SOUTH DAKOTA STATEWIDE ASSESSMENT OF FOREST RESOURCES

June 2010

RESPEC CONSULTING & SERVICES

SOUTH DAKOTA DEPARTMENT OF AGRICULTURE

SOUTH DAKOTA STATEWIDE ASSESSMENT OF FOREST RESOURCES

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Cover Photos: Diversity of forest types across South Dakota.

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EXECUTIVE SUMMARY

This report is a general assessment of forest resources for the entire state of South Dakota. The assessment is a compilation of existing forest management documentation, U.S. Department of Agriculture Forest Inventory and Analysis (FIA) data, and a state priority area analysis conducted by the South Dakota Department of Agriculture. This document reviews the major forest types in the state, including coniferous, upland hardwood, bottomland, shelterbelts, and community forests. Included for each of these forest types is a summary of the extent and condition, values, threats, ownership, needs, problems, and opportunities.

Coniferous forests make up 77 percent of the state's forest and primarily consist of ponderosa pine in the Black Hill area. The age class distribution shows there is good regeneration, but many of the ponderosa stands are overcrowded and in poor general health. These forests not only contribute to the state's economy but provide valuable wildlife forage and cover. The most serious threats to South Dakota's coniferous forests are insect infestation, disease, and fires; most of these problems can combine and result in high tree mortality. Two-thirds of the coniferous forests in the state are on national forest land.

Upland hardwood forests make up approximately 20 percent of South Dakota forest land and are scattered among small stands across the state. Species in this forest type include elm, ash, bur oak, and aspen, among others. In general, upland forests have declining regeneration and face threats of disease, invasive species, and land-use changes. Perhaps the most valuable asset of hardwood forests are the recreational opportunities they provide, including hunting, camping, and wildlife viewing. Approximately two-thirds of the upland hardwood forests are privately owned; the rest are dominantly federally owned.

Bottomland forests make up only 3 percent of the forested land in the state. These forests consist primarily of cottonwood, willow, green ash, and elm trees located within the riparian zone of streams. These trees provide tremendous value in improving water quality and flood control. The biggest threat to current riparian forests is the lack of regeneration of cottonwood trees; cottonwoods require periodic flooding to regenerate with virtually no young saplings existing. Approximately 71 percent of these important bottomland forests in South Dakota are privately owned.

Shelterbelts and windbreaks are not typically thought of as forested land but serve an important ecological niche and cover approximately 200,000 acres in South Dakota. Windbreaks protect fields and structures from wind and snow and help prevent soil erosion; they also provide notable habitat for pheasant and other birds. Shelterbelts are composed of a wide variety of species, but there is little information about the extent, condition, and ownership as most of these trees do not meet FIA classification of forested land. Shelterbelts face similar threats as other forests types, but the biggest concern they face is the need for renovation and

improvement. There is no ownership data for windbreaks, although most are considered to be privately owned.

Urban or community tree lands occupy approximately 103,000 acres in the state. There is a large number of species present within community forests with ash, elm, crabapple, and maple being a few of the most common. Helping administer community tree management programs, 34 cities and towns in South Dakota are members in the Tree USA program. Community tree inventories reveal that the majority of community forests are in good condition and have a good age distribution. In communities, trees provide energy conservation, improved water quality, and aesthetic appeal, among other values. Common threats include diseases, development, and weather events.

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LIST OF ACRONYMS

ACE	Army Corps of Engineers
BHNF	Black Hills National Forest
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BMP	Best Management Practices
CARS	Community Accomplishment Reporting System
CFAC	Community Forestry Advisory Council
CWCP	Comprehensive Wildlife Conservation Plan
CWPP	Community Wildfire Protection Plan
CY	Calendar Year
DCA	Damage Casual Agent
DBH	Diameter at Breast Height
DED	Dutch elm disease
DEM	Digital Elevation Model
EAB	Emerald ash borer
EQIP	Environmental Quality Incentives Program
FIA	Forest Inventory and Analysis
FIDO	Forest Inventory Data Online
FSCC	Forest Stewardship Coordinating Committee
GFP	Game, Fish & Parks
GIS	Geographic Information Systems
GPC	Great Plains Center
GPI	Great Plains Tree and Forest Invasives Initiative
GPS	Global Positioning System
HUC	Hydraulic Unit Code
HWC	Human-Caused Ignition
NHD	National Hydrologic Dataset
NLCD	National Land Cover Data
NRCS	Natural Resource Conservation Service
Pse	Percent Sampling Error
RC&F	Division of Resource Conservation and Forestry
RHV	Risk, Hazard Value

LIST OF ACRONYMS
(Continued)

SAFR	Statewide Assessment of Forest Resources
SAP	Spatial Analysis Project
SDDA	South Dakota Department of Agriculture
SD DENR	South Dakota Department of Environment and Natural Resources
SSURGO	Soil Survey Geographic
SWAP	Statewide Source Water Assessment Program
T&E	Threatened and Endangered
USDA	United States Department of Agriculture
USFS	United States Forest Service
USGS	U.S. Geological Survey
WFS	Division of Wildland Fire Suppression
WUI	Wildlife Urban Interface

INTRODUCTION

Forested land makes up less than 4 percent (1.7 million acres) of South Dakota's total land. However, the forests are a vital part of the state's ecosystem and environment. This assessment of forest resources is a compilation of existing forest management documentation, U.S. Department of Agriculture Forest Inventory and Analysis (FIA) data, and a state priority area analysis conducted by the South Dakota Department of Agriculture (SDDA). This report summarizes the extent and condition, values, threats, ownership, needs, problems, and opportunities by major forest type.

The purpose of this forest resource assessment is to:

- Analyze present conditions, trends, and threats on all ownerships using publicly available information.
- Identify forest-related threats, benefits, and services consistent with the State and Private Forest Redesign national themes.
- Delineate priority rural and urban forest landscape areas to be addressed by the state resource strategy.
- Identify multistate areas that could receive designation as regional priorities.

This document is intended to satisfy the requirements in the 2008 Farm Bill; this bill requires each state prepare a Statewide Assessment of Forest Resources (SAFR) to qualify for funding through U.S. Department of Agriculture Forest Service State and Private Forestry grants. In South Dakota, these grants are administered by the SDDA Resource Conservation and Forestry Division (RC&F) and the Wildland Fire Suppression Division (WFS).

This report is divided into nine chapters and seven appendices. Each of the main forest types in the state are described in Chapters 1.0–5.0; each forest type includes specific information on extent and condition; values; threats; ownership; and needs, problems, and opportunities. Chapter 6.0 briefly summarizes forest ownership by owner. Suitability analysis and results for areas deemed priority areas are provided in Chapter 7.0. A summary of the report is given in Chapter 8.0. The report concludes with a full bibliography of referenced forest management plans and other references. Appendix A includes a summary table of common goals and threats found in the forest management plans. Methodology for the creation of the priority area map is described in Appendix B. Access information for the Statewide Forest Legacy Plan is provided in Appendix C. Appendix D includes information about fires within the Black Hills, and Appendix E contains additional information on the community tree inventories. Surveys designed to help identify the state's priority areas, threats, and strategies are provided in Appendices F and G.

MAJOR FOREST TYPES IN SOUTH DAKOTA

For this report, analysis was performed to obtain forest areas, extents, ownership, and composition in two different ways. The graphs and tables that summarize areas and quantities were derived using FIA data. The maps were created by the RC&F Division using Geographic Information Systems (GIS) with National Land Cover Data (NLCD) from 2001. Data sources and layer construction methods used for the GIS analyses are given in Appendix B. For both analyses, major forest types in South Dakota were separated into five categories:

- Coniferous
- Upland hardwood
- Bottomland
- Shelterbelts and windbreaks
- Urban and community forests.

FIA data were accessed using the United States Forest Service (USFS) Forest Inventory Data Online (FIDO) Analysis Tools 2.0 [U.S. Department of Agriculture, 2009a]. FIDO queries FIA data to build user-defined tables. One-fifth of forest plots in the FIA are surveyed each year; after 5 years of surveying, the cycle starts again. All acreages given in this report, unless cited otherwise, were retrieved from FIDO queries of the FIA data using the 2008 survey year. A 2008 query will return a summary of the data from the previous 5-year period (Years 2004–2008) of the FIA survey rotation.

Because FIDO does not cluster FIA data into the forest types given above, data were combined manually from FIA-defined forest-type groups into the three general forest types: coniferous, upland hardwood, and bottomland. The classification scheme is listed below.

- Coniferous
  - White spruce
  - Eastern redcedar
  - Rocky Mountain juniper
  - Ponderosa pine
  - Nonstocked.
- Upland Hardwood
  - Bur oak
  - Mixed upland hardwoods
  - Sugar maple/beech/yellow birch

  - Aspen
  - Paper birch
  - Eastern redcedar/hardwood
  - Elm/ash/black locust
  - Sugarberry/hackberry/elm/green ash
  - Other hardwoods
  - Other exotic hardwoods.
- Bottomland
  - Cottonwood
  - Cottonwood/willow.

Because it is not feasible to sample and evaluate all of South Dakota's 1.86 million acres of forest land, the FIA process is to sample many small, widely spaced plots of different types of forest across the state and apply the resulting information to the entire forest. This methodology results in coarse estimates which, in some cases, contain a high level of error, as indicated by color on FIDO query results (i.e., red values indicate that percent sampling error is greater than 50 percent). Another example of how the methodology results in errors is seen when examining estimates of forest ownership. The South Dakota Department of Game, Fish & Parks (GFP) owns upland hardwood forest in several parks and game production areas across the state, including Newton Hills and Sica Hollow, but the analysis of ownership returns zero acres of upland hardwood in state ownership. When examining FIA results, one must also bear in mind that the geographic area occupied by a forest-type group, although often named after one or more major tree species, may contain many different tree species. For example, those unfamiliar with forestry classification might assume that the "cottonwood/willow" forest-type group implies that these are the only species within the forest. However, the bottomland area occupied by this forest-type group also may contain elm, ash, Eastern redcedar, Rocky Mountain juniper, Russian olive, and other woody plants. The white spruce classification in the FIA data refers to the population of Black Hills spruce as a variety of white spruce unique to the Black Hills (*Picea glauca var. densata*); the Black Hills spruce is the state tree of South Dakota. Also, some of the FIA forest-type groups list species that do not occur in South Dakota. Beech, yellow birch, and sugarberry are not found in the state. These species will be deleted from further listings in this document.

FIA data represent a coarse sample of South Dakota's forests and is the most complete and robust dataset to evaluate and characterize South Dakota's forests for all ownerships. It is not an absolute representation of tree species, extents, conditions, or forest composition. FIA data for South Dakota could provide a better representation of South Dakota forest types with intensification of the inventory sample; that is, by adding more plots to the sample. The Black Hills National Forest and Custer State Park maintain their own inventories and should be

consulted for data specific to their ownerships, as their inventories are more complete and provide a better representation of those forests.

Other information in this report regarding forest values, threats, problems, needs, and opportunities was obtained through review of multiple documents, including many forest resource plans, fire management plans, forest reports, environmental impact statements, internet Web sites, and other sources of information.

1.0 CONIFEROUS FORESTS

1.1 DEFINITION

Coniferous forests are dominated by conifers–vascular plants that bear naked seeds. The seeds are arranged in cones, a characteristic which separates them from other gymnosperms. All cone-bearing trees have needles or scale-like leaves and are usually evergreens. Wood from these trees is known as "softwood." Boreal coniferous forests, the world's largest terrestrial biome, are spread over massive areas and are found predominantly at high altitudes or cooler climates in the northern hemisphere. Coniferous forests in South Dakota are found mostly in the Black Hills as ponderosa pine (Figure 1-1), Rocky Mountain juniper, and Black Hills spruce, although small patches of ponderosa pine, white spruce, Rocky Mountain juniper, and Eastern redcedar occur in other parts of the state.

Figure 1-1. Stand of Ponderosa Pines in the Black Hills West of Crazy Horse Monument With the Beginnings of Bark Beetle Infestation [South Dakota Department of Agriculture, 2006].

1.2 EXTENT AND CONDITION

Coniferous forests make up approximately 77 percent, or 1.44 million acres, of South Dakota's 1.86 million acres of forest land. Coniferous forest lands are shown in Figure 1-2.

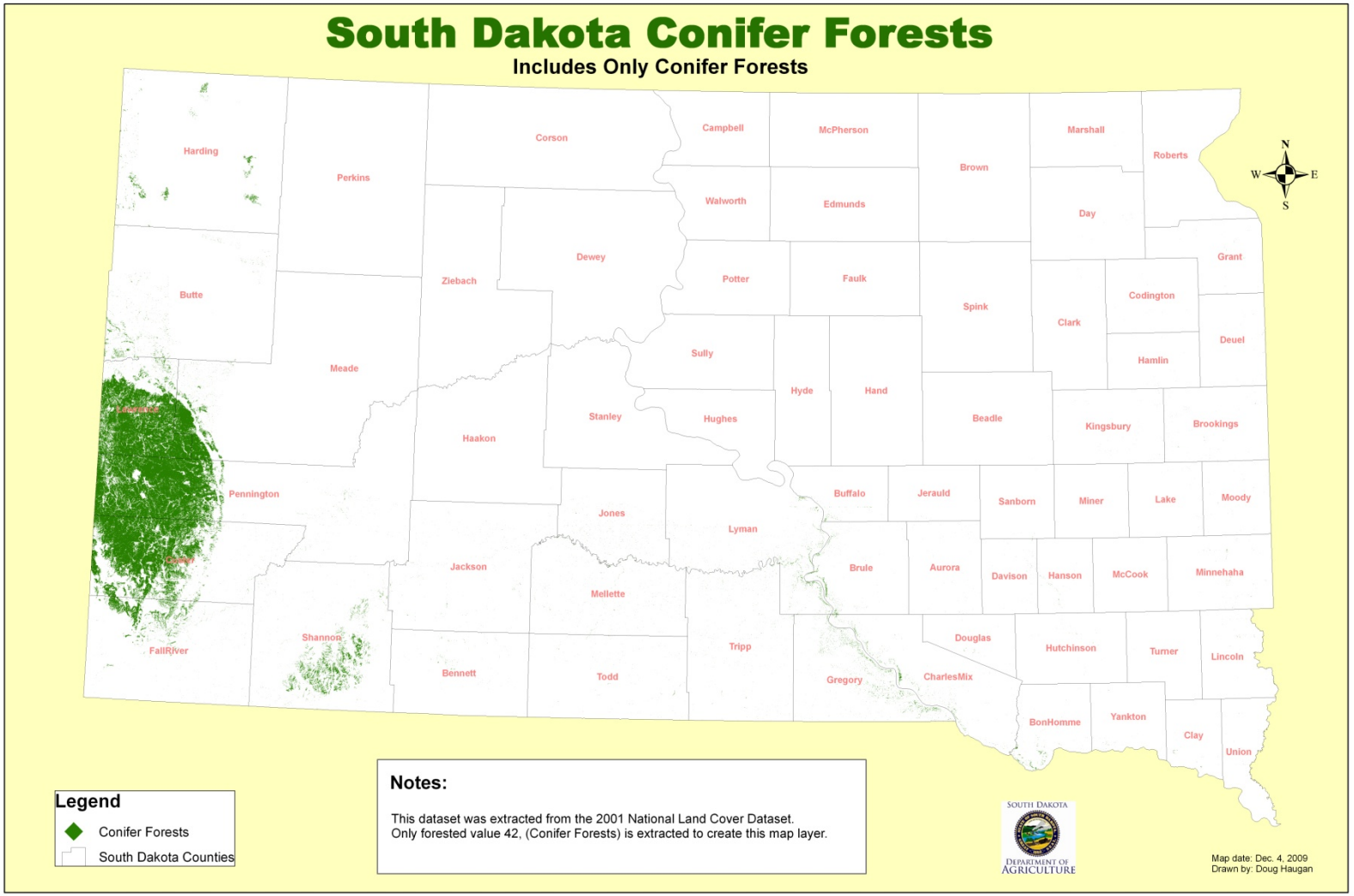


Figure 1-2. South Dakota's Coniferous Forests.

Approximately 94 percent of South Dakota's coniferous forests are in the Black Hills, with 1.17 million acres of ponderosa pine, 57,000 acres of Black Hills spruce, and 120,000 acres of nonstocked, largely because of the Black Hills' Jasper Fire that burned over 83,000 acres west of Custer in 2000. The Black Hills also contains small stands of lodgepole pine and limber pine.

Although not accurately represented by NLCD on Figure 1-2, there are also areas of mixed forest (conifer and deciduous) in Shannon, Butte, Jackson, Bennett, and Todd Counties. Ponderosa pine, Rocky Mountain juniper, and Eastern redcedar are found on the Pine Ridge and Rosebud Indian Reservations as well as in Bennett and Jackson Counties. Harding County also has ponderosa stands in the Custer National Forest and adjacent areas. Draws along the Cheyenne and Missouri Rivers are populated with Rocky Mountain juniper and Eastern redcedar. Abandoned fields and pastures support Eastern redcedar and Rocky Mountain juniper, with Eastern redcedar dominating in eastern South Dakota and Rocky Mountain juniper dominating in the west. Both species are expanding their range, especially on the uplands along the Missouri River in south-central South Dakota [Piva et al., 2009].

The age-class distribution, or stand age, is closely correlated to stand-size class as smaller trees tend to be younger with larger trees older [Piva et al., 2009]. The age of a forest is important in determining regeneration, economic potential, suitability for a particular wildlife species, insect and disease susceptibility, and past disturbances such as fire [Piva et al., 2009]. Coniferous forest age class in South Dakota is well distributed throughout the young and early-mature range (Table 1-1 and Figure 1-3). Although ponderosa pines older than 700 years have been found in the Black Hills, very few specimens over 200 years of age exist.

Black Hills ponderosa pine has a tremendous capacity to regenerate itself. The species generate a large seed crop every 3 years. Germination of seed and establishment of seedlings occurs in the spring, which is the wettest time of year. This combination of a proximate seed source, prolific seed production, and timely rainfall results in regeneration rates of up to 6,000 seedlings per acre.

Figure 1-4 shows the stocking class of the ponderosa pine forest type. Stocking is defined as the relative degree of occupancy of land by trees, measured as basal area, or the number of trees in a stand by size or age and spacing, compared to the basal area or number of trees required to fully use the growth potential of the land. South Dakota contains over 1.3 million acres of ponderosa pine timberland, with approximately 1.2 million acres in the Black Hills. Approximately 52 percent of ponderosa forest is poorly stocked, 32 percent is medium stocked, and only 7 percent is fully stocked. The balance, almost 120,000 acres (9 percent), is nonstocked mostly because of fires. Stocking class and productivity class are important measures of economic condition of the Black Hills' ponderosa pine forest because much of the ponderosa pine is in the Black Hills and the forest trees are used to supply local sawmills with timber.

Table 1-1. Area of Coniferous Forest Type by Tree Age Class, in Acres (From U.S. Department of Agriculture [2009a])

Forest Type	Tree Age Classification (years)								
	0–19	20–39	40–59	60–79	80–119	120–159	160–199	200+	Total
White spruce	–	5,833	–	24,067	14,280	12,549	–	–	**56,729**
Eastern redcedar	–	4,901	22,650	10,057	–	–	–	–	**37,608**
Rocky Mountain juniper	–	5,190	20,156	23,423	11,730	–	–	–	**60,499**
Ponderosa pine	25,737	52,207	129,339	297,465	495,165	122,563	34,547	1,657	**1,158,680**
Nonstocked	120,174	–	–	–	–	–	–	–	**120,174**
Total Acres	**145,911**	**68,131**	**172,145**	**355,012**	**521,175**	**135,112**	**34,547**	**1,657**	**1,433,690**
Percent of Total	**10%**	**5%**	**12%**	**25%**	**36%**	**9%**	**2%**	**0%**	**100%**

Note: The color of each estimated value represents its percent sampling error (pse); if value is black, pse is less than or equal to 25 percent; if value is green, pse is greater than 25 percent and less than or equal to 50 percent; if value is red, pse is greater than 50 percent.

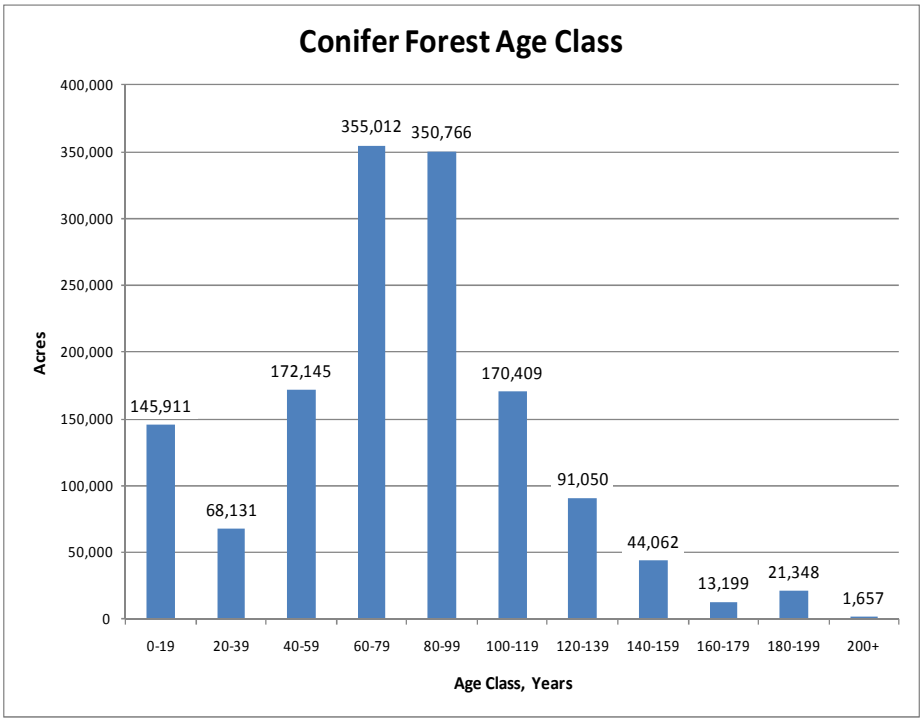


Figure 1-3. Conifer Forest Age Class.

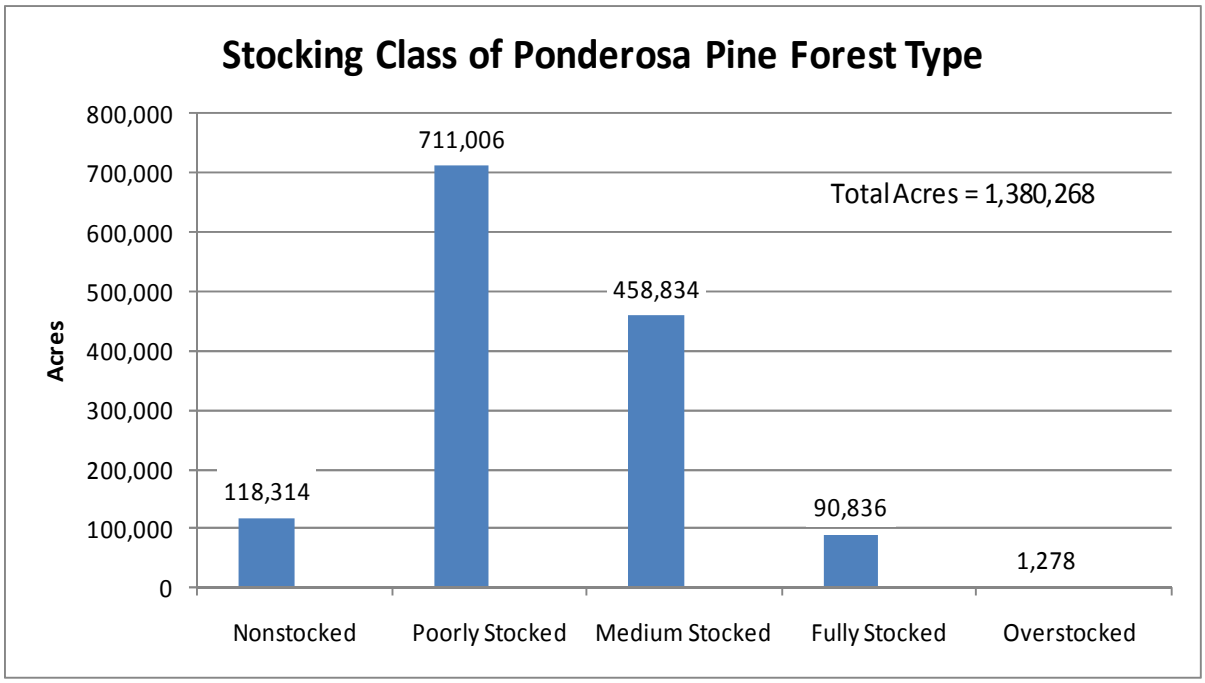


Figure 1-4. Stocking Class of Ponderosa Pine Forest-Type Group.

Figure 1-5 shows the site productivity of the ponderosa pine forest-type group, defined as the potential annual cubic volume growth per unit land area in fully stocked natural stands. Approximately 85 percent of ponderosa forest has the potential to produce between 20 and 50 cubic feet of wood per acre per year, and almost 13 percent has the potential to produce between 50 and 85 cubic feet of timber per acre per year.

1.3 VALUES

Tourism brings millions of dollars to the South Dakota economy each year. The high number of tourists that visit South Dakota each year is at least partially attributable to the coniferous forests of the Black Hills. Recreational opportunities in the forests of the Black Hills include hunting, hiking, camping, mountain biking, gold panning, skiing, snowmobile riding, fishing, and horseback riding.

Coniferous forests provide valuable wildlife forage and cover. Evergreen forests in South Dakota are a haven for deer; elk; turkeys; mountain lions; coyotes; bighorn sheep; and numerous smaller animals such as squirrels, porcupines, raccoons, rabbits, skunks, mice, bats, and birds. Conifers provide food directly for squirrels, birds, and porcupines and indirectly for a number of other forest animals. Coniferous forests host a variety of insects which are an important part of the forest food web. Several mammal species and many bird species make their homes in conifers.

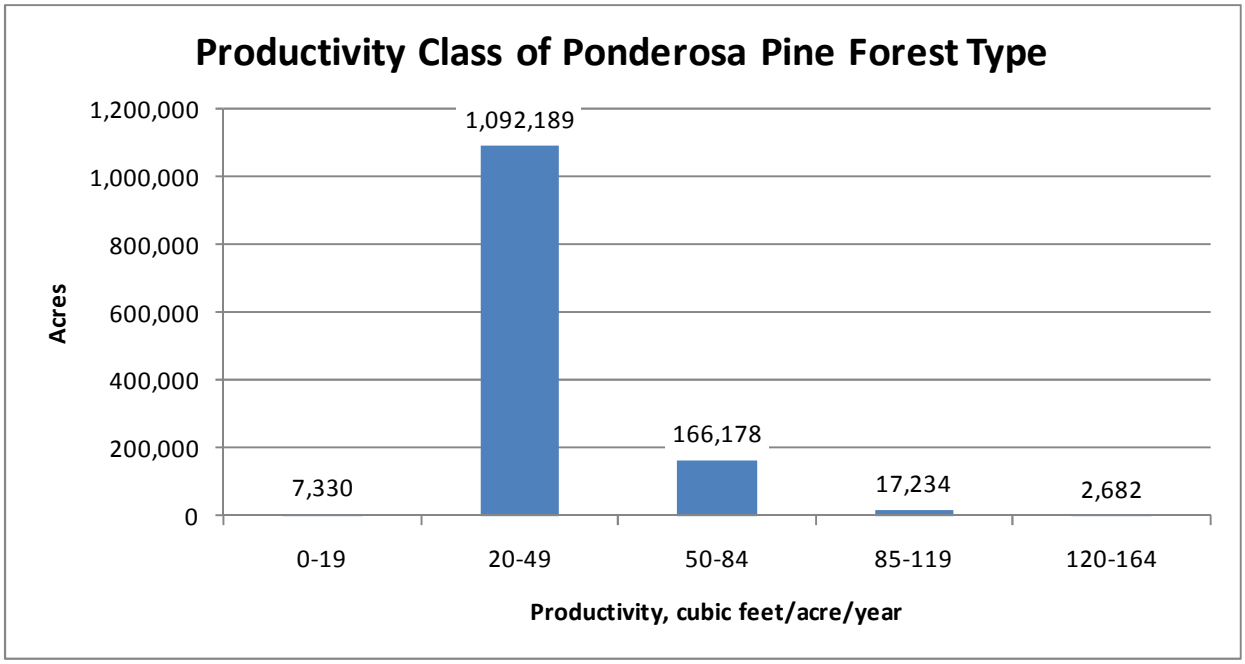


Figure 1-5. Site Productivity Class of Ponderosa Pine.

The Black Hills coniferous forests are leased by ranchers to graze cattle. In the Black Hills National Forest in 2009, 260 permittees leased 90 percent of the 1.16 million acres of federal forest land. In Harding County, approximately 74,000 acres of Custer National Forest are open to lease for grazing. Grazing also occurs on many of the 308,000 acres of private coniferous forest land. In 2007, cattle receipts in Lawrence County totaled nearly 12 million dollars. [U.S. Department of Agriculture, 2009b]. Lawrence County, being over 90 percent conifer forest, is a good indicator of potential value of conifer forest land to grazing. Other South Dakota counties that host grazed conifer forests are Harding, Meade, Pennington, Custer, and Fall River. Grazing also reduces fire danger by removing fuels and maintains the ecology of the pine savannah which developed under grazing pressure.

Conifer forests are important to water-quality protection. Tree canopies and forest litter protect soils from erosion by dispersing rain and slowing runoff. Conifer forest litter has a high capacity to absorb water. Roots protect soils from erosion by providing a matrix for soil cohesion and stability. All of these factors play a role in reducing erosion and the amount of sediments that enter waterways. This is particularly important in areas such as the Black Hills that have salmonid and other fish species that need clean, silt-free gravel beds for spawning and reproduction.

Forest industry is a major economic contributor to the state's economy. Ponderosa pine is extensively used in the Black Hills for dimension lumber, boards, decking, shop, poles, posts, log homes, and other products such as firewood. Mill residue created through the industrial

processing of timber is used in fiber products, industrial fuel, domestic fuel, livestock bedding, and mulch. Conifers are also used for Christmas trees. Most of the sawmills in South Dakota and several forest products businesses exist in and around the Black Hills, including in the towns of Belle Fourche, Sturgis, Whitewood, Pringle, Newell, Spearfish, Hill City, and Rapid City. These sawmills directly employ hundreds of people. The forest products industry also provides revenue for private landowners that wish to generate income from treed land. In addition to the economic benefits provided by forest products, the industrial infrastructure provides opportunities to conduct vegetative management treatments on all ownerships that would otherwise not be possible, except at great expense.

A potential for biomass value exists in the Black Hills because of conifers. In 2006, woody biomass boiler feasibility studies were undertaken at six schools in the Black Hills area. Three of the systems were found to be immediately feasible; the other three cases would require changes to the existing facilities before they would be feasible. Study results showed that costs would be recapped over a 30-year life expectancy [South Dakota Department of Agriculture, 2006]. Even with the industrial infrastructure that exists, woody biomass is still underused. In 2004, harvesting of industrial roundwood products left over 8.8 million cubic feet of residues on the ground [Piva et al., 2004]. Skog et al. [2008] estimates that there are over 112,000 oven-dry tons per year of biomass available in South Dakota.

The Black Hills National Forest estimates 93,512 bone dry tones of wood residues are created each year from whole tree harvesting in the Black Hills National Forest (BHNF) [Cook, 2009]. These residues form 1,600 slash piles each year, and there is an estimated 3-year backlog of piles on the forest. Custer State Park estimates they create 4,733 bone dry tones of recoverable wood biomass residues following timber harvest each year [Hill, 2006]. In the absence of an industry to use these residues, they are burned as weather allows to reduce the fire hazard.

The Black Hills are a valuable cultural resource. The name “Black Hills” is a translation of the Lakota “Paha Sapa,” so-called because of the black appearance from the surrounding plains because of the conifer forest. Today, Paha Sapa remains a sacred place in Lakota and Cheyenne culture where it is considered the center of the world. Lakota and previous indigenous tribes left petroglyphs, pictographs, fire rings, burial mounds, and other artifacts. The Black Hills is also home to more recent cultural resources, including evidence of the Custer expedition, flume trails from mining, and ghost towns.

1.4 THREATS

Based on the documents reviewed, the largest threats to South Dakota’s coniferous forests are insect infestation, disease, and fires. Other threats and problems include fragmentation, forest health, weeds and invasive species, water quality and quantity, climate change, lack of species diversity in planted forests, lack of wood products industry, and loss or degradation of

wildlife habitat. These can also combine to increase the relative threat from each individual threat. For example, fires that occur in areas of heavy tree mortality because of pine beetle infestations can burn hotter because of the high concentration of dry, dead timber. Also, beetles may be attracted to trees that are weakened by fire damage [Sieg et al., 2006].

The mountain pine beetle (*Dendroctonus ponderosae)* is a native species across much of western United States, Canada, and Mexico and is about the size of a grain of rice. The beetles prefer large trees that are in a state of stress, typical of heavily stocked areas where competition for sunlight and water exists. Heavy stocking also makes it easier for the beetle to migrate and attack nearby trees. The beetle attacks ponderosa pine, lodgepole pine, and limber pine and kills trees by boring into and feeding on the phloem layer and infecting the tree with the blue stain fungi, which blocks the tree's natural resin response. The current beetle epidemic began in 1996, with approximately 1,500 trees killed [Ball and Foss, 2009]. In 2001, it is estimated that over 450,000 trees were killed by these beetles [Piva et al., 2007]. The beetles continue to spread, with areas around Harney Peak being recently infested (Figure 1-6); in some areas, there is almost 100 percent mortality. The mountain pine beetle is the most serious threat to pines throughout the Black Hills.

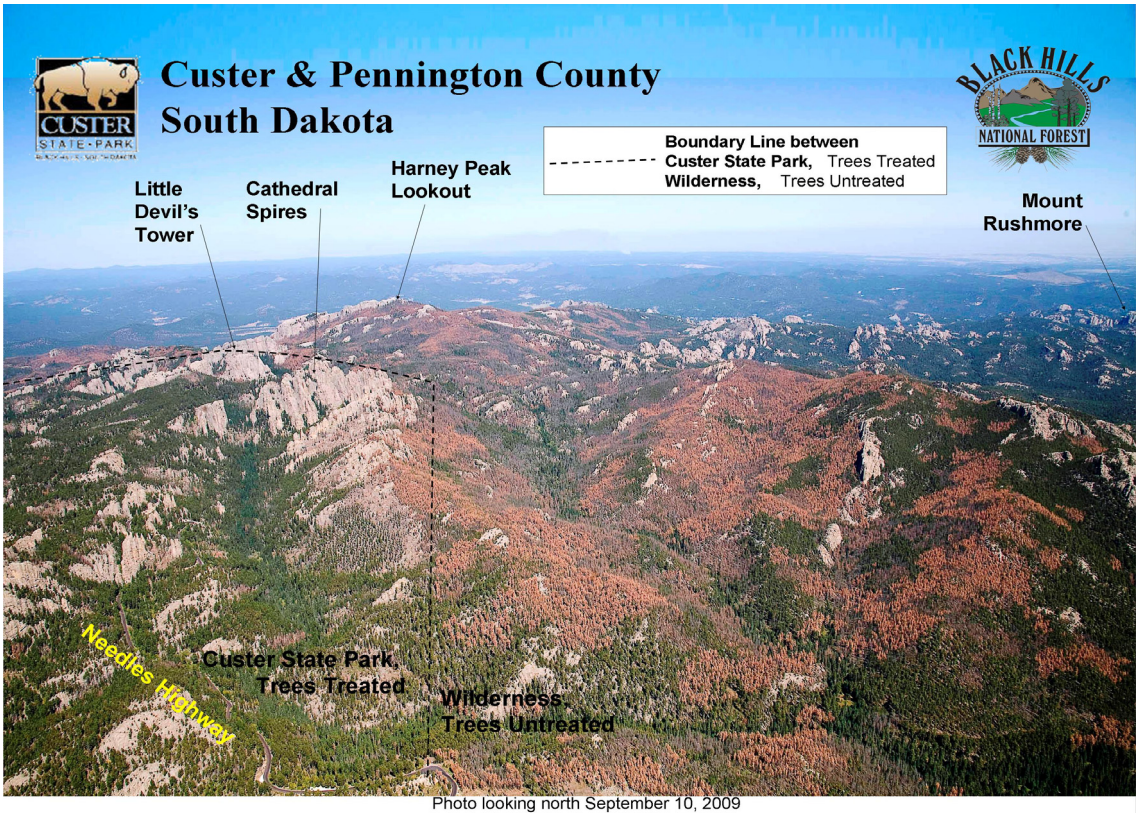


Figure 1-6. Effects of the Rocky Mountain Pine Beetle Infestation in the Central Black Hills [U.S. Forest Service, 2009]. Successful efforts to reduce the beetle migration into the park include "the cutting of a buffer strip between the wilderness and the park, spot baiting the park, and treating infested trees" [Ball and Foss, 2009].

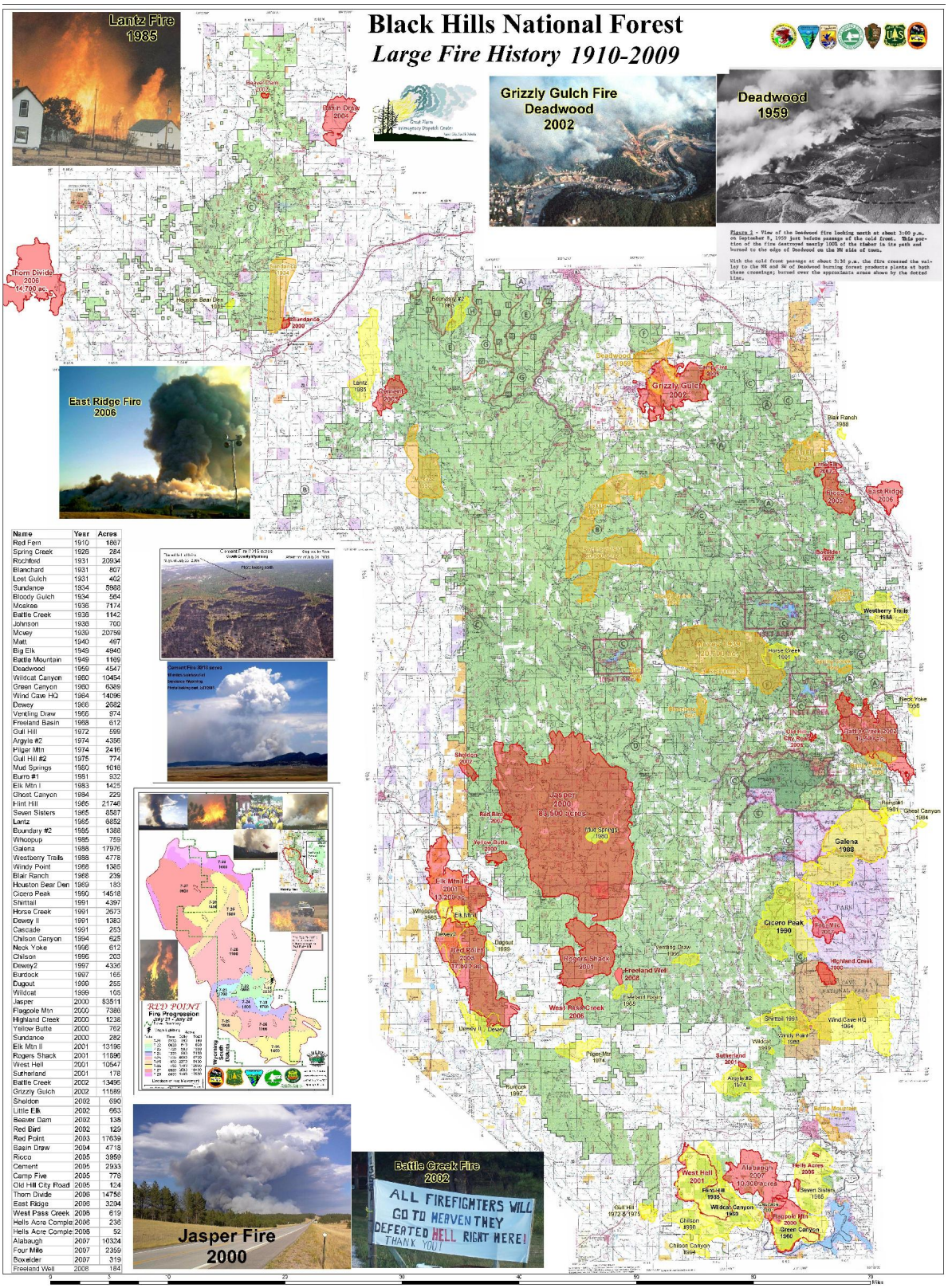
The pine engraver beetle (*Ips pini*) also kills ponderosa and lodgepole pine trees that are stressed or damaged by wind, snow, fire, or lightning. The engravers prefer slash, but will take to smaller trees, saplings, or the tops of larger trees when slash volume is limited, when slash becomes too dry, or when populations get very high. Other insects that pose problems in conifer forests include the cedar bark beetle, pine needle scale, pine sawfly, pine tip moth, spruce needleminer, spruce spider mite, and the Zimmerman pine moth.

Diplodia tip blight is a disease caused by the fungus *Sphaeropsis sapinea* that affects ponderosa pine statewide. Usually older, stressed trees are affected and repeated infections can lead to death of the tree. It is a common disease of pine windbreaks and has increased in incidence to 300 acres in the Black Hills in 2003 [Ball et al., 2003]. Blight, another fungus that kills the foliage on conifers, primarily affects firs, spruce, and occasionally juniper [Ball and Foss, 2009]. Other diseases that can be a minor problem in coniferous forests in South Dakota are cedar-apple rust, cytospora canker, dothistroma needle blight, elytroderma needle cast, juniper blight, and western gall rust.

Forest fires are a large threat to the conifer forest type in South Dakota and the development which has occurred in the wildland urban interface (WUI). Historically, natural and anthropogenic fire thinned the trees with small fires and large-stand replacing fires. Figure 1-7 is a map showing areas of major fires within the Black Hills between 1910 and 2009. Wildfires have occurred throughout history with the largest occurring during drought periods and fire occurrence more frequent in the dryer portions of the southern Black Hills. Additional information about wildfires in the Black Hills is presented in Appendix D.

The arrival of settlers in western South Dakota in the late 1800s brought the beginning of fire suppression and the end of anthropogenic fire for management. Fire was replaced by mechanical efforts to thin trees, with the objective of removing most trees while leaving some to grow to maturity. In the absence of fire, fuel buildup within conifer forests can create a multitude of problems [Arno and Brown, 1991]. Prescribed fire has been practiced since the 1970s. Still, most thinning is done mechanically. First done with axes and hand saws, now thinning is done with a combination of chainsaws, shearers, and mulchers. Fire has returned as an important management tool to eliminate residues from thinning and to accomplish other management objectives such as wildlife habitat improvement. Even with active fire suppression and mechanical thinning, fire continues to be part of the landscape.

As a result of land fragmentation, fire not only threatens forests and trees, it also threatens homes that are built within treed areas. The Black Hills is home to 1.2 million acres of national forest land interlaced with a patchwork of private land where development is continuing to take place. Fire suppression is necessary to protect homeowners because the Black Hills are highly developed. Wildfire, except in the most remote areas of the state, almost immediately threatens homes. If allowed to burn, the fires will eventually threaten homes or towns.



Name	Year	Acres
Red Fern	1910	1887
Spring Creek	1926	284
Rochford	1931	20934
Blanchard	1931	807
Lost Gulch	1931	402
Sundance	1934	5988
Bloody Gulch	1934	564
Moskee	1936	7174
Battle Creek	1936	1142
Johnson	1936	700
Mosey	1939	20758
Matt	1940	467
Big Elk	1949	4940
Battle Mountain	1949	1169
Deadwood	1959	4547
Wildcat Canyon	1960	10454
Green Canyon	1960	6389
Wind Cave HQ	1964	14096
Dewey	1966	2682
Vending Draw	1966	974
Freeland Basin	1968	612
Gulf Hill	1972	599
Argyle #2	1974	4356
Piger Mtn	1974	2416
Gulf Hill #2	1975	774
Mud Springs	1980	1016
Burro #1	1981	932
Elk Mtn I	1983	1425
Ghost Canyon	1984	229
Flint Hill	1985	21746
Seven Sisters	1985	8507
Lantz	1985	6852
Boundary #2	1985	1388
Whoopup	1985	759
Galena	1988	17976
Westberry Trails	1988	4778
Windy Point	1988	1385
Blair Ranch	1988	239
Houston Bear Den	1989	183
Cicero Peak	1990	14518
Shirttail	1991	4397
Horse Creek	1991	2673
Dewey II	1991	1383
Cascade	1991	253
Chilson Canyon	1994	625
Neck Yoke	1996	612
Chilson	1996	203
Dewey2	1997	4336
Burdock	1997	165
Dugout	1999	255
Wildcat	1999	105
Jasper	2000	83511
Flagpole Mtn	2000	7386
Highland Creek	2000	1236
Yellow Butte	2000	762
Sundance	2000	282
Elk Mtn II	2001	13196
Rogers Shack	2001	11996
West Hell	2001	10547
Sutherland	2001	178
Battle Creek	2002	13496
Grizzly Gulch	2002	11589
Sheldon	2002	690
Little Elk	2002	663
Beaver Dam	2002	138
Red Bird	2002	129
Red Point	2003	17639
Basin Draw	2004	4718
Ricco	2005	3959
Cement	2005	2933
Camp Five	2005	776
Old Hill City Road	2005	124
Thorn Divide	2006	14758
East Ridge	2006	3294
West Pass Creek	2006	619
Hells Acre Comple	2006	236
Hells Acre Comple	2006	52
Alabaugh	2007	10324
Four Mile	2007	2359
Boxelder	2007	319
Freeland Well	2008	184

Figure 1-7. Black Hills Fire History Map [Marchand, 2010].

All counties in the Black Hills have prepared Community Wildfire Protection Plans (CWPP), including Butte, Custer, Fall River, Lawrence, Meade, and Pennington. Perkins and Harding Counties, although outside of the Black Hills, have also prepared a CWPP. These plans all have the same general objectives and goals, including fire management and suppression by reduction of litter, slash, and ladder fuels, and managing forests in such a way as to create open spaces and reduce densities. Areas of WUI within the Black Hills National Forest based on CWPPs are presented in Figure 1-8. Virtually all of the Black Hills fall within a 3-mile radius of a WUI. Vegetative treatment recommendations for these interface areas are presented in Table 1-2. All goals and objectives in the CWPPs are designed to reduce risk. CWPPs need to be considered when forest management agencies are developing forest planning documents, writing environmental impact statements, consulting landowners for input on management plans, and planning logging activities.

Aurora, Brown, Charles Mix, Day, and McPherson Counties have Comprehensive Fire Management Plans that were prepared in 2004 and 2005. With the exception of Charles Mix County, these counties have little or no forest land. Charles Mix County has deciduous forest along the Missouri River and some Eastern redcedar encroachment on the upper slopes and rangelands along the Missouri River. The primary threat of wildland fire is from agricultural burning and range fires. Mitigation measures include prescribed burning, grazing, creating fire breaks by disking and harrowing, mowing, and cultivation of shelterbelts.

1.5 OWNERSHIP

Two-thirds of the coniferous forests in South Dakota are on national forest land, most of which is in the Black Hills, but includes some land in Harding County in Custer National Forest (Table 1-3). The “Other Federal” forest lands are primarily National Park Service (Wind Cave, Jewel Cave, Mount Rushmore) and Bureau of Land Management (BLM). Private ownership constitutes approximately 23 percent of coniferous forests in South Dakota, which includes areas in the Black Hills; Indian reservation land; and breaks and draws containing Eastern redcedar and juniper, mostly along the Cheyenne River, White River, and the lower Missouri River. South Dakota has over 56,000 acres of white spruce forest type, all of which is in the Black Hills. Most of the state ponderosa pine is located in the Black Hills and Harding County.

In the Black Hills, private lands form a lattice network throughout the National Forest System lands. Many of these private lands are being subdivided and developed, which continually increases the threat of wildfire to homes. This in turn precludes “let burn” policies that have been adopted on the more remote national forests in the west.

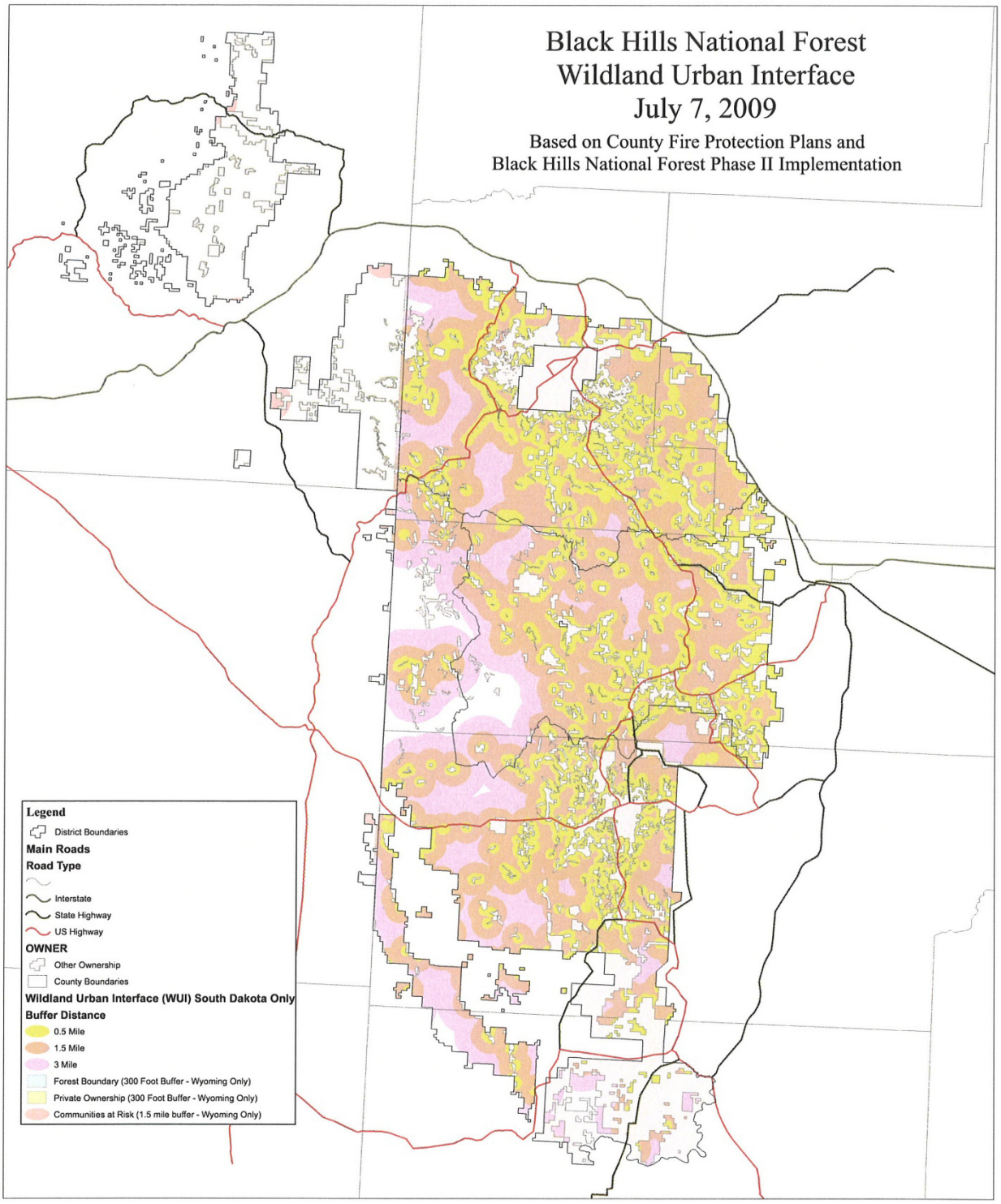


Figure 1-8. Black Hills National Forest Wildland Urban Interface Map [Black Hills National Forest, 2010].

Table 1-2. Community Wildfire Protection Plan Vegetative Treatment Recommendations

County	½-Mile Buffer	1½-Mile Buffer	3-Mile Buffer
Fall River	20-foot-crown spacing, eliminate ladder fuels, treat surface fuels	9-foot crown spacing	Treat to reduce probability of high-intensity wildfire (crownfire)
Lawrence	20-foot-crown spacing, eliminate ladder fuels, treat surface fuels	10-foot crown spacing	Treat to reduce probability of high-intensity wildfire (crownfire)
Meade	60-foot burn area, all slash removed	80-foot burn area, remove ladder fuels close to private property	Treat to reduce probability of high-intensity wildfire (crownfire)
Pennington	20-foot-crown spacing, eliminate ladder fuels, treat surface fuels	10-foot-crown spacing	Treat to reduce probability of high-intensity wildfire (crownfire)
Custer	Encourage subdivision associations to adopt covenants, provide direction to property owners on an individual basis, encourage adoption of Firewise principles.		
Perkins	Establish fireguards, maintain road ditches, maintain windbreaks, create fuel breaks, establish survivable space around homes		
Butte	Establish firebreaks, planned grazing, mowing ditches and driveways, maintain windbreaks, plant windbreaks with fire-resistant species, thin pine trees		

1.6 NEEDS, PROBLEMS, AND OPPORTUNITIES

Conifer forests are the predominant forest type in South Dakota. Despite the abundance of data available, additional needs, problems, and opportunities are described further.

- Much of the forest in the United States is made up of a patchwork of various ownerships. Increases in housing density and development are creating a greater fragmentation and strain on wildlife habitats and general forest health [Stein et al., 2005]. Within South Dakota, and especially the Black Hills, development is rapidly increasing on private forest lands and immediately adjacent to national forests. As housing density increases and lands become fragmented, a number of negative impacts may result, including reduction in wildlife habitat and browse, increases in human/wildlife conflicts, reduction in habitat connectivity, poorer water quality, and reduced outdoor recreational opportunities [Stein et al., 2007]. This patchwork of land holdings in the Black Hills provides an opportunity to develop a model for shared land management on a landscape scale between private landowners, the state, and the federal government. Laws and regulations to manage federal public lands should be flexible enough to allow for local collaborations that provide for cultural resource and environmental protection, sustainable timber harvest, livestock grazing, mining, wildlife habitat, and recreation.

Table 1-3. Coniferous Ownership by Forest-Type Group (From U.S. Department of Agriculture [2009a])

Forest-Type Group	National Forest	National Park Service	Bureau of Land Management	Other Federal	State	Local (County, Municipal)	Undifferentiated Private	Total
White spruce	52,169	–	4,559	–	–	–	–	**56,728**
Eastern redcedar	–	–	–	4,569	–	–	33,038	**37,607**
Rocky Mountain juniper	11,677	–	15,710	5,487	–	–	27,625	**60,499**
Ponderosa pine	815,955	10,380	13,350	21,025	57,599	–	247,129	**1,165,438**
Nonstocked	77,240	–	–	4,378	13,105	–	25,452	**120,175**
Total Acres	957,041	10,380	33,619	35,459	70,704	–	333,244	**1,440,447**
Percent of Total	66%	1%	2%	3%	5%	0%	23%	**100%**

Note: The color of each estimated value represents its percent sampling error (pse); if value is black, pse is less than or equal to 25 percent; if value is green, pse is greater than 25 percent and less than or equal to 50 percent; if value is red, pse is greater than 50 percent.

- As a result of the mountain pine beetle, drought conditions, and fire, there is an abundance of coniferous forest land in the Black Hills that is in need of increased forest management. Many dead trees remain standing with additional unburned slash and increasing litter density. Many ponderosa pine stands are also overcrowded and in poor general health. This issue crosses county, state, and federal agency jurisdictions, but there is a need to take action and an opportunity for collaboration. Funding must be acquired and action taken to limit the spread of insect infestations, increase forest thinning in the densest stands, and remove dead tree stands and forest litter. The availability of wood biomass residues remaining in the forest following timber harvest and other silvicultural operations provides an opportunity for product development or energy production.

- There is an opportunity for an expansion of the prescribed burning program, particularly for fuels reduction and habitat modification. There is also a need for an improved wildfire assessment map that more accurately reflects the effects of fire, weather, and topography. Additionally, most counties within the Black Hills have CWPPs, but there is an opportunity for each county to reduce the likelihood and severity of fires while working with other county, state, and federal agencies.

- Across the state, there is still a need for additional research and information relating not only to the forest health, but also its role in the entire ecosystem.

2.0 UPLAND HARDWOOD FORESTS

2.1 DEFINITION

Upland hardwood forests occur outside of floodplains where drainage is sufficient so that soils do not become saturated for extended periods of time. Tree canopy in upland forests is usually dense, so shade-tolerant species are prevalent. Upland hardwood forests in South Dakota are dry to mesic and support species such as bur oak, black walnut, basswood, maple, aspen, green ash, and box elder.

2.2 EXTENT AND CONDITION

Upland hardwood forests make up approximately 19 percent, or 360,000 acres of South Dakota's 1.86 million acres of forest lands. Upland hardwood forest range and extent is shown in Figure 2-1. The majority of upland forests are populated by the forest types bur oak, elm-ash-black locust, hackberry-elm-green ash, and aspen (Figure 2-2). Other upland forests include the maple and basswood type forests in eastern South Dakota [Piva et al., 2009]. Areas in South Dakota with concentrated upland forests are western Harding County; the northern Black Hills and central Pennington County; northwestern Bennett County; western Todd County; eastern and northeastern South Dakota; and outside of floodplains along some reaches of the Cheyenne River, Big Sioux River, Belle Fourche River, James River, White River, and the southern portion of the Missouri River. It should be noted that some of the forest land identified in Figure 2-1 is not accurately represented by NLCD as there are also areas of mixed forest (conifer and deciduous) in Shannon, Butte, Jackson, Bennett, and Todd Counties.

Age-class analysis shows that approximately 73 percent of South Dakota's upland hardwood forests fall into the 40- to 100-year range (Table 2-1 and Figure 2-3). Only aspen and "other hardwoods" have stands in the seedling-sapling range of 0 to 20 years, implying declining regeneration of upland forest.

Bur oak, at more than 88,000 acres, is widely distributed in South Dakota and is the only native oak found throughout most of the state. Bur oak is found in eastern South Dakota along stream bottomlands, draws, and upper slopes; in dry prairie uplands in central South Dakota; and in the foothills and hogback draws of the Black Hills [Leatherberry, et al., 2000]. Age-class analysis of bur oak suggests that sapling size trees are not dominant anywhere, while 38 percent of stands are in the 40–80-year age class, and 57 percent of stands are older than 80 years (Figure 2-4). The age-class value used by FIA, however, is the midpoint of the age class based on the dominant and codominant trees or the ages of trees within the recorded stand size class. Thus although trees of a wide variety of ages may be present in any given stand, only one age class is recorded. Leatherberry et al. [2000] states that over 75 percent of the area of bur oak types supported stands that were at least 40 years old, but 54 percent of the area also supported sapling-seedling stands. This shows good regeneration and the ability to dominate on drier sites.

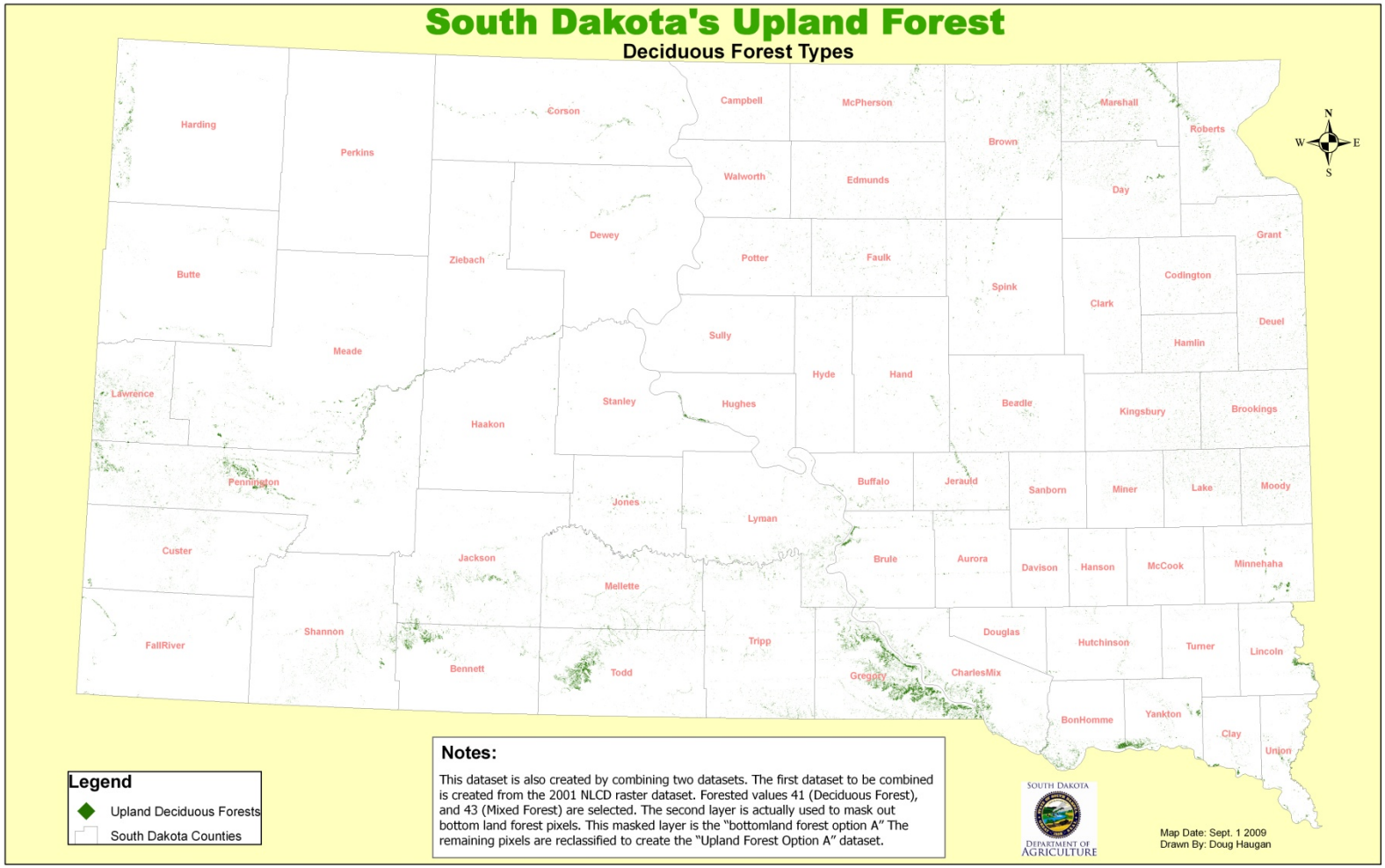


Figure 2-1. South Dakota's Upland Forests.

Figure 2-2. Newton Hills State Park in Southeastern South Dakota [South Dakota Department of Agriculture, 2006].

Table 2-1. Area of Upland Forest by Tree Age Class, in Acres (From U.S. Department of Agriculture [2009a])

Forest Type	Tree Age Class (years)						
	0–19	20–39	40–59	60–79	80–99	100–119	Total
Eastern redcedar/hardwood	–	–	7,672	–	–	–	**7,672**
Bur oak	–	4,743	19,872	13,198	27,464	23,310	**88,588**
Elm/ash/black locust	–	9,184	15,070	5,754	24,993	5,487	**60,489**
Mixed upland hardwoods	–	–	–	1,405	–	3,942	**5,347**
Hackberry/elm/green ash	–	5,487	41,501	22,044	24,805	–	**93,837**
Sugar maple	–	–	–	8,791	–	–	**8,791**
Aspen	7,045	3,833	19,577	–	11,677	–	**42,132**
Paper birch	–	–	–	–	–	6,274	**6,274**
Other hardwoods	5,837	4,775	1,478	–	5,110	10,146	**27,346**
Other exotic hardwoods	–	5,910	15,358	–	–	–	**21,268**
Total Acres	**12,882**	**33,932**	**120,528**	**51,192**	**94,049**	**49,159**	**361,744**
Percent of Total	**4%**	**9%**	**33%**	**14%**	**26%**	**14%**	**100%**

Note: The color of each estimated value represents its percent sampling error (pse); if value is black, pse is less than or equal to 25 percent; if value is green, pse is greater than 25 percent and less than or equal to 50 percent; if value is red, pse is greater than 50 percent.

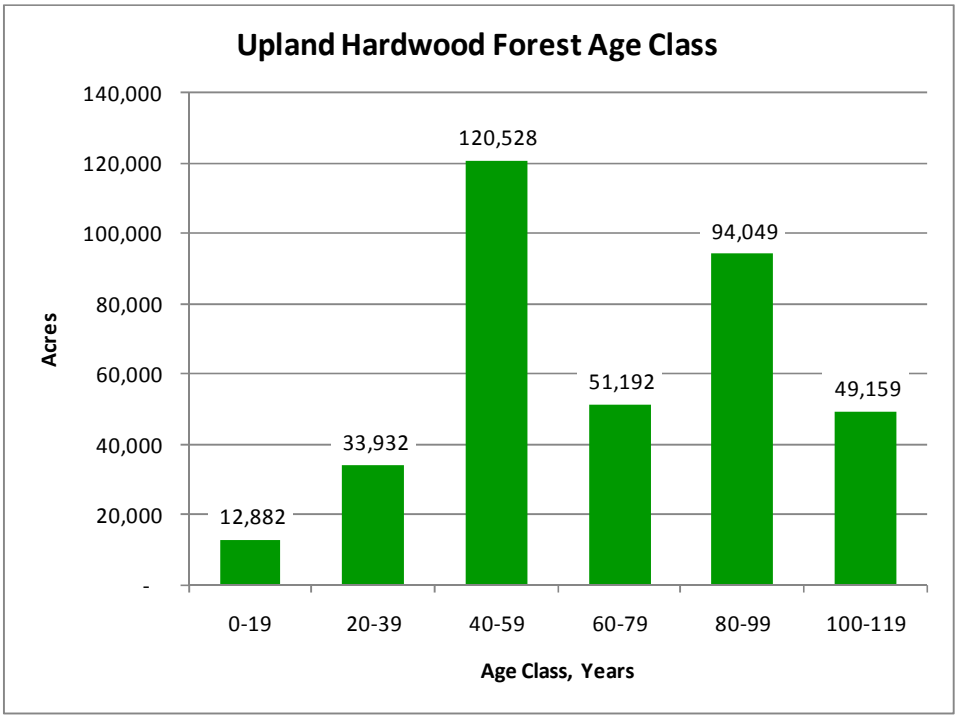


Figure 2-3. Upland Hardwood Forest Age Class by Total Acres.

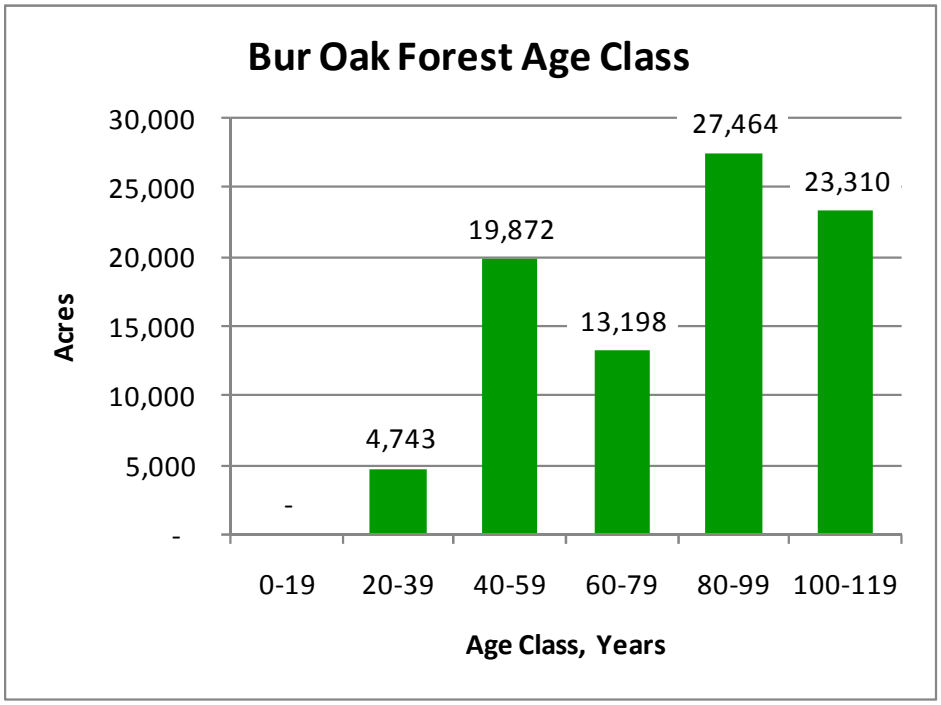


Figure 2-4. Bur Oak Forest Type Age Class.

The aspen-birch forest type is found mostly in the Black Hills with some occurrence in the northeast corner of South Dakota. It occupies more than 48,000 acres and is in relatively pure stands [Leatherberry et al., 2000]. In Custer State Park, bur oak and quaking aspen are the most abundant hardwood species with approximately 1,500 acres [Walker et al., 1995]. The aspen-birch type in the Black Hills has approximately 35 percent of its area in young stands, which suggests natural regeneration (Figure 2-5). Although disturbances (chiefly fire) that aid in aspen regeneration by reducing competition from softwoods and encouraging root suckering have declined, evidence suggests that aspen communities are very stable and the total area of this type may be expanding [Piva et al., 2009]. The sugar maple forest type accounts for approximately 8,800 acres of private upland forest, all of which is in the 60–79-year age class.

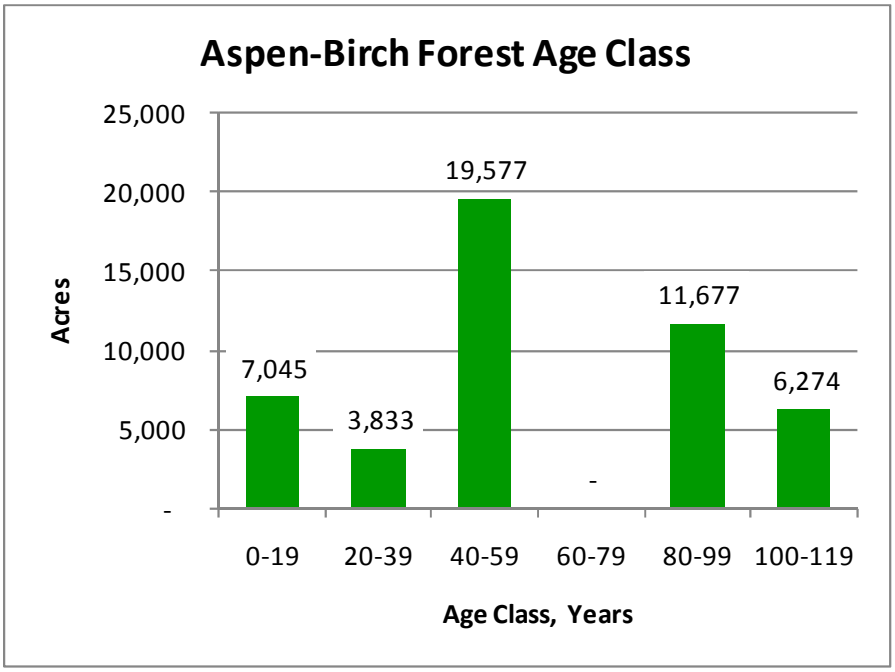


Figure 2-5. Aspen-Birch Forest Type Age Class.

Green ash and elm show good regeneration with just over 50 percent of stands of medium diameter and relatively equally proportions of small- and large-diameter tree stands. Although the early age class is missing in the data, the fairly homogenous age distribution of the 60,500 acres of elm-ash-black locust forest type (Figure 2-6) and the 93,800 acres of hackberry-elm-green ash forest types (Figure 2-7) implies good regeneration of trees in these forests. Younger trees are likely present but do not dominate sampled plots.

Leatherberry et al. [2000] states that there are approximately 5,000 acres in the maple-basswood forest type occurring in the eastern side of the state. In areas of the Coteau, the upland forest is expanding out of the woody draws and onto the surrounding uplands. This is likely because of the lack of any disturbance, such as grazing or fire, to prevent the spread.

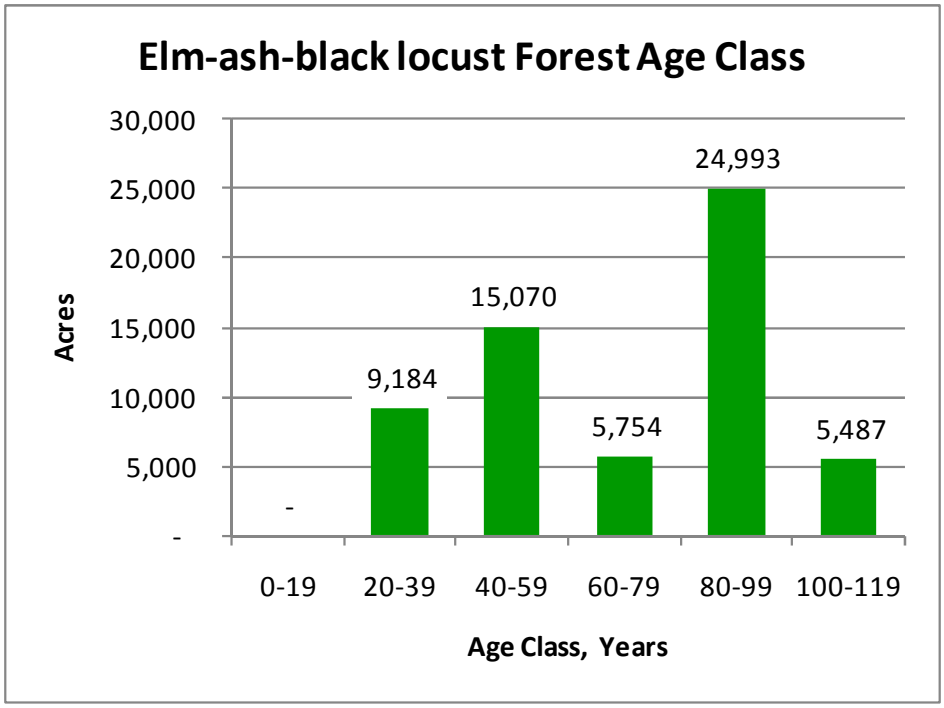


Figure 2-6. Elm-Ash-Black Locust Age Class.

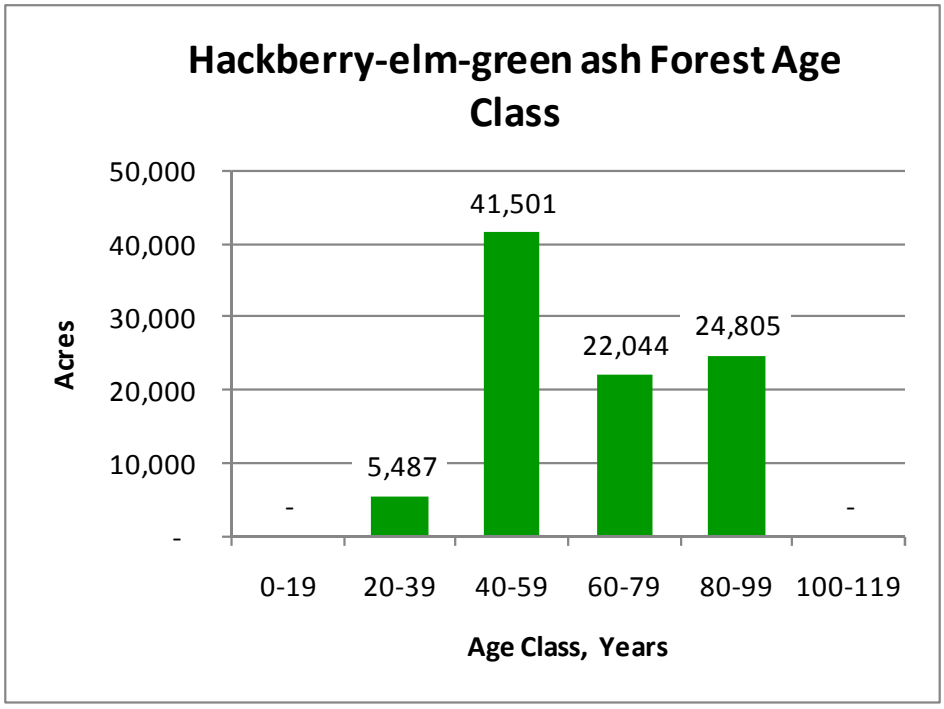


Figure 2-7. Hackberry-Elm-Green Ash Forest Age Class.

The RC&F conducted a project in 2001 and 2002 to determine the extent of Eastern redcedar encroachment on range, crop, and forest lands along eight counties of the lower Missouri River and to determine the economic potential for utilization of forest resources [Stukel, 2002]. Results indicate that the draws, slopes, and drainages along the Missouri River are dominated by hardwoods forest. Eastern redcedar appears to dominate the upper slopes between the hardwoods and the uplands and is aggressively encroaching on the upper third of slopes and onto the rangelands. Cottonwood regeneration was almost nonexistent, with zero percent of the 0–3- and 4–7-inch diameter at breast height (dbh) classes, although cottonwood represented a large fraction of tree volume in the bottomlands with 95 cubic feet per acre. Within the forests, bur oak has the largest volume at 101 cubic feet per acre and also had the highest tree count of trees with dbh of 8 inches or greater. Ash had the greatest total volume at 3.8 million cubic feet.

2.3 VALUES

Nonreserved stands across South Dakota are usually small and of low quality with large distances between them. Therefore, harvest of these stands is usually not cost effective and a demand market for hardwood has not evolved in South Dakota. Some hardwood use is realized on a local scale through firewood harvesting and traditional products such as boards, biomass, and post/beam timbers. There are five small primary wood processors near the Minnesota and Iowa borders (Deuel, Brookings, Minnehaha, and Lincoln Counties) that saw boards for local markets. One small sawmill and a shavings mill are located in Gregory County.

Upland hardwood forests in reserved status offer many recreational opportunities such as hunting; hiking; camping; horseback riding; relief from sun, wind, and precipitation; and wildlife forage and cover (Figure 2-8). People living in South Dakota usually place high aesthetic value on upland trees because of the limited number.

South Dakota GFP surveyed state citizens in 2002 to determine perceptions of outdoor recreation and needs of park users. In answer to the question, “How often do you consider the following qualities when deciding to go to a South Dakota park or recreation area,” respondents could check either “always consider,” “sometimes consider,” or “never consider.” In response to this question, “trees” ranked 4 out of 22, with 6 percent of respondents checking “always consider,” “scenery” ranked 3, and “water quality” ranked 2, both of which are highly influenced by forest health.

The value of upland hardwoods in the Black Hills was recognized as early as 1951. The Custer State Park Management Plan stated that bur oak has indirect value by providing shelter and cover to bees, small game, rodents, and birds; providing erosion control; and breaking up continuity of pines and spruce, thereby reducing or slowing spread of disease and insects [Walker et al., 1995]. Similarly, the 1951 plan identified the values of aspen and birch as browse and cover for forest animals, food and dam building material for beavers, winter feed for

birds, erosion control, and breaking up conifer continuity. Although the plans from 1951 and 1970 recognized the value of the hardwood types in Custer State Park, the 1981 plan was the first to indicate the importance of retaining and expanding hardwood stands by setting management goals to accomplish this objective.

Figure 2-8. Upland Forest (Photograph Courtesy of the South Dakota Department of Agriculture).

Hardwood forests are vital to water-quality protection. Tree canopies and forest litter protect soils from erosion by slowing rain and dispersing runoff. Roots also protect soils from erosion by providing a matrix for soil cohesion and stability. Live root systems act as a filtration buffer to absorb fertilizers that are applied to nearby cropland before they can enter streams. Both help to reduce the amount of sediments that enter waterways.

The eight-county inventory conducted in 2001–2002 along the lower Missouri River found that any potential for forest products manufacturing would be based primarily on use of hardwood species such as bur oak, elm, and green ash [Stukel, 2002], with the use of Eastern redcedar being secondary. Maintenance, forest management, and a market for forest products are lacking. Improvements, cooperation among landowners, and long-term commitment would be necessary to make the capital investment in forest resources feasible, such as building a local manufacturing facility.

2.4 THREATS

Threats to the upland hardwood forest type are insect infestation, disease, invasive species, drought, and land-use change and other natural factors. Several insects and diseases affect or

have the potential to affect upland hardwood forests in South Dakota [Piva et al., 2009]. These include but are not limited to the emerald ash borer (EAB); two-lined chestnut borer; poplar borers; Dutch elm disease (DED) which attacks all elm but especially American elm; oak wilt which attacks bur oak, gypsy moth, armillaria root disease; and Cytospora and Hypoxylon canker (alders and aspens). Of these, those that constitute major threats are described in more detail below.

The emerald ash borer (*Agrilus planipennis*) (EAB) was found first in Michigan in 2002 and has since been found in 11 states and as far west as St. Paul, Minnesota, in May 2009. It is estimated to have been in St. Paul for 3–5 years before it was discovered. It is the largest single threat to ash trees in North America, with 100 percent mortality rates of attacked ash trees. If trends continue, there is a high probability that the entire North American ash population will be decimated [Ball and Foss, 2009]. EAB has not been found in South Dakota at the time this report was prepared, although ash anthracnose, a common fungal disease, has been noted [Ball and Foss, 2009].

Dutch elm disease (DED) is caused by a fungus (*Ophiostoma ulmi*) that is dominantly spread by bark beetles. Once the fungus is established in a tree, it spreads rapidly, causing the tree to wilt and eventually die. In South Dakota, DED was first detected in Minnehaha County in 1967 and has since spread to every county in the state [South Dakota Department of Agriculture, 2008]. A large number of elm trees have been killed, although the rate of tree loss because of DED is currently decreasing because of programs focusing on prompt removal of infected trees [South Dakota Department of Agriculture, 2008] and the limited number of American elm left in South Dakota.

Two-lined chestnut borer (*Agrilus bilineatus*) attacks bur oaks that are in a distressed state because of drought, floods, physical damage, or disease, causing disfigurement or death in 1 to 3 years. Large infestations are found in south-central South Dakota and in Brookings, Lawrence, Lincoln, Mellette, Pennington, and Todd Counties [Ball, 2008].

Oak wilt is a disease caused by the fungal pathogen *Ceratocystis fagacearum* that can kill an otherwise healthy bur oak in 1 to several years, although some trees survive infection. It was thought that oak wilt occurrence in South Dakota was limited to a few confirmed infections in Minnehaha County [Ball, 2008], but recently it was also found in the Black Hills.

Common buckthorn (*Rhamnus cathartica*) is an invasive species native to Europe and found in South Dakota's upland hardwood forests, bottomlands, and agricultural areas in eastern and southeastern South Dakota. Buckthorn can host the soybean aphid *Aphis glycines* which winters in buckthorn and spreads to soybeans in the spring. Buckthorn is also an alternate host to oak wilt. Buckthorn can outcompete native forest plants, degrade wildlife habitat, and form impenetrable layers that shade out understory vegetation. Buckthorn lacks natural controls,

such as insects or disease, that would otherwise curb its growth and spread. Buckthorn is tolerant of many soil types.

Other threats include drought, fragmentation, climate change, livestock grazing, and other natural factors. Droughts often result in loss of upland hardwood trees by weakening the trees, making them susceptible to insects and diseases; particularly, low regeneration of bur oak may be the result of drought conditions. Fragmentation can cause loss of upland forest because of development of forested lands or expanded agricultural production. Deer commonly browse on young bur oak, causing lack of regeneration of forested lands. Competition for light can also cause lack of regeneration of bur oak, including in areas with high buckthorn occurrence.

2.5 OWNERSHIP

Almost 65 percent of the upland hardwood forest land in South Dakota is privately owned (Table 2-2). Of the remaining acreage, 33 percent is on federal land and 2 percent is owned by counties, cities, or other municipalities.

Table 2-2. Area of Upland Forest Ownership (From U.S. Department of Agriculture [2009a])

Forest-Type-Group	National Forest	Bureau of Land Management	Other Federal	State	Local (County, Municipal)	Undifferentiated Private	Total
Bur oak	–	5,837	23,374	–	–	59,377	**88,588**
Eastern redcedar/ hardwood	–	–	–	–	–	7,672	**7,672**
Elm/ash/black locust	–	–	1,372	–	8,767	50,350	**60,489**
Mixed upland hardwoods	–	–	–	–	–	5,347	**5,347**
Sugar maple	–	–	–	–	–	8,791	**8,791**
Hackberry/elm/ green ash	–	–	15,342	–	–	78,495	**93,837**
Aspen	40,354	–	–	–	–	1,778	**42,132**

Note: The color of each estimated value represents its percent sampling error (pse); if value is black, pse is less than or equal to 25 percent; if value is green, pse is greater than 25 percent and less than or equal to 50 percent; if value is red, pse is greater than 50 percent.

Gregory County has the largest amount of upland hardwood forest with 38,000 private acres near the Missouri River. Here and in most of eastern South Dakota, the upland forest is privately owned. FIA data are accurate on a statewide basis but lose accuracy when subdivided into ownership groups. For example, the South Dakota GFP owns upland hardwood forest in

several parks across the state, including Newton Hills and Sica Hollow, but the ownership analysis gives zero acres of upland hardwood in state ownership. These inaccuracies could be corrected with intensification of the inventory sample. However, at this time, the FIA data are the best statewide measure available.

2.6 NEEDS, PROBLEMS, AND OPPORTUNITIES

Despite the plethora of data available, there are still data needs to help understand and manage the forests. These needs, listed below, are not necessarily limited to upland forest.

- A better understanding of exotic and invasive plant species distributions.
- A more extensive assessment of wildlife forage and cover needs, including location of critical habitat areas.
- Intensification of inventory sample to reflect the extent and condition of state-owned upland hardwood forests.
- Upland forest management education and creation of markets.
- Expanded wood products industry.

Very little is known about the extent and condition of upland hardwood forests owned by the state. Respondents of the South Dakota GFP recreation survey indicated that trees were one of the most important factors when deciding to go to a park or recreation area, yet the extent or condition of the forest and tree resource is not described in the *South Dakota Statewide Comprehensive Outdoor Recreation Plan 2002* [South Dakota Game, Fish & Parks, 2003]. Knowledge of the condition of the state forests can help ensure they will be available for enjoyment by future generations. For example, planning for the arrival of EAB is very difficult without knowledge of the ash component of these forests.

Opportunities for forest improvement are available in the area of the eight-county inventory conducted in 2001–2002 along the lower Missouri River [Stukel, 2002]. Forest management planning could be beneficial to livestock and wildlife production. Research is needed to determine if prescribed fire could have a beneficial effect for regenerating hardwood forests. Potential for sustainable use of the forest resource exists with improved forest management. Because the ownership is rather fragmented, however, success would require coordination and cooperation of interested parties.

3.0 BOTTOMLAND FORESTS

3.1 DEFINITION

Bottomland, or riparian, forests occur inside floodplains where soils become saturated for extended periods of time. For this report, bottomland forests were defined as trees in the cottonwood/willow forest-type group in the riparian zone within 200 feet of either side of a major stream, perennial stream, or key intermittent stream that generally flows during "normal" rainfall years (Figures 3-1 and 3-2). Bottomland forests are hydric to mesic and support key species such as cottonwood and willow.

Figure 3-1. Bottomland Forest Along Slip-Up Creek East of Sioux Falls [RESPEC, 2009].

Figure 3-2. Riparian Forest Along James River in Sanborn County (Photograph Courtesy of the South Dakota Department of Agriculture).

3.2 EXTENT AND CONDITION

Bottomland forests make up approximately 3 percent, or 60,000 acres, of South Dakota's 1.86 million forested acres (Figure 3-3). Although only a small percent of the total forest land in South Dakota is bottomland forest, most of the forest outside of the Black Hills region is found within a few miles of streams and rivers [Piva et al., 2009]. The majority of bottomland forests are populated by cottonwood, willow, green ash, and elm [Piva et al., 2009]. Preliminary data from the Great Plains Initiative (GPI) indicate that willow is the predominant species followed by ash. Many river basins, ponds, lakes, and streams in South Dakota have adjacent areas of concentrated bottomland forests.

Cottonwoods are majestic and magnificent trees. They are typically found near streams, drainages, and ponds as they survive best around a source of shallow water. In general, cottonwood trees can quickly grow large, although they are weak-wooded and have a safe lifespan of 70 years. In South Dakota, cottonwoods make up 2 percent of all forest land [Piva et al., 2009]; estimates using FIA data suggest approximately 3 percent of forest in South Dakota is made up of bottomland forest types. About one-half of all cottonwoods in South Dakota forests are at least 60 years old with very few stands of young cottonwoods and virtually no saplings (Table 3-1 and Figure 3-4).

A study by Dixon et al. [2010] looked at cottonwoods along several stretches of the Missouri River from Montana down to Missouri, covering 930 river miles. A stretch along the Missouri River from Oahe Dam to Big Bend Dam in South Dakota has seen significant decreases in cottonwoods and bottomland forest in general [Dixon et al., 2010]. Findings along this stretch also concur with FIA age data; about 91 percent of existing cottonwood stands along this stretch are greater than 50 years old [Dixon et al., 2010]. According to Dixon et al. [2010], the stand condition along this stretch of the Missouri River "has the poorest condition of all sampled study segments."

Cottonwood regeneration in South Dakota has drastically declined primarily because of alteration of natural flood events caused by the construction of dams. Cottonwood regeneration is highly dependent upon flood events which facilitate the meandering of stream channels and the creation of new sandbar habitat suitable for seedling growth. Spring dam releases designed to mimic natural spring snowmelt runoff have the potential to improve cottonwood age-class distribution by increasing cottonwood regeneration along riparian corridors in some areas. Recent flooding in the northeast portion of South Dakota has increased the extent of cottonwood and willow [Foss and Brown, 2010].

Willow trees grow in similar environments as cottonwoods but there is a lower concern about their condition and regeneration. Total acreage of cottonwoods is approximately 53,000 acres with an additional 6,800 acres of cottonwood/willows.

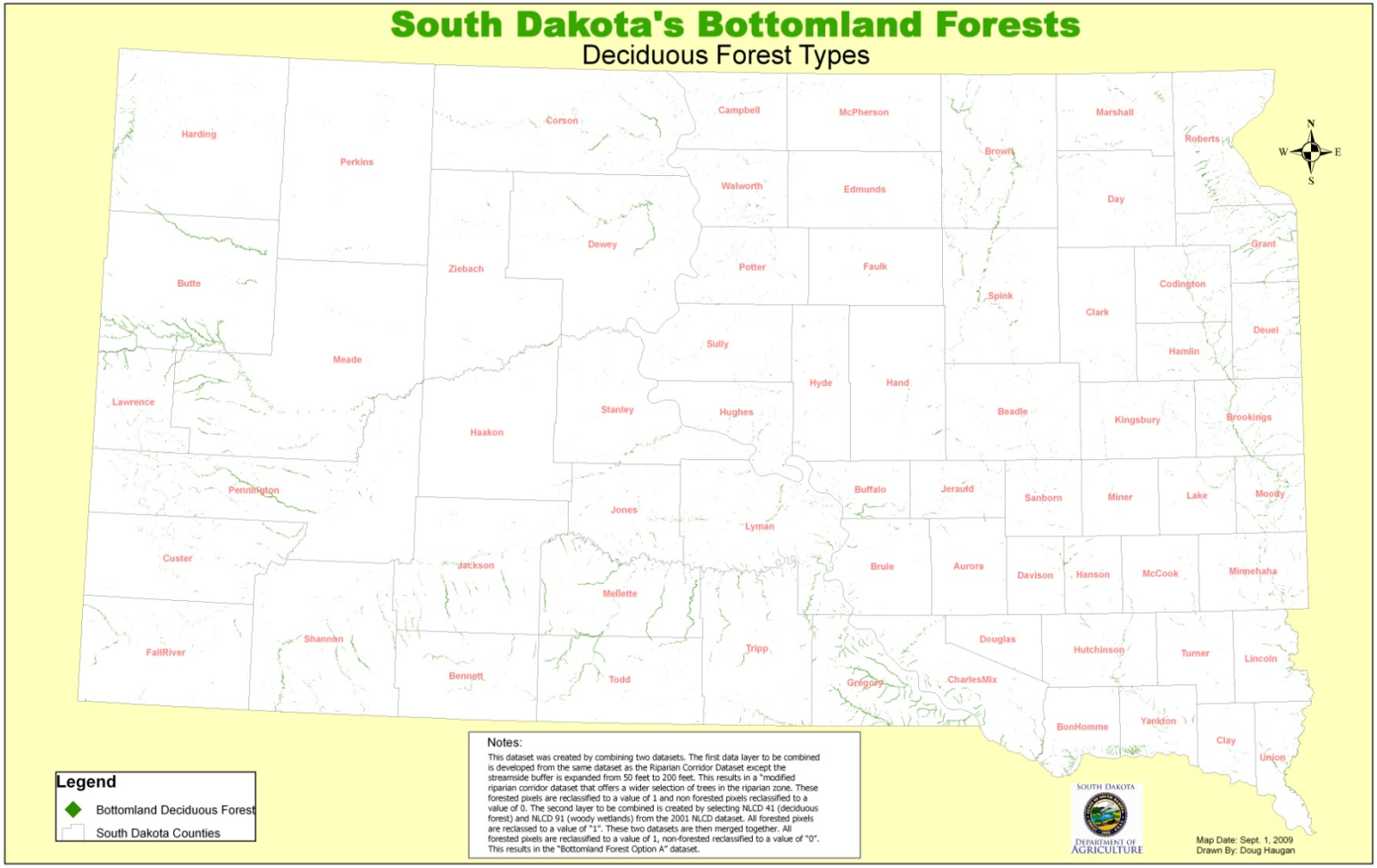


Figure 3-3. South Dakota's Bottomland Forests.

Table 3-1. Area of Bottomland Forest by Tree Age Class, in Acres (From U.S. Department of Agriculture [2009a])

Forest Group	Tree Age Class (years)						
	0–19	20–39	40–59	60–79	80–99	100–119	Total
Cottonwood	–	4,547	20,394	11,801	10,240	5,781	52,763
Cottonwood/ willow	–		6,801				6,801
Total Acres	**0**	**4,547**	**27,195**	**11,801**	**10,240**	**5,781**	**59,564**
Percent of Total	**0%**	**7%**	**46%**	**20%**	**17%**	**10%**	**100%**

Note: The color of each estimated value represents its percent sampling error (pse); if value is black, pse is less than or equal to 25 percent; if value is green, pse is greater than 25 percent and less than or equal to 50 percent; if value is red, pse is greater than 50 percent.

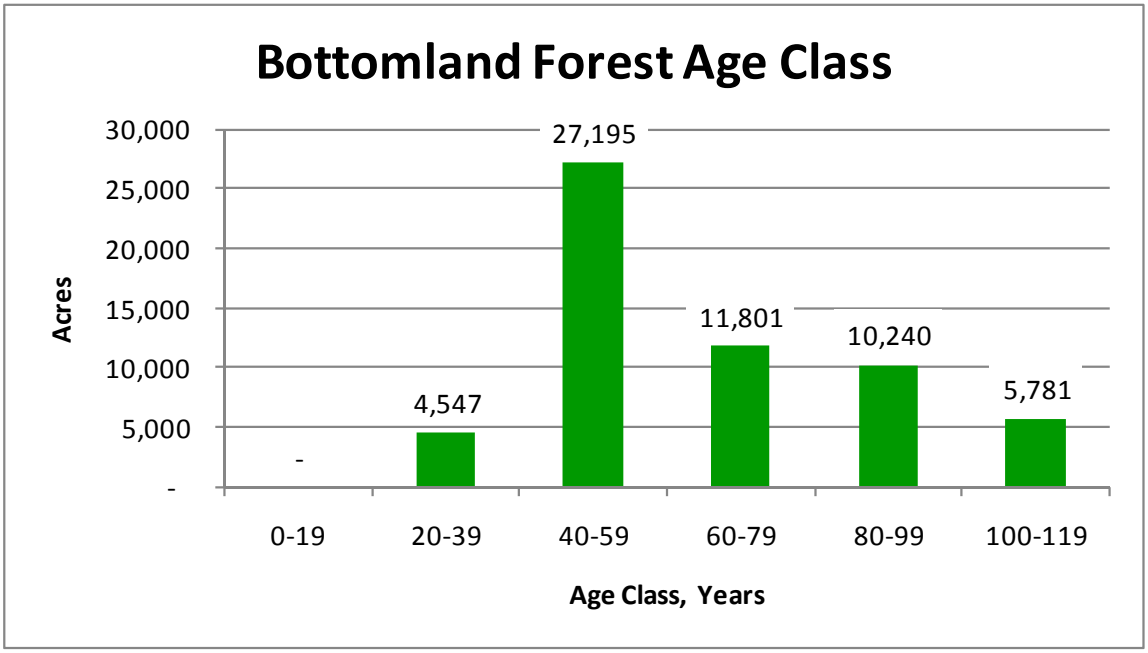


Figure 3-4. Bottomland Forest Age Class by Total Acres.

Bottomland forests may also contain elm, ash, Eastern redcedar, Rocky Mountain juniper, Russian olive, and other woody plants. These species are gradually replacing cottonwoods and willows through succession. The absence of floods, especially along the Missouri River, is causing the pioneer species to be replaced by more shade-tolerant species.

3.3 VALUES

Bottomland, or riparian, forests have many benefits to South Dakota. They provide improved flood control and water quality, are areas of important wildlife habitat, provide aesthetic and cultural appeal, and provide recreation opportunities for the state's population [Piva et al., 2009]. Bottomland forests are not a major source of timber production; however, in many parts of the state, "riparian forests are the only source of merchantable timber" [Piva et al., 2009].

Improved flood control and water quality are important benefits of bottomland forests. Riparian areas act as water storage areas which can reduce downstream flood height. Also, abundant vegetation helps to decrease flood water velocities and stabilize streambanks, reducing sediment runoff. They also improve water quality by reducing nonpoint sources of pollution, including animal wastes, nutrients, pesticides, and sediment. The riparian forests act as a buffer area allowing sediment and organics to settle out from surface runoff or flood waters.

Bottomland forests comprise only a small percentage of the South Dakota landscape, yet provide vital habitat for numerous species. These forests provide shade to streams to help maintain temperature for fish habitat and increase dissolved oxygen levels. Trees and bottomland habitat provide shelter and food for birds and other animals. Based on a study in eastern South Dakota [Emmerich and Vohs, 1982], more species of birds used bottomland habitat throughout the year than other habitats. Because of their height and bulk, cottonwoods are important roosting and nesting sites for many species, including bald eagles.

Bottomland forests also provide aesthetic and cultural benefits in addition to recreational opportunities (Figure 3-5). These forests have been a source of exploration and settlement over much of human history with much of the early settlements in South Dakota being along stream valleys. Bottomland forests provide many recreational benefits, including trapping; hunting; fishing; hiking; biking; photography; observing nature; and a source of physical, mental, and spiritual refreshment.

3.4 THREATS

Based on the documents reviewed, the biggest threats to the bottomland forests in South Dakota are stream alterations, insect infestation, disease, invasive species, and grazing. Other

threats and problems include fragmentation, degradation of water quantity and quality, climate change, lack of species diversity, and degradation of wildlife habitat.

Figure 3-5. Cottonwood Forest Type on the Banks of the Cheyenne River (Photograph Courtesy of the South Dakota Department of Agriculture).

A major threat to the native speciation of the bottomland forest type is stream alteration through the construction of dams which prevents natural flooding and sediment transportation. Riparian forests, especially cottonwood and willow trees, need periodic flooding to replenish rich soils and create new habitat for seedlings. Although flooding is necessary for cottonwood reproduction, prolonged flooding can kill trees whose roots become starved for oxygen [Piva et al., 2009].

Ash and elm are becoming established along riparian corridors as cottonwoods are declining. DED and the EAB are two threats that, combined, have the potential to destroy the entire ash and elm population in the state (described in Section 2.4). Eastern redcedar is also becoming established in bottomland areas where cottonwood is not reproducing (Figure 3-6). Being very shade tolerant, Eastern redcedar can outcompete most other species.

Two of the more prominent invasive species include salt cedar and buckthorn. Salt cedar (*Tamarix*) is a flowering tree/shrub that is considered a noxious weed as it absorbs a large amount of water, leaves behind large deposits of salt, aggressively replaces native riparian vegetation, and is difficult to eradicate once established. Invasive buckthorn is found in bottomland areas of elm and ash and in minor amounts in cottonwood stands; buckthorn is described in more detail in Section 2.4 of this report.

Figure 3-6. Cedar Encroachment (Photograph Courtesy of U.S. Forest Service).

Overgrazing can lead to a decrease in riparian vegetation. Livestock often prefer the edges of waterways and will often spend much of their time around or in wet and shady areas. If not controlled with fences or other measures, unrestricted stock can often lead to a loss in vegetation and regeneration, soil erosion, decreased water quality, and weed invasion.

Grazing practices can be implemented to increase tree productivity in draws and along riparian corridors. Such practices include a rest-rotation grazing system, where cyclical movement of cattle through multiple pastures improves root systems and assists in seed dissemination and establishment. In this type of management system, wooded draws and riparian areas can be used primarily as wintering and calving areas during the nongrowing dormant season [Boettcher and Johnson, 2005; McCarthy, 2003].

3.5 OWNERSHIP

Approximately 71 percent of the bottomland forest in South Dakota is privately owned. Of the remaining acreage, 12 percent is owned by the state and approximately 17 percent is owned by the federal government (Table 3-2).

3.6 NEEDS, PROBLEMS, AND OPPORTUNITIES

Although almost all privately owned, bottomland forests "provide important public benefits to the people of South Dakota" [Piva et al., 2009]. Because of the number and significance of threats to bottomland forests, it will be crucial to include public outreach and education in all efforts to preserve bottomland forests and riparian areas. Some areas of potential improvement including the following:

- There are numerous classification methods of bottomland or riparian forests that result in multiple acreage values between different agencies. A unified classification for all forest types would serve to create cohesion between reporting agencies.
- Several interested parties are conducting research concerning regeneration of cottonwoods. Despite recent interest, "regeneration is not keeping pace with losses of cottonwoods" [Dixon et al., 2010]. Cooperation between various Native American groups and the Army Corps of Engineers will likely continue, although there is opportunity for almost all federal and state agencies to become involved in developing solutions to this problem.
- There is a need and opportunity for the state to interact with private landowners to develop best management practices (BMPs) for livestock grazing in riparian corridors.
- The aging cottonwood population, increasing invasives, and threat of DED and EABs collectively could significantly alter the entire bottomland forest habitat.
- There is a need to better understand riparian ecosystems and the role the vegetation or loss of vegetation may have on water quality and wildlife.
- Research is needed to determine if prescription fire could play a role in management of riparian areas.
- A more robust wood products industry offers management opportunities that would otherwise be too expensive.
- A more inclusive, specific, and robust forest inventory is necessary to assist in the analysis, planning, and management of forest areas.

Table 3-2. Area of Bottomland Forest by Ownership (From U.S. Department of Agriculture [2009a])

Forest-Type Groups	Other Federal	State	Undifferentiated Private	Total
Cottonwood (703)	9,905	7,338	35,520	**52,763**
Cottonwood/willow (709)	–	–	6,801	**6,801**
Total Acres	**9,905**	**7,338**	**42,321**	**59,564**
Percent of Total	**17%**	**12%**	**71%**	**100%**

Note: The color of each estimated value represents its percent sampling error (pse); if value is black, pse is less than or equal to 25 percent; if value is green, pse is greater than 25 percent and less than or equal to 50 percent; if value is red, pse is greater than 50 percent.

4.0 SHELTERBELTS AND WINDBREAKS

4.1 DEFINITION

Shelterbelts and windbreaks are planted forests made of trees or shrubs planted in rows to provide shelter from the wind and snow and to protect against soil erosion. They occur in discontinuous patches across South Dakota (Figure 4-1). Shelterbelts and windbreaks, also known as living fences or working trees, are composed of a variety of species, including the Eastern redcedar, Rocky Mountain juniper, green ash, elm, Russian olive, honeylocust, caragana, spruce, and cotoneaster. The terms “shelterbelt” and “windbreak” are synonymous; herein, “windbreak” shall be used and taken to mean any row or belt of working trees.

Figure 4-1. Farmstead and Field Windbreaks [South Dakota Department of Agriculture, 2010].

4.2 EXTENT AND CONDITION

There are approximately 1.3 million acres of nonforested land with trees in South Dakota, including wooded strips, shelterbelts, windbreaks, and pastures with trees [Leatherberry et al., 2000] [South Dakota Department of Agriculture, 2007b]. Of this acreage, there are 95,000 acres of narrow wooded strips and 105,000 acres of windbreaks [South Dakota Department of Agriculture, 2007b]. These lands are widely dispersed on agricultural land across the state. The majority of treed shelterbelts and narrow windbreaks are located in the Bad-Missouri-

Coteau-James and Minnesota-Big Sioux-Coteau river basins within the eastern half of the state [Piva et al., 2009].

Most windbreaks do not meet FIA classification of forested land as most are less than 1 acre in size and less than 120 feet wide; thus, these treed lands are not thoroughly documented. Minimal data exist regarding the extent, condition, and ownership of shelterbelts within the state. Of the data that do exist, most are outdated.

The Natural Resource Conservation Service (NRCS) maintains the only data of tree and shrub plantings by conservation districts in South Dakota. This data includes total acres planted by year from 1935 through the present (Table 4-1). During this period of record, over 350,000 acres of windbreaks, including over 200 million trees, have been planted. Over the last 10 years (since 2000), there has been an average of 6,500 acres, or 2.6 million trees, planted each year. Typically, the number of acres planted in a year is dependent upon the availability of funds from cost-share programs with more trees planted in times of greater funding [Hinners, 2010]. The majority of these trees were planted as field, farmstead, and feedlot windbreaks; a smaller percentage was planted for wildlife or to renovate existing windbreaks (Table 4-1). Since 1980, approximately 63 percent of trees planted have been deciduous with only 37 percent being coniferous.

An ongoing survey, known as the Great Plains Initiative (GPI), is being conducted to inventory tree species on nonforest land with trees; the final analysis should be complete in 2010 or early 2011. This data is not collected under the FIA. The preliminary data from the GPI inventory indicate that ash is the predominant species in windbreaks statewide. Table 4-2 provides preliminary GPI tree counts for rural areas.

A study in 1977 showed that mortality in windbreaks increase until they reach the 31–40-year age group, after which mortality seems to stabilize [Walker and Suedkamp, 1977]. This study also revealed that the condition of windbreaks improve in relation to the number of rows, with a nine-row belt most likely to be in good to excellent condition. A study in 1987 covering 27 counties revealed that 61 percent of South Dakota's windbreaks were missing 30 percent or more of their canopy and were in need of renovation [Shaefer et al., 1987]. Another study conducted in 1997 across the northern two-thirds of the state found that 87 percent of windbreaks were in need of renovation [South Dakota Department of Agriculture, 2007b]. Renovations differ depending on the goal and can include thinning, row removal, pruning, supplemental planting, sod release, coppicing, root pruning, and complete removal and replanting.

4.3 VALUES

Approximately 90 percent of South Dakota land-use classification is for agricultural use (cropland or rangeland). Windbreaks provide many values to much of this land, especially to

Table 4-1. Conservation Tree and Shrub Plantings in South Dakota [Natural Resources Conservation Service, 2010]

Year	Total (acres)	Field Windbreaks (miles)	Field Windbreaks (acres)	Farmstead and Feedlot Windbreaks (acres)	Other Windbreaks (acres)	Renovation Plantings (acres)	Wildlife Plantings CRP (acres)	Conifer Trees Planted	Deciduous Trees Planted	Total Trees Planted	Average Trees per Acre
1940–1949	30,827	286	1,818							25,826,225	796
1950–1959	55,486	1,517	12,758	6,831	1,819					30,652,980	554
1960–1969	64,621	4,045	17,884	16,553	3,001					31,880,369	493
1970–1979	59,731	3,664	13,729	31,672	7,793	1,431				27,426,385	458
1980–1989	44,380	2,200	7,583	23,227	7,366	4,576	1,630	6,842,718	14,507,126	21,349,844	484
1990–1999	43,293	2,594	7,642	17,821	6,883	4,017	6,931	8,559,391	13,381,690	21,941,081	508
2000–2009	65,156	6,021	24,864	28,201	4,985	5,318	7,887	10,537,378	15,941,235	26,475,613	401
Total	**363,494**	**20,327**	**86,278**	**124,306**	**31,846**	**15,341**	**16,447**	**25,939,487**	**43,830,051**	**185,552,497**	**3,964**

Table 4-2. Estimated Number of Rural Trees on Nonforest Land by Species[a]

Species	No Windbreak Present	Windbreaks	Abandoned Farmstead	Natural Riparian Forest Buffer	Narrow Wooded Strip	Total Trees
Total	**25,364,461**	**41,445,809**	**3,309,106**	**3,874,736**	**255,210**	**74,249,322**
Redcedar/juniper spp.	4,411,752	6,537,274	46,402	175,996	0	11,171,424
Spruce spp.	128,413	490,906	0	0	0	619,319
Pine spp.	490,991	23,201	0	0	0	514,192
Ponderosa pine	1,989,968	1,669,703	0	0	0	3,659,671
Scotch pine	59,681	0	0	0	0	59,681
Maple spp.	193,159	1,090,441	46,402	0	0	1,330,002
Boxelder	2,103,191	1,964,508	305,589	219,143	46,402	4,638,833
Silver maple	9,172	164,957	0	0	0	174,129
Hackberry spp.	9,172	789,263	185,607	0	0	984,042
Ash spp.	6,182,944	15,656,598	1,415,253	980,634	69,603	24,305,032
Honeylocust spp.	157,532	23,201	23,201	0	0	203,934
Walnut spp.	36,689	0	0	0	0	36,689
Mulberry spp.	73,379	199,197	46,402	0	0	318,978
Cottonwood and poplar spp.	1,389,505	1,795,168	23,201	143,735	0	3,351,609
Cherry and plum spp.	665,246	1,849,877	0	69,603	0	2,584,726
White oak	1,562,215	977,054	0	23,201	0	2,562,470
Willow spp.	2,743,060	1,046,313	0	1,807,177	0	5,596,550
Elm spp.	2,311,580	2,812,192	997,637	279,251	0	6,400,660
Siberian elm	749,692	3,971,657	219,412	23,201	0	4,963,962
Russian olive	97,120	384,299	0	152,795	139,205	773,419

(a) Preliminary data from the Great Plains Initiative Inventory.

farms and ranches across the state. These values include snow control, sun protection, soil protection, improvements in water quality, energy conservation, livestock protection and production, increases in wildlife habitat, recreation improvements, and aesthetics.

Windbreaks are economically and ecologically friendly agricultural practices for improving sustainability. They protect farmsteads and crops from winds by reducing soil erosion on fields and reducing heating and cooling costs in residences and outbuildings. The trees also provide privacy to farmsteads by reducing the visibility and traffic noise of roadways. Windbreaks provide shelter to livestock during hot summer days and cold windy winters. If the trees are planted downwind of a livestock production facility, they can potentially reduce odor concentrations in areas further downwind by redirecting airflow.

Windbreaks scattered across the state fill an important ecological niche and increase diversity in the often otherwise monocultural setting. Windbreaks provide habitat for a large number of birds, but usually support fewer species than other forest types such as bottomland forests. Emmerich and Vohs [1982] found that windbreaks had the highest density of birds during the reproduction season. These areas are also notable pheasant habitat, providing hunting opportunities for South Dakotans and out-of-state residents, and thereby providing economic benefits as well as recreational. Criteria for selecting the best locations and species that benefit wildlife are described in Capel [1988]. The National Agroforesty Center has done significant research on the value of windbreaks (*http://www.unl.edu/nac/windbreaks.htm* contains more information).

When planted along roads, windbreaks act as living snow fences and are an environmentally sound solution to improve snow management (Figure 4-2). The primary benefits provided include the following:

- Prevention of large drifts that lead to stranded motorists
- Improvement in driver visibility which reduces accidents
- Reduction in plowing fees for both public and private owners
- Reduction in salt use, truck use, and fuel consumption
- Reduction in shipping delays for goods and services
- Reduction in lost wages and salaries
- Improvement in biodiversity and wildlife habitat (as compared to a structural snow fence).

Properly maintained windbreaks can create a buffer in grass fires and may help to reduce fire intensity and provide suppression opportunities during a wildfire event [Mattox, 2009a]. Windbreaks also provide additional value to South Dakota because of increased scenic beauty of the landscape, they provide for recreational opportunities such as hunting and trapping, and they can provide fruit for use in the production of jams and wine.

A

B

Figure 4-2. Picture (A) Is the Road Before the Living Snow Fence Was Installed. Picture (B) Is the Same Site, 7 Years Later, After Planting a Living Snow Fence.

4.4 THREATS

Windbreaks face threat of damage and diminishment from drought; disease; changes in land use; insects; weeds and invasive species; herbicide drift; livestock; old age; lack of species diversity within rows; improper planting and maintenance; climate change; and intense weather such as tornados, blizzards, and heavy ice/snow events. Persistence of some weed fabrics used when planting windbreaks has become an issue. Perhaps the biggest threat is simple deterioration because of lack of upkeep. The NRCS is partially addressing this issue through the Environmental Quality Incentives Program (EQIP) being implemented in the Coteau area.

Insects and disease are a threat to windbreaks, especially those that are single species. Because they are typically dense, single-species windbreaks can be decimated by insects or disease when attacked. Those with diversified tree species are under less of a threat but still can be heavily damaged. Trees that are already stressed from drought or overcrowding are at a higher risk. The two dominant species in shelterbelts, green ash and Siberian Elm, are under greatest threat of mortality and deterioration over eastern South Dakota [Walker and Suedkamp, 1977]. All green ash are at high risk of decimation from EAB. Dutch elm disease is a threat to many elm windbreaks. Eastern redcedar and Rocky Mountain juniper may become infected with Cedar-Apple Rust fungus (*Gymnosporangium juniper-virginianae*) or juniper twig blight (*Phomopsis juniperovora*) [Ball and Foss, 2009]. Caragana may be threatened by blister beetles, stem decay, branch cankers, and septotoria leaf spot. Other concerns are pine wilt, pinewood nematode, pine tip moth, and Zimmerman pine moth [Piva et al., 2009].

Damage from deer, livestock, and other animals poses a threat to newly planted and established windbreaks. Several species of tree are enjoyed by ruminants, thus fences and other protection are important around saplings and established windbreaks.

The implications of these problems are substantial. If supplemental and replacement planting does not occur, shelterbelts will continue to deteriorate. The deterioration could lead to increased soil erosion, increases in energy costs to farms, and a decrease in critical wildlife habitat.

4.5 OWNERSHIP

Because windbreaks usually do not fall under the FIA definition of forest, there are no data regarding ownership in the FIA database. It is assumed that nearly all windbreaks are on privately owned land.

4.6 NEEDS, PROBLEMS, AND OPPORTUNITIES

Currently there is little information about the extent, species, and condition of windbreaks across the state. Data needed to help understand and manage windbreaks are listed below.

- Studies should be conducted to determine if South Dakota has adequate numbers of windbreaks and appropriate windbreak placement.
- Most windbreaks do not fall under the FIA definition of forest, and thus no FIA data are collected on them. Because FIA is the most extensive and ubiquitous compilation of forest data, it would be logical to include windbreak data. An intensification of the FIA sample is needed across the Great Plains to collect information about this important resource.
- There is a great need to renovate existing windbreaks that are aging and becoming ineffective. Approximately 60–80 percent of windbreaks are in poor health and no longer functioning as designed. The lack of public education and funding for windbreak renovation remains a key problem. Conservation districts in the Coteau area have been successful using the EQIP program to address windbreak deterioration.
- More robust forest products industry is needed to use wood from windbreak renovation activities.

5.0 URBAN AND COMMUNITY FORESTS

5.1 DEFINITION

An urban or community forest is all the trees and shrubs found within a city or town. These areas include city parks; landscaped boulevards; and trees on public, private, and commercial lots (Figure 5-1).

Figure 5-1. Urban Forest in Pierre, South Dakota [Coppess, undated].

5.2 EXTENT AND CONDITION

In South Dakota, there are approximately 103,000 acres of community forests [Leatherberry et al., 2000], although these areas do not meet the FIA classification of forested land. Statewide, an estimated 3.8 million urban and community trees exist [Nowak and Greenfield, 2010]. A large number of species are present within community forests with ash, elm, crabapple, maple, hackberry, honeylocust, linden, and cottonwood being the most common.

The SDDA ranks the condition of South Dakota's community forests using four different distinctions: good, fair, poor, and dead. A strong majority of the trees are in good condition at 63 percent, 27 percent are in fair condition, and 10 percent are either in poor condition or dead (9 percent poor and 1 percent dead) [Johnson, 2010]. The poor and dead trees are the high-

priority trees because of the risk they pose to the general public. Additional information on community trees is provided as part of community tree inventories, detailed in Section 5.2.2 below.

5.2.1 Tree City USA Communities

The Arbor Day Foundation administers a program called "Tree City USA" for cities and towns in the United States. There are 34 Tree City USA cities and towns in South Dakota, as illustrated in Figure 5-2. Member cities must meet four standards established by the Arbor Day Foundation. These four standards are:

- The community must have a Tree Board or Commission charged by ordinance with developing and administering a comprehensive tree management program.
- A Tree Care Ordinance designating the establishment of a Tree Board or Forestry Department given the responsibility for writing and implementing an annual community forestry work plan.
- A community forestry program with an annual budget of at least $2 per capita.
- An Arbor Day observance, celebration, or proclamation.

These standards provide the framework for annual, systematic tree management. Other benefits provided by Tree City USA membership include education opportunities, increased public image and citizen pride, and higher chances of being awarded tree-related grants or other forestry-type grants when competing with nonmember cities. Tree City USA members have celebrated Arbor Day publicly every year as it is one of the required standards. Most Arbor Day ceremonies usually consist of tree plantings and a proclamation of Arbor Day by the mayor of the community.

5.2.2 Community Tree Inventories

The RC&F has been in the process of collecting community street tree data for approximately 10 years. The intent of this project is to develop a clear picture of the diversity, age, and condition of the community forests across the state. Since it would be impractical to inventory all the communities across the state, a stratified, random sampling of communities was undertaken so a statistically valid database was created. In addition, the communities in which the inventories were conducted will have a working inventory of their street trees. The South Dakota inventory project is helping communities spot trends, create long-term plans and realistic budgets for tree management, and schedule regular maintenance and tree care.

The division has inventoried 30 communities and the Capitol complex area using Davey Resource Group's *TreeKeeper*™ online inventory software. There are two more communities in the process of entering their data into the online database. With each new survey, data

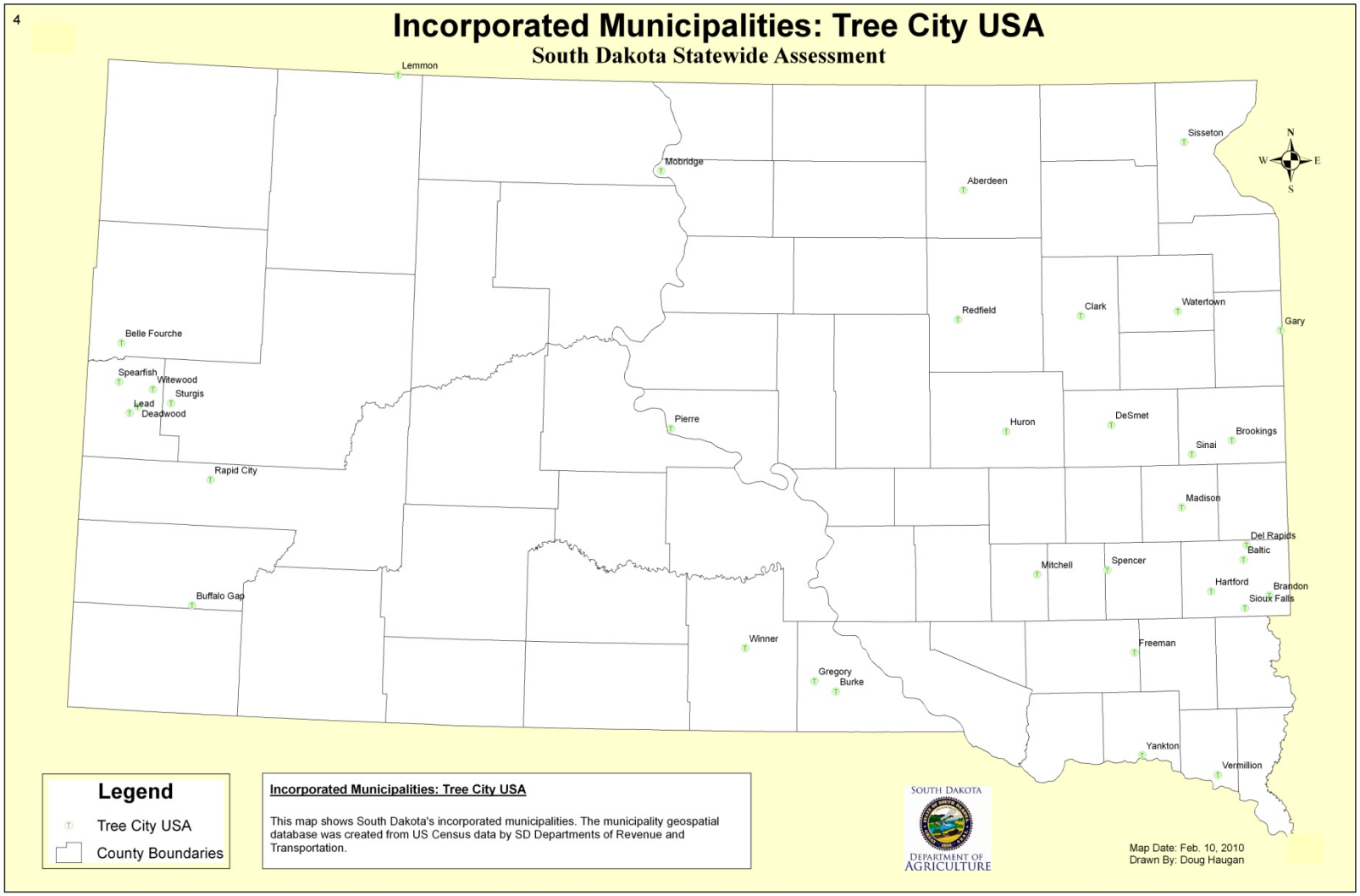


Figure 5-2. South Dakota's Tree City USA Communities.

presented in this section will continue to change. For updated information contact the RC&F to obtain the most recent copy of their 1-page annual summary of the community tree inventory. Appendix E contains additional information about the inventory.

The *TreeKeeper*™ inventory data show that the majority of the trees are in good condition (63 percent) and do not need attention. The trees that are in fair condition (27 percent) mean they need pruning or other work (Figure 5-3). The trees in poor condition (9 percent) are a higher percentage than desired. These trees should be removed. The most disturbing finding is that 1 percent of the trees are "standing dead." As new inventories are completed and data entered, these percentages will change.

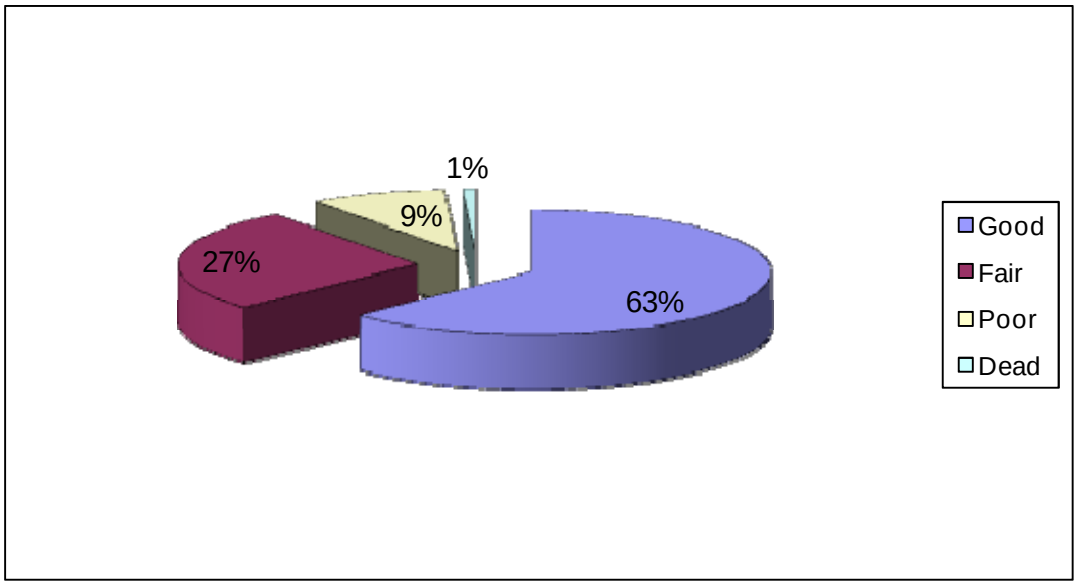


Figure 5-3. Community Forest Condition.

Looking at the diameter at breast height (DBH) gives an indication of age diversity of the trees within our communities. Figure 5-4 shows that there is a good age distribution. Trees ranging from newly planted to 24 inches in diameter make up 86 percent of the tree population. The reason there are not more large trees is because trees do not grow as large in South Dakota because of growing conditions.

Looking at species diversity in Figure 5-5, green ash makes up the majority of the tree population. This is important because when the EAB arrives in South Dakota, it will devastate our urban areas [Ball et al., 2007]. Another alarming finding is that only one-half of available planting spaces have trees. Active community forestry programs are needed within communities across the state to promote tree plantings and proper tree care. RC&F has a cost-share program to assist communities to develop and maintain their tree resources.

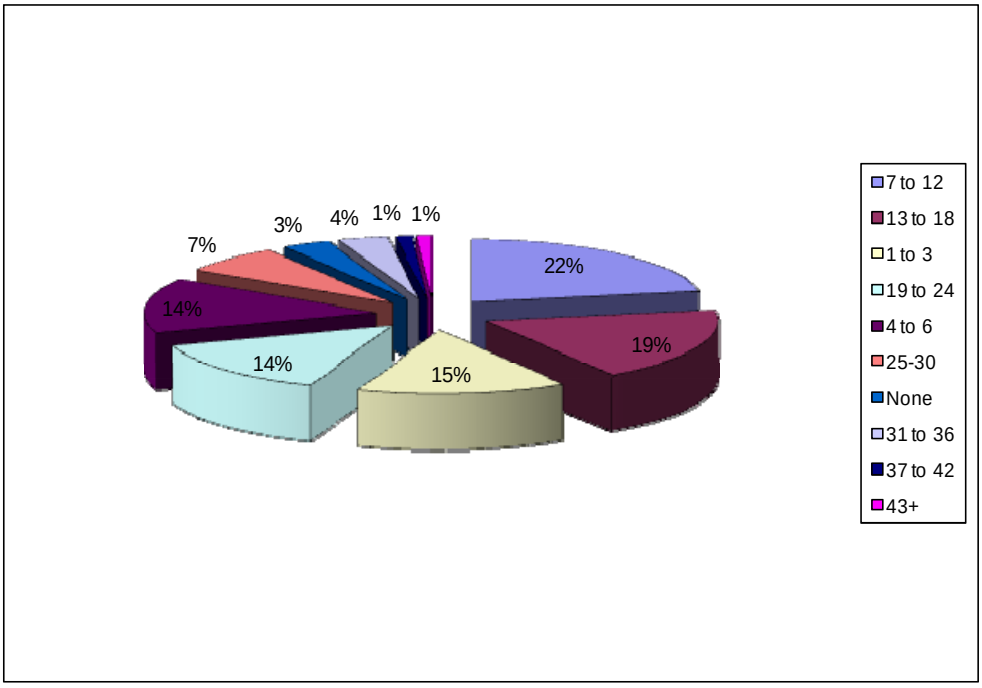


Figure 5-4. Community Forest Diameter at Breast Height.

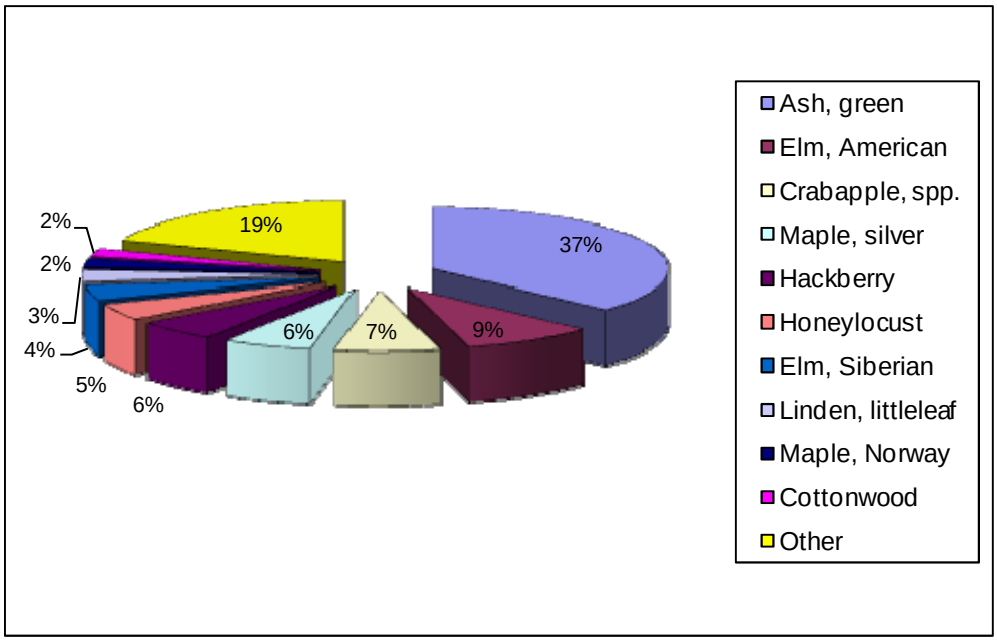


Figure 5-5. Community Forest Species.

5.2.3 Community Forest Priority Areas

The Community Forests map in Figure 5-6 shows South Dakota's incorporated municipalities. They were assessed a risk level based on four criteria: (1) the level of community forest management, (2) the community size and percentage of high-risk tree species, (3) if they fell in the projected expanded developing areas by 2030, and (4) if they are a Tree City USA community. By delineating high-, medium-, and low-priority community forests in South Dakota, this map illustrates where the Community Forestry Program needs to focus its efforts over the next 5 years.

A majority of the "high" priority areas are the communities surrounding larger cities in the state. The reason for this is because those communities have the most population expansion. The majority of these communities do not have active community forestry programs. Therefore, these communities need to be encouraged to develop management plans, conduct a tree inventory of some sort, prepare city tree ordinances, and ensure proper arboricultural practices are followed when caring for the communities' trees; basically, assist communities to develop an all-encompassing community forestry program. The goal for these communities is to encourage some type of community forestry program and to move out of the "high" priority category and into the "medium" or "low" priority category by encouraging them to become a Tree City USA or to a "Managing" community as designated by the U.S. Forest Service's Community Accomplishment Reporting System (CARS).

The "low" priority communities have the highest population class of the three levels. This is mostly because larger communities have larger infrastructure and higher tax base from which to fund community forestry programs. Most of these cities are "Managing" according to CARS; they have active community forestry programs and most of them have city foresters, certified arborists, or a forester on contract to assist them with their management. Since these communities have an active community forestry program, they are potential partners with RC&F to perform demonstration projects or leverage funds for federal grant projects. However, for the most part, they do not require technical assistance from RC&F. They occasionally apply for a community forestry comprehensive challenge grant to help fund special projects.

5.3 VALUES

The values of community forests are similar to values of other forested land; in municipalities, however, greater population densities allow these benefits to be experienced by more people. In communities, trees provide energy conservation, improved water quality by reducing stormwater runoff, wildlife habitat, aesthetics, recreation opportunities, improved air quality, carbon sequestration, and production of biomass that is used in several communities for heating and energy generation.

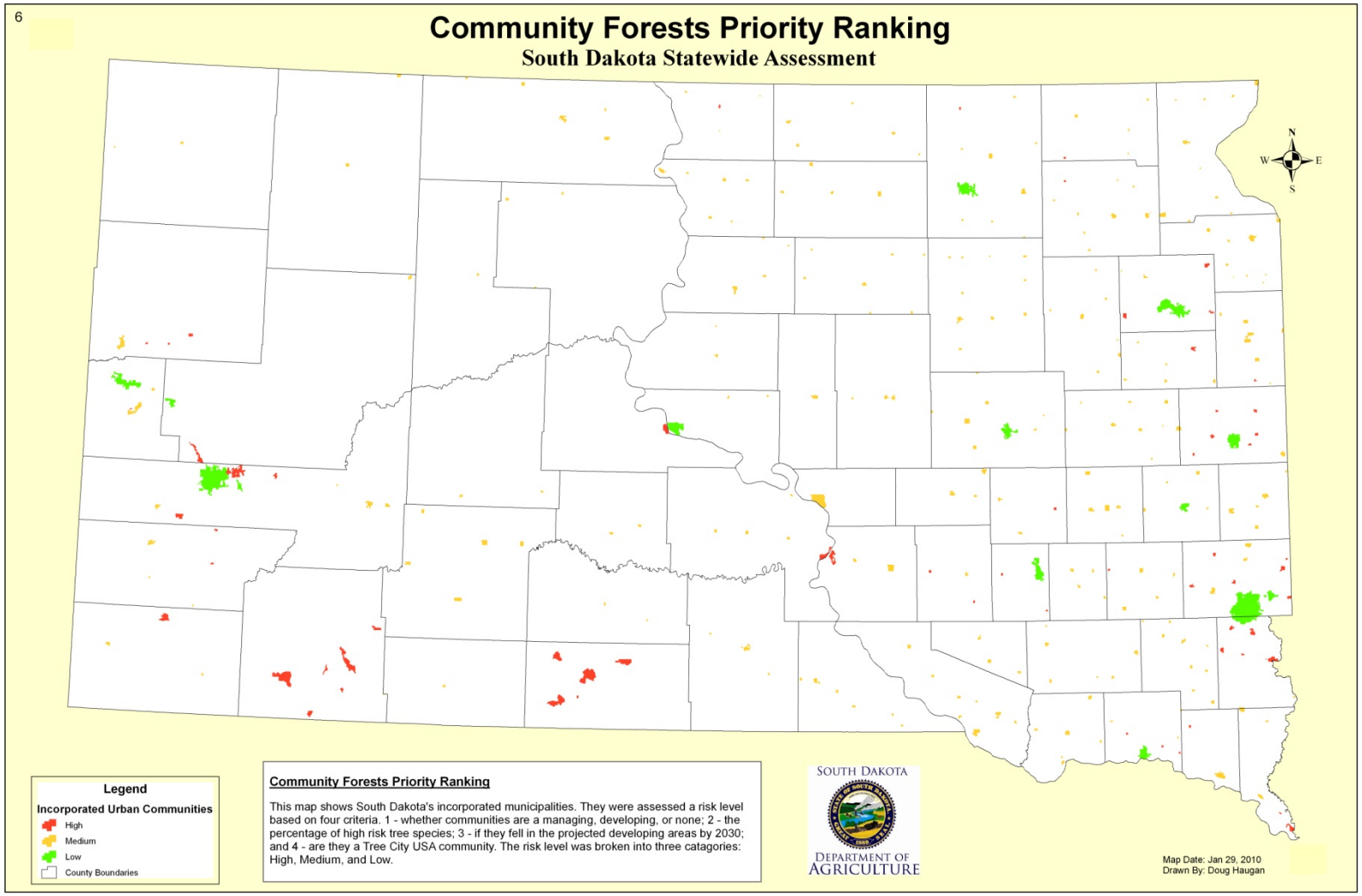


Figure 5-6. Community Forests Map Illustrating the Locations of Priority Communities.

Trees provide energy conservation because of shading of buildings during the summer and shielding from wind and weather during winter months (Figure 5-7). Trees also are effective sound and visual barriers, allowing residents more privacy and increasing property values. Additionally, trees improve the water quality in urban streams by reducing the amount of impervious area, slowing raindrop velocity with associated reduction of erosion, and providing a root matrix to hold soils in place along urban riparian corridors and other urban areas. Over the long term, trees can aerate the soil by leaving dead roots which decompose and provide pathways for water infiltration, thereby reducing the amount and intensity of stormwater runoff. Trees provide a buffer region between overland urban flow and urban streams, which can reduce pollutants entering the streams by filtration mechanisms and also by harboring specialized bacteria that break down pollutants.

Figure 5-7. Freeman, South Dakota (Photograph Courtesy of the Freeman Arbor Board).

Trees make community streets and parks more appealing for walking and jogging and also give people in the city access to nature. Community parks often provide a setting for festivals and other special events that contribute to local economies. People also take advantage of the aesthetics of community trees through photography, painting, and wildlife viewing.

Community tree biomass is a resource that can be used for mulch, compost material, energy, and heat generation. Some of the larger cities in South Dakota currently have processes at

their landfill facilities to use this material by processing chips, limbs, and yard wastes into compost and mulch, which also helps sequester carbon. Some communities are using trees to heat community buildings. There is a lack of empirical data in carbon sequestration regarding how much carbon can be sequestered by wood over time, though it is estimated that community trees in South Dakota remove about 450 metric tons of air pollution, including CO, NO_2, O_3, SO_2, and PM_{10}, each year [Nowak and Greenfield, 2010]. Also, trees are a carbon neutral form of energy as wood combustion only releases carbon that is already in the carbon cycle, although, the burning of brush piles increases the rate at which carbon reenters the atmosphere.

5.4 THREATS

The community forests in South Dakota are under threat from both natural and man-made causes. These threats include insect infestation, diseases, fire, weather events, spraying herbicides for crop production, and development. Additionally, climate change, weed and invasive species, water quantity and quality, lack of species diversity, improper planting and maintenance, old age, and lack of a wood products industry are notable threats and problems.

Because of the wide variety of tree species found in community forests, there is a large variety of insects and diseases that can stress the trees. These threats include, but are not limited to, canker disease, DED, EAB, and oak wilt.

Dutch elm disease, emerald ash borer, and oak wilt have been described in previous sections. Canker disease is caused by various species of fungi and bacteria that invade wounded or injured bark tissue such as those commonly caused by lawnmowers and other yard equipment.

Strong winds, lightning, ice storms, and heavy snows often cause damage to trees. These weather-related events also affect other forest types but are a greater threat to community trees as these forests are less dense, and damage to even a single tree is more noticeable and may result in structural damage. Community trees also pose a higher risk than traditional forests because of the targets found in cities and towns. Trees and branches can break and fall on homes, cars, and even people. Fire is also a threat to urban forests, particularly in communities that are adjacent to coniferous forests in the Black Hills region. These areas are known as Wildland Urban Interface (WUI) and also occur where grasslands and forests are adjacent to urban areas.

Development and land-use changes pose one of the largest risks to urban forests. Forests along the edge of developing communities are especially susceptible to removal. Trees in vacant lots are also threatened by development. Trees may also become damaged or stressed from other sources such as nearby construction, vandalism, chemical pollution, improper planting, and/or pruning, and over/underwatering.

5.5 OWNERSHIP

The majority of urban forest land is under private and local ownership. A small percentage of urban forests, including city parks, are owned by local governments and conservation groups. Communities and city governments have jurisdiction over trees that are planted in public right-of-ways, commonly known as street trees.

5.6 NEEDS, PROBLEMS, AND OPPORTUNITIES

As development and urbanization increase across South Dakota, community forests will continue to play an important role in local ecosystems and the quality of life. Since most community forest land is privately owned, it will take education, active management, and investment of resources from both government organizations and homeowners. Following is a brief description of issues and opportunities in the area of urban forestry.

- The health and condition of community forests are the responsibility of a great number of people. Unfortunately, many citizens, business owners, and local officials fail to understand the benefits that these trees provide to the vast majority of South Dakota's citizens. There is a need to inform the public about this vital resource and the importance of community forest management.
- Urban waste, including lawn clippings, branches, and even Christmas trees, is a valuable and easily available biomass source. Much of this material is land-filled or burned instead of composted or used for heating and boilers. For example, some urban tree waste in eastern South Dakota is being used to provide energy to an ethanol plant in Chancellor. Although some communities take advantage of this resource, there remains much opportunity for expansion, especially by smaller communities across the state.
- Nonnative plants can pose a threat to both urban and rural forests by spreading to natural areas and overcoming and replacing plants that are native to the area.
- Street tree inventories are currently conducted by the RC&F in cooperation with local communities. These inventories seek to determine how many trees are present, what condition they are in, and the sizes. This data helps communities better manage their trees and develop plans for improving community forests. There is still a need, however, for additional and continued inventories as well as a public database of this information.
- Data for all inventoried cities to help show the benefits of street and community trees should be obtained.
- Management of WUI areas, focusing on hazardous fuel reduction should continue (and/or improve).
- Inventories show a need for more species diversity in community forests so that a single pathogen or pest, such as DED or EAB, will not have as much impact on communities.

This will require education of community leaders, planners, architects, landscape designers, arborists, and citizens.

- The community risk data layer, which was used to create the Community Forestry Priority Areas, is based on the presence of high-risk species and community size. The data need further examination to determine if there are other variables that provide a better prediction for community risk.
- Communities are responsible for updating their information within the *TreeKeeper*™ online database, yet better practices need to be established to actually have this information updated more frequently. Often, the information is only updated annually or not at all.

6.0 FOREST OWNERSHIP BY OWNER

6.1 INTRODUCTION

Forest land in South Dakota is owned by federal, state, and local agencies in addition to private ownership. Table 6-1 presents the most recent summary of ownership data provided using FIA. A brief summary of forest ownership by owner follows.

Common goals and threats found in forest management plans were reviewed as part of this assessment report. A summary matrix of forest management plan objectives and goals is provided in Section A-1 of Appendix A. The purpose of the goals matrix is to correlate, amongst different agencies, the management goals and objectives stated in reviewed Forest Management Plans. Management goals were grouped into categories for ease of comparison. Similar goals and opportunities those similarities provide are described in Section 6.7.

In addition to the goals matrix, a threat summary matrix correlates the threats posed to trees and forests within the state (Section A.2 in Appendix A). The threats most commonly referred to in forest management and other plans include: fire, invasive species, pests/disease, and land-use changes. Most counties and agencies within the Black Hills have Wildfire Protection Plans.

6.2 FEDERAL FOREST LANDS

Over one-half of the forest land, or approximately one million acres, is federally owned in South Dakota. The majority of this land is managed by the USFS as part of the Black Hills National Forest and Custer National Forest. A small amount of forest is managed by the National Park Service (10,000 acres) and the BLM (40,000 acres). Forest types include white spruce, Rocky Mountain juniper, ponderosa pine, aspen, paper birch, and other hardwoods. Ponderosa pine is by far the dominant species on federal forest land consisting of almost 80 percent of federal forest land and 45 percent of all forest land in South Dakota.

Almost every federal agency with forest land has some sort of forest management plan or includes forest management in their general plans. The general goals of each agency differ somewhat and are presented in Table A-1 of Appendix A. The dominant goals shared by most agencies include: general forest management, fire management/suppression, pest and disease management, and protection of wildlife habitat. A brief summary of goals for each federal agency is discussed below.

Table 6-1. Area of Sampled Forest Land by Forest Type and Ownership (in Acres) (From U.S. Department of Agriculture [2009a])

	Ownership										
Forest Types	**National Forest**	**National Park Service**	**Bureau of Land Management**	**Other Federal**	**State**	**Local (County, Municipal)**	**Undifferentiated private**	**Total**	**Total Upland**	**Total Bottomland**	**Total Conifer**
White spruce	52,169	–	4,559	–	–	–	–	56,728			56,728
Eastern redcedar	–	–	–	4,569	–	–	33,038	37,608			37,608
Rocky Mountain juniper	11,677	–	15,710	5,487	–	–	27,625	60,499			60,499
Ponderosa pine	815,955	10,380	13,350	21,025	57,599	–	247,129	1,165,438			1,165,438
Nonstocked	77,240	–	–	4,378	13,105	–	25,452	120,174			120,174
Cottonwood	–	–	–	9,905	7,338	–	35,520	52,763		52,763	
Cottonwood/ willow	–	–	–	–	–	–	6,801	6,801		6,801	
Eastern redcedar/ hardwood	–	–	–	–	–	–	7,672	7,672	7,672		
Bur oak	–	–	5,837	23,374	–	–	59,377	88,588	88,588		
Elm/ash/black locust	–	–	–	1,372	–	8,767	50,350	60,489	60,489		
Mixed upland hardwoods	–	–	–	--	–	–	5,347	5,347	5,347		
Hackberry/ elm/green ash	–	–	–	15,342	–	–	78,495	93,837	93,837		
Sugar maple	–	–	–	–	–	–	8,791	8,791	8,791		
Aspen	40,354	–	–	–	–	–	1,778	42,132	42,132		
Paper birch	6,274	–	–	–	–	–	--	6,274	6,274		
Other hardwoods	20,031	–	–	5,837	–	–	1,478	27,346	27,346		
Other exotic hardwoods	–	–	–	--	–	–	21,268	21,268	21,268		
Totals:	**1,023,701**	**10,380**	**39,456**	**91,289**	**78,042**	**8,767**	**610,121**	**1,861,756**	**361,744**	**59,564**	**1,440,447**

The USFS has Forest Management Plans for both the Black Hills National Forest and Custer National Forest. In addition to general forest management, goals in these plans include control of pests and disease, fire management, protection of wildlife habitat, protection of water resources, improvement of access, sustainable timber management, and providing for scenic quality and recreational opportunities. The National Forests also have a goal to cooperate with landowners, organizations, and other agencies while coordinating planning and project implementation.

Both Wind Cave National Park and Jewel Cave National Monument fall under the jurisdiction of the National Park Service but are managed by staff on site. The general management plan for Wind Cave includes goals related to forestry, including general forest management, wildlife protection, and scientific research. Jewel Cave has both a general management and a fire management plan. Goals mentioned fall under the broad category of protection of natural and cultural resources; specifically, these include controlling the spread of invasive exotic species, protection of wildlife habitat, fire management and prevention through reduction of fuels, and increasing scientific research. Jewel Cave's goal of cooperative protection involves working with neighboring landowners, including Black Hills National Forest (BHNF), to ensure that practices on lands adjacent to the Monument do not threaten the Monument's resources.

The BLM has not recently updated its land management plans, although previous goals listed concern management for forestry products; fire management; protection of wildlife, especially protection of habitat for threatened and endangered species; sediment reduction in streams; and recreation development.

The Army Corps of Engineers (ACE), as it is responsible for all navigable waters, is interested in cottonwood regeneration along the Missouri River and how it relates to wildlife habitat and watershed health. The ACE has the goal of working with other agencies to map and evaluate the health of cottonwood forests and create site-specific regeneration plans.

6.3 STATE FOREST LANDS

The state of South Dakota owns approximately 78,000 acres of forested land, only 4 percent of the total forested land in the state. The majority of this land lies within designated state parks, with Custer State Park being the largest with approximately 50,000 total forested acres. The South Dakota School and Public Lands is the next largest owner of state forest lands; these lands are managed by the commissioner of School and Public Lands to provide revenue for the public school system. Data from FIA does not include areas of upland hardwood forest in several parks across the state, including Newton Hills and Sica Hollow owned by the state GFP.

The GFP plans focus primarily on outdoor recreation and wildlife conservation. Recently, the GFP completed a comprehensive wildlife conservation plan for the state [South Dakota Department of Game, Fish & Parks, 2006]. This document is a blueprint for the state, potentially involving private, tribal, and government entities. The plan reviews essential habitats and where they are located, what habitats have changed since the settlement of South Dakota, what animals need special attention, and how to manage wildlife and habitat. Within the state, there are several birds and a mammal species of concern that are dependent upon forested ecosystems. The South Dakota Comprehensive Wildlife Conservation Plan (CWCP) [South Dakota Game, Fish & Parks, 2006] has more detailed information. The South Dakota Natural Heritage Program maintains a list of species of concern which is reflected in the CWCP. The Natural Heritage Program was consulted in the development of the Threatened and Endangered Species map used to establish priority areas. This inclusion is designed to satisfy the requirement of the State & Private Forestry Redesign to include the CWCP in this SAFR.

Custer State Park has a current Resource Management Plan [Walker et al., 1995]. This plan includes goals and activities related to management of forestlands, rangelands, wildlife, bison, fire use, and fire suppression. The plan includes specific forest management goals of increasing species diversity, maintaining and improving forest health, and increasing productivity (Table A-1 in Appendix A).

Although not owning any forest land, the SDDA provides assistance to state and private forest landowners in the state. The RC&F develops forest stewardship plans for private forest landowners, provides forestry-related technical assistance, and forest health assistance to private landowners and communities. This includes improving the awareness and support for forestry and proper management of the state's forest resources. Among other things, the SDDA has specific goals to create or restore wetland and riparian areas and renovate shelterbelts. The WFS is charged with wildland fire suppression on state and private lands in the Black Hills and as requested outside the Black Hills. The WFS also provides a hazardous fuel mitigation program that provides technical assistance to forest landowners who are concerned about the threat of wildland fire.

6.4 CITY AND COUNTY FOREST LANDS

Approximately 9,000 acres of forested land are owned by local city and county governments, less than 1 percent of the total forested land in the state. The majority of these forests serve as public parks and nature preserves. All of this land is of the upland forest type of elm/ash/black locust.

Many communities, and all Tree Cities, have differing ordinances pertaining to urban and community trees. The ordinances provide guidance for planting and maintaining trees and controlling pest and disease problems. Goals and threats of individual community forests were

not reviewed; however, most communities have similar (if not formalized) views on community forests.

As part of this assessment, Community Wildfire Protection Plans (CWPPs) from six counties in western South Dakota were reviewed including: Custer, Fall River, Lawrence, Meade, Pennington, and Perkins. Most counties in the eastern one-half of the state have little to no forested land, although, Aurora, Brown, Charles Mix, Day, and McPherson Counties have Comprehensive Fire Management Plans. The primary goal of these plans is to reduce the risk of wildfire to life, property, and critical infrastructure.

6.5 PRIVATE FOREST LANDS

Approximately 610,000 acres, or 33 percent, of South Dakota's forest land is privately owned. Private forests include almost all forest types and tree species. Nearly all the urban forest and agroforest (primarily shelterbelts and windbreaks) land is privately owned with minor amounts of privately owned coniferous, upland, and bottomland type forests.

Forest management plans and goals have not been published for any individual or private company holding forest lands. The biggest reason for this is the small size of most family or individual forest ownership, with 68 percent of family forest owners having fewer than 10 acres of forest land. Reasons for and concerns of ownership are described by Piva et al [2009]. In general, most family forest owners have the same concerns as large forest managers (pests, disease, fire) with the exception that the main concern of family forest owners is property taxes.

6.6 NATIVE AMERICAN FOREST LANDS

Leatherberry et al. [2000] estimates there are about 93,000 acres of timberland held by Native American tribal groups. The amount of Native American forest land is relatively small, although noteworthy stands of ponderosa type forests are present on Pine Ridge and Rosebud Indian Reservations, and upland and bottomland forests are present in reservations along the Missouri River.

The BIA and the federal government have a standard set of goals to address forest resource management [Intertribal Timber Council, 1993]. Additionally, each tribal government can add additional goals or create a specific forest management plan.

Within South Dakota, the Rosebud Indian Reservation has such a plan. Goals included in the Rosebud plan include protection of wildlife, the watershed, recreation, aesthetics, and cultural resources. The plan also includes specific goals for fire management and timber harvest management. There is little forestry data specific to the reservation, so another goal is

to complete a reservationwide hardwood inventory. Plans for other reservations were not obtained at the time of this assessment.

6.7 OPPORTUNITIES FOR COLLABORATION

Most of the various agencies that own or manage forests with South Dakota have Forest or Resource Management Plans that address their goals of managing forest resources (Section A.1 in Appendix A). The similarities between goals and objectives provide an opportunity for these various agencies to collaborate in accomplishing their goals and reducing threats to South Dakota forests.

For example, much of the coniferous forest in South Dakota is made up of a patchwork of various ownerships. This patchwork of land holdings in the Black Hills provides an opportunity to develop a model for shared land management on a landscape scale between private landowners, the state, and the federal government. Nearly every forest management agency or owner is concerned about fire management issues. The issue of how to respond to and prevent fires extends across any political boundary. Most counties within the Black Hills have a CWPP, but there is an opportunity for each county to reduce the likelihood and severity of fires while working with other county, state, and federal agencies. Fire is also a management tool that can be used for fuel hazard reduction and wildlife habitat improvement. The use of fire in management offers an excellent opportunity for integrating collaboration and training.

Many ponderosa pine stands are also overcrowded and in poor general health. This issue crosses county, state, and federal agency jurisdictions, but there is a need to take action and an opportunity for collaboration. Funding must be acquired and action taken to limit the spread of insect infestations, increase forest thinning in the most dense stands, and remove dead tree stands and forest litter. Additionally, other forest types have the need for interagency collaboration for tracking and controlling pests and disease.

Several agencies list protecting or increasing wildlife habitat as a goal under forest management. There is opportunity for these agencies not only to work together to improve the forests but to work with the GFP and other wildlife-focused agencies to determine exactly what forest management measures improve wildlife habitat. An additional opportunity for collaboration is to develop a way to spatially assign goals and spatially show threats by jurisdiction, to further landscape level collaboration.

7.0 IDENTIFICATION OF PRIORITY AREAS

7.1 INTRODUCTION

The determination of priority areas for the (SAFR) is a requirement of the State & Private Forestry Redesign as required by the amendment to the Cooperative Forestry Assistance Act as enacted in the 2008 Farm Bill. The process has involved input from natural resource interest groups across the state, as well as the state Forest Stewardship Coordinating Committee (FSCC), Community Forestry Advisory Council (CFAC), and the NRCS State Technical Committee.

7.2 PUBLIC INPUT

RC&F conducted two surveys to obtain input into the identification of statewide priority areas and the development of strategies for addressing threats and opportunities in South Dakota's forests.

The first survey was designed to help identify the state's priority areas. A questionnaire listing benefits from and threats to South Dakota's forests was developed (see Appendix F). The questionnaire was sent directly to 535 forest landowners, private interest groups, and natural resource agencies (Appendix F). The state's NRCS office assisted with distribution of the questionnaire to the State Technical Committee. The target group was given a list of 12 benefits from and threats to South Dakota's forests and was asked to identify the top five. The RC&F received 315 responses. The results of the questionnaire are presented in Figure 7-1.

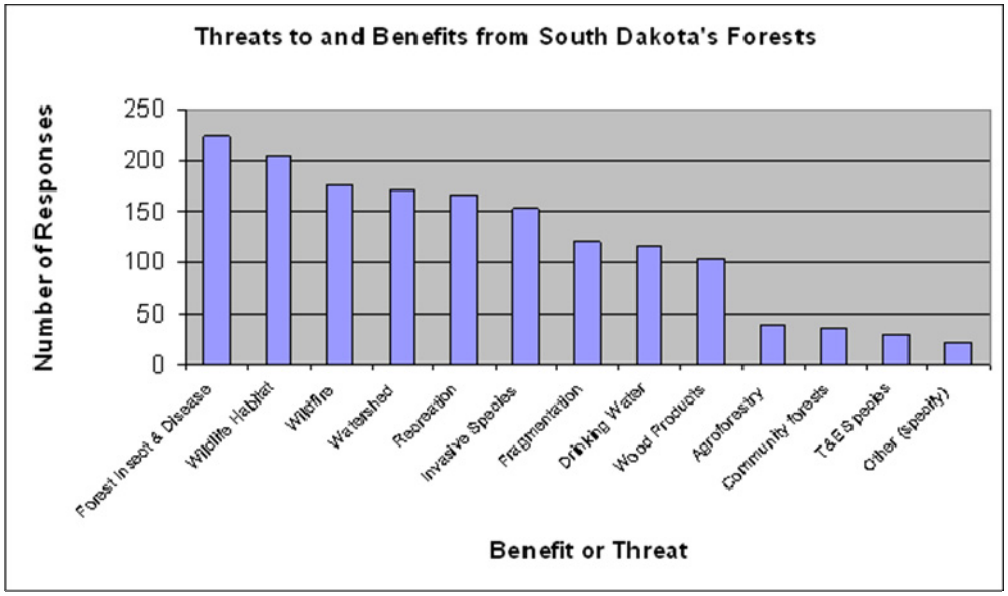


Figure 7-1. Threats to and Benefits From South Dakota's Forests.

Where possible, geospatial data were matched to the identified benefits and threats. Weights of these data layers were assigned relative to their importance as identified by respondents. A complete discussion of the questionnaire results and how the results were used in priority area determination is presented in the methodology report (see Appendix B).

A second survey was distributed to help determine the most serious threats to each of the state's forest types and to solicit ideas for solutions and strategies to address those threats. This second questionnaire was sent to members of the FSCC, CFAC, and internal field staff. A total of 45 questionnaires were sent out. Responses were received from 18 individuals providing 534 written comments identifying threats, solutions, and strategies. Many respondents mirrored each other as they identified the threats to the different forest types. This allowed the threats to be grouped, as shown in Table 7-1. A complete list of responses is provided in Appendix G.

The threats listed here were applied to the discussions of the forest types in this document. These threats, as well as the proposed solutions and strategies, will be carried forward to the statewide strategy document. In addition to the surveys, draft copies of both the statewide assessment and statewide strategy were sent to FSCC and CFAC members with request for comments.

The draft assessment and strategy reports were both placed on the RCF Web site for public comment. The draft assessment and draft strategy reports were presented to the State Technical Committee with a request for comments.

7.3 PRIORITY AREA METHODOLOGY

Analysis for determining priority areas in the state developed from two pools of information: the 2007 South Dakota Forest Stewardship Plan [South Dakota Department of Agriculture, 2007c] and a questionnaire. The *South Dakota Forest Stewardship Program Spatial Analysis, Project Summary, and Methodology Report* [South Dakota Department of Agriculture, 2007c] contains details on the creation of the stewardship potential map. Appendix B contains additional information about the questionnaire and results.

The stewardship potential map offered an excellent starting point but was not adequate for this assessment for a number of reasons. Consequently, the RC&F began developing a new priority map while building on what was started in 2007. Twelve geospatial data layers were eventually chosen to be included in the priority area analysis. Organized by national theme, these layers include:

Table 7-1. Statewide Threats by Forest Community Type (Gray Blocks Indicate Applicability of a Threat to a Forest Type)

Threat	National Theme[a]	Forest Type				
		Conifer	Upland	Bottomland	Windbreak	Community
Fragmentation	CRF, PFH	■	■	■		
Forest Health	PFH	■	■	■	■	■
Wildfire	PFH	■				■
Weeds and Invasive Species	PFH, EPB	■	■	■	■	■
Water Quantity and Quality	EPB	■	■	■	■	■
Climate Change	PFH, EPB	■	■	■	■	■
Lack of Species Diversity	PFH, EPB	■		■	■	■
Over Mature and Dying Trees	PFH, EPB			■	■	■
Poor Survival and Maintenance of Planted Trees	PFH, EPB				■	■
Loss of Urban Trees to Development	PFH, EPB					■
Livestock Grazing	PFH, EPB		■	■	■	
Inadequate Forest Inventory Information	CRF, PFH, EPB		■	■	■	■
Underuse of Woody Biomass	CRF, PFH, EPB	■	■	■	■	■
Loss or Degradation of Wildlife Habitat	CRF, EPB	■	■	■	■	

(a) National themes: Conserve Rural Forests (CFR), Protect Forests from Harm (PFH), Enhance Public Benefits from Trees and Forests (EPB).

- Conserving Rural Forests
  - Federal Forest Lands
  - Nonfederal Forest Lands
  - Proximity to Private Lands
- Protecting Forests From Harm
  - Forest Health Issues
  - Wildfire Assessment
  - Developing Areas
- Enhancing Public Benefits From Trees and Forests
  - Riparian Corridors
  - Agroforestry Suitability
  - Priority Watersheds Hydrologic Unit Code (HUC) 12
  - Public Water Drinking Supply Sources
  - Threatened and Endangered Species
  - Community Forest Priority Ranking.

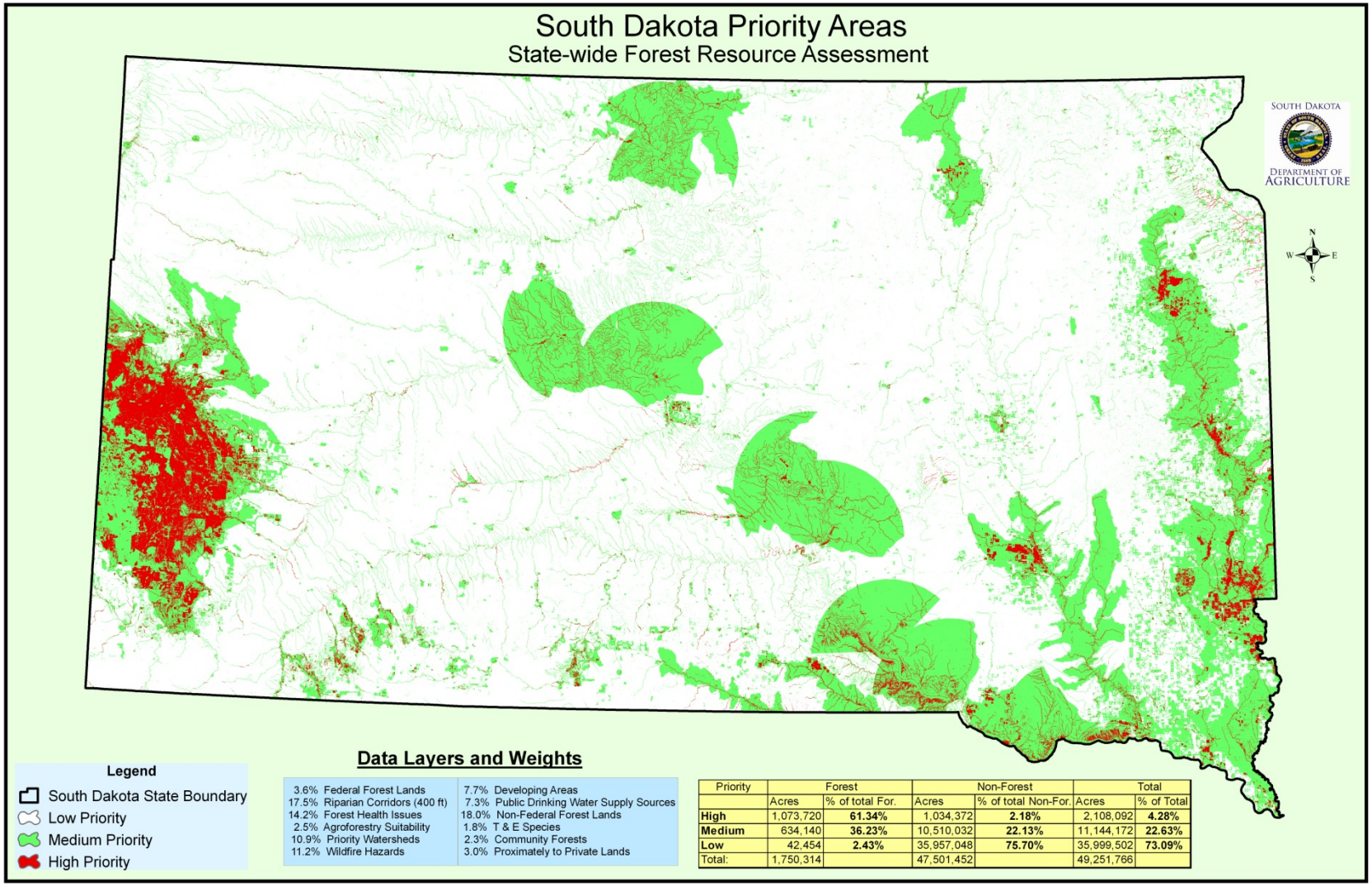
Details about the creation and weighting of these layers are presented in Appendix B.

7.4 SOUTH DAKOTA FOREST PRIORITY AREAS

The South Dakota Forest Priority Area map is shown in Figure 7-2. At a glance, this map shows areas that have a high or moderate need for risk management and mitigation.

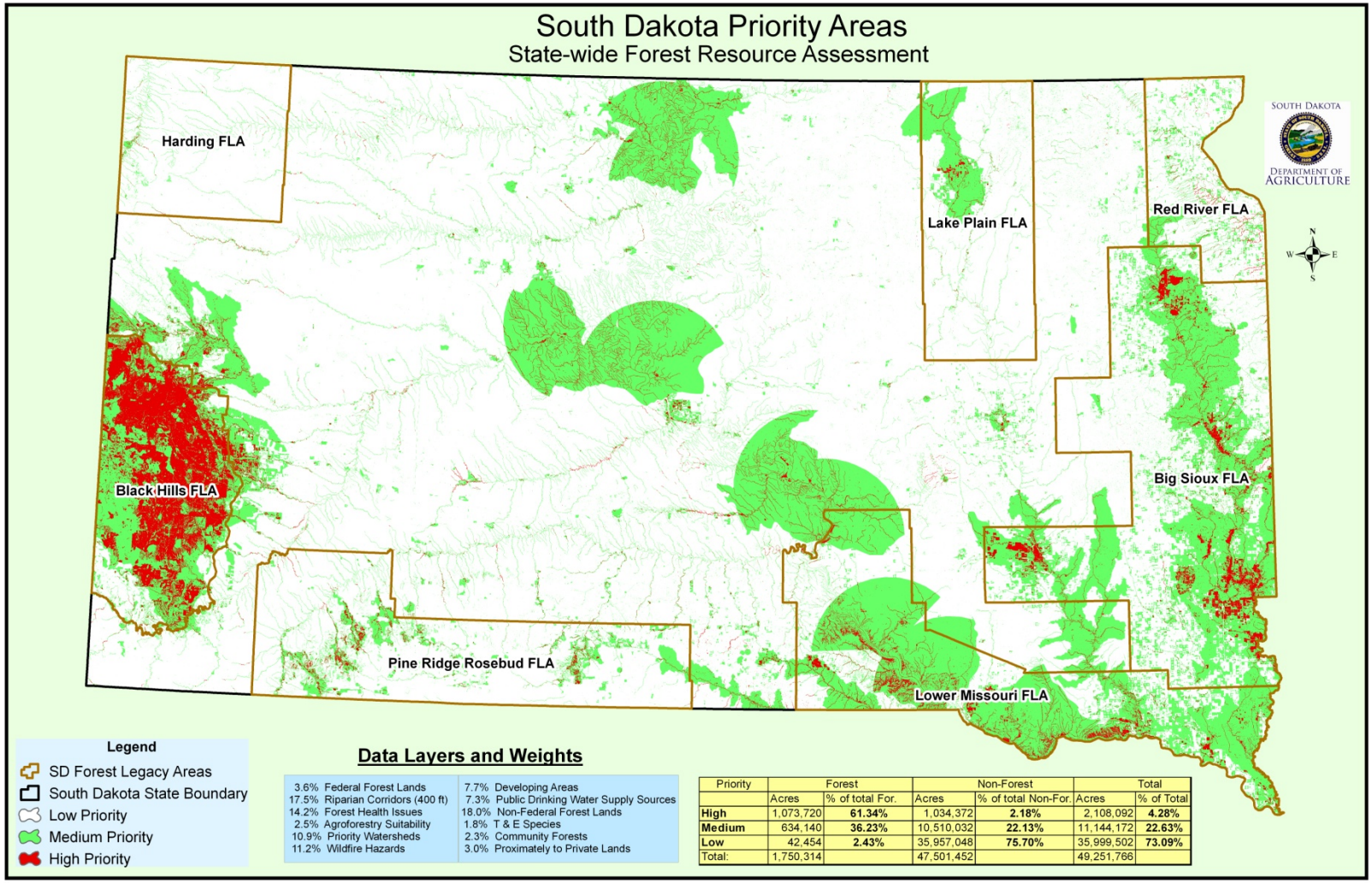
Approximately 61 percent of forested land is classified as high risk, and 36 percent of forested land is classified as medium risk (Table B-3 in Appendix B). Compared to the total land area in the state, only 4 percent of the total area is of high risk and 23 percent of medium risk. High-risk areas are primarily located within the Black Hills, the Big Sioux River Valley, and the James River. Areas of moderate risk are largely concentrated along the Missouri River, Big Sioux River, James River, and the Black Hills.

The South Dakota Forest Legacy map was created during the development of the Statewide Forest Legacy Assessment of Need for the South Dakota Forest Legacy Program (Appendix C). This dataset will not be given a weight in the determination of priority areas but was applied as an overlay on the priority map (Figure 7-3) to illustrate the relationship between the two maps.



Priority	Forest		Non-Forest		Total	
	Acres	% of total For.	Acres	% of total Non-For.	Acres	% of Total
High	1,073,720	**61.34%**	1,034,372	**2.18%**	2,108,092	**4.28%**
Medium	634,140	**36.23%**	10,510,032	**22.13%**	11,144,172	**22.63%**
Low	42,454	**2.43%**	35,957,048	**75.70%**	35,999,502	**73.09%**
Total:	1,750,314		47,501,452		49,251,766	

Figure 7-2. South Dakota Priority Areas.



Priority	Forest		Non-Forest		Total	
	Acres	% of total For.	Acres	% of total Non-For.	Acres	% of Total
High	1,073,720	**61.34%**	1,034,372	**2.18%**	2,108,092	**4.28%**
Medium	634,140	**36.23%**	10,510,032	**22.13%**	11,144,172	**22.63%**
Low	42,454	**2.43%**	35,957,048	**75.70%**	35,999,502	**73.09%**
Total:	1,750,314		47,501,452		49,251,766	

Figure 7-3. South Dakota Priority Area Map With Forestry Legacy Areas Outlined.

A large portion of areas identified by the priority area analysis are contained within the legacy areas, although a significant amount of moderate-risk areas along the Missouri River are not included in any legacy area. The Statewide Forest Legacy Assessment of Need was not changed during preparation of the SAFR, but it is incorporated into this document in its entirety by reference.

7.5 MULTISTATE PRIORITY AREAS AND COOPERATION

There are several areas within the state that may provide opportunities for multistate cooperation. These localities include:

- Black Hills (South Dakota and Wyoming)
- Pine Ridge (South Dakota and Nebraska)
- Missouri River corridor and riparian areas (most midwest states).

Invasive species, insects, and disease have no political boundaries and have the potential to spread from state to state throughout the country; for this reason, it is critical to continue to work with other states on monitoring and suppressing these problems. Additionally, agroforestry and windbreaks have currently taken a backseat to other issues; foresters in the central part of the country need to work together to develop a multistate Agroforestry initiative.

The GPI is an effort of state forestry agencies in Nebraska, Kansas, North Dakota, and South Dakota working together to prepare for the arrival of invasive species in the Great Plains. The agencies are assessing the region's tree resources, determining and addressing the potential impacts of invasives to those resources, creating public awareness of invasive species, and promoting species diversity. A key component of the GPI is for a total ash (and other tree) inventory on the rural and urban landscape. This has never been done before and will entail close to 2,000 communities and 2.2 million acres of nonforest land with trees that will be sampled. An assessment of the ash resource for the four-state region and each individual state tree and forest resource assessment will be assembled after the inventory data are collected and analyzed. The initiative is funded by a U.S. Forest Service grant and matching state funds. Further opportunities for collaboration between agencies within South Dakota were described in Section 6.7.

8.0 SUMMARY AND CONCLUSIONS

Only 4 percent of the state's land is covered by forested land, yet the benefits of our forests extend beyond their boundaries. This assessment reviewed the major forest types in the state, including coniferous, upland hardwood, bottomland, shelterbelts, and community forests. Included for each of these forest types was a summary of the extent and condition; values; threats; ownership; and needs, problems, and opportunities.

The forest lands that are of the greatest priority for South Dakota are scattered across the state. These rural and urban forest landscape areas identify locations where forestry program outreach and activity will need to be emphasized and coordinated. The determination of these priority areas is helping to set the stage for development of strategies to address critical issues facing these landscapes and meeting both national and local objectives.

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U.S. Department of the Interior, 1999b. *Final Forest Management Plan, Rosebud Indian Reservation, South Dakota*, prepared by U.S. Department of Interior Bureau of Indian Affairs, Washington, D.C., for Rosebud Sioux Tribe, Rosebud, SD.

U.S. Department of Interior, 1994. *Final General Management Plan and Environmental Impact Statement, Wind Cave National Park, South Dakota*, prepared by U.S. Department of Interior, National Park Service, Denver, CO.

U.S. Department of the Interior, 1993. *Draft General Management Plan and Environmental Impact Statement*, 1993–839 027, prepared by U.S. Department of the Interior, National Park Service, Jewel Cave National Monument, Custer, SD.

U.S. Department of Interior, 1986. *Record of Decision for South Dakota Resource Management Plan and Final Environmental Impact Statement*, prepared by U.S. Department of Interior, Bureau of Land Management, Miles City District, MT.

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APPENDIX A

FOREST MANAGEMENT PLANS
GOALS AND THREAT MATRIX

APPENDIX A
FOREST MANAGEMENT PLANS
GOALS AND TREAT MATRIX

A.1 FOREST MANAGEMENT PLAN OBJECTIVE AND GOAL SUMMARY MATRIX

The purpose of the goals matrix is to correlate, amongst different agencies, the management goals and objectives stated in reviewed Forest Management Plans. Management goals were categorized into the fields below. These fields make up the columns in the goals and objectives in Table A-1 and are referenced by the number given below.

01 Control Invasives

02 Pest and Disease Management

03 Protect Cultural Resources

04 Wildlife Habitat (identify, protect, increase or maintain diversity)

05 Promote and Conduct Scientific Research

06 Cooperative Protection

07 General Forest Management

08 Fire Management/Suppression

09 Improve Timber Harvest Practices

10 Wetlands/Watershed/Water Quality Protection and Management

11 Aesthetic/Spiritual and Recreational Protection/Improvement

12 Carbon Sequestration/Climate Change Policy

13 Management of Nonforest Areas (shelterbelts, urban)

14 Improve Access

15 Increase Public Education/Outreach

Table A-1. Summary of Common Forestry-Related Goals (Page 1 of 3)

Forest Management Plan or Report Title	Goals (Refer to list on page A-2)														
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
Black Hills National Forest Land and Resource Management Plan 1997 Revision, Phase II Amendment [U.S. Department of Agriculture, 2007]		X		X		X	X	X		X	X			X	
Custer State Park Resource Management Plan 1995–2010 [Walker et al., 1995]	X	X		X			X	X		X				X	
Draft Jewel Cave General Management Plan and Environmental Impact Statement [U.S. Department of the Interior, 1993]	X		X												
Fire Management Plan for Jewel Cave National Monument [U.S. Department of Interior, 2004]			X	X	X	X		X							
Jewel Cave National Monument Resource Management Plan [U.S. Department of Interior, 1999a]			X	X	X	X									
Final General Management Plan and Environmental Impact Statement Wind Cave National Park, South Dakota, [U.S. Department of Interior, 1994]				X	X		X								
Forest Service Global Change Research Strategy, 2009-2019 [U.S. Department of Agriculture, 2009c]	X	X		X	X		X	X			X	X			X
Integrated Natural Resources Management Plan and Environmental Assessment for the West Camp Rapid Training Area (2006–2010) [AMEC Earth & Environmental, Inc., 2005]		X					X								
Final Forest Management Plan, Rosebud Indian Reservation, South Dakota, [U.S. Department of Interior, 1999b]		X		X	X			X	X	X	X			X	

Table A-1. Summary of Common Forestry-Related Goals (Page 2 of 3)

Forest Management Plan or Report Title	Goals (Refer to list on page A-2)														
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
Custer National Forest Management Plan [U.S. Department of Agriculture, 1986]		X		X			X	X	X						
Cottonwood Regeneration Along the Missouri National Recreational River [Army Corps of Engineers, undated]							X								
Bald Eagle and Cottonwood Management Along the Missouri River [Army Corps of Engineers, undated]				X			X			X					
Record of Decision for South Dakota Resource Management Plan and Final Environmental Impact Statement [U.S. Department of the Interior, 1986]				X				X	X		X				
Affected Environment - Final EIS [Bureau of Land Management, 1986]				X						X					
South Dakota Statewide Comprehensive Outdoor Recreation Plan 2002 [South Dakota Department of Game, Fish and Parks, 2003]										X	X				
South Dakota Comprehensive Wildlife Conservation Plan[South Dakota Department of Game, Fish and Parks, 2006]				X	X					X					X
Custer County Community Wildfire Protection Plan [Custer County Emergency Services, 2006]							X	X							
Fall River County Community Wildfire Protection Plan [Mattox, 2009a]								X					X		X
Lawrence County Community Wildfire Protection Plan [Mattox, 2009b]								X							

Table A-1. Summary of Common Forestry-Related Goals (Page 3 of 3)

Forest Management Plan or Report Title	Goals (Refer to list on page A-2)														
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
Community Wildfire Protection Plan Meade County, South Dakota [Mattox, 2005]	X	X					X	X	X		X				
Pennington County Community Wildfire Protection Plan [Mattox, 2007]								X							
Perkins County Community Wildfire Protection Plan [Mattox, 2008]								X							
State of South Dakota Coordinated Plan for Natural Resources Conservation [South Dakota Department of Agriculture, 2007a]				X						X	X		X		
State of South Dakota Forest Stewardship Plan 2007 Revision [South Dakota Department of Agriculture, 2007b]							X								
Revised Land and Resource Management Plan for the Nebraska National Forest [U.S. Department of Agriculture, 2009d]		X		X			X	X	X						

A.2 FOREST THREAT SUMMARY MATRIX

The purpose of the threats matrix is to correlate, amongst different agencies, the threats posed to the forest and trees stated in reviewed Forest Management Plans. Threats were categorized into the fields below. These fields make up the columns in the threats matrix in Table A-2 and are referenced by the number given below. Other reviewed documents were also referenced, including Wildfire Protection Plans, Environmental Impact Statements, Recreation Management Plans, Records of Decision, Strategic Plans, and scientific reports and studies.

01 Fire

02 Invasives

03 Pests and Diseases

04 Development/Land-Use Changes

05 Funding/Taxes

06 Wildlife/Endangered Species

07 Timer Cutting

08 Low Regeneration

09 People (trespassing, litter)

10 Global Changes (climate, atmosphere)

11 Aesthetic/Spiritual and Recreational Protection/Improvement

12 General Forest Health and Condition

13 Erosion

Table A-2. Summary of Common Forestry-Related Threats (Page 1 of 3)

Forest Management Plan or Report Title	Threats (Refer to list on page A-6)												
	01	02	03	04	05	06	07	08	09	10	11	12	13
Draft Jewel Cave General Management Plan and Environmental Impact Statement [U.S. Department of the Interior, 1993]		X											
Fire Management Plan for Jewel Cave National Monument [U.S. Department of the Interior, 2004]	X												
Jewel Cave National Monument Resource Management Plan [U.S. Department of the Interior, 1999a]		X											
Integrated Natural Resources Management Plan and Environmental Assessment (2006–2010) for the West Camp Rapid Training Area [AMEC Earth & Environmental, Inc., 2005]			X										
Final Forest Management Plan, Rosebud Indian Reservation, South Dakota, [U.S. Department of Interior, 1999b]	X		X			X	X						
Final Forest Management Plan, Rosebud Indian Reservation, South Dakota, [U.S. Department of Interior, 1999b]	X		X			X	X		X				X
Custer State Park Resource Management Plan 1995–2010 [Walker et al., 1995]	X	X							X			X	
Forest Service Global Change Research Strategy, 2009–2019 [U.S. Department of Agriculture, 2009c]		X		X						X			
Custer National Forest Management Plan [U.S. Department of Agriculture, 1986]	X												
Cottonwood Regeneration Along the Missouri National Recreational River [Army Corps of Engineers, undated]											X		
Bald Eagle and Cottonwood Management Along the Missouri River [Army Corps of Engineers, undated]													

Table A-2. Summary of Common Forestry-Related Threats (Page 2 of 3)

Forest Management Plan or Report Title	Threats (Refer to list on page A-6)												
	01	02	03	04	05	06	07	08	09	10	11	12	13
Record of Decision for South Dakota Resource Management Plan and Final Environmental Impact Statement [U.S. Department of the Interior, 1986]	X												
Affected Environment–Final EIS [Bureau of Land Management, 1986]											X		X
South Dakota Statewide Comprehensive Outdoor Recreation Plan 2002 [South Dakota Department of Game, Fish & Parks, 2003]				X									
South Dakota Comprehensive Wildlife Conservation Plan [South Dakota Department of Game, Fish & Parks, 2006]	X	X		X		X							
Custer County Community Wildfire Protection Plan [Custer County Emergency Services, 2006]	X		X									X	
Fall River County Community Wildfire Protection Plan [Mattox, 2009a]	X												
Lawrence County Community Wildfire Protection Plan [Mattox, 2009b]	X	X											
Community Wildfire Protection Plan, Meade County, South Dakota [Mattox, 2005]	X	X	X								X		
Pennington County Community Wildfire Protection Plan [Mattox, 2007]	X										X	X	
Perkins County Community Wildfire Protection Plan [Mattox, 2008]	X												
Final General Management Plan and Environmental Impact Statement, Wind Cave National Monument, [U.S. Department of Interior, 1994]	X	X											
Resource Ramblings, [Curtin, 2009]		X						X					

Table A-2. Summary of Common Forestry-Related Threats (Page 3 of 3)

Forest Management Plan or Report Title	Threats (Refer to list on page A-6)												
	01	02	03	04	05	06	07	08	09	10	11	12	13
State of South Dakota Coordinated Plan for Natural Resources Conservation [South Dakota Department of Agriculture, 2007a]													
State of South Dakota Forest Stewardship Plan 2007 Revision [South Dakota Department of Agriculture, 2007b]	X		X	X				X				X	
Revised Land and Resource Management Plan for the Nebraska National Forest, [U.S. Department of Agriculture, 2009d]													
Black Hills National Forest Land and Resource Management Plan 1997 Revision, Phase II Amendment [U.S. Department of Agriculture, 2007]	X		X									X	

APPENDIX B

SOUTH DAKOTA STATEWIDE ASSESSMENT OF FOREST RESOURCES PRIORITY AREA DETERMINATION METHODOLOGY REPORT

APPENDIX B
SOUTH DAKOTA STATEWIDE ASSESSMENT OF FOREST RESOURCES PRIORITY AREA DETERMINATION METHODOLOGY REPORT

FOREST STEWARDSHIP POTENTIAL MAP

Our analysis for determining priority areas in the state developed from two pools of information. The first came from the Forest Stewardship Potential Map developed during the formation of our 2007 South Dakota Forest Stewardship Plan. The second pool of information arose from a questionnaire sent out to landowners and various conservation groups interested in South Dakota's native forests, agroforests (windbreaks), and community forests.

The stewardship potential map was created from 12 geospatial data layers and reflected recommendations developed in consultation with the Forest Stewardship Coordinating Committee (FSCC). The Forest Stewardship Potential Map was a starting point for an integrated resource approach to priority area determination. The advantage to this approach was the set of known sources of readily available geospatial data.

The stewardship potential map offered an excellent starting point but was not adequate for this assessment for a number of reasons. It does not include federal, state, or community forest lands. Data for some of the layers changed since the map was created. The focus of this assessment is on the three national themes: conserving forest lands, protecting forests from harm, and enhancing public benefits from trees and forests. Consequently, the Resource Conservation and Forestry (RC&F) division set out to develop a new priority map while building on what was started in 2007.

CONSTRUCTION OF THE DATA LAYERS USED TO CREATE THE PRIORITY AREA MAP

The first step in developing a priority area map was to update the geospatial data layers that had new data available. The updated data layers were Forest Health Issues, Priority Watersheds, Public Drinking Water, Wildfire Assessment, and Threatened and Endangered (T&E) species. After updating these layers, the Forest Stewardship Potential Map became the base map for priority area determination.

Some data layers used in the Forest Stewardship Potential Map were removed or modified for this assessment. The All Forest Lands data layer was divided to represent federal forest lands and nonfederal forest lands. Forested Wetlands were included in the federal and nonfederal forest lands datasets and were eliminated as a separate data layer. Topography has

almost no geographic impact on the map and was excluded as a data layer. Forest Patch Size was not included because it was not considered critical to the assessment. Proximity to Public Lands was not included because it was not considered to be critical to this effort.

Twelve geospatial data layers were eventually chosen to be included in the priority area analysis. The Forest Legacy Area data layer areas is displayed as an add-on layer after prioritization was completed to show the juxtaposition of legacy areas to priority areas. The following sections explain how each data layer was constructed; layers are organized by national theme as identified in the State and Private Forestry Redesign.

B.1 NATIONAL THEME—CONSERVING RURAL FORESTS

B.1.1 Federal Forest Lands

The purpose of this layer is to show all forested lands that are federally owned public lands. The initial forested land data was extracted from the 2001 National Land Cover Data (NLCD) raster dataset. Forested values 41 (Deciduous Forest), 42 (Evergreen Forest), 43 (Mixed Forest), and 91 (Woody Wetlands) are selected and reclassed to a value of "1." All nonforested lands were reclassed to a value of "0" or "NoData." Then a mask consisting of just public lands under federal control (not state or local) was used to extract those forested lands from the forested lands dataset. The resulting raster data layer shows only federal forested lands and is shown in Figure B-1.

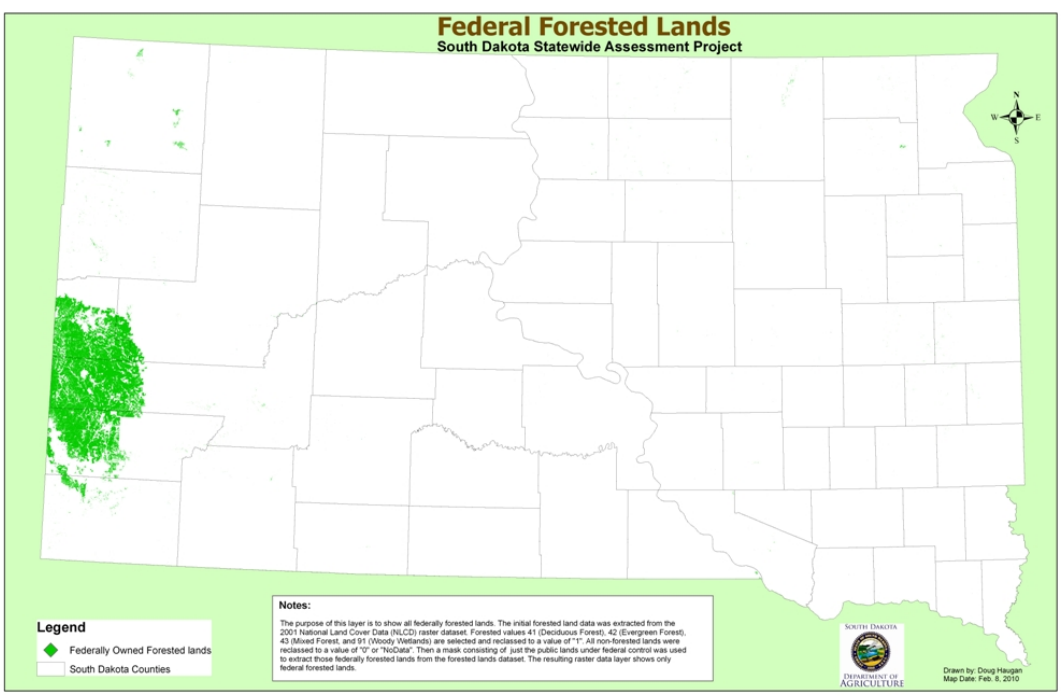

Figure B-1. Federal Forested Lands Map.

B.1.2 Nonfederal Forested Lands

The purpose of this layer is to show all nonfederal forested lands. This includes all private forested lands and all public lands that are under state, municipal, county, or tribal jurisdiction. The initial forested land data were extracted from the 2001 NLCD raster dataset. Forested values 41 (Deciduous Forest), 42 (Evergreen Forest), 43 (Mixed Forest), and 91 (Woody Wetlands) are selected and reclassed to a value of "1." All nonforested lands were reclassed to a value of "0" or "NoData." Then a mask consisting of just public lands under federal control (not state or local) was used to extract federally owned forested lands from the forested lands dataset. The resulting raster data layer shows only the nonfederally owned forested lands and is shown in Figure B-2.

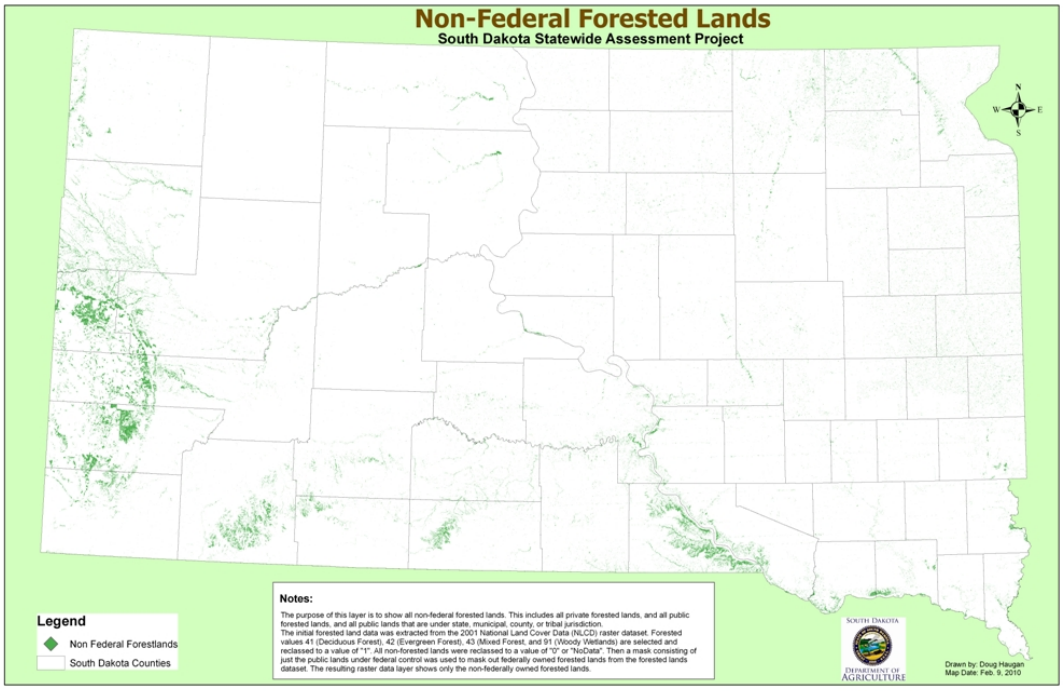

Figure B-2. Nonfederal Forested Lands Map.

B.1.3 Proximity to Private Lands

The purpose of this dataset is to identify those regions of public lands that lie within ½ mile of private lands. All federal, state, and municipal lands were merged to create the public lands layer shapefile. A reverse buffer was created on the edge of this shapefile where public lands contacted private lands, highlighting public lands within ½ mile of private lands. The buffered shapefile became the Proximity to Private Lands dataset as illustrated in Figure B-3.

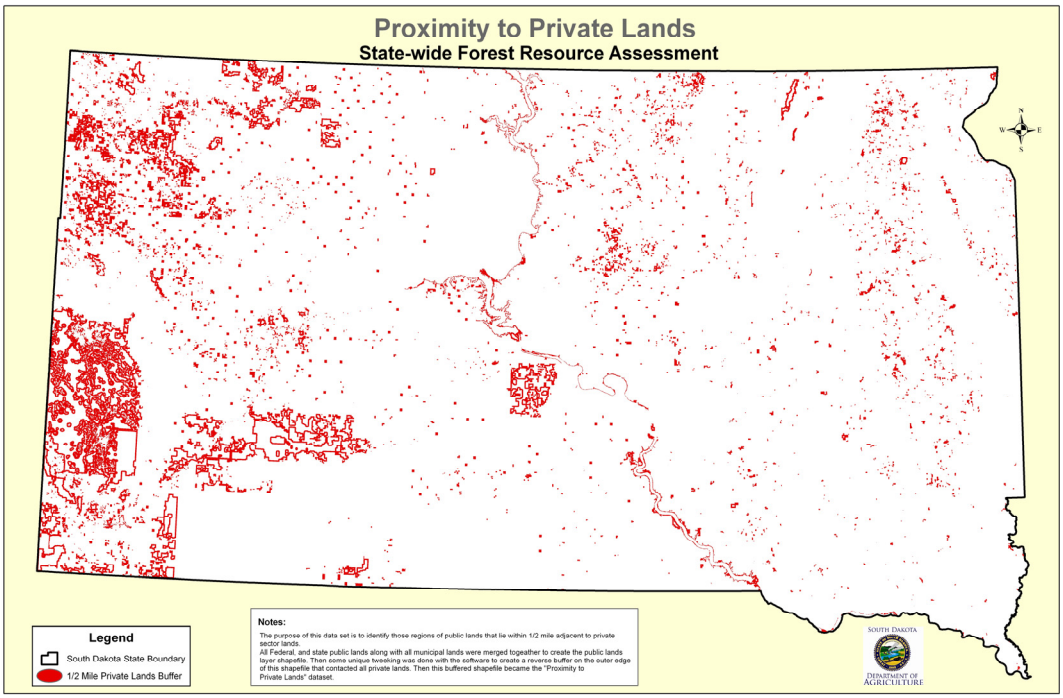

Figure B-3. Proximity to Private Lands Map.

B.2 NATIONAL THEME—PROTECTING FORESTS FROM HARM

B.2.1 Forest Health Issues

The forest health issues layer was produced by using U.S. Forest Service (USFS) Region 2, forest health aerial survey data [U.S. Forest Service, 2010]. Updated aerial surveys from 2008, 2007, 2006, and 2005 were used to better illustrate the bark beetles extent. Damage Causal Agent (DCA) codes (Appendix C) of 11006, 11029, 11030, and 11055 were selected to show areas of bark beetle activity. DCA codes of 15005, 24022, and 25000 were selected to show areas of twolined chestnut borer activity, Dutch elm disease spread, and other defoliator issues. Other DCA codes selected are 30000 (fire), 50000 (weather), and 70000 (man-caused) damages. These extracted datasets were converted to raster form (ESRI **GRID**) and then merged to create the final layer, shown in Figure B-4.

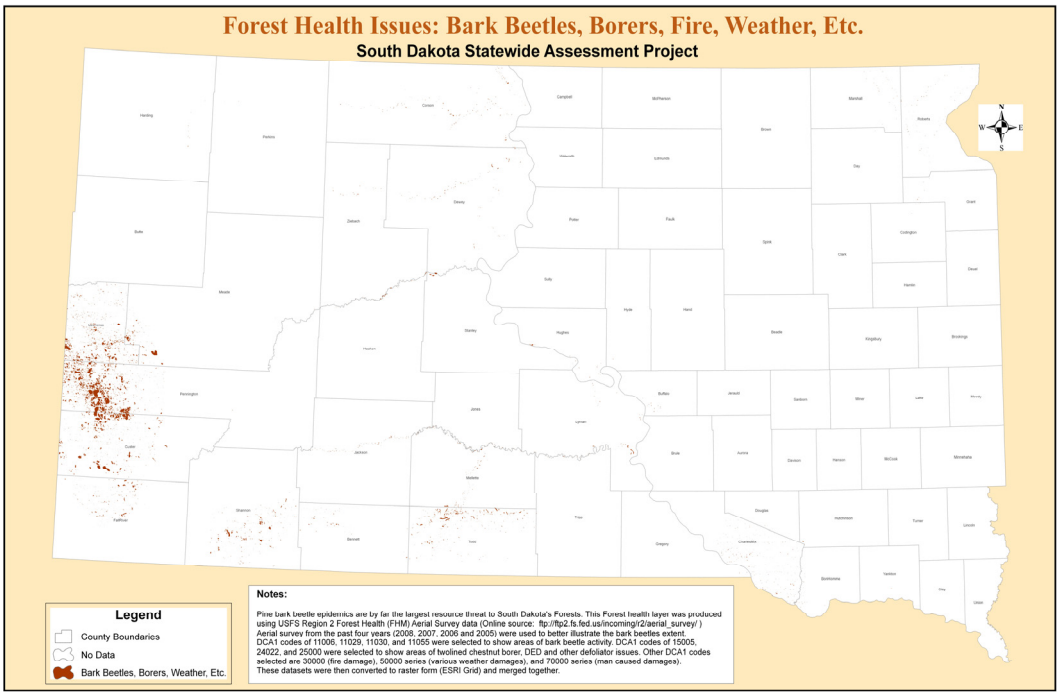

Figure B-4. Forest Health Issues Map.

B.2.2 Wildfire Assessment

The Wildfire Assessment Layer (Red Zone Layer) (Figure B-5) was extracted from the reclassified Risk, Hazard Value (RHV) dataset for South Dakota. Those areas that were classified as "High Risk" for wildfire occurrence are considered critical for the Statewide Assessment of Forest Resources. The reclassified RHV layer was created by overlaying the wildfire risk grid, the wildfire hazards grid, and the social value grid.

1. The wildfire risk grid was extracted from 10 years of past wildfire occurrences.
2. The social value grid was created by extracting data from the "Housing Density" field of the 2000 U.S. Census inventory database.
3. The wildfire hazard grid was created from overlaying "vegetation fuels loading hazards" grid, "vegetation disturbance regimes hazards grid, and terrain hazards grids (i.e., slope and aspect grids).
4. Vegetation fuels loading and disturbance regimes were derived from the National Land Cover Database (NLCD) 92 dataset.
5. The slope and aspect grids were extracted from the South Dakota 30m (30-meter) Digital Elevation Model (DEM) raster dataset.

This assessment of risk is based on wildfire occurrences and housing density. However, it underemphasizes wildfire hazard from fuels, weather, and topography. There is still a need for a better representation of these hazards in South Dakota.

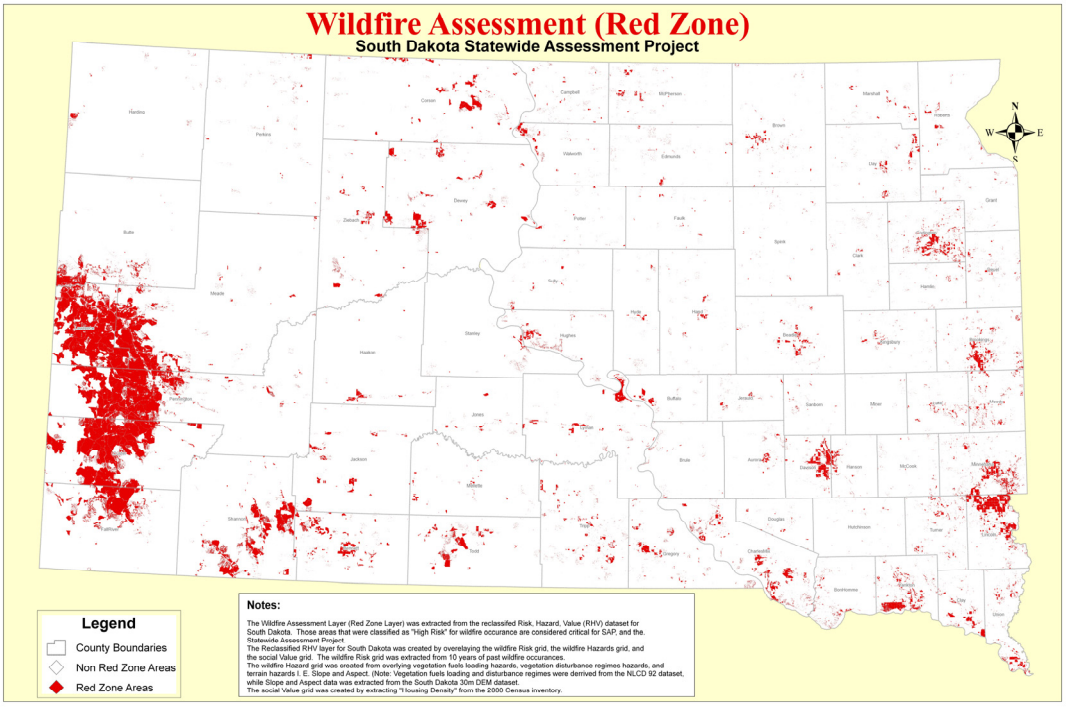

Figure B-5. Wildfire Assessment Map.

B.2.3 Developing Areas

Dr. David Theobald produced the housing density layer used for the South Dakota Forest Stewardship Program spatial analysis and is also being used for the South Dakota Statewide Assessment of Forest Resource (SAFR) project. This data was part of his Western U.S. Housing Density Map used for his "Forest on the Edge" study. The data are produced by subtracting state and federal lands and census water from the 2000 Census Block database and recalculating acres per house for each census block unit. Density projections for 2030 are subtracted from the 2000 density to determine areas under pressure from development. Finally, this Developing Areas layer (Figure B-6) was converted into a grid (raster) and reclassified so grid cells representing development return a "1" and grid cells representing other areas return a "0" (NoData).

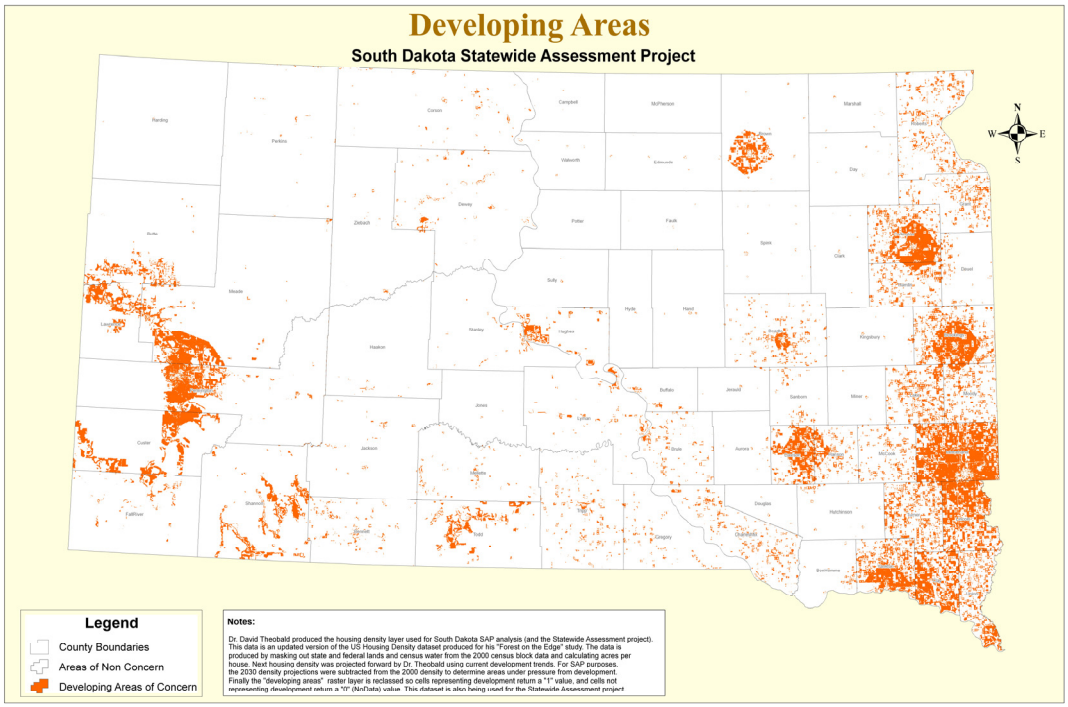

Figure B-6. Developing Areas Map.

B.3 NATIONAL THEME—ENHANCING PUBLIC BENEFITS FROM TREES AND FORESTS

B.3.1 Riparian Corridors

The riparian corridors dataset was derived from the U.S. Rivers and Streams portion of the National Hydrologic Dataset (NHD). This particular dataset was provided by ESRI. The U.S. Rivers and Streams dataset provides a database of linear water features that interconnects and identifies the stream segments and reaches that comprise the surface water drainage system of the United States. The U.S. Rivers and Streams dataset was digitized from 1:24,000 scale U.S. Geological Survey (USGS) topographic maps. For the purpose of the SAFR, rivers and streams data were extracted from the 1:24,000 rivers dataset that covered the state. This data was then queried to select all the major streams, all the perennial streams, and key intermittent streams that generally remain flowing during "normal" rainfall years. Next, this data was buffered by a 200-foot distance on either side of the stream course to produce a buffered vector dataset. This buffered dataset was then converted to an ESRI grid (raster) for the final layer as shown in Figure B-7.

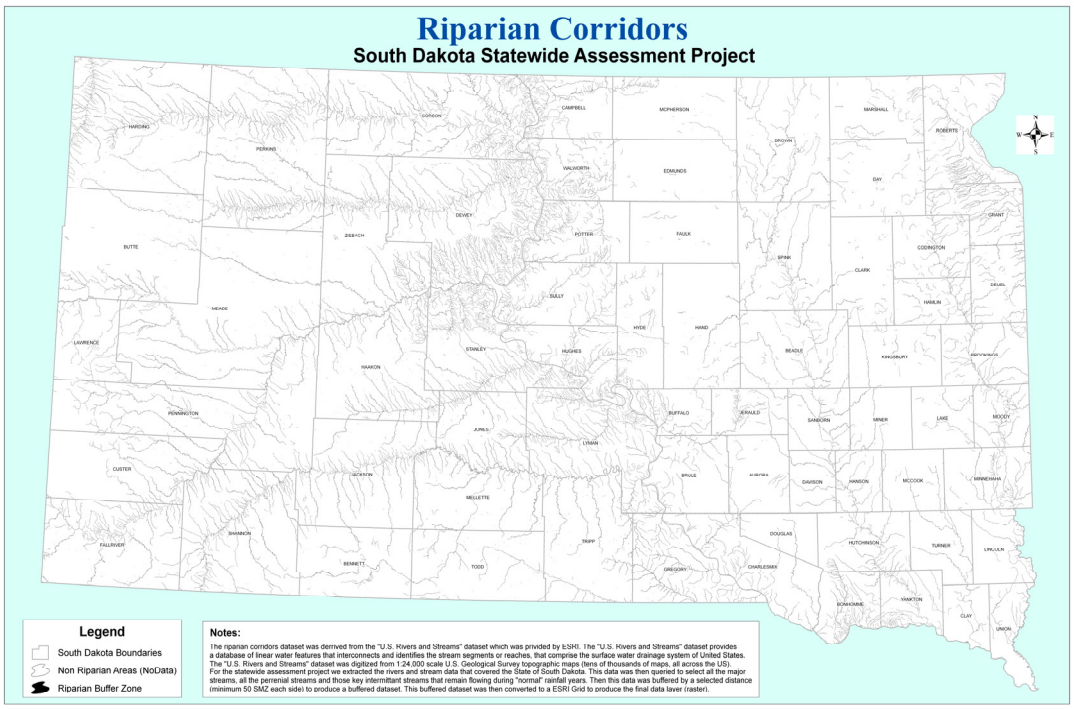

Figure B-7. Riparian Corridors Map.

B.3.2 Agroforestry Suitability

Data used to create the Agroforestry Suitability dataset for the South Dakota SAFR was created from the Natural Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) database and soils geospatial database. The NRCS soils geospatial database contains digitized soils mapping unit polygons for 64 of South Dakota's 65 counties (Lawrence County is not complete).

The SSURGO soils database contains dozens of fields containing unique soil properties. The key field needed for agroforestry purposes is the "Conservation Tree & Shrub Groups." The soils in this field are rated ordinarily for their ability to support trees and shrubs for shelterbelts and other agroforestry purposes.

There are ten primary groups and some specialized subgroups for selected primary groups. For the SAFR Agroforestry Suitability layer, criteria the top five primary groups and associated subgroups were selected by query. This was performed for all of South Dakota's counties (except Lawrence). These top five groups were merged into one group titled "Agroforestry Suitability." Once this was completed for each county, the data were converted to a grid (raster dataset). Then each of these county raster datasets were merged together to create the statewide agroforestry suitability layer, shown in Figure B-8.

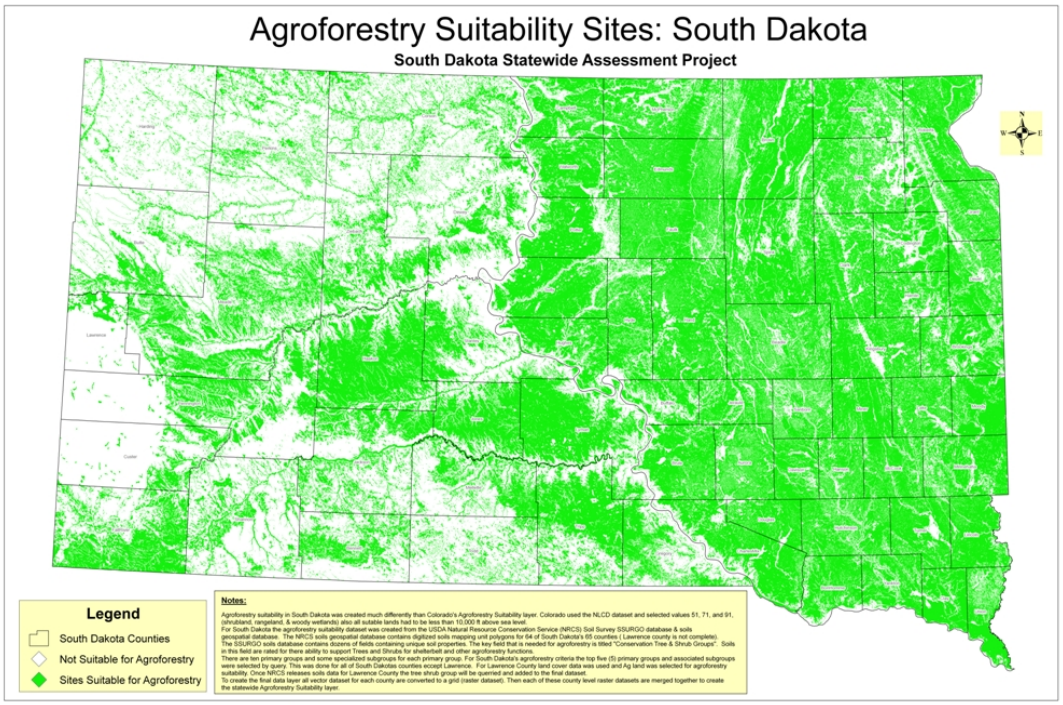

Figure B-8. Agroforestry Suitability Map.

B.3.3 Priority Watersheds Hydrologic Unit Code 12

Priority watersheds in South Dakota were determined using the "319 Project Status" dataset produced by the South Dakota Department of Environment and Natural Resources (SD DENR). SD DENR created this updated dataset from a combination of the new Hydrologic Unit Code (HUC) 12 watershed datasets and scanned DENR 319 project maps. Generally, the 319 dataset is updated every 2 years. The key attribute in this dataset is DENR Status, in which there are four watershed categories: assessed, assessing, implemented, and implementing. For the SAFR, only the "implementing" SD DENR status category is considered as "priority watersheds." These identified 319 "implementing" watersheds are combined with the "impaired waterbodies" dataset which is also produced by the SD DENR and based on the new HUC 12 watershed dataset, resulting in the new Priority Watersheds dataset used for the SAFR (Figure B-9).

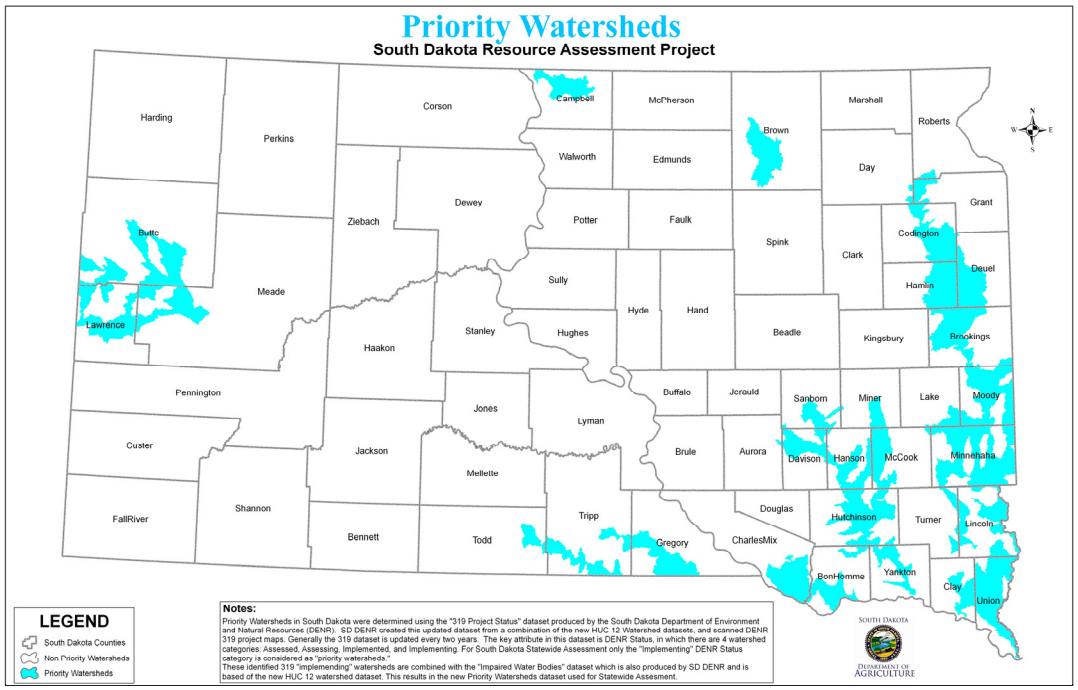

Figure B-9. Priority Watersheds Map.

B.3.4 Public Drinking Water Supply Sources

The South Dakota "Public Drinking Water Supplies" data layer was extracted from the Statewide Source Water Assessment Program (SWAP) dataset. The statewide SWAP dataset was created and maintained by the SD DENR, with watershed delineations in the Black Hills Region coming from the USGS. SD DENR used "Hydrologic Modeling" concepts and HUC 11 watershed data to create this dataset. The key field in the statewide SWAP dataset for SAFR is the "Zone" field which is actually called "Priority Zones." There are three categories: Zone A, Zone B, and Zone C.

Zone A is considered the critical zone. This zone is where drinking water supplied for each community originates. In the Black Hills area, it includes recharge areas for wellheads and a ¼-mile buffer zone around perennial streams that feed these watersheds. In the greater Missouri River watersheds, Zone A includes ¼-mile buffer zones around wellheads and perennial streams and up to 10 miles upstream from each community.

Zone B is not as critical as Zone A but is important because groundwater originating in Zone B watersheds flows into Zone A watersheds. Zone B is the remaining priority watersheds in the Black Hills area. In the greater Missouri watersheds, Zone B is buffered to within 25 miles of the wellheads, within the confines of the watershed boundaries.

Zone C constitutes the remainder of the greater Missouri River watersheds.

For the purpose of SAFR project analysis, only Zones A and B were used to build the "Public Drinking Water Supplies" layer shown in Figure B-10.

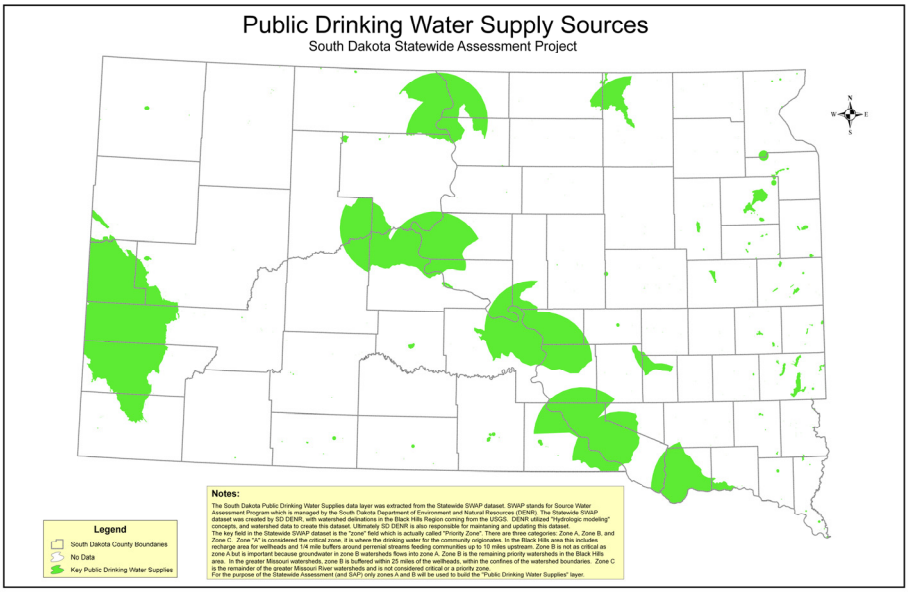

Figure B-10. Public Drinking Water Supply Sources Map.

B.3.5 Threatened and Endangered Species

Threatened and endangered (T&E) species data comes from the South Dakota Natural Heritage Database Program. The South Dakota Department of Game Fish & Parks (GF&P) archives this geodataset. The raw T&E species data was obtained from the GF&P. The T&E species dataset contains point, line, and polygon vector attributes. Some of these T&E species sites are active and some are not.

For the SAFR project, only the forest dwelling species, such as Bald Eagles, were of a concern. The key T&E species were selected by querying and selecting all state endangered and state-protected areas, and by querying and selecting all federally endangered, federally threatened, and candidate species. Also, active T&E species sites were selected by querying the data field "Last Observed" and selecting observation dates ranging from 1990 and later. The burying beetle found in Tripp County was also included. This active T&E species vector dataset was then converted to a grid (raster dataset) for the final updated T&E species layer (Figure B-11).

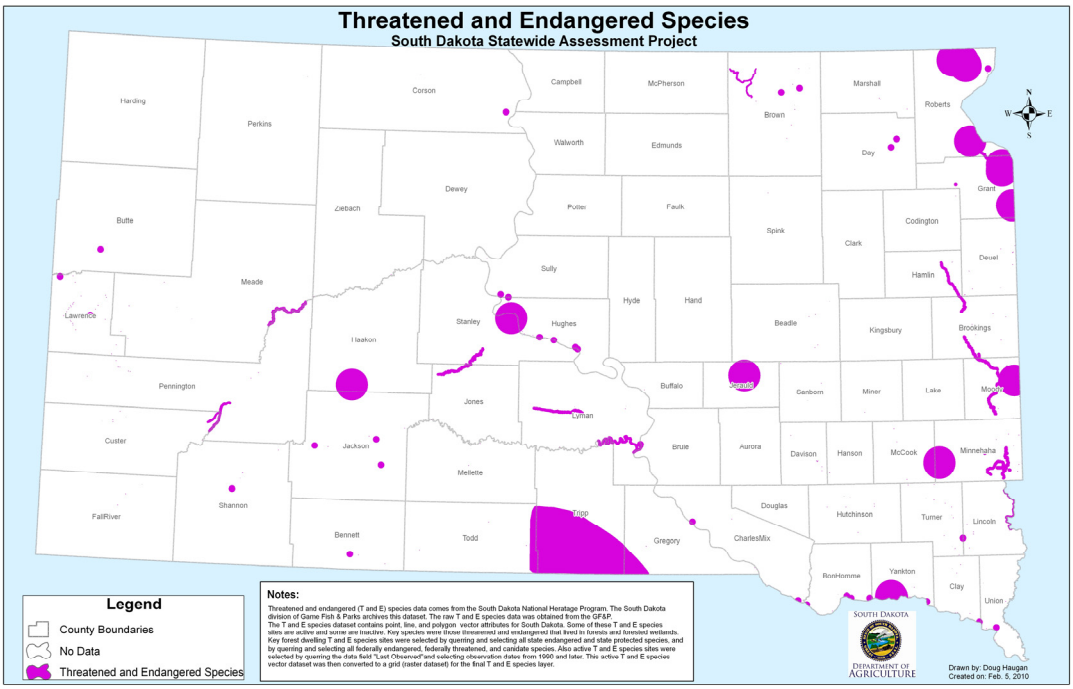

Figure B-11. Threatened and Endangered Species Map.

B.3.6 Community Forest Priority Ranking

This map in Figure 5–6 in the main body of the assessment report. The Community Forest Priority Ranking map is a compilation of the five data layers listed below.

1. Incorporated municipalities (Section B.3.6.1).
2. If the community fell in projected Developing Areas (Section B.3.6.2).
3. A community risk rating based on the size of the municipality and the percentage of high-risk tree species (Section B.3.6.3).
4. A ranking of communities that are managing their community forest, developing a management program, or have no management and none planned. (Section B.3.6.4).
5. Community certification as a Tree City USA (Section B.3.6.5).

This dataset places communities into "high, medium, and low" priority categories. **High** priority communities have the following characteristics:

- On average, the community has a high or medium percentage of ash, elm, and walnut according to the Community Risk Rating.
- The community falls within the *future growth areas* as illustrated on the Developing Areas map.
- The community is not a Tree City USA.
- The community does not have a community forestry program (not "Managing" or "Developing" according to Community Accomplishment Reporting System (CARS)).

Medium priority communities have the following characteristics:

- The community on average has a high or medium percentage of elm, ash and walnut according to the Community Risk Rating.
- The community either has no community forestry program or is developing one.
- The community falls within the *future growth areas* according to the Developing Areas map and is a Tree City USA.
- The community is not in the future growth areas according to the Developing Areas map and is not a Tree City USA.

Low priority communities have the following characteristics:

- The community has a low percentage of elm, ash, and walnut, according to the Community Risk Rating.
- These communities are a focal point of the Developing Areas; that is, the Developing Areas are extending out from these communities.

- The community has an established community forest management program or is developing one as defined by CARS.
- The community is a Tree City USA.

The raster dataset used for modeling the SAFR Priority Area map was created by assigning a 1 to high-priority communities and 0 to all other communities and "no data" values. Thereby, only high-risk communities are represented in the Priority Area map. The following data layers were used to create the Community Forests Priority Ranking data layer.

B.3.6.1 Incorporated Municipalities

Figure B-12 shows all of South Dakota's incorporated municipalities. Data for this layer are extracted from the South Dakota Municipality geospatial dataset, which is derived from the U.S. Census by the South Dakota Departments of Revenue and Transportation.

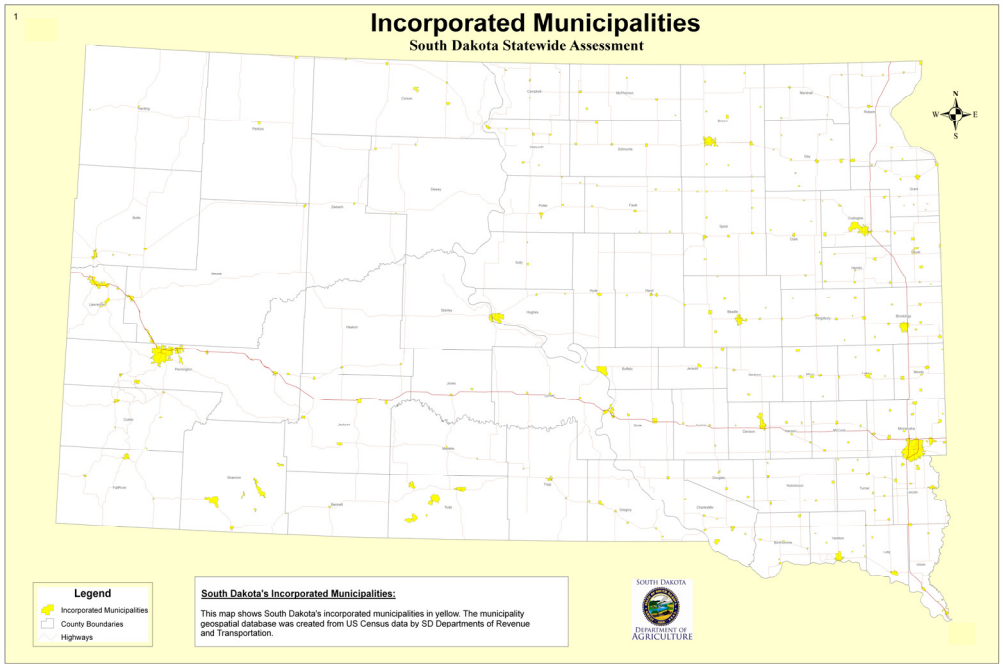

Figure B-12. Incorporated Municipalities.

B.3.6.2 Incorporated Municipalities: Developing Areas

This map combines the Incorporated Municipalities and Developing Areas data layers. Figure B-13 shows all of South Dakota's incorporated municipalities in yellow. The orange areas are the projected expanded urban areas developed by USFS Spatial Analysis Project (SAP) layers for 2030. This is an important layer because it shows where the possible urban growth will be. Communities were evaluated that fell within the expanded areas and whether or not they were managing, developing, or doing nothing for the community forests; whether they were a Tree City USA; and what species risk designation they fell in. The communities that did not have any of these designations and fell in the "medium" and "high" species risk categories were automatically bumped up to "high" priority on the final community forests priority map.

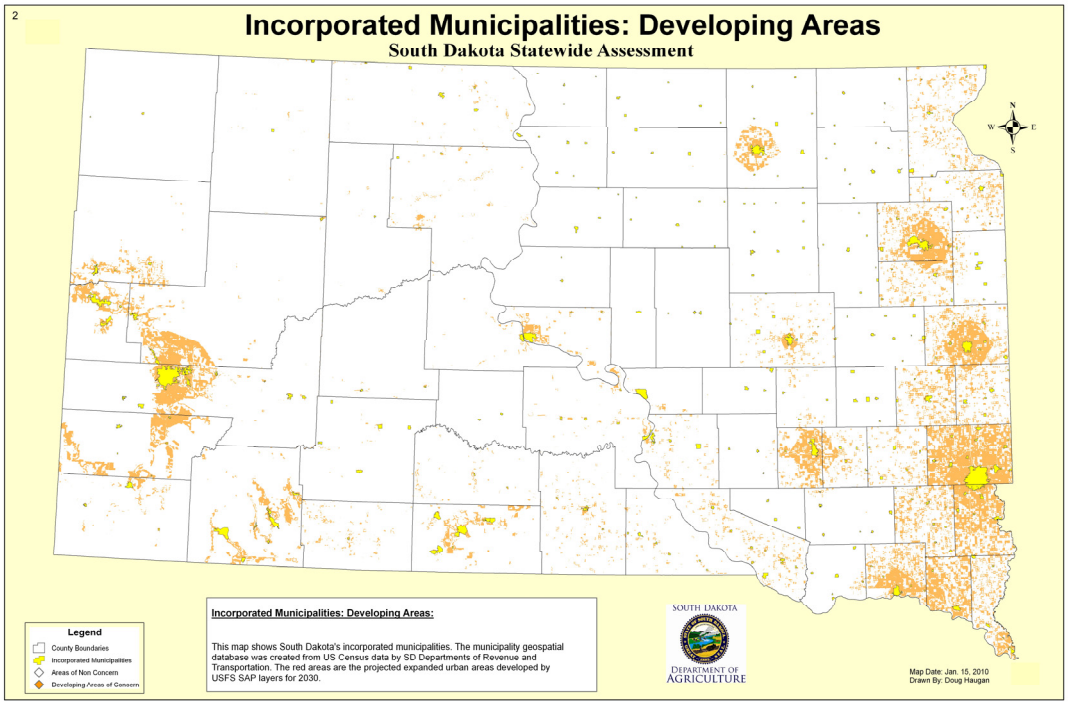

Figure B-13. Incorporated Municipalities and Developing Areas Map.

B.3.6.3 Incorporated Municipalities: Risk Rating

Figure B-14 shows all of South Dakota's incorporated municipalities. The communities are categorized and separated by human population classes based on the South Dakota Municipal League classification shown in Table B-1. The three classes are: Class 1–5,000 and over, Class 2–5,000 to 500, and Class 3–500 and less. Based on sample street tree inventories completed in 30 communities across the state, the data to cover all of the municipality classes were expanded.

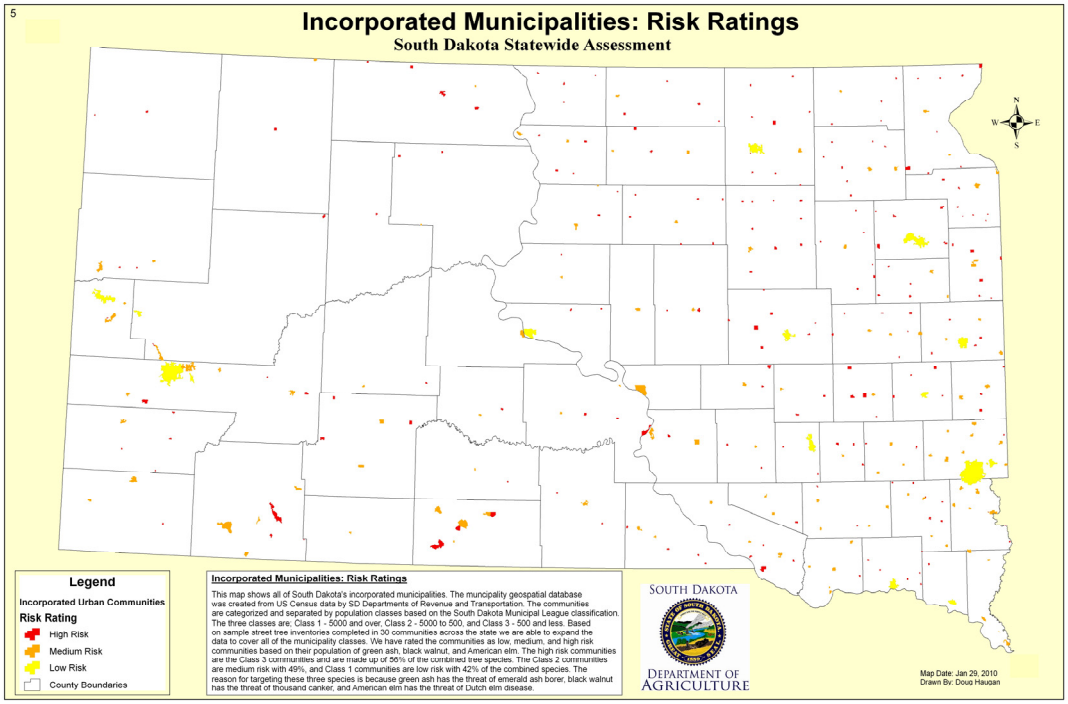

Figure B-14. Incorporated Municipalities Risk Ratings.

Table B-1. Municipal League Classification

Size of Community	Percent High Risk Species	Risk Rating
Class 1	42	Low
Class 2	49	Medium
Class 3	56	High

Municipalities were rated as low, medium, and high risk based on their human population and their population of high-risk tree species: green ash, black walnut, and American elm. These tree species are considered high risk because green ash is threatened by emerald ash

borer, black walnut is threatened by thousand cankers disease, and American elm is threatened by Dutch elm disease.

The number of high-risk trees in inventoried Class 1 municipalities was averaged to arrive at 42 percent of the trees in inventoried Class 1 municipalities as high risk species. This 42 percent was extrapolated to all Class 1 municipalities in the state. The same process was used for Class 2 and Class 3 municipalities. The result was in Class 2 municipalities, 49 percent of the trees are high-risk species and in Class 3 municipalities, 56 percent of the trees are high-risk species. The classes were ranked from lowest to highest, given the risk rating.

B.3.6.4 Incorporated Municipalities: Managing, Developing, or None

Figure B-15 shows all of South Dakota's incorporated municipalities. This map has separated the communities into "Managing," "Developing," or "None" categories. These categories are set by the U.S. Forest Service's CARS. Managing communities are defined as (1) having active urban and community tree and forest management plans; (2) employing or retaining through written agreement the services of professional forestry staff; (3) adopting local/statewide ordinances or policies that focus on planting, protecting, and maintaining their urban and community trees and forests; and (4) having local advocacy/advisory organizations, such as active tree boards, commissions, or nonprofit organizations. Developing communities are defined as having between one and three of the above categories. If the municipality falls in the "None" category, they could have none or one of the above categories and the municipality did not receive any assistance from the RC&F within the past fiscal year.

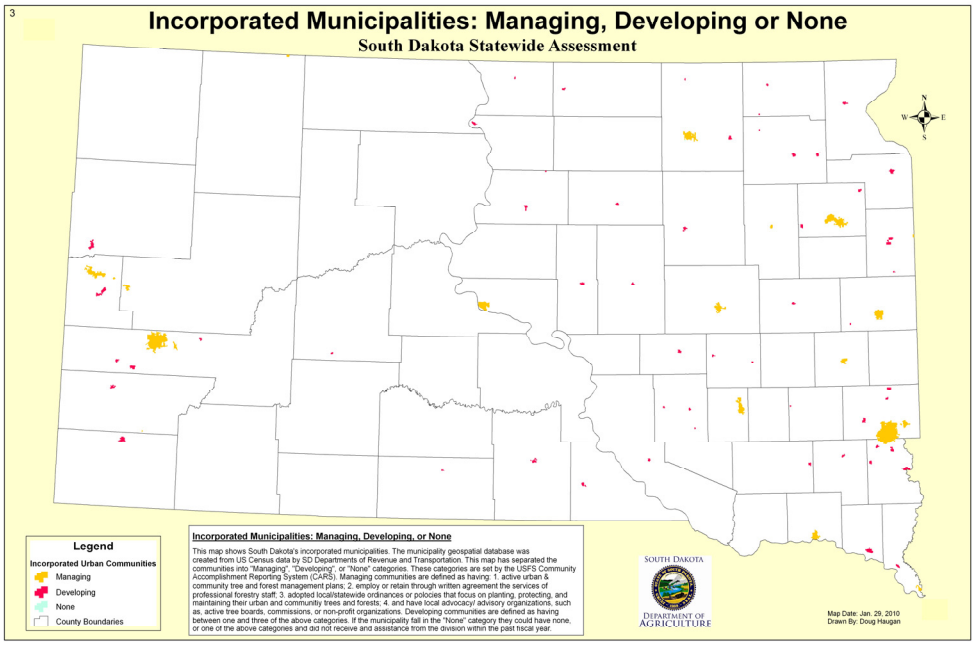

Figure B-15. Classification of Municipalities as Managing, Developing, or None.

On Figure B-15, the highest ranking to “None” communities was given, the second highest ranking was to “Developing,” and the lowest ranking was to “Managing.” The reasoning behind this is “managing” communities do not need a lot of technical assistance; developing will need some technical assistance; and “none” will need substantial of help from RC&F as they do not have the knowledge, funds, or capability of establishing or maintaining a community forestry program of their own.

B.3.6.5 Incorporated Municipalities: Tree City USA

Figure B-16 shows all Tree City USA communities as designated by the Arbor Day Foundation. This map shows all Tree City USA communities as designated by the Arbor Day Foundation. Tree City USA communities are ranked low priority because by being a Tree City USA, they have shown they are capable of maintaining a community forestry program and typically need little technical assistance from RC&F.

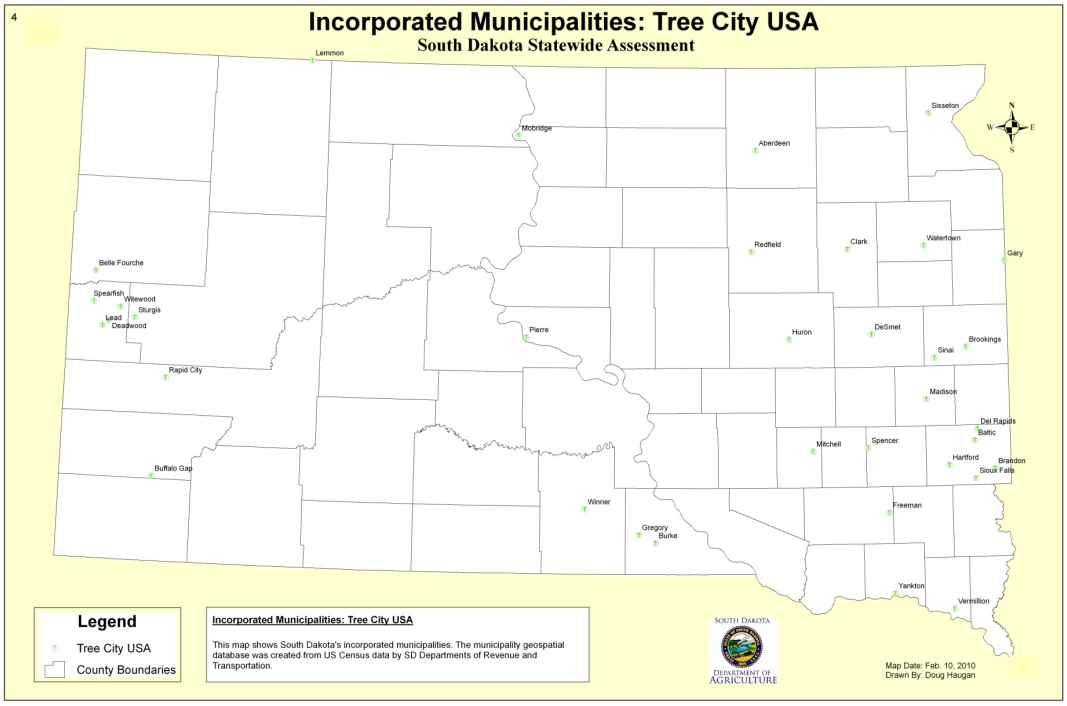

Figure B-16. South Dakota’s Tree City USA Communities.

B.4 QUESTIONNAIRE RESULTS

To determine the benefits and threats to South Dakota’s forests, RC&F developed a questionnaire that was sent to 535 forest landowners, private interest groups, and natural resource agencies. The groups included forest stewards; Certified Tree Farmers; conservation districts; arborists; county commissioners; consulting foresters; Sierra Club; Rocky Mountain Elk Foundation; FSCC; Community Forestry Advisory Council (CFAC); Wild Turkey

Federation; Ducks Unlimited; forest products industries; tribal offices; local, state, and federal agencies; and numerous other organizations. The target group was given a list of 12 benefits from and threats to South Dakota's forests and was asked to identify the top five. We received 315 responses—59 percent response. The results of the questionnaire are presented in Figure B-17.

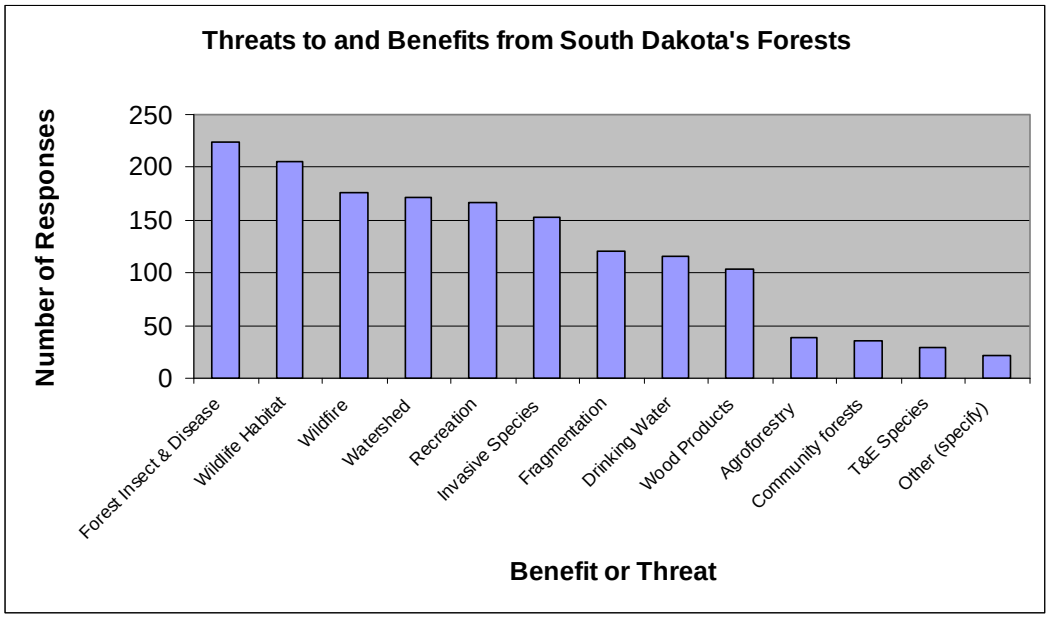

Figure B-17. Results of a Questionnaire Sent to Natural Resource Interest Groups Requesting Identification of Important Benefits From and Threats to South Dakota's Forests.

B.5 WEIGHTING

Unfortunately, statewide geospatial data are not available for all of the benefits and threats listed: data are not available for wildlife habitat, recreation, or invasive species. Wood Products is available as point data reflecting the locations of primary wood processors in the state. These processors are well represented in the forested areas of the state, and for priority analysis purposes, are included in the weight given to the forest land base. Discussion of the wood industry and its infrastructure will be included in the assessment. Data layers representing forest insect and disease, wildfire, watershed, fragmentation, drinking water, agroforestry, community forests, and T&E species are all included in the priority area map.

Weights were assigned to the federal, nonfederal, proximity to private lands, and riparian corridor layers and weights of all other layers were calculated based on importance as defined in responses to the questionnaire. Forested areas were assigned weight because this assessment focuses on forested areas in the state. Riparian corridors were assigned weight

because historical evidence suggests trees and other woody plants were once present along stream courses, and they offer the best opportunity for trees and woody plants to affect water quality. The formula used for calculating layer weights is:

$$w = \left(a / b \times \left(100 - c\right)\right) \tag{B-1}$$

where:

w = data layer weight in percent

a = sum of responses by a threat or benefit that is represented by a data layer

b = sum of responses for all threats and benefits that are represented by data layers

c = sum of assigned weights for Federal forest land, nonfederal forest land, riparian corridors, and proximity to

a/b = relative importance of a threat or benefit.

The use of calculated weights for most of the data layers limited the manipulation of only four data layer weights to affect priority area determination. The weight used for each layer is presented on the map for each alternative. The sum of all data layer weights must equal 100 percent. Low-, medium-, and high-priority areas were identified using the Natural Breaks classification algorithm (Jenk's algorithm).

During the initial meeting of the FSCC and CFAC to review the process of priority area determination, the group decided that the Forest Legacy areas should not be assigned a weight, but rather, should be applied as a highlighted overlay on the priority area map to illustrate the juxtaposition of the two maps. The alternative maps that were most acceptable to the group were those that reflected responses to the questionnaire sent out earlier in the summer.

In addition to applying weight to the various data layers for setting priority areas, the amount of area identified as high priority needed to be limited because too much high-priority land essentially eliminates any prioritization; that is, if everything is high priority, there is no prioritization. There is no national guidance regarding how much land should be high priority.

A total of 22 alternative maps were created. Some were discussed at an August 2009 meeting with the FSCC and CFAC. The committees requested to have additional alternative maps created based on suggestions made at the meeting. However, instead of attending an additional meeting, the new results were mailed out with a request for comments. For the review of alternatives, RC&F identified Alternative 16 as its preferred alternative. Alternative 16 identified 38.54 percent of forest lands in high priority and 3.15 percent of all lands in South Dakota as high priority. Feedback from reviewers supported Alternative 16. However,

concerns were expressed that not enough federal forest land was identified as high priority, given the pressures placed on federal agencies to intensively manage federal forest lands for mountain pine beetle control and fuel hazard reduction. Also, concerns were expressed that there were more high-priority nonforest acres than high-priority forest acres in the Alternative.

With these comments in mind, RC&F modified the preferred alternative to create the proximity map illustrated in Figure B-3. The map includes a proximity to private lands layer that was not included in earlier alternatives. Including this layer increased the importance of federal land within ½ mile of private land to high priority. This will better reflect public and private concerns about the influence of federal land management decisions on adjacent private land. It also reflects the need for cross-border management of the forest; that is, priority areas for treatment do not necessarily stop at the ownership boundary.

The data layers listed in Table B-2 were used in the formation of the priority area map. The weight determination method is listed for each layer. The layers are organized by national themes. Explanations for how these maps were created are discussed later in this document.

Table B-2. Data Layers, Weight Determination Method, and Final Weighting Used in Priority Area Determination

Data Layer	Weight Determination	Weight
Conserving Working Forests		
Forest Legacy Areas	No weight given	0
Federal Forest Lands	Assigned	3.6
Nonfederal Forest Lands	Assigned	17.5
Proximity to Private Lands	Assigned	3.0
Protecting Forests From Harm		
Forest Health Issues	Calculated	14.2
Wildfire Assessment	Calculated	11.2
Developing Areas	Calculated	7.7
Enhancing Public Benefits From Trees and Forests		
Riparian Corridors	Assigned	17.5
Agroforestry Suitability	Calculated	2.5
Priority Watersheds–HUC 12	Calculated	10.9
Public Drinking Water Supplies	Calculated	7.3
Threatened and Endangered Species	Calculated	1.8
Community Forests	Calculated	2.3
Total		**100**

B.6 PRIORITY AREAS

The distribution of priority area weights presented in Table B-1 provided the best interaction among the data layers. No single data layer is high priority unless it combines with some other layer such as riparian areas and drinking water supply sources, priority watershed and forest land. There is an acceptable distribution of forest and total land area in low-, medium-, and high-priority areas, as illustrated in Table B-3. The Final Priority Assessment Map is presented in Figure 7-1 in the main body of the assessment report.

Table B-3. Distribution of Forest, Nonforest, and Total Land Area in South Dakota Among High, Medium, and Low Priority

Priority	Forest		Nonforest		Total	
	Acres	Percent of Total Forest Land	Acres	Percent of Total Nonforest Land	Acres	Percent of Total Land
High	1,073,720	61.34%	1,034,372	2.18%	2,108,092	4.28%
Medium	634,140	36.23%	10,510,032	22.13%	11,144,172	22.63%
Low	42,454	2.43%	35,957,048	75.70%	35,999,502	73.09%
Total	**1,750,314**		**47,501,452**		**49,251,766**	

The final map used in the assessment does not distinguish between forest and nonforest areas. This separation was a requirement of the Forest Stewardship Potential Map, but it is not required of the priority area map. However, the distinction was important in the analysis for showing where forest lands occur in the state.

Figure B-18 shows the Priority Area Map with the Forest Legacy areas delineated. The two layers are complementary.

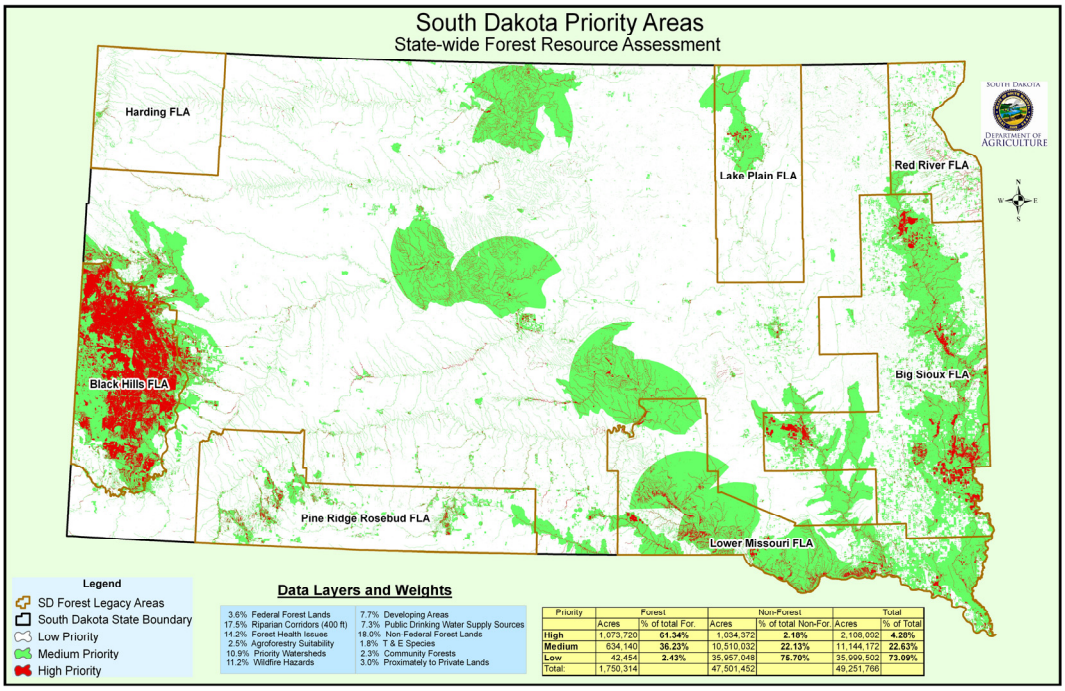

Figure B-18. South Dakota Priority Area Map With Forestry Legacy Areas Outlined.

B.7 METHODOLOGY REPORT BIBLIOGRAPHY AND GEOGRAPHIC INFORMATION SYSTEM DATA RESOURCES

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APPENDIX C

STATEWIDE FOREST LEGACY PLAN

APPENDIX C
STATEWIDE FORESTRY LEGACY PLAN

The statewide Forest Legacy Assessment of Need can be obtained by contacting the Division of Resource Conservation and Forestry (RC&F), or it can be downloaded from *http://sdda.sd.gov/Forestry/Programs-Services/forest-legacy.aspx*

APPENDIX D

BLACK HILLS WILDFIRES

APPENDIX D
BLACK HILLS WILDFIRES

LAWRENCE AND MEADE COUNTIES

Data analysis conducted by the South Dakota Division of Wildland Fire Suppression (WFS) for Calendar Years (CY) 1988–2008 shows 447 wildfire ignitions for this fire zone on its jurisdictional lands within the Great Plains Center (GPC) Initial Attack area. Total acreage burned for the 20-year time period was 18,884 acres, which included acreage burned on neighboring federal agency lands. Two wildfires, Grizzly Gulch (2002) and East Ridge (2006), accounted for approximately 74 percent of the total acreage burned in this zone by wildfires started on WFS jurisdiction. The 20-year analysis showed that 68 percent of the ignitions in this zone were human caused and 32 percent were lightning-caused ignitions on WFS jurisdictional lands. The frequency of wildfire occurrence in this area of the Black Hills Forest Fire Protection District only accounts for 26 percent of the wildfire ignitions on WFS jurisdictional lands based on the 20-year analysis.

PENNINGTON, CUSTER, AND FALL RIVER COUNTIES

Data analysis conducted by the South Dakota WFS for CY 1988–2008 shows 1,262 wildfire ignitions for this fire zone on its jurisdictional lands within the GPC Initial Attack area. Total acreage burned for the 20-year time period was 89,063 acres, including acreage burned on neighboring federal agency lands. The 20-year analysis showed that 46 percent of the ignitions in this zone were human caused and 54 percent were lightning-caused ignitions on WFS jurisdictional lands. The frequency of wildfire occurrence in the Black Hills Forest Fire Protection District areas of Pennington, Custer, and Fall River Counties accounts for 74 percent of all the wildfire ignitions on WFS jurisdictional lands based on the 20-year analysis.

Tables D-1 and D-2 show the frequency of wildfire occurrence by fire weather zones in the Black Hills Forest Fire Protection District on WFS jurisdictional lands (private and state ownership) by county. Figure D-1 shows the number of acres burned in the Black Hills.

Table D-1. Rate of Fire Occurrence 1988–2008

	Lawrence/ Meade	Custer/Fall River/ Pennington	Totals
Human Caused	306	583	889
Lightning	141	679	820
Totals	**447**	**1,262**	**1,709**

Table D-2. Acreage Burned, Including Acres Burned on Federal Agency Lands From Wildfire Ignitions on Wildland Fire Suppression Jurisdictional Lands 1988–2008

	Lawrence/ Meade	Custer/Fall River/ Pennington	Totals
Human Caused	15,036	38,788	53,824
Lightning	3,849	50,275	54,124
Totals	**18,885**	**89,063**	**107,948**

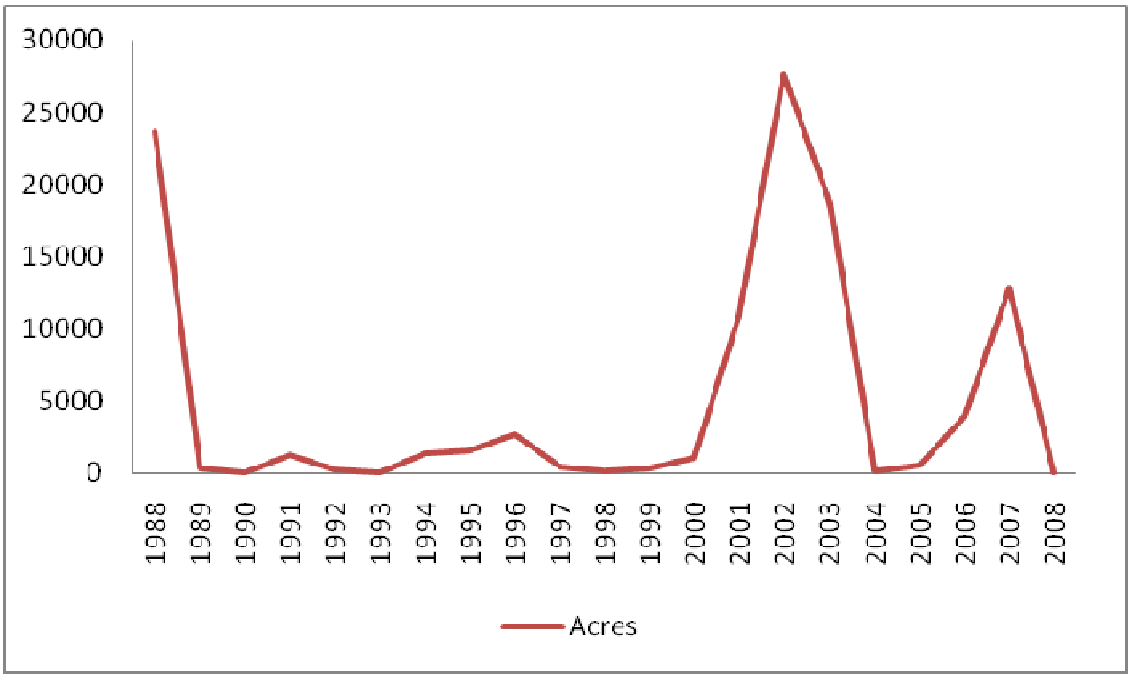

Figure D-1. Graph Showing Trend Over a 20-Year Study Period of Acres Burned by Ignitions on Wildland Fire Suppression Jurisdictional Lands in the Black Hills Forest Fire Protection District.

Descriptive statistics for both human caused and lightning-caused ignitions combined on WFS jurisdictional lands in the Black Hills Forest Fire Protection District from 2005–2007 as delineated by WFS Field Offices service areas. Note the stochastic pattern of lightning ignitions as compared to human-caused ignitions (HWC), as the HWC ignitions are significantly closer to road systems (Tables D-3 and D-4).

Table D-3. Sample Means (*X*) of Explanatory Variables Classified by Wildland Fire Suppression Field Office

Variable	Unit	*X*	Hot Springs	Custer State Park	Rapid City	Lead
HWC–Elevation	Meters	1,346	1,400	1,452	1,266	1,432
Light– Elevation	Meters	1,321	1,238	1,460	1,220	1,406
HWC–Slope	%	7.0	4.0	16.0	8.0	12.0
Light–Slope	%	11.0	8.0	15.0	10.0	13.0
HWC–Road	Meters	201	227	346	194	163
Light–Road	Meters	497	572	554	406	305

Table D-4. Percentage of Occurrence by Wildland Fire Suppression Field Office, 2005–2007 (*n* = number)

Dataset	*n*	Hot Springs	Custer State Park	Rapid City	Lead
HWC	171	35%	4%	46%	16%
Lightning	157	36%	30%	23%	13%
HWC	171	35%	4%	46%	16%
Lightning	157	36%	30%	23%	13%
HWC	171	35%	4%	46%	16%
Lightning	157	36%	30%	23%	13%

APPENDIX E

STREET TREE INVENTORY

APPENDIX E
STREET TREE INVENTORY

The community risk data layer was derived from information gathered during community street tree inventories that have been conducted across the state. Over the past 10 years, the division, with the help of South Dakota State University and the communities has completed 30 street tree inventories. The communities involved in the inventory are shown in Table E-1.

Table E-1. Communities With Completed Tree Inventories

Aberdeen	Andover	Bison	Box Elder
Britton	Brookings	Bryant	Burke
Canton	Clark	DeSmet	Eagle Butte
Elk Point	Freeman	Gregory	Highmore
Kennebec	Lemmon[(a)]	Mobridge	Murdo
Pierre	Platte	Roscoe	Selby
Spearfish	Sturgis	Tripp	Wall
Wasta	Webster	Whitewood[(a)]	Winner

(a) In the process of entering data.

Communities initially were selected to get the best geographical variety of communities in the state. In selecting these communities, all of South Dakota was represented. The software that was chosen for the street tree inventories was Davey Resource Group's *TreeKeeper*™. *TreeKeeper*™ is an online database which houses tree information and allows anyone access where internet service is available.

TreeKeeper™ collects tree data using personal digital assistants (PDAs) with Window's Mobile data collection software. This allows for easy transfer of data from field collection into the online database. The data collected include:

- Species
- Diameter at breast height (DBH) (measured in 3-inch increments; e.g., 1–3, 4–6)
- Height which is measured in feet (typically 1–30, 31–45, and 46+)
- Condition (good, fair, poor, and dead)
- Clearance (street lights, traffic lights, traffic signs, struck by vehicles, and struck by pedestrians)

- Maintenance (if it needs to be pruned, removed, remove deadwood, or planted because it is empty)
- Hardscape damage caused by the tree (damage to curb and gutter)
- Electrical codes (whether it is growing into power lines or not).

The process in which *TreeKeeper*™ locates the trees is by using street addresses, then numbered spots at that address. The downside of collecting data in this order is that data need to always be collected by working west to east or east to west, north to south or south to north on the roads so the numbered sites are always the same. If this process is not followed, it is difficult to go back to find a particular tree. This has been the case with some of the inventories. The software allows the communities to set up work plans around what the data say; however, when a crew goes out to find the tree to perform the work, the tree was not there. In many cases, the tree was on the other side of town or just on the other end of the property. This type of problem could be solved by using geospatial imagery to map the trees. By using aerial photographs and global positioning system (GPS) points to map the trees, some of the problems would be eliminated. Other functions aerial mapping provides is being able to look at density, canopy cover, and detecting impervious surfaces. With this additional information, better observations could be made in trends in planting, gain or loss in canopy cover, and tracking of where our open spaces.

The Resource Conservation and Forestry (RC&F) Division recently purchased software that has geospatial capabilities. The RC&F hopes to use this software for future city street tree inventories.

APPENDIX F

STATEWIDE FOREST RESOURCE ASSESSMENT QUESTIONNAIRE NO. 1

Statewide Forest Resource Assessment Questionnaire

The South Dakota Department of Agriculture, Resource Conservation & Forestry Division is developing an assessment of South Dakota's forest resources. The assessment will consider all ownerships, including state, private, federal, and tribal forest lands. As part of this assessment, we are evaluating the importance of benefits and threats to the State's forests.

The following is a single question asking you to identify the five most important benefits and threats to South Dakota's forest lands. **Please complete the question and return this page in the enclosed self-addressed envelope by July 31.** Thank you.

The following benefits and threats to South Dakota's forest lands are listed in no particular order. What are your top five most important state-wide benefits or threats? Please place an "X" in the space provided identifying your top five selections.

_____ Watershed
_____ Recreation
_____ Wildfire
_____ Forest Insects and Diseases
_____ Invasive Species
_____ Threatened and Endangered Species
_____ Wood Products
_____ Wildlife Habitat
_____ Drinking Water
_____ Agroforestry
_____ Fragmentation (parceling for development)
_____ Community forests
_____ Other (specify)_____

Individuals, Groups, Organizations, and Agencies Targeted for Forest Benefits and Threats Questionnaire Used for Identifying State-wide Priority Areas

Audubon Society Chapter Services Office
Black Hills Council of Governments
Central Plains Water Development District
Cheyenne River Sioux Tribe
County Commissions
Crow Creek Sioux Tribe
Dakotas Society of American Foresters
Ducks Unlimited, Inc.
East Dakota Water Development District
First Planning & Development District
Flandreau Santee Sioux Tribe
James River Water Development District
Lower Brule Sioux Tribe
Northeast Council of Governments
Oglala Sioux Tribe
Pheasants Forever
Rosebud Sioux Tribe
Rural Water Systems
SD Arborist Association
SD Ass'n of Rural Water Systems
SD Association of Conservation Districts
SD Association of County Commissioners
SD Community Forestry Advisory Council
SD Conservation Districts
SD Department of Environment & Natural Resources
SD Department of Game, Fish, & Parks
SD Forest Stewardship Coordinating Committee Members
SD Lakes & Streams Association
SD Private Professional Foresters
SD Tree Cities USA
SD Tree Farm Committee Members
SD Wild Turkey Federation
Sierra Club
Sisseton-Wahpeton Sioux Tribe
South Central Water Development District
Southeastern Council of Governments
Standing Rock Sioux Tribe
State Conservation Commission
Stewardship Forest Landowners
Third Planning & Development District
Trout Unlimited - National Office
US Army Corps of Engineers
US Fish & Wildlife Service
USDA FS Black Hills National Forest
USDA FS Buffalo Gap National Grasslands
USDA FS Cedar River Grassland
USDA FS Dakota Prairie Grasslands
USDA FS Fort Pierre National Grasslands
USDA FS Grand River Grassland
USDA Natural Resource Conservation Service
USDA NRCS State Technical Committee
USDA Resource Conservation & Development Districts
USDI Bureau of Land Management
USDI NPS Badlands National Park
USDI NPS Jewel Cave National Monument
USDI NPS Lewis & Clark Nat'l Historic Trail
USDI NPS Minuteman Missile Nat'l Historic Site
USDI NPS Missouri National Recreational River
USDI NPS Mount Rushmore National Memorial
USDI NPS Wind Cave National Park
Vermillion Basin Water Development District
West Dakota Water Development District
West River Water Development District
Yankton Sioux Tribe

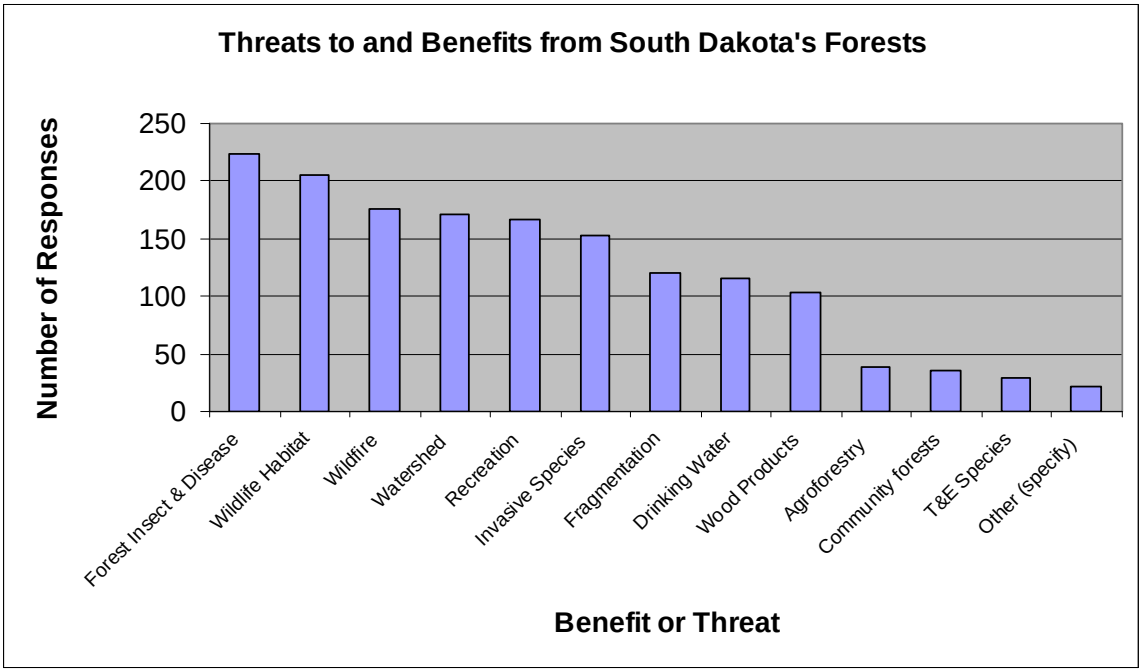

Figure F-1. Threats to and Benefits From South Dakota's Forests.

APPENDIX G

STATEWIDE FOREST RESOURCE STRATEGY QUESTIONNAIRE NO. 2

APPENDIX G

STATEWIDE FOREST RESOURCE STRATEGY QUESTIONNAIRE NO. 2

A second survey was distributed to help determine the most serious threats to each of the state's forest types and solicit ideas for solutions and strategies to address those threats. This second questionnaire was sent to members of the Forest Stewardship Coordinating Committee (FSCC), Community Forestry Advisory Council (CFAC), and internal field staff. The questionnaire asked the following three questions for each forest type:

1. What are the three most important problems facing this forest type?
2. How can we (all the responsible management agencies) address the problems you identified?
3. What should be our top three management strategies for this forest type?

Table G-1. Problems, Solutions, and Strategies Survey Responses—Black Hills Conifer Forests (Page 1 of 2)

Problems	Responses	Solutions	Responses	Strategies	Responses
Conifer encroachment	1	**Treatments**		**Treatments**	
Invasives	2	Thinning	1	Mechanical thinning	1
Unmanaged recreation	1	Marketing		Herbicides to control weeds	1
Distance to viable markets	4	Promote, develop, and fund specialty markets	1	**Marketing**	
Limited professional technical assistance	2	Protect industrial infrastructure	1	Promote niche market development	1
Fire	1	**Financial Incentives**		Develop new markets (biofuels)	2
Forest health	3	Taxes–maintain agriculture status	1	**Financial Incentives**	
Fragmentation by development	2	Continue cost-share for fuel reduction, fuel breaks, thinning	1	Taxes–maintain agriculture status	1
Lack of management	1	**Technical Assistance**		Develop revolving loan program to encourage forest management	1
		Provide foresters on the ground	1	**Technical Assistance**	
		Develop program to help landowners manage lands	1	Maintain management assistance to public	1
		Encourage management	1	Switch from rape-and-pillage to sustainable management	1
		Education		Manage for species diversity	1
		Educate landowners	3	Provide landowner assistance to control Mountain Pine Beetle	1
		Encourage management	1	Help local governments to limit fragmentation	1
		Interagency Coordination		**Education**	
		Develop multiagency weed boards	1	Education	1

Table G-1. Problems, Solutions, and Strategies Survey Responses—Black Hills Conifer Forests (Page 2 of 2)

Problems	Responses	Solutions	Responses	Strategies	Responses
		Coordinate with Bureau of Indian Affairs (BIA), tribal government, private landowners	1	Educate landowners	1
				Classes	1
				Educate public	1

Table G-2. Problems, Solutions, and Strategies Survey Responses—Conifer Forests Outside the Black Hills

Problems	Responses	Solutions	Responses	Strategies	Responses
Conifer encroachment	1	**Treatments**		**Treatments**	
Invasives	2	Thinning	1	Mechanical thinning	1
Unmanaged recreation	1	Marketing		Herbicides to control weeds	1
Distance to viable markets	4	Promote, develop, and fund specialty markets	1	**Marketing**	
Limited professional technical assistance	2	Protect industrial infrastructure	1	Promote niche market development	1
Fire	1	**Financial Incentives**		Develop new markets (biofuels)	2
Forest health	3	Taxes–maintain agriculture status	1	**Financial incentives**	
Fragmentation by development	2	Continue cost-share for fuel reduction, fuel breaks, thinning	1	Taxes–maintain agriculture status	1
Lack of management	1	**Technical Assistance**		Develop revolving loan program to encourage forest management	1
		Provide foresters on the ground	1	**Technical Assistance**	
		Develop program to help landowners manage lands	1	Maintain management assistance to public	1
		Encourage management	1	Switch from rape-and-pilage to sustainable management	1
		Education		Manage for species diversity	1
		Educate landowners	3	Provide landowner assistance to control Mountain Pine Beetle	1
		Encourage management	1	Help local government to limit fragmentation	1
		Interagency Coordination		**Education**	
		Develop multiagency weed boards	1	Education	1
		Coordinate with BIA, tribal government, private landowners	1	Educate landowners	1
				Classes	1
				Educate public	1

Table G-3. Problems, Solutions, and Strategies Survey Responses—Upland Hardwood Forests

Problems	Responses	Solutions	Responses	Strategies	Responses
Lack of timber management	1	**Treatments**		**Treatments**	
Lack of markets for timber management	5	Control invasives	1	Early detection of pests	1
Poor inventories	2	Promote practices that favor regeneration	1	Establish and Implement best management practices	1
Forest health—insects	2	Reforest historically forested sites	1	**Marketing**	
Regression to softwoods	1	Monitoring	1	Promote markets	3
Invasive species	3	**Marketing**		Inventory	3
Livestock grazing	2	Promote markets for timber	4	**Financial Incentives**	
Lack of recognition and management as forest	3	Identify the resource (inventory)	2	Promote cost-share/co-op programs	2
Poor diversity of species	1	**Financial Incentives**		Incentives to control livestock access	1
Resources managed for nonforestry objectives	1	Implement cost-share and co-op programs	1	**Technical Assistance**	
Lack of management	2	**Technical Assistance**		Promote rotational grazing	1
Lack of regeneration	2	Provide technical assistance to landowners	2	Promote multiple uses	1
Fragmentation—conversion to other land uses	1	Encourage sustainable management	1	Manage for diversity	1
Fire management	1	Promote management, offer tours of managed forests	1	Promote management	1
		Education		Provide technical assistance	2
		Educate public of benefits of forest and management	2	**Education**	
		Share information	1	Education	3

Table G-4. Problems, Solutions, and Strategies Survey Responses—Bottomland/Riparian Forests (Page 1 of 2)

Problems	Responses	Solutions	Responses	Strategies	Responses
Loss of species and age diversity	6	**Marketing**		**Treatments**	
Invasive pests	5	Control invasives—market development?	1	Restore natural riparian forests	1
Loss to agricultural uses	2	Inventory	1	Limit livestock use	1
Perception of treeless prairie outside the Black Hills	1	**Financial Incentives**		Establish riparian forests in critical areas	1
Lack of cottonwood regeneration	1	Provide funding	1	Treat invasives	1
Lack of understanding of riparian forest benefits	2	Provide incentives to protect riparian areas	2	Encourage more waterflows	1
Livestock grazing	6	**Technical Assistance**		**Marketing**	
Flooding	1	More foresters on the ground	1	Utilize invasives	1
Forest health—emerald ash borer (EAB), diseases	3	Provide technical assistance	1	Inventory existing riparian forests and identify potential forest areas	1
Dams	2	**Education**		**Financial Incentives**	
No management	1	Educate public, landowners	7	U.S. Department of Agriculture and U.S. Fish and Wildlife grants	1
Loss of acres of this forest type	1	Protect from over grazing	2	Incentives and education to restrict grazing	2
		Interagency Coordination		Cost-share to regenerate hardwoods	3
		Coordination between agencies	2	Continue cost-share	1
		Coordinate tree plantings	1	**Technical Assistance**	
				Technical assistance to private landowners	3
				Grazing plans	1

Table G-4. Problems, Solutions, and Strategies Survey Responses—Bottomland/Riparian Forests (Page 2 of 2)

Problems	Responses	Solutions	Responses	Strategies	Responses
				Promote species diversity	1
				Develop best weed management practices	1
				Education	
				Educate urban and rural people about riparian benefits	1
				Develop best weed management practices	1
				Educate ranchers—rotational grazing	3
				Develop “show case” forests	1

Table G-5. Problems, Solutions, and Strategies Survey Responses—Windbreaks (Page 1 of 2)

Problems	Responses	Solutions	Responses	Strategies	Responses
Lack of interest by young landowners	1	**Treatments**		**Treatments**	
Overly mature/dying windbreaks	13	Get cattle out of windbreaks	1	Increase acres of plantings	2
Cost of renovation	1	Monitoring	1	Pesticides	1
No incentive for planting windbreaks	2	Replanting	1	Exclude cattle	2
Drought	1	**Marketing**		Renovate windbreaks	3
Wildlife damage	1	Inventory	1	**Marketing**	
Weeds—invasives	2	**Financial Assistance**		Develop markets for debris from renovation	1
EAB threat	3	Cost-share from conservation commission and U.S. Department of Agriculture	1	Inventory	1
Lack of management—plant and forget mentality	4	Cost-share	6	Monitor for insects and diseases	1
Lack of symmetry between incentives and needs	1	**Technical Assistance**		**Financial Assistance**	
Lack of understanding of benefits	1	More foresters on the ground	1	Target specific areas, not statewide	1
No support for maintenance	1	Technical assistance	4	Get funds for renovation	2
No till and minimum tillage have replaced trees for soil protection	1	Encourage species diversity	3	**Technical Assistance**	

Table G-5. Problems, Solutions, and Strategies Survey Responses—Windbreaks (Page 2 of 2)

Problems	Responses	Solutions	Responses	Strategies	Responses
Herbicide drift	1	**Education**		Target specific areas, not statewide (reword)	1
Lack of species diversity	3	Education of landowners	8	Technical assistance	4
Windbreak design	1	Encourage species diversity	3	Promote management	2
Livestock damage	1	**Interagency Coordination**		Promote benefits of windbreaks	1
Policies of U.S. Fish and Wildlife and Game, Fish and Parks	1	Coordination with Natural Resources Conservation Service, conservation districts, other agencies	4	Promote diversity	2
Lack of cost share for nonagriculture producers	1	**Research**		Develop programs to encourage planting	1
Lack of importance to Congress and state legislators	1	Research—growth, survivability, sod control, renovation, utilization	1	**Education**	
Migration from rural to urban population	1			Educate rural youth (4-H, FFA)	1
				Develop “show piece” examples in geographic areas	1
				Educate landowners, conservation districts, public	6
				Promote diversity	2
				Regulation	
				Moratorium on ash in certain counties	1

Table G-6. Problems, Solutions, and Strategies Survey Responses—Community Forests (Page 1 of 2)

Problems	Responses	Solutions	Responses	Strategies	Responses
Lack of species diversity	9	**Treatments**		**Treatments**	
Lack of age classes	4	Monitoring	1	Tree care	1
Invasives	3	**Marketing**		Pesticides—kill bugs	1
Improper planting and care	10	Provide inventory for each town	1	**Marketing**	
Poor location	4	Inventory—I-tree	1	Promote urban wood waste utilization	1
Lack of funding	3	**Financial Assistance**		Inventory—tree works	5
Insects and diseases (I&D)	6	Provide incentives—people, money, tax breaks	1	**Financial Assistance**	
Lack of public understanding	2	Cost-share for buying trees	1	Provide cost-share	1
Removal of hazard trees	1	Provide competitive funding opportunities	1	Grant opportunities	1
Open areas that could support trees	1	Funding for removals and replacements	1	Increase state and private resources to assist communities	1
Lack of inventory	1	**Technical Assistance**		**Technical Assistance**	
		Community outreach	1	Species diversity	3
		Partner with communities to develope plans	1	Technical assistance to communities	2
		Education		Work with nurseries on diversity	1
		Educate communities about species diversity	4	Increase public relations	1
		Educate communities—benefits	2	Provide communities guidelines for ordinances	3
		Education public, communities—planning, planting, care, maintenance	7	Increase state and private resources to assist communities	1

Table G-6. Problems, Solutions, and Strategies Survey Responses—Community Forests (Page 2 of 2)

Problems	Responses	Solutions	Responses	Strategies	Responses
		Promote community forest as part of community infrastructure	1	Early detection of I&D	2
		Educate to report I&D problems	1	Encourage communities to develop plans	3
		Interagency Coordination		**Education**	
		Coordinate across ownerships	2	Educate landowners, civic leaders, business owners of benefits	9
		Coordinate with park and recreation boards	1	One-stop shopping for info	1
		Coordinate among agencies	1	Educate school children	1
		Planning	2	**Regulation**	
				Provide communities guidelines for ordinances	3
				Ordinances to eliminate insect infestations	1
				International regulations to stop exotics	1