

NEBRASKA

Statewide Forest Action Plan



2015



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NEBRASKA FOREST SERVICE

Dr. Scott Josiah, State Forester & Director
102 Forestry Hall
PO Box 830815
Lincoln, NE 68583-0815
nfs.unl.edu
trees@unl.edu

NFS Statewide Forest Action Plan Strategy Team:

Eric Berg, Community Forestry & Sustainable Landscapes Program Leader
John DuPlissis, Rural Forestry Program Leader
John Erixson, Deputy Director
Mark Harrell, Forest Health Program Leader
Kyle Martens, Communications Specialist
Casey McCoy, Wildland Fire Training Manager
Adam Smith, Forestry Project Coordinator
Joe Stansberry, GIS Specialist

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PREFACE: FOREST ACTION PLAN NATIONAL PRIORITIES

National Priority goals are presented throughout the plan in different areas and in different ways. Chapter 9, breaks down the goals to the objectives outlined in Table 1 (page 7). The priorities include:

- Conserve and Manage Working Forest Landscapes for Multiple Values and Uses
- Protect Forests from Threats
- Enhance Public Benefits from Trees and Forests

A summary of recent successes is outlined below with more detail in Chapter 9.

Conserve and Manage Working Forest Landscapes for Multiple Values and Uses

Nebraska's Forest Stewardship and Forest Legacy are the main programs that address this priority. Forest Stewardship Plans and management plans promote sustainable planning and active management that support multiple landowner objectives. Forest Legacy protects working forests from being converted into other uses such as ranchette development. Recent successes include maintaining 461 acre forest legacy project Chat Canyon in north central Nebraska (page 131). The Nebraska Forest Service (NFS) develops over 200 forest plans annually, and has implemented tree planting and/or forest improvement projects on over 30,000 acres.

Protect Forests from Threats

Nebraska's Wildland Fire and Forest Health programs work together to address this priority. Wildland fire efforts include not only fire training, but also fire prevention programs and building capacity. Nebraska's wildland fire program has placed over 700 pieces of wildland fire equipment throughout the state with Volunteer Fire Districts. Similarly, the Forest Health program includes a strong detection and monitoring component to help prevent epidemic outbreaks of insects and diseases. Recent successes include the Nebraska Emerald Ash Borer working group, working to monitor and train professionals to respond to EAB. Nebraska has 109 communities certified as TCUSA, four utility providers certified as Tree Line USA, and six campuses certified as Tree Campus USA that continually enhance the value of community forests.

Enhance Public Benefits from Trees and Forests

All of the programs within the NFS have a component of education and outreach. Our staff provides over 180 programs to the citizens of Nebraska reaching in excess of 200,000 individuals annually. Recent successes include 185 communities participating in community forest programs, 134 communities involved in Retree Nebraska programs, and 17 sustainable schoolyard demonstrations.



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EXECUTIVE SUMMARY

With more than 1.5 million acres of forestland and another 2.01 million acres of non-forestland with trees, Nebraska is rich in tree and forest resources. This document, the Nebraska Forest Action Plan (FAP), is a comprehensive geospatial assessment of the state's tree and forest resources, prepared by the Nebraska Forest Service. The 2015 FAP is based on the Nebraska Statewide Forest Resource Assessment and Strategy conducted by the NFS in 2010. The FAP identifies key issues of prime importance to our tree and forest resources, updates forested areas of high priority for intervention, describes a range of accomplishments achieved since 2010 in implementing the first Statewide Forest Resource Assessment and Strategy, and presents a wealth of strategic goals, opportunities and actions for sustainably managing these critically important resources.

This Assessment relies heavily on the input of our partners. To update this Forest Action Plan 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, and the US Forest Service – Nebraska National Forest and many other partners. Combined, this information provided us with valuable insights about the nature, complexity and value of our forest resources which was used to identify priority

forest areas across the state.

The Nebraska FAP identifies 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 the 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 trees can and do make a difference. Yet energy security, climate change (fostering severe weather and drought), urbanization, invasive species, expansion in the range of undesired species,

declining rural economies and catastrophic wildland fires either jeopardize our state's trees and forests or provide opportunities for their rejuvenation. Whatever the impacts, these serious issues are complex, interrelated, defy single-remedy solutions and must be addressed.

Fortunately, sustainably managing our tree and forest resources can play a significant role in addressing these issues. The Nebraska Forest Service (NFS) works closely with people, agencies and organizations across the state to identify and tackle these issues head-on and carry out its mission of improving lives by protecting, preserving and enhancing Nebraska's tree and forest resources. The Nebraska Forest Action Plan (FAP) will help to 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 (a.k.a. Forest Action Plan) to guide the long-term management of its forest resources. The 2014 Farm Bill re-affirmed this mandate with the Assessment to be revised by 2015 as a State Forest Action Plan. The assessment analyzes 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 our priority forest landscapes and focuses such investments where they can most effectively stimulate or leverage desired action while engaging multiple partnerships.

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.

RESPONDING TO CLIMATE CHANGE

Nebraska’s forests are expected to undergo profound changes over the coming decades, caused by the inexorable impacts of a changing climate. Being a Great Plains state, Nebraska has always been a transition zone between grasslands and forests, with severe weather constantly posing many challenges to tree and forest growth and survival. However, climate models increasingly predict a future in Nebraska dominated by hotter temperatures, even more frequent and extreme weather events, and deeper droughts. These new climatic conditions and extreme weather anomalies are outside of Nebraska’s experience, and have already and will continue to drastically and potentially rapidly impact the health, vigor and extent of trees and forests in both rural and urban areas of Nebraska.

To address these changes, the NFS will be introducing a wide range of initiatives over the next five years (described in this FAP) that are intended to increase the health and resiliency of trees and forests in rural, urban and conservation forests within the context of a rapidly changing climate. We expect that by 2020, this FAP will be strongly oriented towards initiatives and programs that adapt and mitigate the impacts of climate change to improve the health and resiliency of our tree and forest resources.

HISTORY & CULTURAL HERITAGE

Based on discoveries of stone tools and weapons, archaeologists estimate humans arrived in Nebraska about 10,000 to 25,000 years ago. Before European settlers colonized the Great Plains, Native Americans had inhabited the area for thousands of years. The Missouri, Omaha, Oto and Ponca tribes farmed and hunted along Nebraska rivers. About 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. Three reservations are in Nebraska—the Santee Sioux, Omaha and Winnebago—all 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 began 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, about 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. 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 Bessey Ranger District of the U.S. Forest Service (USFS) 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 this unique hand-planted forest are managed by the USFS.

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 for the establishment of 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. Cottonwood is the primary tree species harvested in the state for commercial use (Meneguzzo, et al. 2005).

In 1895, the Nebraska legislature declared Nebraska the “Tree Planter’s State” as

Arbor Day originated here. In 1945 the state legislature changed the official state name to the “Cornhusker State,” after the nickname for the University of Nebraska’s athletic teams.

Today, Nebraska has over 1.55 million acres of forest lands. One hundred and six of our communities are Tree City USA communities. The state has two national forests and 54 state parks.



CHAPTER 2: METHODOLOGY

GEOSPATIAL ANALYSIS

To assess the forest-related conditions, trends, threats and opportunities in Nebraska, NFS identified priority forest areas by using a GIS platform to combine maps representing nine of the 10 assessment objectives (Table 1). 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. 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 weighted 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 wildfire impacts	0.1185
Protect, 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 value of trees and forests	0.1287
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

The current version of the FAP was distributed to key stakeholder groups and made available to the public for their review and input.

A draft of the Assessment and Strategy was made available in 2010 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 in 2010, provided stakeholders and the public with an additional forum for providing feedback. In 2015, a survey was made available for stakeholder review and comment. A survey monkey was sent to stakeholders and the public asking for feedback on the Forest Action Plan. More than 150 respondents provided feedback using survey monkey see results in Chapter 10.



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, CA., 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 tree cover in metro Atlanta saved residents about \$2.8 million in energy costs (American Forests, 2008). A similar study from 1999 showed 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 strategic tree plantings could reduce nationwide air conditioning use by at least 10% (Harden, 2006). The city of Los Angeles expects to achieve a return of \$2.80 in energy savings,

pollution reduction, stormwater management and increased property values for every \$1 spent 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, CA., revealed 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 describing 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, 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 1.55 million acres of forestland (Meneguzzo, et al. 2014) and non-forestland with trees influence water quality and the quantity of water on the surface and underground. In riparian areas, trees protect water quality by stabilizing stream banks 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) may be purchased by those wishing to offset their carbon footprint. Nebraska’s 1.57 million acres of forestland currently sequesters about 83.8 million metric tons annually (92.4 million U.S. tons of carbon (Meneguzzo, et al. 2014). The soil and live trees (both above- and below-ground components) sequester 85% of this carbon, while the remaining 15% is sequestered in standing dead trees, the forest understory, downed dead trees and the forest floor (Meneguzzo, et al. 2014). Nebraska’s community forests store an additional 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 and improved vigor during spring calving, reduced energy consumption on farms and acreages, and through the production of economically valuable products.

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FOREST PRODUCTS

TRADITIONAL WOOD PRODUCTS

workers with an output of \$286 million (U.S. Census Bureau, 2002). The USDA Forest Service, Northern Research Station Resource bulletin NRS-28, “Nebraska Timber Industry—An Assessment of Timber Product Output and Use, 2009,” (Walters, Piva & Adams, 2012) summarizes the 2009 survey of all Nebraska sawmills and other primary wood products manufacturers.

- Nebraska's primary wood-using industry includes 62 mills (57 sawmills and 5 mills producing other products) (Table 3).
- Nebraska's primary wood-using mills (Figure 1) processed 4.1 million cubic feet of industrial roundwood in 2009, a 19% decrease from 2006. Industrial roundwood production decreased by almost 33%, from 6.1 million cubic feet in 2006 to 4.1 million cubic feet in 2009 (Figure 2).

Table 3. Lumber Production in Nebraska

SAWMILL CAPACITY ¹	1980	1993	2000	2006	2009
5,000 mbf* or greater	--	2	2	2	2
Between 1,000 and 4,999 mbf	7	10	5	3	2
Between 100 and 999 mbf	35	8	6	10	8
Less than 100 mbf	--	12	19	34	45
TOTAL	42	32	32	49	57
Number of Other Wood Product Manufacturers ²	4	3	2	5	5
ALL PRODUCERS	46	35	34	54	62

*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.

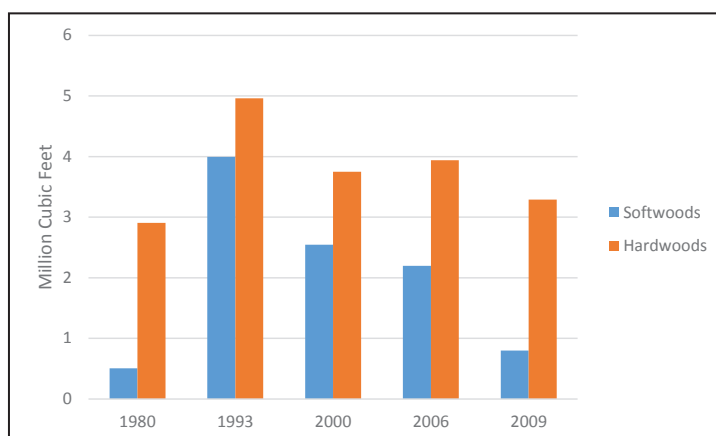
Source: Nebraska Timber Industry—An Assessment of Timber Product Output and Use, 2006

- More than 90% of the industrial roundwood processed by Nebraska mills was cut from Nebraska forests. Cottonwoods account for almost 90% of the total volume processed.
- 75% of the industrial roundwood harvested was cottonwood. Ponderosa pine (10%) and eastern redcedar (*Juniperus virginiana*) (10%) were the other major species harvested (Figure 3).
- Nebraska sawmills processed 19.3 million board feet of saw logs in 2009, a decrease of 16% from 2006.
- Cottonwood and ponderosa pine account for 91% of Nebraska's harvest.
- 8.3 million cubic feet of total wood material removed during harvest was less than 0.5% of the total live volume of trees in forestland.

Woody Biomass

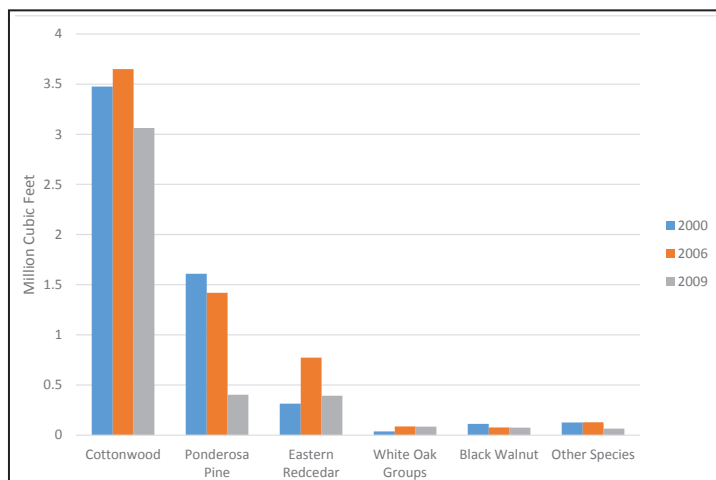
Woody biomass is a proven, reliable energy source for both heating and cooling, as well as industrial applications, electricity during the harvest of industrial roundwood

Figure 2. Industrial Roundwood Production



Source: NFS

Figure 3. Industrial Roundwood Production



Source: NFS

generation and ethanol production. Woody biomass is a near-carbon-neutral that was used for primary wood products. The remainder (1.5 million cubic feet) was left on the ground as harvest residues (Figure 4).

- The 5.6 million cubic feet of total wood material removed during harvesting was less than 1% of the total live volume of trees in forestland.
- Nebraska's primary wood-using industries generated 68,000 green tons of wood residues (slabs, sawdust, bark, etc.); 76% of which were used for fuel, mulch, animal bedding, etc. The remaining 24% went unused.

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 each year. In 2011, the Nebraska College of Technical Agriculture in Curtis completed converting to a woody biomass thermal energy system, and several other facilities are considering 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 cubic feet (Meneguzzo, et al. 2008, NFS, 2010). An estimated 36.7 million cubic feet (590,000 net air-dry tons) of woody biomass growing on 2.01 million acres of non-forestland with trees across the state (NFS, 2010). As these trees die or are trimmed or pruned, a tremendous volume of material is left to decompose or be burned in waste piles. Eighty-eight percent of live woody biomass in Nebraska grows on

Figure 4. Industrial Roundwood By Product

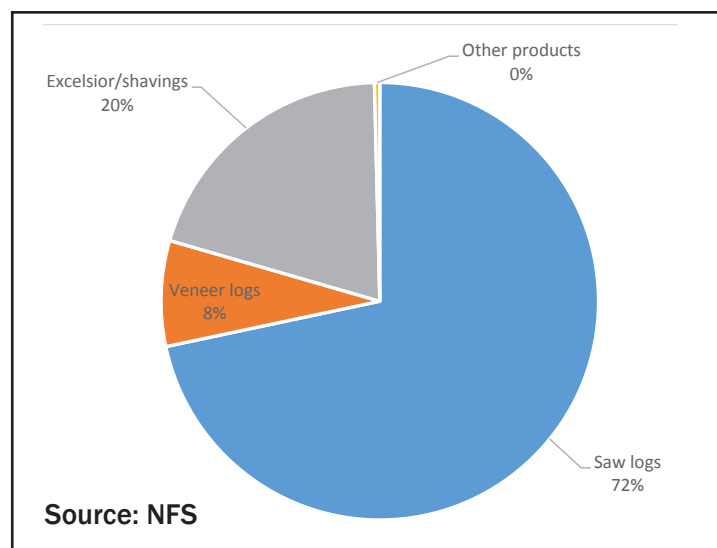
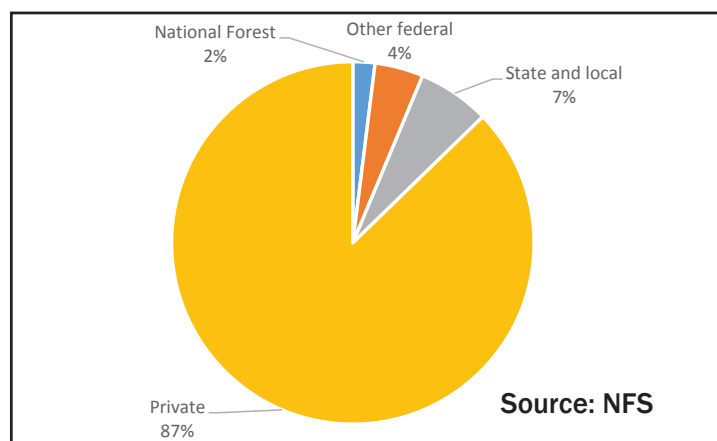


Figure 5. Ownership of Live Biomass



privately owned land (Figure 5). Table 4 shows biomass by species.

Woody biomass 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. In a study completed in 2008, the Nebraska Wood Waste Supply and Utilization Assessment, identified an annual available resource of potential woody biomass fuel of 270,000 green tons of processed and unprocessed woody biomass from forest biomass, residual byproducts and community waste wood sources (Table 6). Currently, there are eight commercial-scale wood-fired boilers in Nebraska.

The wood waste generated from wood products manufacturers represents an important bioenergy feedstock source in Nebraska. A significant amount of this processed wood waste is currently used for landscape



Woody biomass is a proven, reliable, readily available energy source that creates jobs in rural areas.
Photo: NFS

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 6).

From 2005 through 2015 fuels treatment activities conducted on 1,173 acres of forestland in Nebraska's Pine Ridge yielded considerable benefits for the area in the form of:

- 15,667 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).



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

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 land)
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

Table 5. Green Tons of Processed Wood Waste Generated Annually

MAJOR CATEGORY	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 Products	11,385	6.6%
Municipal Waste Disposal Facilities	22,854	13.3%
Tree Care Services	32,236	18.7%
City Governments	12,542	7.3%
Utility Companies	9,506	5.5%
TOTAL	172,395	100.0%

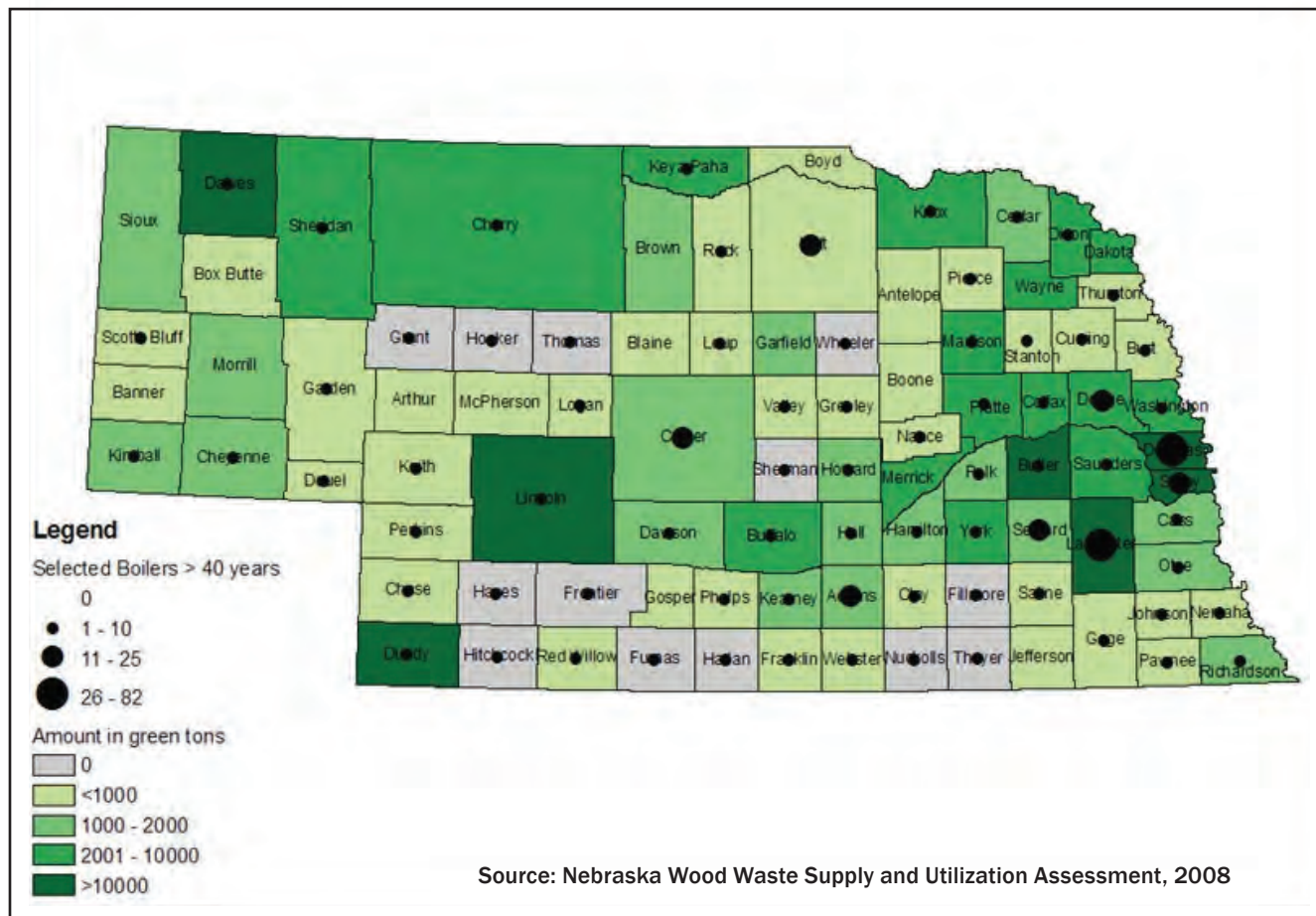
Source: NFS Wood Waste Supply & Utilization Assessment, 2008

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	100.0%

Source: NFS Wood Waste Supply & Utilization Assessment, 2008

Figure 6. Wood Waste Supply Amounts/Boiler Conversion Potential



Source: Nebraska Wood Waste Supply and Utilization Assessment, 2008

Figure 7. County Level-Wood Waste Supply Diversity

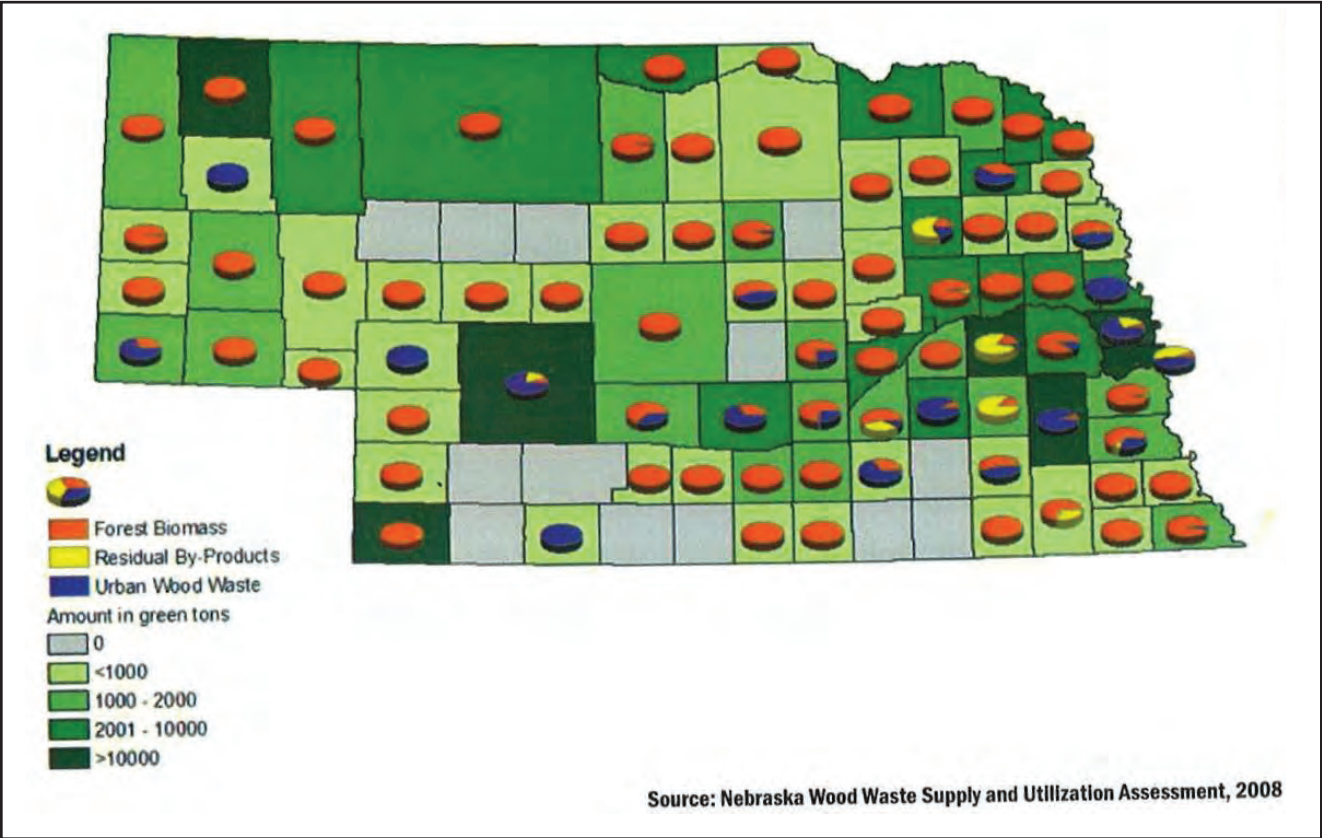


Figure 8. No-grade Live Volume on Forestland

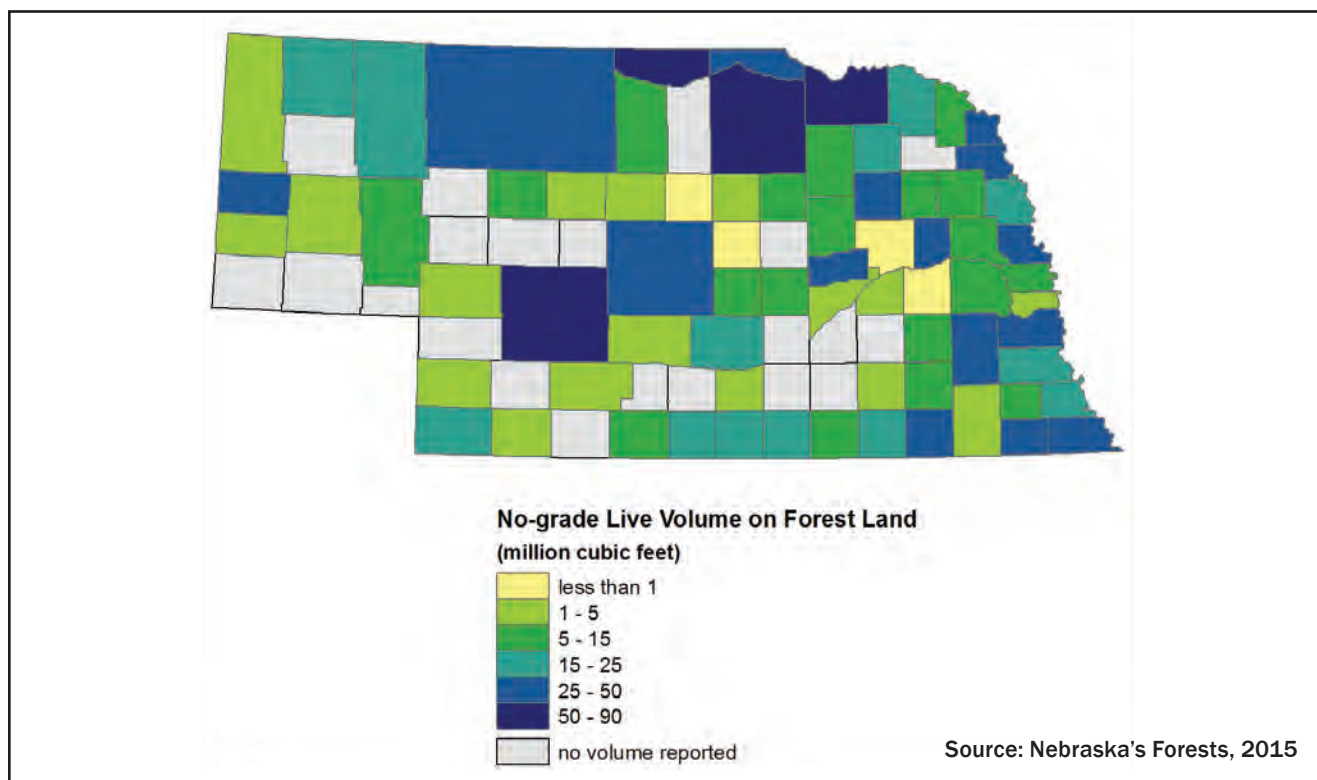


Figure 9. Sawtimber volume (billion board feet)

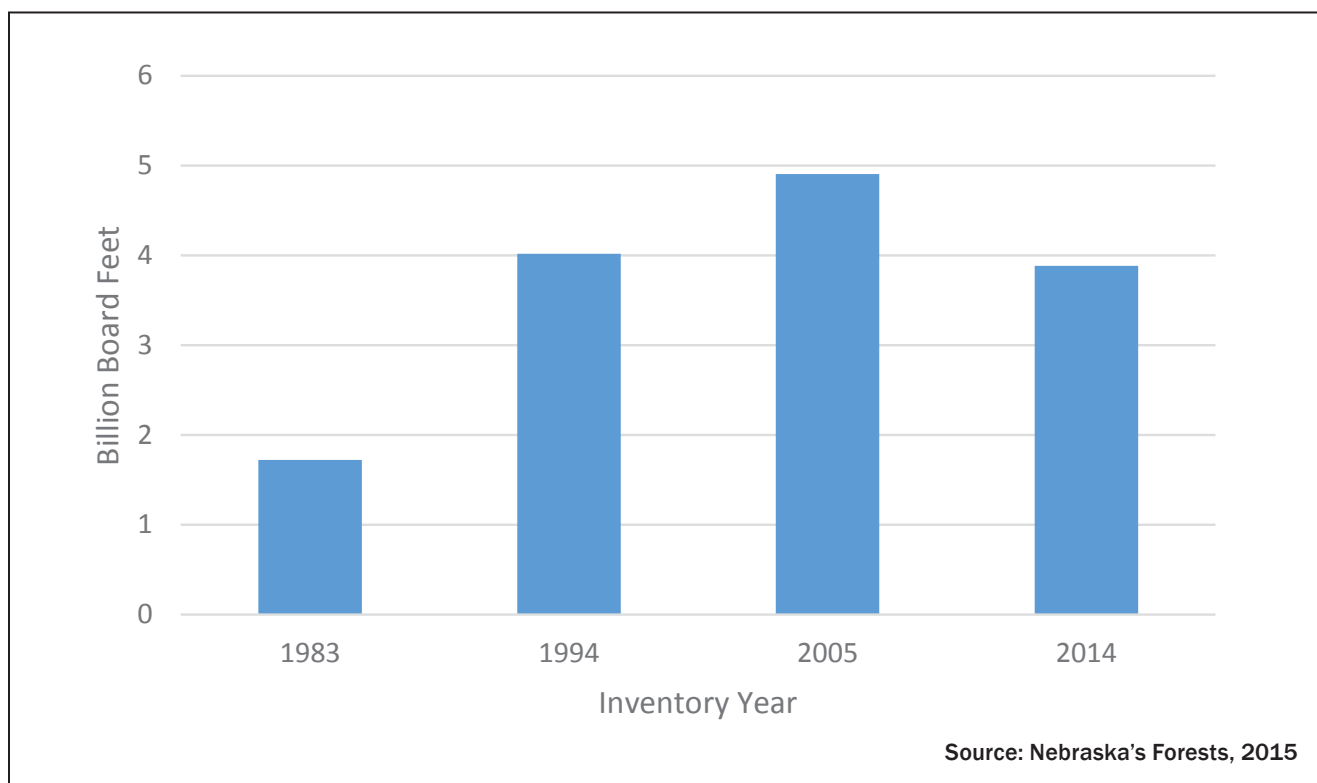
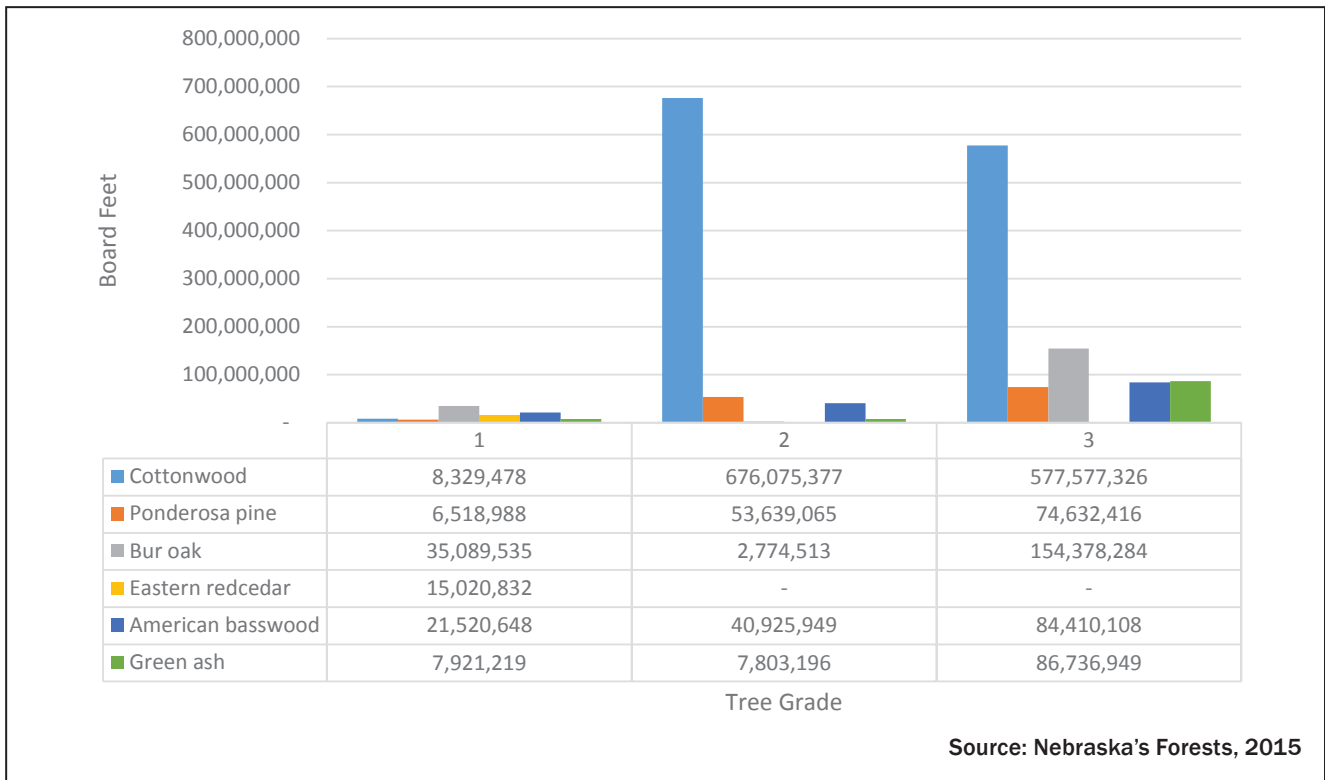


Figure 10. Sawtimber Volume by major species (million board feet)



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 energy sources that can offset use by coal-burning power plants which reduces air pollution and offset carbon emissions. For industrial applications, woody biomass can replace fossil fuels, increasing profitability and reducing net carbon emissions.

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.

As an industry, woody biomass creates jobs and new sources of income. In 1991, Chadron State College installed a woody biomass heating

system. 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.

SOCIAL BENEFITS

Community forest resources and the natural environments they provide are 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, research suggests a similar experience is provided by the view of a 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 pleasure from trees (Lewis, 1996).

Researchers have demonstrated exposure to green surroundings reduces mental fatigue and irritability associated with stress. The ability to concentrate is refreshed by views of a community forest, along with the ability and willingness to deal constructively with problems often associated with living in highly constructed environments. Trees add to 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 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 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).

Trees and community forests have many other social benefits:

- 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



Trees play an important role in creating healthier and more livable communities. Photo: NFS

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 have 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).

Considerable evidence suggests 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 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.

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).



Multiple scenic byways stretch 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*) during their annual spring migration.

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 unchanneled.

Many of Nebraska's parks are forested. The Nebraska Game and Parks Commission manages 87 properties covering about 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.

The National Park Service manages four properties in Nebraska: Agate Fossil Beds National Monument near Harrison, Niobrara



Photo: NFS

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 Jan. 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, trees and wildlife.



Nebraska's forests provide a number of recreational opportunities, in addition to fish and wildlife habitat. Photo: NEBRASKAland Magazine/ NGPC.



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

While Nebraska's forests are extensive and growing in area, they face a wide range of serious threats. These threats range from uncharacteristic 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, small trees and debris that accumulated on the forest floor. 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 80 or more years, most wildland fires have been suppressed resulting in fuel loads increasing dramatically to unnatural levels. With increased fire suppression, pine needles, pine cones 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 this erratic behavior, high-intensity crown fires are harder to suppress, making firefighters' jobs far more difficult and dangerous. As the crowns of trees are consumed by fire, a tremendous amount of energy is released. This heat energy creates powerful columns of rising air capable of carrying firebrands, such as burning pine cones 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 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 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 uncharacteristic wildland fires occur. These interface settings are

common in the Pine Ridge, Niobrara Valley and Wildcat Hills. They are 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. Many ranches and farms are at risk in some areas.



Pine Ridge Wildfire, 2006. Photo: NFS

Summers are 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 59,240 acres have burned by wildfires during the past 50-year period.

The ponderosa pine forests of western Nebraska exhibit unique characteristics that can lead to extreme fire behavior and a high rate of spread. As droughts strengthened in July 2012, lightning-caused fires blackened almost 85,000 acres across Banner, Brown, Keya Paha and Dawes counties. The scenic Niobrara River valley was the hardest hit by the Region 24 Complex, Fairfield Creek, Wentworth and Hall fires which burned more than 75,000 acres and destroyed 31 structures, including several homes. The July 2006 Spotted Tail Fire burned through 12 miles of ponderosa pine forest in less than five hours and entered the town of Chadron. At its peak, the Spotted Tail Fire consumed more than 20 acres of forest per minute. In a 10 hour period, this complex of fires burned over 23 square miles. Fires during the summer of 2006 alone consumed 3.5 million tons of woody biomass, enough to heat and cool Chadron State College for 350 years.

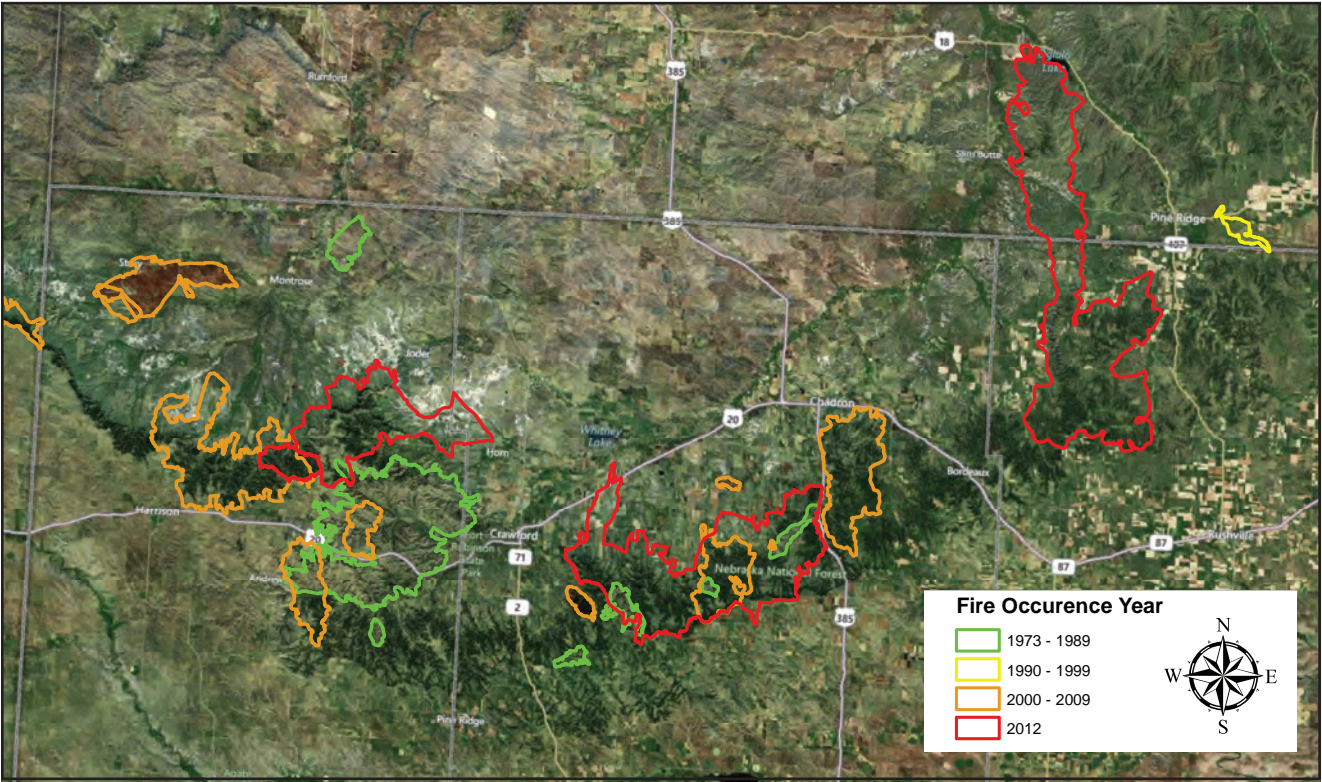
Nebraska's ponderosa pine forests are the eastern-most occurrence of this species in North

America. Ponderosa pine in this area is known for re-generating in dense, overstocked stands which create ladder fuels in pockets within the understory. Combined with persistent, often green, lower branches of the overstory pine trees and the heavy fine fuel loads of the native grasses found in both the forests and adjoining rangelands; the potential for intense, fast moving wildfires exists. This arrangement of heavy fine fuels under dense ladder fuels in close proximity of mature ponderosa pine forest has led to very destructive stand-replacing wildfires in both 2006 and 2012. These recent fires have completely removed live green ponderosa pine from many areas of the landscape, leaving no seed source to regenerate the forest.

Ongoing programs for forest fuels reduction in western Nebraska are critical to mitigate the risk of stand-replacing fires. These projects provide excellent fuel breaks helping firefighters control fires when they are smaller and provide an opportunity to catch the fires during initial attack.

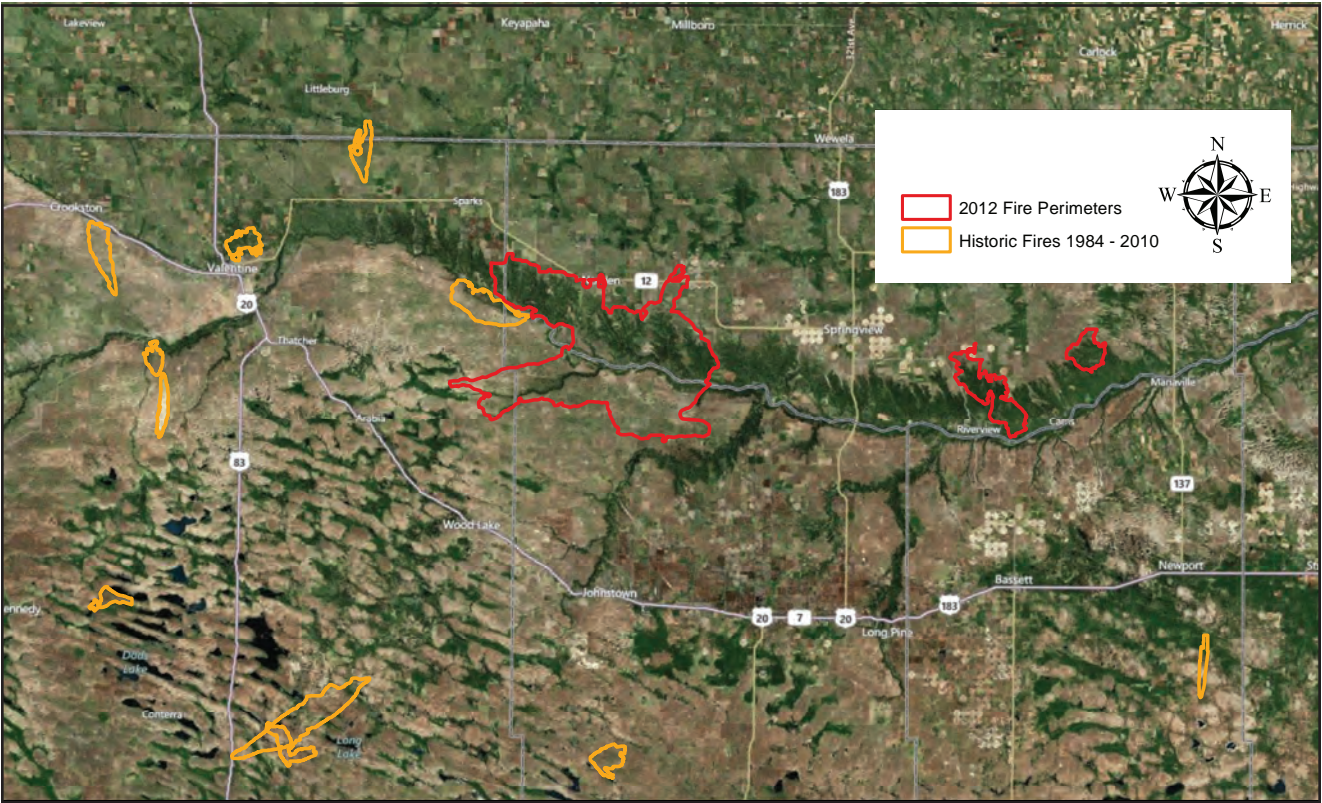
The fire history in Nebraska includes stand replacing fires, like those fires in 1965, 1972, 1973, 1989, 1999, 2000 and 2006 (Figures 11, 12), where tens of thousands of acres were burned, including areas where the pine forests was converted to grasslands. More recent fires have seen more extreme fire behavior with high

Figure 11. Historic Fires of the Pine Ridge



Source: NFS

Figure 12. Historic Fires of the Niobrara Valley



Source: NFS

intensity and high severity. The 2012 fire season far exceeded all others on record, burning over half a million acres statewide. Many of these pine forests were converted to grasslands where 100% of the ponderosa pine was lost during these fires, leaving no future crop trees.

Like much of the country, people in Nebraska are moving to forested areas at an increasing rate, particularly in coniferous and riparian forest areas of Nebraska. Wildland fires in these areas pose a significant risk to lives and property. In 2006, fires in Valentine and Chadron destroyed 23 structures. In 2012, an additional 65 structures were lost due to major fires.

Future Conditions & Trends

Several trends have combined to aggregate the already at-risk conditions. Increasing forest fuel loads, increasing extent of eastern redcedar, expansion of housing into WUI areas, increasing temperatures, drier conditions combined with longer fire seasons all increase the risk to life and property from the uncharacteristic wildfires.

Impacts on Nebraska's Forest Resources

Today, high intensity wildland fire is one of the greatest threats to our forest ecosystems. In riparian forest, eastern redcedar is an increasing component in both the understory and overstory. When wildland fires ignite in dense riparian forests or in a mixed pine/cedar forest the fire intensity is often extreme to severe resulting in the entire forest ecosystem being lost. These areas are converted to grassland for the foreseeable future resulting in the loss in ecological diversity and economic value associated with the forests.

The uncharacteristic wildfires in western Nebraska have negatively

affected tourism, land values for private forest owners and safety of the residents of Nebraska.

The 2009 discovery of mountain pine beetle (*Dendroctonus ponderosae*) in the Wildcat Hills and the Pine Ridge forests is of great concern due to beetle-killed trees exacerbating the area's wildland fire risk. In addition, mountain pine beetle and Ips (Ips spp.) attack the fire weakened trees, further devastating the fragile ponderosa pine ecosystem.

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,



Forester inspecting charred pine trees following wildfire event.
Photo: NFS

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 (*Cryphonectria parasitica*), respectively. Currently, a number of insect and disease threats are negatively affecting Nebraska's forests, and several more are looming on the horizon.

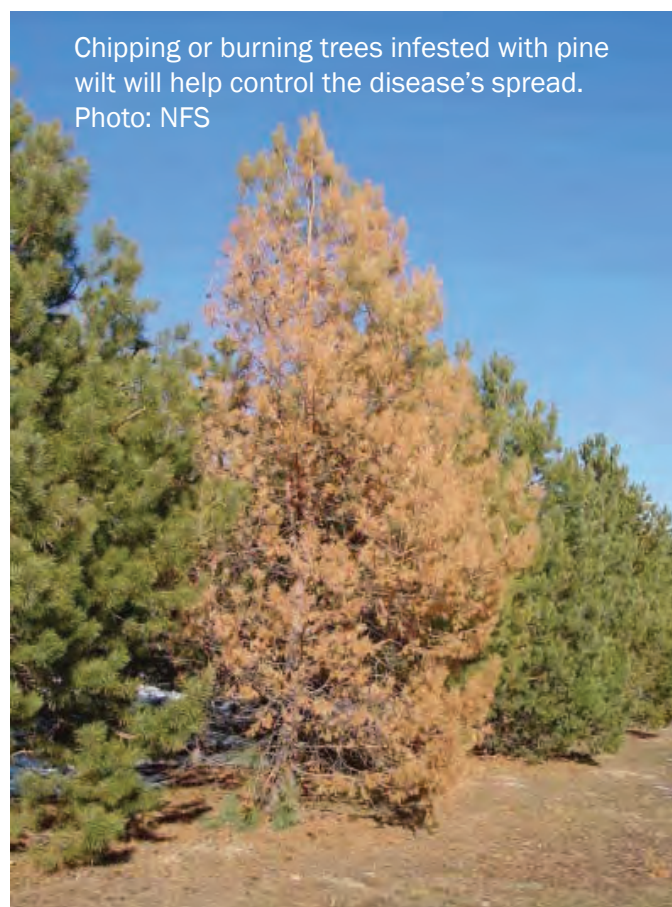
Current & Emerging Insect & Disease Threats

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*) is also 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



Chipping or burning trees infested with pine wilt will help control the disease's spread.
Photo: NFS

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 25 states and two Canadian provinces (Arkansas, Colorado, Connecticut, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland,



Massachusetts, Michigan, Minnesota, Missouri, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and Wisconsin and Ontario and Quebec, Canada). Native to Asia, the highly invasive beetle is believed to have arrived in the United States in the 1990s 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 one to two miles per year, but can travel 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 30 miles of the state's borders. Nebraska's estimated 46 million ash trees in communities, agroforestry plantings and native woodlands are at great risk (Figure 13). Municipal costs to remove, dispose of and replace nearly 1 million community and private ash trees will likely exceed \$961 million.

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 in the western U.S. in Oregon, Idaho, Utah, Arizona, New Mexico, Colorado, Washington and California, and is known to be present in the eastern U.S. in Tennessee, North Carolina, Virginia, Indiana, Ohio, Pennsylvania and Maryland.

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 is thought to have co-evolved with Arizona walnut, on which it causes little damage. However, eastern black walnuts in urban forests are highly susceptible to this disease.

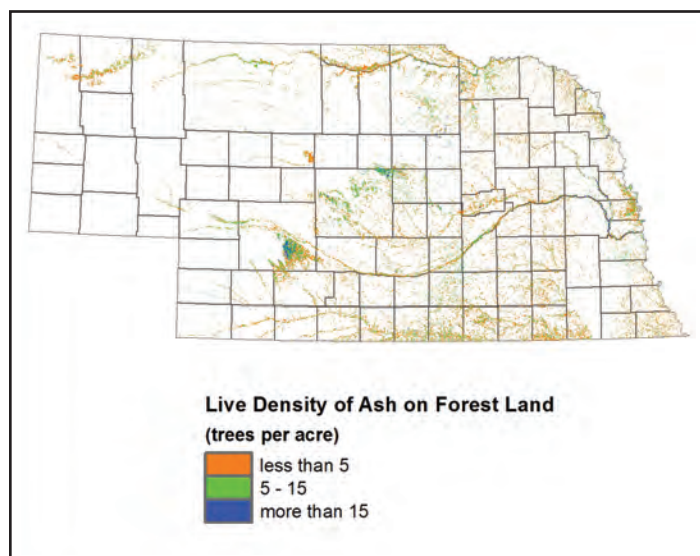
Thousand cankers is largely spread through the transport of firewood. In this manner it was spread to Colorado's Front Range communities and has nearly wiped out black walnut trees in Boulder and Colorado Springs. It has not yet been identified in Nebraska but poses an enormous threat to all black walnut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

Also, there are several hundred nut tree growers with nearly 4,000 grafted high-quality nut 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.

Figure 13. Live Density of Ash on Forest Land



Source: NFS

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, Mass., in 2008. It presumably is spread by the transport of infested firewood.

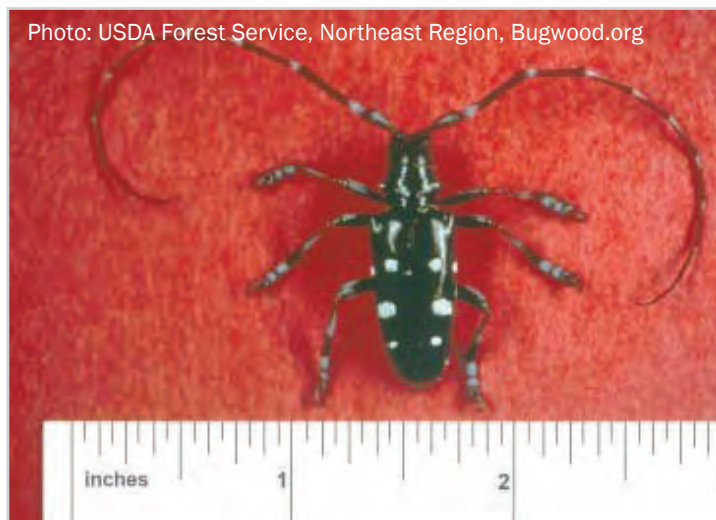
The insect attacks multiple species of hardwoods, including birch (*Betula spp.*), Ohio buckeye (*Aesculus glabra*), elm, horse chestnut (*Aesculus hippocastanum*) and willow. Asian longhorned beetle (ALB) also attacks, and is thought to prefer, species in the maple (*Acer spp.*) family including boxelder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

Other Forest Health Concerns

Diplodia blight of pines (caused by the fungus *Diplodia pinea*) and Zimmerman pine moth and related species (*Dioryctria zimmermani*, *D. ponderosae* and *D. tumicolella*) 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 and related species tunnel 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. These insects have killed hundreds of trees and have 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 difficult place to grow 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 2014 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.

Parts of Nebraska experienced severe D2 drought or greater on the National Drought Mitigation Center's scale in 13 of the past 14 years (2002, 2003, 2004, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013 and 2014), 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

Nebraska's 1.5 million acres of forests are unique in that they generally exist on the eastern, western or southern edges of their native ranges, and grow under stressful conditions more conducive to prairie ecosystems than to forests. These tree and forest resources provide critically important economic and ecosystem services.

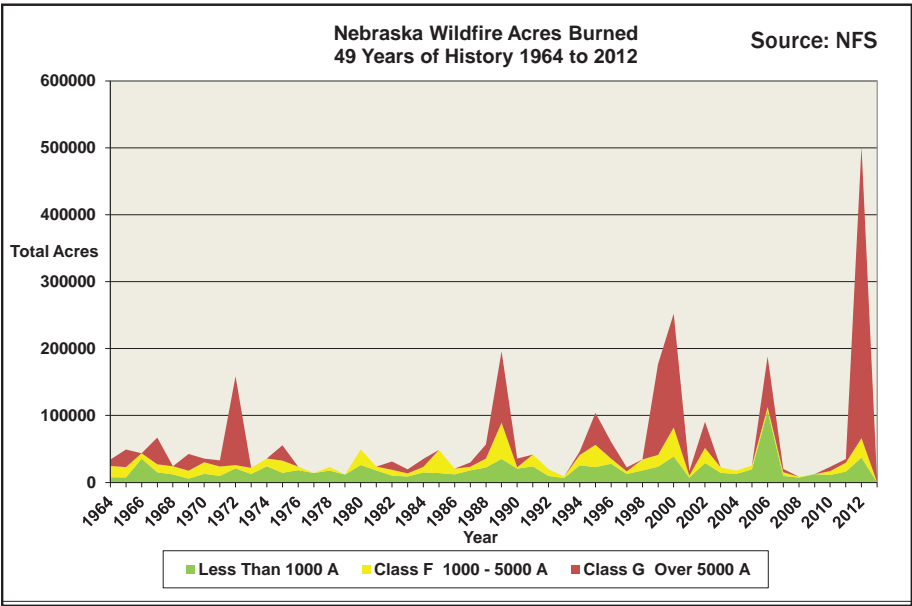
Changes in Nebraska's climate projected in the 2014 report "Climate Change Impacts in the United States" will have, and arguably are having, substantial and negative impacts on the state's tree and forest resources. Increased incidence and severity of drought and severe weather events, and higher day and night temperatures will seriously affect the health, vitality and resilience of individual trees and urban and rural forest ecosystems.

More intense droughts compounded by higher temperatures and excessive forest fuel loads have already damaged trees and forests across the state, have substantially increased the risk to life and property due to catastrophic wildfires, and have reduced sequestration and storage of atmospheric carbon. Large wildfire events have increased in frequency and size over the past 50 years (Figure 14). Repeated, intense and uncharacteristic wildfires occurring in the ponderosa pine forests of the Pine Ridge in northwestern Nebraska have reduced forest cover from 194,000 acres to approximately 120,000 acres since 1994. These forests burned so intensely that nearly all living trees were eliminated across large landscapes, converting former forests

to grassland. Intense wildfires driven by projected increases in temperature and drought will gravely threaten Nebraska's remaining pine forests. Given that these forests represent the easternmost extension of ponderosa pine in North America, their loss would eliminate unique genetic adaptations to low elevation, hotter conditions.

Higher temperatures, especially those at night, combined with drought reduces carbohydrate reserves essential for vigorous growth and pest resistance, often for several years. Trees stressed by the drought and higher temperatures were more susceptible to attacks by the mountain pine beetle attacks, and Nebraska's pine forests lost thousands of trees in the 2000s to this pest, part of the 35 million acres of forests killed recently by the beetle in N. America. Ips (*Ips spp.*) engraver beetles are additional pests currently attacking and killing heat and drought stressed pines across the Pine Ridge and Niobrara Valley. Increasing temperatures and drought also negatively affect urban forests, disproportionately killing nonnative tree species (e.g., white pine, spruce, etc.) that are poorly adapted to these changing conditions. Reduced vigor and increased mortality of trees in urban areas will further decrease the capacity of urban forests to mitigate higher urban temperatures, compromising human health.

Figure 14. Nebraska Wildfire Acres Burned in 49 Years



Nebraska has historically experienced a wide range of severe weather events. The predicted increased frequency and intensity of such events will clearly and negatively impact trees and forests statewide. The unprecedented flooding of 2011 along the Missouri River inundated 26,000 acres of bottom-land forest in Nebraska for nearly the entire growing season. Tens of millions of trees died, as few native riparian forest species are adapted to such long periods under water. Other severe weather events common to the Plains (tornadoes, straight line winds, ice and early winter snow storms, early fall and late spring freezes, etc.) already damage Nebraska's trees and forests. An increase in frequency and intensity of these events will likely substantially increase these losses. The loss of windbreaks and forested riparian buffers from more frequent severe weather events will increase soil erosion, impair air and water quality, and decrease crop yields and quality across Nebraska.

The focus of the following NFS programs and initiatives will increasingly address the challenges of climate change on Nebraska's trees and forests over the next five years.

- Increasing species and seed source diversity will enhance resilience of urban and conservation plantings.
- Thinning coniferous forests will reduce competition for water, improve tree vigor, protect remaining islands of live forest stands isolated by previous wildfires, and decrease the risk of catastrophic crown fires.
- Developing new products and markets for wood, especially for bioenergy applications, will create market drivers that support expanded forest thinning operations and offset the use of fossil fuels and further releases of ancient CO₂.
- Large-scale tree planting campaigns will encourage the replacement of trees and forests damaged or killed by severe weather events and stressful climate conditions aggravated by climate change.

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. About 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* Ledeb and *Tamarix parviflora* DC) and phragmites (*Phragmites australis* subsp. *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 using 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 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 bottom-land 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, woodland 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*) is also 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 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

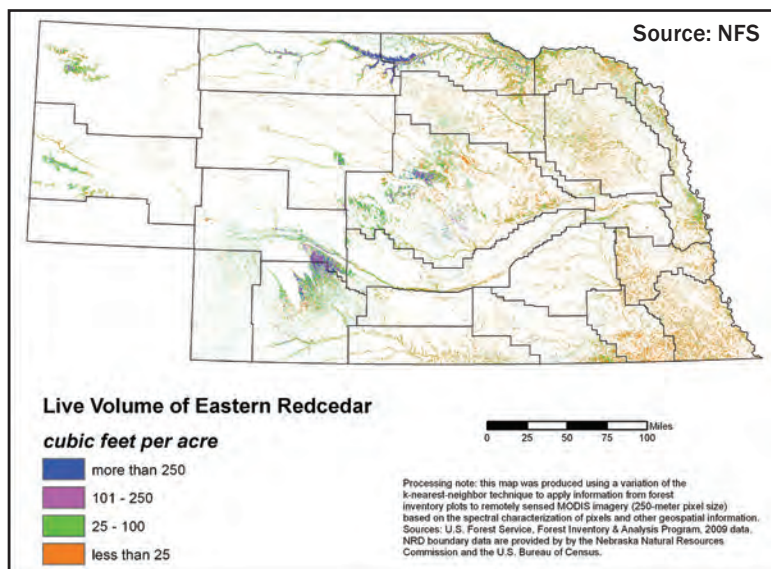
growth rate. However, this native is a prolific multiplier and, if left unmanaged, can quickly take over pastureland, forestland and riparian areas. Improved fire prevention and suppression efforts, and changes in agricultural practices have allowed eastern redcedar to expand in both total area and number 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. Methods such as mechanical removal of larger trees and chemical control, can also 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 the invasive and aggressive plant species range will continue to expand in Nebraska's forests, negatively affecting these ecosystems. This issue will be exacerbated by the expected changes in climate as outlined in "Understanding and Assessing Climate Change: Implications for Nebraska" published in September of 2014.

Figure 15. Live Volume of Eastern Redcedar



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 expansion can reduce the productivity of pastureland by reducing forage production and degrading 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 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 the deer eat broadleaf trees and shrubs within reach (up to 7 feet). Trees protected either by thorns [such as honey locust (*Gleditsia triacanthos*); Osage-orange (*Maclura pomifera*); Russian olive,



Eastern redcedar and Russian olive trees can be found growing in riparian corridors.
Photo: NFS

etc.] or having 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. 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). Because many of the benefits provided by trees and forests are intangible, it is often difficult for the public to understand their value.



Photo: NFS



Future Conditions & Trends

In rural areas, increasing crop prices and drought negatively affect people's 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 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 changed from 1,826,341 in 2010 to 1,881,503 in 2014 (U.S. Census Bureau, 2015).

Census data show Nebraska is 77.7% white, 17.1% Hispanic or Latino, 13.9% black, 1.2% 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, 2015). 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 2010, 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.

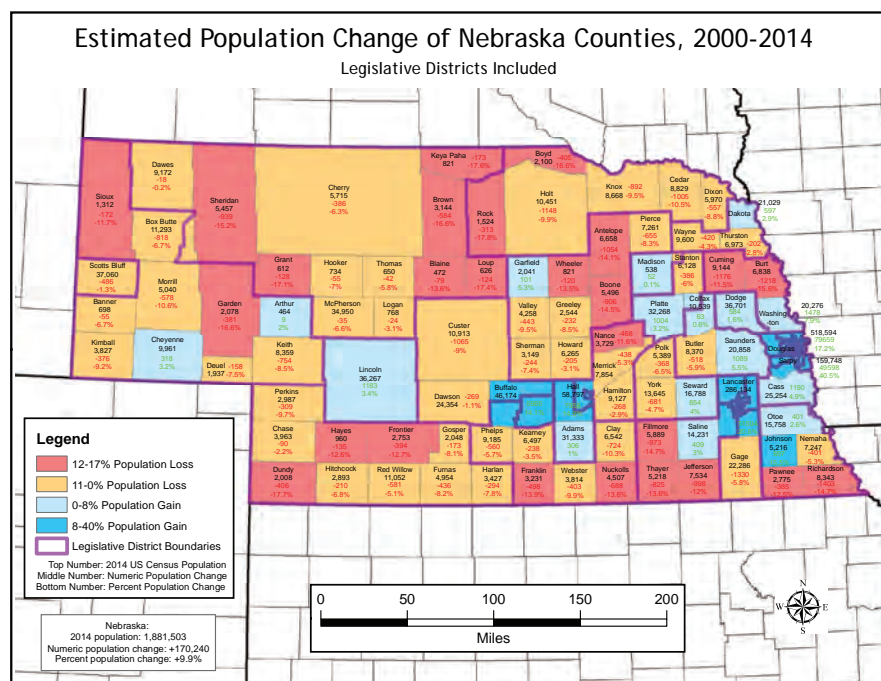
(Nebraska Blue Book, 2015).

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 16. Estimated Population Change of Nebraska Counties, 2000-2014



Source: US Census Bureau, 2015

FOREST LANDOWNER ISSUES & OPPORTUNITIES AFFECTING FOREST CONSERVATION

Current Conditions

According to the USDA National Agricultural Statistics Service (2009), about 97% of all land in Nebraska is privately owned, as is 85% of forestland. Of the 49.5 million acres (77,359 square miles) that make up Nebraska, 473,500 acres are covered by open water. In 2015, federally owned land comprised approximately 538,860 acres, and 1,205,900 acres were in commercial or residential development.

Nebraska is largely an agricultural state. In 2013, Nebraska had 49,300 farms and ranches using 45.3 million acres, about 92% of the land area. In 2007, there were 96,131 registered wells and 5,000 surface water rights irrigating about 8.3 million acres of crop and pastureland (NDA, 2015).

At more than \$23 billion in 2013, Nebraska's produced 5.9% of the U.S. agricultural production. Nebraska's total ethanol production ranks second 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 (NDA, 2011, 2015).

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, 2015).

Impacts on Nebraska's Forest Resources

Despite the 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 about 1 million trees sold annually for those same purposes.

People's 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 droughts — 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, Wildcat Hills and Niobrara River valley), increased fragmentation of large, intact forested acres into smaller acreages or "ranchettes" creates significant WUI issues and negatively affects 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 affect 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. More recently, mortality of the ponderosa pine from bark beetle infestation has increased the local availability of roundwood in the Black Hills woodbasket. Currently there are no demands for timber from Nebraska for this market. Various attempts over the past 30 years to establish



Eastern redcedar log deck Photo: NFS

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. 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. The Republican and Big Blue rivers drain the southern part of the state. About 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 about 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. 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 17).

Data Layers:

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

Desired Outcomes:

A public 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.

Data Gaps:

- Fine-resolution (1-meter preferred) community forest canopy cover and riparian areas, both Ortho and color infrared.
- Geospatially based woody biomass data.
- 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, non-forestlands 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 will be the social, economic and ecosystem impacts on forest stand dynamics with the loss of ash due to emerald ash borer?

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 18).

Data Layers:

- Statewide wildfire risk (SAP)
- Wildland Urban Interface (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 effects 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.

Figure 17. Actively and Sustainably Manage Forests

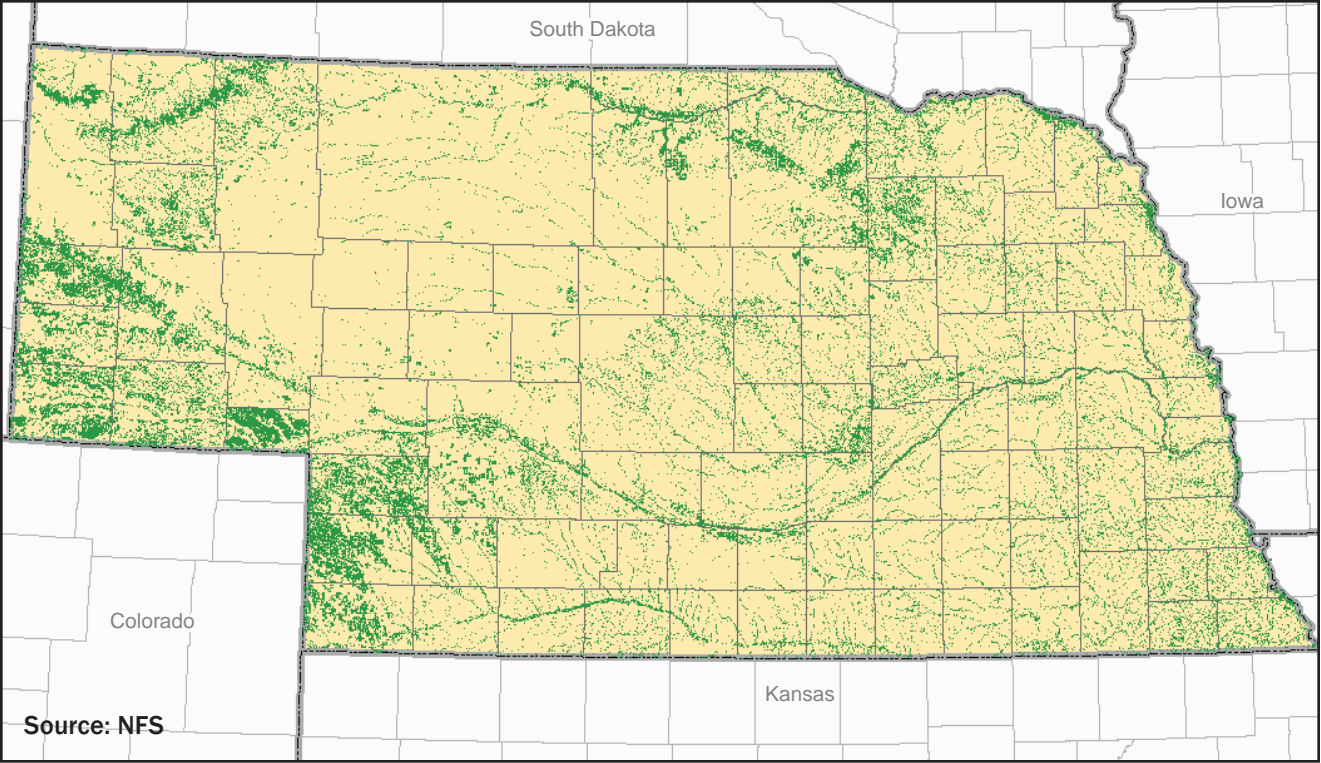
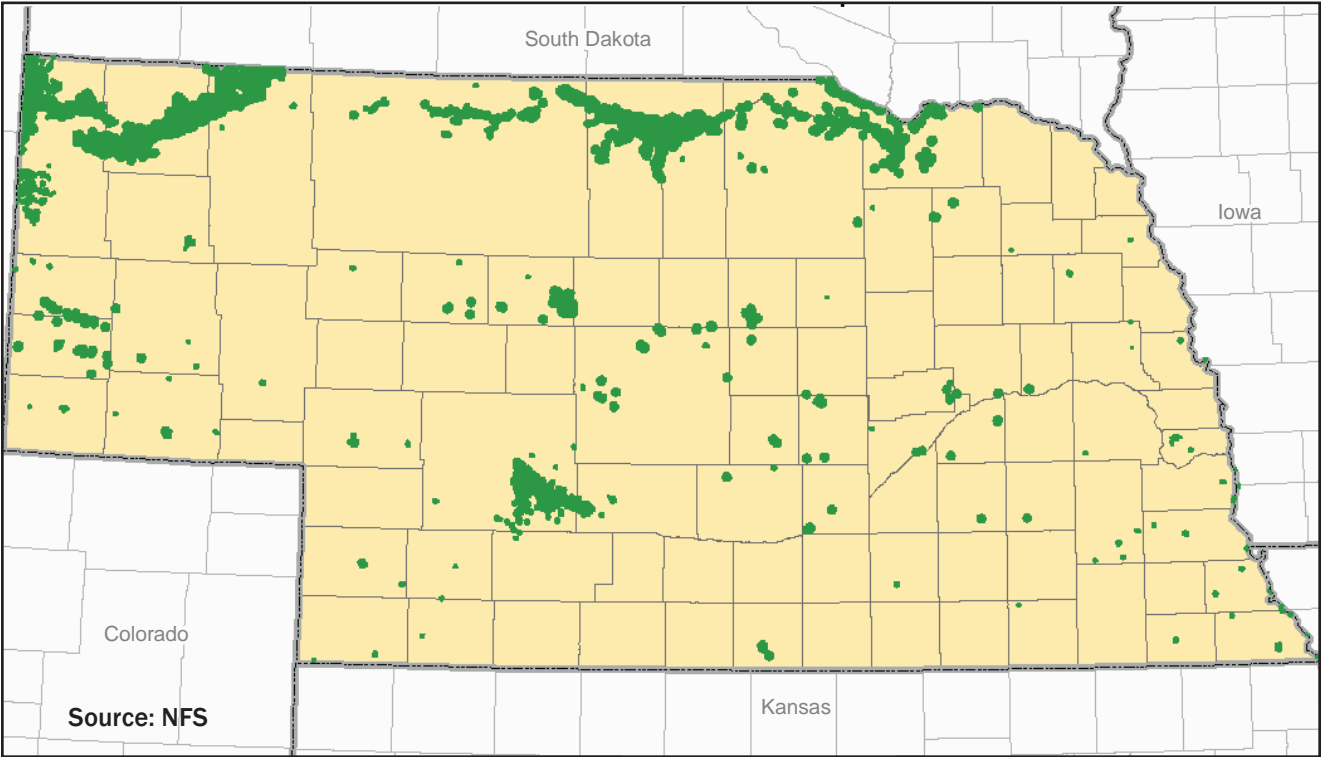


Figure 18: Restore Fire-Adapted Lands & Reduce Risk of Wildfire Impacts



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 for wildland fires (e.g., grassland, forested areas).
- WUI map based on a nationally developed standard WUI definition.
- Accurate wildland fuel model for Nebraska.

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.

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 19).

By identifying forest areas especially vulnerable to existing or potential forest health risks, NFS will be able to target forest management practices most likely to prevent and mitigate impacts and successfully restore affected 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).
- Educate the public 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.
- Geospatially based mapping of plant communities to identify and monitor change over time.
- Updated fine-resolution (1-meter preferred) forest health risk data by insect species/disease and location.

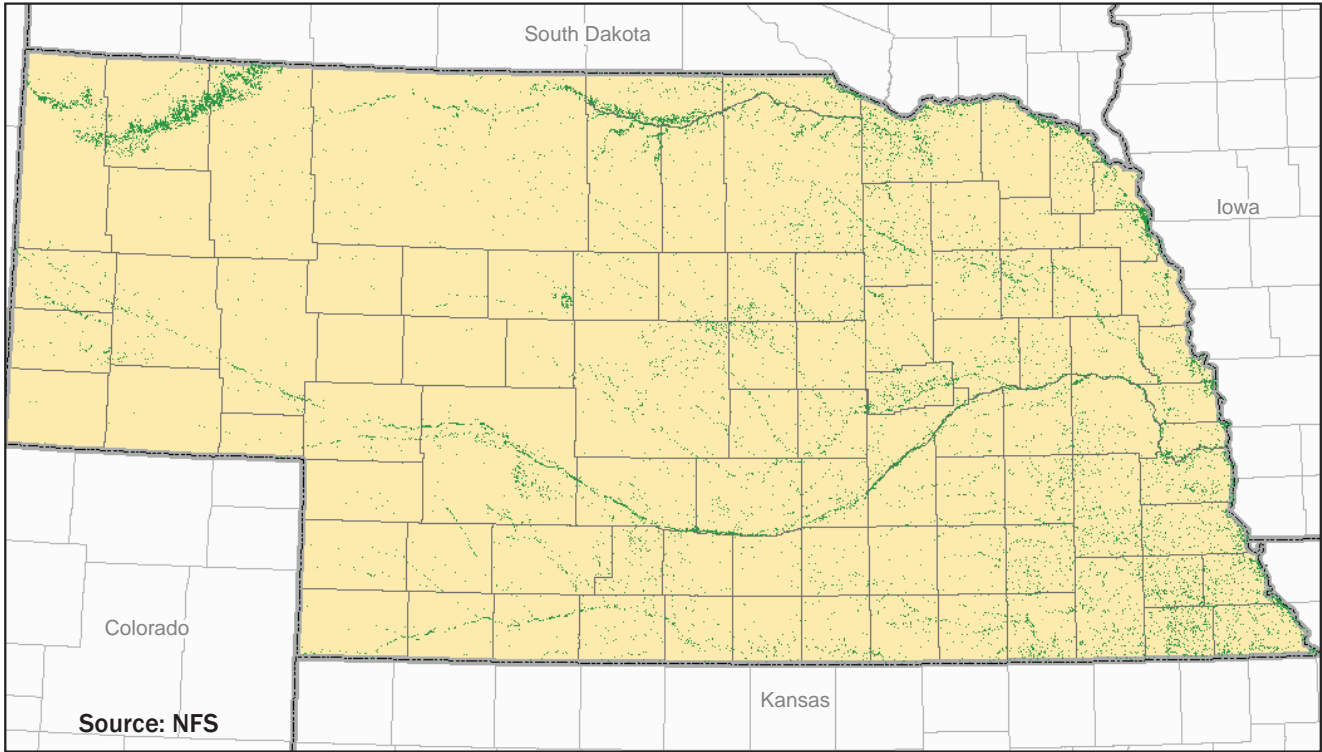
Research Needs:

- What are the social, ecological and economic impacts of the loss of ash trees in rural forests and urban areas due to emerald ash borer?
- 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?



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

Figure 19. Identify, Manage & Reduce Threats to Forest & Ecosystem Health



- 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 with increasing extreme and changing climatic conditions?
- What is the impact of climate change on the forest plant community?

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 20).

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 in these ecosystems, 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 storm water runoff and preserve and protect water resources are increasingly implemented in urban areas.

Data Gaps:

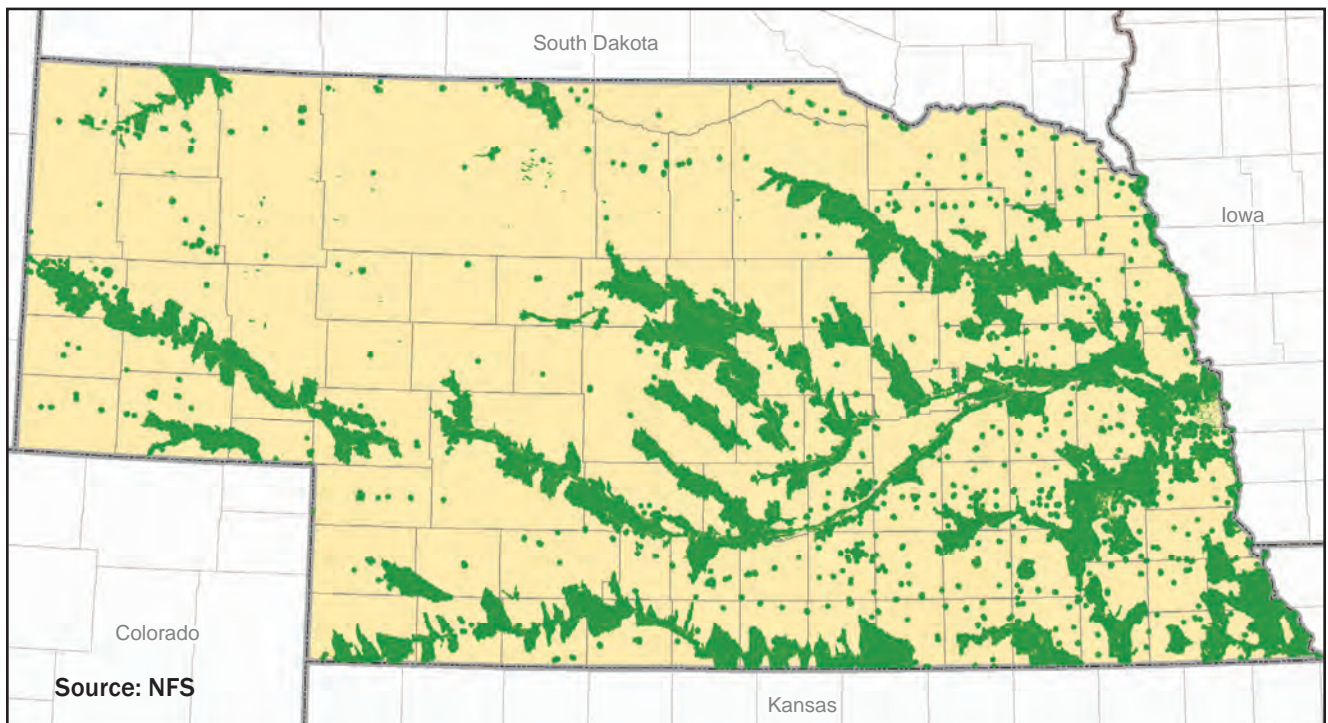
- Fine-resolution (1-meter preferred) community forest canopy cover and riparian areas, both Ortho and color infrared.
- Updated census data and development projections.

Research Needs:

- What are the social, ecological and economic impacts of the loss of ash trees in rural forests and urban areas due to emerald ash borer?
- 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, non-forestlands 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



Figure 20. Protect & Enhance Water Quality & Quantity



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 community forest cover, including agroforestry plantings, can improve air quality, reduce energy consumption and produce biomass for energy production (Figure 21).

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 and energy savings is actively managed.
- Institutions, facilities and businesses are converted to woody biomass as their energy source, where feasible.
- Promote and support windbreak planting for energy conservation.
- Promote and support management of existing windbreaks for energy conservation and ecosystem benefits.

Data Gaps:

- Fine-resolution (1-meter preferred) community forest canopy cover and riparian areas, both Ortho and color infrared.

- Geospatially based woody biomass data.
- Geospatially based mapping of windbreaks.

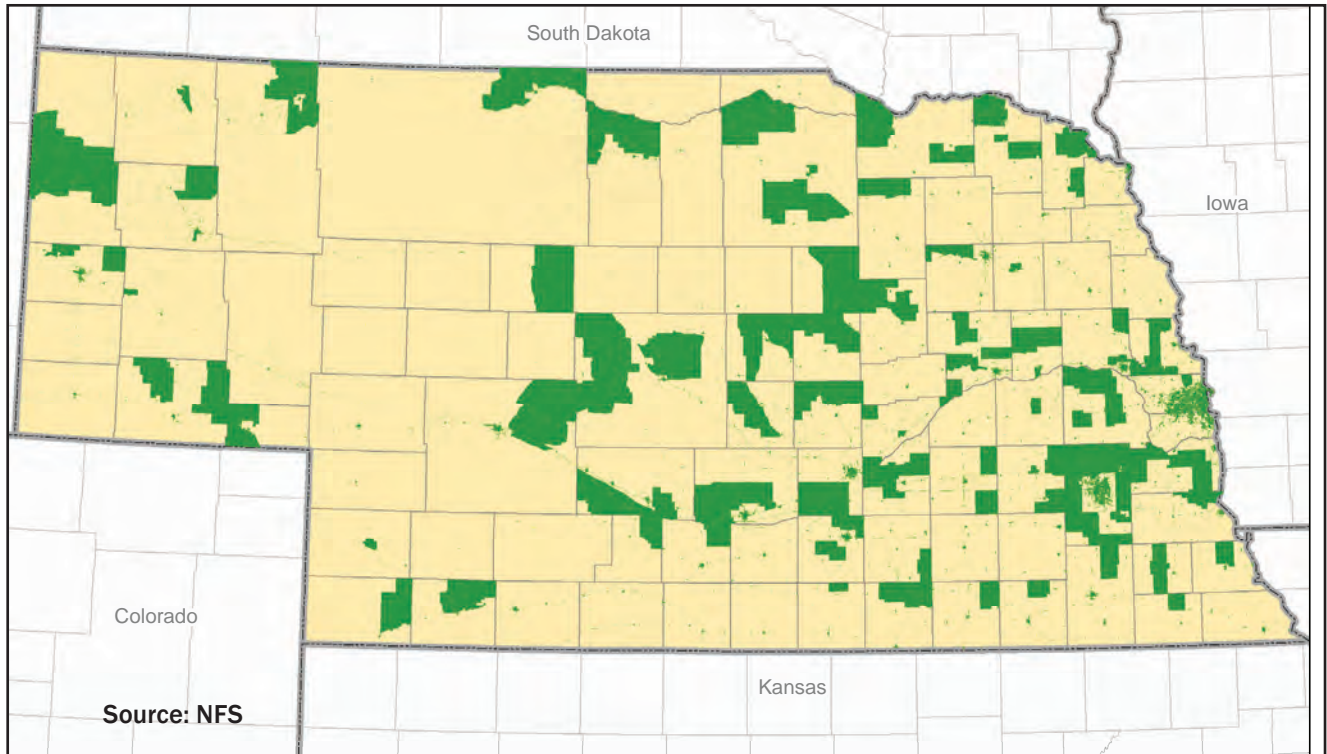
Research Needs:

- What approaches maximize landowner/ acreage owner adoption of field and farmstead windbreaks?
- What approaches are the most effective in promoting and supporting community tree planting?
- What elements are both necessary and sufficient to foster increased conversion by institutions and organizations to woody



Wood-fired boiler system
Photo: NFS

Figure 21. Improve Air Quality & Conserve Energy



Community forest cover can improve air quality, reduce energy consumption and produce biomass for energy production.
Photo: NFS

biomass as their primary energy source?

- What are the economic, social and ecological benefits to producers with the installation of agroforestry practices?

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.

Many communities next 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 22).

Data Layers:

- WUI
- Community wildfire protection plans
- Wildfire risk (SAP)

Desired Outcomes:

- Elected officials 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 fire suppression and prevention effectiveness and safety.
- Increasing number of communities are covered by community-wide protection plans.

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?

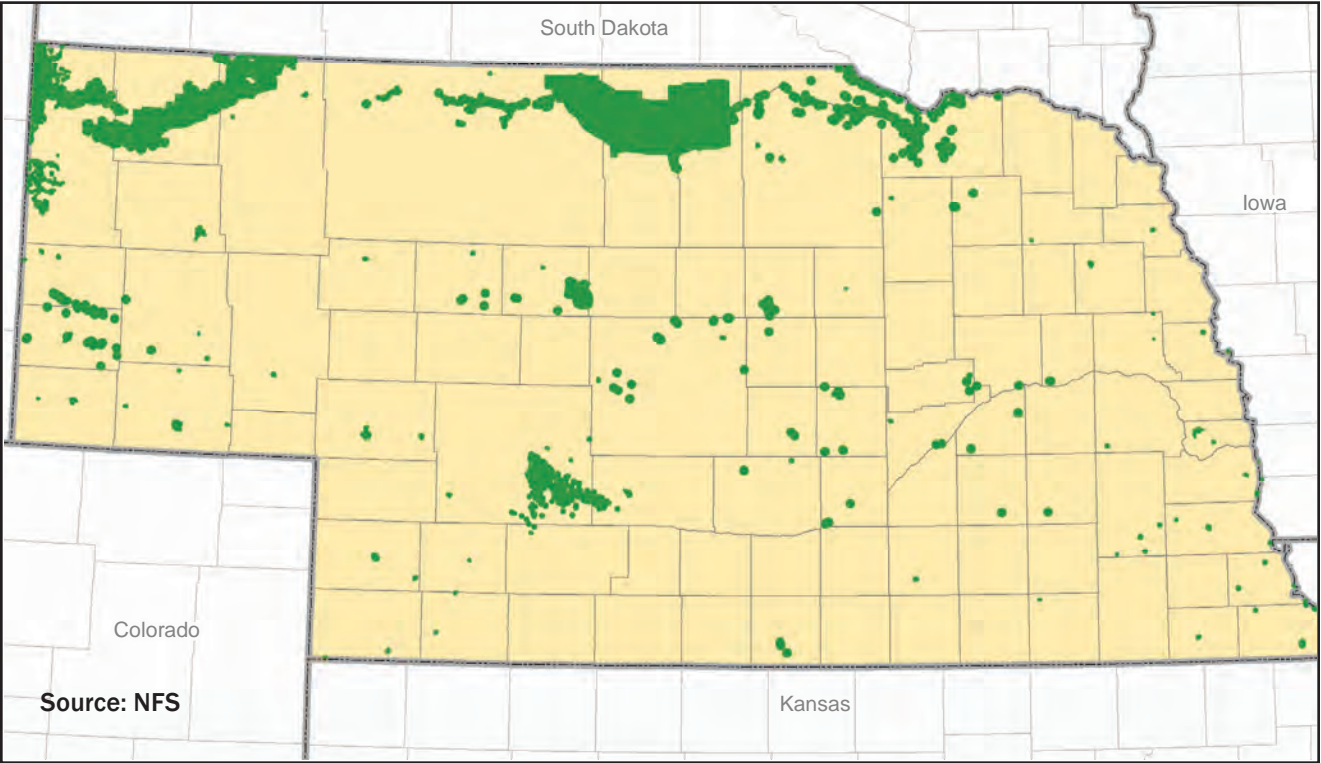
OBJECTIVE 7—MAINTAIN AND ENHANCE THE ECONOMIC BENEFITS AND VALUE OF TREES AND FORESTS

Forested areas present opportunities for economic development through 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.

Figure 22. Assist Communities in Planning for & Reducing Wildfire Risks



- Associated infrastructure necessary to support forest product markets is developed and sustained with market demands.
- 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 maintain and enhance the health and productivity of forests and do 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 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 and program changes are needed to increase 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?



Eastern redcedar lumber at sawmill. Photo: NFS



Clockwise from top: Close up shot of hazelnuts; fence posts derived from small diameter pine trees; woody biomass in the form of chips. 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 23).

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 and diverse wildlife habitats (contiguous or connected), contain high species richness, represent core habitat or focal conservation species, and help preserved, protect and enhance these attributes.

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.

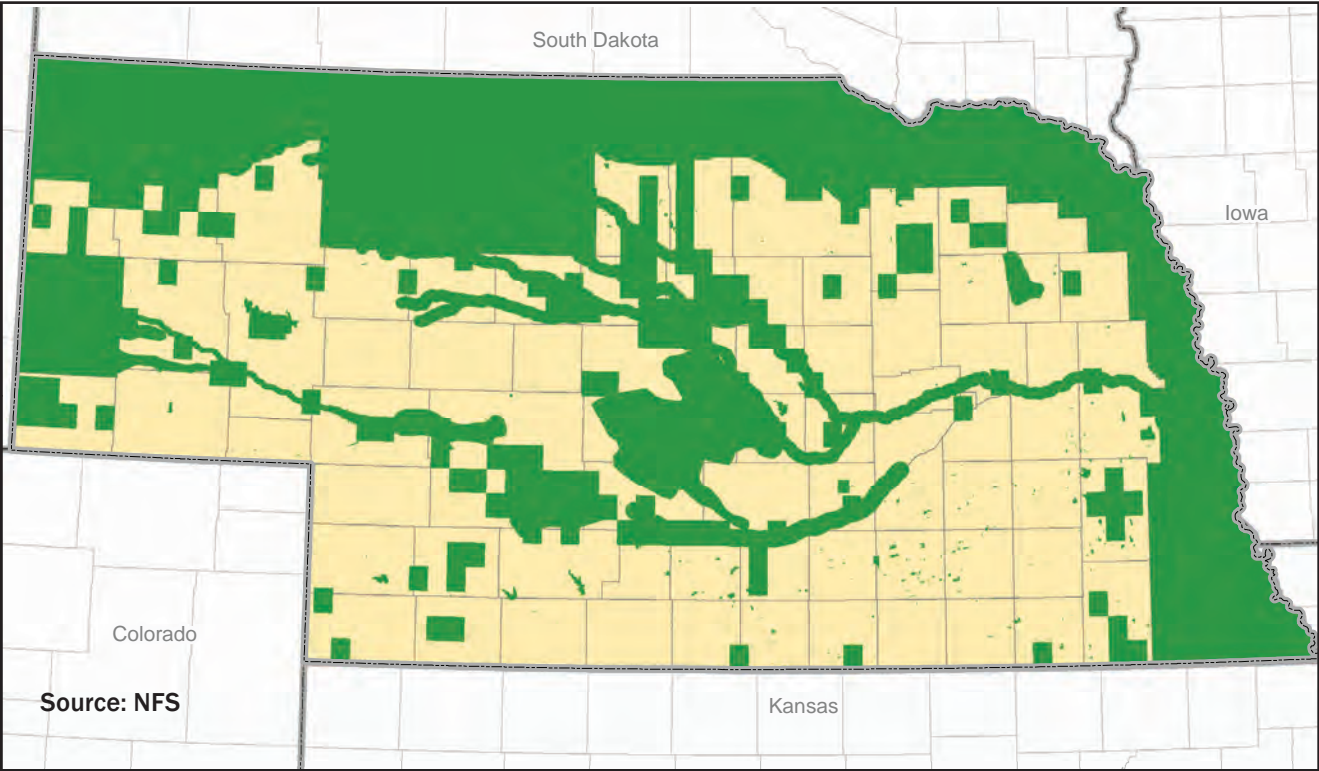
- Updated fine-resolution (1-meter preferred) forest health risk data.
- Relevant threatened and endangered species data as applicable and available.
- Forestation and land use conversion trends.

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 to 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 allow for the 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 23. Protect, Conserve & Enhance Fish & 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. 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 24).

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.

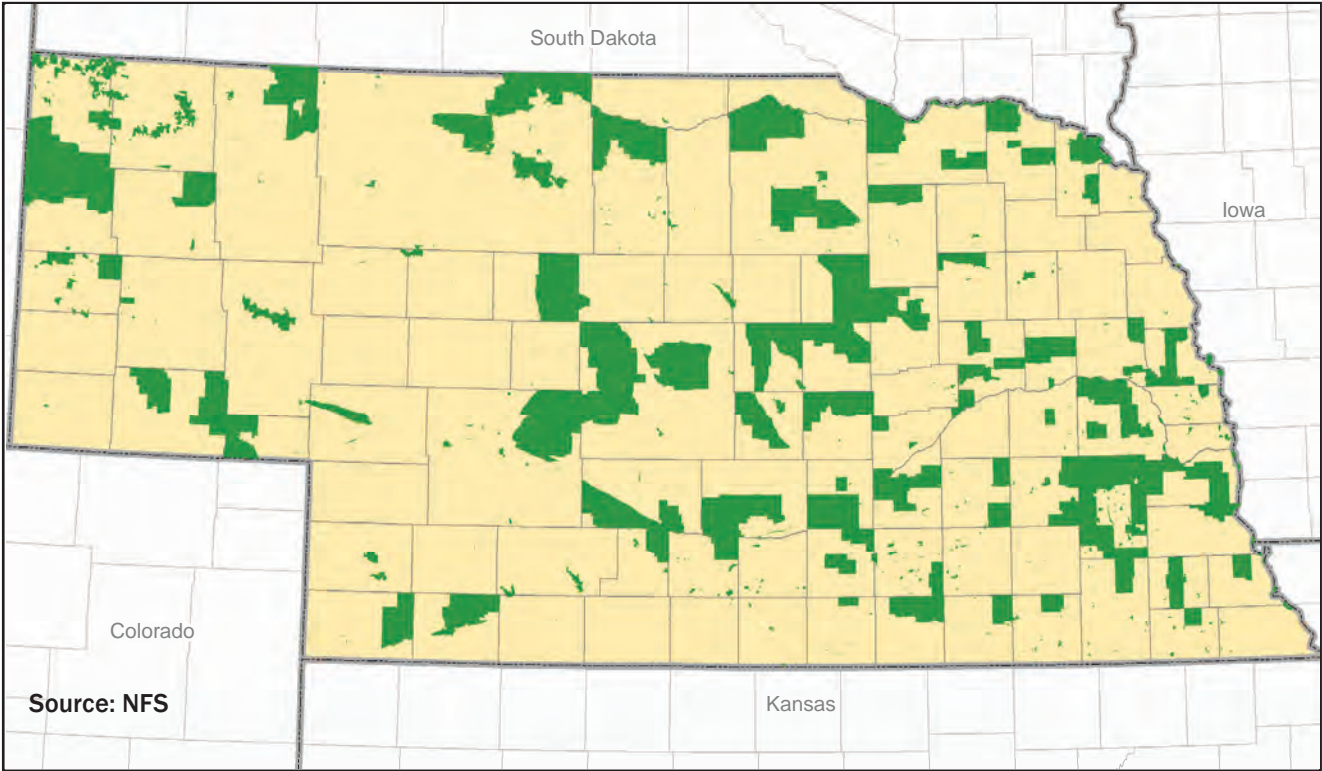


- Community greenways or green infrastructure.

Research Needs:

- What is the knowledge level of the general public regarding the extent, value and importance of trees and forests in Nebraska?

Figure 24. Connect People to Trees & Forests & Engage Them In Environmental Stewardship Activities



Public landscapes rich in community trees are more attractive and comfortable than similar settings lacking tree cover. Photo: NFS

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

Nebraska's forests have the potential to offset significant carbon emissions. 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 affected by climate change, preserving forest landscapes is critical in ensuring that these benefits are sustained (Figure 25).

Data Layers:

- Potentially affected forests

Desired Outcomes:

- A forest canopy that generates substantial energy savings is maintained and actively managed.
- 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.
- Sustainable forestry practices that preserve and protect water resources are increasingly implemented in rural areas.
- Sustainable forestry practices that minimize urban stormwater runoff and increasingly preserve and protect water resources in urban areas.
- Forest productivity, growth and carbon sequestration is enhanced through forest-stand improvement activities.

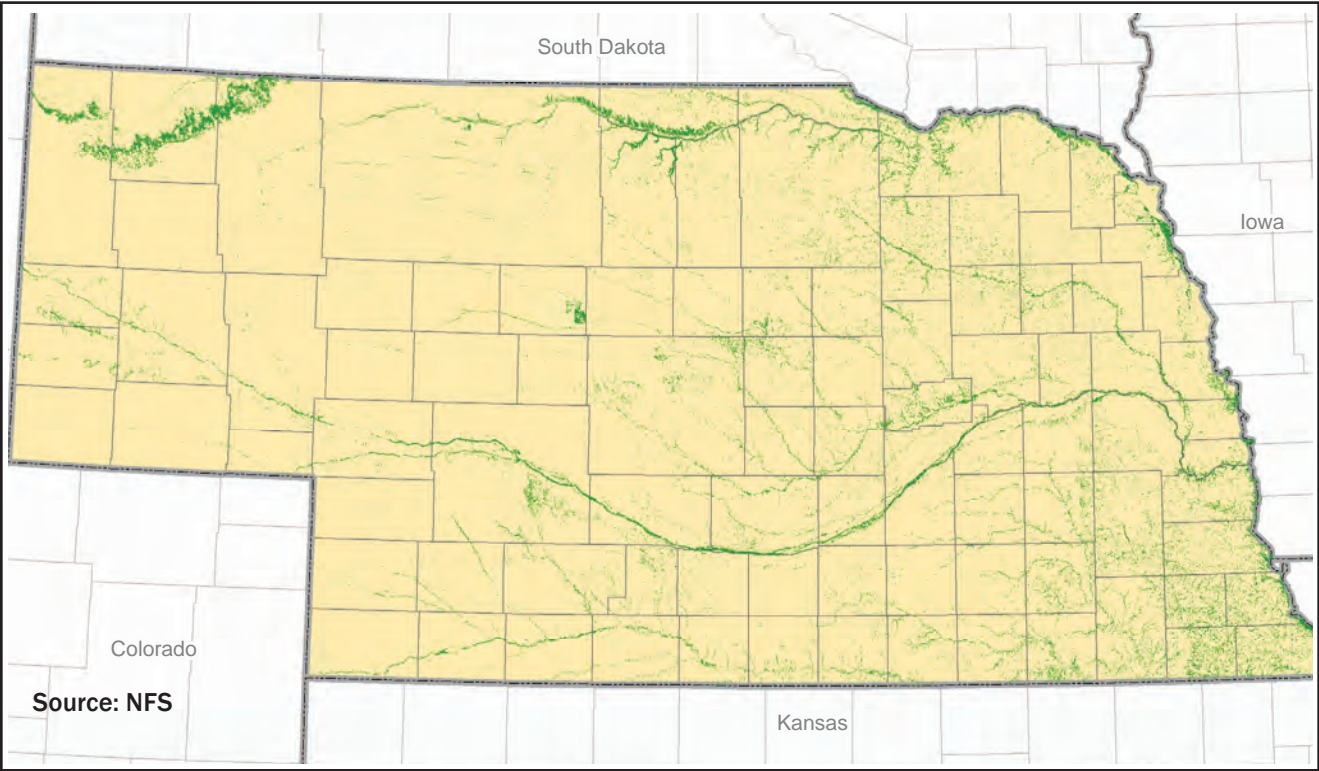
Data Gaps:

- Climate change models 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 and non-forestlands with trees and urban areas.

Figure 25. Manage & Restore Trees & Forests to Mitigate & 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 256 m. (840 feet above sea level) lies along the Missouri River in Richardson County (southeast Nebraska), and the highest point 1653 m. (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 non-forest 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 contains nearly 352 million live trees and represents a unique mix of

vegetation types. The forestland of Nebraska's central hardwood forests are representative of the eastern United States, ponderosa pine forests representative of the Rocky Mountains, and the birch/aspen forests are 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 non-forestland 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.

About 85% (slightly more than 1 million acres) of Nebraska's forestland is privately owned, and about 34,000 acres are owned by private entities, corporations, tribes and other groups (Figure 28).

In addition to forestland acres, Nebraska has an estimated 1.5 million acres of rural non-forestland (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,

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

Forested Area/Nonforest with Tree Area	
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
Nonforested with Tree Providing Conservation Value	423,098
Urban/Community Forest	470,000
TOTAL AREA WITH FOREST / TREES	3,292,890

Figure 26. Top 10 Species by Groups on Forestland

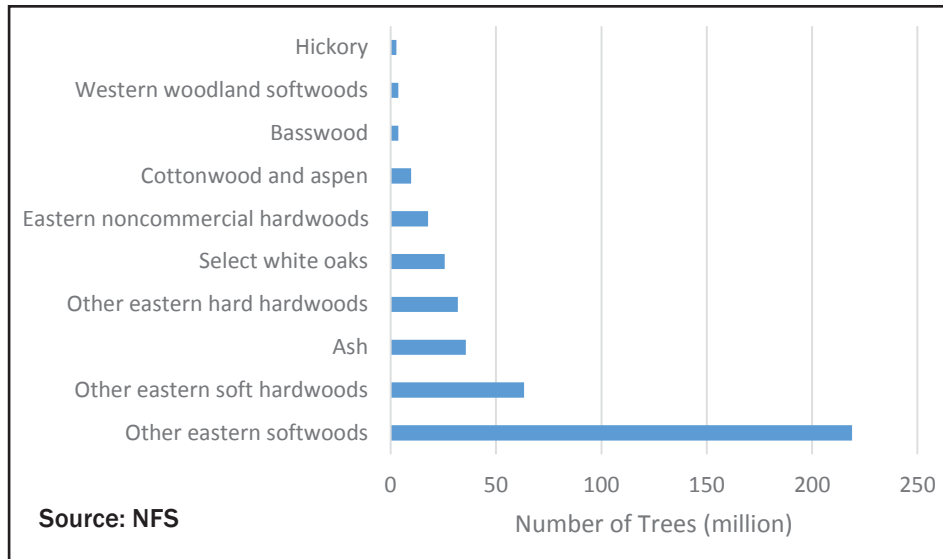
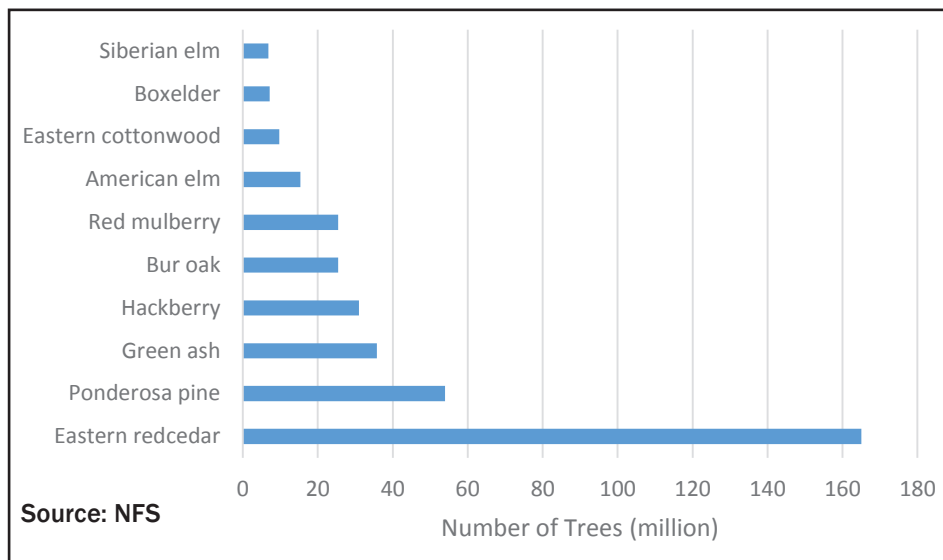


Figure 27. Top 10 Species by Groups on Nonforestland



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 non-forestland

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 1,041 forest stewardship plans placing 151,115 acres of private forest lands under management (NFS, 2015).

Figure 28. Distribution of Forestland by Ownership Class

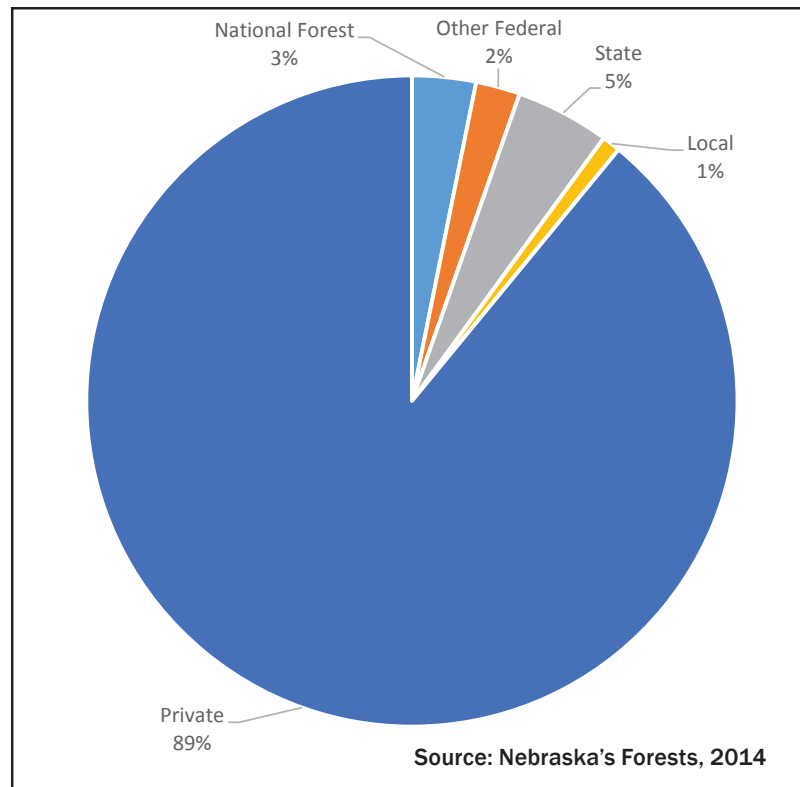


Table 8. Acres of Nebraska's Rural Nonforestedland With Trees*

MAJOR CATEGORY	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 benefits (windbreaks, wildlife planting, etc.)	254,833
Areas of natural and/or native tree units with minimal management evident yet still providing primary function, services or benefits (narrow wooded strips, natural wooded riparian buffers, etc.)	168,265
TOTAL	1,535,975

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

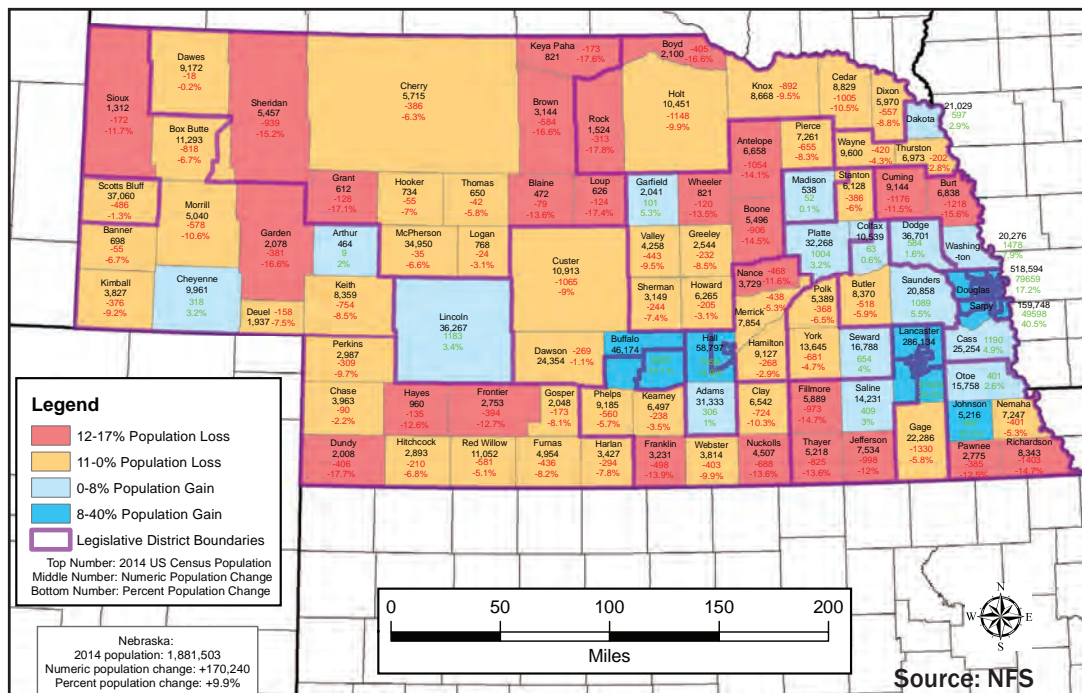
Source: Great Plains Initiative Inventory, 2008-2009

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
Ponderosa pine	851,738	499,411	352,327
Pine spp.	167,548	147,793	19,755
Scotch pine	73,067	20,887	52,180
Other conifer trees (fir, hemlock, baldcypress, etc.)	42,178	0	42,178
Siberian elm	17,301,813	15,619,792	1,682,021
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	10808630	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	298,280
Russian olive	3,702,206	3,700,401	1,805
Honey locust spp.	3,649,989	3,405,525	244,464
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	221,120
White oak family (bur oak)	783,280	608,096	175,184
White oak family (bur oak)	717,082	252,690	464,392
Other hardwood trees (hard maples, basswood, fruit trees, red oak family, birch, Kentucky coffee tree, etc.)	6,491,168	4,531,291	1,959,877
ALL RECORDED TOTAL	119,220,904	106,161,866	13,059,038

Source: Great Plains Initiative Inventory, 2008-2009

Figure 29. Estimated Population Change of Nebraska Counties, 2004-2014



PRIORITY FOREST LANDSCAPE: CONSERVATION FORESTRY 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 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 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's Bessey Nursery near Halsey.

Since 2002 the Conservation Trees for Nebraska program has been coordinated by the Nebraska Association of Resources Districts (NARD),

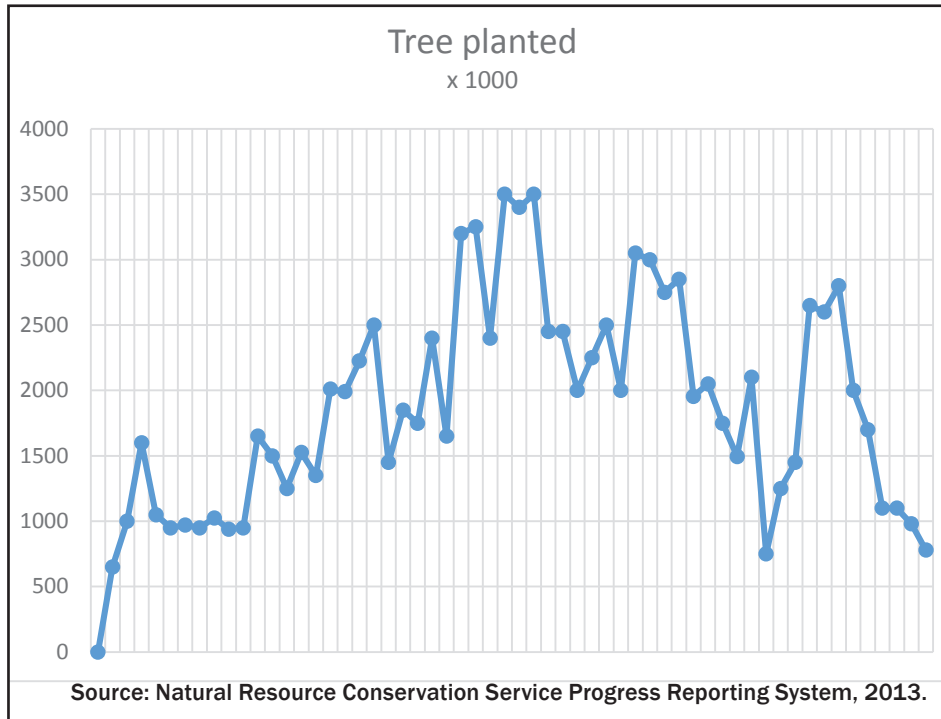
with each Natural Resource District (NRD) administering their local tree program. About 1 million conservation tree/shrub seedlings are distributed by Nebraska's 23 NRDs each year. Annual conservation tree/shrub seedling sales in the state have declined from a peak of more than 3 million in the 1980s to about 1 million from 2005 through 2009 (Figure 30). The decline can be attributed to a combination of factors: 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.

- 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.

Figure 30. Conservation Trees Sold, 1926 - 2013



PRIORITY FOREST LANDSCAPE: COMMUNITY FORESTS

Urban and community forests are of immense 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 about 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 31). 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 32, 33).

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; and
- sequestering 50,706 tons of carbon/year; at a value of \$1 million removing 1,146 tons of total pollutants/year; at a value of \$8.4 million including 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); 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;

Figure 31. Statewide Community Forest Species

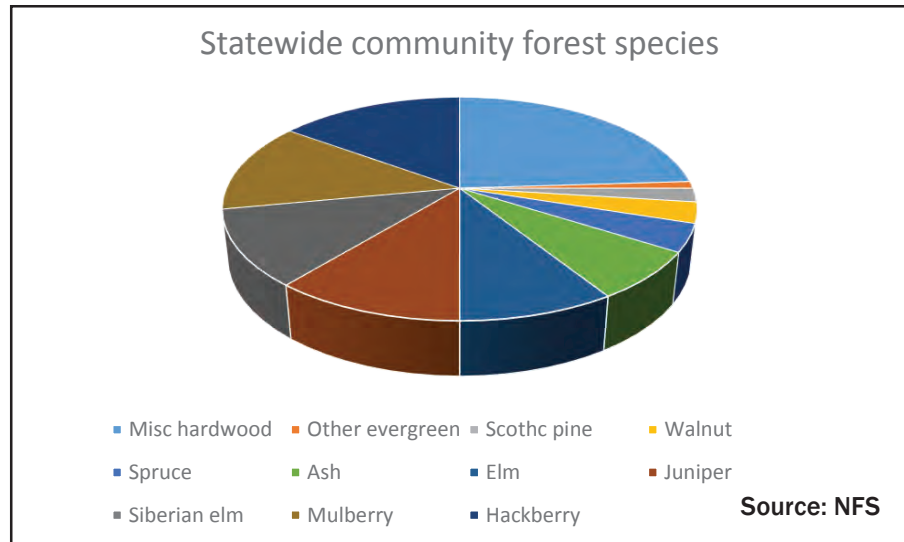


Figure 32. Omaha Community Forest by Species

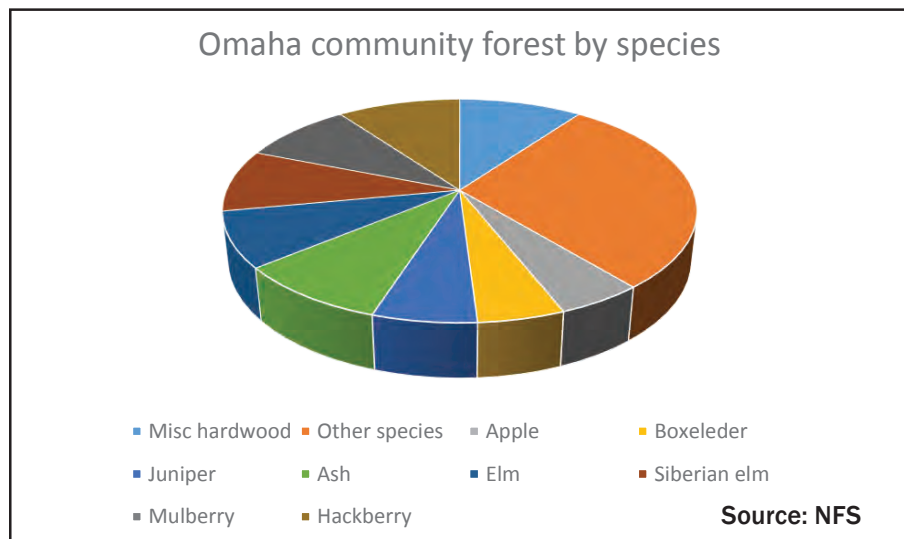


Figure 33. Lincoln Community Forest by Species

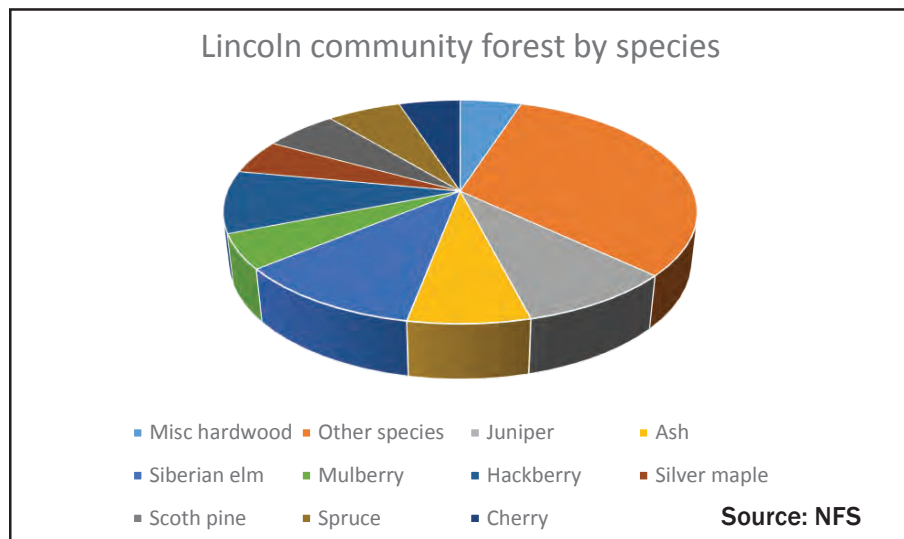


Table 10. Estimate of Nebraska's Nonforest Rural Areas with Trees 1 Inch or Larger

PLANTING TYPE	ACRES OF RURAL NONFOREST 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	25.56%
Living Snow fence		
Home Acreage Planting	12214	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	143707	35.22%
Narrow Wooded Strip	24,558	50.62%
TOTAL OF ALL AREAS OF NONFOREST ACRES WITH TREES 1" OR LARGER DBH	1,535,975	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

ACRE ESTIMATED OF TREES PROVIDING A PRIMARY FUNCTION, SERVICE OR BENEFIT AND THEIR CONDITION	ACRES OF WINDBREAK OR TREE UNIT (nonforest) ACRES WITH 1" DBH OR GREATER	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
TOTAL	413,207	232,304	180,902

Source: Great Plains Inventory, 2008-2009

Table 12. Conservation Practices Implemented in Nebraska (2004-20015)

Year	Firebreak (ft)	Forest Stand Improvement (acres)	Riparian Buffer (acres)	Tree/shrub Establishment (acres)	Windbreak Establishment (feet)
2004	13,794	502	464	327	3,136,042
2005	85,772	-	392	264	2,536,577
2006	3,125	-	132	476	1,804,460
2007	-	165	240	1,689	1,383,130
2008	56,451	-	74	6,735	1,024,260
2009	44,473	430	46	579	697,203
2010	266,374	1,704	-	57	748,424
2011	446,177	1,487	5	2,965	2,024,282
2012	2,314,179	1,394	1	1,052	1,796,231
2013	1,010,705	428	51	114	711,457
2014	709,648	1,815	23	402	1,013,557
2015	571,103	641	16	334	749,129
TOTAL	5,521,801	8,566	1,444	14,994	17,624,752

Source: Natural Resources Conservation Service Progress Reporting, 2015.



- increased property values;
- provision of wildlife habitat;
- improved aesthetics; and
- improved community cohesion.

There are 530 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 with 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 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.

Table 13. Nebraska Municipal Classifications

COMMUNITY TYPE	COMMUNITY SIZE	NUMBER OF COMMUNITIES
Metro	300,000+	1
Primary	100,001-299,999	1
First Class	5,001-100,000	30
Second Class	801-5,000	116
Village	100-800	382
TOTAL		530

Source: Nebraska League of Municipalities, 2015.

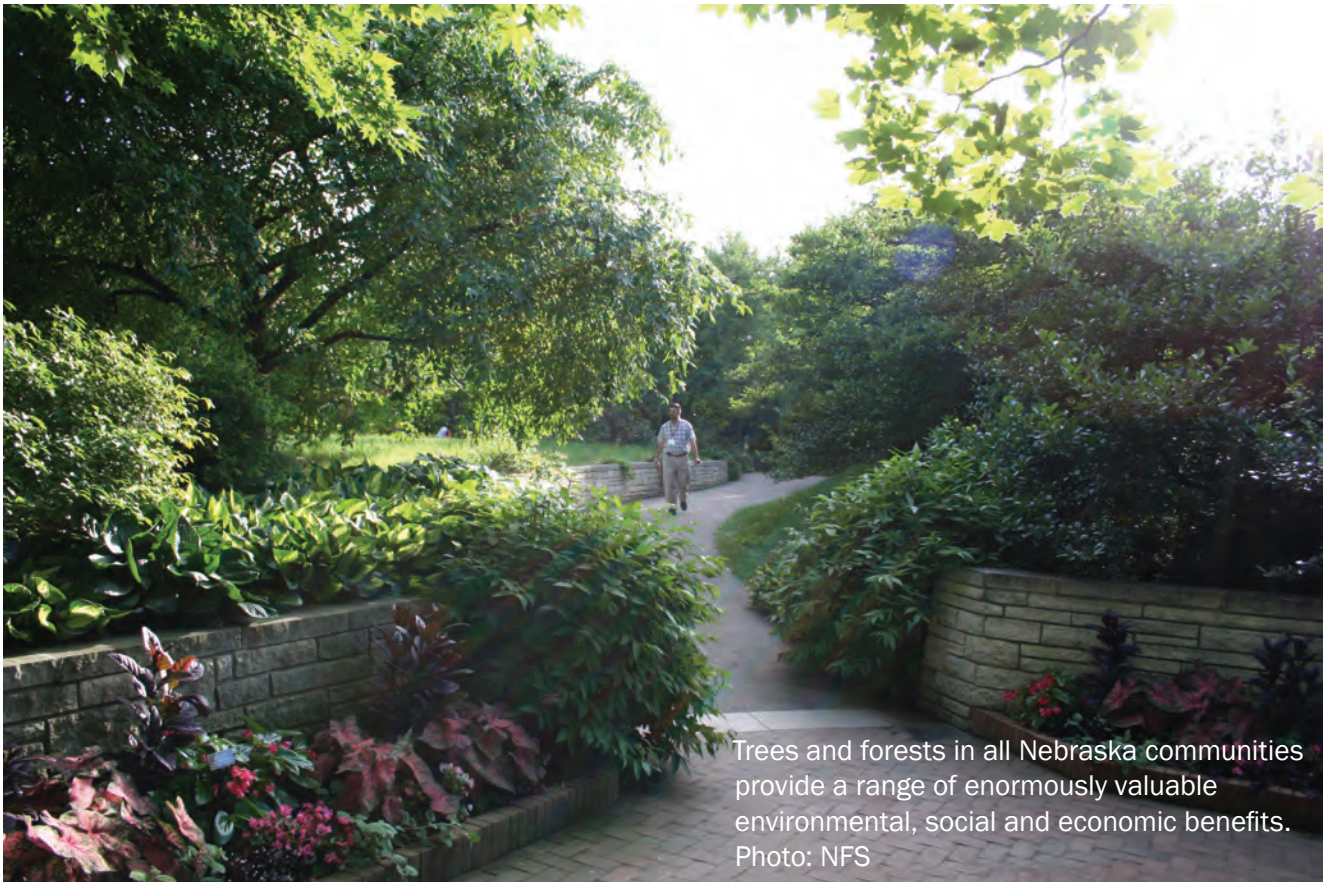


Table 14. Summary of Nebraska's Community Trees

FEATURE	MEASURE
Number of trees	13,317,398
Tree Cover	11.3%
Most Common Species	Hackberry, mulberry, Siberian elm, juniper, elm, ash
Percent of tree over 6" DBH	23.0%
Carbon Storage (tons)	2,096,338
Carbon Value (\$)	\$ 39,830,000
Carbon Sequestration (tons/year)	84,527
Carbon Sequestration (\$/year)	\$ 1,606,000
TOTAL ENVIRONMENTAL, SOCIAL & ECONOMIC BENEFITS	\$9.7 billion

Source: NFS

In 2010, NFS inventories and calculations using UFORE (Urban Forest Effects Model) estimated that there were about 13.3 million trees in Nebraska communities. 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 (Table 14).

A 2010 UFORE analysis of Lincoln and Omaha, which collectively represent approximately 40% 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 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 resources face additional threats. Various 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 cause \$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 cause \$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 still has the potential to cause \$423 million in losses in structural value to the state's native elm population with \$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 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 34-37).

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).

Figure 34. Value of Nebraska's Community Trees

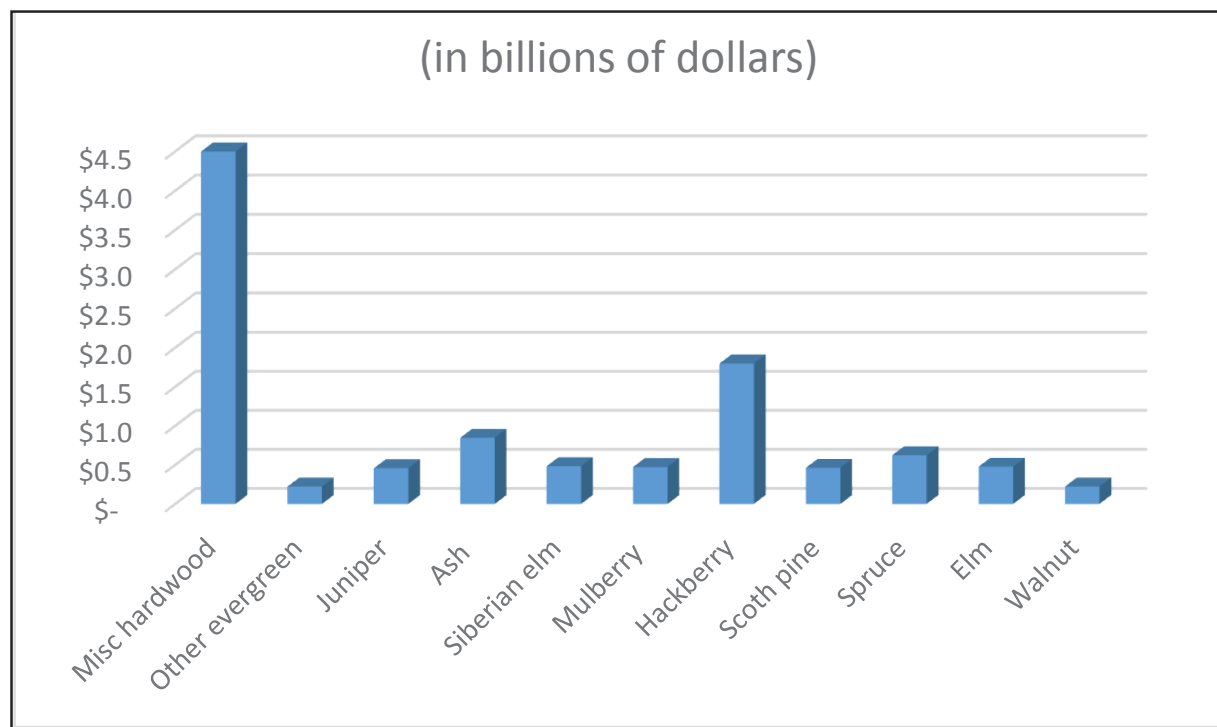


Table 15. Lincoln & Omaha Forest Resource Summary

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, eastern red cedar, Scotch pine & ash	Mixed hardwood, hackberry, Siberian, ash & mulberry	
Percent of tree over 9" DBH	65.0%	78.0%	72.0%
Carbon Storage (tons)	320,972	689,084	1,010,056
Carbon Value (\$)	\$ 6,400,000	\$ 13,700,000	\$ 20,100,000
Carbon Sequestration (tons/year)	12,347	25,015	37,362
Carbon Sequestration (\$/year)	\$ 246,940	\$ 500,300	\$ 747,240
Structural Value (\$)	1,426,151,669	2,553,650,935	3.98 billion

Source: NFS

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

Area	Number of Ash Trees	Structural Value	Removal Cost	Replacement Cost	Total Cost (indirect and direct)
Lincoln	108,145	\$ 89,000,000	\$ 64,000,000	\$ 32,000,000	\$ 185,000,000
Omaha	359,316	\$ 192,000,000	\$ 215,000,000	\$ 107,000,000	\$ 514,000,000
Statewide	986,474	\$ 823,000,000	\$ 591,000,000	\$ 295,000,000	\$1.7 billion

Source: NFS

- 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.

Figure 35. Potential Insect & Disease Impacts on Nebraska's Urban & Community Forest Resources

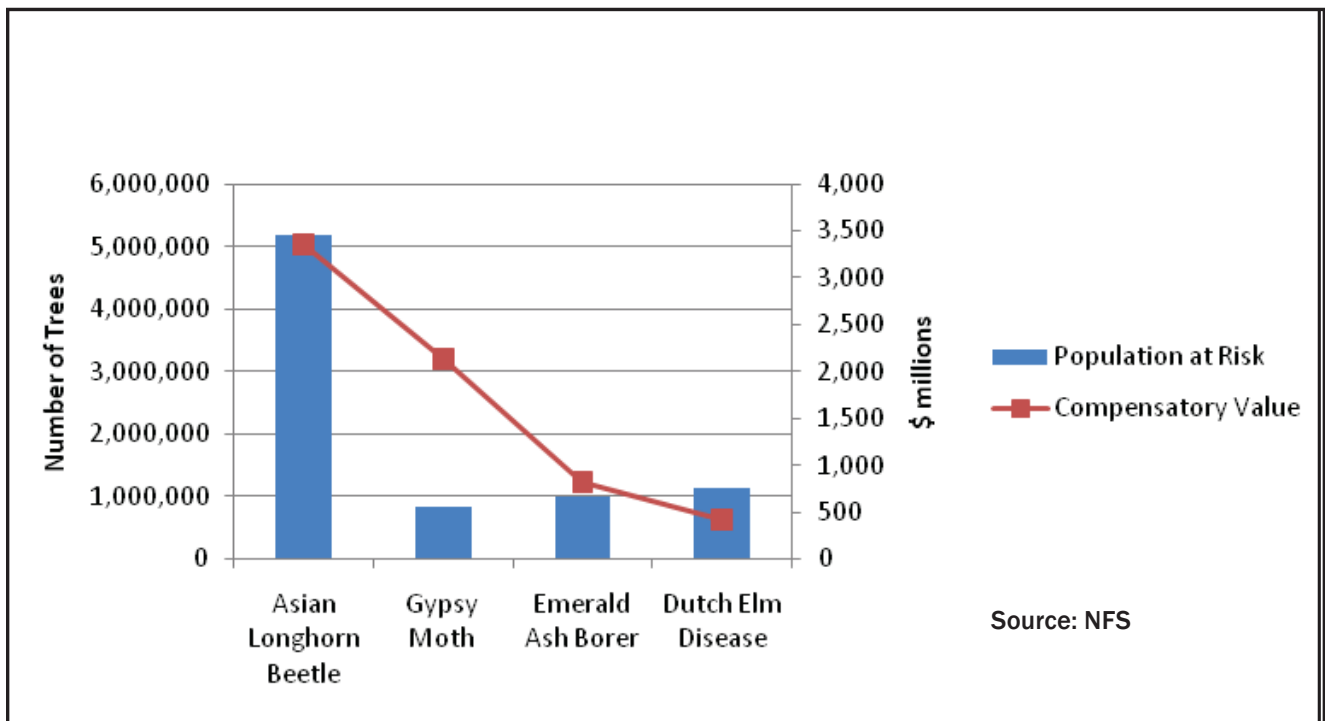


Figure 36. Potential Insect & Disease Impacts on Omaha's Urban & Community Forest Resources

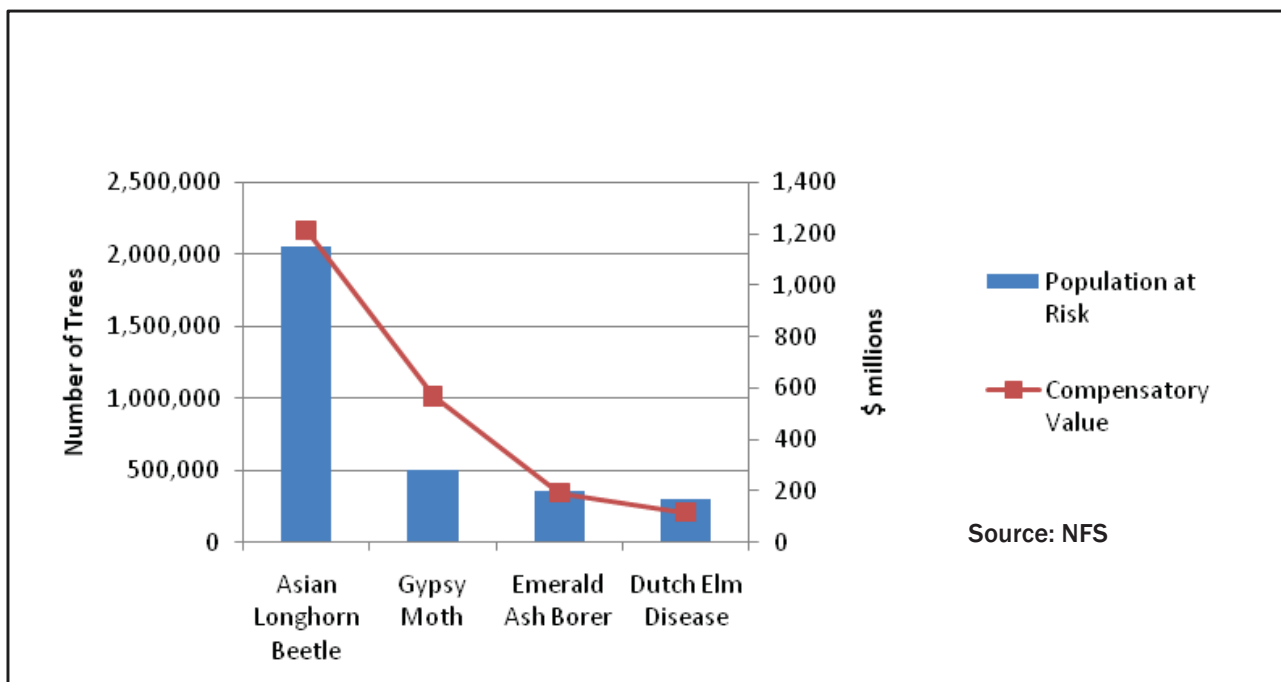
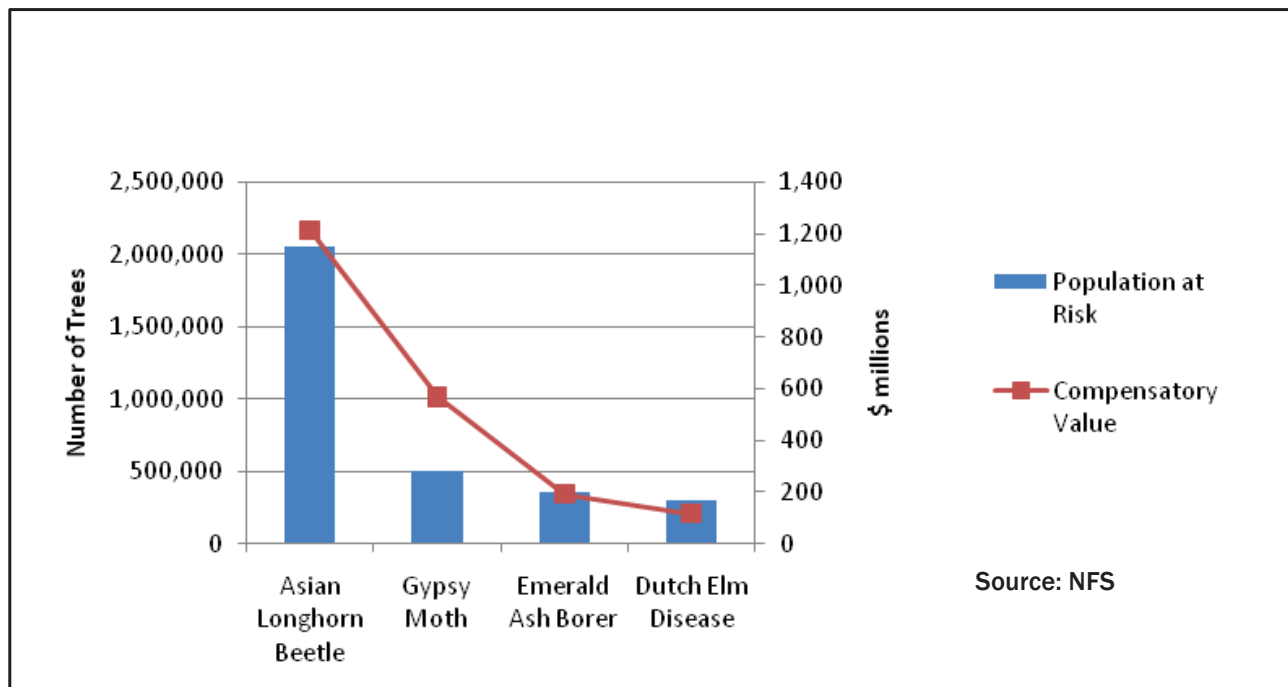


Figure 37. Potential Insect & Disease Impact's on Lincoln's Urban & Community Forest Resources



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.

CONIFEROUS FORESTS

Nebraska's coniferous forests are largely composed of three species:

- Ponderosa pine (*Pinus ponderosa*),
- 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.

Priority Forest Landscape: Pine Ridge

The Pine Ridge is a rocky precipice rising several hundred feet from the surrounding plains in Sioux, Dawes and Sheridan counties in northwest Nebraska. Ponderosa pine woodlands (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.

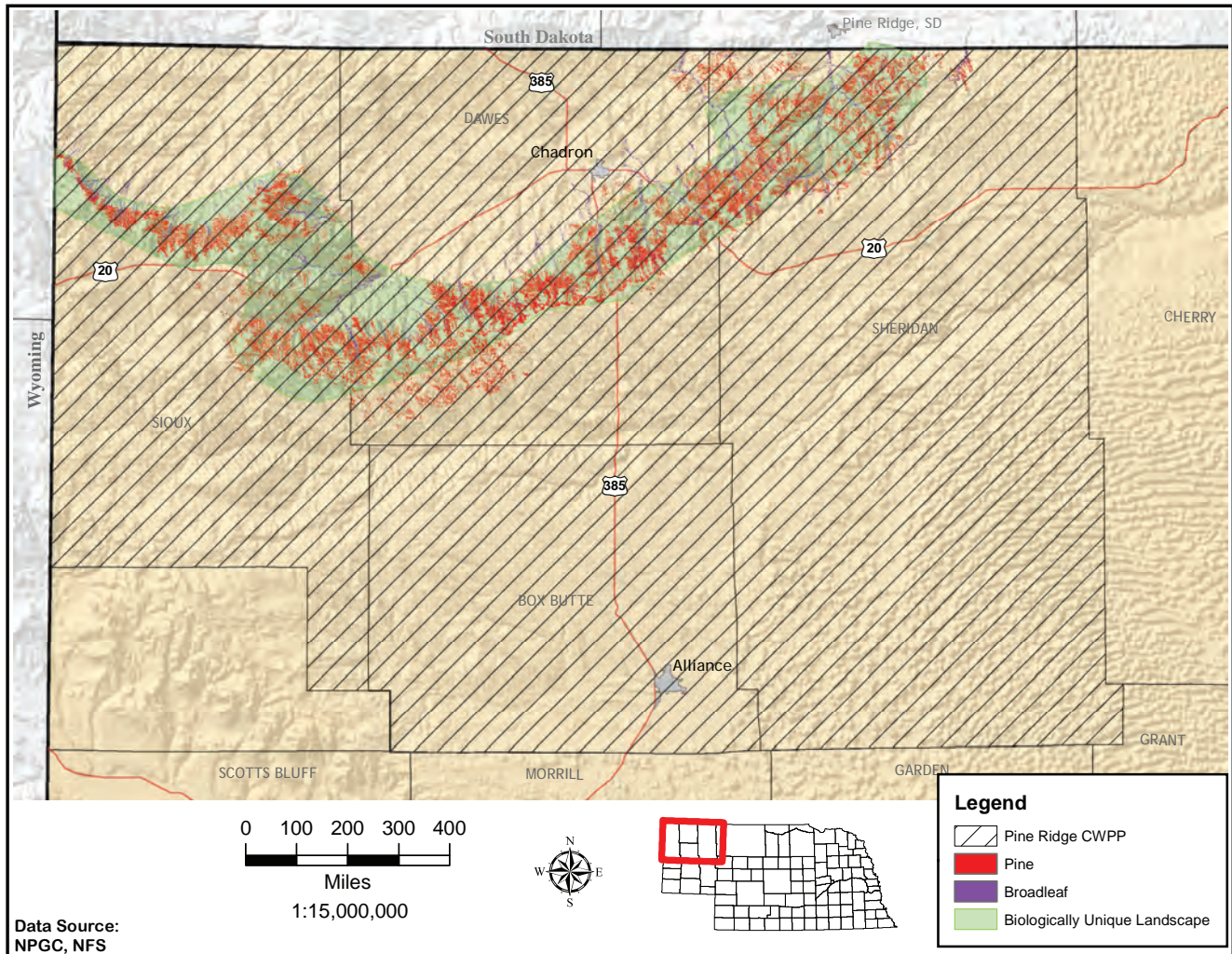
The Pine Ridge is a pine-dominated escarpment within the grassland-dominated Great Plains. It supports many at-risk species at the edge of their range, including two of the state's three populations of Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*).

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



Photo: NFS

Figure 38. Priority Forest Landscape: Plne Ridge





Critical Issues:

Loss of an estimated 74,000 acres of ponderosa pine woodlands and forest in the past 10 years due to catastrophic wildfire (NFS 2015).

- Increasing risk of catastrophic wildfire due to very high and growing fuel loads, chronic drought and severe weather.
- Increasing development and fragmentation of forest and woodlands.
- High concentration of green ash (susceptible to EAB).

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 Scottsbluff, Banner and Morrill counties, and extends into portions of Kimball and Cheyenne counties. 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.

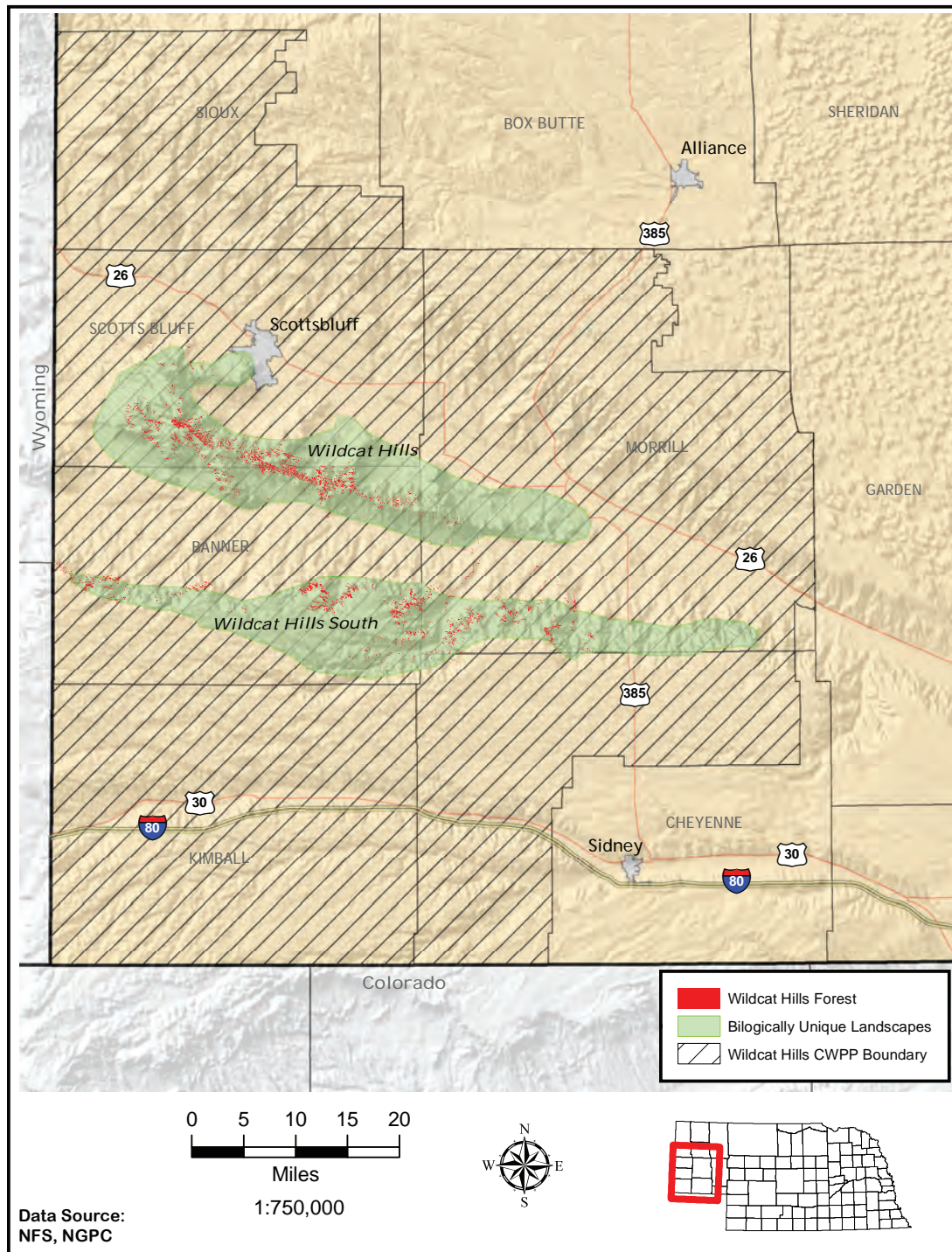
The Wildcat Hills also support one of three Rocky Mountain bighorn sheep populations in the state. Protected lands within the Wildcat Hills include Wildcat Hills State Recreation and Wildlife Management Area, Buffalo Creek Wildlife Management Area, Cedar Canyon Wildlife Management Area, Platte River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

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

Critical Issues:

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

Figure 39. Priority Forest Landscape: Wildcat Hills



Priority Forest Landscape: Loess Canyons

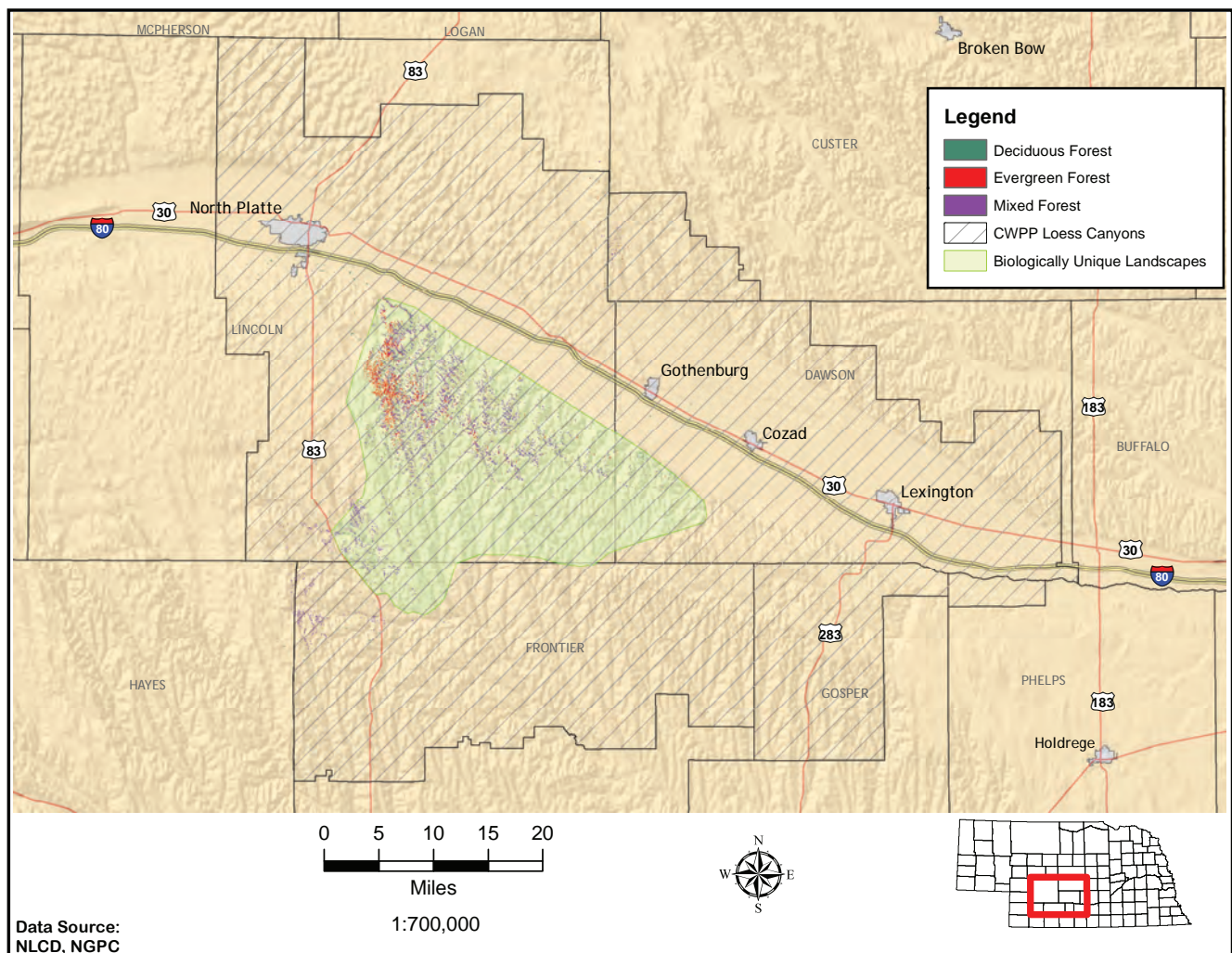
The Loess Canyons consist of steep loess hills and canyons south of the Platte River in Lincoln, Dawson and northern Frontier counties in west central Nebraska. These hills support mixed-grass prairie and are used primarily as rangeland, though scattered crop fields occur. The mixed-grass prairies have been heavily invaded by eastern redcedar in recent decades. This cedar resource shows potential to become a valuable source of 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.

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 development and fragmentation of forest and woodlands.

Figure 40. Priority Forest Landscape: Loess Canyons





TRANSITIONAL MIXED FOREST

Priority Forest Landscape: Niobrara River Valley

The Niobrara River begins in the high plains of eastern Wyoming and flows 535 miles to the Missouri River in northeast Nebraska. 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.

NGPC designated the following BULs within the Niobrara Valley: Lower Niobrara River, Middle Niobrara River and Upper Niobrara River.

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 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 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*).

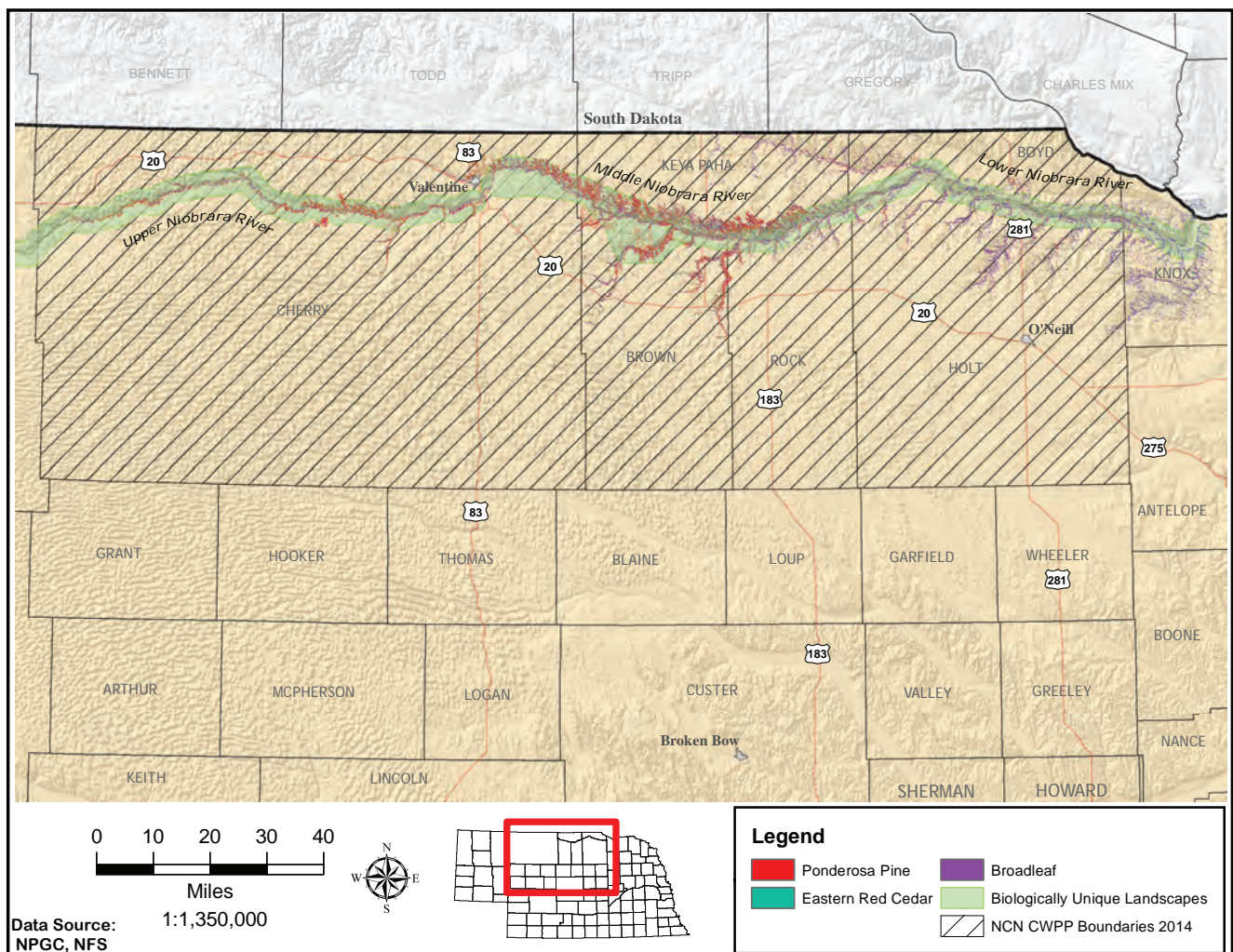
Protected areas on the upper Niobrara include Agate Fossil Beds National Monument, The Nature Conservancy's Cherry Ranch and Prairie Plains Resource Institute's Guadalcanal Memorial Prairie.

This area also was identified as a priority under Nebraska's Forest Legacy Program, and a CWPP is in place for a portion of this area.

Critical Issues:

- Increasing risk of catastrophic wildfire due to very high and growing fuel loads and chronic drought.
- Increasing development and fragmentation of forest and woodlands.
- 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.

Figure 41. Priority Forest Landscape: Niobrara Valley





Priority Forest Landscape: Central Loess Hills

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. 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 relic ponderosa pines, mixed-grass prairie and cropland. The flatter tablelands of this landscape contain playa wetlands that are used by whooping cranes during migration.

NGPC designated the Central Loess Hills as a BUL in its 2005 Natural Legacy Project.

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 development and fragmentation of forest and woodlands.

Figure 42. Priority Forest Landscape: Central Loess Hills





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. 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.

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, 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.

Priority Forest Landscape: Missouri River

The Missouri River extends along the eastern edge of Nebraska from the Nebraska/Kansas border to the Nebraska/South Dakota border. 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 dioica*), 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.

There are 11 state-listed species that occur within the Missouri River corridor, six of which are also federally listed. The majority of the floodplain's riparian forests have been converted to cropland. 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. This area was also designated as a priority under Nebraska's Forest Legacy Program.

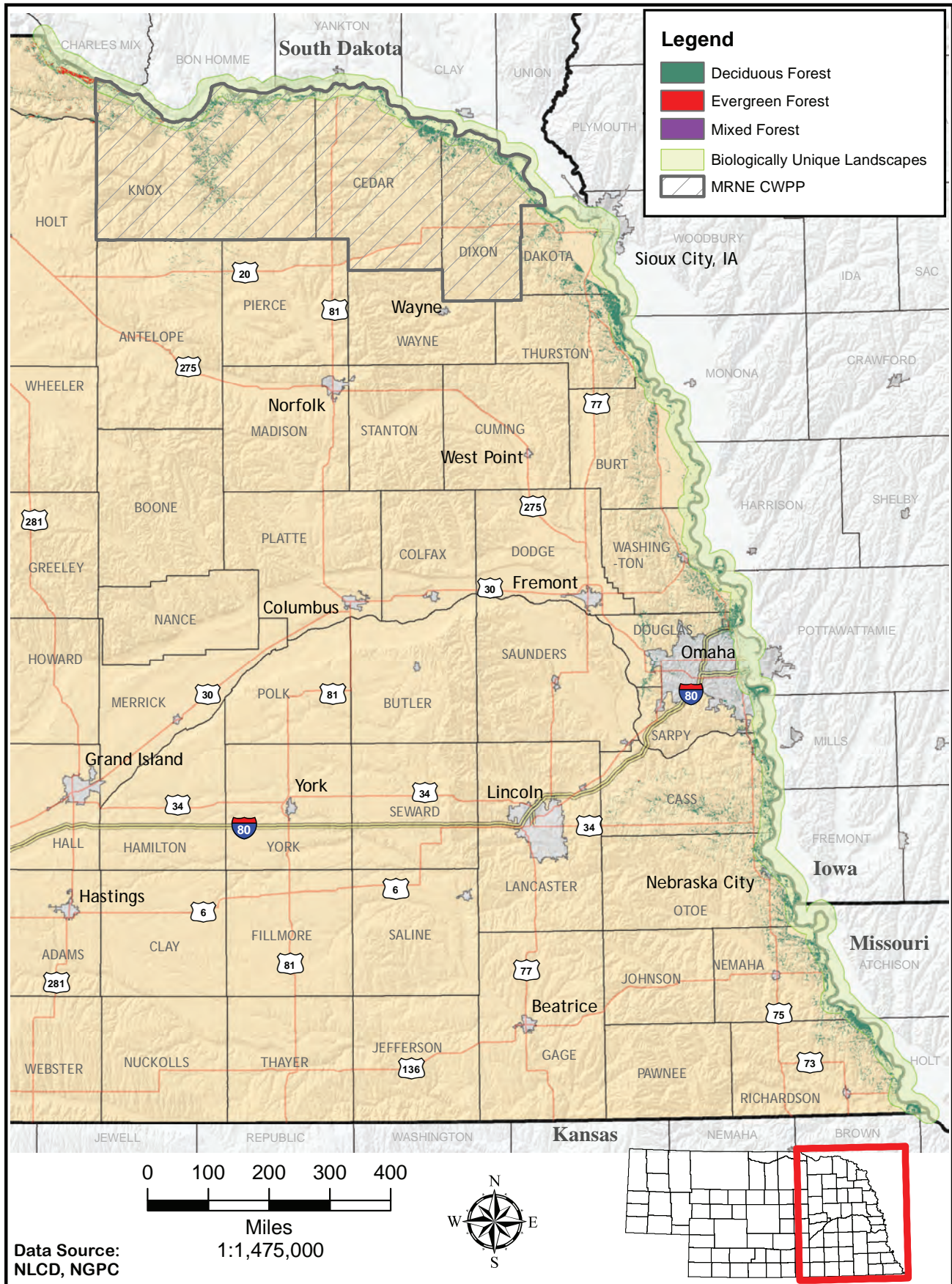
Critical Issues:

- 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 affecting 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 development and fragmentation of forest and woodlands.
- High concentration of green ash and black walnut at risk to EAB and thousand cankers disease, respectively.

Figure 43. Priority Forest Landscape: Missouri River



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. 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.

Critical Issues:

- High concentration of green ash and black walnut, at risk to EAB and thousand cankers disease, respectively.

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

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

Critical Issues:

- High concentration of green ash and black walnut, at risk to EAB and thousand cankers disease, respectively.

Figure 44. Priority Forest Landscape: Nemaha River

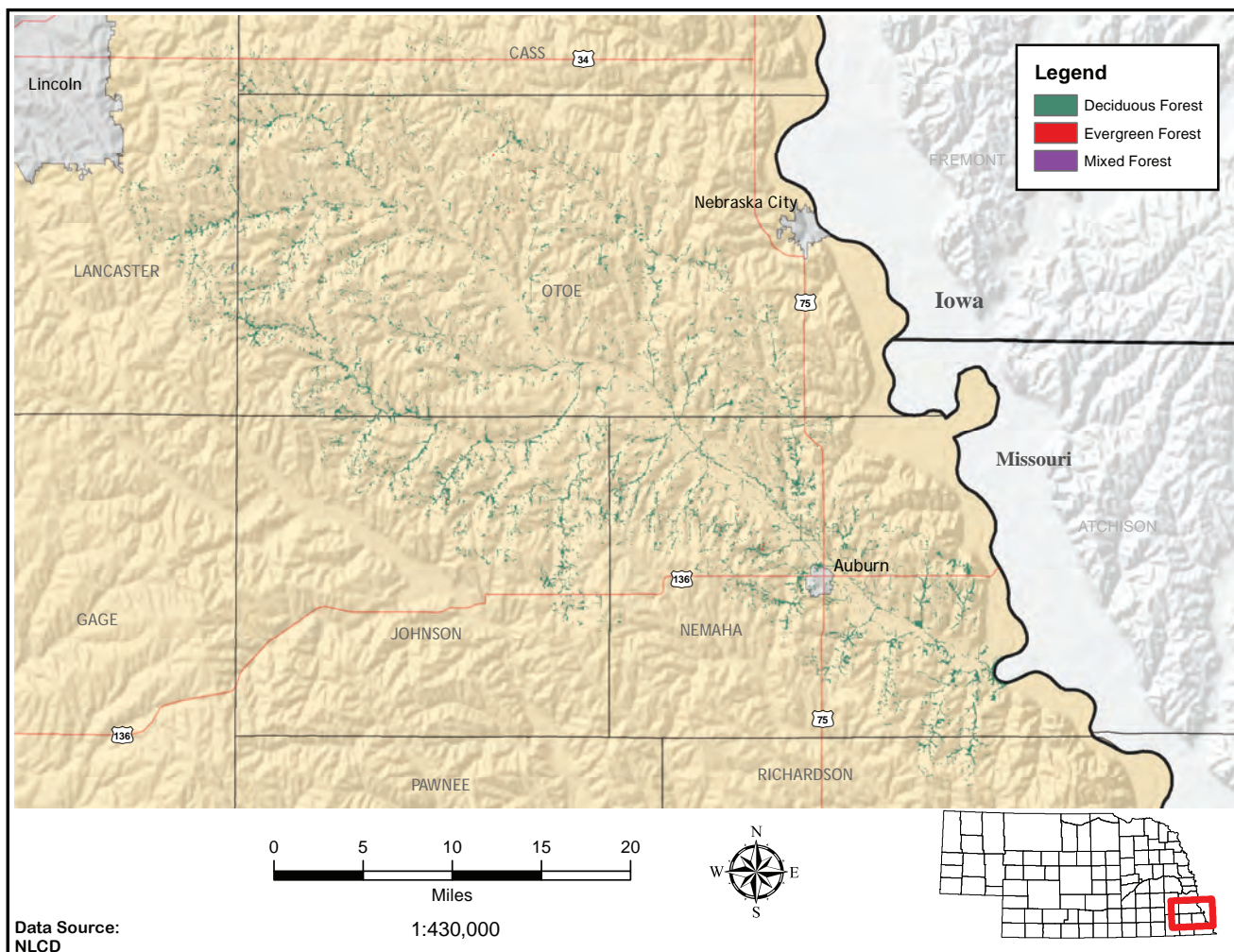


Figure 45. Priority Forest Landscape: Big Blue River

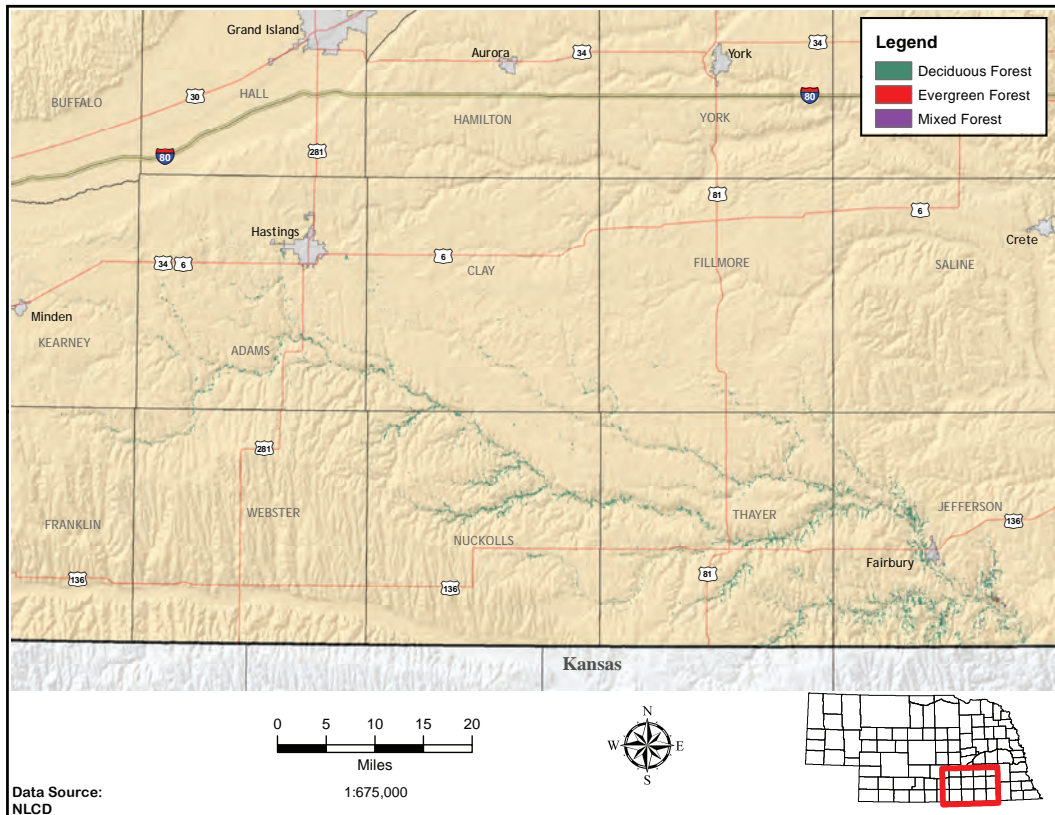
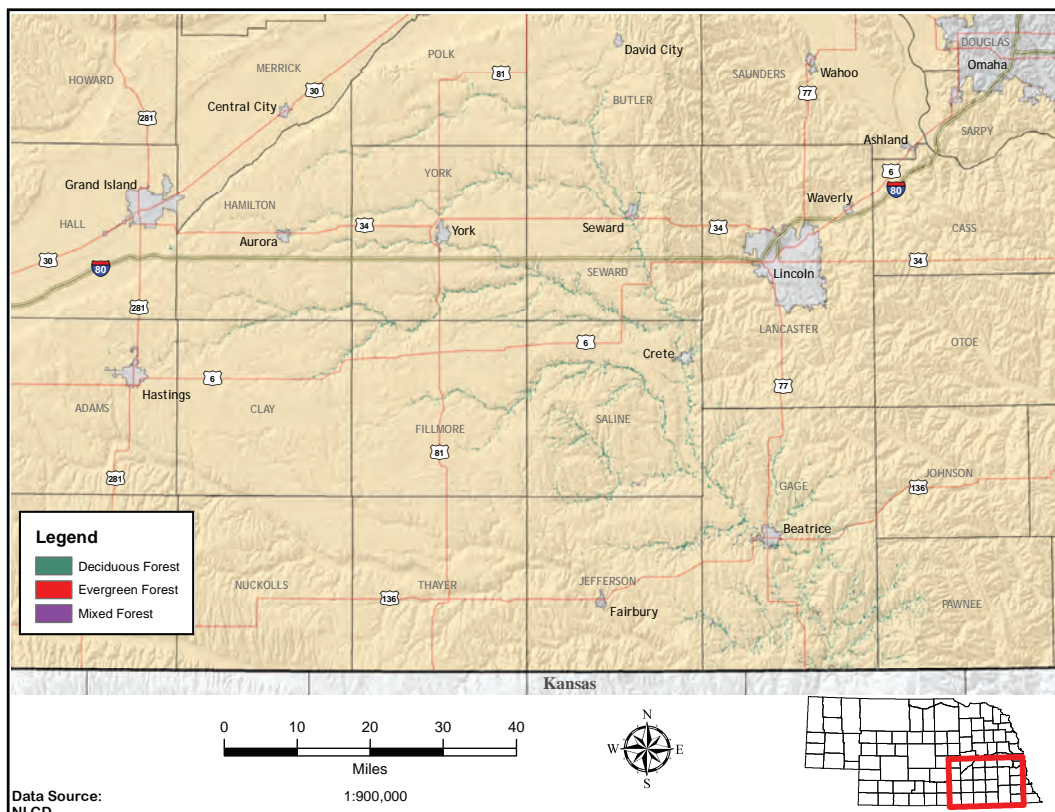


Figure 46. Priority Forest Landscape: Little Blue River





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

Priority Forest Landscape: Platte River

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.

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. Because the river no longer floods, native cottonwood stands established in scouring floods many years ago are over-mature, 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.

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*).

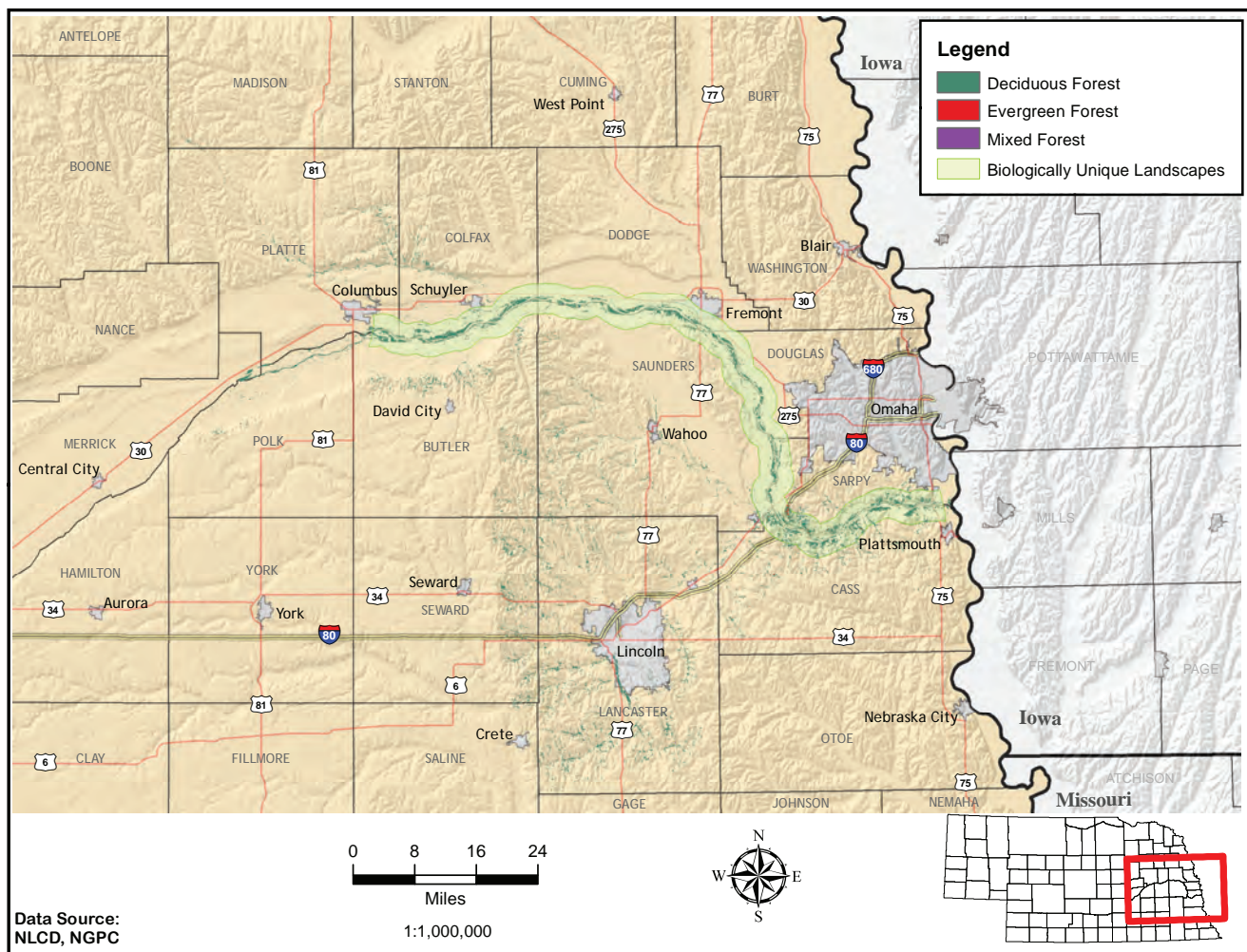
Protected areas along this reach of the Platte River include Two Rivers State Recreation Area, Louisville State Recreation Area, Platte River State Park and Mahoney State Park.

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 non-woody invasives (phragmites, purple loosestrife).
- High wildlife values for uncommon and/or migratory bird species.
- Increasing development and fragmentation of forest and woodlands.
- High concentration of green ash and black walnut, at risk to EAB and thousand cankers disease, respectively.

Figure 47. Priority Forest Landscape: Eastern (Lower) Platte River



Central Platte River

The central Platte River includes the Platte River channel and floodplain from central Dawson County eastward to central Hamilton County. 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.

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. Roosts numbering in the tens of thousands are scattered throughout the Platte River. The shortage of wet meadows in spring staging areas on the Platte River is considered to be a potential threat to the mid-continental 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.

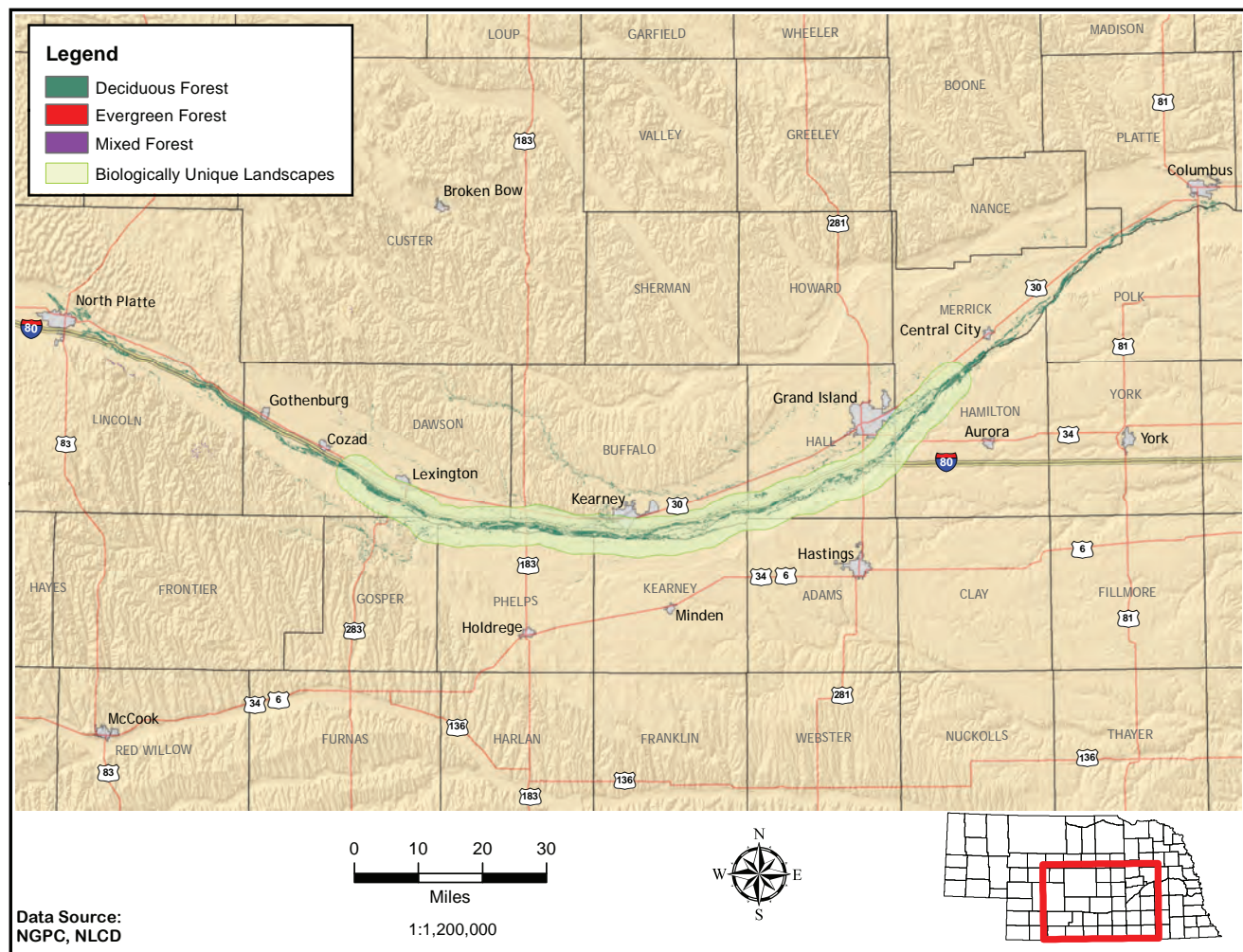
In addition to Sandhill cranes, millions of geese, ducks and other waterfowl, and a variety of shorebirds use this stretch of the river. Five federal and/or state-listed species occur along the Central Platte: whooping crane, interior least tern, piping plover, bald eagle and river otter (*Lutra canadensis*). 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 non-woody invasives (*phragmites*, *purple loosestrife*).
- High wildlife values for uncommon and/or migratory bird species.
- High concentration of green ash at risk to EAB.

Figure 48. Priority Forest Landscape: Central Platte River



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. Russian olive, phragmites, saltcedar and eastern redcedar have colonized the floodplain woodlands and meadows.

Both the North Platte and South Platte rivers in this reach are shallow streams with braided, mostly wooded channels. 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*).

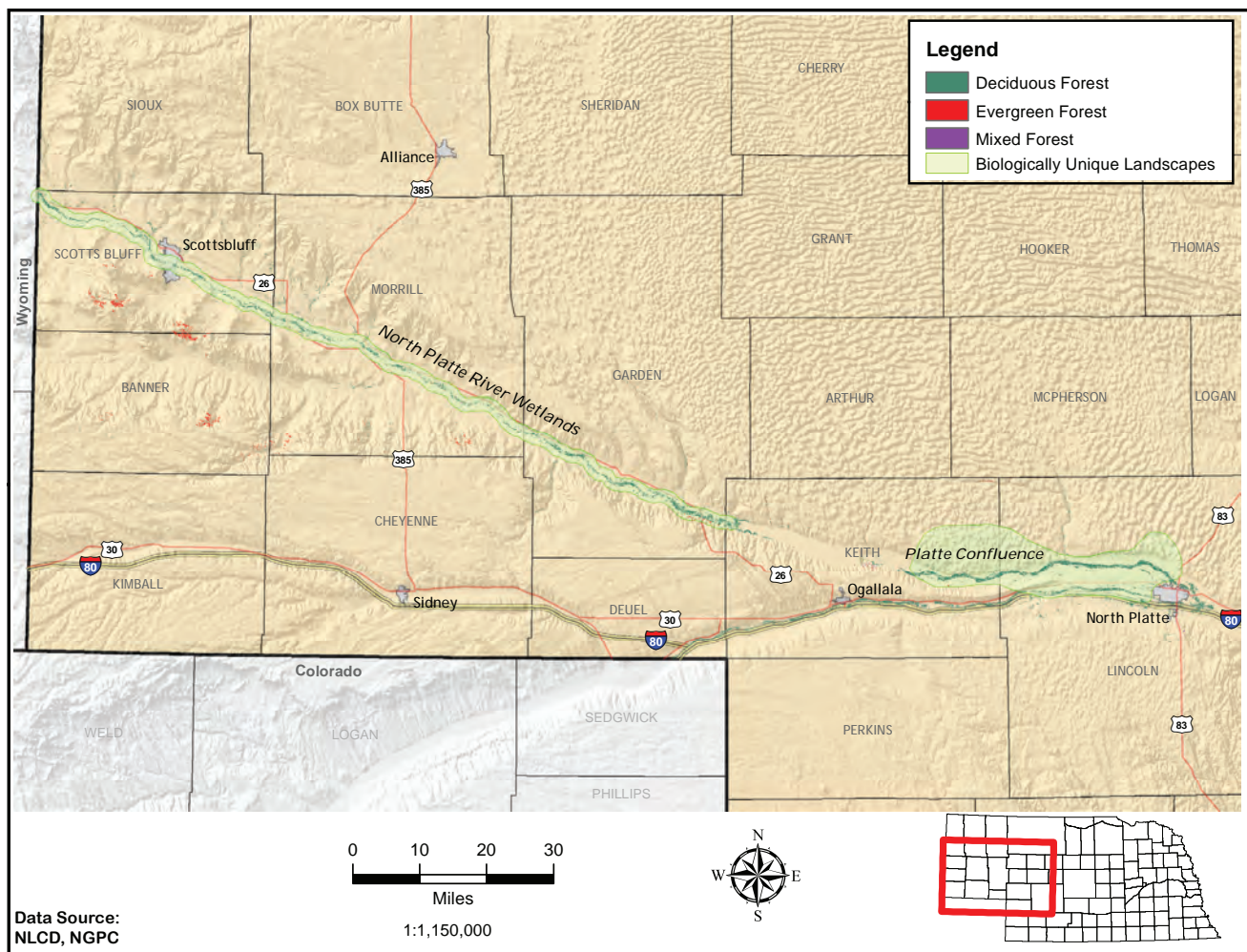
NGPC designated several BULs along the Platte River as part of the 2005 Nebraska Natural Legacy Project: Lower Platte River, Central Platte

River Platte Confluence and North Platte River Wetlands.

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 non-woody invasives (*phragmites*, *purple loosestrife*).
- High wildlife values for uncommon and/or migratory bird species.
- Increasing development and

Figure 49. Priority Forest Landscape: Western Platte River



fragmentation of forest and woodlands.

- High concentration of green ash at risk to EAB.

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. 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.

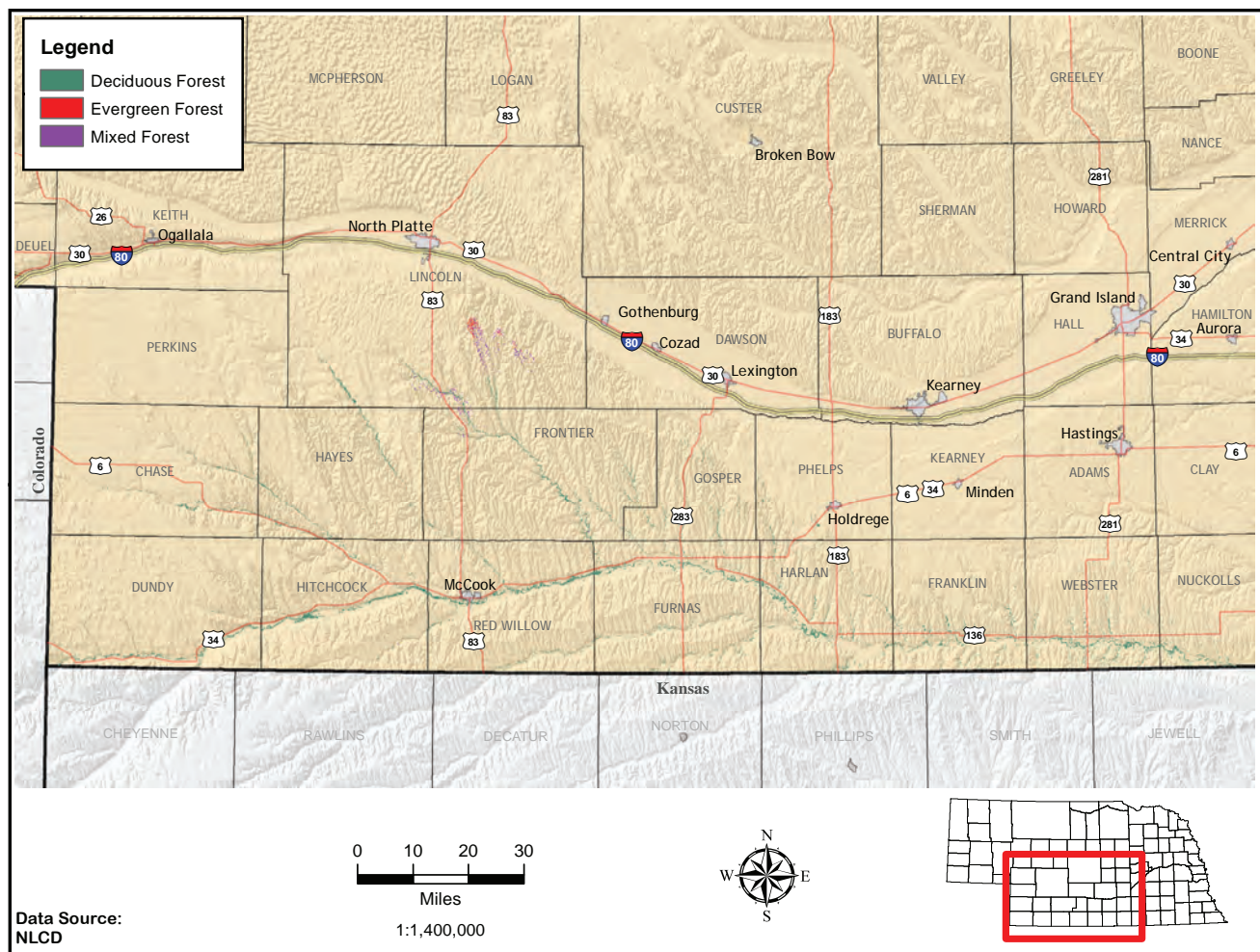
Riparian forests have experienced significant damage due to declining water tables in recent drought years. Over the past decade, most of

the eastern reaches of this river were invaded by phragmites, requiring massive control efforts to restore streamflows. 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.

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

Figure 50. Priority Forest Landscape: Republican River



migratory bird species.

- Increasing development and fragmentation of forest and woodlands.
- High concentration of green ash and black walnut, at risk to EAB and thousand cankers disease, respectively.

Priority Forest Landscape: Loup River

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.

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.

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 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 because 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

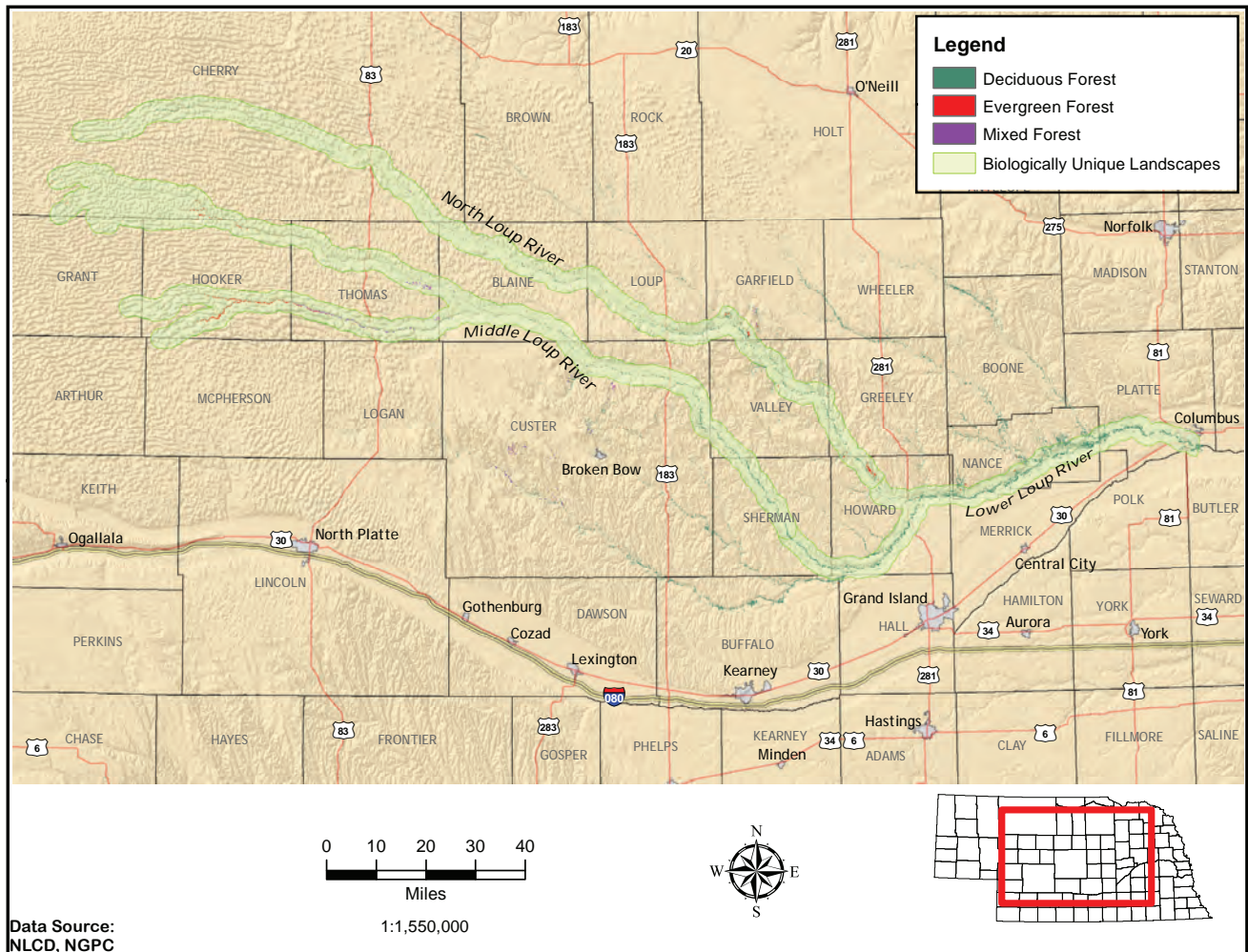
include portions of the Nebraska National Forest (Bessey District) and a few smaller wildlife management areas.

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.

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 development and fragmentation of forest and woodlands.
- High concentration of green ash and black walnut, at risk to EAB and thousand cankers disease, respectively.

Figure 51. Priority Forest Landscape: Loup River





Priority Forest Landscape: Elkhorn River

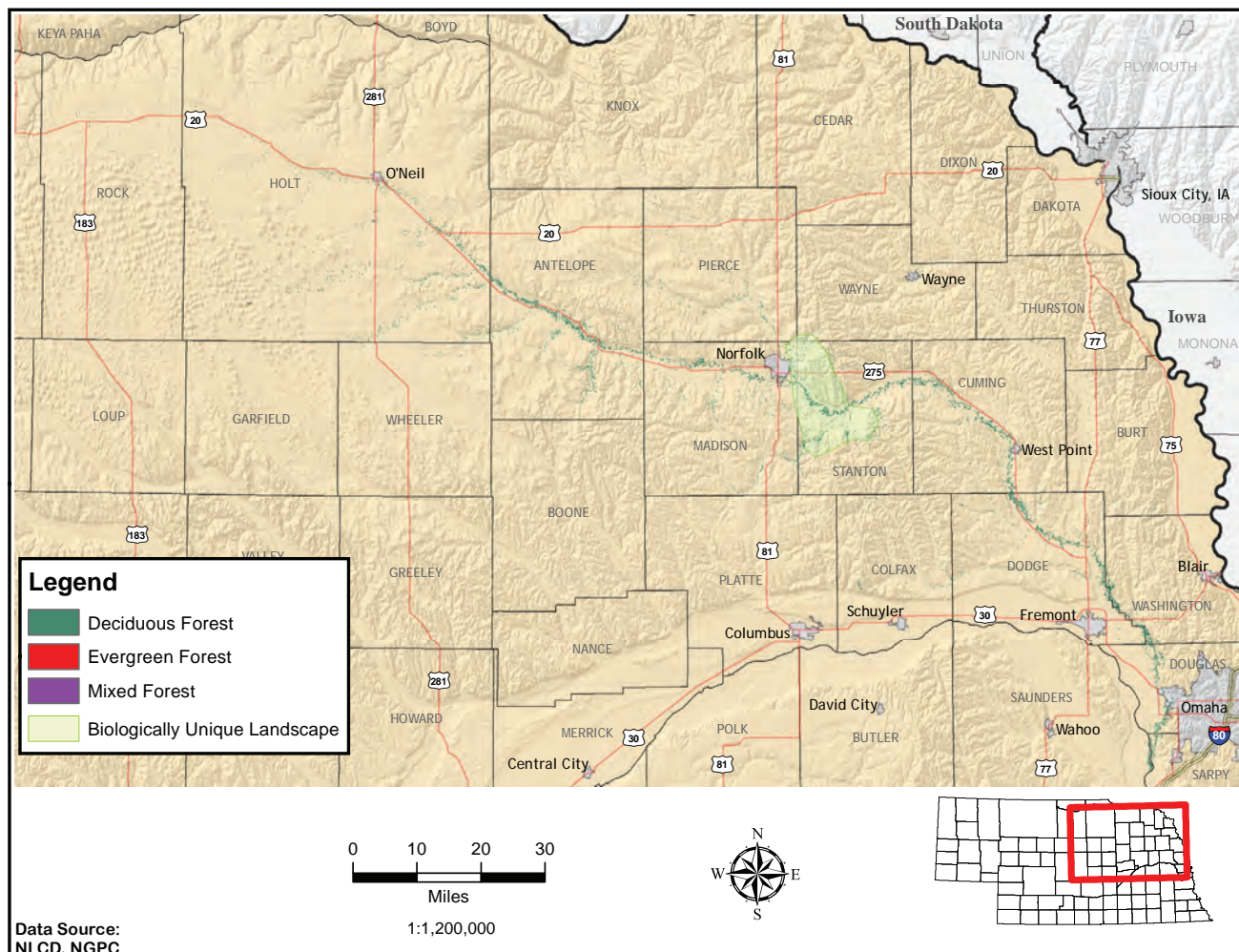
The Elkhorn River originates in north central Nebraska and meets the Platte River near Gretna. The Elkhorn River's floodplain is primarily cropland but also contains cottonwood dominated woodlands, wet meadows and freshwater marshes. The uplands on the south side of the river are composed of sand dunes originating from river alluvium. Dry-mesic sand prairie, mostly grazed, and bur oak woodlands occupy the dunes.

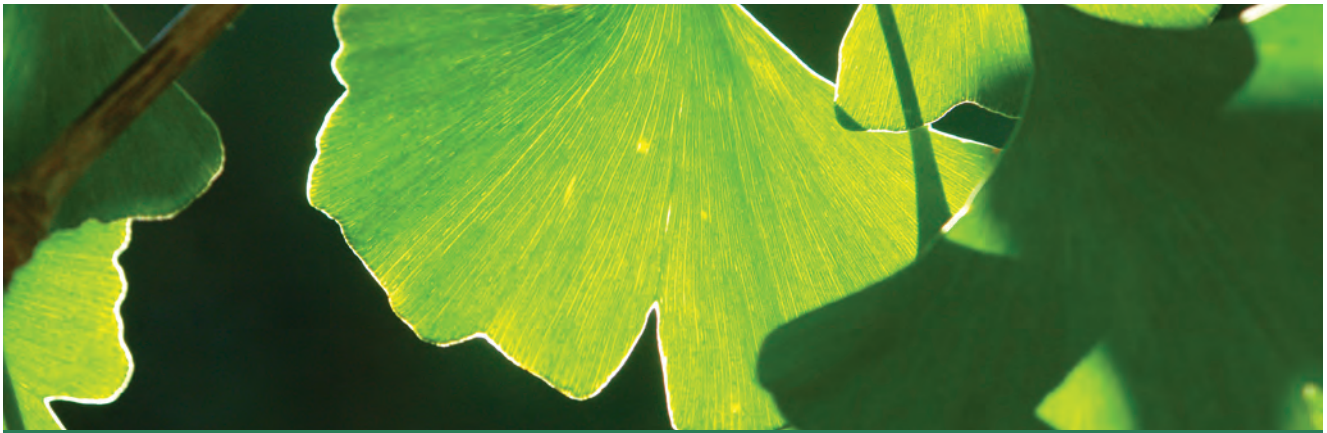
NGPC designated the Elkhorn Confluence a BUL in its 2005 Natural Legacy Project.

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 development and fragmentation of forest and woodlands.
- High concentration of green ash and black walnut, at risk to EAB and thousand cankers disease, respectively.

Figure 52 Priority Forest Landscape: Elkhorn River





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

Protecting, enhancing and using our tree and forest resources statewide is a large 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 NFS 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 (NNF), 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 had traditionally worked closely with NRCS field staff to implement forestry practices at the local level, this collaboration allowed 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 had 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 were funded 75% by NRCS and 25% by NFS, a unique arrangement existing in only two other states.

In 2008 and 2009 NRCS also designated substantial Environmental Quality Incentives Program (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 the Nebraska Association of Resource Districts (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, one NRD forester is funded under

cooperative agreements with the Lower Platte South NRD. In addition, two NFS district foresters, a forest fuel management specialist and a fire management specialist 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 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. It also 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 detection 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 longhorned 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 WMAs' boundaries.

NFS works with three WMAs (Northern Dawes County Cooperative Weed Control Project, Northern Sioux County Weed Control and Sandhills WMA) that manage lands next 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 APHIS's 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 increasing 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 2007, NFS has distributed more than \$1.8 million 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 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.

Since 2012, NFS directly provided almost 600 hours of training to more than 1,000 firefighters across the state. Financial, administrative and logistical assistance were leveraged via many interagency partners to provide training to an additional 1,500 firefighters through Nebraska State Fire School and the Les Lukert Winter Conference.

As Nebraska's only non-federal representative 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 Emergency Management Agency, Nebraska State Fire Marshal's Office, National Weather Service, National Park Service, Nebraska Game and Parks Commission, and local emergency managers and

fire departments, offers classes each spring.

Since 2009, 18 new courses have been provided that were previously available in Nebraska on a very limited basis. Plans for 2016 also include eight additional new courses.

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 were 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. In 2015, more than 700 pieces of equipment were on loan to the VFDs with an estimated replacement value in excess of \$67 million.

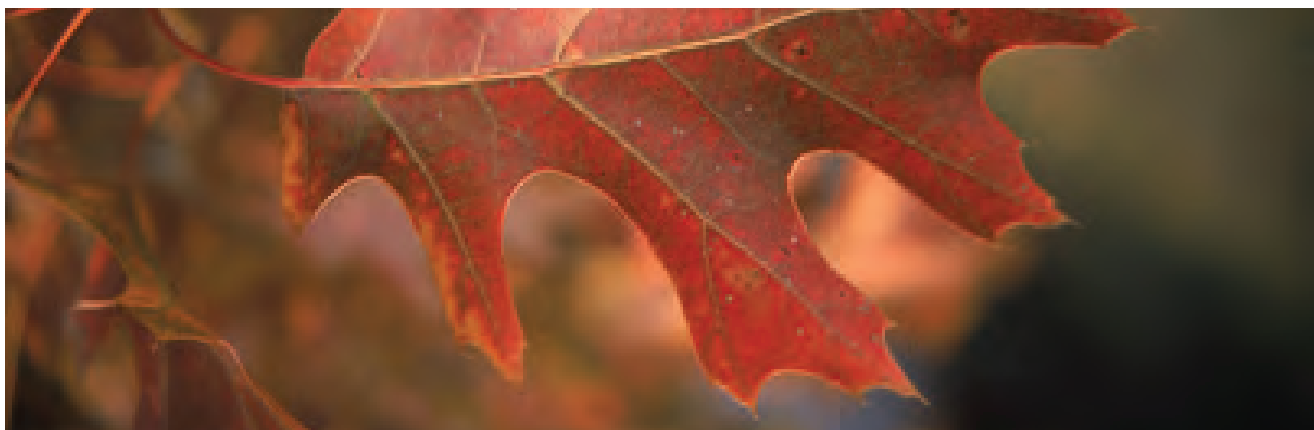
NFS is responsible for screening, retrieving, reconditioning, inventorying and assigning equipment obtained through these programs. This includes determining repairs and upgrades necessary to bring the equipment to current safety standards. Additional safety devices, such as back-up alarms, light bars, 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 and 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 Community Wildfire Protection Planning.

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. The plan 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.



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
- enhancing public benefits from trees and forests.

With more than 40 full-time employees, NFS is a small organization with large and important 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 enriches lives by protecting, enhancing and utilizing Nebraska’s tree and forest resources.

Vision: The Nebraska Forest Service is the leader in the state, inspiring and assisting others to create and sustain healthy, productive forests.

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 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 Nebraska's 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 while concurrently expanding 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 and 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 a 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 invasive species 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.) which 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 multi-state 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, non-forestlands with trees and urban areas.
- What are the most effective methodologies to use in restoring 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 COMMUNITIES

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 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 enhance 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 Memorandum of Understanding (MOU) 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 of 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 affected 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.
- Impacts of invasive and aggressive native plant species as well as 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 lists 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.

3.2a.1 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 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 use of these forests using best management practices.

4.2d Work with partners in Nebraska and 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, non-forestlands 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 convert 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.



Photo: NFS

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).
- Increase implementation of sustainable harvesting practices that maintain and enhance 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.

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.
- Increase implementation of sustainable management of forested landscapes to ensure continued supply of timber and biomass and subsequent productivity and viability of forest product industries.
- Increase implementation of sustainable harvesting practices that maintain and enhance 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 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.

8.9a.1 Better understand NFS constituents (especially members of key clientele groups).

8.9a.2 Conduct survey to define and characterize our stakeholder and client needs, preferences and perceptions.

8.9a.3 Identify and orient communications to needs, preferences and perceptions.

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



Photo: NFS

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 Plan events, publications and outreach efforts to specifically:

8.10a Change values/attitudes;

8.10b Achieve on-the-ground impacts;

8.10c Stimulate action, change behavior and inspire action; and

8.10d 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 affected 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 considering a changing climate.

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.

- 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, non-forestlands 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:

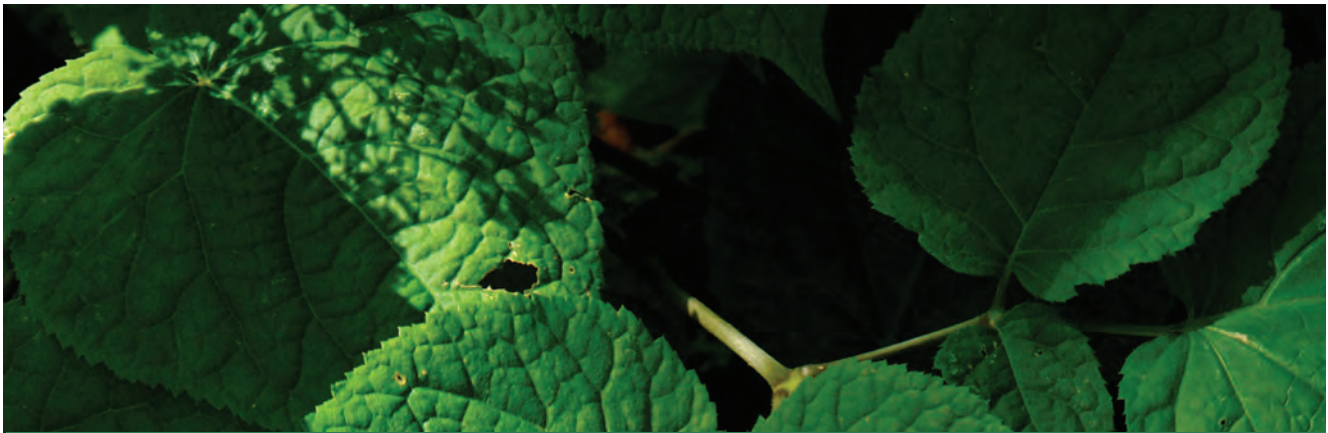
- supporting marketing and utilization activities;
- expanded inventory data acquisition and analyses;
- expanded fuels reduction work in high-risk areas; and
- capital costs for conversion of thermal energy systems to woody biomass.

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.

Research Needs:

- What will be the impacts of climate change on Nebraska's tree and forest resources?



CHAPTER 9: SUMMARY OF IMPLEMENTATION

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.

2010-2015: Provide a brief summary of implementation highlights

- Provided fire training in cooperation with two state community colleges. Developing new partnerships and building on existing partnerships and training opportunities.
- Engaged 229 communities with project investments totaling \$3.1 million for the creation, support and management of resilient landscape practices and programs.
- In collaboration with green industry partners, supported or provided 114 workshop and training activities for 8,300 participants.
- Produced 280 news items (newsletters, news releases, news coverage), to support the need and opportunity to actively manage the community forest resource reaching an estimated 25% of the state's population.
- Provided direct technical assistance to nearly 5,000 woodland owners. Provided assistance to 3,100 new contacts and 1,850 existing clients to help them manage their woodland properties.
- NFS Rural Forestry Staff prepared nearly 350 Forest Stewardship Plans covering over 77,000 acres to help woodland owner's access financial assistance programs to implement stewardship practices on their lands.

Education and Outreach

Programs organized	88
Attendance programs	3,242
Presentation given	471
Attendance presentations	16,009

Indirect Technical Assistance (Education and Outreach)

Radio and TV appearance	211
News Articles Written	260
Newsletters Published	6
Publications	11
Other	276
Office Assists walk-in, phone calls and email	11,899

2010-2015: Provide a brief summary of implementation challenges

- Gaining recognition within UNL system of the necessity and benefits of teaching fire management topics to students in natural resources fields.
- Encouraging communities to adopt practices which lead to meaningful and lasting change beyond the scope of project implementation.
- Measurable and ongoing climate extremes of drought, flooding, temperature fluctuations and related weather extremes continue to degrade community forests. Economic and related municipal budget fluctuations have limited consistent and long-term investments in community tree planting efforts.
- The current volunteer base is aging and recruitment of younger volunteers has lagged, leading to a decrease in community enthusiasm and engagement.
- Scheduling workshops at appropriate times to draw participants, especially during times of the year when they'd prefer to be outdoors working.
- Woodland-owner participation in organizations and related networks that provide assistance in the management of their land has declined. Nebraska currently has four certified Tree Farms and one pending approval.
- Windbreak plantings have declined significantly, fueled by increasing crop prices and land values.
- Existing windbreaks have been removed and the land planted to commodity crops in response to changes to the federal tax code that provides tax credits for agricultural land improvement.
- Catastrophic wildfires in the Pine Ridge and Niobrara Valley have destroyed almost two-thirds of the ponderosa pine woodlands and forests of Nebraska since 2006. Many of these burned lands are not regenerating due to destruction of the seed banks, loss of shade, as well as the destruction of mature, cone bearing trees.
- Forest restoration efforts in the Pine Ridge and Niobrara Valley as well as the use of ponderosa pine in windbreaks and shelterbelts have been largely unsuccessful due to high mortality of planted bare-root seedlings.
- Eastern redcedar is widely planted through the western two-thirds of Nebraska for soil, water and livestock protection. However, it has spread into the understory of native forests, woodlands, and savannas and is replacing understory species, resulting in a slow conversion of species, the loss of natural forests, decrease in the quantity and quality of wildlife habitat and increased potential for catastrophic wildfire.

2015-2020: Identify the implementation plan

- Work with UNL Administration to integrate fire training into a developing fire ecology course.
- Continue to engage and expand new partnerships to leverage local investments.
- Seek and develop nontraditional partnerships and funding resources to expand meaningful and lasting impacts and outcomes.
- Develop and use metrics to accurately define tangible green infrastructure impacts relating to the environmental, social and economic benefits.
- Create, implement and promote grassroots community tree advocacy programs to engage a broader and younger volunteer base with special emphasis targeting nontraditional and underserved populations.
- Develop a "Nebraska Forestry Association" to serve as an umbrella organization to provide structure and support for woodland owners, loggers, and industry through planned programs and peer-to-peer networks.

2015-2020: Identify the data needs and new issues

- Measurable impacts are needed for specific projects and program investments.
- Community leaders increasingly require ROI analysis to justify investments in green-infrastructure programming given increasingly strained operational budgets.
- Developing meaningful data on forest fragmentation.
- Developing meaningful data on climate change impacts on native forests and vegetation.
- The National Climate Assessment for the Great Plains describes one of the most significant potential impacts from climate change as the increased demand and competition for water. This will create new and increasingly difficult challenges to maintain forest structure and function due to synergistic effects that will favor invader/invasive species and higher failure rates of afforestation and reforestation efforts.
- Establish a baseline vegetation survey across the state to monitor changes in the natural vegetative community.
- State specific BMPs to reduce fuel loads and risk of catastrophic wildland fire in ponderosa pine stands.
- Develop state specific BMPs for silvopastoral systems most appropriate to maximize both forage and wood production.
- Development of state specific BMPs that are the most appropriate stocking levels to optimize forest health and wildlife habitat and minimize introduction of invasive species in Nebraska.

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

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

2010-2015: Provide a brief summary of implementation highlights

- Established Nebraska's first Firewise Community, 2013.
- CWPPs completed for: Pine Ridge, Niobrara Valley, and Loess Canyons.
- CWPPs in progress for: Missouri River and Wildcat Hills.
- Fuels reduction: 325 projects complete, 11,163 acres treated, total cost \$4.2 million.
- Constructed three SEAT bases (Valentine, Chadron, Alliance), plus developed a mobile base in 2013 and have a base planned for construction in 2015.
- Identified four SEAT base manager (SEMG) trainees within NFS in addition to four SEMG from local VFDs or partner agencies.
- Completed NFS Fire Aviation mobile app.
- Cooperating aerial applicators 2010 – 26, 2015 – 19.
- Fire training: courses: 235; students: 5866; training hours: 69,861.
- FEPP/FFP numbers: placed 65-90 trucks/yr. Increased total trucks from 279 in 2006 to 621 in 2015. Replaced (upgraded) approximately 20/yr.

- Firewise presentations and promotion: 2014–2, 2015–1.
- Created two Nebraska Firewise publications (2011): “Living with Fire-Eastern Nebraska” and “Living with Fire-Western Nebraska.”
- Implemented interagency incident management team to administer Nebraska Wildland Fire Academy.
- Secured \$300,000 grant “Building Interagency Capacity in Prescribed Fire.” Has provided training for 375 students which attended PFTC, TREX, NWFA, and others.
- NFS staff has attended IMT training for operations, safety, planning and public information.
- NFS staff assisted with incident management and direct suppression on wildfires in 2012.
- NFS sent its first staff member on an out-of-state fire assignment in 2014 (Carlton Complex, WA) and continue to do so in 2015.
- Awarded a Wildland-Urban Interface grant to provide fuels reduction cost-share, which is being matched by state funding to landowners in the area. A demonstration fuels reduction project is being established at the Cedar Canyon Demonstration Forest.
- Demonstration will be used to provide opportunities for hands-on learning about fuels reduction and wildfire mitigation practices and strategies for both landowners and local forestry contractors.
- Over 5,000 acres of woodlands were treated to improve structure and function for the reduction in the risk of loss due to catastrophic wildfire.

2010-2015: Provide a brief summary of implementation challenges

- Recruitment and retention of quality staff in the fire program.
- Fuels reduction contractors must be

educated on fuels reduction practices and stand manipulation.

- Fuels reduction contractors require education on bidding fuels reduction projects and general business practices.
- Lack of fuel reduction contractors.

2015-2020: Identify the implementation plan

- Continue expansion of formal certification within NFS, partner agencies and local fire departments.
- Recruit additional aerial applicators into aviation program.
- Place FEPP/FFP strategically with consideration for the overall fire suppression needs of the state.
- Graduate student at UNL will perform risk and hazard assessments of six communities in conjunction with NFS.
- Expand Nebraska Wildland Fire Academy to include additional courses and locations with the goal to increase overall participation.
- Recover capacity to deliver wildland fire focused prevention programs.
- Encourage, support and participate in development of Nebraska IMT3 with our partner agencies.
- NFS will develop demonstration forest stands at Cedar Canyon Demonstration Forest to provide education for landowners, contractors and stakeholders.
- Conduct workshops to educate local contractors about fuels reduction practices at Cedar Canyon Demonstration Forest to ensure proper forest management and wildfire mitigation.
- Develop additional Community Wildfire Protection Plans in other priority forest landscapes around the state.
- U.S. Forest Service Forest Inventory and Analysis data is very broad scale and difficult to use for estimating the amount of wood available to any one sector of forest products industry. Develop broad based inventory of the Pine Ridge and Wildcat Hills.

- Provide the forest products industry with economic and development information to help decision makers understand specific utilization opportunities and standards for various tree species in Nebraska.
- Update the current primary processors list to include specific utilization standards for products by species.
- Perform wood basket survey/growth and drain analysis to identify existing resources of timber and the availability of the timber for specific mills or industries.
 - Species by volume and grade,
 - Ability to access timber,
 - Where it is located, what ownership group, and
 - Estimated transportation cost.
- Evaluate potential of biomass bioenergy using non-commercial species, invasive species, low-quality materials and wood waste to restore forest ecosystems.
- Implement an applied research project, in cooperation with the U.S. Forest Service's Bessey Nursery, to determine the most appropriate seed sources and seedlings (potted) to ensure higher survival rates and replace eastern redcedar as a preferred species for shelterbelts and windbreaks.

2015-2020: Identify the data needs and new issues

- Work with state, regional and national partners to develop/improve fire occurrence reporting system, enabling and encouraging rapid, reliable reporting with the ability to share data easily.
- Improve the Fire Risk Assessment for the state of Nebraska.
- Develop forest management guidelines using 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 to promote forest health and reduce the risk of catastrophic wildfire.
- Develop forest management guidelines that identify residual stocking densities

that maximize timber and grass production, thus economic output.

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

A healthy forest landscape can renew and recover 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 that are likely to prevent and mitigate impacts and successfully restore affected forests.

2010-2015: Provide a brief summary of implementation highlights

- Prepared and distributed 16 new publications with information and recommendations for controlling forest pests, including nine discussing the emerald ash borer and related ash problems, two discussing the mountain pine beetle and other bark beetles of pines, five that discussed thousand cankers disease of walnut, pine wilt, Diplodia blight of pines, and iron chlorosis of broadleaf trees and conifers.
- Established a citizen-based Tree Pest Detector network of 120 volunteers in 48 communities across the state to enhance detection of invasive tree pests and accelerate management interventions.
- With 13 other state, federal and local agencies and green industry organizations, expanded the Nebraska Emerald Ash Borer Working Group. Significantly revised the Nebraska Emerald Ash Borer Response Plan and prepared and distributed the information and recommendations document: "Emerald Ash Borer Key Points and Recommendations."
- Conducted detection surveys for emerald ash borer in 26 communities, parks and

campgrounds and for thousand cankers disease of walnut in 44 communities, parks, plantations and high risk sites.

- Provided cost-share funding to landowners and local government partners for stand thinning, infested tree removals and spray treatments to mitigate the damage caused by the mountain pine beetle and Ips bark beetles of pines.
- Developed and awarded 2010 USFS redesign project investment of \$300,000 for “ReTree Nebraska, Targeting People and Technology for Healthier Forests.” This project investment created the statewide ReTree Initiative with the goal of planting and caring for one million trees over



Photo: NFS

10 years. The goal was to reverse the downward trend of the health and viability of the local Urban and Community Forest (U&CF) resource.

- Developed and awarded 2010 USFS redesign project investment of \$300,000 for “Sustainable Communities for the Great Plains.” This project investment targeted 23 projects in seven “keystone” communities for a total program value of \$363,381 with a calculated outcome totaling more than \$4 million in social, economic and environmental benefits.
- Developed and awarded 2010 USFS redesign project investment of \$150,000 for “Community Threat Assessment Protocol.” This project investment identified the resource threats and potential impacts of invasive insects and disease and wildfire for 67 communities across the state. It also created a rapid



Photo: NFS

assessment protocol and systems approach to community inventory and risk planning and mitigation.

- Conducted bus tours and field reviews to green infrastructure sites in Fort Collins (2013) and Kansas City (2014). More than 100 community leaders and tree managers toured a successful community forestry programs at both sites with a focus on environmental, economic and social benefits to communities.
- Nearly 600 acres of woodlands were treated to improve structure and function to reduce the risk of loss to mountain pine beetle.



Photo: NFS

2010-2015: Provide a brief summary of implementation challenges

- Few challenges hindered progress on the objectives. The most notable one was working with people who represent a broad range of public and private interests on the Nebraska Emerald Ash Borer Working Group and coming to a group consensus on recommendations for dealing with the emerald ash borer.

- Community forest resources remain threatened by invasive insects and disease, extreme weather and municipal and state budget limitations.

2015-2020: Identify the implementation plan

- Continue working with the Tree Pest Detector network of citizen volunteers to enhance early detection of the emerald ash borer, thousand cankers disease of walnut and other invasive pests.

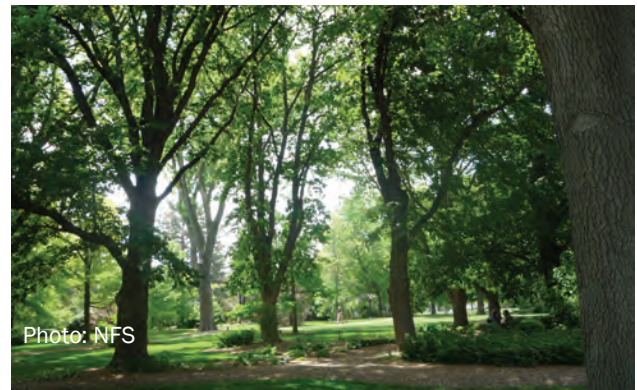


- Continue working with the Nebraska Emerald Ash Borer Working Group to revise the Nebraska Emerald Ash Borer Response Plan and Emerald Ash Borer Key Points and Recommendations as needed.
- Continue working with our Nebraska Department of Agriculture and University of Nebraska Extension partners to coordinate invasive pest detection surveys and presentations on managing invasive pests given to communities and other groups.
- Continue monitoring the movement of invasive pests across the country and keep informed about current management recommendations.
- Continue detection surveys for invasive pests at high-risk sites and evaluation surveys for native pests when needed.
- Continue technical assistance to landowners, tree care professionals, government agency personnel, UNL staff, and others concerning the management of forest insect pests and diseases.

- Continue programs and practices to improve forest health conditions.
- Support and expand granting programs and technical assistance to promote use of native and regional adapted species to improve plant diversity and climate resiliency.

2015-2020: Identify the data needs and new issues

- Major new issues include the effects of climate change directly on trees as moisture and temperature conditions change and the effects it will have on the survival and spread of tree insect pests and diseases.
- Ability to measure tree stress levels and track these changes in levels with satellite data would be very valuable.
- Ecological and economic impacts of the loss of ash in rural forests and urban areas due to EAB.



- Ecological and economic impacts of the loss of black walnut in rural forests and urban areas due to thousand cankers disease.
- Most effective methods for slowing the spread of thousand cankers disease, EAB, mountain pine beetle and other forest pests.
- Recommended tree species 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 sustained and improved.



2010-2015: Provide a brief summary of implementation highlights

- In partnership with the Nebraska Statewide Arboretum Inc. (NSA), developed and awarded 2010 Nebraska Environmental Trust project investment of \$900,000 for “Water-Wise Landscape Initiative.” This program effort invested in 24 projects statewide totaling over \$931,000 in direct installation investments.
- In partnership with the NSA, developed and awarded 2013 Nebraska Department of Environment Quality project investment of \$60,000 for “Water-Wise Landscaping.”
- Over 500 acres of timber stand improvement projects, designed to increase the structure and function of riparian forests, were implemented through direct technical assistance of NFS staff.
- Over 50 acres of riparian forest buffers were created through direct technical assistance of NFS Staff.

2010-2015: Provide a brief summary of implementation challenges

No challenges were experienced during the implementation of this objective.



2015-2020: Identify the implementation plan

- Plan to revisit the State BMP for Forestry and Riparian Area Management.

2015-2020: Identify the data needs and new issues

- There is a need to collect data showing the effect of management on water quality.

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.

2010-2015: Provide a brief summary of implementation highlights

- NFS has established a demonstration of alley-cropping systems at Horning Farm Demonstration Forest, providing a diversified agroforestry approach to management.
 - Demonstration consists of cultivars of American chestnut, black walnuts, Chinese chestnut and northern pecans with a hay

crop produced between the tree rows.

- NFS is testing the use of woody florals planted within the tree rows of windbreaks for non-traditional forest products.
- NFS has established a demonstration “edible buffers” by restoring degraded field windbreaks for wind protection while producing specialty forest products.
- NFS has established a demonstration arboretum and community forestry demonstrations to educate growing urban populations of Lincoln, Omaha and Douglas, Sarpy and Cass counties, and other cities and towns in tree planting techniques, species/cultivar choices and landscape design.
- Demonstrations of community tree species and cultivar trials, including those adapted to a changing climate; tree planting technique demonstrations; pruning demonstrations; and permeable pavement/green infrastructure demonstrations in parking lots.
- Nebraska has established a cottonwood restoration project which focused on the development of a woody biomass cover crop on a 5 to 7 year rotation.
- At the Timmas Farm Ecological Reserve, NFS is testing 14 varieties of fast growing willow species to determine their suitability for woody crop production.

2010-2015: Provide a brief summary of implementation challenges

- Changing and inconsistent weather conditions created challenges in the establishment of test plots and plantation. In 2011, flooding was a consistent problem along the Missouri River in eastern Nebraska. In 2012, drought was an issue for survival and implementation of demonstrations.

2015-2020: Identify the implementation plan

- NFS will participate in a joint effort between North Dakota State and Kansas State universities along with NRCS and state forestry agencies from North Dakota to Oklahoma and two provinces in Canada. The goal of the project is to take advantage of today’s custom farming practices to collect accurate crop production data across fields that are protected by windbreaks and compare the yield data against similar field without windbreaks.
- NFS will continue to develop and test cultivars of American chestnut.
- NFS will continue to plant and monitor diverse species varieties, cultivars and hybrids into the Horning State Farm Demonstration Forest Arboretum to determine the long-term survival and suitability as adaptive species for climate change.

2015-2020: Identify the data needs and new issues

- Ecological and economic impacts of the loss of ash in rural forests and urban areas due to EAB.
- Ecological and economic impacts of the loss of black walnut in rural forests and urban areas due to thousand cankers disease.
- Most effective methods for restoring degraded cottonwood riparian forests.
- Best approaches to encourage landowner adoption of riparian forest buffers.
- Current situation/trends in retention/expansion of existing riparian forests, field and farmstead windbreaks and other agroforestry practices.
- Key factors leading to gain or loss of riparian forest acres.
- How landscape-level impacts can best be achieved through individual landowner action.
- Establishing a baseline inventory across the state to monitor change in composition, diversity and species due to climate change is needed.

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.

2010-2015: Provide a brief summary of implementation highlights.

- In July 2013, as a result of the passage of the Wildfire Control Act of 2013 in the state legislature, NFS established the Forest Products Utilization (FPU) program. The FPU program seeks to identify new and expanding economic markets for Nebraska's forest products. Partnering with local, state and federal partners, the FPU program works with interested businesses and individuals to investigate new forest product options and conduct product and market development projects to improve market strength in the state, leading to increased forest management.
- Developed the TREES Heat Nebraska program to provide technical and financial assistance to facilities interested in the converting to woody biomass energy.
- Completed preliminary or engineering feasibility studies for:
 - City of South Sioux City, city offices in South Sioux City;
 - Nebraska Department of Correctional Services, state penitentiary in Lincoln;
 - Papio Valley Nursery, commercial greenhouse nursery in Papillion; and
 - Keya Paha County Schools and Courthouse, municipal facilities in Springview.
- Received a 2015 Wood Innovation Grant to evaluate the feasibility of creating a district heating system originating from the existing woody biomass system at Chadron State College to include nearby school, city and county facilities.
- In partnership with the NSA, developed and awarded 2010 Nebraska Environmental Trust project investment of \$900,000 for "Trees for Nebraska Towns." This project invested \$1.8 million with the completion of 141 statewide projects and the planting of more than 7,063 trees in Nebraska communities. Collectively these projects are calculated to produce more than \$700,000 in annual tree benefits in supporting local green infrastructure objectives.
- In partnership with the NSA, developed and awarded 2010 Nebraska Environmental Trust project investment of \$900,000 for "Water-Wise Landscape Initiative." This investment engaged and created 24 demonstration sites across the state with over 12 acres replanted/reshaped, installation of over 75,000 plants with up to 500,000 cubic feet of storm water diverted and treated.
- In partnership with the NSA, developed and awarded 2015 Nebraska Environmental Trust project investment of \$524,000 for "Greener Nebraska Towns: Resilient, Sustainable, Biodiverse and Water Wise."
- Developed and awarded 2015 USFS redesign project investment of \$300,000 for "Nebraska's Ten Largest Communities."
- Developed and awarded 2014 USFS redesign project investment of \$75,000 for "Arborists Safety."



Photo: NFS

- Promoted and implemented ISA certification standards and opportunities for NFS/CFSL staff with eight staff completing/maintaining ISA Certified Arborist, three completing ISA Municipal Specialist, and four completing Tree Risk Assessment Qualification.
- Over 4,800 acres of woodlands and forest were treated to increase their health and vigor through direct technical assistance.



- Nearly 100 acres of field windbreaks were renovated through direct technical assistance of NFS staff.
- NFS assisted 72 landowners with the harvest of over 13 million board feet of timber with an estimated values of over \$275,000 of income generated for landowners.
- Nearly 700 acres of woodlands were replanted by landowners through direct technical assistance of NFS staff.
- Nearly 1,150 acres of field windbreaks were planted through direct technical assistance of NFS staff.

2010-2015: Provide a brief summary of implementation challenges

- Declining natural gas prices which make woody biomass energy less economically feasible.
- Increasing insurance costs for logging operations and sawmills.
- The reduction of sawmills in neighboring states due to the recession of the late 2000s.



- Lack of statewide understanding of the importance of forest product markets.
- Lack of technical assistance outside of NFS for the development of new forest products.
- Lack of available financial assistance for the investigation and development of new forest products and forest product markets.
- Maintaining consistent program contact with local government and their familiarity of project scope and implementation.
- Opportunity to identify quantifiable practice changes in relationship to community leaders and related investments.

2015-2020: Identify the implementation plan

- Conduct a statewide outreach effort to promote FPU program offerings and the state's existing forest products industry.
- Work with businesses and individuals to promote their current products as well as assist with the identification of new products based on current and evolving market demands.
- Traditional partners (e.g. U.S. Forest Service and the Forest Products Laboratory) will be approached about becoming more active in the development

of forest product markets in Nebraska.

- New partnerships (e.g. Nebraska Department of Economic Development and other state and private forestry market and utilization personnel) will be forged to increase NFS's technical knowledge for expanding Nebraska's existing markets, improve new market and business recruitment to the state and develop innovative new projects to evaluate potential market options (e.g. industrial and agricultural biochar).
- Continue to work with statewide partners to develop and implement granting objectives.
- Forest certification systems are market-based, non-regulatory means to assure end users that the wood products they purchase have been grown, managed, and harvested in socially acceptable and environmentally responsible ways.
- These market-based solutions provide landowners, land managers and the forest products industry with an economic incentive to pursue sustainable forest management as a means of maintaining existing markets and expanding market share as consumer demand for certified products grows.
- Determine which type of certification schemes best meet the needs of Nebraska's forest products industry, NIPF Landowners, and NFS capacity to administer.
- Identify how the NFS might encourage participation in a forest certification scheme or the development of an ATFS or FSC independent Management Group.
- Continue existing NFS programs that provide woodland owners with technical assistance including the development of forest stewardship plans and access to third party certification scheme provide the basis for landowners to access carbon markets.

- Develop the capacity to inventory and model carbon sequestration to help woodland owners understand the potential economic benefits of participating in carbon markets.

2015-2020: Identify the data needs and new issues

- Opportunities for interaction and collaboration among state and federal forest products development personnel need to be provided at the Forest Service regional and national levels to facilitate stronger partnerships and innovative cross-boundary projects.
- In Nebraska, a statewide comprehensive economic impact survey of the forest industry would provide evidence of the importance of the industry and markets to overall forest health.
- The development of a Nebraska forest products association would provide a voice for the state's sawmills, wood energy users, logging operations and urban wood processors. The development of this organization would also lead to better communication of issues, concerns and successes between those within the industry.
- Economic impacts of NFS's programs on Nebraska's economy.
- Economic benefits to producers and society from the installation of agroforestry practices.
- Economic impacts of trees and forests on Nebraska's economy.
- Opinions of landowners and producers of their agroforestry and forestry perceived needs, willingness to install agroforestry plantings, incentives needed and barriers to adoption.
- Policy changes needed to foster increased tree planting in both urban and rural areas.
- Potential economic impacts of ecosystem markets on individual landowner incomes.
- Potential economic impacts of ecosystem markets aggregated statewide.
- Best 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.

2010-2015: Provide a brief summary of implementation highlights

- In partnership with the NSA and UNL Department of Entomology, developed and awarded 2015 Nebraska Environmental Trust project investment of \$700,000 for "Community as Habitat: Nebraska Communities Supporting Pollinators and Landscape Diversity Through Native WaterWise Plant Habitats."
- Nearly 2,100 acres of trees and shrubs were planted to create or improve wildlife habitat through direct technical assistance of NFS staff.
- Chat Canyon Forest Legacy project protected 460 acres of Sandhill prairie and forestland along the Niobrara River in Cherry County, Nebraska.

2010-2015: Provide a brief summary of implementation challenges

No challenges were experienced during the implementation of this objective.

2015-2020: Identify the implementation plan

- Continue to work with statewide partners to develop and implement granting objectives.
- Update existing Voluntary Best Management Practices and adopt a series of field tested, silvicultural guidelines for the management of major timber types in Nebraska.
- Continue to work with communities, counties, NGOs and private landowner's to protect critical habitat and Biologically



Unique Landscapes through the Forest Legacy Program.

2015-2020: Identify the data needs and new issues

- Density, type and arrangement of agroforest systems using trees and shrubs that will improve wildlife habitat in agriculture-dominated landscapes.
- Best management practices for western ponderosa pine forests as silvopastoral systems to 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.
- Appropriate deer population densities to permit natural or artificial regeneration of valuable tree species and forest 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.

2010-2015: Provide a brief summary of implementation highlights

- In partnership with the NSA, developed and awarded 2012 Nebraska Environmental Trust project investment of \$519,000 for “Sustainable Schoolyard Partnership.” This project delivered 50 workshops and trained more than 750 educators in curriculum topics addressing forestry and water quality. In collaboration with 10 partnering schools, technical and financial assistance was provided to improve outdoor environment and integrate in the classroom through PLT Green Schools.
- Developed and awarded 2012 USFS redesign project investment of \$300,000 for “Conservation Stewardship Education for Nebraska’s Educator’s and Youth.” This project delivered 50 workshops and trained more than 750 educators in curriculum topics addressing forestry and water quality. In collaboration with 10 partnering schools technical and financial assistance was provided to improve outdoor environment and integrate in the classroom through PLT Green Schools.
- Developed and awarded 2013 USFS redesign project investment of \$300,000 for “Community Marketing for Trees.”
- Developed and awarded 2015 USFS redesign project investment of \$300,000 for “Full Circle Benefits.”
- Created, supported and continue to promote 12 unique social medial channels via Facebook, Twitter, Pinterest, Instagram and YouTube with an outreach of 10,500 and growing subscribers.
- Restructured the Nebraska Community Forestry Council to a 15 member advocacy board with representatives of all major green industry organizations.
- Established and implemented ReTree Leadership team and created and supported an advocacy network comprising 220 ReTree Ambassadors, 28 ReTree participating nurseries supported by four partnership organizations. These advocacy groups in coordination with volunteer tree board members, tree planters and community activist logged



Photo: NFS

a total of 198,500 volunteer’s hours to support the planting and care of local community forestry resources.

- Supported and promoted Arbor Day Foundation suite of programs including Tree City USA, Tree Campus, Tree Line and Growth Awards. Collectively these programs have supported the planting of more than 23,310 trees, pruning of 128,860 and removal of 27,755 dead and dying trees. In total these local efforts have invested a total of \$32.5 million in local greening efforts where 87% of the state population reside.



Photo: NFS

2010-2015: Provide a brief summary of implementation challenges

- Defining stronger emphasis on ecological benefits such as improved habitat, biodiversity, pollinator support and use of native and regionally adapted plant materials.

Photo: NFS



2015-2020: Identify the implementation plan

- Continue to work with statewide partners to develop and implement granting and program objectives.



Photo: NFS

2015-2020: Identify the data needs and new issues

- Continue to work with statewide partners to develop and implement granting and program objectives.

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

Nebraska's forests offset significant carbon emissions; 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 affected by climate change, preserving forest landscapes is paramount to ensure that these benefits are sustained.

2010-2015: Provide a brief summary of implementation highlights

- Developed and awarded 2013 USFS redesign project investment of \$150,000 for "Environmentally Adapted Trees." This project investment created a network of green industry professionals who have identified, propagated, trialed and promoted proven and underused seed sources and plant materials which are time tested and proven to survive the weather extremes of the Great Plains.
- Nebraska has established a cottonwood restoration project with short rotation woody biomass.
- NFS is testing use of woody biomass systems which replaces ancient carbon (fossil fuels) with carbon readily available within the system.
- NFS is testing short rotation woody biomass species for growth and suitability as woody crops.
- Nebraska has planted 60 tree species to test their suitability in Nebraska with climate change as a consideration.

2010-2015: Provide a brief summary of implementation challenges

No challenges were experienced during the implementation of this objective.

2015-2020: Identify the implementation plan

- Initiate preparations for the impacts of an increase in fire intensity and frequency coupled with a nationwide decline in volunteerism resulting in a decrease in safe, efficient fire suppression capacity in Nebraska.



- Continue to work with statewide partners to develop and implement granting objectives.

2015-2020: Identify the data needs and new issues

- Analyze the hours expended in fire suppression by volunteer fire departments to detect trends.
- Impacts of climate change on Nebraska's tree and forest resources.
- Specific actions needed 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, non-forestlands with trees and urban areas.



CHAPTER 10: STAKEHOLDER SURVEY

STAKEHOLDER FEEDBACK

In support of evaluating the effectiveness and collaboration with partners the Nebraska Forest Service conducted a statewide survey to solicit feedback on implementation of the Nebraska State Forest Action Plan (SFAP). Utilizing the online service Survey Monkey, state partners and cooperators were solicited and asked to rate the importance of the nine identified NFS objectives within the SFAP as well as rating their level of satisfaction with the effectiveness of NFS programs in meeting those objectives.

One hundred twenty-five cooperators or partner agencies completed the survey with 74% to 93% reporting the nine identified objectives were either important or very important.

Ninety percent of those responding were either satisfied or very satisfied with the objective of “Actively and sustainably manage forests,” 59 percent were either satisfied or very satisfied with the effectiveness of NFS programs to meet this objective.

Eight-seven percent of those responding were either satisfied or very satisfied with the objective

Table 17: Relative importance of SFAP objectives

Please rate the importance of the following Nebraska Forest Service objectives as they relate to Nebraska's tree and forest resources:

Answer Options	Very Important	Important	Neutral	Of Little Importance	Not Important	Don't Know	Response Count
Actively and sustainably manage forests	62	49	11	2	0	0	124
Restore fire-adapted lands and reduce risks of wildfire impacts in forests and adjacent communities	56	51	13	4	0	1	125
Identify, manage and reduce threats to forest and ecosystem health	66	50	6	1	1	1	125
Protect and enhance water quality and quantity	70	33	15	4	2	1	125
Improve air quality and conserve energy	46	45	21	8	2	2	124
Maintain and enhance the economic benefits and values of trees and forests	41	59	17	2	3	0	122
Protect, conserve and enhance fish and wildlife habitat	61	48	9	2	4	1	125
Connect people trees and forests and engage them in environmental stewardship activities	57	47	15	3	1	2	125
Manage and restore trees and forests to mitigate and adapt to global climate change	45	38	28	7	5	2	125
Other (please specify)							12
answered question							125
skipped question							0

of “Restore fire-adapted lands and reduce risks of wildfire impacts in forests and adjacent communities,” 53 percent were either satisfied or very satisfied with the effectiveness of NFS programs to meet this objective.

Ninety-three percent of those responding were either satisfied or very satisfied with the objective of “Identify, manage and reduce threats to forest and ecosystem health,” 64 percent were either satisfied or very satisfied with the effectiveness of NFS programs to meet this objective.

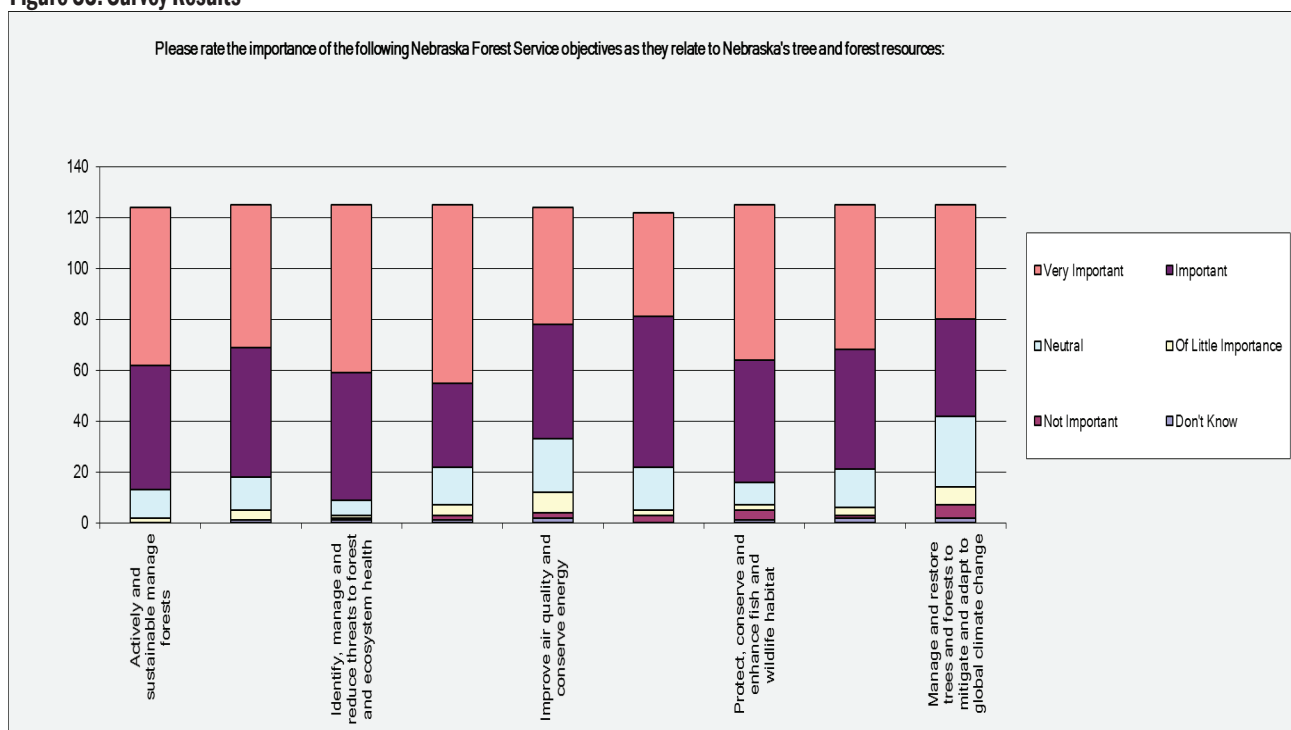
Eighty-four percent of those responding were either satisfied or very satisfied with the objective

of “Maintain and enhance the economic benefits and values of trees and forests,” 58 percent were either satisfied or very satisfied with the effectiveness of NFS programs to meet this objective.

Eighty-nine percent of those responding were either satisfied or very satisfied with the objective of “Protect, conserve and enhance fish and wildlife habitat,” 53 percent were either satisfied or very satisfied with the effectiveness of NFS programs to meet this objective.

Eighty-three percent of those responding were either satisfied or very satisfied with the objective

Figure 53: Survey Results



of “Protect and enhance water quality and quantity,” 47 percent were either satisfied or very satisfied with the effectiveness of NFS programs to meet this objective.

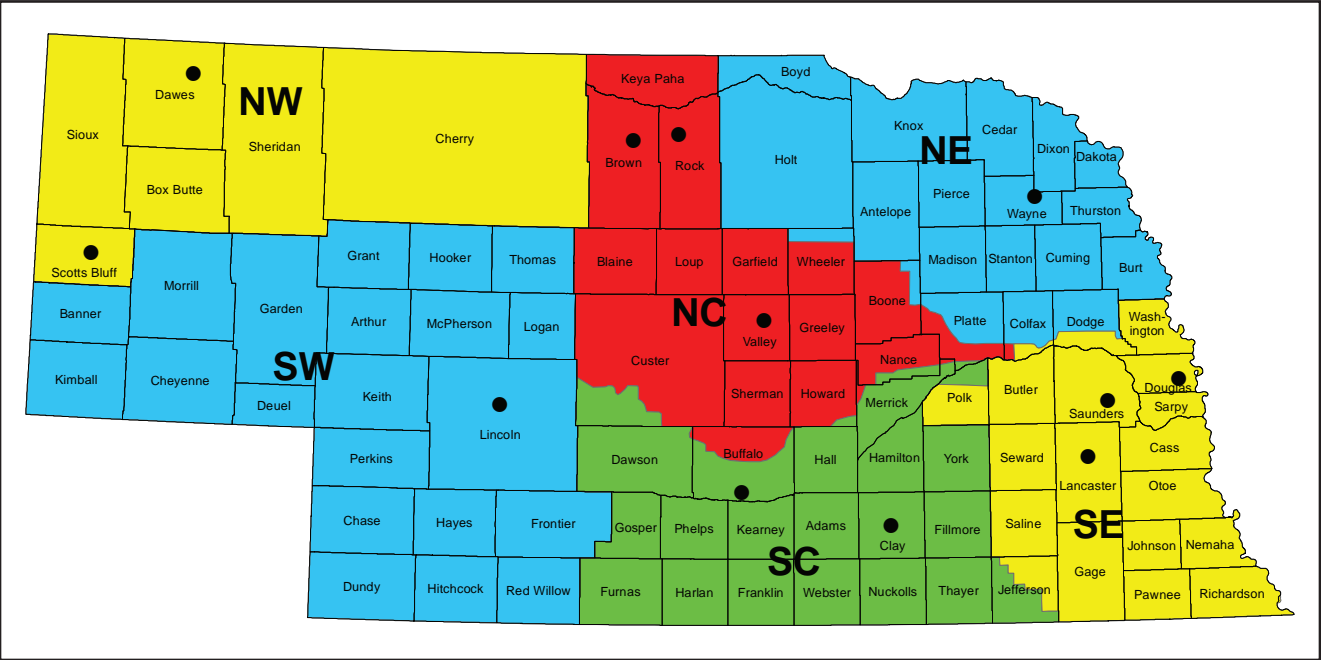
Seventy-four percent of those responding were either satisfied or very satisfied with the objective of “Improve air quality and conserve energy,” 40 percent were either satisfied or very satisfied with the effectiveness of NFS programs to meet this objective.

Seventy-nine percent of those responding were either satisfied or very satisfied with the objective

of “Connect people trees and forests and engage them in environmental stewardship activities,” 57 percent were either satisfied or very satisfied with the effectiveness of NFS programs to meet this objective.

Sixty-six percent of those responding were either satisfied or very satisfied with the objective of “Manage and restore trees and forests to mitigate and adapt to global climate change,” 41 percent were either satisfied or very satisfied with the effectiveness of NFS programs to meet this objective, 57% were neutral or did not know.

Figure 54. Nebraska Forest Service Districts and Offices



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