Wildlife Service and functions to preserve critical wildlife habitat and biological diversity. The refuge's unique topography nurtures a diverse array of plants and wildlife.





CHAPTER 4: CRITICAL ISSUES, THREATS & OPPORTUNITIES AFFECTING NEBRASKA'S FOREST RESOURCES

While Nebraska's forests are extensive and growing in area, never before have they faced such a wide range of serious threats, from catastrophic wildland fire to destructive invasive insects and diseases to climate change and an increasingly urbanized state.

ROLE & IMPACTS OF WILDLAND FIRE

Current Conditions

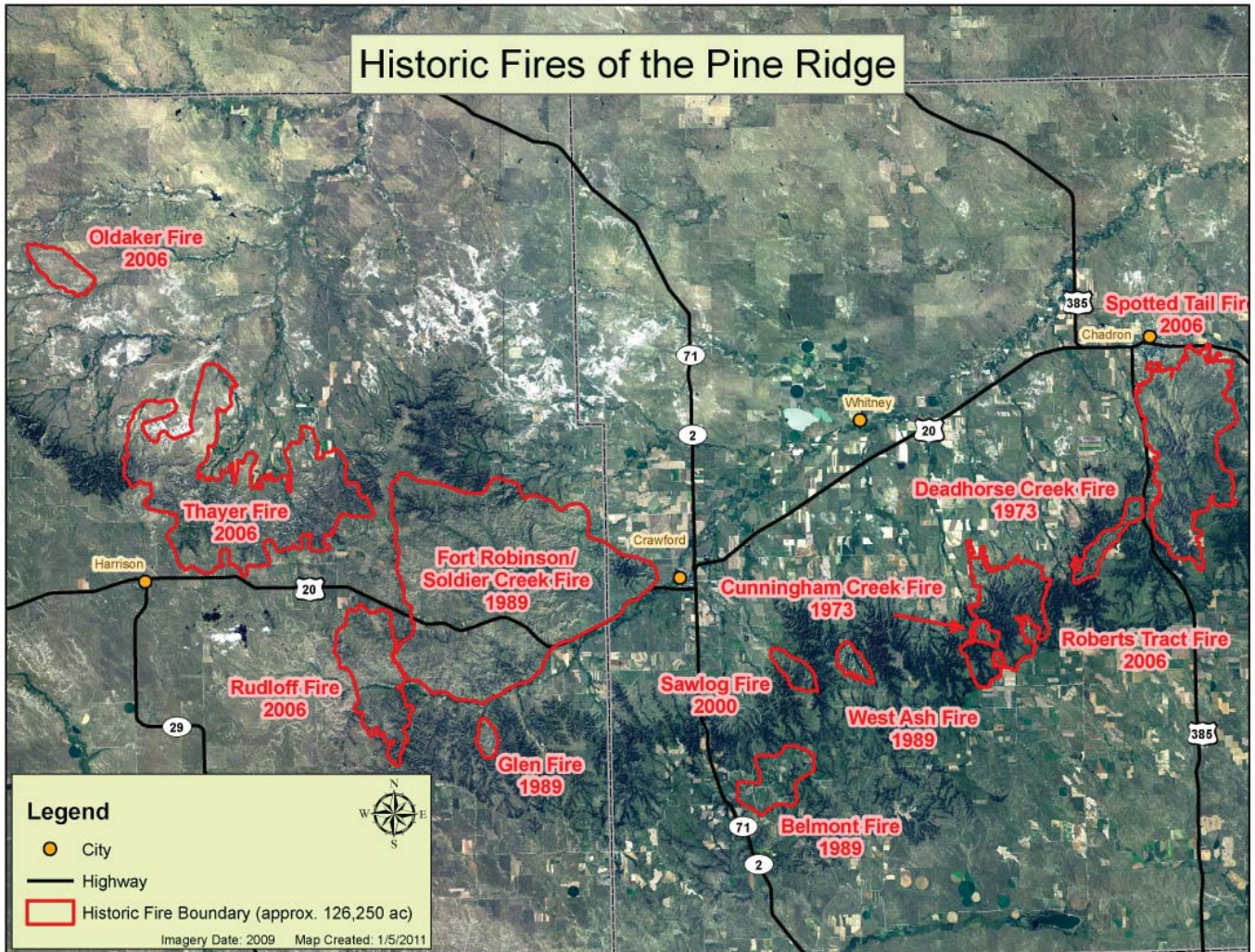
For many centuries wildfires have burned across the forest landscape. These low-intensity fires were frequent enough that they reduced forest fuel loads by burning grass and other debris that accumulated on the forest floor and killing brush and tree seedlings in less protected areas. Because they remained mostly surface fires and didn't spread into the forest canopy, these fires were less destructive than those seen in Nebraska during the past few decades.

With today's growing and dispersing population, wildland fires cannot be allowed to burn as they once did. For the past 60 or more years, most wildland fires have been suppressed, allowing fuel loads to increase dramatically to unnatural levels. With increased fire suppression, pine needles, pinecones and

branches have accumulated on the forest floor. Brush and small-diameter trees have become established in the forest understory, creating "ladder fuels" that serve as pathways for ground fires to become highly destructive crown fires. When fires reach the forest canopy, they behave erratically and can quickly spread and change direction. Because of their erratic behavior, high-intensity crown fires are also harder to suppress, making firefighters' jobs far more difficult and more dangerous. As the crowns of trees are consumed by fire, there is a tremendous release of energy. This heat energy creates powerful columns of rising air capable of carrying firebrands, such as burning pinecones or small branches. These firebrands cause spot fires in front of the advancing fire and rain down on structures in the fire's path, putting property—and lives—at risk.

In addition to the accumulation of forest fuels, a growing wildfire risk factor is the increasing size of the wildland urban interface (WUI) in western Nebraska. With more people moving into rural, often forested areas, fire suppression has become much more difficult and dangerous. Firefighters must be concerned with evacuations and trying to prevent structures from catching fire in addition to

Figure 12. Historic Fires of the Pine Ridge



Source: NFS



The 2006 Spotted Tail Fire near Chadron burned 12 miles of ponderosa pine in less than five hours. The fire entered the Chadron city limits, resulting in the evacuation of 1,000 people, the Chadron hospital, Chadron nursing home and the Chadron State College campus. Photo: NFS.

fighting the fire. Many housing developments in forested areas have only one access point and little water available for fire suppression. There are few zoning restrictions. The result is that an increasing number of homes, other structures and residents are highly vulnerable when catastrophic wildland fires occur. These interface settings are common in the Pine Ridge, Niobrara Valley and Wildcat Hills. They're also found in the Loess Hills in southwestern Nebraska, along the Republican and Platte rivers, and in the Devil's Nest area of northeast Nebraska where eastern redcedar is increasingly common. Ranches and farms may also be at risk in some areas.

Summers appear to be getting longer and hotter, and winters are getting shorter and warmer. Across the western United States, including western Nebraska, fire seasons are starting sooner and lasting longer. In Nebraska, an annual average of 52,851 acres have been burned by wildfires during the past 45-year period.

The ponderosa pine forests of western Nebraska exhibit unique characteristics that lead to extreme fire behavior and rate of spread. The July 28, 2006, Spotted Tail Fire burned through 12 miles of ponderosa pine forest in less than five hours and entered the Chadron city limits. More than 1,000 people were evacuated, along with a hospital, nursing home and the Chadron State College campus. At its peak, the Spotted Tail Fire was burning more than 20 acres of forest per minute. In less than 10 hours, a complex of fires had burned 23 square miles. Fires during the summer of 2006 destroyed 3.5 million tons of woody biomass, enough to heat and cool Chadron State College for 350 years.

Nebraska's ponderosa pine forests are the eastern-most occurrence of this species in North America. Ponderosa pine in this area has heavy seed production with a high rate of seedling re-generation. Seedlings are relatively shade tolerant and lead to dense, stagnant



Photo: NFS

stands of ladder fuels in the understory. Persistent lower branches on this type of pine and the native grasses found in the forests and adjoining meadows and rangelands add to the explosive threat. This arrangement of very large amounts of fine fuels beneath dense stands of ladder fuels has led to very destructive and dangerous wildfires.

Wildfires in western Nebraska's forests have been stand-replacement fires. The historic range of Western Nebraska's ponderosa pine was located on the steep, rocky uplands and had persisted through thousands of years of presettlement fire. Recent fires have completely removed this component, leaving no seed source to regenerate the forest.

Ongoing programs for forest fuels reduction in western Nebraska are critical for the mitigation of stand-replacing fires. Fuels reduction projects provide excellent fuel breaks that help firefighters control wildfires. Mechanical forest fuels reduction also is a critical first step for efficient and safe prescribed burning.

Fire intensity and losses appear to be growing worse. Nebraska periodically experiences high-intensity, catastrophic wildland fires. Several wildland fires occurred in 1965, 1972, 1973, 1989, 1999, 2000 and 2006 (Figure 12), with hundreds of thousands of acres burned, including tens of thousands of acres of pine forests in the Pine Ridge that were subsequently converted to grasslands.

People are also moving to forested areas at an increasing rate, particularly in coniferous and riparian forest areas. Wildland fires in these areas pose a risk to lives and property. In 2006, fires in Valentine and Chadron destroyed 23 structures. Wildland fires also destroy a valuable resource that takes generations to regrow, if it regrows at all.

Future Conditions & Trends

Several trends have combined to aggregate the already severe conditions. Increasing forest fuel

loads, increasing extent of eastern redcedar, expansion of housing into WUI areas, increasing temperatures, drier conditions and longer fire seasons all increase the risk of catastrophic wildland fire.

Impacts on Nebraska's Forest Resources

Today catastrophic wildland fire is perhaps the greatest threat to our coniferous forest ecosystems and is an emerging threat in several areas of riparian forest succeeding to eastern redcedar. When wildland fires ignite overly dense forests, fire intensity is so high that one entire forest system often reverts to grassland with the loss of great ecological and economic value and large-scale degradation of associated environmental services.

The catastrophic wildfires in western Nebraska have negatively impacted tourism, land values for private forest owners and safety.

The 2009 discovery of mountain pine beetle (*Dendroctonus ponderosae*) in the Wildcat Hills and the Pine Ridge forests is of great concern because beetle-killed trees will exacerbate the areas' wildland fire risk.

INSECT & DISEASE PESTS

Current Conditions

Across the United States insect and disease pests damage and destroy thousands of acres of forestland each year. Erratic and severe weather, as well as a maturing forest resource, all reduce forest health and vigor, making trees more susceptible to attack by insect and disease pests.

In Nebraska, forests are threatened by a variety of insect and disease pests. During the 20th century, the state's American elm (*Ulmus americana*) and American chestnut (*Castanea dentata*) populations were decimated by Dutch elm disease (*Ophiostoma ulmi*) and chestnut blight (caused by the fungus *Cryphonectria parasitica*), respectively. Currently, a number of

insect and disease threats are negatively impacting Nebraska's forests, and several more are looming on the horizon.

Current & Emerging Insect & Disease Threats

Pine Wilt

Scotch pine (*Pinus sylvestris*), a popular tree for ornamental plantings, windbreaks and Christmas trees, is rapidly disappearing from Nebraska's landscape. Tens of thousands of Scotch pines have been killed by pine wilt since the mid-1990s. Austrian pine (*Pinus nigra*) also is susceptible.

Pine wilt is common in the southeast part of the state but is spreading west and north. Outside Nebraska pine wilt is a problem in Iowa, Kansas, Missouri, Illinois and Michigan.

Pine wilt is caused by the pinewood nematode (*Bursaphelenchus xylophilus*), a microscopic worm-like organism that is carried from tree to tree by pine sawyer beetles (*Monochamus spp.*). Once inside the tree, the nematodes multiply rapidly and disrupt resin flow. Symptoms soon develop, and the tree dies. Control of pine wilt involves limiting the spread of infested wood by chipping or burning diseased trees. Injection treatments are available to protect high-value pines but are expensive and provide limited protection.

Mountain Pine Beetle

The current outbreak of mountain pine beetle in North America is one of the largest in recorded history. This native bark beetle is estimated to have killed more than 40 million acres of



forests in the United States and Canadian Rocky Mountains. Areas that have not historically had a problem with the insect are being affected.

Nebraska's first documented cases of mountain pine beetle occurred in June 2009 in the Wildcat Hills and the Pine Ridge. These areas have significant value for recreation and wildlife habitat. Discovering the insect at this early stage provides an unusual opportunity to mitigate the impacts of this pest and protect these forests, as well as planted pines in nearby windbreaks and urban areas.

With more than 250,000 acres of ponderosa pine forest in the state, mountain pine beetle poses a substantial threat to Nebraska's forests.

Emerald Ash Borer

Emerald ash borer (*Agrilus planipennis*) has killed tens of millions of ash (*Fraxinus spp.*) trees in Michigan, Ohio, Illinois, Indiana, Kentucky, Pennsylvania, New York, Maryland, Missouri, Minnesota, Virginia, West Virginia, Wisconsin and Ontario and Quebec, Canada. Native to Asia, the highly invasive beetle is believed to have arrived in the United States on infested wooden packing materials from China. It was first discovered in 2002 near Detroit.

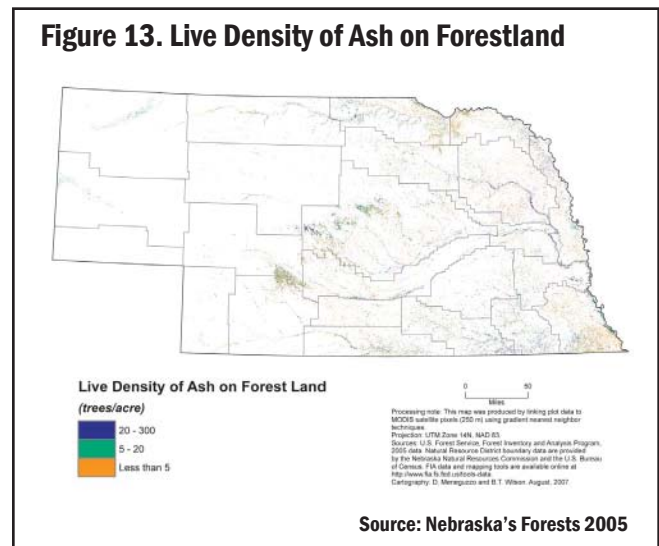
Emerald ash borer (EAB) larvae tunnel under the bark of trees, disrupting the flow of water and nutrients and causing canopy dieback and eventual tree death.

On its own, EAB can spread 1-2 miles per year, but travels much longer distances through the transport of infested firewood, nursery stock and ash wood products. EAB has not been found in Nebraska but is within 250 miles of the state's borders. Nebraska's estimated 44 million ash trees in communities, agroforestry plantings and native woodlands are at great risk (Figure 13). Municipal costs to remove, dispose of and replace more than 1.01 million community ash trees will exceed \$1 billion.

Thousand Cankers Disease of Black Walnut

Thousand cankers is a fungal disease of black walnut (*Juglans nigra*) that is spread by the walnut twig beetle (*Pityophthorus juglandis*). Thousand cankers disease is widespread throughout Oregon, Idaho, Utah, Arizona, New Mexico, Colorado and portions of California. The walnut twig beetle is native to North America and was first discovered in 1928 on trees in southern New Mexico. However, black walnut trees across the western United States have been declining for decades due to a fungus (*Geosmithia spp.*) carried by the walnut twig beetle which is presumed to also be native. The disease apparently co-evolved with Arizona walnut, on which it causes little damage. However, eastern black walnuts in urban forests are highly susceptible to this disease.

Figure 13. Live Density of Ash on Forestland



Thousand cankers is largely spread through the transport of firewood. In this manner it was spread to Colorado's Front Range communities and has wiped out black walnut trees in Boulder and Colorado Springs. It has not yet been identified in Nebraska but poses an enormous threat to all black walnut trees in the state.

Black walnut is widely planted across Nebraska for both nut and timber production. It also occurs in native riparian forests throughout the eastern portion of the state. More than 1.5 million walnut trees in Nebraska forests contain more than 40 million board feet of merchantable wood worth up to \$80 million. Up to one million board feet of walnut is harvested annually, with an annual contribution to the Nebraska economy of \$3.5 million.

There also are several hundred nut tree growers with nearly 4,000 grafted high-quality bearing trees in production. The value of the walnut crop to Nebraska's economy is at least \$1.2 million yearly. Hundreds of landowners with extensive plantings of walnut stand to lose their entire investments to this disease, with millions in additional negative economic impacts. Overall economic impacts include more than \$81 million in potential uninsured losses to trees killed by thousand cankers disease, and more than \$4.7 million lost annually in economic impacts from the loss of wood and nuts to be processed and sold.

Sudden Oak Death

First reported in 1995 along California’s central coast, sudden oak death is caused by the fungus *Phytophthora ramorum* that causes a bleeding canker on the stem, resulting in death. To date, the disease has killed tens of thousands of oaks (*Quercus spp.*) in California.

While originally identified in oak trees, the fungus also attacks hackberry (*Celtis occidentalis*), bay laurel (*Laurus nobilis*), Pacific madrone (*Arbutus menziesii*), bigleaf maple (*Acer macrophyllum*), manzanita (*Arctostaphylos spp.*) and California buckeye (*Aesculus californica*). In these species the fungus causes leaf spots and twig dieback. While the disease poses a risk to Nebraska’s oaks, it has not been found in the state, and its potential impact on oak resources is unknown.

Asian Longhorned Beetle

Asian longhorned beetle (*Anoplophora glabripennis*) was discovered in 1996 in Brooklyn. The insect is native to Asia and is believed to have arrived in the United States on wooden pallets and other wood packing materials. In 1998, another infestation was identified in the Chicago suburbs. Its most recent discovery was in Worcester, Massachusetts, in 2008. It presumably is spread by the transport of infested firewood.

The insect attacks multiple species of hardwoods, including birch (*Betula spp.*), Ohio buckeye (*Aesculus glabra*), elm, horse chestnut (*Aesculus hippocastanum*) and willow. Asian longhorned beetle (ALB) also attacks, and is thought to prefer, species in the maple (*Acer spp.*) family including boxelder (*Acer negundo*),



Photo: NFS



Photo: Whitney Cranshaw, Colorado State University, Bugwood.org



Photo: Eric R. Day, Virginia Polytechnic & State University, Bugwood.org



Photo: USDA Forest Service Northeast Area, Bugwood.org

Clockwise from top left: Pine wilt and mountain pine beetle are present in Nebraska and threatening pine species in forest, agroforest and landscape settings. While neither Asian longhorned beetle nor EAB are currently in Nebraska, they both pose a significant threat to forests across Nebraska. For EAB alone, the costs to remove, dispose of and replant dead ash trees in community forests will exceed \$1 billion. The associated loss of ecosystem services will cause further economic losses.

Norway maple (*Acer platanoides*), red maple (*Acer rubrum*), silver maple (*Acer saccharinum*) and sugar maple (*Acer saccharum*). ALB larvae tunnel under the bark of trees, causing canopy dieback and, eventually, tree death.

ALB poses a grave threat to Nebraska's hardwood tree resources should it be introduced here.

Other Forest Health Concerns

Diplodia blight of pines (caused by the fungus *Sphaeropsis sapinea*) and Zimmerman pine moth (*Dioryctria zimmermani*) are pests that have been in Nebraska for many years and continue to kill and deform trees in native and planted pine stands.

Diplodia blight kills and damages stressed pine trees and has killed thousands of planted Austrian and ponderosa pines in eastern Nebraska and native ponderosa pines in the Pine Ridge and Niobrara River valley.

Zimmerman pine moth tunnels in the trunk and branches of pines. The tunneling girdles trees or causes them to break apart during times of strong wind or heavy snow. Ponderosa, Austrian and Scotch pines are very susceptible to the insect. Zimmerman pine moth has killed hundreds of trees and has destroyed many windbreaks and other pine plantings, especially in the central portion of the state.

Future Conditions & Trends

The eventual introduction of EAB and thousand cankers disease, plus expanded damage by mountain pine beetle and pine wilt, will have devastating impacts on Nebraska's trees and forests. Stress due to changing climatic conditions likely will aggravate the damage.

Impacts on Nebraska's Forest Resources

Invasive insect and disease pests are a threat to Nebraska's forests because of their potential to essentially wipe out entire species within the state. In communities, dead and dying

trees create a hazard and must be removed at tremendous cost to municipalities.

In both urban and rural areas, insect and disease pests can result in the loss of many millions of dollars of ecosystem services provided by trees.

CLIMATE CHANGE

Current Conditions

With its weather extremes, Nebraska already is a tough place for trees. The state is characterized by hot summers and cold winters, late spring and early fall freezes, fluctuating rainfall and growing seasons, frequent heavy to severe winds and early snows and ice storms. Average precipitation between 1990 and 2000 ranged from 18 inches in the west to 32 inches in the southeast, but this can vary markedly from year to year. Snowfall throughout the state ranges from 20 to 40 inches yearly. The decline in moisture is the result of a combination of factors: 1) Nebraska's interior Plains location; 2) the Rocky Mountains blocking moisture from the Pacific Ocean; and 3) increasing distance from the Gulf of Mexico. Variation in precipitation from north to south is not significant.

Nebraska experienced severe D2 drought or greater on the National Drought Mitigation Center's scale in five of the past eight years (2002, 2003, 2004, 2006 and 2007), resulting in significant agricultural losses and stress on the state's tree and forest resources. The Panhandle and Sandhills were hit especially hard, with parts of the southwest also suffering. Nebraska receives three-fourths of its rainfall during April and through September. However, precipitation varies widely from month to month for all Nebraska locations. The growing season in Nebraska ranges from 120 days in the extreme northwest to 170 days in the southeast.

Torrential downpours, severe straight-line winds,

tornadoes and hail are common. Tornadoes occur yearly but in varying number and intensity. Hailstorms are very severe, particularly in western Nebraska, which reportedly has the highest hail frequency in the country. During dry years, dust storms occasionally develop in the Panhandle and in the southwestern part of the state.

Future Conditions & Trends

Climate change is expected to have significant impacts on the Great Plains. Scientists project that temperatures will continue increasing during this century, with summer changes in the southern and central Great Plains projected to be larger than winter changes (Christensen, et al, 2007). Some studies indicate that average temperatures in the Great Plains have increased 1.5 degrees Fahrenheit relative to a 1960 to 1979 baseline (Karl, Melillo and Peterson (eds.), 2009).

An average of several climate change computer models indicates the entire state will become warmer, with hotter summers, warmer winters, warmer overnight temperatures and a fourfold increase in weather “anomalies,” presumably including extended and intensified droughts. Other anticipated long-term climate changes include more frequent heat waves and heavy rainfall that will impact many aspects of life throughout the Great Plains (Karl, Melillo and Peterson (eds.), 2009).

Impacts on Nebraska’s Forest Resources

While it is difficult to determine the impacts of climate change on Nebraska’s tree and forest resources, it is anticipated that climate change will result in reduced forest productivity, substantially greater risk of catastrophic wildland fire and irregular flows along riparian systems, which will alter the availability of water resources. Projected impacts of climate change in Nebraska also include changes in agricultural systems, as well as the alteration of key habitats of native plant and animal species and the proliferation of some invasive species (Karl,

Melillo and Peterson (eds.), 2009). For example, it is thought that cold winter temperatures previously kept mountain pine beetle, which is native to the western United States, out of Nebraska. As winters have become warmer, mountain pine beetle’s range has expanded to include western Nebraska.

INVASIVE & AGGRESSIVE NATIVE PLANT SPECIES

Current Conditions

The U.S. Department of Agriculture’s National Invasive Species Information Center defines invasive species as species that are non-native to an ecosystem, or species whose introduction to an ecosystem causes or is likely to cause harm to the ecosystem’s economy or environment or to human health (USDA NISIC, 2009). Invasive species can be plants, animals or other organisms, such as microbes. Approximately 400 of the almost 1,000 threatened or endangered species classified under the Endangered Species Act are considered at risk primarily due to competition with or predation by non-native species (Pimentel, Suniga & Morison, 2005). In the United States, damages and losses due to invasive species total almost \$120 billion each year (Pimentel, Suniga & Morison, 2005).

In Nebraska, purple loosestrife (*Lythrum salicaria*), saltcedar (*Tamarix ramosissima* Ledev and *Tamarix parviflora* DC) and phragmites (*Phragmites australis* spp. *australis*) threaten the integrity of riparian ecosystems across the state. These species spread aggressively throughout river systems, outcompeting more desirable native species by blocking and slowing water flow and utilizing large quantities of scarce water.

Russian olive (*Elaeagnus angustifolia*) is native to southeastern Europe and western Asia. The tree was introduced to the United States in the late 1800s as an ornamental but quickly escaped and established itself throughout most of the country. In upland areas of



Invasive and aggressive native species are serious threats to the ecological stability of some of Nebraska's forested areas.
Photo: NFS.

western Nebraska, Russian olive is a valuable conservation tree because of its drought and pest tolerance, ability to thrive in a variety of growing conditions and value to wildlife. The tree spreads aggressively, particularly in bottomland areas where moisture is abundant. Without management, Russian olive will spread vigorously and outcompete neighboring species. In many riparian areas, especially in western and central Nebraska, Russian olive is threatening native riparian cottonwood ecosystems.

Other non-native invasives are becoming serious threats to the ecological stability of central hardwood forests in eastern Nebraska, including honeysuckle (*Lonicera spp.*) and buckthorn (*Rhamnus spp.*). Native to Asia, honeysuckle is a deciduous shrub that was introduced into the United States in 1846. It escaped cultivation due to high seed production with the seeds eaten and dispersed by birds and other animals. It forms dense understory thickets in forests, shading out other shrubs and tree seedlings and disrupting tree reproduction and forest succession. Common buckthorn is a shrub or small tree that invades open oak woods, deadfall openings in woodlands, woods' edges, roadsides, prairies and open fields. It forms dense thickets, crowding and shading out native shrubs and herbs, often completely eradicating them.

Japanese barberry (*Berberis thunbergii*) also is becoming a serious invasive pest in eastern hardwood forests. It typically is found in locations of partial sunlight, such as a forest edge, and can survive well under an oak canopy where it shades out other understory species. Recent research studies indicate that Japanese barberry changes the soil chemistry in the environment it inhabits.

Aggressive native species are species that are native to an ecosystem but can outcompete more valuable species under favorable conditions. Eastern redcedar is valued in conservation plantings because of its hardiness

and rapid growth rate. However, this native is a prolific multiplier and, if left unmanaged, can quickly take over pastureland, forestland and riparian areas. Improved fire prevention and suppression efforts and changes in agricultural practices have allowed eastern redcedar to expand in both total area and number of trees.

Prescribed fire is an efficient method of controlling smaller eastern redcedar trees, but the number of acres that can be burned each year is limited due to weather, the availability of trained professionals and the terrain of the area to be burned. Denser stands of larger eastern redcedar cannot be burned without the risk of creating an intense wildland fire. Other methods, such as mechanical removal of larger trees and chemical control, also can be effective. While trees are small, winter grazing by goats may effectively control eastern redcedar infestations as well. Expanding biomass markets may provide an economic incentive to better manage eastern redcedar.

Future Conditions & Trends

It is anticipated that invasive and aggressive plant species will continue to expand their range in Nebraska's forests, negatively impacting these ecosystems.

Impacts on Nebraska's Forest Resources

Invasive and aggressive native species have the potential to dramatically alter native ecosystems by outcompeting more desirable species. In some riparian areas, invasive species can choke river channels, altering natural hydrologic regimes and resulting in diminished stream flows and increased flooding.

Eastern redcedar has received considerable attention in the past 20 years because of its proliferation into rangeland and forestland. However, there are positive and negative impacts to eastern redcedar's expansion. Eastern redcedar provides wildlife habitat for species dependent on woody vegetation. It can also be harvested for posts, shavings, logs and

biomass, creating additional sources of income for landowners. Alternatively, eastern redcedar's expansion can reduce the productivity of pastureland by reducing forage production and degrade native prairies by outcompeting desirable species. In forested areas, eastern redcedar can form a dense understory, outcompeting desirable species and creating a fire hazard.

Many riparian forests are now at significantly greater risk for wildland fire due to the rapid expansion of invasive and aggressive native species that form a dense, fire-prone understory. In March 2009 a fire in an eastern redcedar/cottonwood riparian forest intensely burned 640 acres along the Platte River. The fire closed Interstate 80 near Kearney for seven hours and resulted in economic losses of nearly \$7 million. With the rapid conversion of cottonwood forests to eastern redcedar forests, an entirely new fire-prone forest type is emerging along hundreds of miles of riparian corridors.

DEER

Current Conditions

The Nebraska Game and Parks Commission estimates that the state's whitetail deer population grew from 11,200 in 1959 to 288,000 by 2008, due primarily to hunting restrictions in many areas of the state. Half of the whitetail deer population is located in the eastern fourth of the state, with the remainder spread throughout the rest of Nebraska, largely in broadleaf woodlands along stream and river corridors.

High deer populations can impact forest regeneration because they eat broadleaf trees and shrubs within their reach (up to 7 feet). Trees protected either by thorns [such as honey locust (*Gleditsia triacanthos*); Osage-orange (*Maclura pomifera*); Russian olive, etc.] or an undesirable taste [such as cedar and Siberian elm (*Ulmus pumila*); etc.] are avoided by deer



and thus have become established in areas with large whitetail deer populations.

Future Conditions & Trends

Legislation passed in 2010 may increase hunting pressure on deer populations. Whether this will result in decreased populations remains to be seen. Continued heavy deer pressure and damage to forest resources are anticipated for the foreseeable future.

Impacts on Nebraska's Forest Resources

The eventual result of continued heavy deer browse could be the conversion of large expanses of deciduous forests from red oak (*Quercus rubra*), bur oak (*Quercus macrocarpa*), chinkapin oak (*Quercus muehlenbergii*), green ash (*Fraxinus pennsylvanica*), red mulberry (*Morus rubra*), American elm, slippery elm (*Ulmus fulva*), walnut, etc., to honey locust, Osage-orange, Russian olive, eastern redcedar

and Siberian elm. In areas where trees colonize grasslands, the same thorned or less-preferred trees compose the majority of the encroaching tree species because deer eat the more preferred species.

PUBLIC PERCEPTION OF THE VALUE OF TREE & FOREST RESOURCES

Current Conditions

Trees and forests provide a number of tangible and intangible benefits that improve the quality of life and the quality of our environment, and proactive management must be taken to ensure these benefits are sustained. The public's valuation of trees and forests plays a key role in accomplishing this.

Public value can be described as "the widely held perceptions of the public regarding the function and service contributions of any public

entity” (Wolf, 2004). However, because many of the benefits provided by trees and forests are intangible, it is often difficult for the public to understand their value.

Future Conditions & Trends

In rural areas, increasing crop prices and drought negatively impact peoples’ perception of the value of forest resources. As crop prices increase, conservation plantings (e.g., windbreaks and riparian buffers) are often removed to increase acres in crop production. During periods of prolonged drought, many producers in stricken areas want trees removed to eliminate the perceived competition for water between trees and crops. Installation of pivot irrigation systems often results in the removal of agroforestry plantings, such as windbreaks and treed fencelines.

A key indicator of the value farmers and

ranchers place on trees is the number of trees they plant. Since 1983, the number of trees planted in conservation practices has declined from a peak of 3.5 million annually to just more than 1 million annually.

In communities, the number of trees in public spaces has declined over the past three decades. Some communities have lost more than 40% of their public trees. Replanting efforts are not currently sufficient to offset mortality and removals, resulting in further declines of community forest canopy cover.

Impacts on Nebraska’s Forest Resources

At the community level, decreasing public valuation of tree and forest resources often leads to reduced budgets for community forestry programs. As funds for tree care are reduced or even eliminated, community forests become vulnerable to insect and disease



As crop prices increase, conservation plantings, such as field windbreaks, are sometimes removed to expand the number of acres in crop production.
Photo: USDA NRCS.



In communities, a decreased public valuation of tree and forest resources can lead to reduced budgets for community forestry programs. As funds are reduced or even eliminated, the benefits provided by community tree and forest resources are jeopardized. Photo: NFS.

pests, as well as increased storm damage. The reduction or elimination of tree planting and maintenance funds results in a decrease in overall community forest canopy, meaning reduced benefits provided by this green infrastructure and a diminished quality of life, especially in small rural communities.

In rural areas, decreasing public valuation of trees and forests results in a decline in conservation planting and removal of existing conservation plantings or natural forests. These actions have negative impacts on water quality, soil erosion, wildlife habitat and energy conservation.

CHANGING DEMOGRAPHICS

Current Conditions

Nebraska's population growth has typically been slower than other states. According to the U.S. Census Bureau, the population change from 2000 to 2010 was 9.7% for the country

but only 6.7% for Nebraska; the total census population in 2010 was 1,826,341 (U.S. Census Bureau, 2011).

Census data show Nebraska is 86.1% white, 9.2% Hispanic or Latino, 4.5% black, 1.8% Asian and 1% Native American, with 2.2% of people reporting two or more races; the state's median age is 36.2 (U.S. Census Bureau, 2011). The Hispanic-Latino component is the fastest-growing minority group, with a statewide growth rate of 77% between 2000-2010 (NebraskaStatePaper.com, 2011).

While Nebraska averages 23.8 people per square mile (U.S. Census Bureau, 2011), most of the population is concentrated in the eastern quarter of the state and along the Platte and North Platte rivers. More than half of Nebraska's population lives in Lancaster, Sarpy and Douglas counties in eastern Nebraska (Nebraska Blue Book, 2009). In 2010, Douglas County, which includes Omaha and is Nebraska's most heavily populated county,

contained 1,562 people per square mile (U.S. Census Bureau, 2011).

Future Conditions & Trends

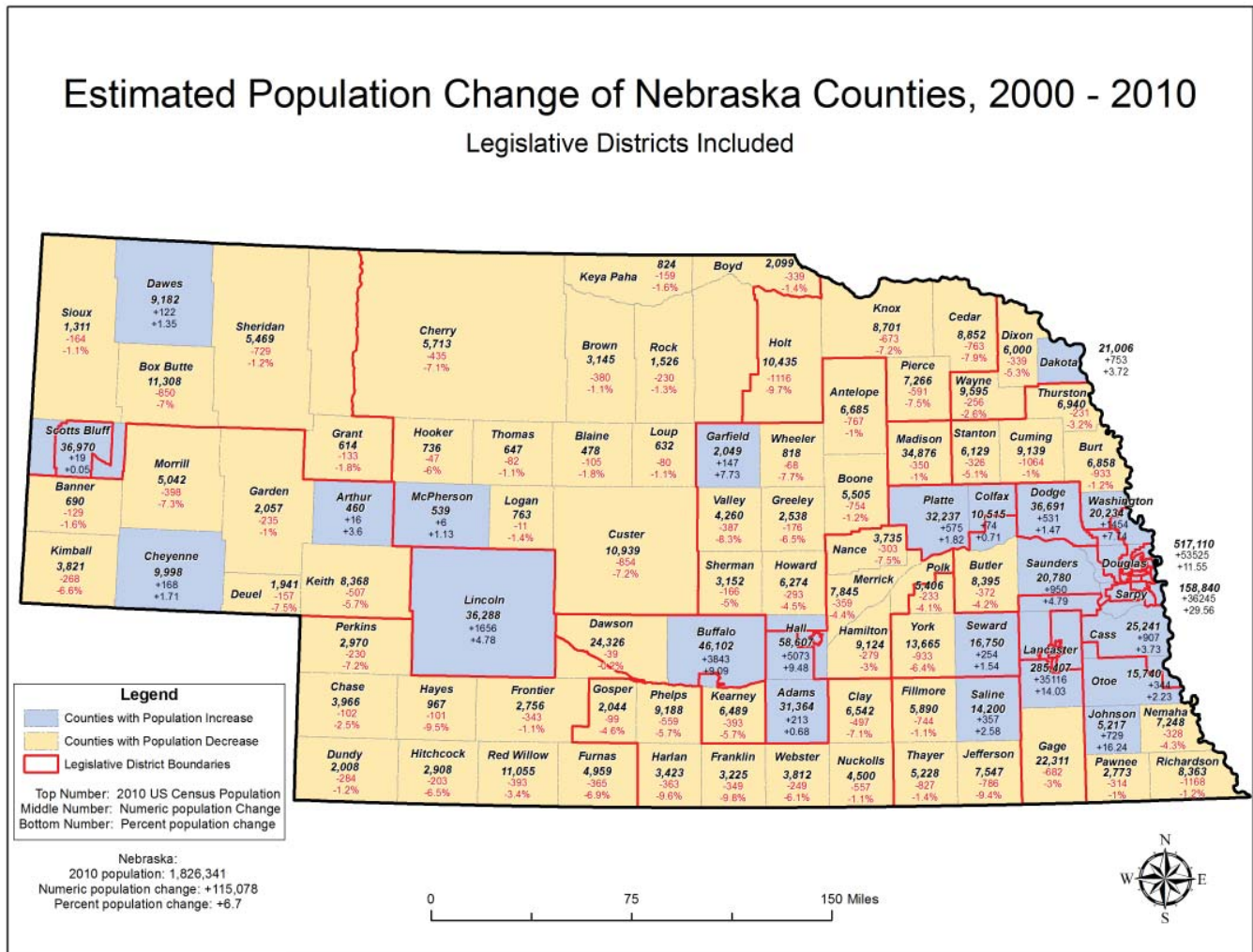
Long-term growth trends show increasing populations in urban areas and continued population declines in many rural counties in central and western Nebraska. In 2000, about two-thirds of Nebraska residents lived in municipalities containing 2,500 or more residents, and the majority of the state's population lived in the eastern third of the state (Nebraska Blue Book, 2009).

Impacts on Nebraska's Forest Resources

Increasing urban populations are creating the need for sustainable community forestry programs and the implementation of green infrastructure into community planning practices.

Declining rural populations will lead to declining budgets in rural communities, which could translate to cuts in community forestry programs. Fewer people also means fewer volunteers to organize and support community forestry programs in shrinking towns.

Figure 14. Estimated Population Change of Nebraska Counties, 2000-2010



Source: U.S. Census Bureau, 2009

FOREST LANDOWNER ISSUES & OPPORTUNITIES IMPACTING FOREST CONSERVATION

Current Conditions

According to the USDA National Agricultural Statistics Service (2009), approximately 97% of all land in Nebraska is privately owned, as is 85% of forestland (1.05 million acres).

Of the 49.5 million acres (77,359 square miles) that make up Nebraska, 473,500 acres are covered by open water. In 1997, federally owned land made up 647,700 acres, and 1,205,900 acres were in commercial or residential development.

Nebraska is largely an agricultural state. In 2009, Nebraska had 47,700 farms and ranches utilizing 45.5 million acres, approximately 92% of the land area. In 2007 there were 91,919 registered wells and 5,000 surface water rights irrigating about 8.5 million acres of crop and pastureland.

At more than \$14.5 billion in 2007, Nebraska's total agricultural receipts ranked fourth in the nation. Nebraska's sales of grains, oilseeds, dry beans and dry peas (\$6.5 billion) and cattle and calves (\$7.3 billion) both rank third in the nation.

Future Conditions & Trends

The number of farms in Nebraska has decreased, but the size of each farm has increased. In 1990, Nebraska had roughly 57,000 farms and ranches with an average farm size of 826 acres; a decade later there were 3,000 fewer farms, but the average farm size had increased by 33 acres (USDA National Agricultural Statistics Service, 2009).

Impacts on Nebraska's Forest Resources

Despite their critical economic and environmental roles in traditional and nontraditional agricultural systems, conservation tree planting has declined significantly since the 1980s. Almost three

decades ago, the Nebraska Conservation Tree Program sold 3-3.5 million trees annually for conservation purposes, such as farmstead windbreaks, wildlife habitat, water quality protection and soil erosion control. From 2005 to 2008, that number dropped to approximately 1 million trees sold annually for those same purposes.

Peoples' attitudes and behaviors toward trees are shifting. Changes in crop prices and land values have led to an increased emphasis on using as much available land as possible for row crops. The recent prolonged drought—leading to concerns about trees competing with crops for water—caused many landowners to question the value provided by conservation plantings. The rapid and widespread adaptation of pivot irrigation systems has spurred landowners to remove many windbreaks across the state. Larger farm sizes mean producers have less time to manage for conservation and instead opt to simplify their operations by removing conservation plantings and not planting trees.

Additionally, as older landowners pass on their land to younger generations, land management objectives may change. In areas of the state where land has development value (e.g., the Pine Ridge), increased fragmentation of large, intact forested acres into smaller acreages or "ranchettes" creates significant WUI issues and negatively impacts the production of ecosystem services provided by larger swaths of forests.

FOREST PRODUCTS INDUSTRY TRENDS

Current Conditions

Nebraska's forests have not historically supported a large forest industry.

The maturing and declining cottonwood resource will negatively impact the state's pallet industry. In 2008, increased diesel costs and mill closures caused the loss of the Black Hills-based sawmill market for ponderosa pine from



the Pine Ridge. Currently there are no markets for timber from this area, other than biomass. Various attempts over the past 30 years to establish sawmilling capacity in the Pine Ridge have been unsuccessful. Other regions of the state also lack capacity to harvest and process forest products.

With the exception of a relatively small and valuable walnut and oak component, Nebraska's hardwood forests are largely composed of hackberry, red mulberry, silver maple, basswood (*Tilia americana*), cottonwood and green ash. These species have low or no economic value in traditional forest product markets. Further, there is a very high percentage of cull trees (poor form, decayed or damaged) in native forests due to improper logging practices, grazing and lack of management.

Impacts on Nebraska's Forest Resources

Woody biomass is the best opportunity to restore both hardwood and coniferous forests to a more diverse and productive condition with higher economic values. Long-term demand for woody biomass will provide landowners with markets for lower-value trees, creating opportunities to improve the health, vigor and species composition of forests statewide.

WATER RESOURCES

Nebraska has the greatest length of rivers of any state in the United States, making forests and water inexorably connected. It has the greatest length of rivers of any state in the United States. Riparian forests are the largest forest type in the state and provide enormous ecosystem services. All of Nebraska's rivers and streams drain into the Missouri River along the eastern border of the state. The Platte River is formed by the North and South Platte rivers, which originate in the Rockies and flow east through central Nebraska. The Sandhills area is drained by the Niobrara, Elkhorn and Loup rivers, and the Republican and Big Blue rivers drain the southern part of the state. Approximately 8 million acre-feet of surface water flows annually from Nebraska into other states. No large natural bodies of water exist in Nebraska, although hundreds of small natural lakes are found throughout the state.

Nebraska possesses vast groundwater reserves. The Ogallala Aquifer, located under much of the central part of the state, provides irrigation to a large part of Nebraska via deep wells. Nebraska aquifers store nearly 2 billion acre-feet of groundwater, most of which is easily accessible. Use of underground water is regulated through 23 Natural Resources Districts throughout the state. In the early 1990s there were 6.3 million acres of irrigated land in Nebraska. By 2007 that number had increased to approximately 8.5 million acres.

Although Nebraska receives an average of 90 million acre-feet of precipitation annually, groundwater irrigation plays an important role in agriculture. More than 106,000 registered irrigation wells existed in the state at the beginning of 2010 (Nebraska Department of Natural Resources, 2010). Nebraska has more center pivot irrigation systems than any other state.

Many projects have been developed to minimize flooding, particularly in southeastern Nebraska, and upstream dams in Montana and

the Dakotas have reduced flooding along the Missouri River. Five reservoirs control flooding on the Republican River in Nebraska; dams control flooding along the Platte River.

Future Conditions & Trends

Some rivers are vulnerable to chronic drought, invasive species and overuse for irrigation and other purposes. Decreasing water tables in riparian areas have resulted in riparian forest decline and mortality. Continued perceptions that trees are significant competitors for water could foster extensive tree removals and clearing of forests.



CHAPTER 5: NEBRASKA FOREST SERVICE PROGRAM OBJECTIVES: A GEOSPATIAL ANALYSIS

The following 10 objectives were jointly identified by USFS and the National Association of State Foresters and capture the efforts NFS has been undertaking to preserve, protect and enhance Nebraska's tree and forest resources. As such, they provide an appropriate framework within which to identify priority forest landscapes in Nebraska.

Each objective is followed by a discussion of desired outcomes, data layers used, data gaps, research needs and a composite geospatial map indicating areas in which management interventions best achieve these desired outcomes. A final, comprehensive composite map can be found at the end of this chapter and helps identify high-priority forest areas.

The process by which these maps were developed is described in Chapter 2.

OBJECTIVE 1—ACTIVELY AND SUSTAINABLY MANAGE FORESTS

The active, sustainable management of Nebraska’s tree, forest and agroforest resources will ensure a continued stream of environmental, economic, social and human health benefits for future generations (Figure 15).

Data layers

- riparian areas (SAP)
- agroforestry (SAP)
- private forestland (SAP)
- forest cover
- community forests
- land in forest stewardship plans (SAP)

Desired outcomes

- A public that is educated about the value and benefits of trees and forests in rural and urban settings.
- Programs that offer assistance and incentives to private landowners to keep working forests working and encourage sustainable forest management are readily available.
- Programs that assist communities in developing sustainable community forest management and green infrastructure programs.

Data gaps:

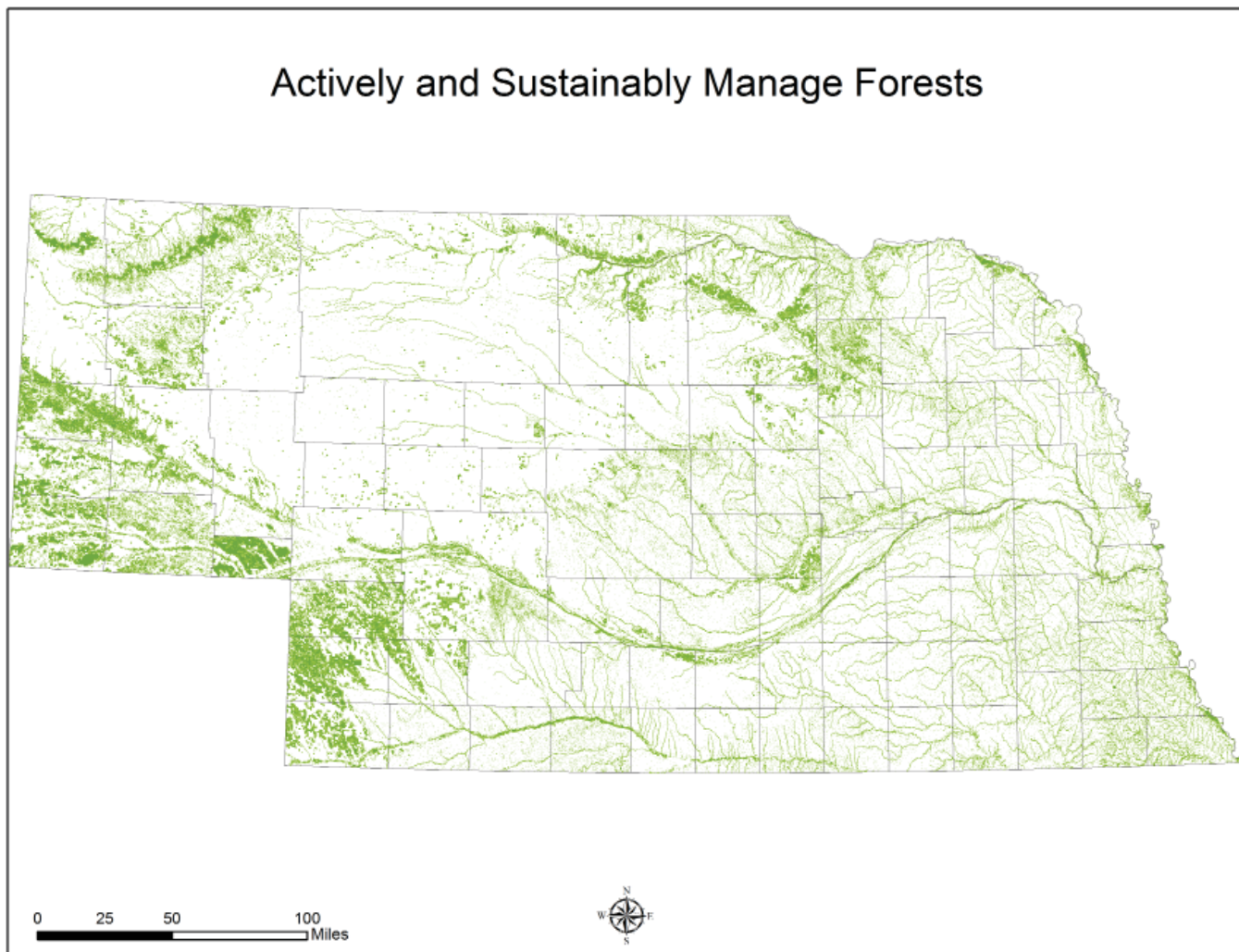
- Fine resolution (1-meter preferred) community forest canopy cover, both Ortho and color infrared.
- Geospatially based woody biomass data.
- Fine-resolution (1-meter preferred) forest canopy cover, including riparian areas.
- Threatened and endangered species data

that is finer than 30-meter resolution.

Research needs

- How can western ponderosa pine forests be optimally managed as silvopastoral systems in ways that maximize forage and wood production, reduce fuel loads and risk of catastrophic wildland fire, reduce risk of spread of invasive species and optimize forest health and wildlife habitat for select species?
- Improved access to more detailed, locally available woody biomass volume information from forestlands, nonforestlands with trees and urban areas.
- What are the most effective methodologies for restoring degraded cottonwood riparian forests?
- How can riparian and other hardwood forests be sustainably managed to produce biomass and other wood products?

Figure 15. Objective 1: Actively and Sustainably Manage Forests



OBJECTIVE 2—RESTORE FIRE-ADAPTED LANDS AND REDUCE RISK OF WILDFIRE IMPACTS

The strategic management of forests to reduce wildfire extent and severity is crucial to the health of Nebraska’s forests, the safety of residents in at-risk areas and the contributions of forests to Nebraska’s economy. Decades of fire suppression and changes in weather and precipitation have disrupted natural fire regimes, resulting in fuel buildup, loss of biological diversity, changed species composition and loss of some fire-dependent species (Figure 16).

Data layers

- wildfire risk (SAP)
- WUI

Desired outcomes

- Reduced risk of catastrophic wildland fire and enhanced multiple benefits provided by Nebraska’s forests.
- Frequency and size of wildland fires kept to a minimum.
- Homeowners and communities in at-risk areas are engaged in Firewise practices.
- Adverse affects of wildland fires on forest resources and ecosystem services are prevented as much as possible.
- Fire-adapted landscapes and natural communities are restored through the use of prescribed fire and other management tools.
- Training, assistance and equipment are provided to Nebraska’s rural volunteer fire districts.

Data gaps

- Updated fine-resolution (1-meter preferred) fire risk map that includes variables such as drought or human development/interaction and includes all areas at risk to wildland

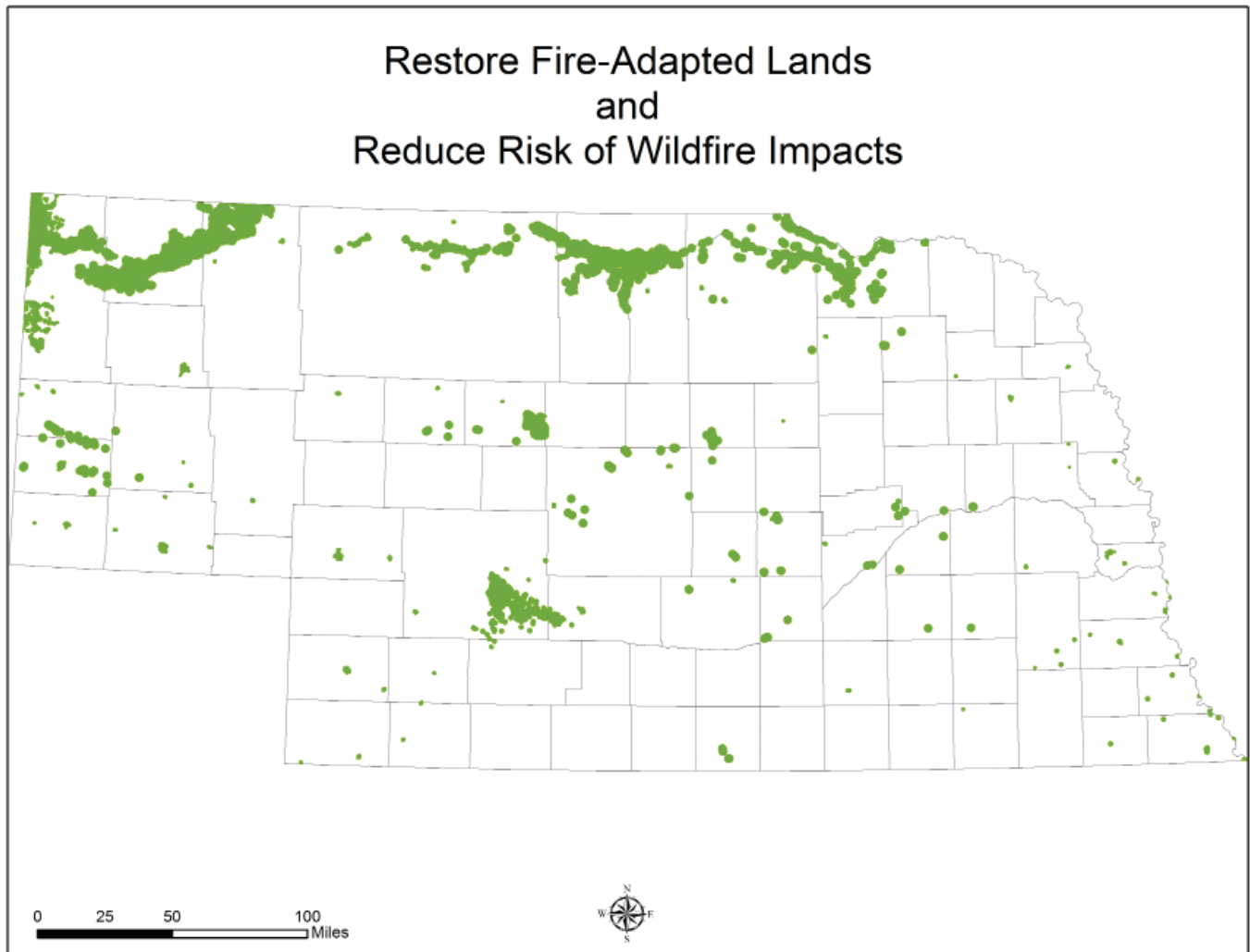
fires (e.g., grassland, forested areas).

- WUI map based off a nationally developed standard WUI definition.

Research needs

- Customized fuels/fire behavior models for Pine Ridge ponderosa pine forests; Niobrara Valley ponderosa pine, eastern redcedar and bur oak forests; and eastern redcedar/hardwood riparian forests.
- Determination of residual stocking densities in ponderosa pine forests that maximize timber and grass production, thus economic output.

Figure 16. Objective 2: Restore Fire-Adapted Lands and Reduce Risk of Wildfire Impacts



Rural firefighters benefit from training at NFS's annual Nebraska Wildland Fire Academy. Photo: NFS.

OBJECTIVE 3—IDENTIFY, MANAGE AND REDUCE THREATS TO FOREST AND ECOSYSTEM HEALTH

A healthy forest landscape has the capacity for renewal and recovery from a wide range of disturbances while continuing to provide public benefits and ecosystem services. Forest health threats include insects, diseases, invasive and aggressive native plant species, air pollution and climate change (Figure 17).

By identifying forest areas that are especially vulnerable to existing or potential forest health risks, NFS will be able to target forest management practices where they are most likely to prevent and mitigate impacts and successfully restore impacted forests.

Data layers

- potential forest health risk

Desired outcomes

- Increased species diversity in urban forests to make them less vulnerable to insect and disease attacks.
- Greater species diversity in conservation and agroforestry plantings so they are less vulnerable to insect and disease attacks.
- Impacts of invasive and aggressive native plant species and insect and disease threats are mitigated through programming with landowners, communities, natural resources and green industry partners and decision makers (e.g., local, state and federal legislators).
- The public is educated about current and emerging threats to forest health in Nebraska.

Data gaps

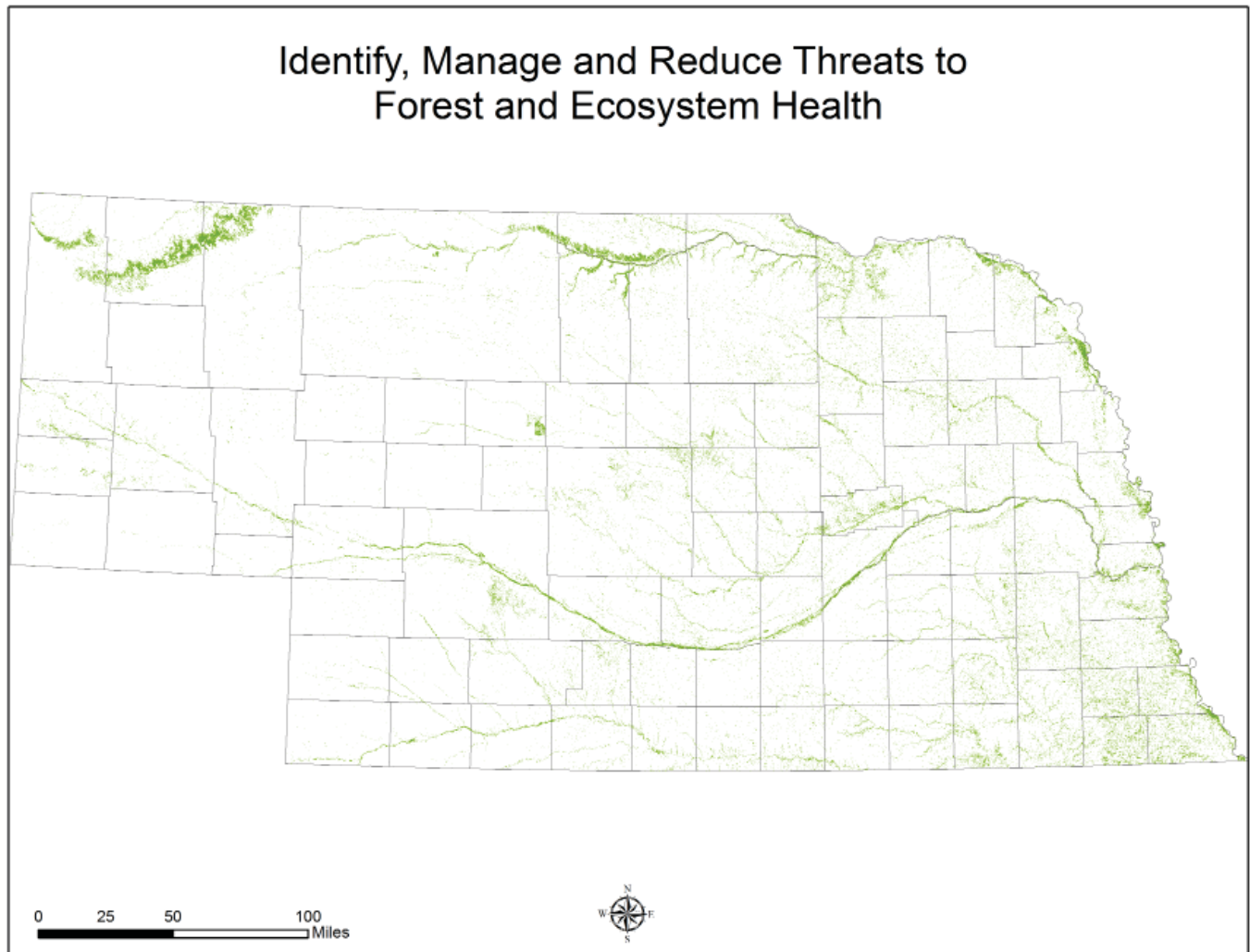
- Geospatially based mapping that includes invasive (Russian olive, saltcedar, purple loosestrife, phragmites) and aggressive native (eastern redcedar) plant species of concern.

- Updated fine-resolution (1-meter preferred) forest health risk data by insect species/disease and location.

Research needs

- What are the ecological and economic impacts of the loss of ash trees in rural forests and urban areas due to EAB?
- What are the ecological and economic impacts of the loss of black walnut trees in rural forests and urban areas due to thousand cankers disease?
- What are the most effective methods for slowing the spread of thousand cankers disease, emerald ash borer, mountain pine beetle and other forest pests?
- What tree species should be recommended for planting in communities and conservation plantings under changing climate conditions?

Figure 17. Objective 3: Identify, Manage and Reduce Threats to Forest and Ecosystem Health



Left: Native eastern redcedar can rapidly take over pastureland, forestland and riparian areas if unmanaged. Right: The ash trees in this park are at serious risk for EAB.

OBJECTIVE 4—PROTECT AND ENHANCE WATER QUALITY AND QUANTITY

Forests and sound forestry practices help protect, restore and sustain water quality, water flows and overall watershed health. Healthy urban and rural forested watersheds absorb rainfall and snow melt, slow storm runoff, recharge aquifers, sustain stream flows and filter pollutants.

By identifying areas where continued forest conservation and management is important, water quality, water flows and overall watershed health will be preserved and sustained (Figure 18).

Data layers

- priority watersheds (SAP)
- water quantity and quality by source (SAP)
- bodies of water

Desired outcomes

- Funds are targeted toward forest landscapes that preserve, protect and enhance water quality, water flows and overall watershed health.
- Aquatic ecosystems, including the plants and animals they support, are maintained and enhanced.
- Water-related recreational opportunities are maintained and enhanced through the implementation of sustainable forestry practices.
- Sustainable forestry practices in rural areas that preserve and protect water resources are increasingly implemented.
- Sustainable forestry practices that minimize urban stormwater runoff and preserve and protect water resources are increasingly implemented in urban areas.

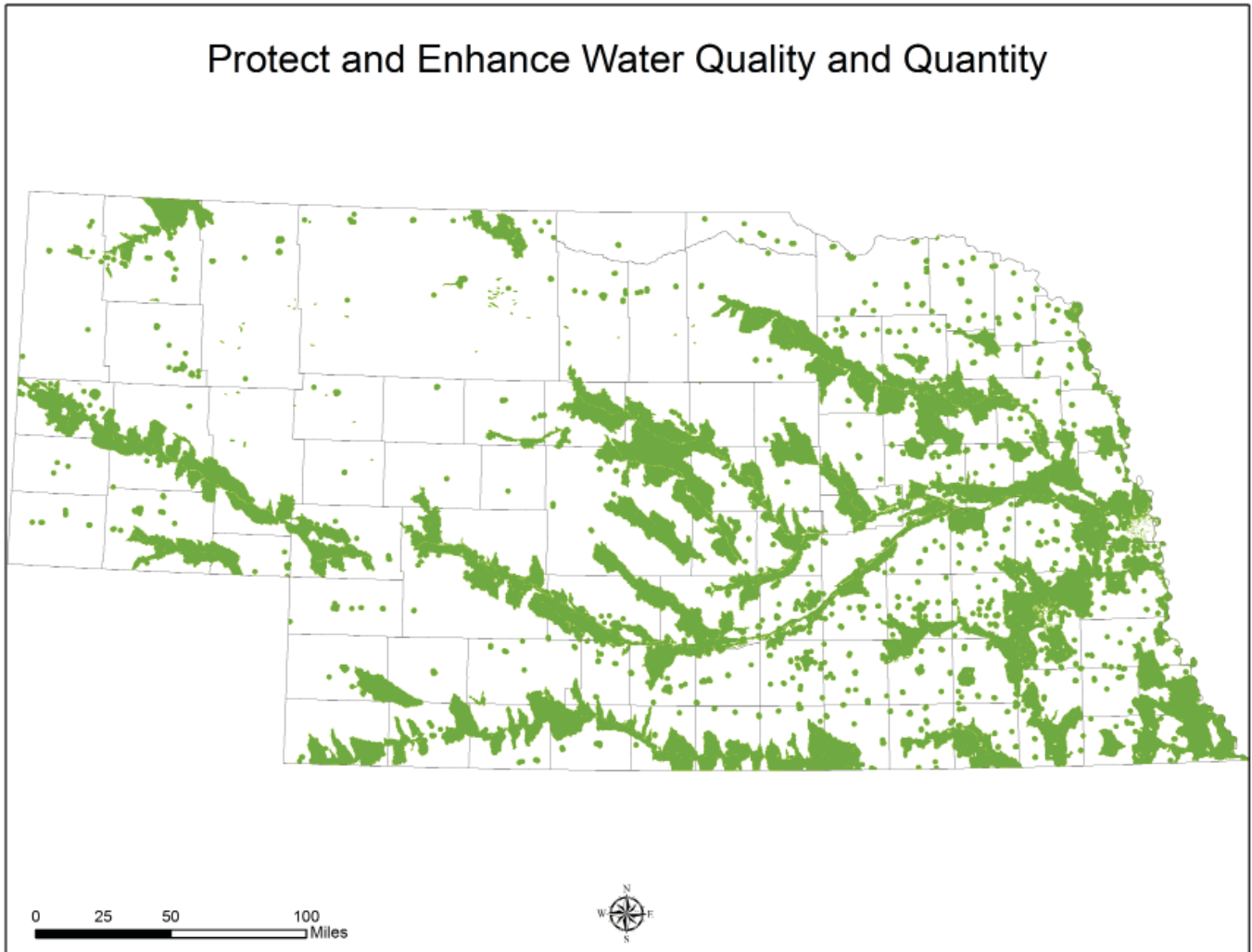
Data gaps

- Fine-resolution (1-meter preferred) mapping of riparian areas, both Ortho and color infrared.
- Fine-resolution (1-meter preferred) community forest canopy cover, both Ortho and color infrared.
- Updated Census data and development projections.

Research needs

- What are the ecological and economic impacts of the loss of ash trees in rural forests and urban areas due to EAB?
- What are the ecological and economic impacts of the loss of black walnut trees in rural forests and urban areas due to thousand cankers disease?
- Improved access to more detailed, locally available woody biomass volume information from forestlands, nonforestlands with trees and urban areas.
- What are the most effective methodologies for restoring degraded cottonwood riparian forests?
- How can riparian and other hardwood forests be sustainably managed to produce biomass and other wood products?
- What approaches maximize landowner adoption of riparian forest buffers?
- What is the current situation/trend(s) in retention/expansion of existing riparian forests, field and farmstead windbreaks and other agroforestry practices?
- What are the key factors leading to gain or loss of riparian forest acres?
- How can landscape-level impacts be best achieved through individual landowner action?

Figure18. Objective 4: Protect and Enhance Water Quality and Quantity



OBJECTIVE 5—IMPROVE AIR QUALITY AND CONSERVE ENERGY

Urban and exurban forest cover, including agroforestry plantings, can improve air quality, reduce energy consumption and produce biomass for energy production (Figure 19).

Data layers

- impervious surfaces
- change in housing density (SAP)
- canopy cover

Desired outcomes

- A community forest canopy that provides positive, measurable impacts on air quality is managed and restored.
- A community forest canopy that generates substantial energy savings is managed and restored.
- Institutions, facilities and businesses are converted to woody biomass as their energy source, where feasible.
- Encourage windbreak planting for energy conservation.
- Encourage management of existing windbreaks for energy conservation.

Data gaps

- Fine-resolution (1-meter preferred) community forest canopy cover, both Ortho and color infrared.
- Geospatially based woody biomass data.
- Fine-resolution (1-meter preferred) forest canopy cover, including riparian areas.
- Geospatially based mapping of windbreaks.

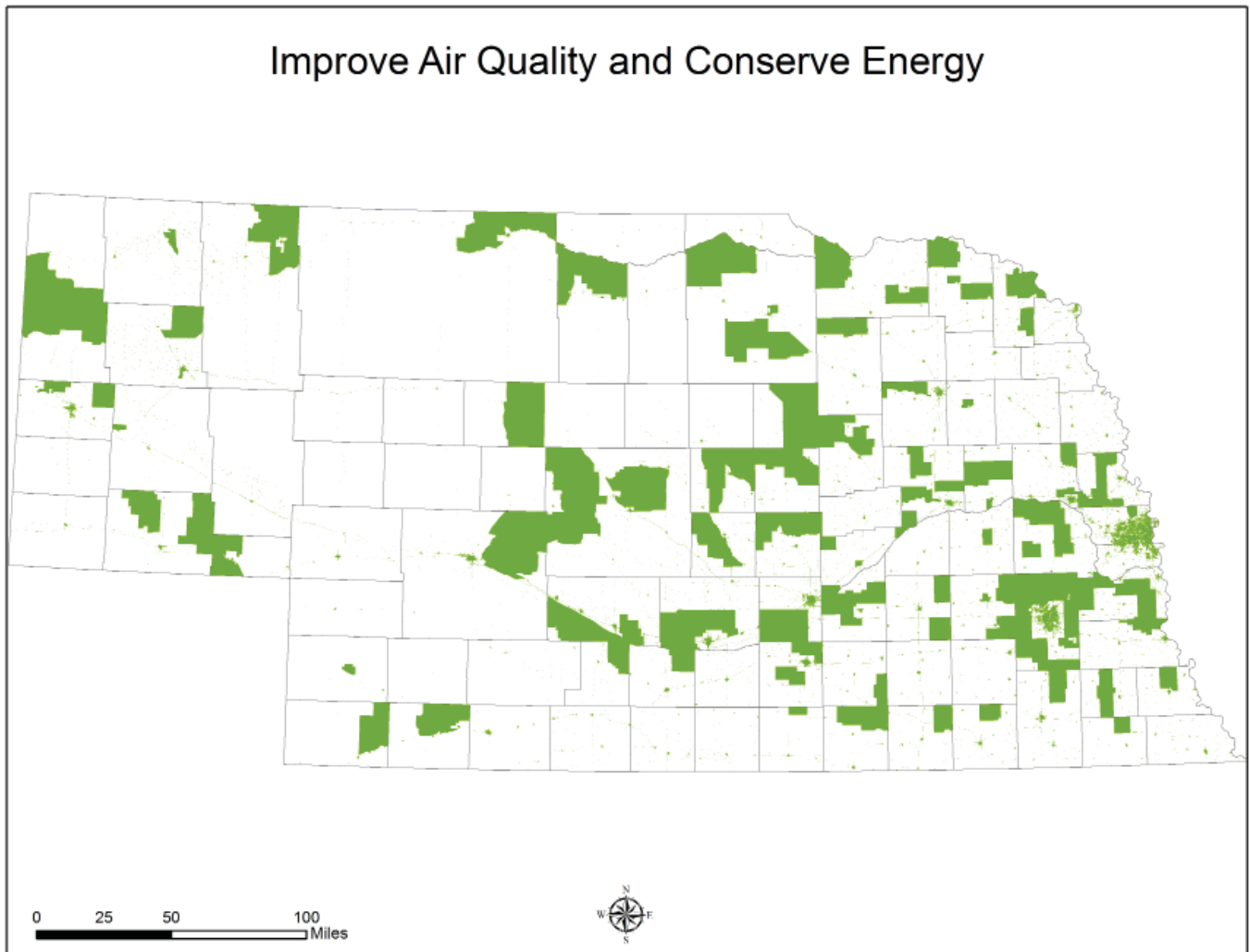
Research needs

- What approaches maximize landowner/acreage owner adoption of field and

farmstead windbreaks?

- What approaches are the most effective in maximizing or stimulating community tree planting?
- What elements are both necessary and sufficient to foster increased conversion by institutions and organizations to woody biomass as their primary energy source?
- What are the economic benefits to producers and society of installing of agroforestry practices?

Figure 19. Objective 5: Improve Air Quality and Conserve Energy



Left: Community trees provide clean air, reduce energy costs, extend the life of roads and increase property values. Right: Woody biomass utilization results in significant energy cost savings and creates new markets for low-value waste wood resources. Photos: NFS.

OBJECTIVE 6—ASSIST COMMUNITIES IN PLANNING FOR AND REDUCING WILDFIRE RISKS

Communities play an essential role in reducing the risks of catastrophic wildland fire. NFS programs assist communities in identifying wildland fire risks, developing community wildfire protection plans and promoting Firewise and other risk-reducing policies and actions.

Some communities adjacent to and within forested areas are particularly prone to loss of life and property from wildland fire. Local or state laws, regulations and ordinances; landowner attitudes; and priorities and public policies all play important roles in managing communities' fire risk (Figure 20).

Data layers

- WUI
- community wildfire protection plans
- wildfire risk (SAP)

Desired outcomes

- Homeowners and communities in at-risk areas are educated about and engaged in Firewise practices.
- Training, assistance and equipment are provided to Nebraska's rural volunteer fire districts to enhance their fire suppression and prevention effectiveness and safety.
- Increasing number of communities are covered by CWPPs.

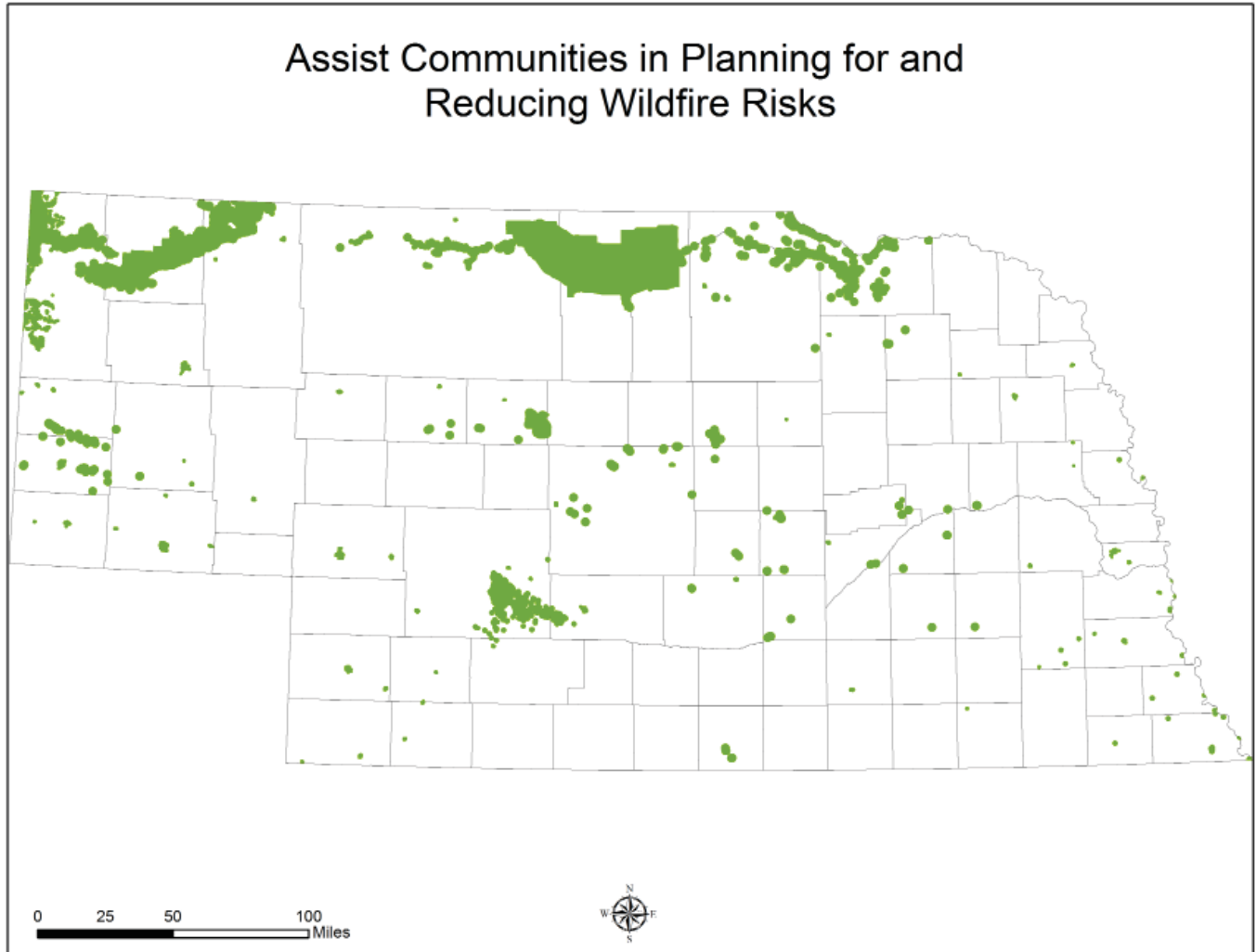
Data gaps

- Updated fine-resolution (1-meter preferred) fire risk map that includes variables such as drought or human development/interaction and includes all areas at risk to wildland fires (e.g., grassland, forested areas).
- WUI map based off a nationally developed standard definition of the WUI.

Research needs

- Customized fuels/fire behavior models for Pine Ridge ponderosa pine forests; Niobrara Valley ponderosa pine, eastern redcedar and bur oak forests; and eastern redcedar/hardwood riparian forests.
- Determination of residual stocking densities in ponderosa pine forests that maximize timber and grass production, thus economic output.
- How can programs be best designed to maximize landscape-level wildfire risk reduction through fuels reduction on individual forest parcels?

Figure 20. Objective 6: Assist Communities in Planning for and Reducing Wildfire Risks



This vehicle was acquired by NFS through the Federal Excess Personal Property Program, brought up to firefighting specifications at the NFS Fire Shop near Mead and placed on loan to the Fremont Rural Fire Department. Photo: NFS.

OBJECTIVE 7—MAINTAIN AND ENHANCE THE ECONOMIC BENEFITS AND VALUES OF TREES AND FORESTS

Forested areas present opportunities for economic development through specialty forest products, traditional forest products, woody biomass and ecosystem services.

Desired outcomes

- Market development is fostered where there is a real, near-term potential to support markets for traditional forest products, specialty forest products, woody biomass or ecosystem services.
- Associated infrastructure necessary to support forest product markets is developed.
- Increased implementation of sustainable management of forested landscapes to ensure continued supply of timber and biomass and subsequent productivity and viability of forest product industries.
- Increased implementation of sustainable harvesting practices that maintains and enhances the health and productivity of forests and does not compromise other benefits provided by forest landscapes.
- Increased establishment of agroforestry/conservation tree plantings to increase adjacent crop-ground yields, reduce soil erosion, reduce snow removal costs on transportation routes, improve livestock health and growth, reduce energy costs and provide ecosystem services across the local rural landscape.

Data gaps

- Fine-resolution (1-meter preferred) community forest canopy cover, both Ortho and color infrared.
- Geospatially based woody biomass data.
- Fine-resolution (1-meter preferred) forest

canopy cover, including riparian areas.

Research needs:

- What economic impacts do NFS's programs have on Nebraska's economy?
- What are the economic benefits to producers and to society from the installation of agroforestry practices?
- What economic impacts do trees and forests have on Nebraska's economy?
- What are the opinions of landowners and producers of their agroforestry and forestry (perceived) needs, willingness to install agroforestry plantings, incentives needed and barriers to adaptation?
- What policy changes are needed to foster increased tree planting in both urban and rural areas?
- What are the potential economic impacts of ecosystem markets on individual landowner incomes?
- What are the potential economic impacts of ecosystem markets aggregated statewide?
- What is the optimal means for landowner participation in ecosystem services markets?



Clockwise from top left: Cottonwood trees account for almost 80% of the industrial roundwood processed in Nebraska; marketable woody florals can be integrated into agroforestry systems; a black walnut stand near St. Paul; hybrid hazelnuts and other specialty forest products have the potential to offer diversified farm and nonfarm income in the state. Photos: NFS.

OBJECTIVE 8—PROTECT, CONSERVE AND ENHANCE FISH AND WILDLIFE HABITAT

Protecting, conserving and enhancing forested habitat are critical to maintaining and enhancing biodiversity and many of the recreational benefits associated with Nebraska’s forests. Major threats to fish and wildlife habitat include land fragmentation, urbanization, invasive and aggressive native species, insects and diseases (Figure 21).

Data layers

- threatened and endangered species habitat
- public lands
- Forest Legacy areas
- state wildlife action plan data

Desired outcomes

- Forest landscapes that represent or contribute to viable wildlife habitats (contiguous or connected), contain high species richness, endemism and/or that represent core habitat or focal conservation species (i.e., species of concern, threatened and endangered species or keystone species that are representative of a healthy ecosystem) are preserved, protected and enhanced.

Data gaps

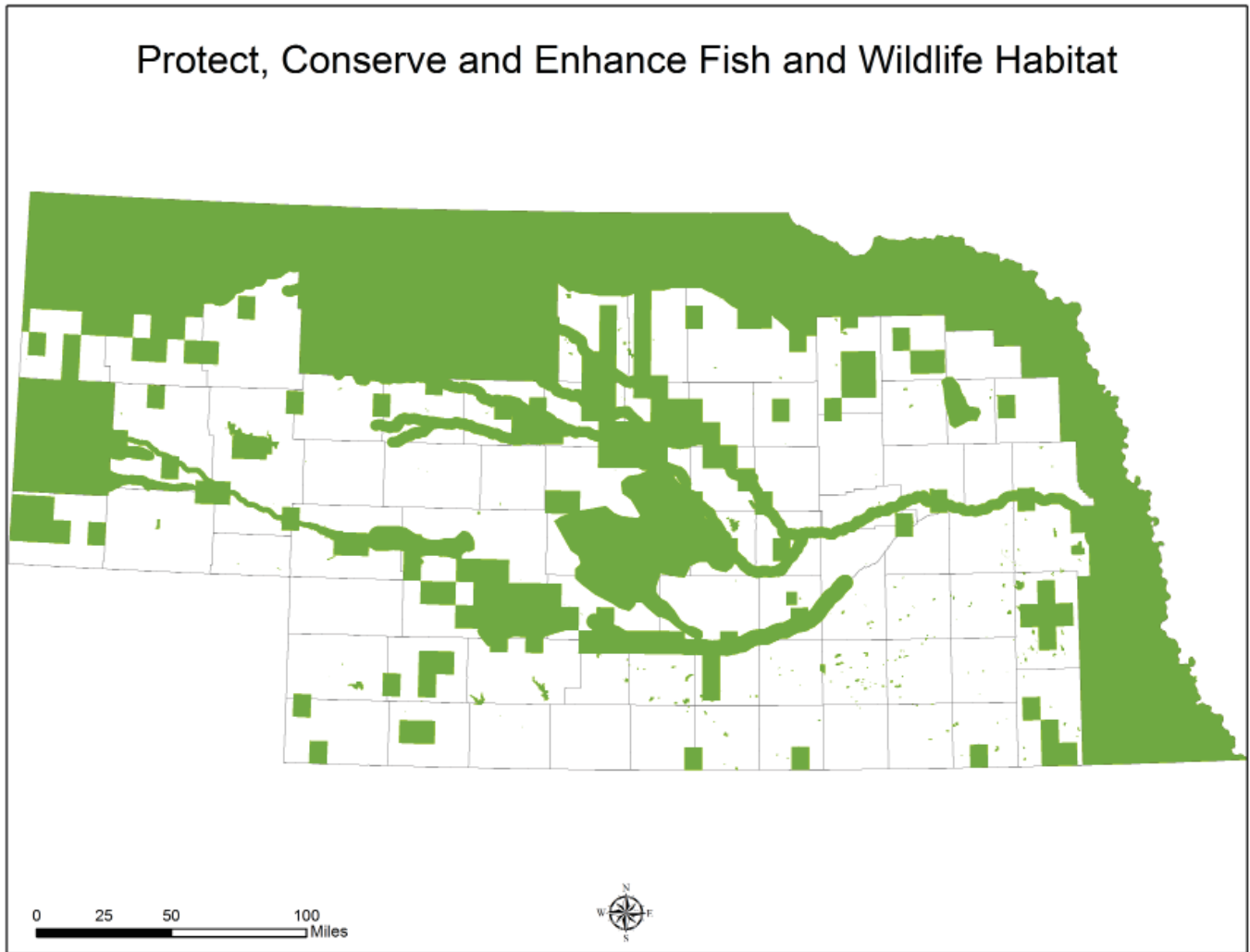
- Geospatially based woody biomass data.
- Fine-resolution (1-meter preferred) forest canopy cover, including riparian areas.
- Geospatially based mapping of windbreaks.
- Geospatially based mapping that includes invasive (Russian olive, saltcedar, purple loosestrife, phragmites) and aggressive native (eastern redcedar) plant species of concern.
- Updated fine-resolution (1-meter preferred) forest health risk data.

- Threatened and endangered species data that is finer than 30-meter resolution.
- Forestation trends.

Research needs

- What density, type and arrangement of agroforest systems (using trees and shrubs) optimize wildlife habitat in agriculture-dominated landscapes?
- How can western ponderosa pine forests be optimally managed as silvopastoral systems in ways that maximize forage and wood production; reduce fuel loads and risk of catastrophic wildland fire; reduce risk of spread of invasive species; and optimize forest health and wildlife habitat for select species?
- What deer population densities will permit natural or artificial regeneration of valuable tree species and forest systems?
- What is the impact of forest fuels reduction operations on fish habitat in streams and river systems?

Figure 21. Objective 8: Protect, Conserve and Enhance Fish and Wildlife Habitat



Trees regulate water temperature and provide both habitat and food for wildlife and aquatic species. Bluegill photo: Eric Engbretson, U.S. Fish & Wildlife Service; wildlife habitat planting photo: NFS.

OBJECTIVE 9—CONNECT PEOPLE TO TREES AND FORESTS AND ENGAGE THEM IN ENVIRONMENTAL STEWARDSHIP ACTIVITIES

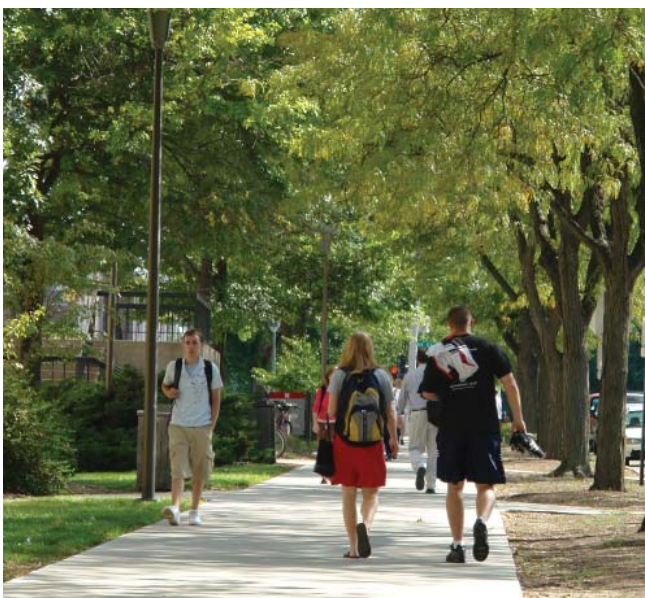
Nebraska’s forests are natural backyards for many communities and serve as a connection between people and nature (Figure 22).

Data layers

- census data (population concentration)
- recreation and trail networks
- hunting and fishing areas

Desired outcomes

- Green infrastructure that effectively connects people with their natural environment is conserved and enhanced.
- Citizens are educated about the importance of proactive management to maintain the sustainability, health and productivity of Nebraska’s forests. Citizens are educated about the benefits provided by Nebraska’s trees and forests.
- Opportunities for individuals to recreate while gaining appreciation for the importance of forests and natural areas are preserved and created.



- Sustainable forestry practices in rural areas that preserve and protect water resources are increasingly implemented.
- Citizens are educated about opportunities provided by the development of emerging carbon markets.

Data gaps

- Fine-resolution (1-meter preferred) community forest canopy cover, both Ortho and color infrared.
- Community greenways or infrastructure.

Research needs

- What do specific groups of people think about the role, value and importance of trees and forests in Nebraska?
- What is the knowledge level of specific groups of people regarding the extent, value and importance of trees and forests in Nebraska?

Below left: Public landscapes rich in community trees are more attractive and comfortable than similar settings lacking tree cover. Below right and opposite page: Tourism and outdoor recreation are strongly associated with Nebraska’s forest resources. Photos: NFS.

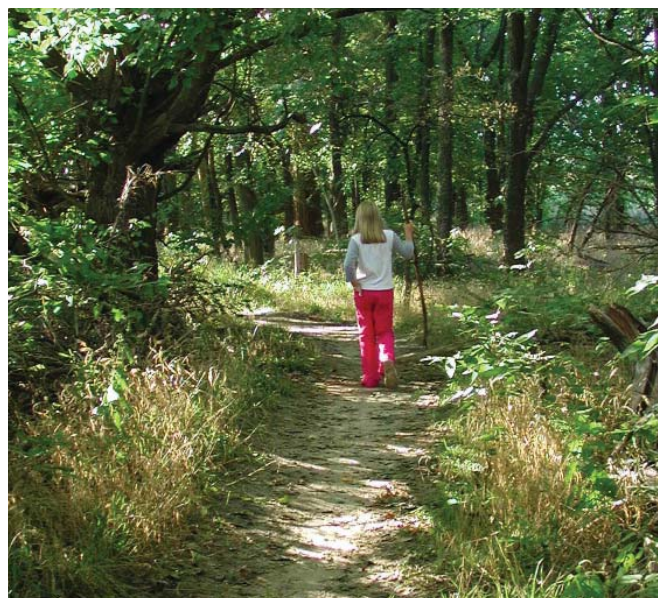
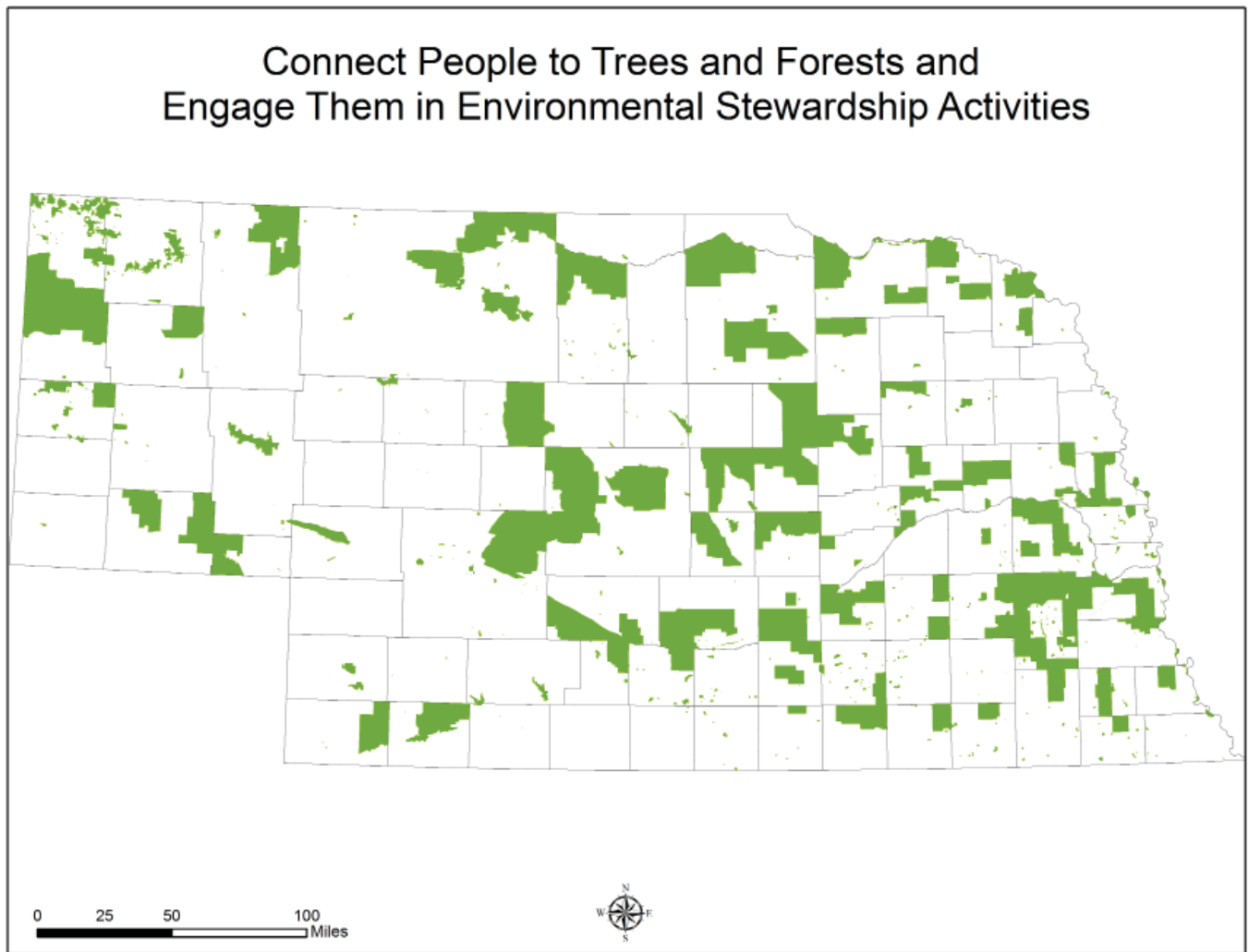


Figure 22. Objective 9: Connect People to Trees and Forests and Engage Them in Environmental Stewardship Activities



OBJECTIVE 10—MANAGE AND RESTORE TREES AND FORESTS TO MITIGATE AND ADAPT TO GLOBAL CLIMATE CHANGE

Nebraska’s forests offset significant carbon emissions, and additional climate change mitigation benefits could be achieved through partnerships and management measures that promote woody biomass energy, tree planting for energy efficiency and tree planting for improved air and water quality. Because forests’ important benefits, including biodiversity, wildlife habitat and protection of water quality and quantity, are also impacted by climate change, preserving forest landscapes is paramount in ensuring that these benefits are sustained (Figure 23).

Data layers

- potentially affected forests

Desired outcomes

- A forest canopy that generates substantial energy savings is managed and restored.
- Institutions, facilities and businesses are converted to woody biomass energy, where feasible.
- Funds are targeted toward forest landscapes that preserve, protect and enhance water quality, water flows and overall watershed health.
- Water-related recreational opportunities are maintained and enhanced through the implementation of sustainable forestry practices.
- Sustainable forestry practices that preserve and protect water resources are increasingly implemented in rural areas.
- Sustainable forestry practices that minimize urban stormwater runoff and preserve and protect water resources are increasingly implemented in urban areas.
- Forest productivity, growth and carbon

sequestration is enhanced through forest stand improvement activities.

- Citizens are educated about opportunities provided by the development of emerging carbon markets.
- Resilient, connected forest ecosystems that continue providing these benefits in a changing climate are preserved, protected and enhanced.

Data gaps

- Climate change models that are more specific to Nebraska and the Great Plains.
- Fine-resolution (1-meter preferred) forest canopy cover, including riparian areas.
- Geospatially based mapping of windbreaks.
- Geospatially based mapping that includes invasive (Russian olive, saltcedar, purple loosestrife, phragmites) and aggressive native (eastern redcedar) plant species of concern.
- Updated fine-resolution (1-meter preferred) forest health risk data.
- Fine-resolution (1-meter preferred) community forest canopy cover, both Ortho and color infrared.

Research needs

- What will be the impacts of climate change on Nebraska’s tree and forest resources?
- What specific actions need to be taken to best mitigate and reduce the severity of the impacts of climate change?
- Improved access to more detailed, locally available woody biomass volume information from forestlands, nonforestlands with trees and urban areas.

Figure 23. Objective 10: Manage and Restore Trees and Forests to Mitigate and Adapt to Global Climate Change





CHAPTER 6: NEBRASKA FOREST SERVICE PRIORITY FOREST LANDSCAPES

Nebraska's terrain slopes gently upward to the northwest with elevation increasing by an average rate of two meters per kilometer. Nebraska's lowest elevation (840 feet above sea level) lies along the Missouri River in Richardson County (southeast Nebraska), and the highest point (5,424 feet above sea level) is in Kimball County in the Panhandle.

The state has highly fertile and productive soils derived from alluvial, colluvial or glacial deposits. Sandhills soils, occupying much of north-central Nebraska, are derived from wind-blown sand. Elsewhere, the soils have formed from wind-blown silt and clay or loess (extremely fine loam deposited by the wind).

Through its Forest Inventory Assessment program, the USFS defines forestland as, "land that is at least 10% stocked by trees of any size or formerly having had such tree cover and not currently developed for nonforest use. The area with trees must be at least 1 acre in size and wooded strips, such as those along roads, streams and agricultural fields, must be at least 120 feet wide and 363 feet long to qualify as forestland" (Meneguzzo, et al., 2008).

By this definition, Nebraska has 1.24 million

acres of forestland that contain nearly 352 million live trees and represent a unique mix of vegetation types, including central hardwood forests representative of the eastern United States; ponderosa pine forests representative of the Rocky Mountains; and birch/aspen forests representative of northern boreal forests (Meneguzzo, et al., 2008). These forest types, combined with elm-ash-cottonwood riparian forests, mixed conifer forests, conservation tree plantings and urban forests, create a highly diverse and unique array of tree and forest resources growing within an agricultural and range landscape.

With the addition of nonforestland with trees, conservation plantings and community forests, the total number of acres of primary treed or forested areas is approximately 3.3 million acres, as described in Table 7 and the text that follows.

Approximately 85% (slightly more than 1 million acres) of Nebraska's forestland is privately owned, and approximately 34,000 acres are owned by private entities, corporations, tribes and other groups. (Figures 24 & 25).

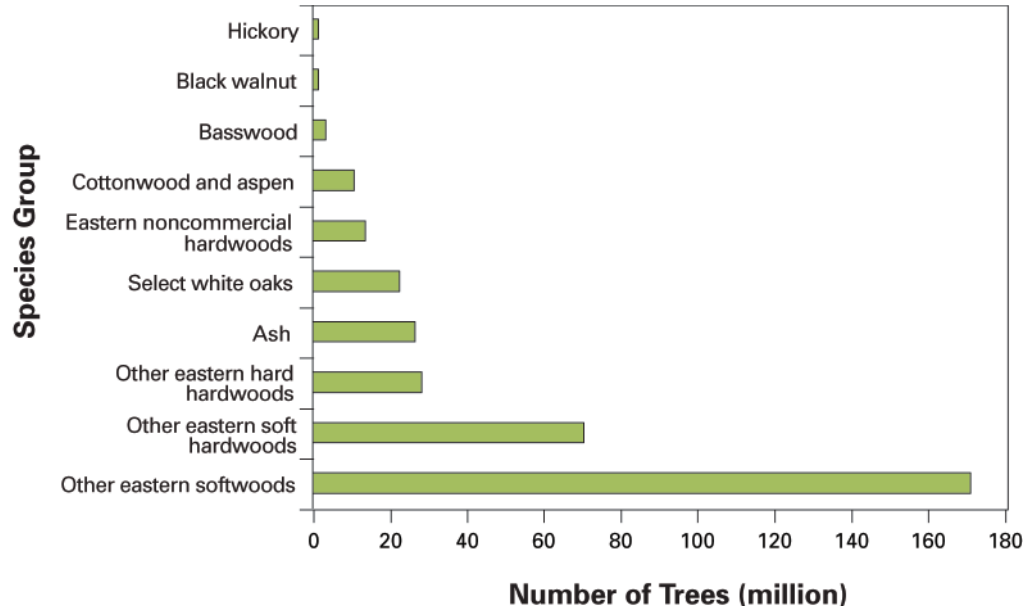
In addition to forestland acres, Nebraska

Table 7. Nebraska's Primary Forested Areas & Their Extent

Forested Area/Nonforest with Tree Area	Extent (Acres)
Pine Ridge	107,232
Wildcat Hills	10,499
Loess Canyons	15,811
Niobrara Valley	225,000
Central Loess Hills	24,632
Missouri River	209,733
Nemaha River	97,599
Big and Little Blue River	109,046
Platte River	225,978
Republican River	80,487
Loup River	104,290
Elkhorn River	76,608
Nonforestland with Trees (no specific function)	1,112,877
Nonforestland with Trees Providing Conservation Value	423,098
Urban/Community Forests	470,000
TOTAL AREA WITH TREES/FORESTS	3,292,890

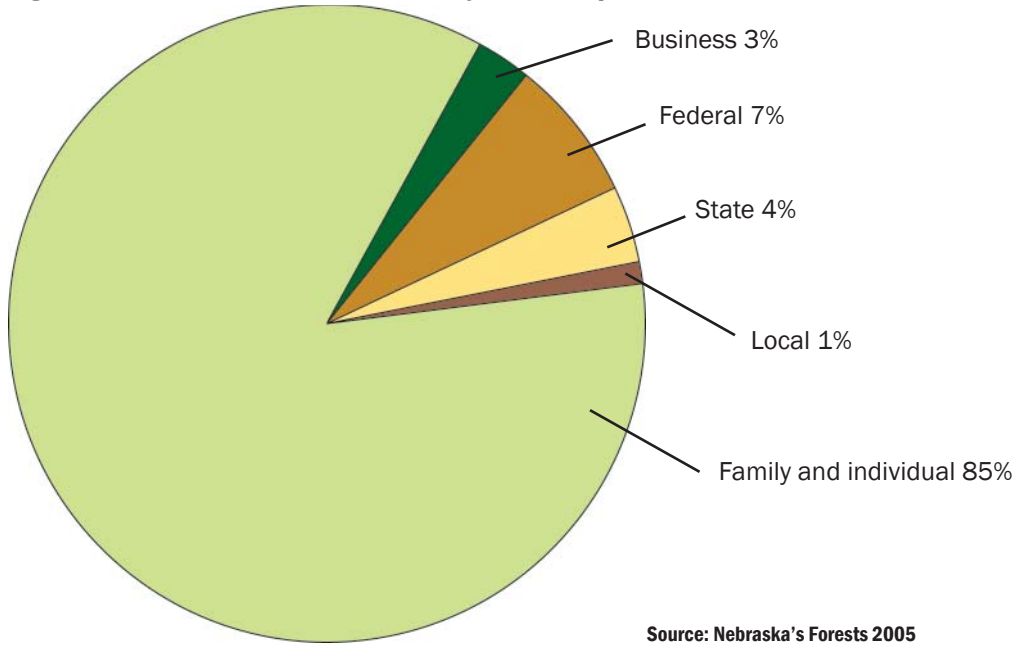
Source: Great Plains Initiative Inventory, 2008-2009

Figure 24. Top 10 Species Groups on Forestland



Source: Nebraska's Forests 2005

Figure 25. Distribution of Forestland by Ownership Class



has an estimated 1.5 million acres of *rural nonforestland* (defined as less than one acre, less than 120 feet wide and less than 10% stocked) with approximately 119 million live trees across the state (Table 8). Dominant species in these areas are eastern redcedar, Siberian elm, hackberry, red mulberry and ash (Table 9). These trees provide unique benefits such as rural home wind protection, snow drift management, energy savings, livestock protection, crop protection and yield increases, water quality and soil protection, wildlife habitat and other ecosystem services. Although not large units individually, combined these areas are important components that provide key and

essential ecosystem services in Nebraska's rural agriculture-dominated landscape.

NFS's Rural Forestry (Forest Stewardship) Program plays a central role in managing and preserving Nebraska's rural forests and nonforestland with trees. Through this program, rural forest landowners receive technical assistance from NFS field foresters in forest and woodlot management; windbreak establishment and management; tree planting; reforestation; and other forestry-related issues. Since 1991, NFS foresters have developed 905 forest stewardship plans placing 110,556 acres of private forest lands under management (NFS, 2010) (Figure 26).

Table 8. Acres of Nebraska's Rural Nonforestland With Trees*

	Acres
Areas with isolated/individual trees with no primary function or service	1,112,877
Areas with planted and/or managed tree units providing a primary function, service or benefit (shelterbelts, windbreaks, wildlife plantings, etc.)	254,833
Areas of natural and/or native tree units with minimal management evident yet still providing a primary function, service or benefit (narrow wooded strips, natural wooded riparian buffers, etc.)	168,265
TOTAL	1,535,974

*Nonforestland is defined as less than 1 acre in size, less than 120 feet wide and less than 10% stocked.

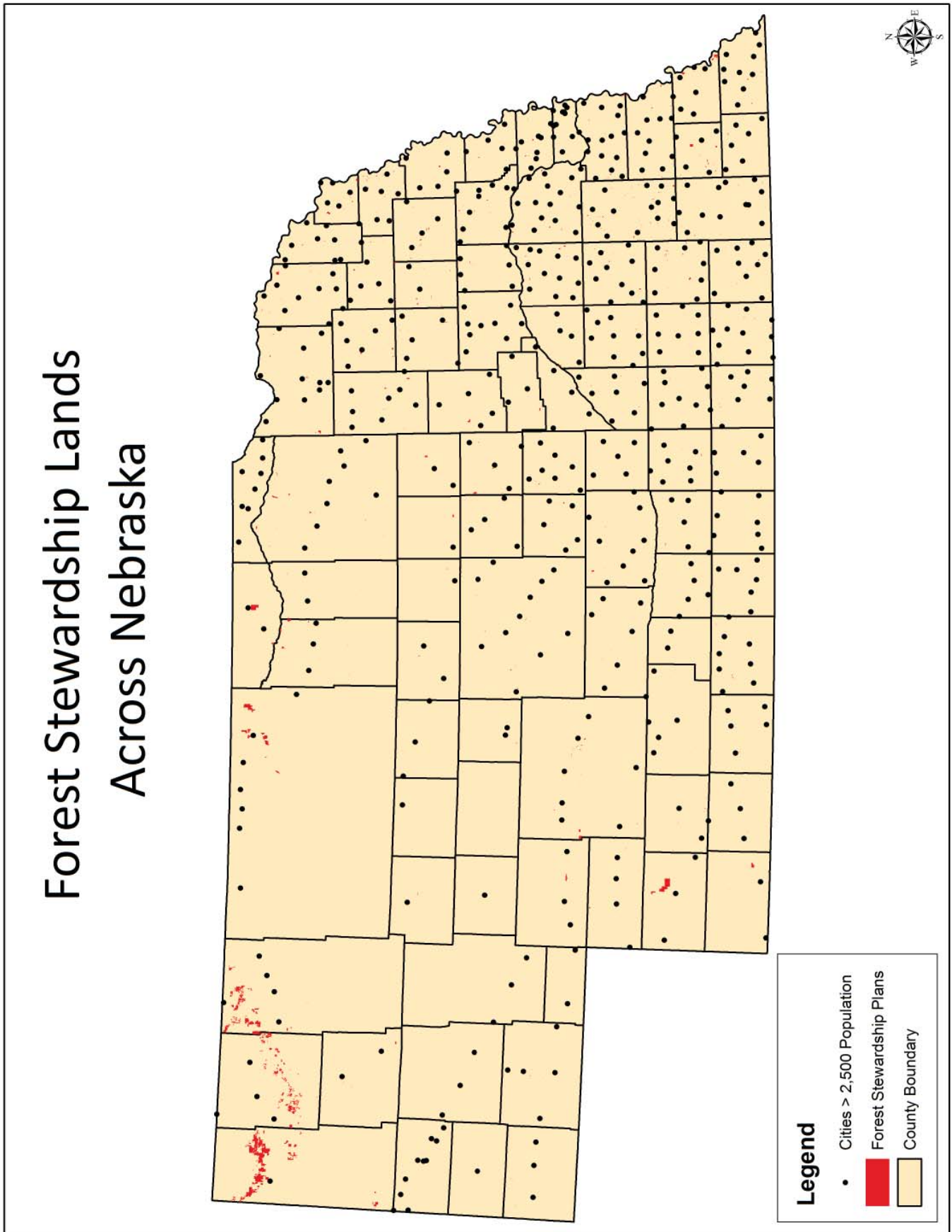
Source: Great Plains Initiative Inventory, 2008-2009

Table 9. Estimated Live Trees by Species or Genus Growing on Nebraska's Nonforestland

Species	Community or Rural Land Combined (trees)	Rural Land (trees)	Community Land (trees)
Redcedar/juniper spp.	24,184,273	23,108,069	1,076,204
Spruce spp.	485,238	56,623	428,615
Scotch pine	851,738	499,441	352,297
Ponderosa pine	167,548	147,793	19,755
Pine spp. (other than Scotch or ponderosa)	73,067	20,887	52,180
Other conifer trees (fir, hemlock, baldcypress, etc.)	42,178	-	42,178
Siberian elm	17,301,813	15,619,792	1,682,022
Hackberry spp.	13,361,994	11,253,387	2,108,607
Mulberry spp.	12,976,368	11,169,845	1,806,523
Ash spp.	11,820,328	10,808,630	1,011,698
Elm spp. (other than Sib. elm)	8,840,412	7,953,889	886,523
Cottonwood and poplar spp.	4,501,891	4,203,611	298,279
Russian olive	3,702,206	3,700,401	1,805
Honey locust spp.	3,649,989	3,405,525	244,463
Willow spp.	3,322,601	3,283,034	39,567
Boxelder	2,575,234	2,433,327	141,907
Osage-orange	2,232,014	2,186,203	45,811
Silver maple	1,140,482	919,362	221,119
White oak family (bur oak)	783,280	608,096	175,184
Walnut spp.	717,082	252,690	464,392
Other hardwood trees (hard maples, basswood, fruit trees, red oak family, birch, Kentucky coffeetree, etc.)	6,491,168	4,531,291	1,959,875
SPECIES (ALL RECORDED TOTAL)	119,220,902	106,161,897	13,059,005

Source: Great Plains Initiative Inventory, 2008-2009

Figure 26. Forest Stewardship Lands





The following forest landscapes (Figure 27) have been identified as being of high priority based on a combination of 1) geospatial analyses; 2) relevant and important nongeospatial data characterizing the value of the particular forest landscape; and 3) the seriousness and complexity of issues affecting the area.

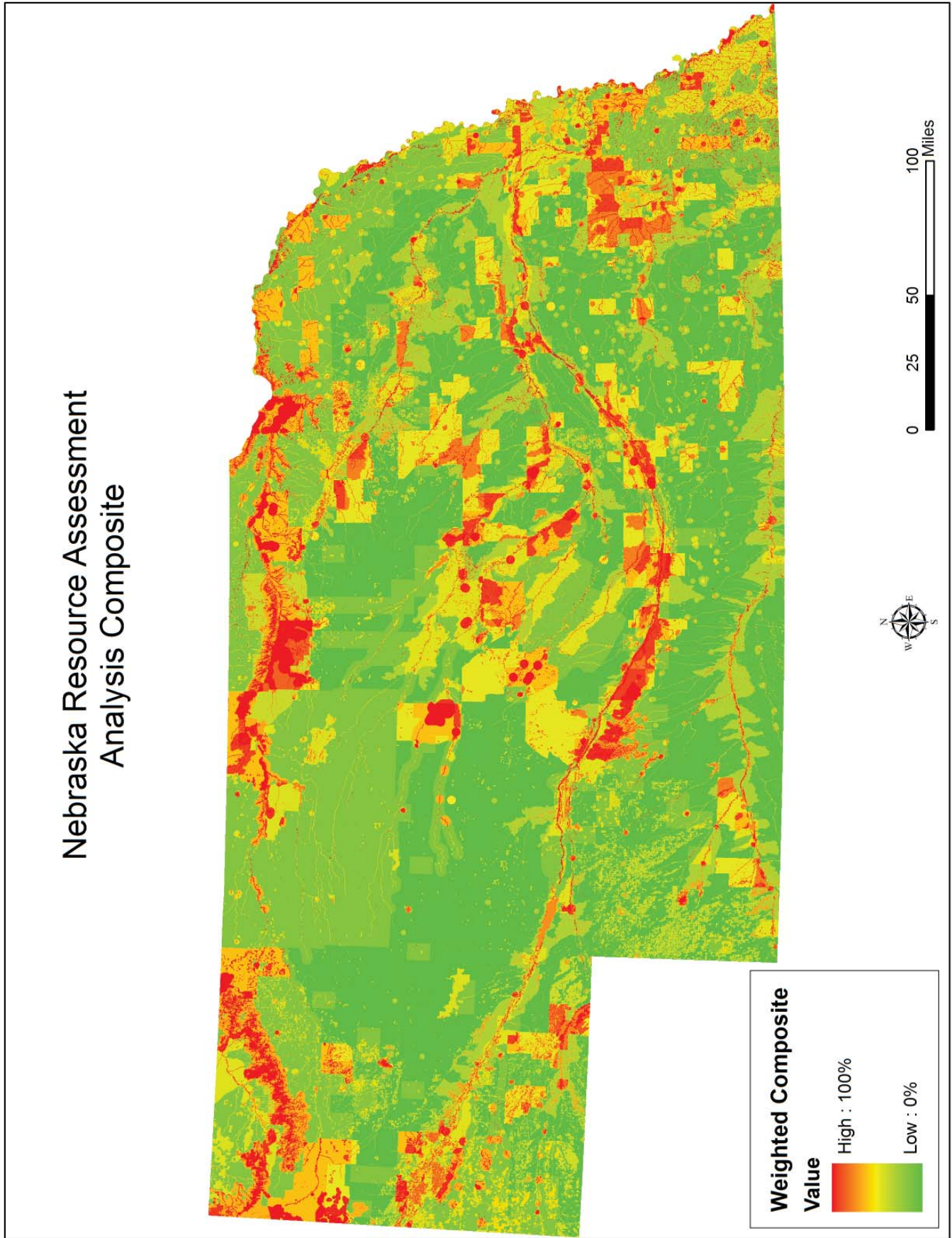
By identifying and then concentrating resources and programming in priority landscapes, NFS will help achieve landscape-level conservation, improving the natural resource base and the lives of people who depend on these resources. Geographic concentration helps reduce “random acts of conservation” by focusing scarce resources in targeted areas.

Areas not included in priority forest areas will still receive NFS programming support.



Photo: NFS

Figure 27. Nebraska's Priority Forest Landscapes



Source: NFS

PRIORITY FOREST LANDSCAPE: CONSERVATION & AGROFORESTRY PLANTINGS & TREES

Trees have long been an important component of Nebraska agriculture. Windbreaks increase crop yields, reduce soil erosion and protect livestock from weather extremes. Riparian forest buffers filter agricultural runoff and sediment, protecting water quality. Farmers who incorporate conservation plantings into traditional row-crop systems benefit from increased crop yields and reduced soil erosion.

Tree plantings are valued additions around Nebraska farmsteads and ranches that help protect buildings, livestock and equipment from the harsh Great Plains weather. It is estimated that more than 80% of active farmstead/ranch headquarters in Nebraska have some type of shelterbelt planting. Inventories conducted in 2008 and 2009 through the Great Plains Initiative showed an estimated 254,832 acres of planted and naturally occurring tree groupings in Nebraska, providing multiple conservation and environmental benefits to the owner and surrounding areas. Conservation trees enhance the quality of life and add beauty and value to farm homes and the rural landscape.

Naturally occurring ponderosa pine forests in western and north central Nebraska are

important silvopastoral systems, enabling the production of timber and simultaneous grazing of livestock. These agroforestry systems generally enhance wildlife habitat and income production, sequester carbon and create and enhance hunting opportunities.

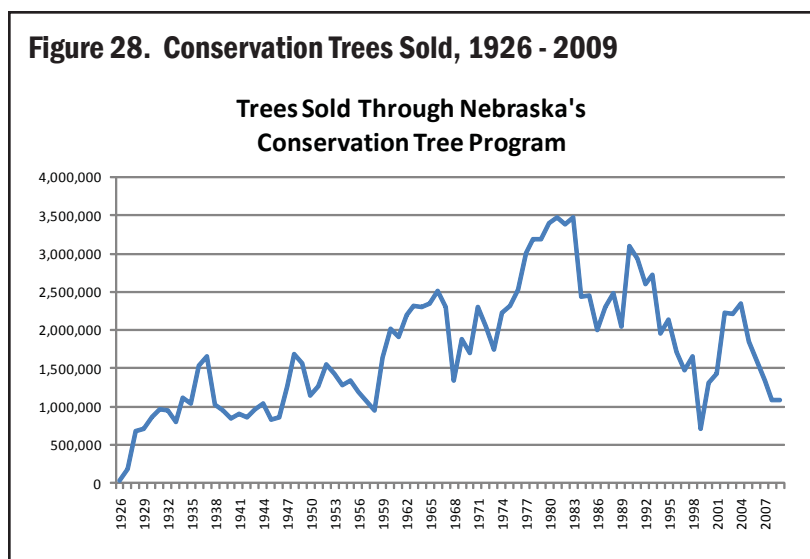
From 1926 through 2002 NFS administered the state's tree seedling distribution program, which in later years became known as the "Conservation Trees for Nebraska" program. The Nebraska program is unique because there is no state nursery or private nurseries to provide conservation seedlings. The primary source of conservation seedlings for Nebraska is the USFS' Bessey Nursery near Halsey.

Since 2002 the Conservation Trees for Nebraska program has been coordinated by the Nebraska Association of Resources Districts (NARD) with each Natural Resource District (NRD) administering their local tree program. Approximately 1 million conservation tree/shrub seedlings are distributed by Nebraska's 23 NRDs each year. Annual conservation tree/shrub seedling sales in the state have declined from a peak of more than 3 million in the 1980s to about 1 million from 2005 through 2009 (Figure 28). The decline can be attributed to a combination of factors, including fewer but larger farms and ranches; high commodity prices; high land values; drought;

large-scale expansion of pivot irrigation systems; reduced livestock production; increased planting costs; generational differences in landowner attitudes; and new conservation planting design specifications that require fewer trees.

Critical Issues:

- Dramatic decline in extent and health of conservation plantings over past several decades.
- High concentration of green ash and Scotch and Austrian pine at risk to EAB and pine wilt, respectively.



Source: Natural Resources Conservation Service Progress Reporting System, 2009

Table 10. Estimate of Nebraska's Nonforest Rural Areas with Trees 1 Inch or Larger

Planting Type	Acres of Rural Nonforest Area for Specific Function	Sample Error* (%)
No windbreak present/isolated trees without a primary function identified	1,112,877	6.77
Farmstead Windbreak	81,011	26.77
Field Windbreak	92,739	17.92
Livestock Windbreak	32,854	27.56
Living Snowfence	none sampled	-
Home Acreage Planting	12,214	53.76
Wildlife Habitat Planting	7,402	40.82
Abandoned Farmstead	1,310	100.43
Planted Riparian Forest Buffer	27,303	100.06
Natural Riparian Forest Buffer	143,707	35.22
Narrow Wooded Strip	24,558	50.62
TOTAL OF ALL AREAS OF NONFOREST ACRES WITH TREES ONE INCH OR LARGER DBH	1,535,974	3.63

*High sample error percentage indicates that relatively few plots for this planting type were measured.

Source: Great Plains Initiative Inventory, 2008-2009

Table 11. Condition of Nebraska's Conservation Trees

Acres estimates of tree plantings providing a primary function, service or benefit and their condition	Acres of Windbreak or Tree Unit (nonforest acres with 1" or > dbh)	Good Condition (acres)	Fair or Poor Condition (acres)
Planted and/or managed tree unit providing a primary function, service or benefit	206,603	116,152	90,451
Farmstead windbreak	81,011	38,095	42,915
Field windbreak	92,739	70,195	22,544
Livestock windbreak	32,854	7,862	24,992

Source: Great Plains Initiative Inventory, 2008-2009

Table 12. Conservation Practices Implemented in Nebraska 2004-2009

Year	Firebreak (feet)	Forest Stand Improvement (acres)	Riparian Forest Buffer (acres)	Tree/Shrub Establishment (acres)	Windbreak/Shelterbelt (feet)	Forestland Re-established or Improved (acres)
2004	13,794	502	464	327	3,136,042	829
2005	85,772		392	264	2,536,577	264
2006	3,125		132	476	1,804,460	476
2007		165	240	1,689	1,383,130	1,854
2008	56,451		74	6,735	1,024,260	6,735
2009	44,473	430	46	579	697,203	1,009
TOTAL	203,615	1,097	1,348	10,070	10,581,672	11,167

Source: Natural Resources Conservation Service Progress Reporting System, 2009

- Amelioration of harsh climatic conditions in the Plains, substantial large-scale impacts on crop yields and quality.
- Ability to ameliorate climate change impacts.
- Consistent and historically high value of conservation tree plantings because of a range of ecosystem services provided; cleaner air and water; and energy and water conserved.
- Economic impact of conservation forest resources on local economy (wildlife habitat, enhanced crop yields and quality, snow management).
- Herbicide damage from agricultural chemicals.



PRIORITY FOREST LANDSCAPE: COMMUNITY FORESTS

Urban and community forests are of great value in the Great Plains. To the 66% (1.2 million) of Nebraskans who live in urban, suburban and community areas, trees provide many goods and services. An urban or community forest refers to the collection of trees, shrubs and related vegetation growing in cities and towns. These areas include city parks, streetscapes and trees on public, private and commercial lands. In Nebraska there are approximately 470,000 acres of community forests (NFS, 2007). A large and diverse number of tree species are found in the community forest with the typical forest resource being dominated by hackberry, red mulberry, Siberian elm, juniper (*Juniperus spp.*), elm, ash and mixed hardwood and evergreen species (Figure 29). In Lincoln and Omaha, the state's two largest cities, the most common species are Siberian elm,

hackberry, eastern redcedar, ash, red mulberry, Scotch pine and mixed hardwood species (Figures 30 and 31). This "green infrastructure" provides many valuable benefits important to human and ecological health (Nowak and Greenfield, 2010) including:

- storing 1.5 million tons of carbon, at a value of \$31.9 million;
- sequestering 50,706 tons of carbon/year, at a value of \$1 million; and
- removing 1,146 tons of total pollutants/year, at a value of \$8.4 million:
 - 20 tons of carbon monoxide/year (value of \$24,600);
 - 205 tons of nitrogen dioxide/year (value of \$1.8 million);
 - 440 tons of ozone/year (value of \$4 million);



Photo: NFS

Figure 29. Statewide Community Forest Species

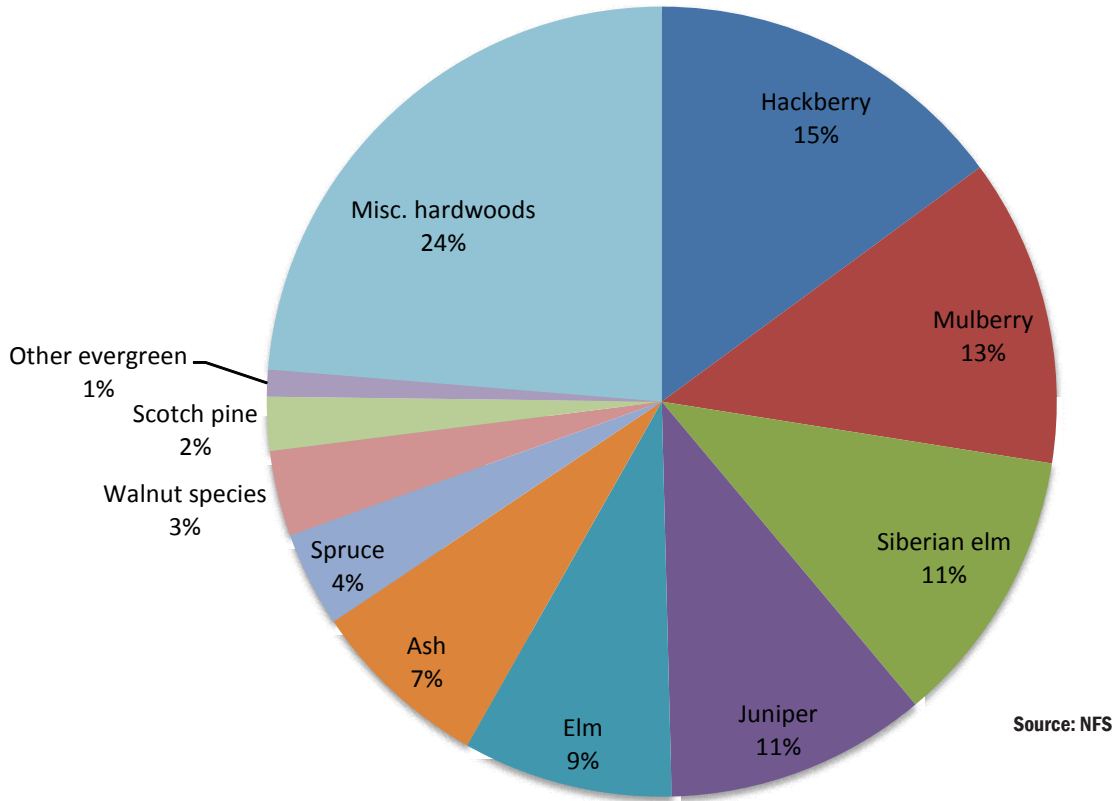


Figure 30. Omaha Forest Resource by Species

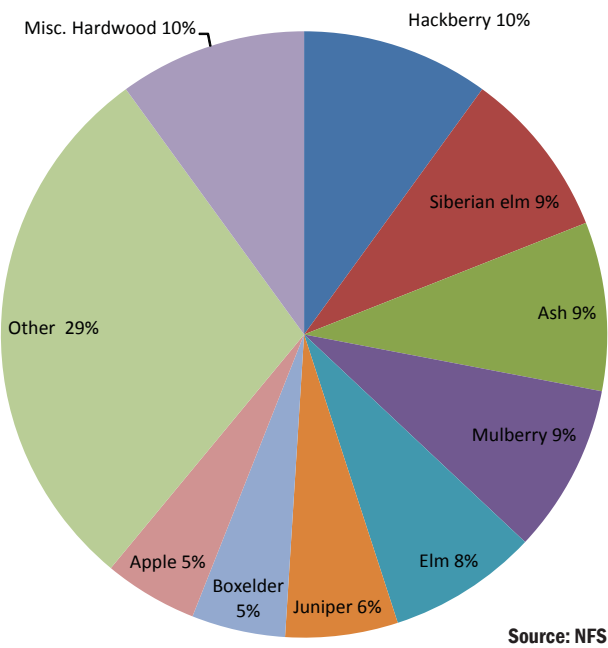
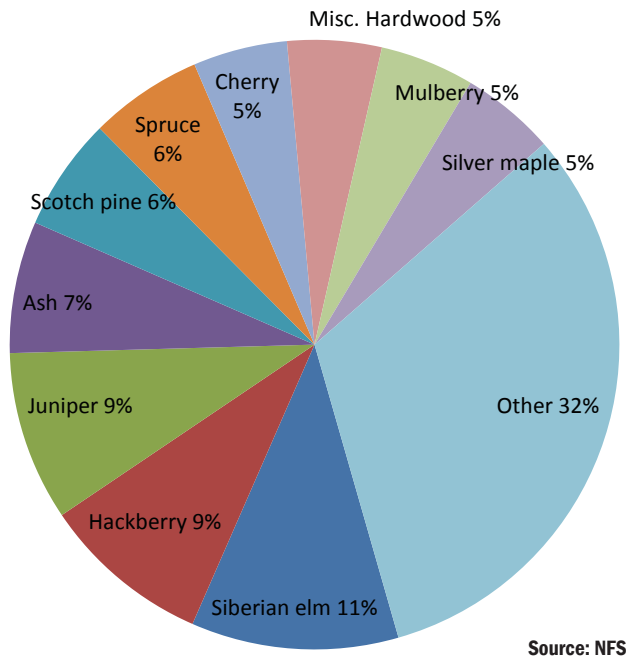


Figure 31. Lincoln Forest Resource by Species



- 68 tons of sulfur dioxide/year (value of \$150,200); and
- 410 tons of particulate matter/year (value of \$2.5 million).

Other measurable benefits of Nebraska’s urban and community forest resource include:

- surface air temperature reduction;
- increased energy efficiency and reduced fossil fuels use;
- absorption of ultraviolet radiation;
- improved water quality;
- reduced noise pollution;
- improved human comfort, health and psychological well being;
- increased property values;
- provision of wildlife habitat;
- improved aesthetics; and
- improved community cohesion.

There are 503 Nebraska municipalities (League of Nebraska Municipalities, 2009) (Table 13). Based on 2010 U.S. Census data, Nebraska has a population of 1,826,341, with three-quarters residing in the eastern third of the state (U.S. Census, 2011; Nebraska Blue Book, 2009). Two-thirds of the population lives within communities that have a population of 2,500 or more people (Nebraska Blue Book, 2009). The trees and forests in all Nebraska communities provide a range of enormously valuable environmental, social and economic benefits. On average, every dollar invested in the community forest resource returns an average of \$2.70 in net annual benefits over the lifespan of a publicly owned municipal tree (McPherson et al., 2005).

NFS’s Community Forestry & Sustainable Landscape program annually cooperates with more than 140 communities. One of

Table 13. Nebraska Municipal Classifications

Metro	300,000 or more	Omaha
Primary	100,001 to 299,999	Lincoln
First Class	5,001-100,000	30
Second Class	801-5,000	116
Village	100-800	382
TOTAL		503

Source: Nebraska League of Municipalities, 2009

the cornerstones of this program effort is the national Tree City USA program sponsored by the Arbor Day Foundation and administered statewide by NFS. Participating communities must meet four standards set by the Arbor Day Foundation including:

1. Existing tree board or department.
2. Established tree care ordinance.
3. Community forestry program with an annual budget of at least \$2 per capita.
4. Arbor Day observation and proclamation.

These standards provide the framework for annual and systematic tree management. Begun in 1976, the Tree City USA program has grown in Nebraska to involve the annual certification of more than 100 communities representing more than 66% of the state’s population. These communities annually invest more than \$5 million in the care and management of local community forest resources with an average per capita expenditure of \$4.93.

In 2010, NFS inventories and calculations using UFORE (Urban Forest Effects Model) estimated that there were approximately 13.3 million trees in Nebraska communities (Table 14). Collectively, the community forests of Nebraska have an average tree cover of 11.3% with a total value of environmental, social and economic benefits to the state of \$9.7 billion (Figure 32).

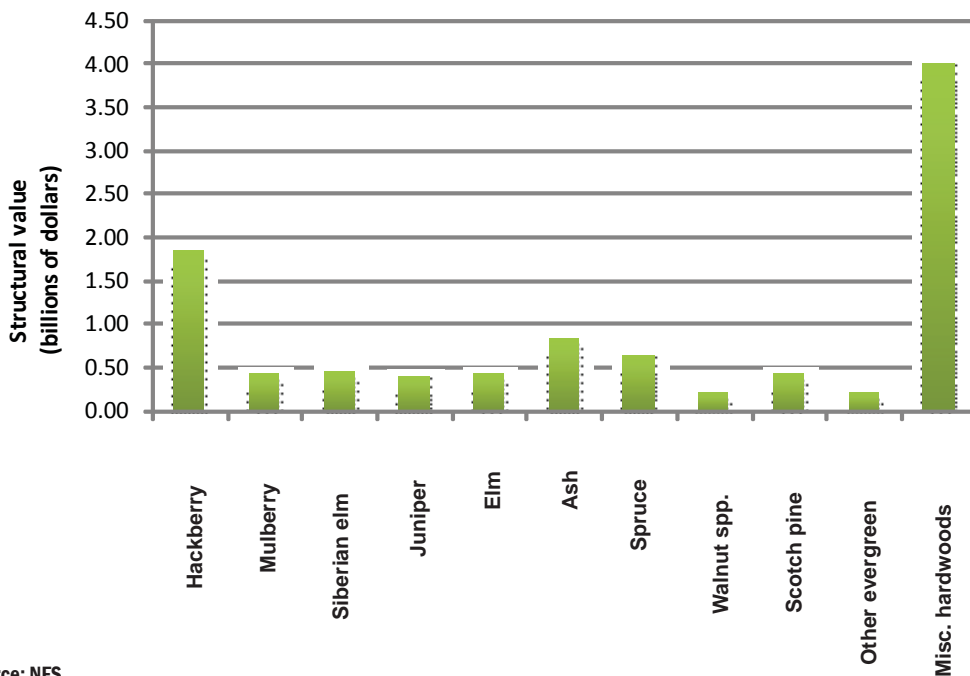
A 2010 UFORE analysis of Lincoln and Omaha, which collectively represent approximately 40%

Table 14. Summary of Nebraska’s Community Trees

Feature	Measure
Number of Trees	13,317,398
Tree Cover	11.30%
Most Common Species	Hackberry, mulberry, Siberian elm, juniper, elm, ash
Percent of Trees < 6 Inches in Diameter	23%
Carbon Storage	2,096,338 tons (\$39,830,000)
Carbon Sequestration	84,527 tons/year (\$1,606,000/year)
TOTAL ENVIRONMENTAL, SOCIAL & ECONOMIC BENEFITS	\$9.7 billion

Source: NFS

Figure 32. Value of Nebraska’s Community Trees



Source: NFS

of the state’s 1.79 million residents, determined there are more than 5.4 million trees in the two cities. These trees provide \$20.1 million worth of carbon storage, \$747,200/year of carbon sequestration and have a structural value of \$3.98 billion (Table 15).

The extent of Nebraska’s urban and community forest resources have steadily declined in recent years. A combination of severe weather events (1991 freeze, 1997 snow storm, 2007 ice storm, tornadoes and high winds), chronic drought, poor planting practices, poor species

selection, insect and disease pests and a preponderance of older trees nearing or past their average life span have severely reduced the number of trees in communities across the state. Trends gleaned from more than 200 community tree inventories conducted by NFS since 1977 indicate that the state has lost approximately 50% of its urban and community forest resource since the late 1970s (NFS, 2007).

Nebraska’s urban and community forest resource faces additional threats. Various

Table 15. Lincoln & Omaha Forest Resource Summary

Feature	Lincoln	Omaha	Total
Number of Trees	1,511,389	3,925,135	5,436,524
Tree Cover	15.8%	21.2%	18.5%
Most Common Species	Siberian elm, hackberry, eastern redcedar, ash, Scotch pine	mixed hardwood, hackberry, Siberian elm, ash, mulberry	n/a
Percent of Trees < 9 Inches in Diameter	65%	78%	72%
Carbon Storage	320,972 tons (\$6.4 million)	689,084 tons (\$13.7 million)	1,010,056 tons (\$20.1 million)
Carbon Sequestration	12,347 tons/year (\$246,940/year)	25,015 tons/year (\$500,300/year)	37,362 tons/year (\$747,200/year)
Structural Value	\$1,426,151,669	\$2,553,650,935	\$3.98 billion

Source: NFS

insects and diseases, with the potential to kill trees and reduce the health, value and sustainability of local tree resources, are either present in or rapidly approaching Nebraska. Of particular concern to Nebraska community forest resources are Asian longhorned beetle, gypsy moth (*Lymantria dispar*), Dutch elm disease and EAB.

If it becomes established in Nebraska, Asian longhorned beetle, an insect that bores into and kills a wide range of hardwood species, could generate \$3.35 billion in losses in structural value to the state’s community forest resource. Asian longhorned beetle’s potential impacts on Omaha and Lincoln alone are \$1.2 billion and \$219 million respectively.

Gypsy moth, which feeds on many tree species causing widespread defoliation and tree death if outbreak conditions last several years, could

generate \$2.13 billion in losses in structural value statewide. Gypsy moth’s potential impacts on Omaha and Lincoln are \$566 million and \$324 million respectively.

Dutch elm disease has been present in the United States since the 1930s and devastated much of Nebraska’s community forest resource during the 1960s and 1970s. Statewide this disease continues having the potential to cause \$423 million in losses in structural value to the state’s native elm population and \$116 million and \$40 million within Omaha and Lincoln respectively.

EAB has killed tens of millions of ash trees in the upper Midwest and is the most serious known threat to the urban and community forest resources across the state. EAB could generate \$823 million in losses in structural value statewide and \$192 million and \$89

Table 16. Potential Impact of Emerald Ash Borer on Urban & Community Forests

Area	Number of Ash Trees	Structural Value	Removal Cost	Replacement Cost	Total Costs (Indirect & Direct)
City of Lincoln	108,145	\$89 million	\$64 million	\$32 million	\$185 million
City of Omaha	359,316	\$192 million	\$215 million	\$107 million	\$514 million
Statewide	986,474	\$823 million	\$591 million	295 million	\$1.7 billion

Source: NFS

million within Omaha and Lincoln respectively (Table 16).

Collectively, these insect and disease pests threaten more than 8 million trees in urban and community landscapes across the state and represent potential structural value losses of \$6.7 billion (Figures 33-35).

Critical Issues:

- Dramatic decline in community forest cover over past 30 years.
- Inadequate species and age diversity to sustain the urban and community forest resource.
- 66% of population lives in cities and towns with 470,000 acres of community forest.
- High concentration of green ash, black walnut and Scotch pine, at risk to EAB, thousand cankers disease, and pine wilt, respectively.

- Declining urban and community forest cover reduces mitigation of harsh climatic conditions in the Great Plains.
- Declining ability to mitigate climate change impacts (temperature, wind, air quality).
- Risk of losses from attack by invasive species due to high value of trees in urban areas and the ecosystem services and economic benefits provided.
- Some communities have greater community forestry assistance needs than others.

Multistate Priority Areas:

Due to their proximity to adjacent states, Omaha is a multistate priority forest area with Iowa, and South Sioux City is a multistate priority area with South Dakota and Iowa.

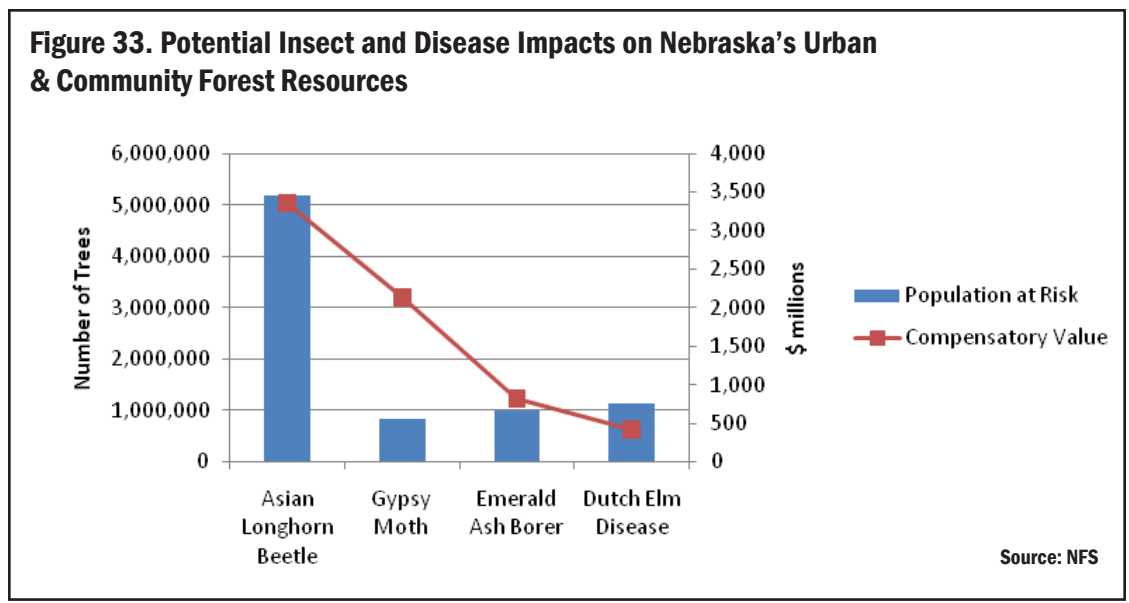


Figure 34. Potential Insect and Disease Impacts on Omaha’s Urban & Community Forest Resources

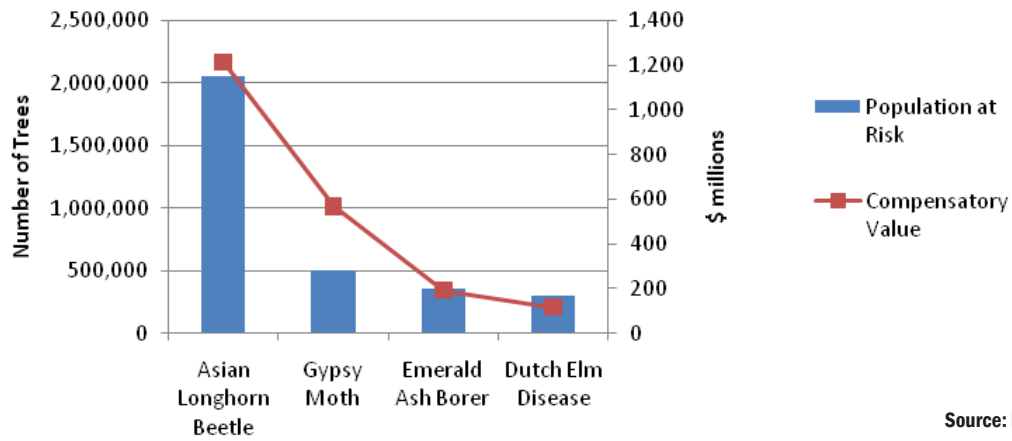
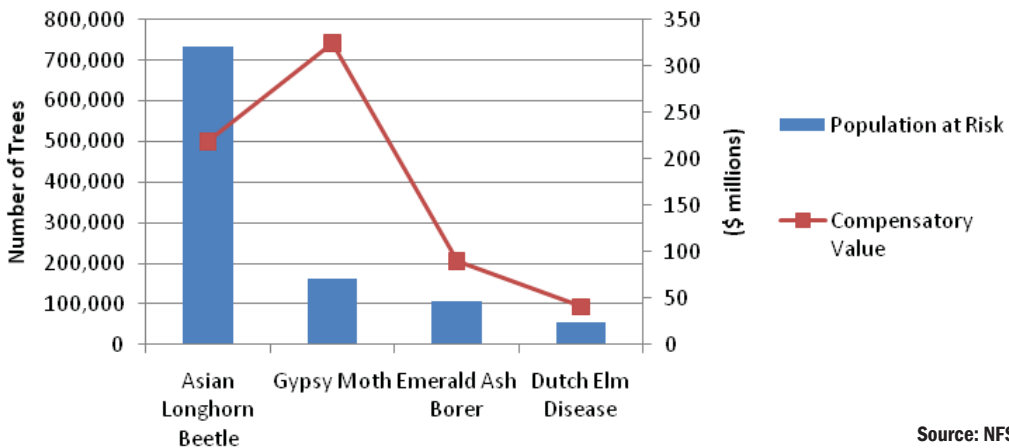


Figure 35. Potential Insect and Disease Impacts on Lincoln’s Urban & Community Forest Resources



CONIFEROUS FORESTS

Nebraska's coniferous forests are largely composed of three species: ponderosa pine, eastern redcedar and Rocky Mountain juniper (*Juniperus scopulorum*).

Ponderosa pine is found in the Pine Ridge, eastward along the Niobrara and Snake rivers, and in other scattered pockets in western Nebraska, such as the Wildcat Hills south of Scottsbluff. North America's easternmost extensions of ponderosa pine occur in Nebraska, with potentially unique genetic adaptations of value in a world with a changing climate. Rocky Mountain juniper (in the west) and eastern redcedar (in central Nebraska) are common components of ponderosa pine forests.

Eastern redcedar is abundant in Nebraska. It is the predominant species in some forested

areas and is frequently an understory tree in conifer and mixed hardwood forests. Between 1983 and 1994, the area of timberland with eastern redcedar as a dominant species increased by 61%, rising from 68,000 acres to 110,000 acres (Schmidt & Wardle, 1998).

The following forested areas, characterized largely as coniferous forests, are described in greater detail.

Priority Forest Landscape: Pine Ridge¹

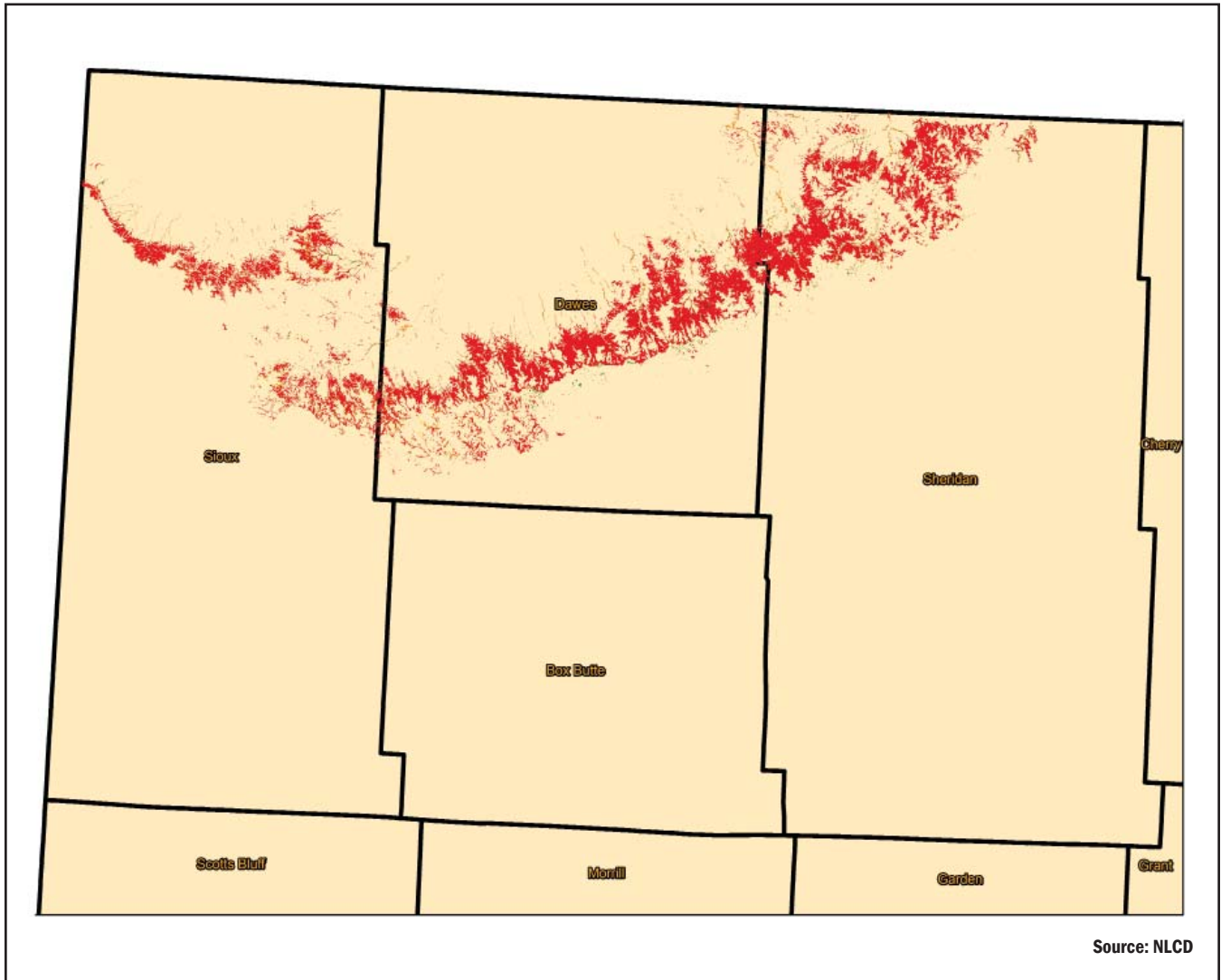
The Pine Ridge is a rocky precipice rising several hundred feet from the surrounding plains in Sioux, Dawes, and Sheridan counties in northwest Nebraska (Figure 36). The formation is composed of sandstone, siltstone and volcanic ash. Ponderosa pine woodlands

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Photo: NFS

Figure 36. Priority Forest Landscape: Pine Ridge



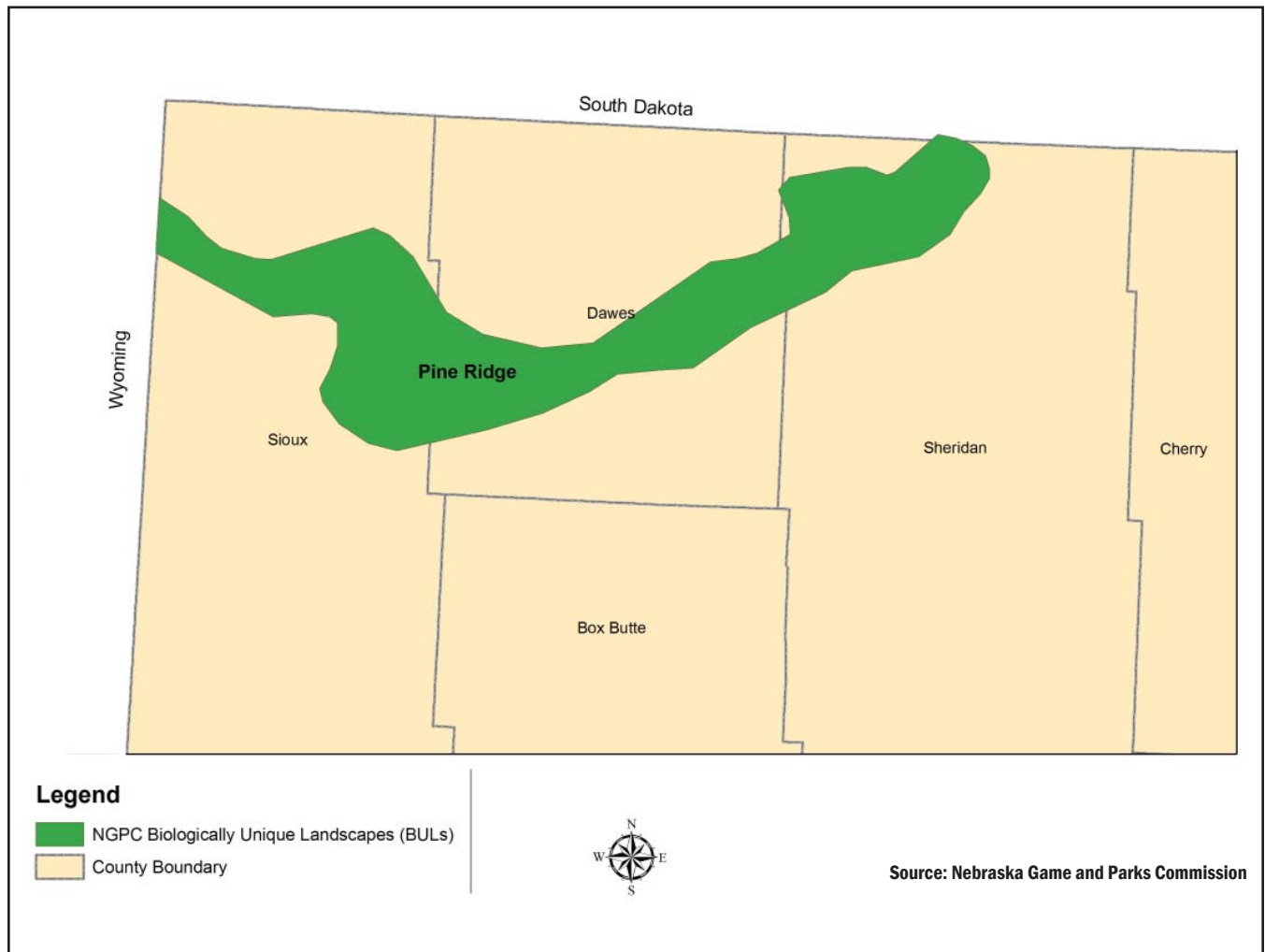
(open stands of trees, generally forming 25-60% cover) and forests (trees with crowns overlapping, forming 60-100% cover) occupy many of the north- and east-facing slopes and bottoms. Pine woodlands and mixed-grass prairie often occupy the south- and west-facing slopes. Several streams, including White River, Hat Creek and Soldier Creek, headwater in the Pine Ridge. The valleys of these northward-flowing streams support deciduous woodlands, composed of green ash, hackberry and boxelder, and meadows in their floodplains.

The Pine Ridge is a pine-dominated escarpment within the grassland-dominated Great Plains. It supports many at-risk species at the edge of their range, including two of the state's

three populations of Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*). There are several large protected areas within this area including the Nebraska National Forest, Fort Robinson State Park and several wildlife management areas.

The area's unique geography has resulted in the development of a unique forest resource. The area of ponderosa pine forests in Nebraska increased from 157,000 acres in 1983 to 174,000 acres in 1994 (Schmidt & Wardle, 1998). However, according to the 2001 National Land Cover Dataset (NLCD), there are 107,232 acres of forestland in the Pine Ridge, including 100,457 acres of coniferous forest, 5,284 acres of deciduous forest and 1,492 acres of

Figure 37. Pine Ridge Biologically Unique Landscape



mixed forest (Homer, et al, 2004). During this period, multiple high-intensity wildland fires repeatedly converted forests to grasslands.

Early records and the existence of old “Bull Pines” from the 1800s indicate that in the Pine Ridge, ponderosa pine was scattered and primarily located on sites that were protected from fires. With European settlement and wildfire control efforts, fires diminished in size and severity, allowing ponderosa pine to expand across the landscape. The Pine Ridge has a long history of ranching, as ponderosa pine is a tree species that can be effectively managed within grasslands as a silvopastoral system to produce both forage and fiber. From 2005 through 2009, fuels treatment activities on 442 acres of forestland generated 5,667 tons of woody biomass (NFS, 2009). Although livestock

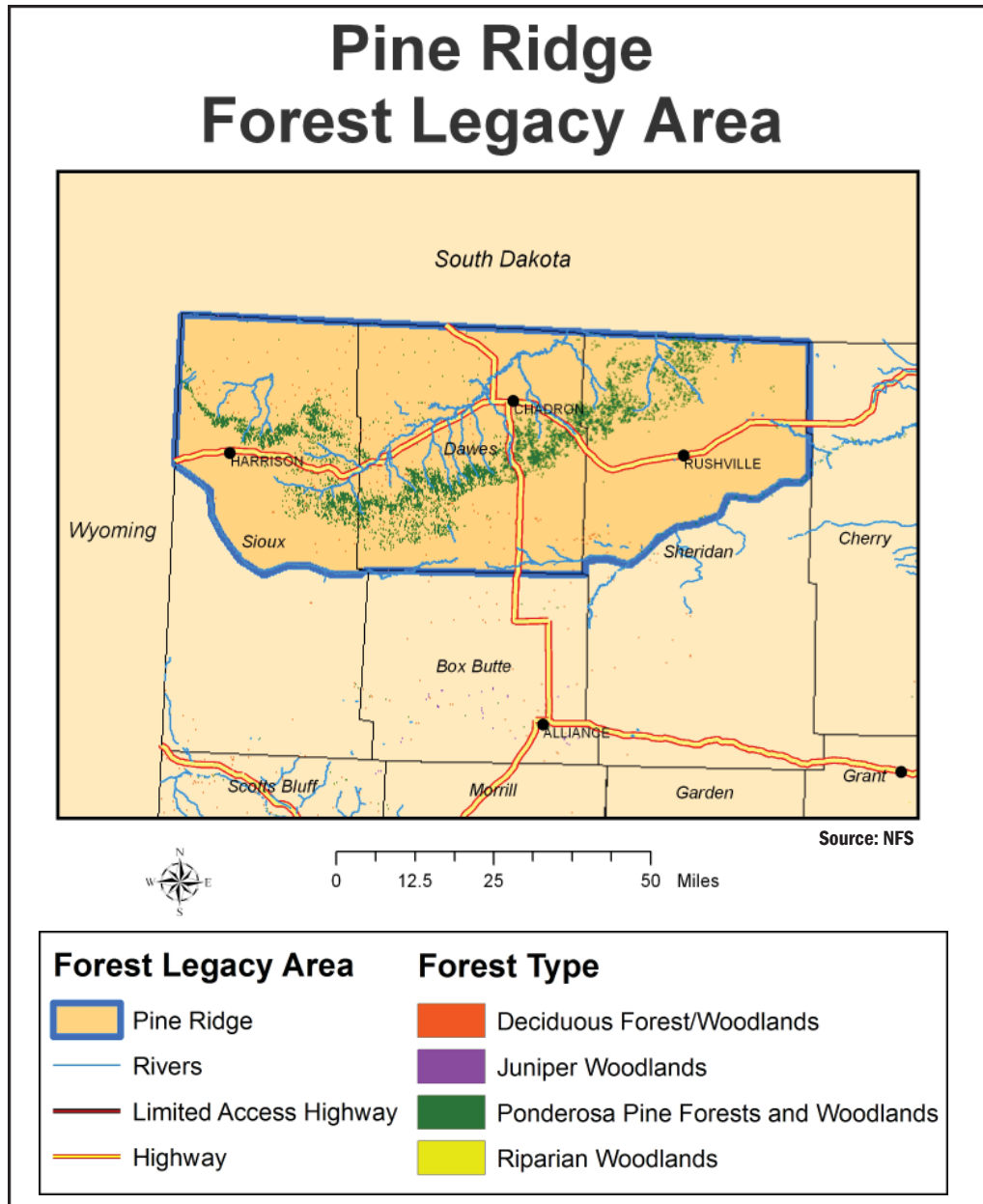
grazing has been the dominant land use in the area, ponderosa pine has continued to thrive and expand.

The Nebraska Game and Parks Commission (NGPC) identified the Pine Ridge as a biologically unique landscape (BUL) (Figure 37) in its 2005 Nebraska Natural Legacy Project (Appendix A). This area also was identified as a priority under Nebraska’s Forest Legacy Program (Appendix B, Figure 38). A Community Wildfire Protection Plan (CWPP) (Figure 39) has been in place for this area since 2003 (Appendix C).

Critical Issues:

- Increasing risk of catastrophic wildfire due to very high and growing fuel loads, chronic drought and severe weather.

Figure 38. Pine Ridge Forest Legacy Area



- Forest health susceptibility to climate change.
- Increasing recreational home development and expansion of WUI areas.
- Increasing forest fragmentation.
- Recent introduction of mountain pine beetle, high concentration of green ash (susceptible to EAB).
- Substantial economic impact of forest resources on local economy.
- Designated as a BUL in the Nebraska Natural Legacy Project.
- Designated as a Forest Legacy priority area.
- Existing CWPP.

Multistate Priority Area:

Due to its proximity to Wyoming and South Dakota, the Pine Ridge is a multistate priority area.

Figure 39. Pine Ridge Community Wildfire Protection Plan

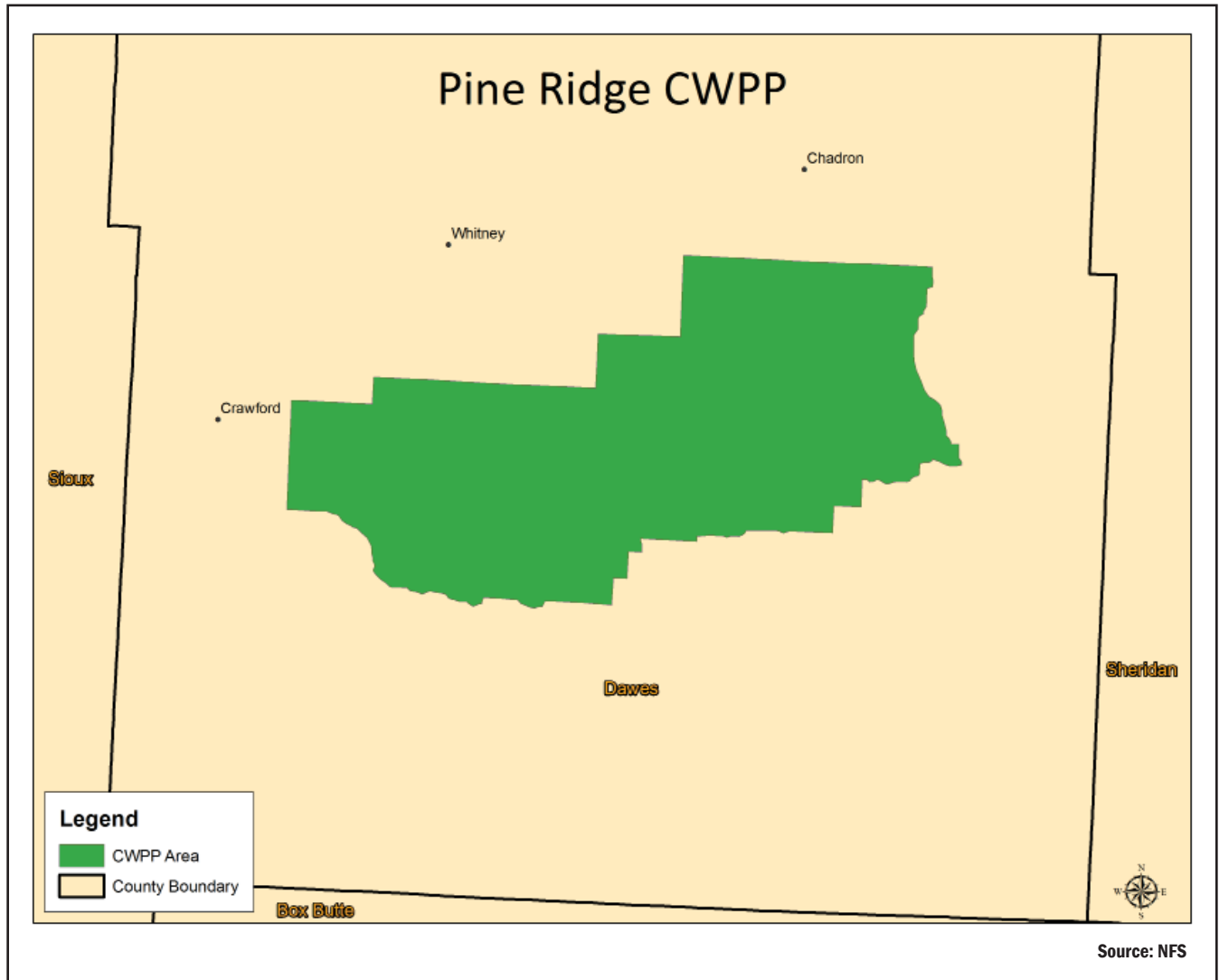
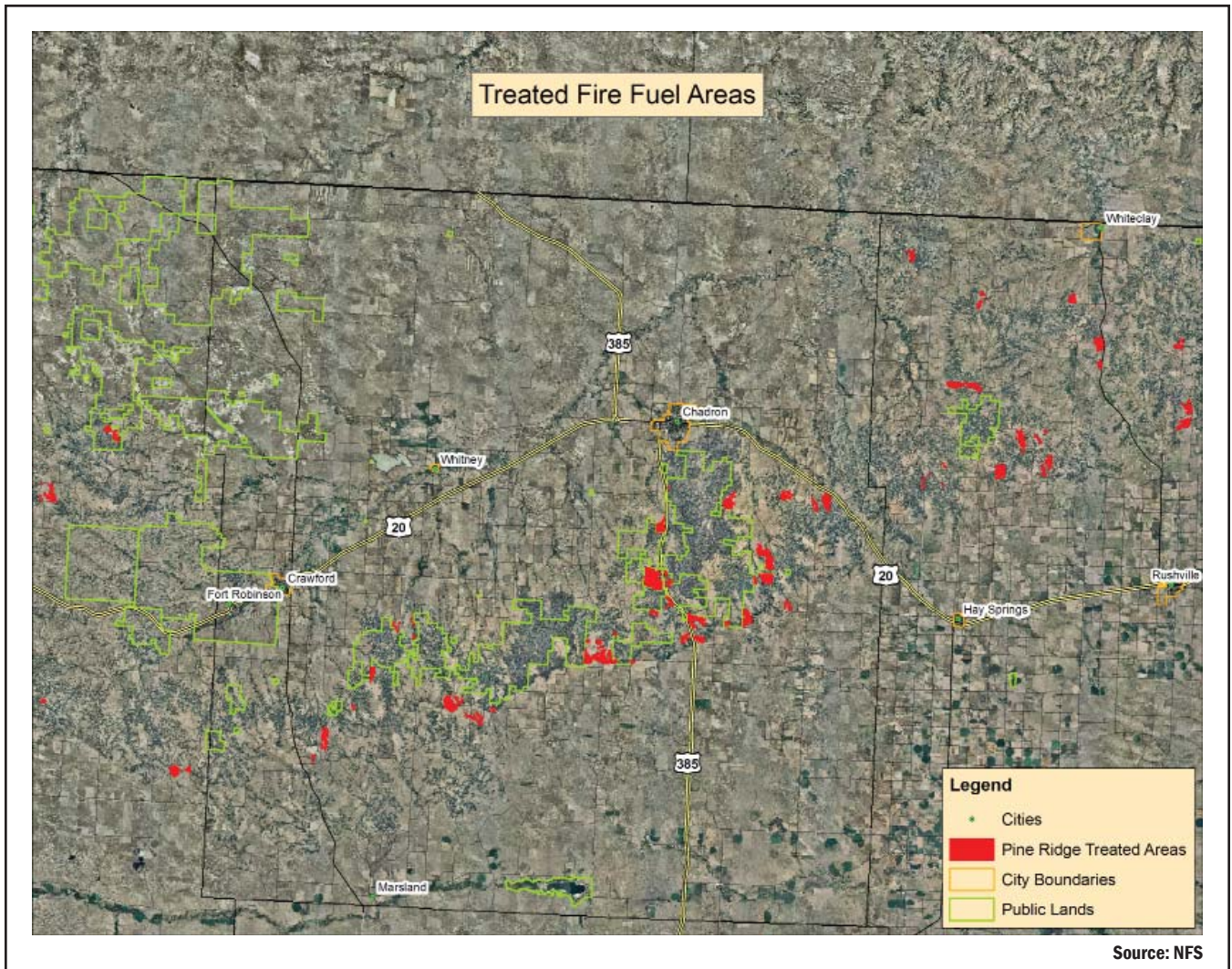


Figure 40. Pine Ridge Fuels Treatment Areas





Priority Forest Landscape: Wildcat Hills

Nebraska's Wildcat Hills is a rocky escarpment that rises several hundred feet on the south side of the North Platte River in Scotts Bluff, Banner, and Morrill counties and extends into portions of Kimball and Cheyenne counties (Figure 41). The formation is composed primarily of sandstone, siltstone and volcanic ash. The north bluff consists of steep, deep canyons that support stands of mountain mahogany (*Cercocarpus montanus*), eastern redcedar and Rocky Mountain juniper. North-facing slopes support ponderosa pine woodlands. Mixed-grass prairie, rock outcrops and scattered patches of sandsage prairie occupy the remainder of the Wildcat Hills.

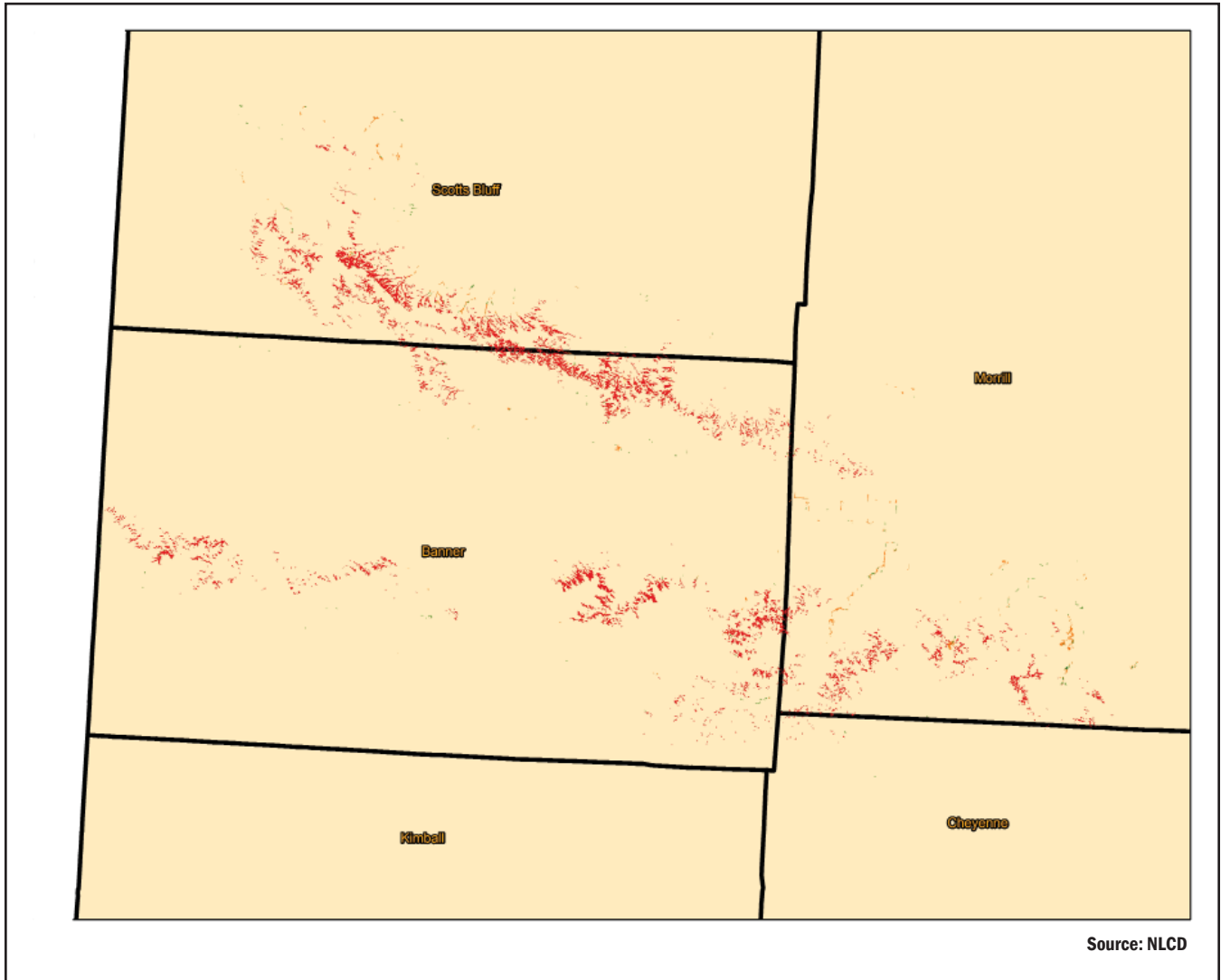
The Wildcat Hills are unique in that they are an intact mosaic of pine woodlands and mixed-grass prairie that support the largest stands of mountain mahogany shrubland in the state.

The Wildcat Hills also support one of three Rocky Mountain bighorn sheep populations in the state. Protected lands within the Wildcat Hills include Wildcat Hills State Recreation and Wildlife Management Area, Buffalo Creek Wildlife Management Area, Cedar Canyon Wildlife Management Area, Platte River Basin Environ's Bead Mountain Ranch and Scottsbluff National Monument.

The Wildcat Hills contain 10,499 acres of forestland, including 441 acres of deciduous forest, 10,052 acres of coniferous forest and 6.4 acres of mixed forest (Homer, et al, 2004).

NGPC identified the Wildcat Hills and Wildcat Hills South as a BUL (Figure 42) in its 2005 Nebraska Natural Legacy Project. This area also was identified as a priority under Nebraska's Forest Legacy Program (Figure 43), and a CWPP (Figure 44 is in place for a portion of this area (Appendix B and Appendix D).

Figure 41. Priority Forest Landscape: Wildcat Hills



Critical Issues:

- Increasing risk of catastrophic wildfire due to very high and growing fuel loads, chronic drought and severe weather.
- Forest health susceptibility to climate change.
- Increasing recreational home development and expansion of WUI areas.
- Increasing forest fragmentation.
- Recent introduction of mountain pine beetle.
- Designated as a BUL in the Nebraska Natural Legacy Project.

- Designated as a Forest Legacy priority area.
- Existing CWPP for a portion of this area.

Multistate Priority Areas:

Due to its proximity to Wyoming and Colorado, the Wildcat Hills is a multistate priority area.

Figure 42. Wildcat Hills Biologically Unique Landscapes

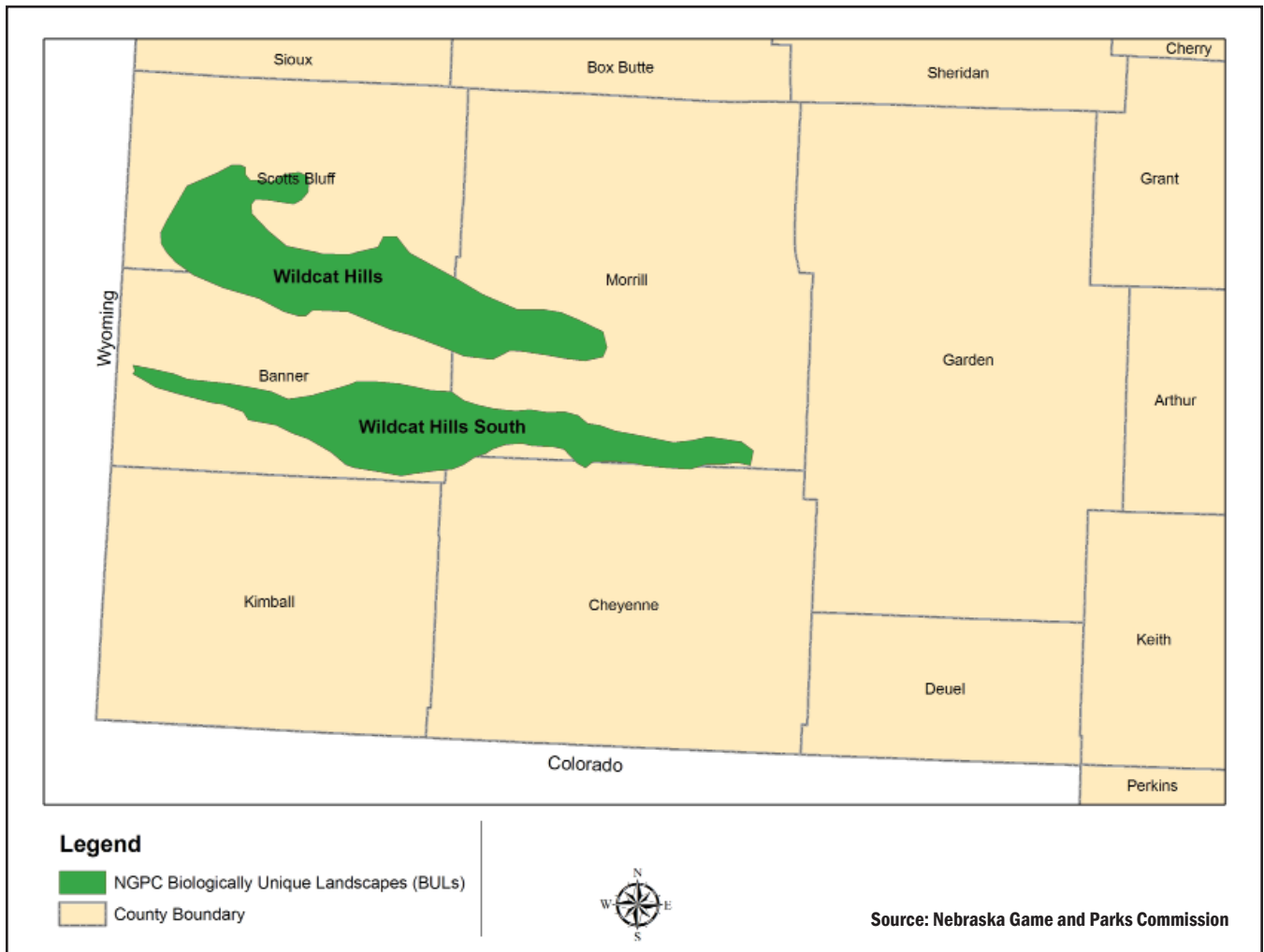
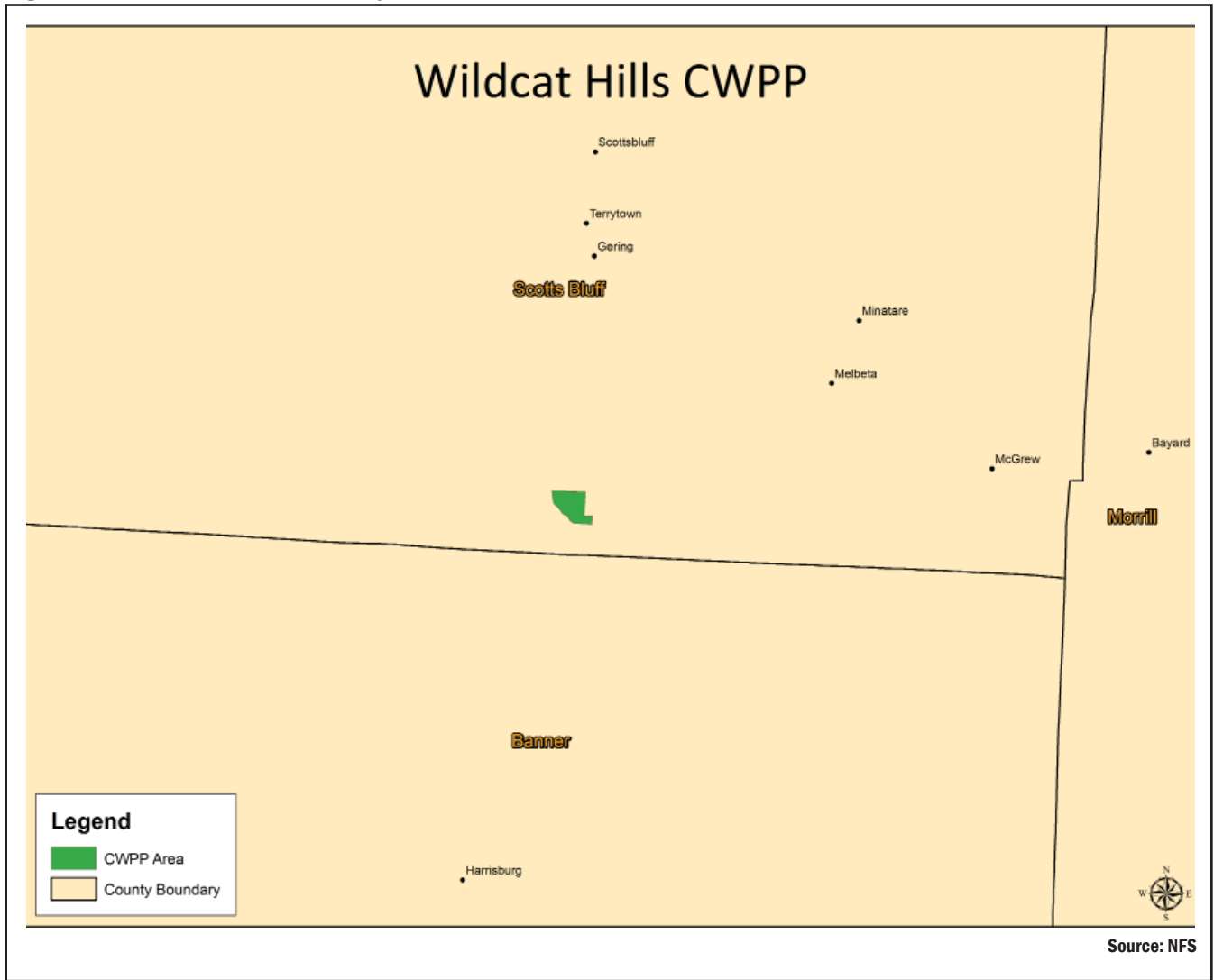


Figure 43. Wildcat Hills Forest Legacy Area



Figure 44. Wildcat Hills Community Wildfire Protection Plan



Priority Forest Landscape: Loess Canyons²

The Loess Canyons consist of steep loess hills and canyons south of the Platte River in Lincoln, Dawson and northern Frontier counties in west-central Nebraska (Figure 45). This area was formed as hundreds of feet of windblown soil was deposited over the area. Soils that are a combination of windblown sand from the Sandhills and loess and till from earlier glacier activity also occur in this region. Areas that are too rough or unsuited for farming are used for livestock grazing. The loess soil is unique because it has a cap of varying soils but will erode from underneath. Canyons were once

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filled with windblown soil. This hilly land is characterized with moderate to steep slopes, sharp ridge crests and remnants of old, nearly level plain that have been eroded by water and wind. Skeletal remains of water animals are found in the tablelands, indicating ponds or lakes were once present. There are difficulties maintaining roads, fences and even fields because the soil will drop out, often in the form of sink holes, making conservation practices important in this area.

These hills support mixed-grass prairie and are used primarily as rangeland, though scattered crop fields occur. The mixed-grass prairies have been heavily invaded by eastern redcedar in recent decades. This cedar resource shows potential to become a valuable source of

Figure 45. Priority Forest Landscape: Loess Canyons

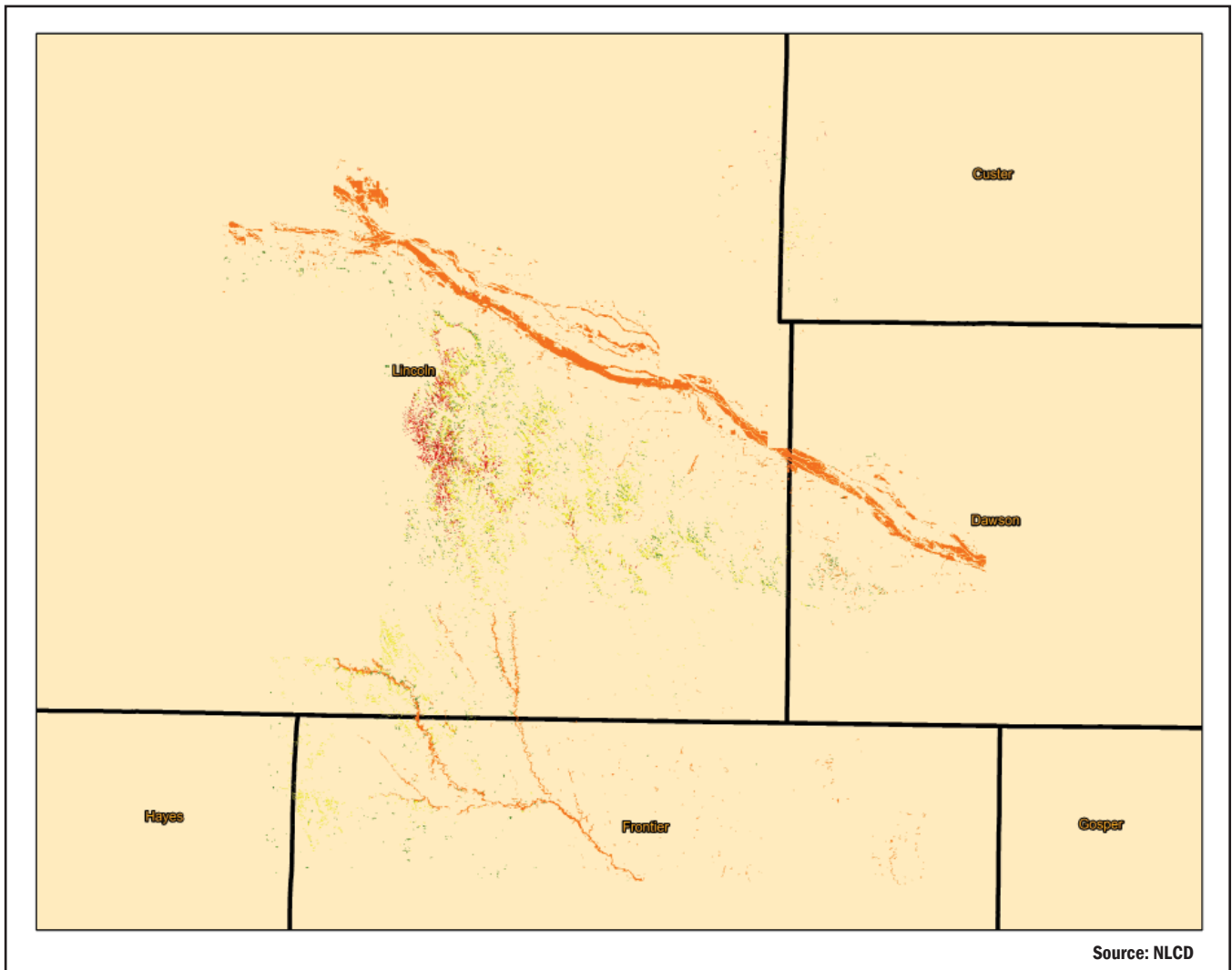
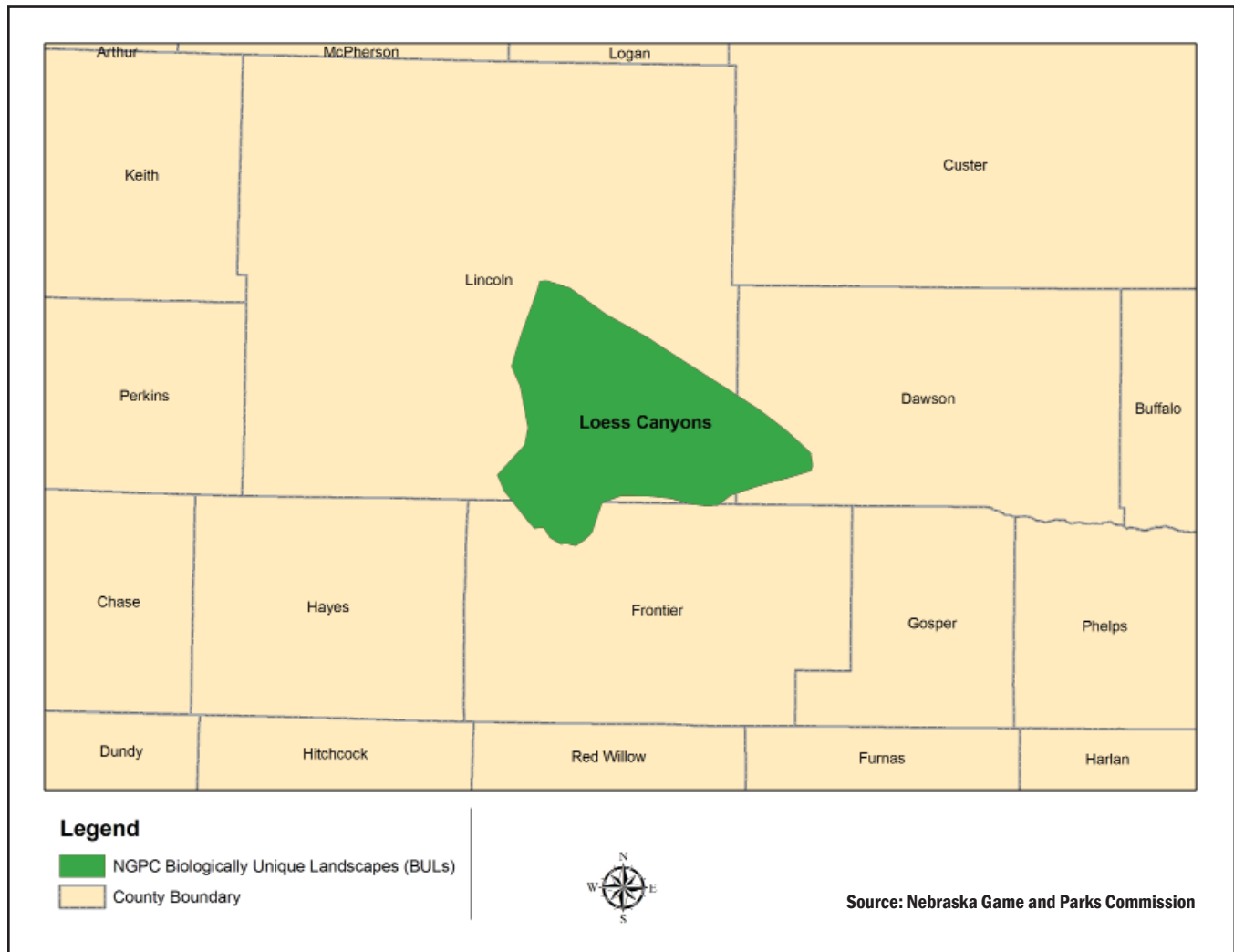


Figure 46. Loess Canyons Biologically Unique Landscape



woody biomass for thermal energy applications in the area. Most grasslands have been overgrazed in the past and are now heavily infested with cheatgrass (*Bromus tectorum*) and Japanese brome (*Bromus japonicus*). The area is significant because it contains one of the largest known populations of the federally and state-endangered American burying beetle (*Nicrophorus americanus*) as well as elk. The Wapiti Wildlife Management Area is included in the Loess Canyons.

The Loess Canyons contain 14,811 acres of forestland, including 2,108 acres of deciduous forest, 2,184 acres of coniferous forest, 5,518 acres of mixed forest and 5,001 acres of riparian forest (Homer, et al, 2004).

In this area NGPC identified the Loess Canyons

as a BUL (Figure 46) in its 2005 Nebraska Natural Legacy Project (Appendix A).

Critical Issues:

- Increasing risk of catastrophic wildfire due to very high and growing fuel loads and chronic drought.
- Recent expansion of eastern redcedar into rangelands, reducing rangeland productivity but providing economic development opportunities through forest utilization.
- Increasing expansion of WUI areas.
- Growing economic impact of forest resources on local economy.
- Designated as a BUL in the Nebraska Natural Legacy Project.



Photo: NFS

TRANSITIONAL MIXED FOREST

Priority Forest Landscape: Niobrara River Valley³

The Niobrara River begins in the high plains of eastern Wyoming and flows 535 miles to the Missouri River in northeast Nebraska (Figure 47). The river drains 12,600 square miles in Nebraska and contains more than 90 waterfalls along its westernmost part. In 1991, Congress designated 76 miles of the river east of Valentine as part of the National Scenic River System. Six major ecosystems converge in the Niobrara valley: northern boreal forest, ponderosa pine forest, eastern deciduous forest, tallgrass prairie, mixed-grass prairie and shortgrass prairie.

There are more than 225,000 acres of timberland in the area, including 83,000 acres of ponderosa pine forest, 46,000 acres of eastern redcedar and 96,000 acres of mixed forests (Homer, et al, 2004), making the Niobrara valley unlike any other forested area in

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Nebraska.

The easternmost portion of the Niobrara River includes the river channel and a two-mile buffer on each side of the river from central Brown County eastward to its confluence with the Missouri River in Knox County. The river in this reach has a broad, braided, somewhat shallow channel with many open sandbars and wooded islands. This reach of the Niobrara River has fairly natural flows. The only obstruction on the river is the low Spencer Dam in Boyd County. Much of the valley bottom is in cropland, though some areas support cottonwood woodlands and bur oak woodlands. Some wet meadows and marshes still remain in the floodplain. The bluff slopes are mainly mixed-grass prairie with oak woodlands in the east and ponderosa pine woodlands in the west, with increasing populations of eastern redcedar throughout the area.

Sandbars on the lower stretch of the Niobrara River from western Holt County eastward support numerous colonies of the federally and state-listed interior least tern (*Sterna antillarum*)

and piping plover (*Charadrius melodus*). Bald eagles (*Haliaeetus leucocephalus*) are also known to nest along this reach of the Niobrara River. Protected areas within the landscape include Red Bird, Bohemia Prairie and Greenvale Wildlife Management Areas and Niobrara State Park.

The middle Niobrara River valley is a 76-mile reach of the river in Cherry, Keya Paha, Rock and Brown counties. This river reach has been designated as a National Wild and Scenic River and is often referred to as the biological crossroads of the Midwest.

The valley, with its diverse mix of plant communities, is home to an incredible diversity of native animal and plant species, including many glacial relic species. The Nature Conservancy's 56,000-acre Niobrara Valley Preserve alone contains 581 species of plants, 213 birds, 86 lichens, 44 mammals, 25 fish, 17 reptiles and eight amphibians. The middle Niobrara River valley also provides habitat for many at-risk species including whooping crane

(*Grus americana*), bald eagle, piping plover, interior least tern and Bailey's eastern woodrat (*Neotoma floridana baileyi*), a subspecies endemic to the valley. The primary protected areas within the landscape include The Nature Conservancy's Niobrara Valley Preserve, Fort Niobrara National Wildlife Refuge and several state wildlife management areas and state recreation areas.

The western portion of the Niobrara River includes the river channel and a two-mile-wide buffer on each side of the river, from eastern Cherry County westward to the Nebraska/Wyoming border. In the far west the Niobrara River is a narrow, cold-water stream within an open, gently sloping valley with few trees. Rocky outcrops are also common along the valley bluffs, and mixed-grass prairie occurs on most of the bluffs. As the river gains flow eastward, the valley becomes entrenched. Where the river enters the Sandhills in western Cherry County the valley is several hundred feet deep. Ponderosa pine woodlands occupy portions of the bluff, and cottonwood dominated-

Figure 47. Priority Forest Landscape: Niobrara Valley

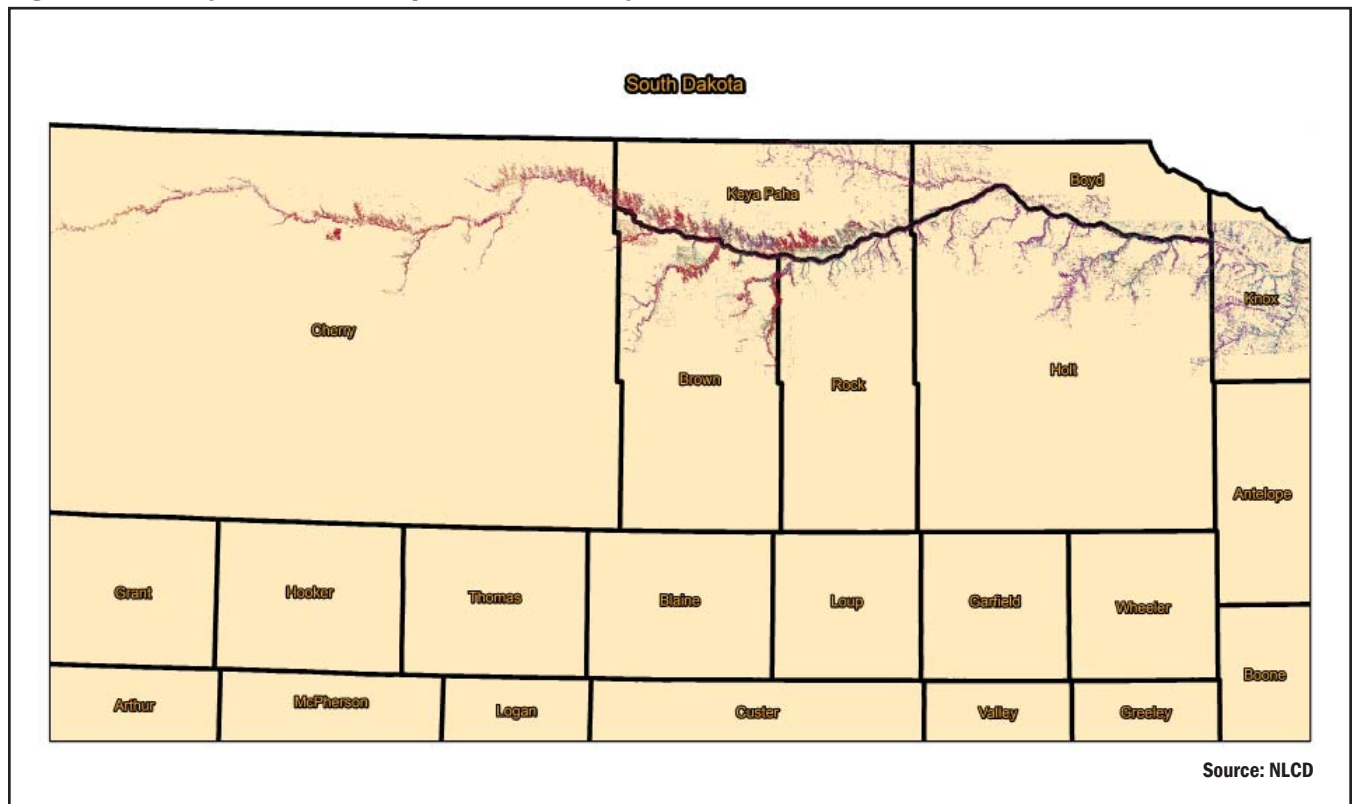


Figure 48. Niobrara Valley Biologically Unique Landscapes

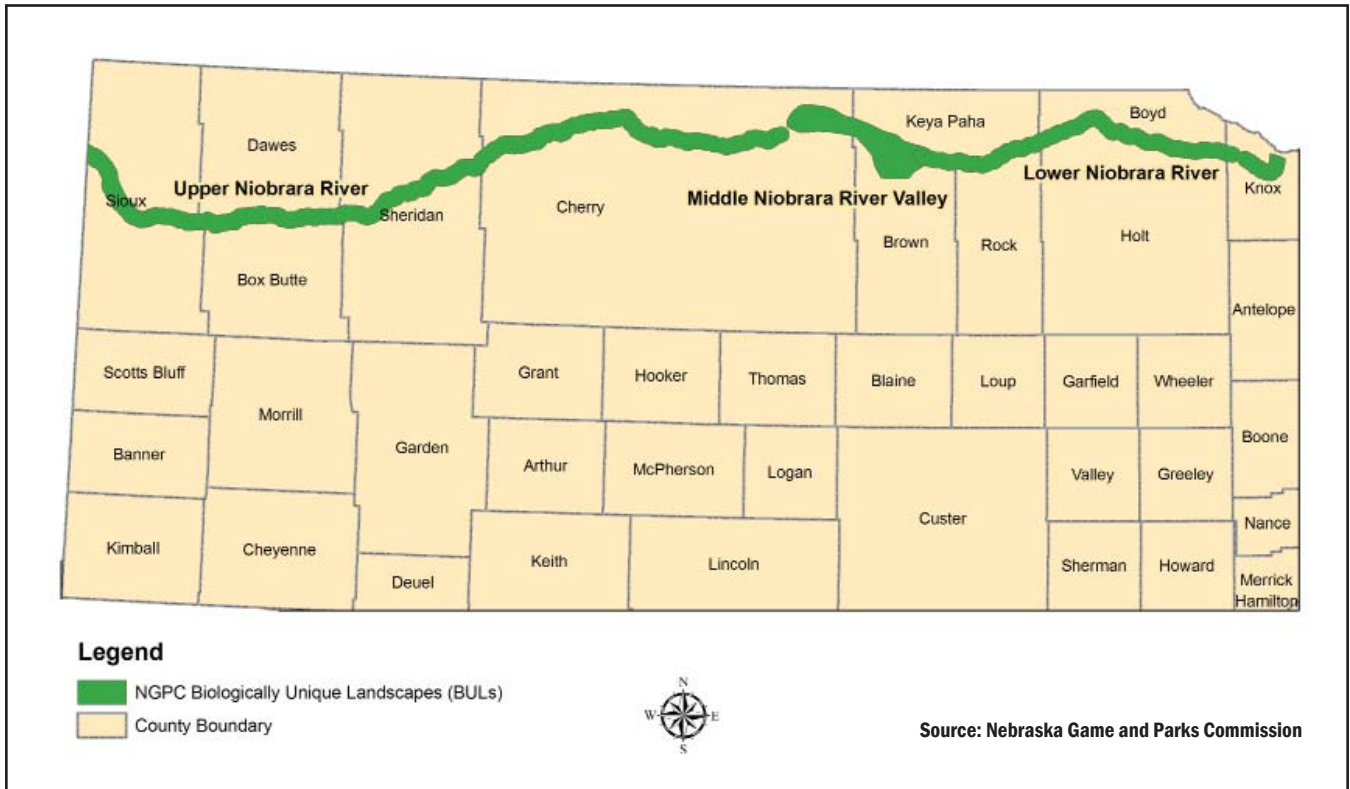


Figure 49. Niobrara Valley Forest Legacy Area

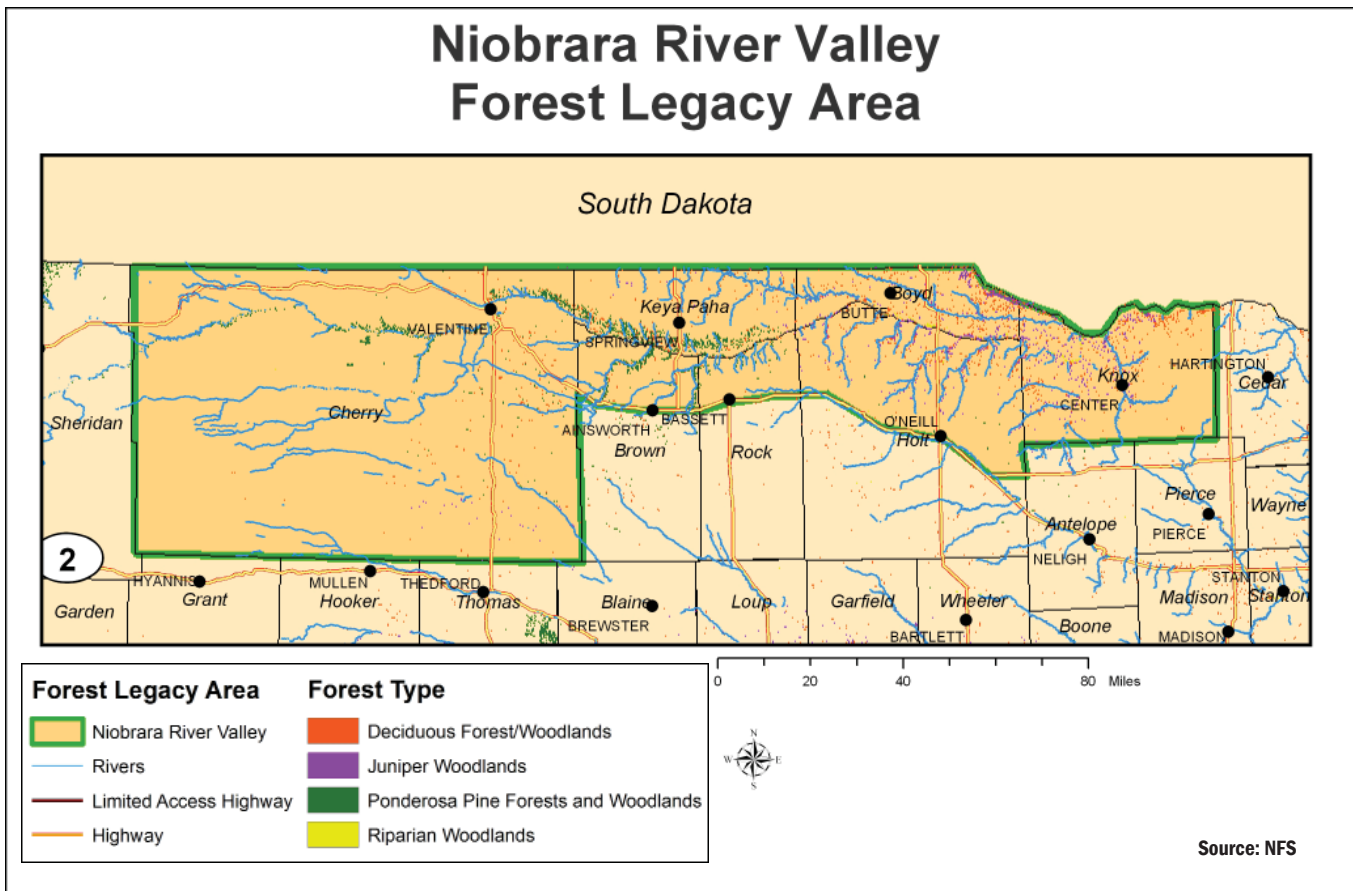
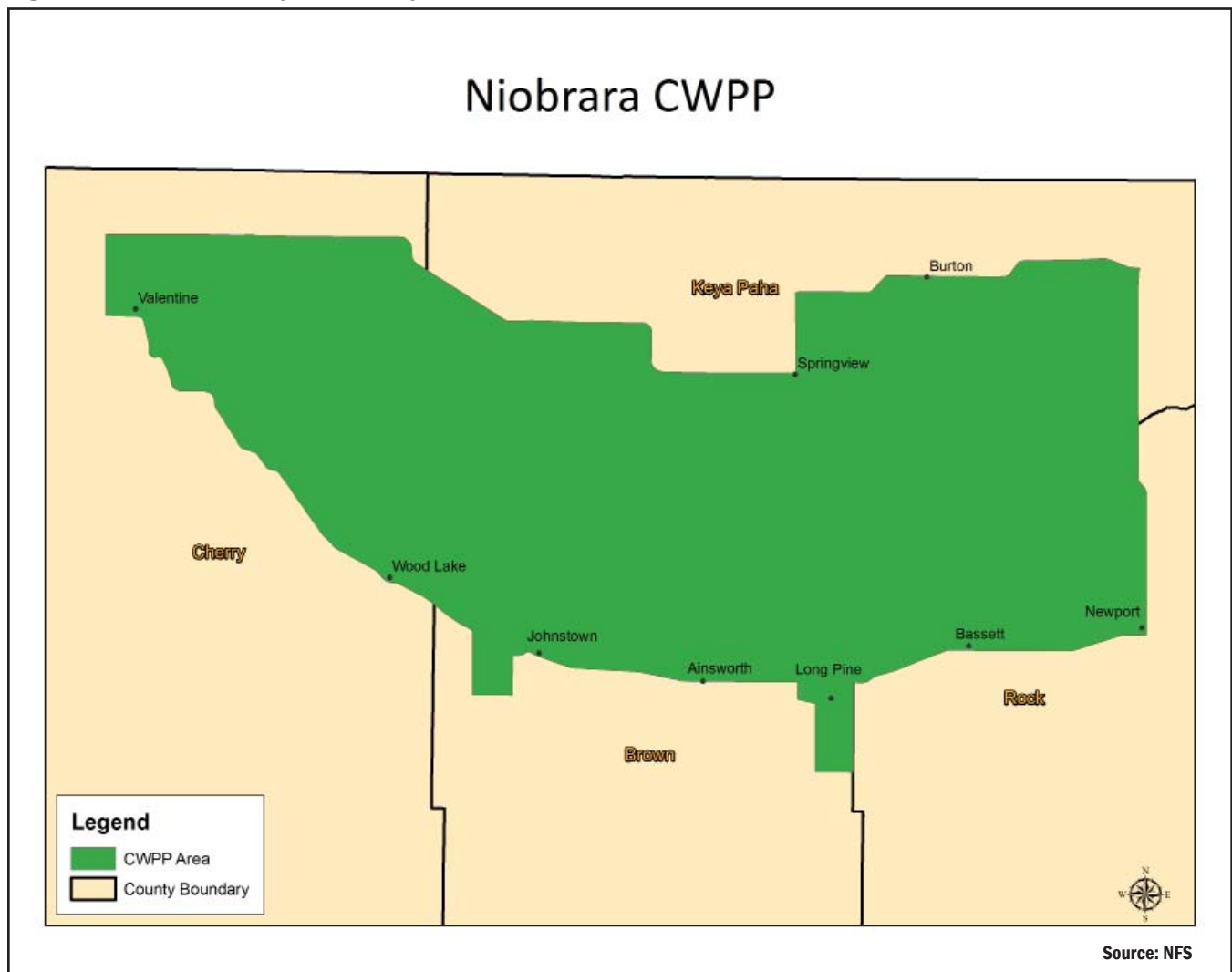


Figure 50. Niobrara Valley Community Wildfire Protection Plan



woodlands occupy portions of the floodplain. Portions of the valley bottom are in cropland.

The only dam on this reach of the Niobrara River forms Box Butte Reservoir in Dawes County, otherwise flows on the river are fairly natural. The upper Niobrara River supports a unique assemblage of cold-water fish including the pearl dace (*Margariscus margarita*), as well as the state-listed blacknose shiner (*Notropis heterolepis*) and finescale dace (*Phoxinus neogaeus*). Wet meadows in the Niobrara River valley in western Sioux County support the state's only known population of Ute ladies'-tresses orchid (*Spiranthes diluvialis*). Protected areas on the upper Niobrara include Agate Fossil Beds National Monument, The Nature Conservancy's Cherry Ranch and Prairie Plains

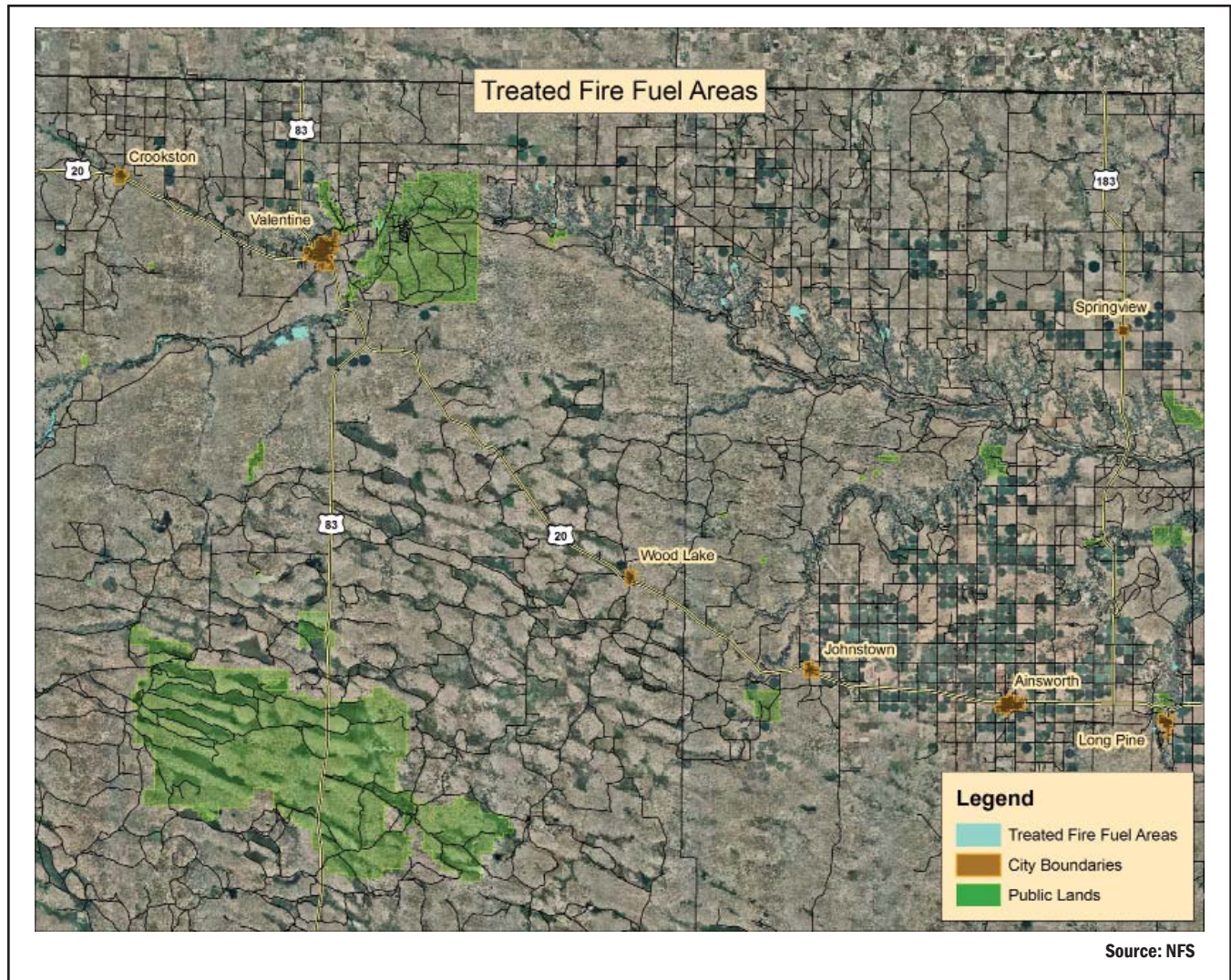
Resource Institute's Guadalcanal Memorial Prairie.

Tributaries lined with dense stands of ponderosa pine and eastern redcedar flow from the south of the river and are popular areas for trout fishing.

NGPC designated the following BULs within the Niobrara Valley: Lower Niobrara River, Middle Niobrara River and Upper Niobrara River (Appendix A, Figure 48)).

This area also was identified as a priority under Nebraska's Forest Legacy Program (Figure 49), and a CWPP (Figure 50) is in place for a portion of this area (Appendix B and Appendix E).

Figure 51. Niobrara Valley Fuels Treatment Areas



Critical Issues:

- Increasing risk of catastrophic wildfire due to very high and growing fuel loads and chronic drought.
- Forest health susceptibility to climate change.
- Increasing recreational home development and expansion of WUI areas.
- Increasing forest fragmentation.
- The easternmost extent of ponderosa pine in the United States is chronically stressed and may be susceptible to mountain pine beetle; high concentration of green ash in the area are susceptible to EAB.
- Unique ecological convergence of forest types in one area, with potentially rare germplasm, all at risk without active management.
- Substantial economic impact of forest resources on local economy.
- Designated as a BUL in the Nebraska Natural Legacy Project.
- Designated Forest Legacy priority area.
- Existing CWPP.

Multistate Priority Area:

Due to its proximity to South Dakota, the Niobrara Valley is a multistate priority area.

Priority Forest Landscape: Central Loess Hills⁴

The Central Loess Hills occupy the loess hills of Custer, Valley, Loup and Garfield counties in central Nebraska from the Sandhills south to the Platte River valley (Figure 52). The landscape consists of rolling to steep loess hills dissected by the valleys of the Loup rivers. The hills are now a mosaic of eastern redcedar forest, isolated stands of relict ponderosa pines, mixed-grass prairie and cropland. The flatter tablelands of this landscape contain playa wetlands that are used by whooping cranes during migration.

There are 24,632 acres of forestland in the Central Loess Hills, including 15,964 acres of deciduous forest, 1,154 acres of coniferous forest, 5,980 acres of mixed forest and 1,534 acres of riparian forest (Homer, et al, 2004).

⁴ Portions of this text are reprinted, in part, from The Nebraska Natural Legacy Project, with permission of the Nebraska Game and Parks Commission.

The largest protected areas in the landscape are Sherman Reservoir and Davis Creek Wildlife Management Areas. NGPC designated the Central Loess Hills as a BUL (Figure 53) in its 2005 Natural Legacy Project (Appendix A).

Critical Issues:

- Increasing risk of catastrophic wildfire due to very high and growing fuel loads and chronic drought.
- Recent expansion of eastern redcedar into rangelands, reducing rangeland productivity but providing economic development opportunities through forest utilization.
- Increasing expansion of WUI areas.
- Economic impact of forest resources on local economy.
- Designated as a BUL in the Nebraska Natural Legacy Project.



Figure 52. Priority Forest Landscape: Central Loess Hills

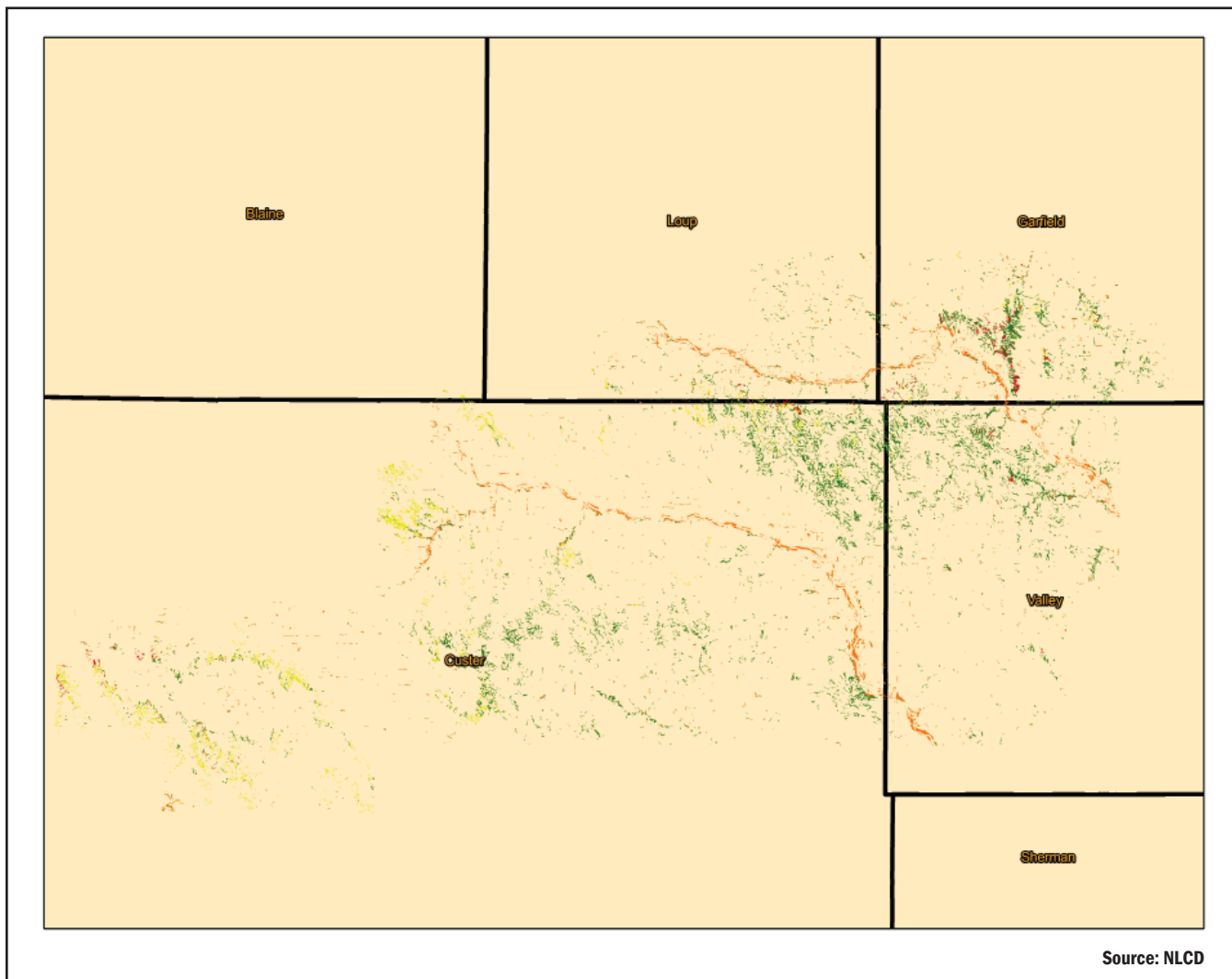
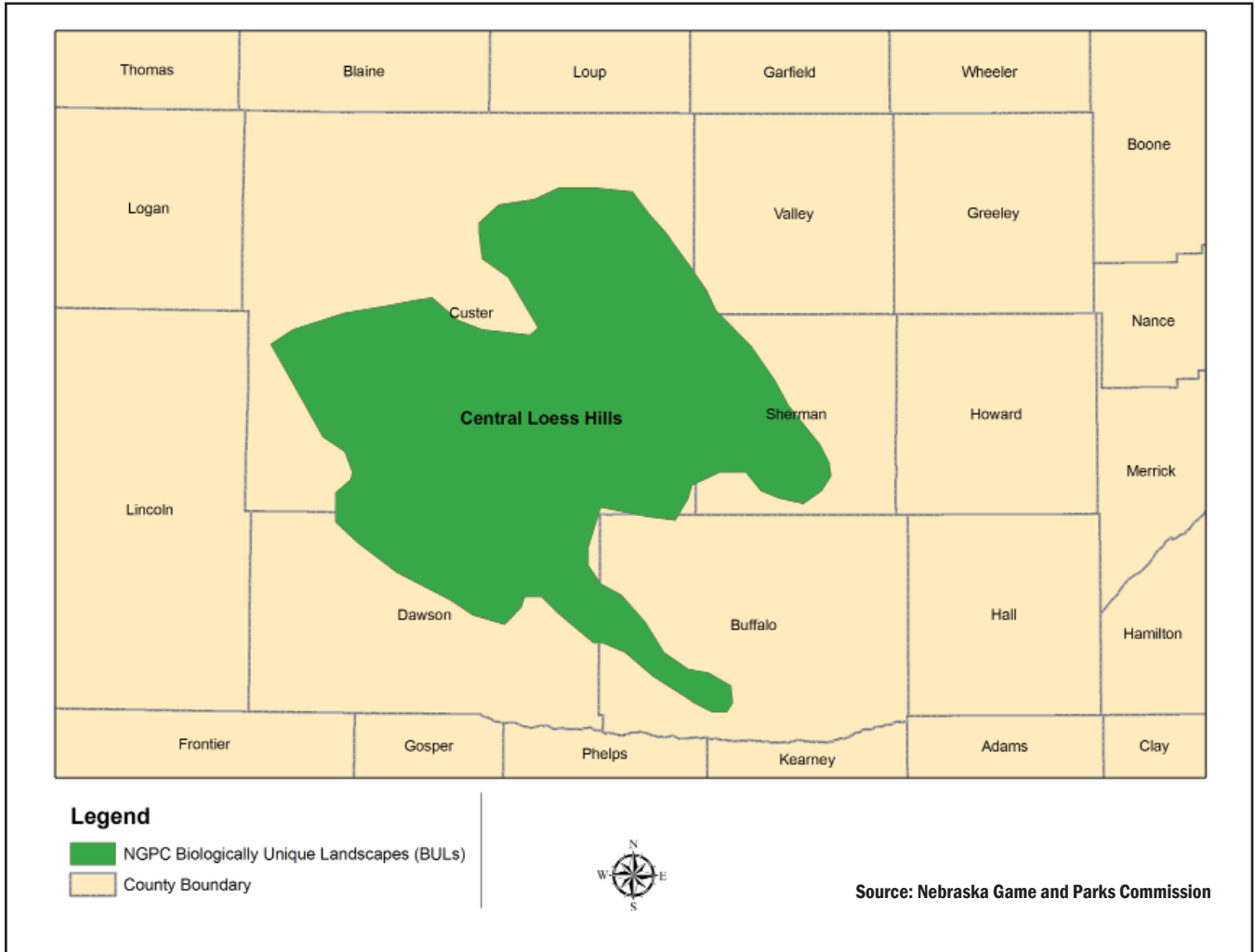


Figure 53. Central Loess Hills Biologically Unique Landscape





RIPARIAN FORESTS

Riparian forests serve as an interface between aquatic and terrestrial ecosystems and often are more diverse in stand structure and species than other forested areas. These forests are a vital resource because they provide critical habitat and travel corridors for wildlife; protect water by filtering sediment and agricultural runoff; moderate water temperatures; stabilize streambanks; slow flooding; and contribute to recreational opportunities.

Riparian zones are the areas adjacent to lakes, rivers and streams. In these areas, a steady water supply creates a moister, more productive habitat than that of nearby upland areas. Some of Nebraska's most productive forested sites are found in riparian zones. Combined with the fact that Nebraska has more miles of river than

any other state, as well as the ecosystem and economic services they provide, riparian forests are vital to the state.

In this assessment riparian forests also include forested bluffs adjacent to rivers.

Several historical accounts demonstrate the breadth of riparian forests across the Plains. In 1835 Henry Dodge wrote that the Platte River near present-day Grand Island had abundant trees on the south bank, and that, from a hill near the confluence of the North and South Platte rivers near present-day North Platte, he could see hills downstream that were "covered with scattered groves" and the "feathery outline of some tall trees . . . above the horizon" (Report of the Secretary of War, 1835).

Other travelers wrote of riparian forests as oases in a sea of grass. In 1849, upon seeing forests along the Republican River after days of crossing the shortgrass prairie, one U.S. military private wrote, "Be Jesus we're in sight of land again" (Mattes, 1953).

Composed primarily of ash, cottonwood, elm, red mulberry, hackberry, boxelder, sycamore (*Platanus occidentalis*), willow (*Salix spp.*), black walnut and, increasingly, eastern redcedar, there are more than 824,000 acres of riparian forests in Nebraska (Homer, et al, 2004), making them a critical (and the largest) component of Nebraska's forest resources. In fact, nearly two-thirds of Nebraska's forestland is adjacent to streams and rivers.

There are an additional 171,000 acres of narrow nonforest treed areas along riparian areas. These narrow but critically important water buffer resources separate the riparian/water resources from direct agriculture activities and are the first line of defense against sediment and contaminants entering the water. Nebraska has more than 50% of the total of these nonforest, treed riparian acres across the four-state region of Nebraska, Kansas, North Dakota and South Dakota. (Nebraska Forest Service, 2010).

Priority Forest Landscape: Missouri River⁵

The Missouri River extends along the eastern edge of Nebraska from the Nebraska/Kansas border to the Nebraska/South Dakota border (Figure 54). The Missouri River drains approximately 529,350 square miles of land, including the entire state of Nebraska. Historically, the Missouri was one of the most dynamic large rivers in North America. Floods were instrumental in creating its constantly meandering course. The river was more than a mile wide and 20 feet deep in places, and its channel laced with sandbars and forested islands. The river's floodplain was a mosaic of

oxbow lakes, backwater marshes, wet prairies and floodplain forests.

Alteration of the Missouri River began in 1829 when snag removal was initiated to improve steamboat navigation. Between the 1930s and 1960s a bank stabilization project armored the banks and created a navigational channel between St. Louis, Missouri, and Sioux City, Iowa. Between 1940 and 1964 six mainstream dams were constructed, which resulted in managed flows.

From an ecological perspective, these attempts to "tame the river" have had many negative consequences for riverine flora and fauna. Sediment transport has been interrupted, resulting in increased sedimentation above Gavins Point Dam and degradation of the

⁵ Portions of this text are reprinted, in part, from The Nebraska Natural Legacy Project, with permission of the Nebraska Game and Parks Commission.

Figure 54. Priority Forest Landscape: Missouri River



Figure 55. Missouri River Biologically Unique Landscapes



streambed and draining of floodplain wetlands below the dam. Channelization has resulted in the elimination of sloughs, backwaters and oxbows. Many riverine species depend upon spring flood pulses as spawning cues and upon the availability of floodplain habitat for many of their life requisites. Alteration of natural flows and elimination of lateral riverine movement has resulted in declining populations of many big-river fish species. There are 11 state-listed species that occur within the Missouri River corridor, six of which are also federally listed. The lack of properly timed flows also has impacted the hydrology of the floodplain wetlands. The majority of the floodplain’s riparian forests have been converted to cropland.

The stretches of the Missouri River from Sioux

City, Iowa, to Gavins Point Dam and from the upper end of Lewis and Clark Lake to the South Dakota border have remained unchannelized and are designated as a National Recreational River. Despite this, regulated flows have altered many natural riverine processes (e.g., sediment transport, annual flooding).

Federal mitigation dollars have helped fund several chute and channel restoration projects on the Missouri River in recent years, such as the Hamburg Bend, Kansas Bend, Langdon Bend, Decatur Bend and Tobacco Bend projects. In addition, Wetland Reserve Program dollars have become available for the restoration of Missouri River floodplain wetlands, forests and associated habitats.

Upland deciduous forests cover the bluffs and loess hills adjacent to the Missouri River

and rolling uplands along the Missouri River Corridor. The majority of these forests are classified as oak-hickory (*Carya spp.*) forests and contain species typical of central hardwood forests. However, the mix and diversity of forest species depends on latitude. For example, the upland deciduous forests in the southern section of the Missouri River corridor often include northern red oak, black oak (*Quercus velutina*), bur oak, chinkapin oak, shagbark hickory (*Carya ovata*), bitternut hickory (*Carya cordiformis*), basswood, black walnut, honey locust, Kentucky coffeetree (*Gymnocladus dioicus*), hop-hornbeam (*Ostrya virginiana*), red mulberry, redbud (*Cercis canadensis*), red elm (*Ulmus rubra*) and hackberry. The northern reaches of the corridor generally do not include the hickories, black oak, chinkapin oak, red mulberry and redbud.

The Missouri River Corridor contains 209,733

acres of forestland, including 165,526 acres of deciduous forest, 5,172 acres of coniferous forest, 67 acres of mixed forest and 38,968 acres of riparian forest (Homer, et al, 2004).

NGPC designated several BULs in this area as part of its 2005 Nebraska Natural Legacy Project: Missouri River, Indian Bluffs, Ponca Bluffs, Rulo Bluffs and Thurston-Dakota Bluffs (Appendix A, Figure 55). This area was also designated as a priority under Nebraska's Forest Legacy Program (Figures 56 & 57) (Appendix B).

Critical Issues:

- Steep decline in gallery cottonwood forest type, with negative ecological and economic impacts.
- High-grading timber harvests (repeatedly removing only the highest quality trees while



leaving poorest quality trees).

- Heavy infestations of invasive woody species (Russian olive, honeysuckle) and aggressive native species (eastern redcedar).
- Livestock grazing impacting forest health and sustainability.
- High wildlife values for uncommon and/or migratory bird species and other mammals and reptiles of concern.
- Herbicide damage from agricultural chemicals.
- Increasing recreational home development and expansion of WUI areas.
- Substantially increasing forest fragmentation.
- High concentration of green ash and black walnut at risk to EAB and thousand cankers disease, respectively.
- Forest health susceptibility to climate change.
- Economic impact of forest resources on local economy (cottonwood and walnut lumber, biomass, hunting).
- Designated as a BUL in the Nebraska Natural Legacy Project.

Figure 56. Missouri River Corridor Forest Legacy Area (North)

Missouri River Corridor Forest Legacy Area (North)







Source: NFS



0 15 30 60 Miles

Forest Legacy Area

-  Missouri River Corridor
-  Rivers
-  Limited Access Highway
-  Highway

Forest Type

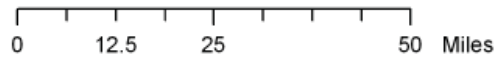
-  Deciduous Forest/Woodlands
-  Juniper Woodlands
-  Ponderosa Pine Forests and Woodlands
-  Riparian Woodlands

Figure 57. Missouri River Corridor Forest Legacy Area (South)





Missouri River Corridor Forest Legacy Area (South)



Source: NFS



Forest Legacy Area

-  Missouri River Corridor
-  Rivers
-  Limited Access Highway
-  Highway

Forest Type

-  Deciduous Forest/Woodlands
-  Juniper Woodlands
-  Ponderosa Pine Forests and Woodlands
-  Riparian Woodlands

Priority Forest Landscape: Nemaha River

Located in southeast Nebraska, the Nemaha River basin, containing both the Big and Little Nemaha rivers, is situated south of the Platte River basin and drains directly into the Missouri River below its confluence with the Platte River. The basin's total area is approximately 2,800 square miles, including all of Johnson, Nemaha, Otoe and Richardson counties and portions of Cass, Gage, Lancaster and Pawnee counties (Figures 58 & 59). Streams in the basin include the Little Nemaha River and Big Nemaha River. The basin receives 29-35 inches of precipitation annually, which is the primary driver of streamflow in the basin. The majority of surface water appropriations in the basin are for irrigation.

Forests typically follow the drainage, with a significant component of upland central hardwood forests. Marginal agricultural land

no longer in crop production is increasingly succeeding from grass and pastoral lands to upland forests composed of honeylocust, hackberry, bur and red oak, walnut, hickory, Osage-orange and eastern redcedar.

There are 97,599 acres of forestland in the Nemaha River basin, including 76,506 acres of deciduous forest, 589 acres of coniferous forest, 411 acres of mixed forest and 20,092 acres of riparian forest in this area (Homer, et al, 2004).

Critical Issues:

- High concentration of green ash and black walnut, at risk to EAB and thousand cankers disease, respectively.
- Forest health susceptibility to climate change.

Figure 58. Priority Forest Landscape: Big Nemaha River

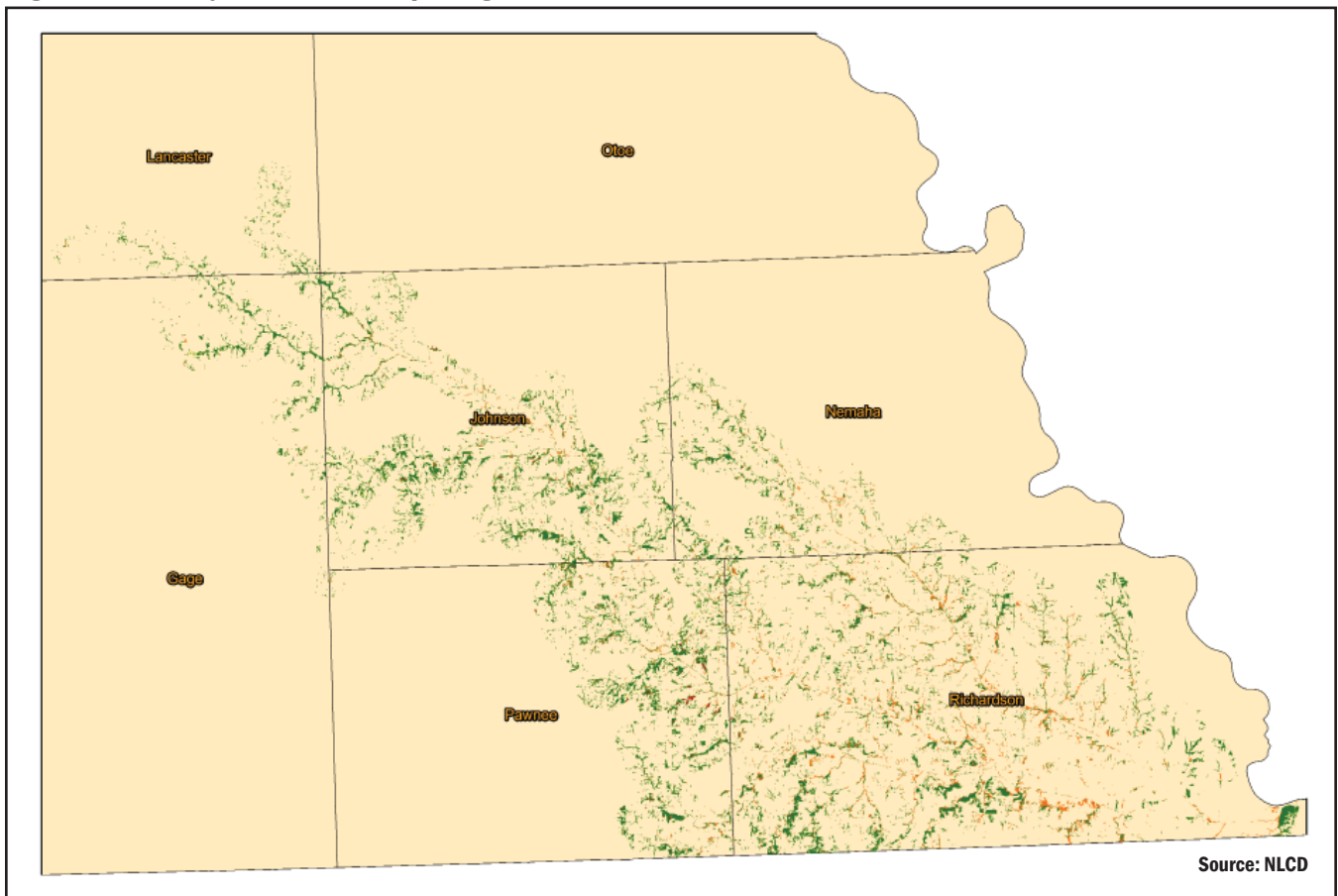
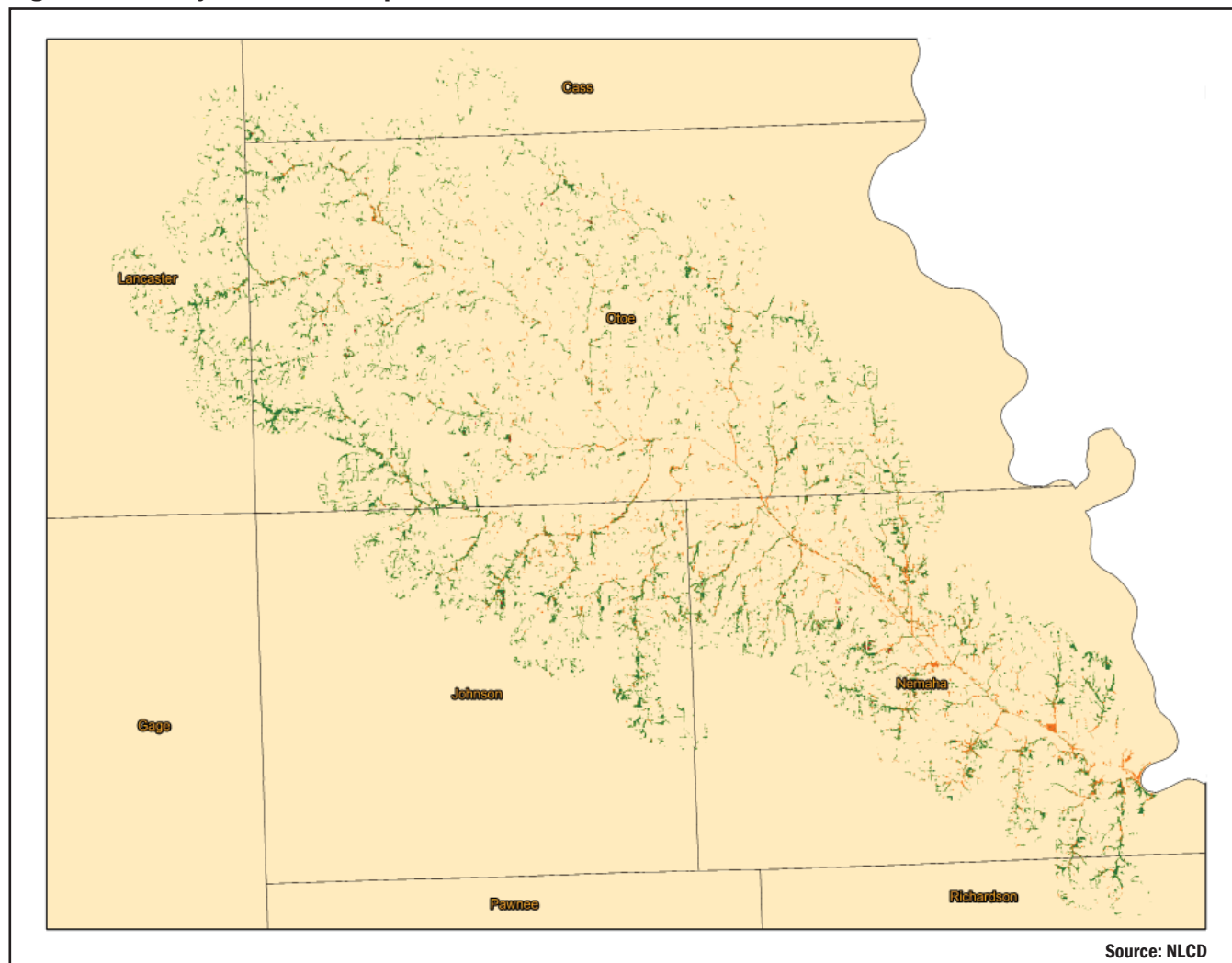


Figure 59. Priority Forest Landscape: Little Nemaha River



Priority Forest Landscape: Big & Little Blue Rivers

The Big Blue River is located in south central Nebraska and flows into Kansas, eventually becoming a tributary of the Kansas River. The basin covers approximately 4,600 square miles and includes all of York County and portions of Adams, Butler, Clay, Fillmore, Gage, Hall, Hamilton, Jefferson, Lancaster, Pawnee, Polk, Saline and Seward counties (Figure 60). Tributaries of the river include Lincoln Creek, West Fork of the Big Blue River, Turkey Creek, Swan Creek and Big Indian Creek.

The Little Blue River is also located in south central Nebraska and flows into Kansas, eventually becoming a tributary of the Big Blue River. Its major tributary is Big Sandy Creek. The

basin covers approximately 2,500 square miles and includes all of Thayer County and portions of Adams, Clay, Fillmore, Franklin, Jefferson, Kearney, Nuckolls, Saline and Webster counties (Figure 61). Annual precipitation in the two basins ranges from 25-30 inches.

Riparian forests generally follow the drainages. Marginal cropland no longer in production is succeeding to mixed hardwoods and eastern redcedar.

There are 100,986 acres of forestland in this area, including 92,918 acres of deciduous forest, 273 acres of coniferous forest, 986 acres of mixed forest and 6,809 acres of riparian forest (Homer, et al, 2004).

Figure 60. Priority Forest Landscape: Big Blue River

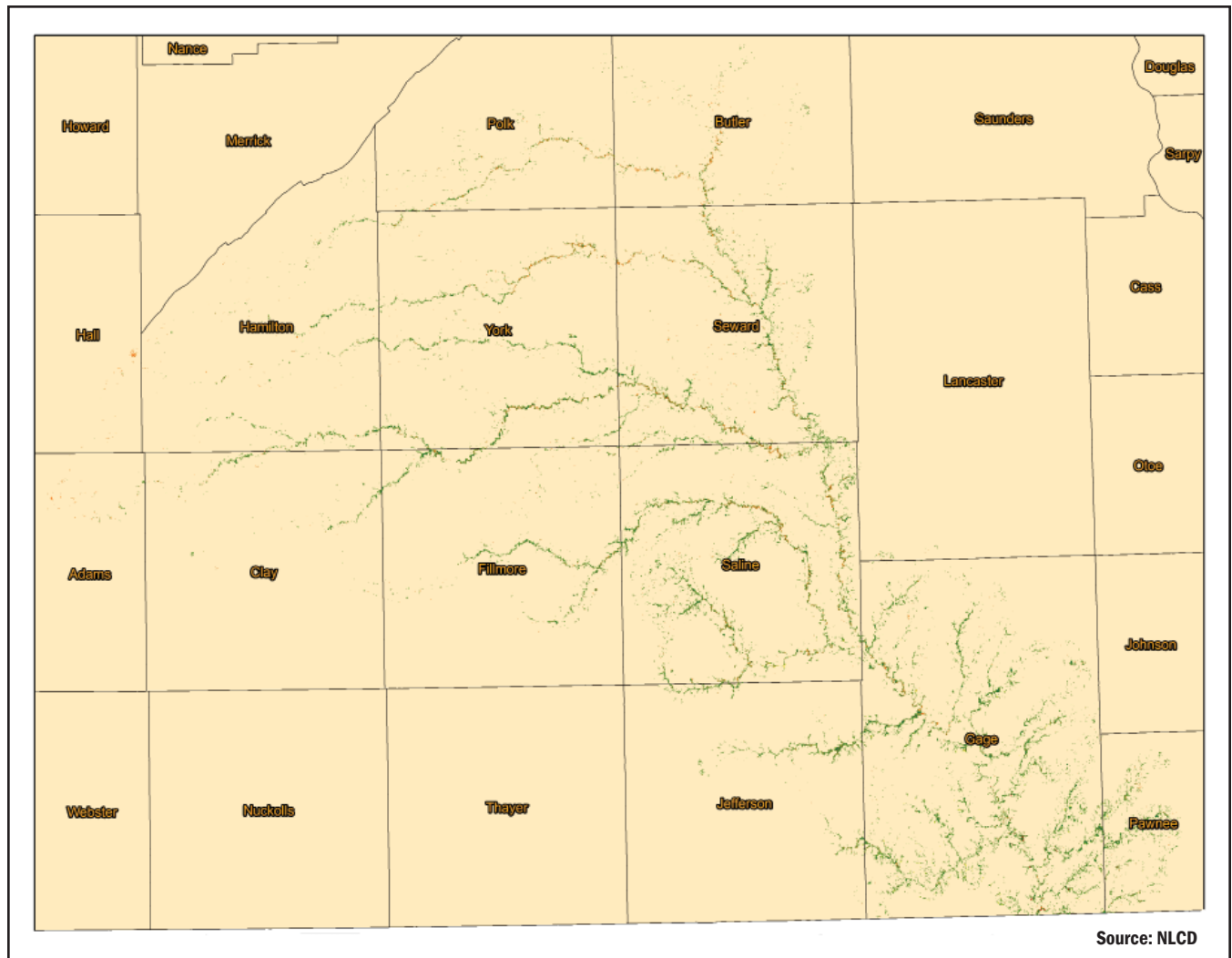
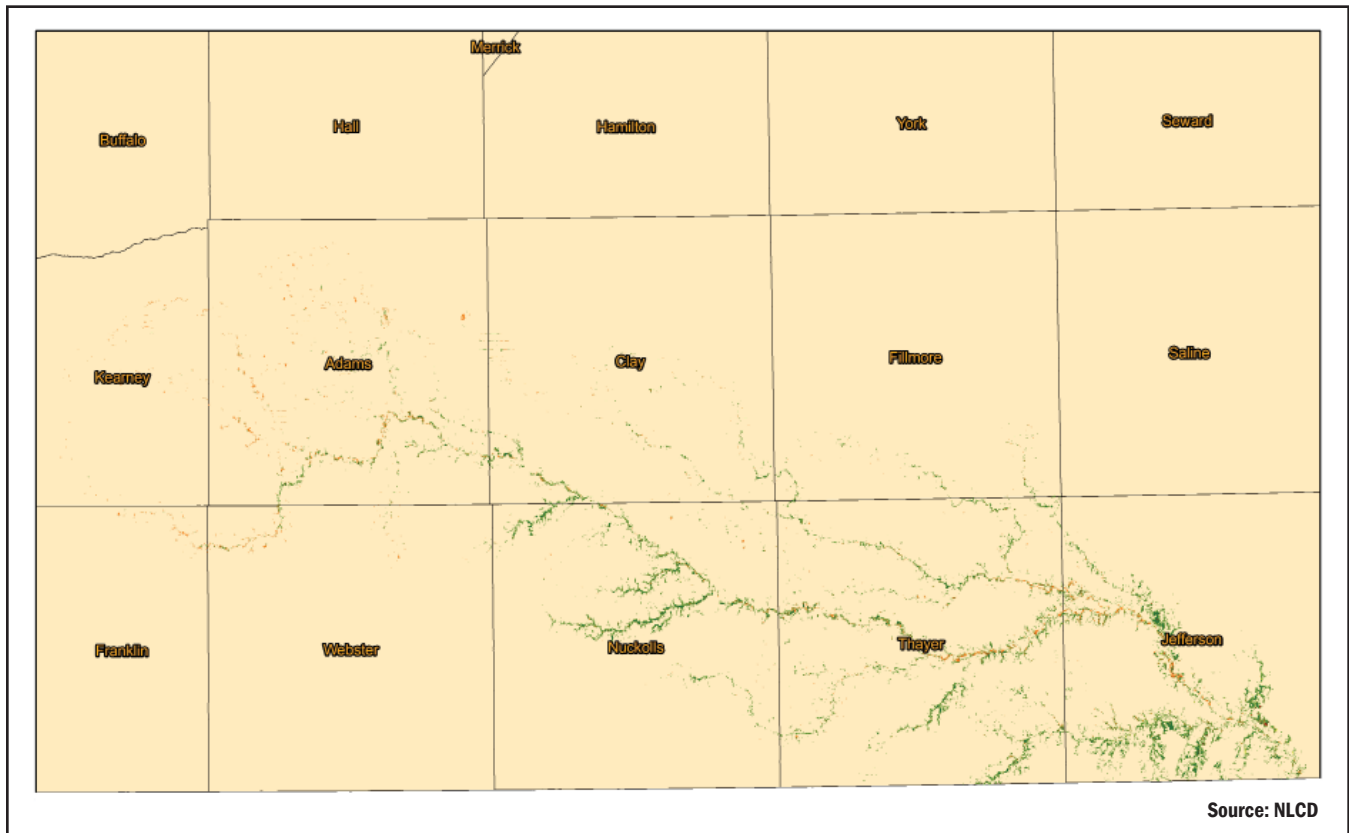


Figure 61. Priority Forest Landscape: Little Blue River



Critical Issues:

- High concentration of green ash and black walnut, at risk to EAB and thousand cankers disease, respectively.
- Forest health susceptibility to climate change.

Priority Forest Landscape: Platte River⁶

The Platte River flows across the entire state of Nebraska and encompasses 225,978 acres of forestland, including 64,678 acres of deciduous forest, 4,528 acres of coniferous forest, 1,192 acres of mixed forest and 155,579 acres of riparian forest (Homer, et al, 2004).

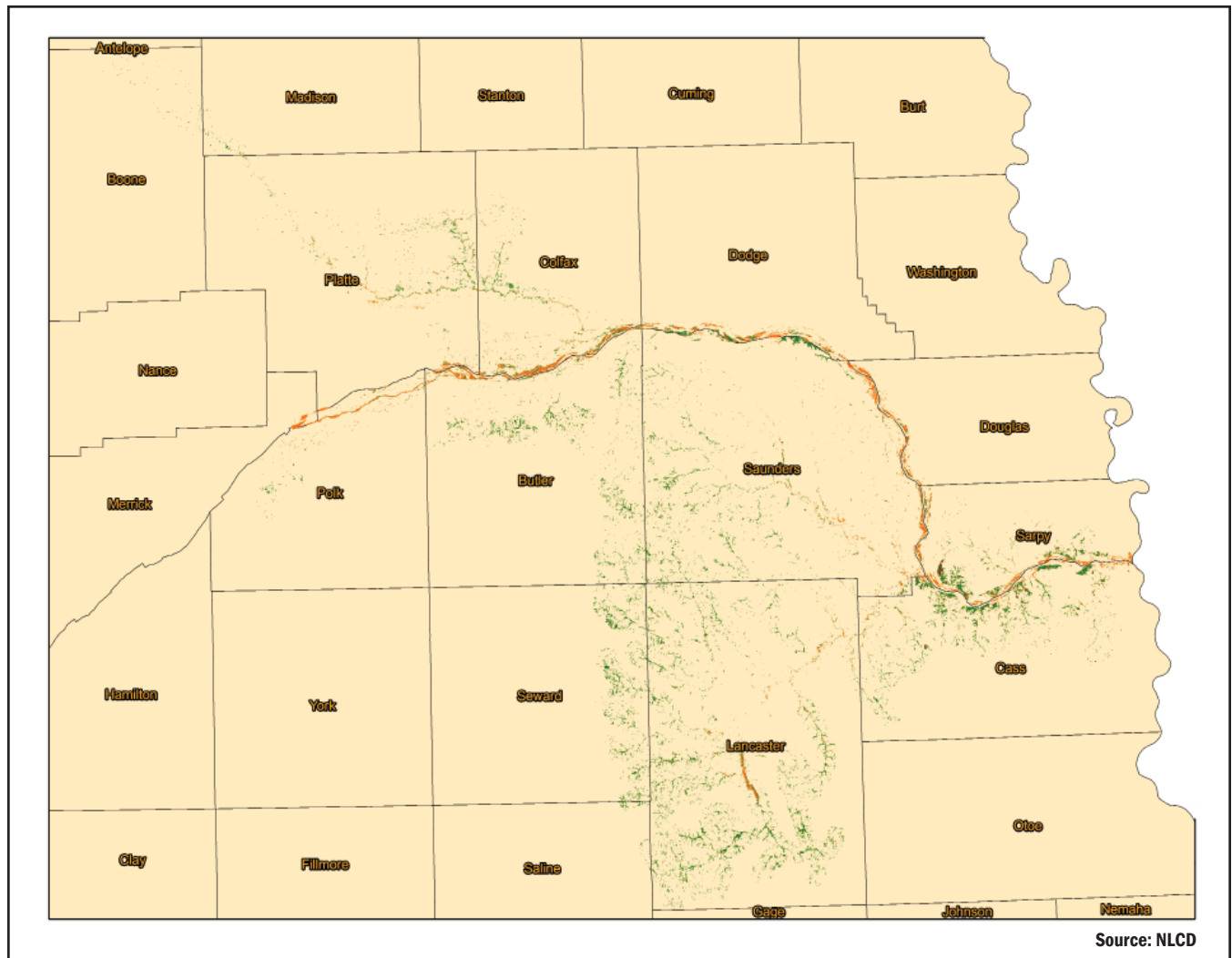
Eastern (Lower) Platte River

The lower portion of the Platte River includes the Platte River channel and its floodplain from the river's confluence with the Loup River in Platte County eastward to its mouth in Sarpy County (Figure 62). The lower Platte

River is a mid-sized, shallow, braided river. Sandbars and wooded islands are common within the channel. Much of the stream bank is wooded, with the dominant species being cottonwood and eastern redcedar, along with red mulberry, hackberry, Northern catalpa (*Catalpa speciosa*), black walnut and boxelder. The width of forests range from just tens of feet to several miles. Because the river no longer floods, native cottonwood stands established in scouring floods many years ago are overmature, decadent and beginning to break up. These stands are being replaced by eastern redcedar or mixed hardwoods (e.g., hackberry, red mulberry, green ash, Russian olive). Conversion to eastern redcedar is creating a new, highly flammable riparian forest type. Sand pits are common along the river and are popular

⁶ Portions of this text are reprinted, in part, from The Nebraska Natural Legacy Project, with permission of the Nebraska Game and Parks Commission.

Figure 62. Priority Forest Landscape: Eastern Platte River



recreation spots, with cabins lining many areas of the riverbank. Most of the river floodplain is now cropland, though there are scattered wet meadows and marshes.

The lower Platte River receives water from the Loup and Elkhorn rivers and has a more stable flow than the central Platte River. The lower Platte River is unique in that its sandbars support numerous colonies of the federally and state-listed piping plover and interior least tern. The construction of dikes and levees has constricted the natural channel and eliminated or isolated most of the floodplain sloughs, backwaters and wetlands. The narrowing of the channel has resulted in higher flow stages after heavy rain events that wash away tern and plover nests. The lower Platte also supports many rare large river fish including lake sturgeon (*Acipenser fulvescens*), blue sucker (*Cycleptus elongatus*), sturgeon chub (*Macrhybopsis gelida*) and pallid sturgeon (*Scaphirhynchus albus*).

Protected areas along this reach of the Platte River include Two Rivers State Recreation Area, Louisville State Recreation Area, Platte River State Park and Mahoney State Park.

Critical Issues:

- Increasing risk of catastrophic wildfire in places due to growing fuel loads of eastern redcedar.
- Conflicts over water availability and endangered species management, threatening the existence of riparian forests.
- Steep decline in gallery cottonwood forest type, with negative ecological and economic impacts.
- Heavy infestations of invasive woody species (Russian olive), aggressive native species (eastern redcedar) and nonwoody invasives (phragmites, purple loosestrife).
- High wildlife values for uncommon and/or migratory bird species.

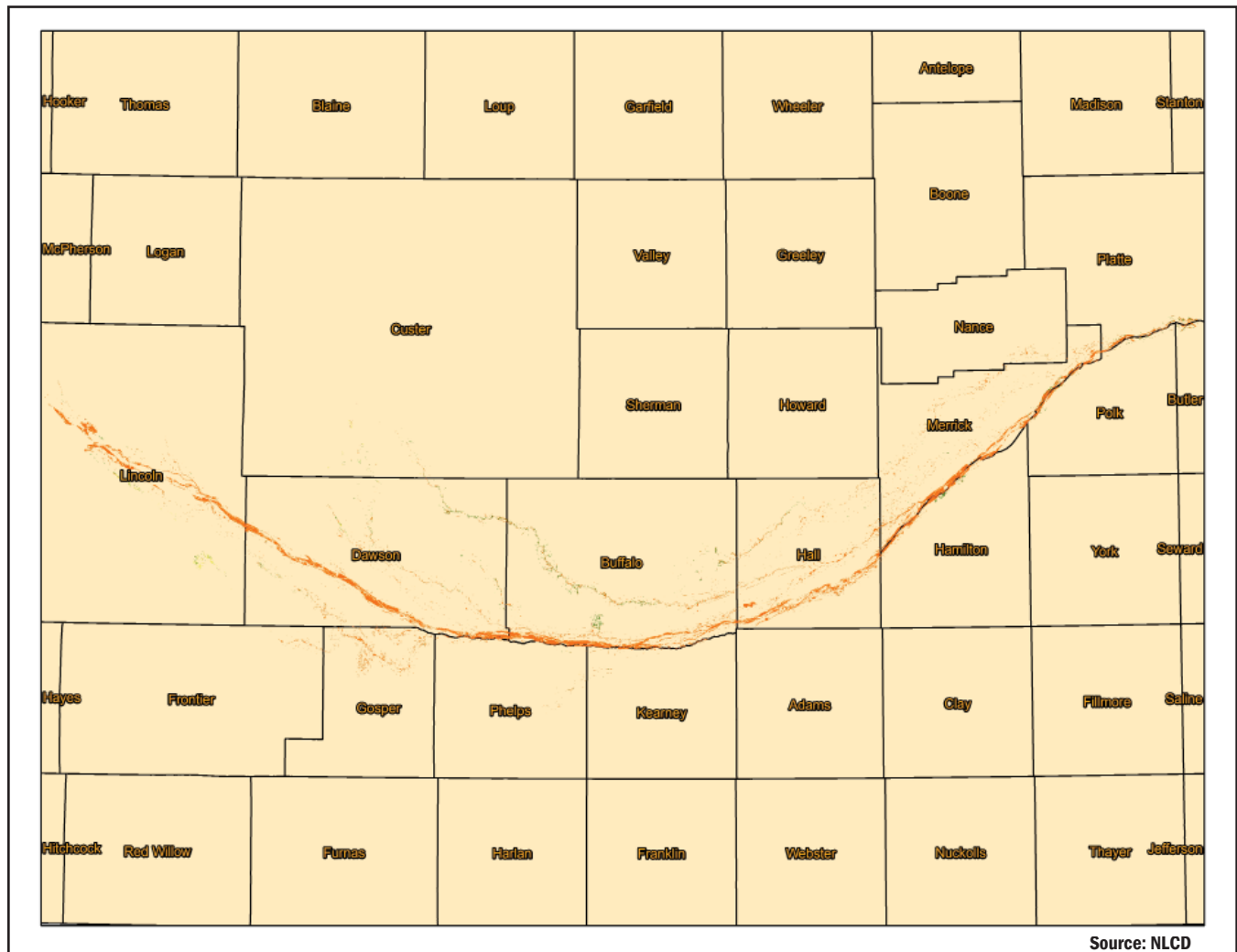
- Increasing recreational home development and expansion of WUI areas.
- Increasing forest fragmentation.
- Forest health susceptibility to climate change.
- High concentration of green ash and black walnut, at risk to EAB and thousand cankers disease, respectively.
- Substantial economic impact of forest resources on local economy (cottonwood, biomass, hunting).
- Portions designated as a BUL in the Nebraska Natural Legacy Project.

Central Platte River

The central Platte River includes the Platte River channel and floodplain from central Dawson County eastward to central Hamilton County (Figure 63). The central Platte River is a large, shallow stream with a braided channel. Sandbars and wooded islands are common within the channel. Much of the stream bank is extensively wooded with the dominant species being cottonwood and eastern redcedar, along with red mulberry, hackberry, green ash, Russian olive and others. Sand pits are common along the river, many with housing developments. Most of the river floodplain is in cropland, though there are scattered wet meadows in areas. Sand dune grasslands occur on the south side of the river in areas.

The staging of Sandhill cranes during spring migration on the Platte River is a unique world-class ecological phenomenon. It is also a critical element in the life cycle of the mid-continent population of Sandhill cranes. Each spring 300,000-400,000 cranes concentrate on the central valley of the Platte River for approximately one month to rest and gain weight before continuing north. Roosts numbering in the tens of thousands are scattered throughout the Platte River. The shortage of wet meadows in spring staging

Figure 63. Priority Forest Landscape: Central Platte River



areas on the Platte River is considered to be a potential threat to the midcontinental population of Sandhill cranes. The International Union for Conservation of Nature considers the protection of the Platte River as migratory habitat for Sandhill cranes a priority for conservation.

In addition to Sandhill cranes, millions of geese, waterfowl and a variety of shorebirds use this stretch of the river. Five federal and/or state-listed species occur along the Central Platte: whooping crane, interior least tern, piping plover, bald eagle and river otter (*Lutra canadensis*). This portion of the Platte is designated as critical habitat for whooping cranes and piping plovers. The Platte River Whooping Crane Maintenance Trust, the

Audubon Society, The Nature Conservancy and NGPC own and manage a number of protected areas within this reach of the river.

Other threats to the river include demand for irrigation water and a massive infestation of invasive phragmites, saltcedar, purple loosestrife and Russian olive along hundreds of miles of river. This stretch of the Platte River has had extensive water depletion and in recent summers has gone dry over much of its reach.

Critical Issues:

- Increasing risk of catastrophic wildfire due to growing fuel loads of eastern redcedar.
- Conflicts over water availability and endangered species management,

threatening existence of riparian forests.

- Steep decline in gallery cottonwood forest type, with negative ecological and economic impacts.
- Heavy infestations of invasive woody species (Russian olive), aggressive native species (eastern redcedar) and nonwoody invasives (phragmites, purple loosestrife).
- High wildlife values for uncommon and/or migratory bird species.
- Increasing recreational home development and expansion of WUI areas.
- Increasing forest fragmentation.
- Forest health susceptibility to climate change.

- High concentration of green ash at risk to EAB.
- Economic impact of forest resources on local economy (cottonwood, biomass, hunting).
- Designated as a BUL in the Nebraska Natural Legacy Project.

Western Platte River

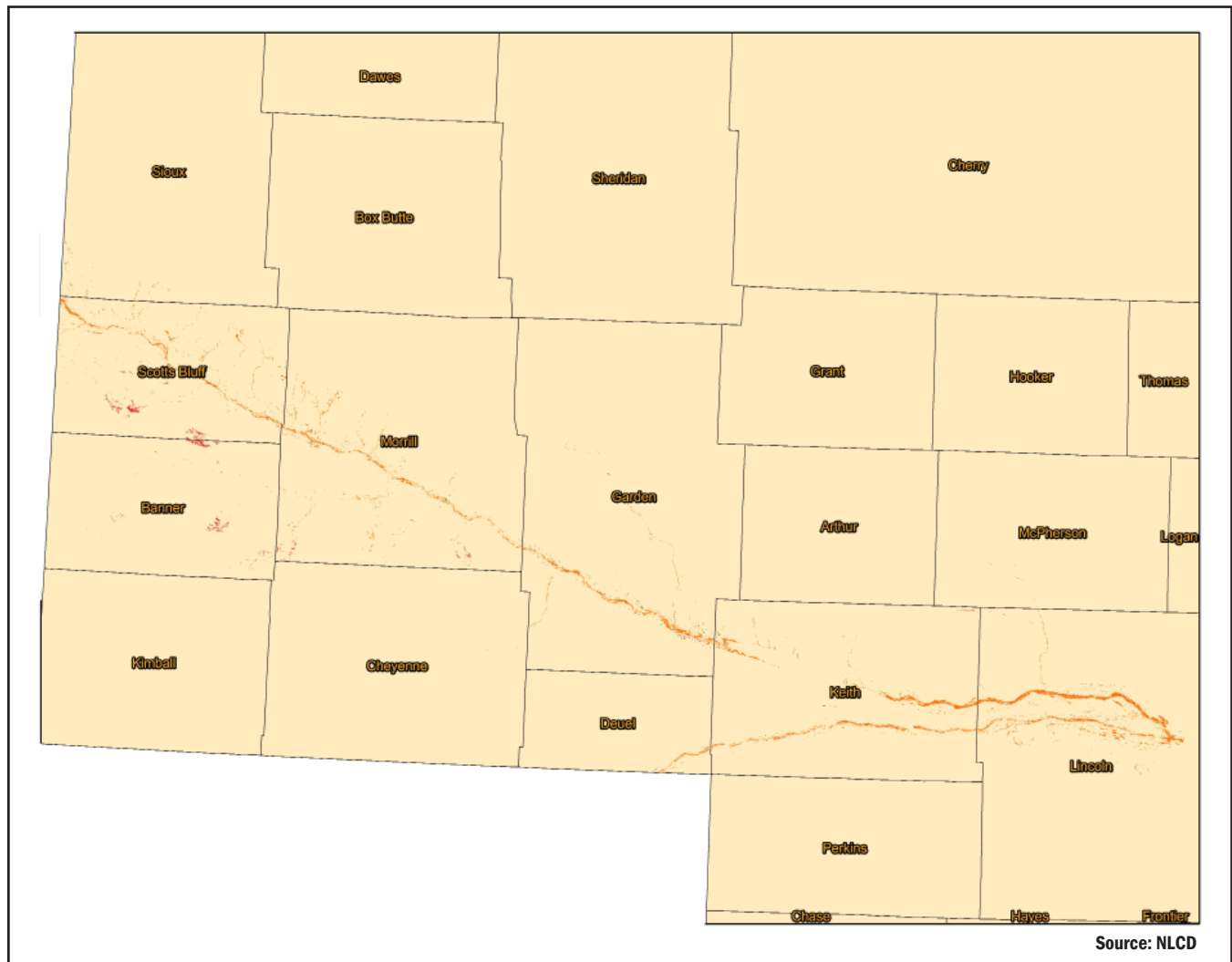
The western most portion of the Platte River includes the North and South Platte river valleys and the land between them in Keith and Lincoln counties (Figure 64). It also includes a small area of Sandhills to the north of the North Platte River valley through which Whitetail Creek, Birdwood Creek and White Horse Creek flow.

Both the North Platte and South Platte



The braided channels and riparian forests of the Platte River. Photo: NEBRASKAland Magazine/NGPC.

Figure 64. Priority Forest Landscape: Western Platte River



rivers in this reach are shallow streams with braided, mostly wooded channels. However, open sandbars and wet meadows are more common in the floodplain than in other reaches of the Platte River in western Nebraska. Sandhill cranes use these open habitats to a limited extent for spring staging. River flows have been greatly depleted by upstream diversion, especially in dry years. Russian olive, phragmites, saltcedar and eastern redcedar have colonized the floodplain woodlands and meadows. Cropland is common in the valley.

Whitetail Creek, Birdwood Creek and White Horse Creek headwater in the Sandhills, their flows derived from the extensive aquifer below the dunes, and flow southward into the North Platte River. In their upper reaches, they are

fairly pristine cold-water streams with wet meadows in their floodplains. These streams are unique in that they support several species of rare cold-water fish, including the northern redbelly dace (*Phoxinus eos*) and finescale dace. The streams also support submergent wetland plants that feed over-wintering trumpeter swans (*Cygnus buccinator*).

NGPC designated several BULs along the Platte River as part of the 2005 Nebraska Natural Legacy Project: Lower Platte River, Central Platte River Platte Confluence and North Platte River Wetlands (Figure 65).

Critical Issues:

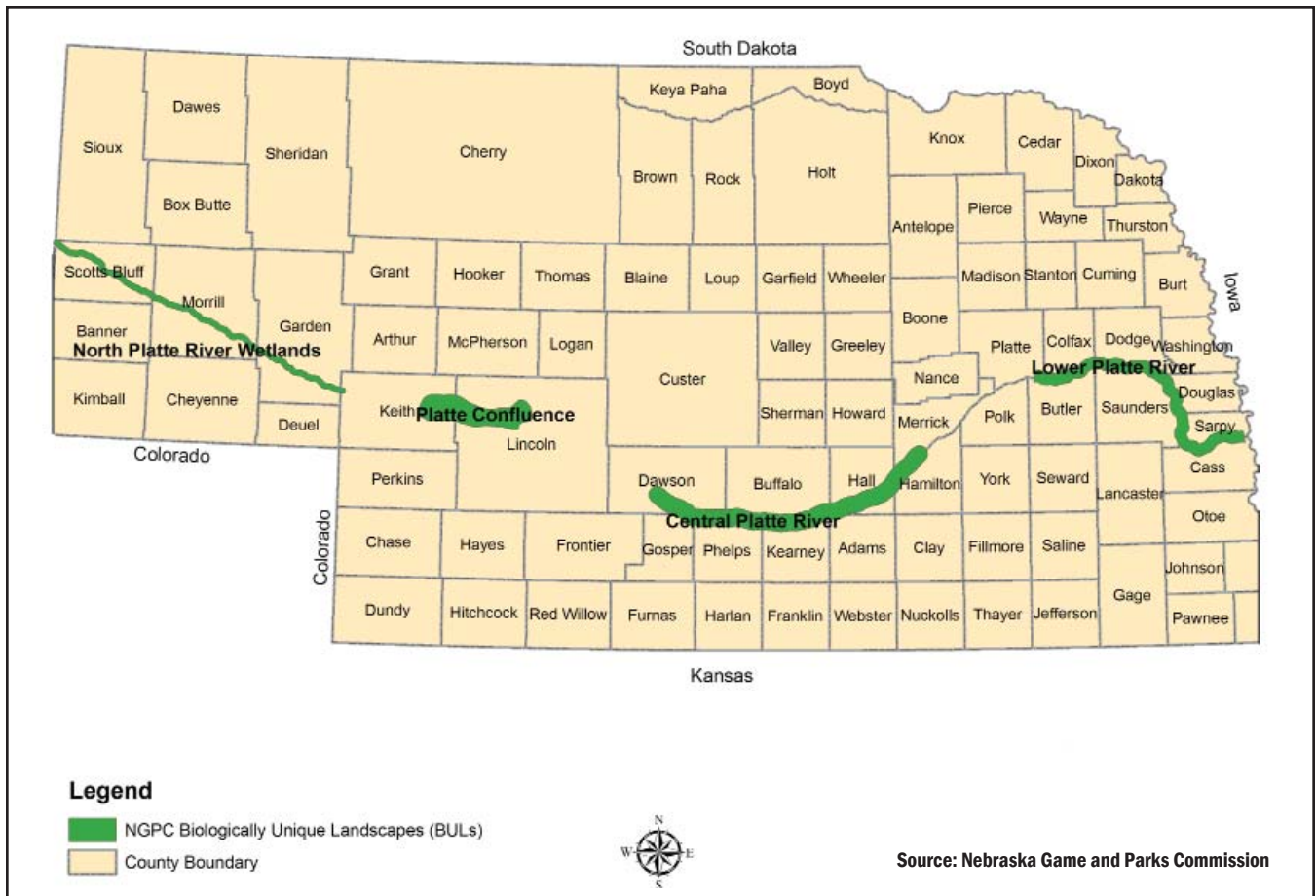
- Increasing risk of catastrophic wildfire due to growing fuel loads of eastern redcedar.

- Conflicts over water availability and endangered species management, threatening existence of riparian forests.
- Steep decline in gallery cottonwood forest type, with negative ecological and economic impacts.
- Heavy infestations of invasive woody species (Russian olive), aggressive native species (eastern redcedar) and nonwoody invasives (phragmites, purple loosestrife).
- High wildlife values for uncommon and/or migratory bird species.
- Increasing recreational home development and expansion of WUI areas.
- Increasing forest fragmentation.
- Forest health susceptibility to climate change.
- High concentration of green ash at risk to EAB.
- Economic impact of forest resources on local economy (cottonwood, biomass, hunting).

Multistate Priority Area:

The North and South Platte Rivers span Nebraska, Colorado and Wyoming, making this area a multistate priority area.

Figure 65. Platte River Biologically Unique Landscapes



Priority Forest Landscape: Republican River

The Republican River begins in southwest Nebraska at the convergence of the North Fork Republican and Arikaree rivers flowing southeast out of Colorado (Figure 66). The South Fork Republican, another Colorado river, also feeds the Republican River. The river flows through the northwest corner of Kansas, re-entering Nebraska near Benkelman. From there it flows more than 200 miles east before re-entering Kansas southeast of Superior and eventually emptying into Milford Lake northwest of Junction City, Kansas.

Four devastating floods that occurred in a 20-day period in 1935 prompted construction of the Swanson Reservoir by Trenton and Harlan County Lake by Republican City. These reservoirs, controlled by the U.S. Army Corps of Engineers, provide flood control and irrigation water to thousands of acres of cropland through a series of canals. The river and its tributaries receive approximately 19 inches of precipitation each year, thus the river is significantly, and negatively, impacted by drought and intensive irrigation. Many reaches of the river run completely dry during drought years.

The Republican is an extremely braided, alluvial river with a sand bed and easily erodible banks. It typically carries a heavy load of sediment and flows through a valley that ranges from 3/4-2 miles wide, occupied by farmland and forests. The river is flanked by hills ranging from steep loess slopes to sharp ridges and also includes many islands of willow thickets created by extended low water flows. Riparian forested stands along the river, characterized by diverse stands of eastern cottonwood, red mulberry, hackberry, green ash, eastern redcedar, Russian olive, black walnut and northern catalpa, are home to deer, turkey (*Meleagris gallopavo*), beavers (*Castor canadensis*), bald eagles, herons, coyotes (*Canis latrans*) and foxes.

Riparian forests have experienced significant damage due to declining water tables in recent

drought years. Over the past decade, most of the eastern reaches of this river were invaded by phragmites, requiring massive control efforts to restore streamflows. When water levels allow, the Corps occasionally releases large quantities of water from Harlan County Lake to ensure multistate water compact requirements are met, indirectly making the area popular for canoeing and tubing. Western reaches have experienced significant colonization by Russian olive and saltcedar. Eastern redcedar is increasingly occurring under deciduous riparian forests along the central portion of the river.

This area contains 80,487 acres of forestland, including 13,544 acres of deciduous forest, 988 acres of coniferous forest, 2,811 acres of mixed forest and 63,143 acres of riparian forest (Homer, et al, 2004).

Critical Issues:

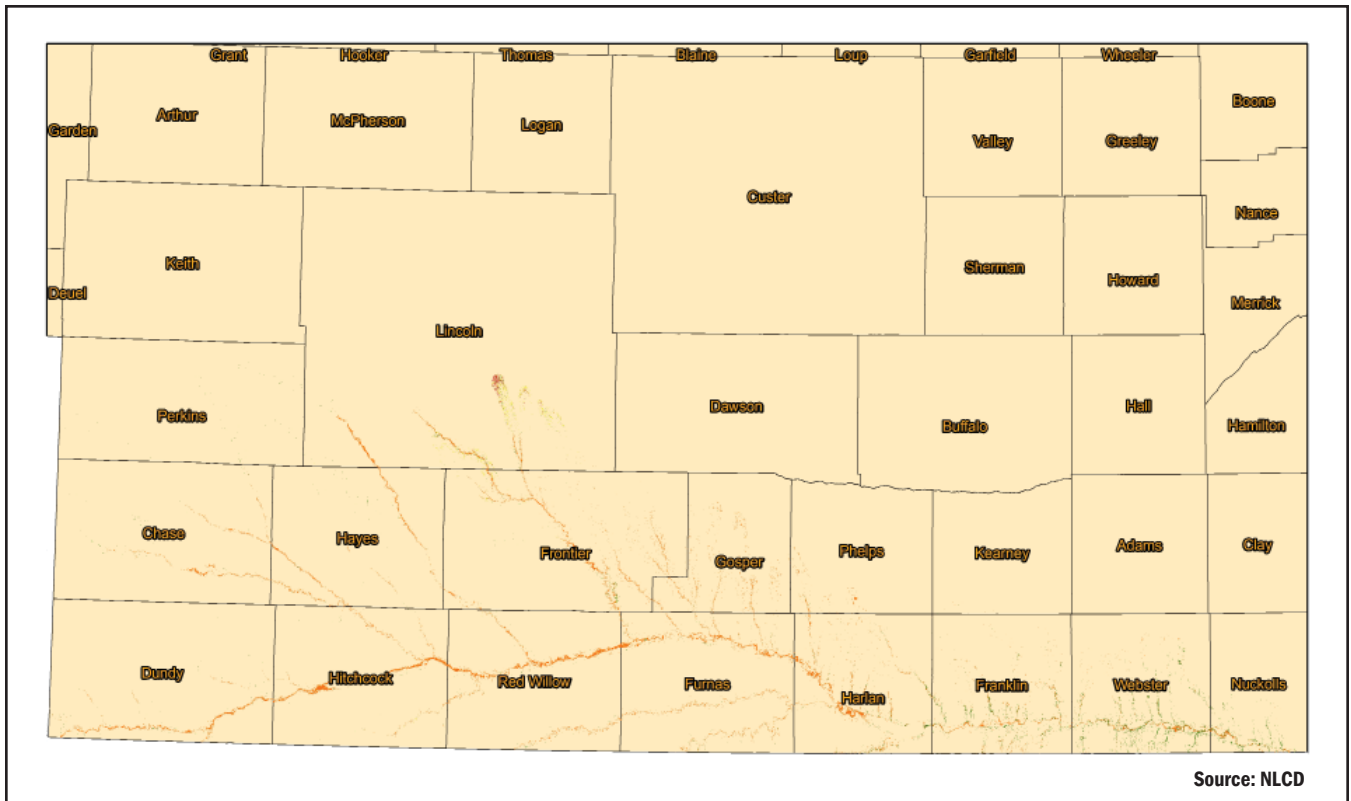
- Increasing risk of catastrophic wildfire due to growing fuel loads of eastern redcedar.
- Conflicts over water availability, threatening existence of the forest.
- Steep decline in gallery cottonwood forest type, with negative ecological and economic impacts.
- Heavy infestations of invasive woody species (Russian olive, saltcedar) and aggressive native species (eastern redcedar).
- High wildlife values for uncommon and/or migratory bird species.
- Increasing recreational home development and expansion of WUI areas.
- Increasing forest fragmentation.
- Forest health susceptibility to climate change.
- High concentration of green ash and black walnut, at risk to EAB and thousand cankers disease, respectively.

- Economic impact of forest resources on local economy.

Multistate Priority Areas

Due to its proximity to Kansas, the Republican River is a multistate priority forest area with Kansas.

Figure 66. Priority Forest Landscape: Republican River



Priority Forest Landscape: Loup River⁷

The Loup River basin includes the lower reaches of the Middle Loup River (north-central Custer County southeastward), North Loup River (southwest Garfield County southeastward), and the Loup River from its origin to the Nance/Platte county line (Figure 67). The landscape includes the river channels and a two-mile buffer on each side of the rivers. The Loup rivers in these reaches are medium-sized rivers with broad braided, somewhat shallow channels. The river channels have many open sandbars and wooded islands and forested banks with typical riparian forest components. The flows on the North Loup River have been modified by the upstream Taylor Dam and irrigation diversions. The flows on the Middle Loup and Loup rivers have been modified by several diversions. Though somewhat modified, the Loup rivers maintain a fairly constant year-

⁷ Portions of this text are reprinted, in part, from The Nebraska Natural Legacy Project, with permission of the Nebraska Game and Parks Commission.

round flow because of the spring-fed nature of the streams in their upper reaches in the Sandhills.

Much of the valley floodplains are cropland, though some areas support cottonwood woodlands, wet meadows and marshes. The valley bluffs are mostly shallow sloped and covered by mixed-grass prairie with bur oak woodlands in areas.

Sandbars on the lower reaches of the Loup River support nesting colonies of the federally and state-listed interior least tern and piping plover. The federally and state-endangered whooping crane uses sandbars and wet meadows in the Loup River floodplains as migratory stopover habitat. Bald eagles also nest in tall cottonwoods along the Loup rivers. Nebraska's most extensive populations of the state-threatened small white lady's-slipper (*Cypripedium candidum*) occur in wet meadows in the Middle Loup River floodplain.



Nebraska's Loup River winds through central Nebraska. Photo: NFS.

Figure 67. Priority Forest Landscape: Loup River



Farther west are the upper reaches of the Middle Loup, Dismal, North Loup and Calamus rivers, including their headwaters in the central Sandhills southeastward to where the rivers enter the Loess Hills. The landscape includes the river channels and a two-mile buffer on each side of the channels. These rivers start as spring-fed streams in Sandhills meadows. They gain flow throughout their journey and most are meandering streams that have cut deep valleys beyond their headwaters. In their upper reaches the streams have a narrow channel, but they become more braided in their lower reaches. The valley bottoms are occupied by wet meadows with some cottonwood woodlands, marshes and isolated cropland. The bluffs are mainly covered with Sandhills dune prairie. The steep bluffs of the North Fork and the South Fork of the Dismal River support eastern

redcedar woodland in some areas.

The upper reaches of these rivers and some of their tributaries are significant in that they support assemblages of rare fish, including the Topeka shiner (*Notropis topeka*), blacknose shiner (*Notropis heterolepis*) and finescale dace. The federally and state-endangered whooping cranes use wider, braided reaches of the stream channels and associated meadows as migratory stopover habitat. The federally and state-threatened western prairie fringed orchid (*Platanthera praeclara*) occurs in wet meadows within the valleys. The American burying beetle (*Nicrophorus americanus*) is found within this landscape. Protected areas within the landscape include portions of the Nebraska National Forest (Bessey District) and a few smaller wildlife management areas.

This area contains 104,290 acres of forestland, including 29,672 acres of deciduous forest, 3,750 acres of coniferous forest, 2,463 acres of mixed forest and 68,406 acres of riparian forest (Homer, et al, 2004).

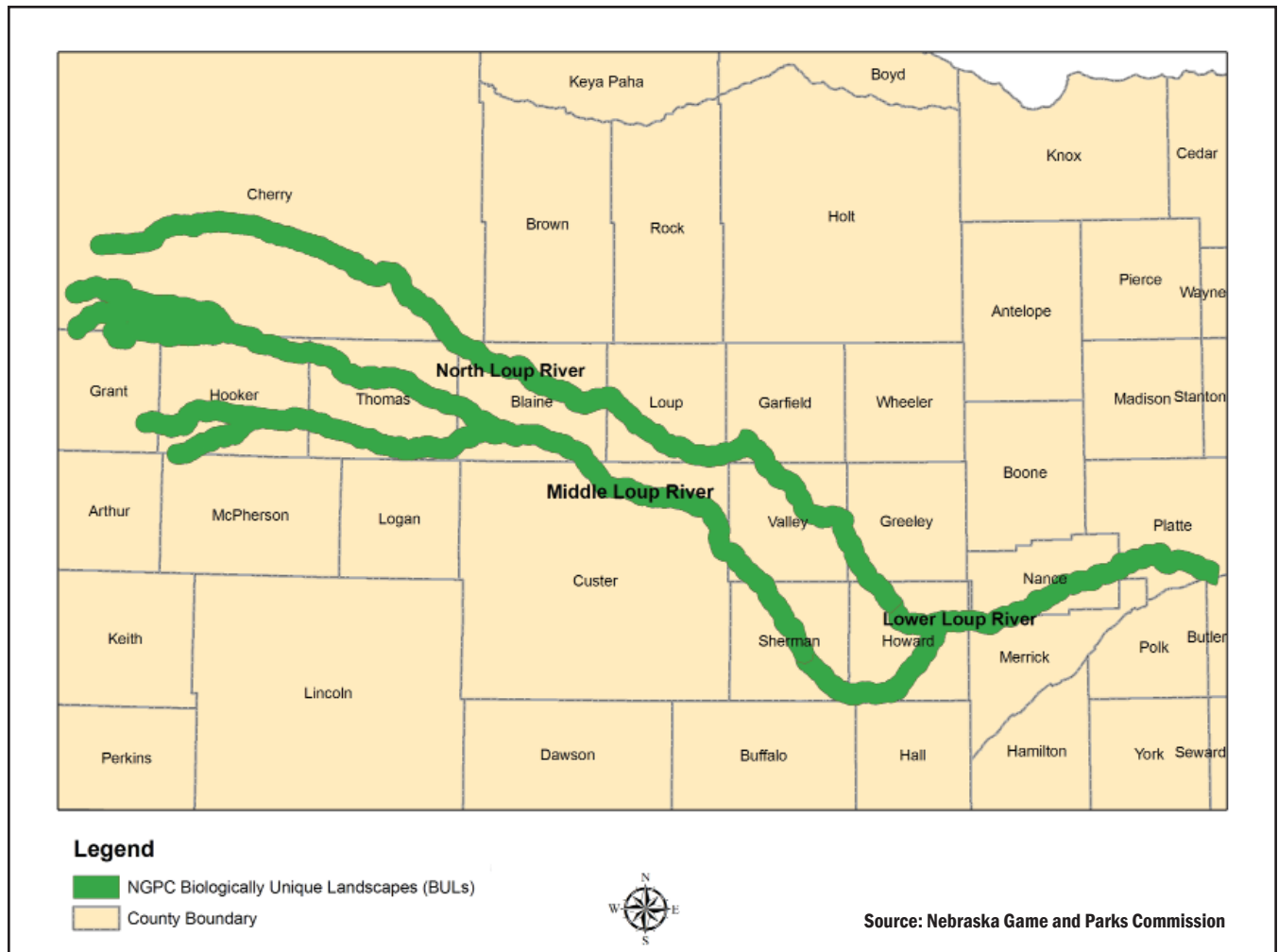
NGPC designated the following BULs in this area as part of its 2005 Nebraska Natural Legacy Project: Lower Loup River and Middle Loup River and tributaries and North Loup River (Appendix A, Figure 68).

Critical Issues:

- Increasing risk of catastrophic wildfire in places due to growing fuel loads of eastern redcedar.
- Conflicts over water availability and endangered species management, threatening existence of the forest.

- Steep decline in gallery cottonwood forest type, with negative ecological and economic impacts.
- Heavy infestations of invasive woody species (Russian olive) and aggressive native species (eastern redcedar).
- High wildlife values for uncommon and/or migratory bird species.
- Increasing recreational home development and expansion of WUI areas.
- Increasing forest fragmentation.
- Forest health susceptibility to climate change.

Figure 68. Loup River Biologically Unique Landscapes



- High concentration of green ash and black walnut, at risk to EAB and thousand cankers disease, respectively.
- Economic impact of forest resources on local economy (cottonwood, biomass, hunting).
- Portions designated as a BUL in the Nebraska Natural Legacy Project.

Priority Forest Landscape: Elkhorn River⁸

The Elkhorn River originates in north central Nebraska and meets the Platte River near Gretna (Figure 69). The river's deep channel and smooth, meandering path make it popular for canoeing. Ice jams and heavy spring rains can result in destructive flooding. More flood damage occurs along the Elkhorn River than any other river in Nebraska.

The Elkhorn River's floodplain is primarily cropland but also contains cottonwood-dominated woodlands, wet meadows and freshwater marshes. The uplands on the south side of the river are composed of sand dunes

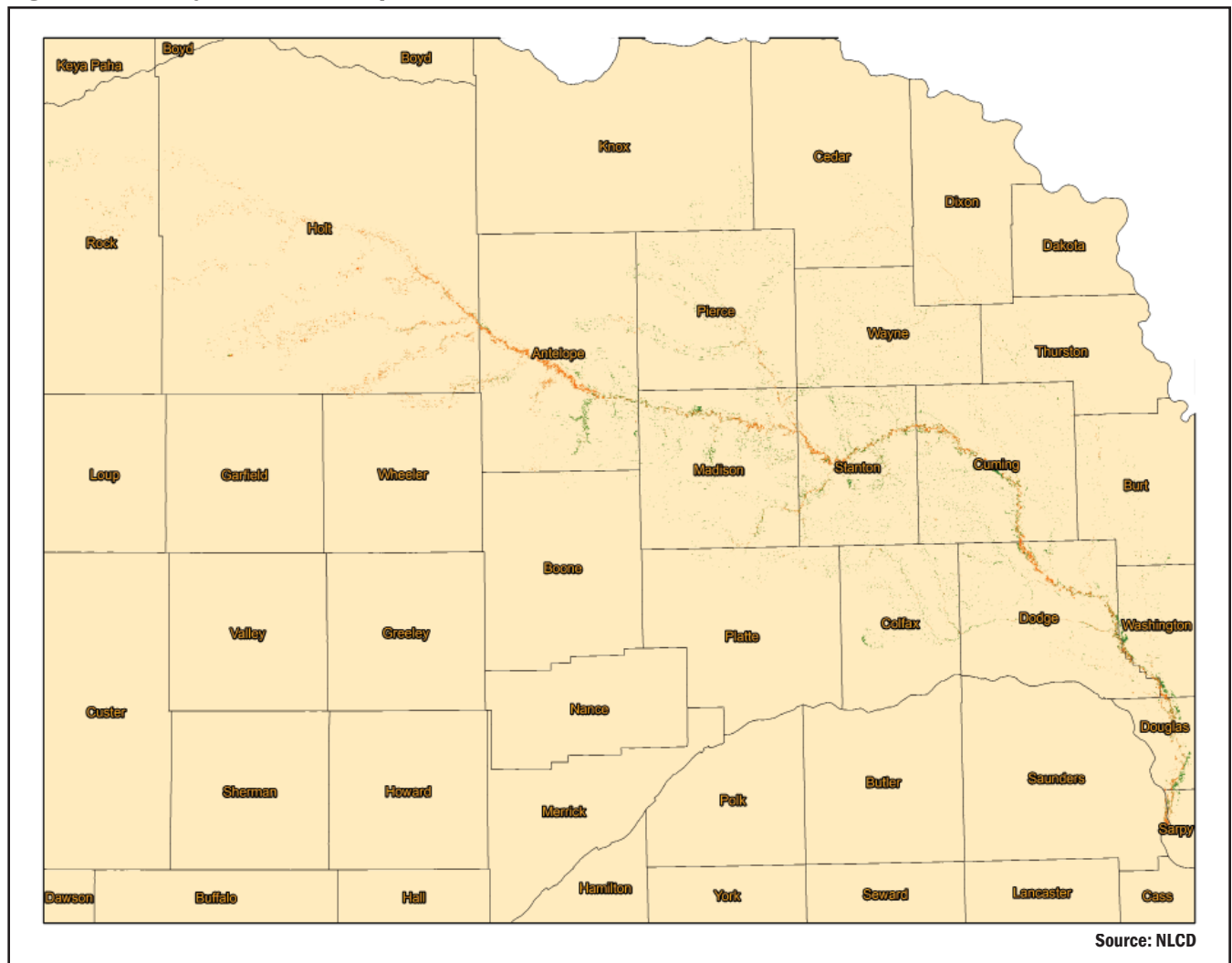
⁸ Portions of this text are reprinted, in part, from The Nebraska Natural Legacy Project, with permission of the Nebraska Game and Parks Commission.

originating from river alluvium. Dry-mesic sand prairie, mostly grazed, and bur oak woodlands occupy the dunes. Most of the sandy soils south of the river have been converted to cropland. The uplands north of the river contain more loam and are mostly in cropland although some degraded tallgrass prairies remain.

This area contains 76,608 acres of forestland, including 36,365 acres of deciduous forest, 43 acres of coniferous forest, 88 acres of mixed forest, 40,112 acres of riparian forest (Homer, et al, 2004).

In this area, NGPC designated the Elkhorn Confluence a BUL in its 2005 Natural Legacy Project (Appendix A, Figure 70).

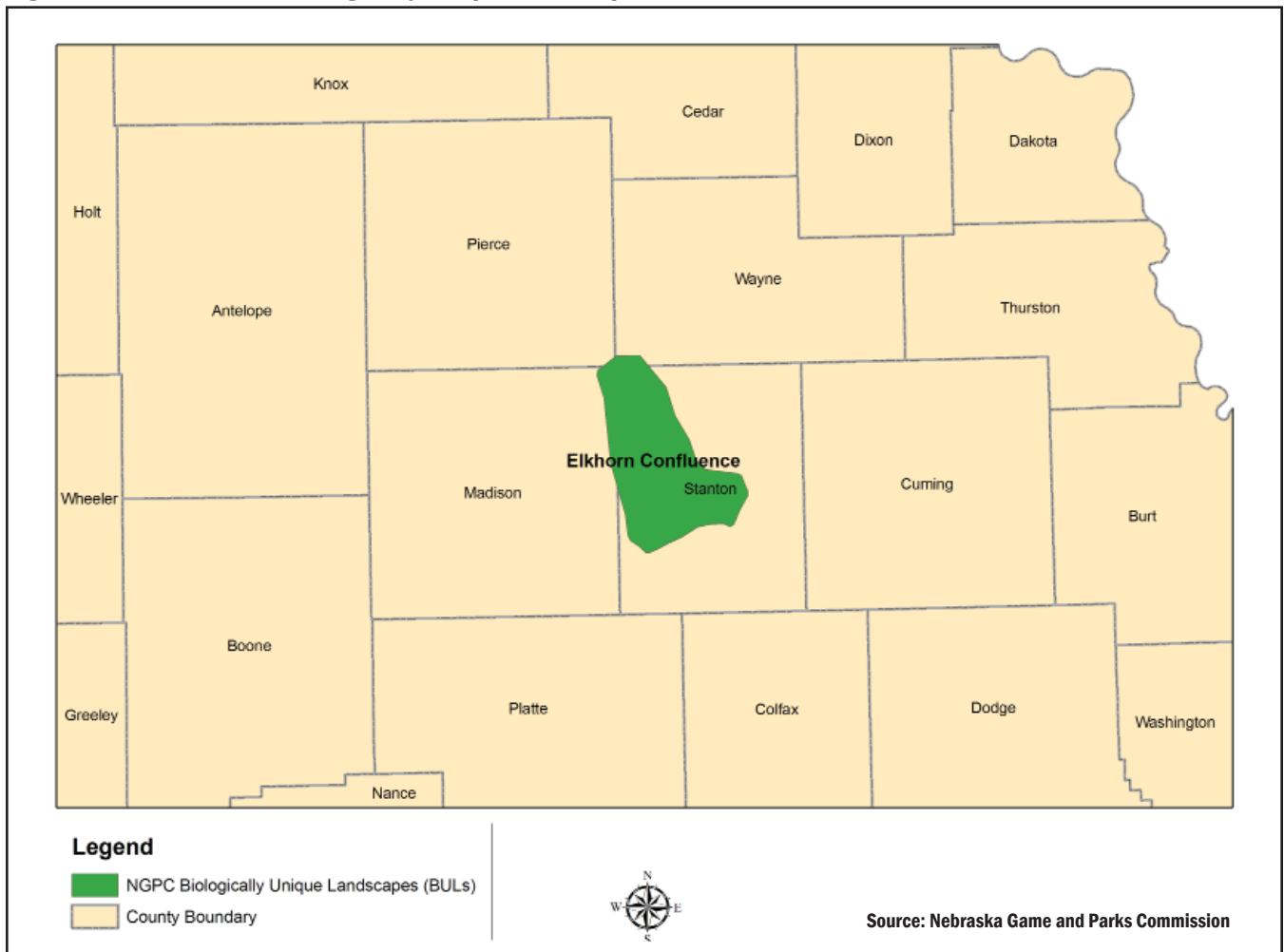
Figure 69. Priority Forest Landscape: Elkhorn River



Critical Issues:

- Increasing risk of catastrophic wildfire in places due to growing fuel loads in dense stands of eastern redcedar.
- Conflicts over water availability and endangered species management, threatening existence of the forest.
- Steep decline in gallery cottonwood forest type, with negative ecological and economic impacts.
- Heavy infestations of invasive woody species (Russian olive) and aggressive native species (eastern redcedar).
- High wildlife values for uncommon and/or migratory bird species.
- Increasing recreational home development and expansion of WUI areas.
- Increasing forest fragmentation.
- Forest health susceptibility to climate change.
- High concentration of green ash and black walnut, at risk to EAB and thousand cankers disease, respectively.
- Economic impact of forest resources on local economy (cottonwood, biomass, hunting).
- Portions designated as a BUL in the Nebraska Natural Legacy Project.

Figure 70. Elkhorn River Biologically Unique Landscapes





CHAPTER 7: ALL LANDS, ALL HANDS—ORGANIZATIONS & RESOURCES SUPPORTING TREES, FORESTS & NATURAL RESOURCES

Protecting, enhancing and utilizing our tree and forest resources statewide is a big job that no one agency or organization can do on its own. Thus, partnerships with a diverse array of organizations is critical. NFS works with a large number of partners, as described in detail below.

USFS STATE & PRIVATE FORESTRY PROGRAM

USFS's State & Private Forestry Program (S&PF) provides technical and financial assistance to state forestry agencies to support state programs targeted to state and privately owned forestlands.

NFS partners with S&PF through four separate programs that complement NFS programs: forest health, urban and community forestry, wildland fire protection and forest stewardship. The USFS S&PF program is an enormously valuable and central partner to NFS and its programs, and has been for many years. USFS S&PF staff have provided important feedback and guidance to state forestry agencies over the years and continue to do so. As new issues emerge, USFS S&PF continues to provide critically needed technical support to the state, including areas such as invasive

species, rural and community forest inventory and analysis, forest health and fire protection and suppression. The USFS Rocky Mountain Research Station and other research stations have conducted important studies and provided results of considerable value to NFS and our programs, forming a partnership that will only strengthen in the future as the demands for tree- and forestry-related research grow.

The Nebraska National Forest, the only national forest in Nebraska, is also a valuable partner. NNF and NFS conduct joint planning activities and collaborate in many ways and in many programs to achieve landscape-level impacts across forest ownerships in the Pine Ridge and around Halsey Unit in north central Nebraska.

NEBRASKA NATURAL RESOURCES CONSERVATION SERVICE

The Nebraska Natural Resources Conservation Service (NRCS), which is part of the U.S. Department of Agriculture, is a federal agency responsible for natural resources conservation on private lands. NRCS works in partnership with private landowners and a variety of natural resource agencies to develop and implement conservation plans that promote healthy, sustainable environmental resources.

Conservation plantings, such as windbreaks and riparian buffers, are a vital component of Nebraska's rural forests. However, forestry-related assistance to rural landowners had traditionally been limited. In 2004, NFS and NRCS engineered an innovative, three-year cooperative agreement to address this issue.

Because NFS district foresters have traditionally worked closely with NRCS field staff to implement forestry practices at the local level, this collaboration allows the organizations to substantially improve this partnership by co-funding four technical service provider (TSP) forester positions at strategic NRCS field offices across the state. These positions have greatly enhanced NRCS's ability to provide forestry technical assistance, particularly with Farm Bill programs, and almost doubled NFS's ability to provide rural forestry assistance.

The TSP positions are funded 75% by NRCS and 25% by NFS. However, TSP foresters are NFS employees. This unique arrangement exists in only two other states.

Due to the considerable success of the initial three-year TSP cooperative agreement, a similar five-year cooperative agreement was executed in 2007 to continue funding the TSP forester positions through September 30, 2012.

In 2008 and 2009 NRCS also designated substantial EQIP funding for forestry cost-share activities statewide.

NATURAL RESOURCES DISTRICTS

Nebraska's 23 Natural Resources Districts (NRDs) are local governmental units charged with protecting the state's natural resources, including soil, water, forestry, range, recreation and fish and wildlife habitat. Nebraska's NRDs work in partnership with state and federal agencies to implement conservation practices that protect Nebraska's natural resources. Because of the common mission relative to conservation tree planting and

forest management, NFS has developed strong partnerships over many years with individual NRDs and NARD.

Since the inception of NRDs in 1972, NFS has entered into a number of cooperative agreements with individual NRDs to enhance forestry activities. Although agreements vary, they all involve shared funding for NRD foresters or their activities. Currently, two NRD foresters are funded under cooperative agreements with the Lower Platte South NRD and the Lower Elkhorn NRD. In addition, two NFS district foresters are housed in NRD offices (Lower Loup NRD and Upper Niobrara-White NRD).

All 23 NRDs administer conservation tree programs to provide low-cost tree/shrub seedlings to landowners for conservation purposes. NFS administered the Nebraska Conservation Trees program statewide from 1926 to 2002, at which time program administration was transferred to the NRDs. NFS continues to strongly support all NRD conservation tree programs.

NEBRASKA GAME AND PARKS COMMISSION

NGPC is the state agency charged with stewardship of the state's fish, wildlife, park and outdoor recreation resources. The Commission manages 87 properties covering almost 300,000 acres across Nebraska and engages in a number of educational programs for both youth and adults.

NGPC currently is a key partner in implementing the Forest Legacy Program, reducing forest fuel loads in wildlife management areas and state parks and in developing improved prescribed burning programs.

NEBRASKA DEPARTMENT OF AGRICULTURE

The Nebraska Department of Agriculture (NDA) regulates the state's food, farming, ranching and green industries and cultivates partnerships with public and private sector

organizations to protect and grow these industries. NFS works with NDA on a number of levels.

Invasive insect and disease pests pose a substantial threat to Nebraska's forest resources. For this reason, NFS works closely with NDA to develop monitoring and detecting activities and preparedness plans for mitigating the impacts of invasive species.

In 2006, NFS began working with NDA and other partners as part of the Nebraska Emerald Ash Borer Working Group with the goal of developing the most effective methods for detecting EAB in Nebraska and developing a statewide readiness and response plan for mitigating EAB's impacts on the state.

Most recently, NFS and NDA partnered to draft and issue an emergency quarantine restricting the importation of black walnut nursery stock and wood products from western states into Nebraska. The quarantine is intended to reduce the possibility of the spread of thousand cankers disease into Nebraska. NFS and NDA will continue working together to implement this quarantine and work toward the development of a national plan to regulate the movement of firewood. The national firewood plan will be aimed at reducing the spread of all invasive pests that can be carried on firewood (such as thousand cankers disease, EAB and Asian long-horned beetle).

Finally, NFS and NDA partner to produce an annual list of Christmas tree growers.

WEED MANAGEMENT AREAS

Since 1998, counties and other interested parties have joined forces to control the spread of invasive species in Nebraska. These partnerships allow for the sharing of knowledge and resources to help control the spread of invasive species. Known as Weed Management Areas (WMAs), these local organizations bring together stakeholders (e.g., landowners, natural

resource professionals) to develop plans for managing invasive species within the Area's boundaries.

NFS works with three WMAs (Northern Dawes County Cooperative Weed Control Project, Northern Sioux County Weed Control and Sandhills WMA) that manage lands adjacent to or near federal properties. NFS reviews their weed management projects annually and provides federal cost-share funds to help WMAs with weed management activities.

NFS also participates in the Governor's Riparian Vegetation Task Force and the Nebraska Invasive Species Council providing technical assistance in the management of invasive plant species along the Platte and Republican river systems.

USDA ANIMAL & PLANT HEALTH INSPECTION SERVICE PLANT PROTECTION & QUARANTINE

USDA Animal and Plant Health Inspection Service (USDA APHIS) is the federal agency charged with protecting Nebraska's agricultural interests through programs in animal health and welfare; plant protection; biotechnology; animal damage management; emergency preparedness and response; permitting; and regulating agricultural imports and exports. Plant Protection and Quarantine (PPQ) is an APHIS program that protects agricultural and natural resource interests from the entry, establishment and spread of plant pests and noxious weeds.

Through Nebraska's Emerald Ash Borer Working Group, NFS worked with USDA APHIS PPQ and other groups to develop effective monitoring and detection methods for EAB and to create a statewide readiness and response plan for mitigating EAB's impacts on Nebraska.

RURAL FIRE DISTRICTS

The volunteers in Nebraska's 476 rural fire districts provide fire protection and fire

prevention education programs to residents of their districts. NFS works closely to provide planning, training, grant assistance and equipment that increases districts' capacity to protect life and property and implement effective education programs.

Volunteer Fire Assistance Program

Through the Volunteer Fire Assistance Program, NFS provides grants to local fire districts for the purchase of materials and equipment that increase their capacity to safely and effectively respond to fires and educate their communities about the importance of fire prevention. Fire districts may apply for up to 50% of their project's cost and must be able to match the award with local funds.

The grants come to NFS through the U.S. Department of Agriculture Forest Service's Volunteer Fire Assistance Program. In the past 30 years, nearly all of Nebraska's 476 local fire districts have received funds through this program. Since 2004, NFS has distributed more than \$900,000 through the Volunteer Fire Assistance Program.

Training

The overwhelming majority of fires in Nebraska are suppressed by volunteer firefighters. To support these dedicated individuals, NFS provides wildland fire training focused on fire behavior, tactics, incident management, leadership and fire prevention. NFS courses are fine-tuned to the needs of local fire departments and address the broad range of wildland fuels in the state. Most courses are offered at no cost in the evening or on weekends to fit the work schedules of the volunteers.

Previously, firefighters often had no choice but to travel out of state to receive this potentially lifesaving instruction and certification. In addition to more time away from home and family than they already give, the increased costs of courses drained fire department

budgets that are slim during even good economic times.

In 2009, NFS directly provided almost 400 hours of training to more than 1000 firefighters across the state. Financial, administrative and logistical assistance were leveraged via many interagency partners to provide training to an additional 2,000 firefighters through Nebraska State Fire School, the Les Lukert Winter Conference and the Central Nebraska Mutual Aid Association Fire School.

As Nebraska's only non-federal member of the National Wildfire Coordinating Group (NWCG), NFS is able to offer national wildland fire certification courses as well. NWCG was established to coordinate programs of participating wildland fire management agencies, including the National Association of State Foresters, USFS, U.S. Fish & Wildlife Service, Bureau of Land Management and the National Park Service. Certification courses are offered in a stand-alone format and as part of the Nebraska Wildland Fire Academy (NWFA). NWFA, an interagency effort of NFS, USFS, Nebraska State Fire Marshal Training Division, National Weather Service and local fire departments, is offered each spring.

In 2009, five courses previously available in Nebraska on a limited basis were expanded to train more than 200 NWFA students. In 2010, NFS began offering hands-on engine training.

Equipment

Through the Federal Excess Personal Property (FEPP) and Fire Fighter Property (FFP) programs, NFS, in cooperation with the USFS, is able to obtain certain types of equipment that is no longer needed by the federal government, including 6x6 trucks, 4x4 trucks, fire trucks, crash trucks, semi-tractors and generators. This equipment is reconditioned at the NFS Fire Shop in Mead and loaned to cooperating rural fire districts. These programs are a tremendous asset to Nebraska because they allow rural fire districts to obtain quality firefighting equipment

they would not be able to afford otherwise.

At the end of 2010 there are more than 400 pieces of FEPP and FFP equipment on loan to 161 rural fire districts across Nebraska. The replacement value of this equipment is nearly \$30 million. Some rural fire districts, including Gracy, Rackett, Mid-Cherry and Barley, are equipped exclusively through these programs.

NFS is responsible for screening, retrieving, reconditioning, inventorying and assigning equipment obtained through these programs. This includes determining repairs and upgrades necessary to bring the equipment to current safety standards. Additional safety devices, such as back-up alarms, light bars, electrical converters and, if necessary, hard tops may be added to vehicles.

Cooperating rural fire districts are responsible for painting and equipping vehicles within six months of receiving them. Additionally, districts must maintain the truck while in use and keep the water load of tanker or pumper trucks within specifications.

Planning

NFS's pre-suppression planning services allow rural fire districts to identify fire hazards and assess firefighting capabilities and future needs in the form of Mutual Aid District Planning, Community Master Planning or Community Wildfire Protection Planning.

Mutual Aid District Planning provides members of Mutual Aid Districts with information about district resources and needs. Community Master Planning is conducted in cooperation with local fire officials to ensure that the district's needs will continue to be met in the future. Community Master Plans contain equipment replacement schedules, insurance information and explanations of the privileges and responsibilities rural fire districts have under state statutes.

A Community Wildfire Protection Plan is developed in cooperation with local government

and local fire officials, as well as other interested state and federal partners, and identifies steps a community will take to reduce its wildland fire risk. The Plan addresses fire response capability, protection of homes and infrastructure, areas for fuels treatment projects and steps for implementing the plan.

PARTNERS IN PREVENTION

In 1999, NFS established Partners in Prevention (PIP) to implement fire prevention programs through fire departments across Nebraska. While charged with developing local fire prevention programs, PIP has taken its work to the state and national levels.

The five-person group, which donates as many as 2,000 person hours annually, teaches each year at Nebraska State Fire School as well as at periodic workshops in Montana, Washington, Colorado, Oregon, Kansas, South Dakota and Wyoming. In 2009 the Partners were awarded a prestigious Silver Smokey Bear Award for their excellence in fire prevention programming on a regional level. They had previously won a Bronze Smokey Bear Award for their work in Nebraska. In addition to creating and distributing fire prevention materials and teaching, PIP worked with a grocery chain to distribute 5 million bags carrying a fire prevention message in 13 states. The promotion was valued at more than \$50,000.

For a comprehensive list of NFS partnering groups, see Appendix F.



CHAPTER 8: STRATEGIES TO ACHIEVE LANDSCAPE-LEVEL CONSERVATION OF TREES & FORESTS IN NEBRASKA

NFS is part of the University of Nebraska system and is administratively located in the University of Nebraska–Lincoln’s Institute of Agriculture and Natural Resources (IANR). NFS strategic goals are aligned with NU, UNL and IANR strategic goals, particularly those focusing on:

- rural economic development and entrepreneurship;
- natural resources management and environmental quality;
- economically viable and sustainable food and biomass systems; and
- communities and appropriate quality of life for individuals and families.

Federal resources used to support NFS programs are focused on contributing to the national program themes of the USFS S&PF Program:

- conserving working forest landscapes;
- protecting forests from harm; and
- enhancing public benefits from trees and forests.

With more than 40 full-time employees, NFS is a small organization with a big responsibility—providing technical and financial support for the improved health of Nebraska’s trees and

forests. Funded through a combination of state and federal sources, NFS relies heavily on partnerships with other federal and state agencies, nonprofits and the private sector to jointly implement a diverse portfolio of programs that address state and national issues of high priority.

Mission: The Nebraska Forest Service improves lives by protecting, enhancing and utilizing Nebraska’s tree and forest resources.

Vision: Nebraska’s community and rural tree and forest resources are healthy, productive, resilient and sustainable ecosystems that meet the social, environmental and economic needs of people.

Legislative Mandates: State Law (85-161) mandates that NFS “provide education and services covering all aspects of planting, protection, care and utilization of the state’s tree and forest resources and shall provide fire protection to all rural land in cooperation with the state’s rural fire protection districts. The NFS shall provide education and services through four core programs: 1) Rural Forestry Assistance Program, 2) the Urban and Community Forestry Program, 3) the Forest Health Program and 4) the Rural Fire Protection

and Control Program.” The statute continues to require cooperative relationships with federal, state and local entities to maximize services and funding.

Nebraska’s trees and forests are facing significant challenges in the very near future. The likely introduction of EAB and thousand cankers disease of black walnut; the recent introduction of mountain pine beetle in our western ponderosa pine forests; an increasing risk of catastrophic wildfire in our coniferous forests; increasing fragmentation of existing forests through urban and recreational home development; substantial declines in tree cover in communities across the state due to age, low species diversity insects and disease severe weather and inadequate planting; and the accelerating decline in the health and extent of cottonwood riparian forests all pose grave threats to our tree and forest resources. All of these threats will likely be substantially compounded by potential changes in long-term climatic conditions.

To address these threats across all-lands, the strategic goals and actions detailed below are organized under a set of objectives and are intended to guide NFS in achieving its mission of protecting, enhancing and utilizing Nebraska’s tree and forest resources and achieving landscape-level conservation of these resources. Several overarching strategies will guide all actions of NFS:

- Orient existing resources and assets to maximize impacts.
- Develop and strengthen partnerships to expand impacts.
- Seek financial resources from an increasingly broad array of sources.
- Build capacity as we concurrently expand programming activities and impacts.

OBJECTIVE 1—ACTIVELY AND SUSTAINABLY MANAGE FORESTS

The active, sustainable management of Nebraska’s forest resources will ensure a continued stream of environmental, economic, social and human health benefits for future generations.

Desired outcomes

- A public that is educated about the value and benefits of trees in rural and urban settings.
- Programs that offer assistance and incentives to private landowners to keep working forests working and encourage sustainable forest management are readily available.
- Programs that assist communities in developing sustainable community forest management and green infrastructure programs.

Strategic goals & actions

1.1 Meet the tree and forestry needs of individuals and communities.

1.1a Work with existing and new clientele groups (industry and professional organizations, etc.) via training and technical support to multiply impacts when they work with their clients.

1.1b Focus largely on critical industry/professional/public agency/nonprofit clientele groups to achieve multiplier effects, specifically groups that can maximize impacts.

1.1c Serve as catalyst to Nebraska’s green industry.

1.1d Work with developers, landscape architects, engineers, community planners, etc., prior to land development to ensure the establishment of healthy

community forests in newly developed areas.

1.1e Work with existing community initiatives and institutions to capitalize on current momentum and capacity.

1.1f Where lacking, organize new clientele groups.

1.2 Develop programs that provide incentives for keeping working forests working and sustainably managing existing forestland.

1.2a Provide state and private forest landowners with forest management planning and technical assistance to enhance long-term health and productivity of forest resources.

1.2b Design and deliver integrated, targeted and relevant programs.

1.2c Cultivate and enhance partnerships to create programs that encourage rural landowners to sustainably manage existing forestland or implement conservation plantings.

1.2d Work with partners to restore the cottonwood gallery forests along appropriate river systems, remove woody invasives and establish local markets for the wood produced.

1.2e Foster and expand long-term local markets and processing infrastructure for traditional timber products as well as low-quality wood and woody biomass.

1.2f Keep abreast of development of ecosystem services markets (carbon, water, etc.) and design and implement programs that assist landowners in participating in these markets.

1.2g Work with Nebraska National Forest personnel to foster landscape-level forest management and conservation.

1.2h Support/facilitate efforts to expand the capacity of UNL and Nebraska's state and community colleges to deliver professional education (undergraduate, graduate, continuing education for professionals and adult education) in tree-related coursework (both formal classroom and field-based experiential).

1.3 Increase program impacts through expanded and effective partnerships.

1.3a To be more effective with limited resources and staff, build the capacity of partner client groups (associations, landowner groups, municipal organizations, industry groups, etc.) who in turn will provide improved services to the public.

1.3b Expand partnerships with federal and state agencies, local governments and municipalities, nonprofits and professional organizations, foundations and for-profit companies and consultants.

1.3c Work with partners to better integrate trees into agricultural and ranching operations through expanded agroforestry and conservation plantings.

1.4 Geographically concentrate program efforts to achieve landscape-level, all-lands impacts.

1.4a Focus and concentrate resources in priority forest landscapes identified in the Nebraska Statewide Forest Resource Assessment to address threats and opportunities and maximize the impacts of investment in these areas.

1.4b Achieve landscape-level conservation and impacts through meaningful collaboration and transparent joint decision making.

1.4c Establish operational plans for each state or multistate priority forest area with specific measurable objectives.

1.5 Improve tree and forest inventory accuracy and intensity to support better decision making on local/regional levels and foster increased use of tree and forest resources.

Research needs

- How can western ponderosa pine forests be optimally managed as silvopastoral systems in ways that maximize forage and wood production, reduce fuel loads and risk of catastrophic wildland fire, reduce risk of spread of invasive species and optimize forest health and wildlife habitat for select species?
- Improved access to more detailed, locally available woody biomass volume information from forestlands, nonforestlands with trees and urban areas.
- What are the most effective methodologies to use to restore degraded cottonwood riparian forests?
- How can riparian and other forests be sustainably managed to produce biomass and other wood products?

OBJECTIVE 2—RESTORE FIRE-ADAPTED LANDS AND REDUCE RISK OF WILDFIRE IMPACTS IN FORESTS & ADJACENT COMMUNITIES⁹

The strategic management of forests to reduce wildfire extent and severity is crucial to the health of Nebraska’s forests, the safety of residents in at-risk areas and the contributions of forests to Nebraska’s economy. Decades of fire suppression and changes in weather and precipitation have disrupted natural fire regimes, resulting in fuel buildup, loss of biological diversity, changed species composition and loss of some fire-dependent species.

In Nebraska, the network of 476 volunteer fire districts (VFDs) provides statewide wildland

⁹ This objective combines Objectives 2 and 6, both of which are discussed in detail earlier in this assessment.

fire response functions. NFS does not provide wildland fire suppression services.

Communities play an essential role in reducing the risks of catastrophic wildland fire. NFS programs assist communities in identifying wildland fire risks, developing CWPPs and promoting Firewise and other risk-reducing policies and actions.

Some communities adjacent to and within forested areas are particularly prone to loss of life and property from wildland fire. Local or state laws, regulations and ordinances, landowner attitudes and priorities and public policies all play important roles in managing communities’ fire risk.

Desired outcomes

- Reduced risk of catastrophic wildland fire and enhanced multiple benefits provided by Nebraska’s forests.
- Frequency, size and intensity of wildland fires are minimized.
- Homeowners and communities in at-risk areas are educated about and engaged in Firewise practices.
- Adverse effects of wildland fires on forest resources and ecosystem services are reduced.
- Fire-adapted landscapes and natural communities are restored through the use of prescribed fire and other management tools.
- The capacity of Nebraska’s rural VFDs to prevent and suppress wildland fire is enhanced.
- Training, assistance and equipment are provided to Nebraska’s rural volunteer fire districts to enhance their fire suppression and prevention effectiveness and safety.
- Increasing number of communities are covered by CWPPs.

Strategic goals & actions

2.1 Build the capacity of VFDs to prevent and suppress wildfires through comprehensive provision of training, planning, equipment and other support.

2.1a Enhance planning services, focusing on CWPPs, mutual aid planning, conducting risk assessments, etc.

2.1b Expand wildland fire training to build a solid foundation of trained individuals and increase capacity statewide via continual higher level training.

2.1c Enhance pre-suppression support activities, including annual MOUs with aerial applicators, establishment and maintenance of retardant caches, etc.

2.1d Increase numbers and quality of equipment loaned to VFDs for fire suppression through FEPP and FFP programs.

2.1e Provide statewide Firewise landscaping training and on-site technical assistance to landowners, homeowners and communities at risk.

2.1f Strengthen partnerships with VFDs, NSVFA, mutual aid associations, Nebraska State Fire Marshal's Office, USFS, state agencies, prescribed burn associations, conservation nonprofits and others.

2.1g Increase the capacity of the fire community, as measured by NWCG and state certifications, through expanded training programs

2.1h Extend fire prevention activities through partnerships with the Partners in Prevention and other agencies and organizations.

2.2 Reduce hazardous forest fuels.

2.2a Achieve landscape-level impacts through targeted all-lands fuels treatment projects that create strategically treated, large-scale corridors with reduced fire risk.

- Use cutting-edge geospatial technologies to accurately track and map areas treated and identify strategic landscapes needing treatment.

2.2b Enhance the technical capacity of organizations involved in prescribed fire training and implementation.

2.2c Increase funding from federal, state and other grant sources for hazardous fuels reduction.

2.2d Increase the number of acres treated to reduce fuel loads in coniferous forest areas at risk to catastrophic wildland fire.

2.2e Expand fuels treatment operations to other areas at risk with concurrent development of CWPPs.

2.2f Begin post-thinning prescribed burning program as needed.

2.3 Respond to fire-induced tree- and forest-related disasters.

2.4 Develop rapid response capabilities and protocols, including outreach and media response.

2.5 Conduct mitigation and restoration with partners (USFS, NEMA/FEMA, others).

2.6 Foster the increased use of woody biomass in thermal applications to reduce open burning and reduce the risk and incidence of slash pile fire escapes.

Research needs

- Customized fuels/fire behavior models for Pine Ridge ponderosa pine forests, Niobrara valley ponderosa pine/eastern redcedar/bur

oak forests and eastern redcedar/hardwood riparian forests.

- Determination of residual stocking densities in ponderosa pine forests that maximize timber and grass production, thus economic output.
- How can programs be best designed and implemented to maximize landscape-level wildfire risk reduction through fuels reduction on individual forest parcels?

OBJECTIVE 3—IDENTIFY, MANAGE AND REDUCE THREATS TO FOREST AND ECOSYSTEM HEALTH

A healthy forest landscape has the capacity for renewal and recovery from a wide range of disturbances while continuing to provide public benefits and ecosystem services. Forest health threats include insects, diseases, invasive and aggressive native plant species, air pollution

and climate change.

By identifying forest areas that are especially vulnerable to existing or potential forest health risks, NFS will be able to target forest management practices where they are most likely to prevent and mitigate impacts and successfully restore impacted forests.

Desired outcomes

- Increased species and age diversity of community trees and forests and conservation and agroforestry plantings to reduce vulnerability to insect and disease attacks.
- Improved vigor, health and productivity of trees and forests.
- Maintain functionality of forest ecosystems to ameliorate climate change.



Photo: NFS

- Impacts of invasive and aggressive native plant species and insect and disease threats are mitigated through proactive programs with landowners, communities, natural resources and green industry partners and decision makers (e.g., local, state and federal legislators).
- Foster and expand long-term local markets and processing infrastructure for traditional timber products as well as low-quality wood and woody biomass.
- The public is educated about current and emerging threats to forest health in Nebraska.

Strategic goals & actions

3.1 Promote species diversity as part of healthy rural and community forest resources.

3.1a With partners, develop list of recommended species suited for planting in community forest landscapes and conservation and agroforestry plantings and suited to climate change scenarios.

3.1b Educate the public about how species diversity contributes to healthy rural and community forest resources.

3.2 Manage for and mitigate damage from threats to forest and ecosystem health.

3.2a Respond to tree- and forest-related disasters.

- Develop rapid response capabilities and protocols, including outreach and media response.

3.3 Conduct mitigation and restoration with partners.

3.4 Proactively deal with emerging trends and threats to the state's trees and forests.

3.4a Develop interorganizational and interstate partnerships to restore riparian forest ecosystems

threatened by woody invasives and use strategically designed and located field demonstrations that restore cottonwood gallery forests.

3.4b Develop and implement ReTree Nebraska, a statewide community tree planting and maintenance initiative to prepare for invasive insect/disease epidemics and deal with declining community tree cover and health.

3.4c Establish citizen-based Tree Pest Detector Network to enhance detection of invasive tree pests and accelerate management interventions.

3.4d Establish portfolio of education and outreach programs and track impacts.

3.4e Expand Tree Pest Detector programs with partners.

3.4f With partners, develop and implement statewide invasive species response and action plans (e.g., EAB, thousand cankers disease, etc.).

3.4g Pursue legislative remedies that limit importation of firewood and other potential sources of invasive pests into Nebraska.

3.5 Prepare for the impacts of climate change on Nebraska's tree and forest resources.

3.5a Identify stresses (e.g. invasive species, habitat fragmentation, catastrophic wildland fire) that will be most exacerbated by climate change and work to reduce those stresses.

3.5b Identify strategies for managing forests under changed climatic conditions.

3.5c Assess how climate change will affect critical ecological processes (e.g. fire/hydrologic regimes).

3.5d Evaluate potential change in

distribution of at-risk and invasive species.

3.5e To deal with enormous uncertainty posed by climate change, work with multiple partners to plan for multiple scenarios.

3.6 Work with NGPC and other partners to manage deer populations at a level which permits adequate regeneration of desired tree species.

3.7 Implement the Forest Legacy Program and other similar programs with partners to address forest fragmentation issues.

Research needs

- What are the ecological and economic impacts of the loss of ash in rural forests and urban areas due to EAB?
- What are the ecological and economic impacts of the loss of black walnut in rural forests and urban areas due to thousand cankers disease?
- What are the most effective methods for slowing the spread of thousand cankers disease, EAB, mountain pine beetle and other forest pests?
- What tree species should be recommended for planting in communities and conservation plantings under changing climate conditions?

OBJECTIVE 4—PROTECT AND ENHANCE WATER QUALITY AND QUANTITY

Forests and sound forestry practices help protect, restore and sustain water quality, water flows and overall watershed health. Healthy urban and rural forested watersheds absorb rainfall and snow melt, slow storm runoff, recharge aquifers, sustain stream flows and filter pollutants. By identifying areas where continued forest conservation and management is important, water quality, water flows and

overall watershed health will be preserved and sustained.

Desired outcomes

- Funds are targeted toward forest landscapes that preserve, protect and enhance water quality, water flows and overall watershed health.
- Aquatic ecosystems, including the plants and animals they support, are maintained and enhanced.
- Water-related recreational opportunities are maintained and enhanced through the implementation of sustainable forestry practices.
- Sustainable forestry practices in rural areas that preserve and protect water resources are increasingly implemented.
- Sustainable forestry practices in urban areas that minimize urban stormwater runoff and preserve and protect water resources are increasingly implemented.

Strategic goals & actions

4.1 Encourage the use of green infrastructure for stormwater management.

4.1a Work with communities to identify areas where green infrastructure would be an effective method of managing stormwater runoff.

4.1b Work with partners to assist communities, via funding and technical assistance, with green infrastructure applications.

4.2 Encourage the implementation of agroforestry practices in riparian areas.

4.2a Work with rural landowners to implement agroforestry practices, such as riparian buffers, that protect water resources from agricultural runoff.

4.2b Inventory and document existing

natural and planted riparian buffers and geospatially identify priority areas for further intervention.

4.2c Work with landowners of native riparian forests to enhance adoption, management and utilization of these forests using best management practices.

4.2d Work with partners within Nebraska and with neighboring states to restore the cottonwood gallery forests along appropriate river systems, remove woody invasives and establish markets for the wood produced.

4.3 Participate in and provide forest-related technical information and input to multi-agency task forces and other groups involved in water quality and quantity management and policy development.

Research needs

- What are the ecological and economic impacts of the loss of ash in rural forests and urban areas due to EAB?
- What are the ecological and economic impacts of the loss of black walnut in rural forests and urban areas due to thousand cankers disease?
- Improved access to more detailed, locally available woody biomass volume information from forestlands, nonforestlands with trees and urban areas.
- What are the most effective methods for restoring degraded cottonwood riparian forests?
- How can riparian and other hardwood forests be sustainably managed to produce biomass and other wood products?



- What approaches maximize landowner adoption of riparian forest buffers?
- What is the current situation/trend(s) in retention/expansion of existing riparian forests, field and farmstead windbreaks and other agroforestry practices?
- What are the key factors leading to gain or loss of riparian forest acres?
- How can landscape-level impacts be best achieved through individual landowner action?

OBJECTIVE 5—IMPROVE AIR QUALITY AND CONSERVE ENERGY

Urban and exurban forest cover, including agroforestry plantings, can improve air quality, reduce energy consumption and produce biomass for energy production.

Desired outcomes

- A community forest canopy that provides positive, measurable impacts on air quality is managed and restored.
- A community forest canopy that generates substantial energy savings is managed and restored.
- Institutions, facilities and businesses are converted to woody biomass as their energy source, where feasible.
- Field windbreaks are established and maintained to reduce wind-induced soil erosion and transport.
- Farmstead windbreaks are established and maintained around concentrated livestock production facilities to intercept odor-laden dust.

Strategic goals & actions

5.1 Encourage rural and community tree plantings for energy conservation, reduction of wind erosion and improved air quality.

5.2 Work with communities to develop strategic planting programs that maximize the benefits of existing and planned tree canopy cover.

5.3 Foster the increased use of woody biomass for thermal applications, reducing the incidence of open burning and subsequent air pollution.

5.4 Foster an increased appreciation/awareness of the need for continued renewal of community forest resources.

Research needs

- What approaches maximize landowner/acreage owner adoption of field and farmstead windbreaks?
- What approaches are the most effective in maximizing or stimulating community tree planting?
- What elements are both necessary and sufficient to foster increased conversion by institutions and organizations to woody biomass as their primary energy source?
- What are the economic benefits to producers and to society from the installation of agroforestry practices?
- Conduct mitigation and restoration with partners (USFS, NEMA/FEMA, others).

OBJECTIVE 6—MAINTAIN AND ENHANCE THE ECONOMIC BENEFITS AND VALUES OF TREES AND FORESTS

Forested areas present opportunities for economic development through specialty forest products, traditional forest products, woody biomass and ecosystem services.

Desired outcomes

- Market development is fostered where there is a real, near-term potential to support markets for traditional forest products, specialty forest products, woody biomass or ecosystem services.

- Associated infrastructure necessary to support forest product markets is developed.
- Implementation of sustainable management of forested landscapes is increased to ensure continued supply of timber and biomass and subsequent productivity and viability of forest product industries.
- Increase implementation of sustainable harvesting practices that maintains and enhances the health and productivity of forests and does not compromise other benefits provided by forest landscapes.
- Increase establishment of agroforestry/conservation tree plantings to increase adjacent crop ground yields; reduce snow removal costs on transportation routes; improve livestock health and growth; reduce energy costs; and provide ecosystem services across the local rural landscape.

Strategic goals & actions

6.1 Develop effective partnerships to promote use of woody biomass for energy and other applications.

6.2 Increase NFS leadership in timber and non-timber marketing and utilization (M&U).

6.2a Increase staff FTE devoted to wood energy development.

6.2b Foster increased industrial capacity in priority forest landscapes.

6.2c Focus on forest products, energy markets and specialty markets.

6.2d Link to fuels reduction activities and urban tree waste stream utilization.

6.2e Foster new market and product development.

6.2f Improve/update directories.

6.3 Work with partners to restore the

cottonwood gallery forests along appropriate river systems, remove woody invasives and establish markets for the wood produced.

Research needs:

- What economic impacts do NFS's programs have on Nebraska's economy?
- What are the economic benefits to producers and society from the installation of agroforestry practices?
- What economic impacts do trees and forests have on Nebraska's economy?
- What are the opinions of landowners and producers of their agroforestry and forestry (perceived) needs, willingness to install agroforestry plantings, incentives needed and barriers to adoption?
- What policy changes are needed to foster increased tree planting in both urban and rural areas?
- What are the potential economic impacts of ecosystem markets on individual landowner incomes?
- What are the potential economic impacts of ecosystem markets aggregated statewide?
- What is the optimal means for landowner participation in ecosystem services markets?

OBJECTIVE 7—PROTECT, CONSERVE AND ENHANCE FISH AND WILDLIFE HABITAT

Protecting, conserving and enhancing forested habitat are critical to maintaining and enhancing biodiversity and many of the recreational benefits associated with Nebraska's forests. Major threats to fish and wildlife habitat include land fragmentation, urbanization, invasive and aggressive native species, insects and diseases.

Desired outcomes

- Forest landscapes that represent or contribute to viable wildlife habitats (contiguous or connected), contain high species richness, endemism and/or that represent core habitat or focal conservation species (i.e., species of concern, threatened and endangered species or keystone species that are representative of a healthy ecosystem) are preserved, protected and enhanced.

Strategic goals & actions

7.1 Work with forest landowners to implement forest management practices that protect, conserve and enhance fish and wildlife habitat.

7.2 Promote landscape-level, all-lands approach to achieve large-scale impacts across ownerships.

7.3 Identify corridors to improve connectivity and allow for wildlife movement and species range shifts due to climate change.

7.4 Prepare for the impacts of climate change on Nebraska's tree and forest resources (see Objective 9 for more detail).

7.5 Expand long-term local markets for low-quality wood and woody biomass as a means to reduce the cost of grassland restoration.

Research needs

- What density, type and arrangement of agroforest systems (using trees and shrubs) optimize wildlife habitat in agriculture-dominated landscapes?
- How can western ponderosa pine forests be optimally managed as silvopastoral systems in ways that maximize forage and wood production, reduce fuel loads and risk of catastrophic wildland fire, reduce risk of spread of invasive species and optimize forest health and wildlife habitat for select species?

- What deer population densities will permit natural or artificial regeneration of valuable tree species and forest systems?
- What is the impact of forest fuels reduction operations on fish habitat in streams and river systems?

OBJECTIVE 8—CONNECT PEOPLE TO TREES AND FORESTS AND ENGAGE THEM IN ENVIRONMENTAL STEWARDSHIP ACTIVITIES

Nebraska's forests are natural backyards for many communities and serve as a connection between people and nature. Many communities in Nebraska are islands of trees and infrastructure in an agricultural or rangeland landscape, enhancing the value and benefits of trees to residents.

Desired outcomes

- Green infrastructure that effectively connects people with their natural environment is conserved and enhanced.
- Citizens are educated about the importance of proactive management to maintain the sustainability, health and productivity of Nebraska's forests. Citizens are educated about the benefits provided by Nebraska's trees and forests.
- Opportunities for individuals to recreate while gaining appreciation for the importance of forests and natural areas are preserved and created.
- Expanded capacity within the green industry, communities and the University of Nebraska to provide and deliver high quality, science-based information and technical assistance in tree selection, planting and care.
- Greater awareness and appreciation of the value of trees and forests and of the critical need for continued and sustained investment in community tree resources.
- Individuals and groups statewide are

interconnected in a “community of interest” focused on community forestry and sustainable landscapes.

Strategic goals & actions

8.1 Combine and fully integrate staff, programs and social networks from Urban and Community Forestry, ReTree Nebraska and the Nebraska Statewide Arboretum into new Community Forestry and Sustainable Landscapes program area.

8.2 Develop programs that inform the public of the environment, economic, psychological, social and human health benefits of trees and forests and the green infrastructure they provide.

8.3 Work with partners to implement forest management practices that encourage people to become connected with trees and forests.

8.4 Target outreach efforts and training in tree selection, planting and aftercare to a wide array of professionals (architects, landscape architects, engineers, civil engineers, developers, city planners, etc.).

8.5 Expand capacity within the University of Nebraska and state and community colleges to deliver expanded educational programming and coursework in woody horticulture, arboriculture and tree care.

8.6 Improve NFS properties to function as demonstration forests for education and outreach purposes.

8.7 Develop a comprehensive statewide tree species testing program (with NSA, Inc. arboretum curators, NFS properties and UNL experiment stations).

8.8 Document current status and performance of select tree species planted statewide.

8.9 Conduct effective tree and forestry education and outreach programs.

8.9a Improve communication methods and messages.

- Better understand NFS constituents (especially members of key clientele groups).

- Conduct survey to define and characterize our stakeholder and client needs, preferences and perceptions.

- Identify and orient communications to needs, preferences and perceptions.

8.9b Enhance outreach methods to maximize effectiveness reaching select publics and client groups.

8.9c Multiply program impacts by providing train-the-trainer programs that target specific clientele groups that provide teaching, training, advice or technical assistance to others.

8.9d Develop and implement peri-urban homeowner/acreage owner assistance programs in peri-urban areas undergoing suburban and acreage development.

8.9e Assist existing and expanding communities in developing model municipal ordinances.

8.9f Continue, improve and expand professional training programs to the green industry and others in arboriculture, tree selection and care.

8.9g Support programs such as Tree City USA, Tree Line USA, Tree Campus USA, Nebraska Champion and Heritage Tree Programs and others to strengthen connections between people and trees.

8.9h Work with developers, landscape architects, engineers, community planners, etc., prior to land development to ensure the establishment of healthy community forests in newly developed areas.

8.10 Orient events, publications and outreach efforts to specifically:

- change values/attitudes;
- achieve on-the-ground impacts;
- stimulate action, change behavior and inspire action; and
- improve quantity and quality of our trees and forests.

8.11 Conduct studies to develop comprehensive statistics on the economic value of NFS programs and of the aggregate economic contribution trees and forests make to the state's economy.

8.12 Be influential in policy setting related to trees and forests.

8.12a With partners, work with the Unicameral to address issues that affect trees/forests.

8.12b Conduct legislative outreach at

the state and federal levels.

8.13 Seek new funds from nontraditional sources.

Research needs

- What do specific groups of people think about the role, value and importance of trees and forests in Nebraska?
- What is the level of knowledge of specific groups of people regarding the extent, value and importance of trees and forests in Nebraska?



Photo: NFS

OBJECTIVE 9—MANAGE AND RESTORE TREES AND FORESTS TO MITIGATE AND ADAPT TO GLOBAL CLIMATE CHANGE

Nebraska’s forests offset significant carbon emissions, and additional climate change mitigation benefits could be achieved through partnerships and management measures that promote woody biomass energy, tree planting for energy efficiency and improved air and water quality. Because forests’ important benefits, including biodiversity, wildlife habitat and protection of water quality and quantity, are also impacted by climate change, preserving forest landscapes is paramount in ensuring that these benefits are sustained.

Desired outcomes

- A forest canopy that generates substantial energy savings is managed and restored.
 - Institutions, facilities and businesses are converted to woody biomass energy, where feasible.
 - Funds are targeted toward forest landscapes that preserve, protect and enhance water quality, water flows and overall watershed health.
 - Water-related recreational opportunities are maintained and enhanced through the implementation of sustainable forestry practices.
 - Sustainable forestry practices in rural areas that preserve and protect water resources are increasingly implemented.
 - Sustainable forestry practices in urban areas that minimize urban stormwater runoff and preserve and protect water resources are increasingly implemented.
 - Forest productivity, growth and carbon sequestration are enhanced through forest stand improvement activities.
 - Citizens are educated about opportunities provided by the development of emerging carbon markets.
- Resilient, connected forest ecosystems that continue providing these benefits in a changing climate are preserved, protected and enhanced.

Strategic goals & actions

- 9.1** Through targeted, relevant programs, encourage rural landowners to keep working forests working and implement sustainable forest management practices.
- 9.2** Through targeted, relevant programs, encourage communities to sustainably manage and improve community forest resources for long-term benefits.
- 9.3** Promote species and age diversity in rural and community forests and conservation plantings.
- 9.4** Test new species and intensively evaluate existing tree plantings statewide for adaptability to newly emerging climatic conditions.
- 9.5** Prepare for the impacts of climate change on Nebraska’s tree and forest resources.
- 9.6** Identify stresses (e.g., invasive species, habitat fragmentation, catastrophic wildland fire) that will be most exacerbated by climate change and work to reduce those stresses.
- 9.7** Identify strategies for managing forests under changed climactic conditions.
- 9.8** Assess how climate change will affect critical ecological processes (e.g., fire/ hydrologic regimes).
- 9.9** Evaluate potential change in distribution of at-risk and invasive species.
- 9.10** To deal with enormous uncertainty posed by climate change, work with multiple partners to plan for multiple scenarios.
- 9.11** Expand long-term local markets for low-quality wood and woody biomass to reduce net carbon emissions, improve air quality, offset use of fossil fuels and foster rural economic development.

Research needs

- What will be the impacts of climate change on Nebraska's tree and forest resources?
- What specific actions need to be taken to best mitigate and reduce the severity of the impacts of climate change?
- Improved access to more detailed, locally available woody biomass volume information from forestlands, nonforestlands with trees and urban areas.

GAPS & LIMITATIONS

The ambitious and aggressive strategy described above will require a comprehensive set of resources and capacity to support successful implementation. In addition to the data gaps identified in Chapter 5, other gaps and limitations needing to be addressed include:

Resources:

- Increased funding and other resources from a range of sources will be needed. Particular gaps in funding exist in:
 - supporting marketing and utilization activities;
 - expanded inventory data acquisition and analyses;
 - expanded fuels reduction work in high-risk areas; and
 - capital costs for conversion of thermal energy systems to woody biomass.

Capacity:

- Additional technical expertise and personnel will be needed in the following areas:
 - geospatial applications and analyses;
 - fuels reduction foresters;
 - riparian forest restoration specialists; and
 - invasive species mitigation and management.

Social:

- Increased social and legislative support will be needed to accomplish the goals laid forth in this strategy. To achieve this, NFS must provide and/or develop:
 - increased evidence of the value of trees and forests to the people and economy of Nebraska and
 - increased networking and formation of social energy/capital to effect long-term, large-scale change.

Efforts to address these gaps and limitations will center on expanding the number and scope of collaborative arrangements with an increasing wide array of partners.

REFERENCES

- American Forests (2008). **Trees and Ecosystem Services**. americanforests.org/resources/urbanforests/naturevalue.php. Retrieved August 11, 2009.
- Bessey, C.E. and Webber, H.J. (1889). **Report of the botanist on the grasses and forage plants, and the catalogue of plants**. Lincoln, NE: Nebraska State Board of Agriculture. State Journal Company.
- Camas Creek Enterprises. (2008). **Nebraska Wood Waste Supply and Utilization Assessment**.
- Center for Urban Forest Research. **Why Shade Streets? The Unexpected Benefit**. Davis, CA: Center for Urban Forest Research, Pacific Southwest Research Station. fs.fed.us/psw/programs/uesd/uep/products/cufr_673_WhyShadeStreets_10-06.pdf. Retrieved March 17, 2010.
- Christensen, J.H., B. Hewitson, A. Busuioc, A. Chen, X. Gao, I. Held, R. Jones, R.K. Kolli, W.-T. Kwon, R. Laprise, V. Magaña Rueda, L. Mearns, C.G. Menéndez, J. Räisänen, A. Rinke, A. Sarr, and P. Whetton. (2007). **Regional climate projections**. In: *Climate Change 2007: The Physical Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, UK, and New York.
- Coder, K.D. (1996). **Identified Benefits of Community Trees and Forests**. Warnell School of Forest Resources. University of Georgia: Athens, GA.
- Faber Taylor, A., Kuo, F.E., & Sullivan, W.C. (2001). **Coping with ADD: The surprising connection to green play settings**. *Environment and Behavior*, 33:1.
- Harden, B. **Tree-Planting Drive Seeks to Bring a New Urban Cool**. The Washington Post, September 4, 2006.
- Homer, C. C. Huang, L. Yang, B. Wylie and Coan, M. (2004). **Development of a 2001 National Landcover Database for the United States**. *Photogrammetric Engineering and Remote Sensing*, 70:7.
- Hull, R. B. (1992). **How the Public Values Urban Forests**, *Journal of Arboriculture* 18:2.
- Kaplan, R. & Kaplan, S. (1989). **The Experience of Nature: A Psychological Perspective**. Cambridge: Cambridge University Press.
- Kaplan, S. (1995). **The restorative benefits of nature: Toward an integrative Framework**. *Journal of Environmental Psychology*, 15:3.

Karl, T.R., J.M. Melillo, and T.C. Peterson, eds. (2009). **Global climate change impacts in the United States**. U.S. Global Change Research Program (USGCRP). Washington, DC: Cambridge University Press.

Kuo, F.E. and Sullivan, W.C. (2001). **Environment and crime in the inner city: Does Vegetation Reduce Crime?** *Environment and Behavior*, 33:3, 343-367.

Kuo, F.E., Sullivan, W.C., Coley, R.L. and Brunson, L. (1998). **Fertile ground for community: Inner-city neighborhood common spaces**. *American Journal of Community Psychology*, 26, 823-851.

League of Nebraska Municipalities (2009). **2009 Nebraska Directory of Municipal Officials**. Lincoln, NE: League of Nebraska Municipalities.

Lewis, C. A. (1996) **Green Nature/Human Nature: The Meaning of Plants in our Lives**. University of Illinois Press, Urbana, Chicago.

Mattes, M.J. (1953). Capt. L.C. Easton's Report: **Fort Laramie to Fort Leavenworth via Republican River in 1849**. *Kansas Historical Quarterly* 20.

McPherson, E.G., Simpson, J.R., Peper, P.J., Maco, S.E., Gardner, S.L., Cozad, S.K., Xiar, Q. (2005). **Midwest Community Tree Guide: Benefits, Costs and Strategic Planning**. NA-TP-05-05. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry.

Meneguzzo, D.M., Butler, B.J., Crocker, S.J., Haugen, D.E., Moser, W.K., Perry, C.H., Wilson, B.T., Woodall, C.W. (2008). **Nebraska's Forests 2005**. USDA Forest Service Resource Bulletin NRS-27. Newtown Square, PA: USDA Forest Service Northern Research Station.

Nebraska Department of Natural Resources (2010). **Nebraska Registered Groundwater Wells**.

Nebraska Blue Book. (2009). Nebraskalegislature.gov/about/blue-book.php. Retrieved April 3, 2009.

Nebraska Forest Service (2007). **ReTree Nebraska**.

Nebraska Forest Service (2009). **Conservation Innovation Grant Summary**.

Nebraska Forest Service (2010). **Great Plains Initiative Inventory, 2008-2009**.

Nebraska Forest Service (2010). **Nebraska Forest Stewardship Forest Stewardship Plan Reporting System**.

Nebraska Game and Parks Commission (2005). **The Nebraska Natural Legacy Project: A Comprehensive Wildlife Conservation Strategy**. Lincoln, NE: Nebraska Game & Parks Commission.

Nebraska Natural Resources Conservation Service. (2009). **Natural Resources Conservation Service Progress Reporting System.**

NebraskaStatePaper.com. **Census: Hispanics Fuel Nebraska Population Growth.** NebraskaStatePaper.com, March 3, 2011.

Nowak, D.J. and Greenfield, E.J. (2010). **Urban and Community Forests of the North Central West Region.** USDA Forest Service General Technical Report NRS-56. USDA Forest Service Northern Research Station.

Pimentel, D., Zuniga, R. and Morrison, D. (2005). **Update on the environmental and economic costs associated with alien-invasive species in the United States.** *Ecological Economics*, 52, 273-288.

Piva, R.J. and Adams, D.M. (2008). **Nebraska Timber Industry—An Assessment of Timber Product Output and Use, 2006.** USDA Forest Service Resource Bulletin NRS-28. Newton Square, PA: USDA Forest Service, Northern Research Station.

Report of the Secretary of War (1835). **Journal of a March of a Detachment of Dragoons, under the Command of Colonel Dodge, During the summer of 1835.** U.S. Congress, 24th Congress, 1st session. H.E. doc. 181.

Sacramento Tree Foundation (2008). **Why Trees?** sactree.com/doc.aspx?73. Retrieved December 4, 2008.

Schmidt, T.L. and Wardle, T.D. (1986). **Forestland Resources of the Nebraska Sandhills.** Agency Report. Lincoln, NE: University of Nebraska, Nebraska Forest Service.

Schmidt, T.L. and Wardle, T.D. (1998). **The Forest Resources of Nebraska.** USDA Forest Service Research Paper NC-332. St. Paul, MN: USDA Forest Service North Central Research Station.

Ulrich, R.S., (1984). **View through a window may influence recovery from Surgery.** *Science*, 224, 420-421.

Ulrich, R.S., Simons, R.F., Losito, B.D., Fiorito, E., Miles, M.A., Zelson, M. (1991). **Stress recovery during exposure to natural and urban environments.** *Journal of Environmental Psychology*, 11.

Ulrich, R.S. (2002). **Health benefits of gardens in hospitals.** Unpublished paper presented at Plants for People International Exhibition, Florida.

U.S. Census Bureau. (2006). **2006 Annual Survey of Manufactures.** factfinder.census.gov/servlet/IBQTable?_bm=y&-ds_name=AM0631GS101. Retrieved April 3, 2009.

U.S. Census Bureau. (2011). **Douglas County Quick Facts from the U.S. Census Bureau.** quickfacts.census.gov/qfd/states/31000.html. Retrieved June 24, 2011.

U.S. Census Bureau. (2011). **Nebraska Quick Facts from the U.S. Census Bureau.** quickfacts.census.gov/qfd/states/31/31055.html. Retrieved June 24, 2011.

U.S. Department of Agriculture National Invasive Species Information Center (2009). **What is an invasive species?** invasivespeciesinfo.gov/whatis.shtml. Retrieved January 15, 2010.

U.S. Department of Agriculture National Agricultural Statistics Service. (2009). **2007 Census of Agriculture-Nebraska.** nass.usda.gov/statistics_by_state/Ag_Overview/AgOverview_NE.pdf. Retrieved January 15, 2010.

U.S. Department of Interior, Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau (2006). **2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.**

Welsch, D.J. (1991) **Riparian Forest Buffers.** NA-PR-07-91. Radnor, PA: U.S. Department of Agriculture Forest Service, Northeastern Area State and Private Forestry.

Wolf, K.L. (2004). **Public Value of Nature: Economics of Urban Trees, Parks and Open Space.** In: Miller, D. & J. A. Wise (eds.) *Design with Spirit: Proceedings of the 35th Annual Conference of the Environmental Design Research Association.* Edmond, OK: Environmental Design Research Association.

Wright, H.E. (1970). **Vegetational history of the Great Plains.** In: Dort, W. and Jones, Y. (eds.) *Pleistocene and recent environments of the central Great Plains.* Spec. Publ. 3. Lawrence, Ks; Department of Geology, University of Kansas.

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