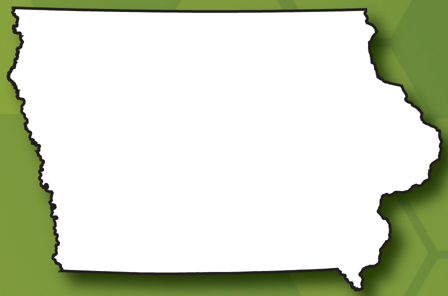
Iowa's Forests 2008



Resource Bulletin
NRS-52

United States Department of Agriculture

Forest Service

Northern Research Station

Abstract

The second full annual inventory of Iowa's forests (2004-2008) reports more than 3 million acres of forest land, almost all of which is timberland (98 percent), with an average volume of more than 1,000 cubic feet of growing stock per acre. American elm and eastern hophornbeam are the most numerous tree species, but silver maple and bur oak predominate in terms of live tree volume. Iowa's forest land is comprised of 65 percent sawtimber, 19 percent poletimber, and 16 percent sapling/seedling or nonstocked size classes. Average annual net growth of growing-stock trees on Iowa's timberland increased during the past decade to the current estimate of nearly 105 million cubic feet. This report includes additional information on forest attributes, land use change, carbon, timber products, and forest health. A DVD included in this report includes 1) descriptive information on methods, statistics, and quality assurance of data collection, 2) a glossary of terms, 3) tables that summarize quality assurance, 4) a core set of tabular estimates for a variety of forest resources, and 5) a Microsoft Access database that represents an archive of data used in this report, with tools that allow users to produce customized estimates.

Acknowledgments

The authors would like to thank the many individuals who contributed both to the inventory and analysis of Iowa's forest resources. Primary field crew and QA staff over the 2004-2008 field inventory cycle included John Benaszeski, James Blehm, Thomas Goff, Glenda Hefty, Peter Koehler, Benjamin Nurre, Eric Schneider, Earl Sheehan, Willard Smith, and Brian Wall. Data management personnel included Gary Brand, Mark Hatfield, Jay Solomakos, James Blehm, and Jeff Wazenegger. Report reviewers included Paul J. Tauke, Aron Flickinger, and Tivon Feeley of Iowa's Department of Natural Resources.

Cover: Forested bluffs and floodplain along Mississippi River, northeastern Iowa. Photograph by Linda Haugen, U.S. Forest Service.

Manuscript received for publication February 2011

Published by:
U.S. FOREST SERVICE
11 CAMPUS BLVD SUITE 200
NEWTOWN SQUARE, PA 19073-3294

For additional copies:
U.S. Forest Service
Publications Distribution
359 Main Road
Delaware, OH 43015-8640

August 2011

Visit our homepage at: **http://www.nrs.fs.fed.us**

Iowa's Forests 2008

Mark D. Nelson, Matt Brewer, Christopher W. Woodall, Charles H. Perry, Grant M. Domke, Ronald J. Piva, Cassandra M. Kurtz, W. Keith Moser, Tonya W. Lister, Brett J. Butler, Dacia M. Meneguzzo, Patrick D. Miles, Charles J. Barnett, and Dale Gormanson

Contact Author:
Mark D. Nelson, mdnelson@fs.fed.us
651-649-5104

About the Authors

Mark D. Nelson is a research forester with the Forest Inventory and Analysis Program, Northern Research Station, St. Paul, MN.

Matt Brewer is the forest assessment leader for the Iowa Department of Natural Resources, Des Moines, IA.

Christopher W. Woodall is a research forester with the Forest Inventory and Analysis Program, Northern Research Station, St. Paul, MN.

Charles H. (Hobie) Perry is a research soil scientist with the Forest Inventory and Analysis Program, Northern Research Station, St. Paul, MN.

Grant M. Domke is a post-doctoral research forester with the Forest Inventory and Analysis Program, Northern Research Station, St. Paul, MN.

Ronald J. Piva is a forester with the Forest Inventory and Analysis Program, Northern Research Station, St. Paul, MN.

Cassandra M. Kurtz is a natural resource specialist with the Forest Inventory and Analysis Program, Northern Research Station, St. Paul, MN.

W. Keith Moser is a research forester with the Forest Inventory and Analysis Program, Northern Research Station, St. Paul, MN.

Tonya W. Lister is a forester with the Forest Inventory and Analysis Program, Northern Research Station, Newtown Square, PA.

Brett J. Butler is a research forester with the Forest Inventory and Analysis Program, Northern Research Station, Amherst, MA.

Dacia M. Meneguzzo is a research forester with the Forest Inventory and Analysis Program, Northern Research Station, St. Paul, MN.

Patrick D. Miles is a research forester with the Forest Inventory and Analysis Program, Northern Research Station, St. Paul, MN.

Charles J. Barnett is a forester with the Forest Inventory and Analysis program, Northern Research Station, Newtown Square, PA.

Dale Gormanson is a forester with the Forest Inventory and Analysis program, Northern Research Station, St. Paul, MN.

Foreword

This report highlights the current status, ongoing trends, and future direction of Iowa's forests. The Iowa forest inventory is conducted as a cooperative program between the Iowa Department of Natural Resources, Division of Forestry, and the Forest Inventory and Analysis program of the U.S. Department of Agriculture Forest Service. Periodic inventories of Iowa's forests were conducted in 1954, 1974, and 1990. Starting in 1999, annual inventories were conducted wherein a portion of field plots were inventoried each year and after 5 years a full inventory was completed. The first Iowa annual inventory covers the period 1999-2003. This second annual inventory, which covers the period from 2004-2008, is completed with this report. With complete remeasurement of annual inventory plots, we produced better estimates of growth, mortality, and removals and detailed land-use change.

Results from this inventory show Iowa's forests continue to grow more wood than is being harvested, providing an important and essential element to our state's economy, the wood industry, and individual woodland owners. Iowa's forests have expanded to more than 3 million acres with an average volume of over 1,000 cubic feet per acre of timberland, providing fine quality hardwood products, habitat for wildlife, clean water and air, soil protection from erosion, and additional ecosystem services.

Although forest land area continues to expand, there are concerns about Iowa's forests. The average size of forest tracts continues to decrease, and some of these holdings are changing ownership, both of which may affect current and future management opportunities. A large and growing number of nonnative invasive plants are competing with native vegetation for sunlight and nutrients. Maturing forests may lead to changes in tree species composition. These and other issues require ongoing monitoring to inform future management decisions. I invite you to read and interpret the latest results of Iowa's forest inventory, to become more interested in our forest resources, and to participate in discussions about the future of forests and forestry in Iowa.

Paul J. Tauke, State Forester,
Iowa Department of Natural Resources

Contents

Photograph courtesy of Tricia Knoot, Iowa State University.

Highlights

On the Plus Side

Statewide forest land area continues to increase at a steady rate and now exceeds 3 million acres, 98 percent of which is classified as timberland.

More than 96 percent of lands that were forested during 1999-2003 persisted as forest land during 2004-2008, with reversions (gains) to new forest land exceeding diversions (losses) by fourfold.

Iowa's forests contain more than 1 billion trees statewide, comprised of at least 61 species.

The quantity of live biomass on Iowa's timberland has increased at a steady rate since 1990, now exceeding one hundred million oven-dry tons.

Total growing-stock volume on Iowa's timberland has more than doubled since the 1954 and 1974 inventories, to a current statewide estimate of more than 3 billion cubic feet.

Forest growth exceeds volume losses from mortality, harvest, and land-use change combined.

Tree crowns across Iowa are on average healthy with minor levels of dieback.

The volume of sawtimber on Iowa's timberland now exceeds 11 billion board feet (International ¼-inch rule), with a decreasing fraction of low-grade trees.

Numbers of standing dead trees (snags) per acre have increased slightly between 1999-2003 and 2004-2008, to 11.8 per acre of forest land, providing important habitat features for wildlife.

Iowa's forests are growing on rich, productive soil, less affected by atmospheric pollution than other parts of the country.

Problem Areas

For "other eastern soft hardwoods" species group (mostly American elm), the total statewide average annual mortality is nearly 20 million cubic feet, a rate of 4 percent per year.

Iowa's forests are a maturing resource that may eventually experience density and age-related changes.

The forest land base of Iowa is highly fragmented due to agriculture and development.

Despite the diverse array of native plant species in the understory of Iowa's forests, growing numbers of invasive plant species are competing with native vegetation.

The average parcel size of privately owned forest land in Iowa continues to decrease with indications that these holdings will be changing owners.

A relative scarcity of large coarse woody debris resources may reduce wildlife habitat quality for some species.

The number of wood-processing mills has been steadily declining, making it harder for landowners to find markets for the timber harvested from management activities on their forest land.

Issues to Watch

A majority of Iowa's forest land lacks interior forest conditions and is subject to edge effects, like increasing nonnative invasive plants.

Increasing pressures to harvest Iowa's forests for energy may compete with traditional forest product industries, and increased harvest utilization rates could possibly impact forest sustainability (decreased harvest residues) and habitat quality.

Tree species composition of Iowa's forests continues to change as oak species are slowly supplanted by other species.

The emerald ash borer, an exotic beetle, recently entered the state, and is expected to kill numerous ash trees in Iowa, both in forests and urban environments. Gypsy moth and bur oak blight also are expected to cause significant damage to Iowa's forests.

Given the gains in growing-stock volume in larger diameter classes for economically important tree species, the regeneration of these species should be monitored to ensure future sustainability.

The management of forests to maximize carbon sequestration may complicate timber management practices due to fluctuating carbon credit markets and consideration of all carbon pools in forests (e.g., soil organic carbon, dead wood, and belowground stocks).

Background

Forested bluffs and floodplain along Mississippi River, northeastern Iowa. Photograph by Linda Haugen, U.S. Forest Service.

An Overview of Forest Inventory

What is a tree?

Trees are perennial woody plants with central stems and distinct crowns. In general, the Forest Inventory and Analysis (FIA) program of the U.S. Department of Agriculture, Forest Service, defines a tree as any perennial woody plant species that can attain a height of 15 feet at maturity. An electronic record of every tree measured in this inventory can be found in the database on the DVD in the inside back cover of this bulletin.

What is a forest?

The FIA program defines forest land as land that is at least 10 percent stocked by trees of any size or formerly having had such tree cover and not currently developed for nonforest use. The treed area must be at least 1 acre in size and at least 120 feet wide to qualify as forest land. Trees in narrow windbreaks, urban boulevards, orchards, and other nonforest situations are very valuable too, but they are not described in this report.

What is timberland, reserved forest land, and other forest land?

FIA defines three subcategories of forest land: timberland, reserved forest land, and other forest land. Reserved forest is land that has been withdrawn from timber utilization through legislation or administrative regulation. Other forest land is typical of poor soils where the forest is incapable of producing 20 cubic feet per acre per year at the culmination of mean annual increment. Timberland is forest land that is not reserved and meets minimum productivity requirements.

During some periodic inventories conducted prior to 1999, only trees on timberland plots were measured. We are therefore unable to report estimates for some attributes (e.g., volume) on non-timberland for those older inventories. Beginning with the implementation of FIA's annual inventory system during 1999-2003, we were able to report forest attributes on all forest land—not just timberland. With the remeasurement of the same annual inventory plots during 2004-2008, we are now able to report growth, removals, and mortality on all forest land, whereas for prior inventories we could only report growth, removals, and mortality on timberland.

How do we estimate forest land area and number of trees?

Forest inventory plots have been established throughout Iowa, with one plot for every 6,000 acres, or so. Those plots located on forest land are measured 'in the field', and they comprise a statistical sample of observations used for estimating various forest attributes. During the 2004-2008 inventory, 12,547 trees that are at least 1 inch in diameter at breast height (d.b.h., 4.5 feet above the ground) were measured on 659 forest plots in Iowa. Unless indicated otherwise, sampling errors reported in text and figures represent 1 standard error (SE). For information on sampling errors, see Statistics, Methods, and Quality Assurance on the DVD at the back of this bulletin.

How do we estimate a tree's volume?

Forest inventories typically express volume in cubic feet (or cubic meters), but many Iowans are more familiar with cords (a stack of wood 8 feet long, 4 feet wide, and 4 feet high). A cord of wood, which is a typical unit for firewood, contains approximately 79 cubic feet of solid wood and 49 cubic feet of bark and air. Volume can be determined precisely by immersing a tree in a pool of water and measuring the amount of water displaced. A less precise, but much cheaper and easier method has been employed in forest inventories, whereby several hundred trees were cut, and detailed diameter measurements were taken along their lengths to accurately determine their volumes (Hahn 1984). Statistical tools were used to model this data by tree species group. Using these models, we can estimate tree volume based on species, diameter, and tree site index. This method was also used to calculate sawtimber volumes. FIA reports sawtimber volumes in International 1/4-inch board foot scale as well as Doyle rule. To convert to the Scribner board foot scale, see Smith (1991).

How much does a tree weigh?

Building on previous work, the U.S. Forest Service's Forest Products Laboratory and others have developed specific gravity estimates for many tree species (Miles and Smith 2009). These specific gravities were then applied to estimates of tree volume to derive estimates of merchantable tree biomass (the weight of the tree's bole). All live tree biomass is estimated by including biomass estimates for the stump, limbs, and bark. We do not currently report the live biomass in roots or foliage. Forest inventory can report biomass as either green weight or oven-dry weight. Green weight is the weight of a freshly cut tree. Oven-dry weight is the weight of a tree with zero percent moisture content. On average 1 ton of oven-dry biomass is equal to 1.9 tons of green biomass

How do we estimate all the forest carbon pools?

FIA does not measure directly the carbon in standing trees; it estimates forest carbon pools by assuming that half the biomass in standing live/dead trees consists of carbon. Additional carbon pools (e.g., soil, understory vegetation, belowground biomass) are modeled based on stand/site characteristics (e.g., stand age and forest type).

How do we compare estimates from different inventories?

Estimates from new inventories are often compared with earlier inventories to determine trends in forest resources. This is certainly valid when comparing the Iowa 2003 inventory to the 2008 inventory, both of which are based on FIA's 'annual inventory' system. Comparisons with older periodic inventories, however, are problematic because procedures for assigning stand characteristics such as forest type and stand size have changed as a result of FIA's ongoing efforts to improve the efficiency, reliability, and national consistency of the inventory. Several changes in procedures and definitions have occurred since the 1990 Iowa inventory. While these changes will have minimal impact on statewide estimates of forest area, timber volume, and tree biomass, they may have significant impacts on plot classification variables such as forest type and stand-size class. Some of these changes make it inappropriate to directly compare the 2008 and 2003 annual inventory tables with those published for the 1954, 1974, and 1990 periodic inventories. Note that estimates of timberland and forest land area reported in the 1954 Iowa report (Thornton and Morgan 1959) were subsequently adjusted in the 1974 Iowa report (Spencer and Jakes 1980) to account for changes in definitions. Adjusted estimates for the 1954 inventory are cited within this report. References to 1954, 1974, and 1990 periodic inventories each refer to that single year of inventory, but references to '2003' and '2008' annual inventories refer to the 5-year periods ending in those years, e.g., 1999-2003 and 2004-2008.

A word of caution on timberland suitability and availability

The FIA program does not attempt to identify which lands are actually suitable or available for timber harvesting. Land classified by FIA as "timberland" is not necessarily suitable or available for timber production, but merely has the potential for such production. Actual suitability and availability are subject to changing laws, economic/market constraints, physical conditions, adjacency to human populations, ownership objectives, and other factors.

How do we produce maps?

Maps produced by FIA are for graphic display to meet general reporting requirements. A geographic information system (GIS) and various geospatial datasets were used to produce the maps portrayed within figures of this report. Unless indicated otherwise, forest resource data are from FIA and base map layers, e.g., state and county boundaries, were obtained from the GIS section of the Iowa Geological and Water Survey, Iowa Department of Natural Resources. Depicted FIA plot locations are approximate. Sources and intended uses of FIA data are available at: http://fia.fs.fed.us/tools-data/. Sources of other geospatial datasets are cited within individual figures. Iowa maps are portrayed in Universal Transverse Mercator projection, Zone 15, North American Datum of 1983.

Forest Features

Aerial photograph of forest/agriculture matrix in northeastern Iowa. Photograph by Linda Haugen, U.S. Forest Service.

Forest Area

Background

Characteristics of geology and climate affect forest distribution, composition, and structure. These characteristics are used to delineate ecological regions, which are shown in Figure 1 (Griffith et al. 2008). A mixture of land uses occur in the 'Central Irregular Plains' in the south-central portion of the State, with wider forested strips occurring along streams. One-fifth of the 'Interior River Lowland', in southeastern Iowa, is in forest, including bottomland deciduous forest, swamp forest, and mixed oak and oak-hickory forest. Flat-bottomed terraced valleys, forested valley slopes, and dissected glacial till plains characterize this ecoregion. In northeastern Iowa, the 'Paleozoic Plateau', also known as the 'Driftless Area', consists of hilly uplands and deeply dissected valleys, containing a significant portion of Iowa's forests, and the majority of its trout streams. Three-fourths of the 'Western Corn Belt Plains' are used for cropland agriculture, with much of the remainder used for livestock forage. This region is characterized as nearly level to gently rolling, with warm, moist soils that support the most productive areas of corn and soybeans in the world. Spatial distribution and trends in forest area may indicate future forest resource trends resulting from changing land use or forest health conditions. Management and decisionmaking depend upon forest monitoring for providing essential information on forest trends.

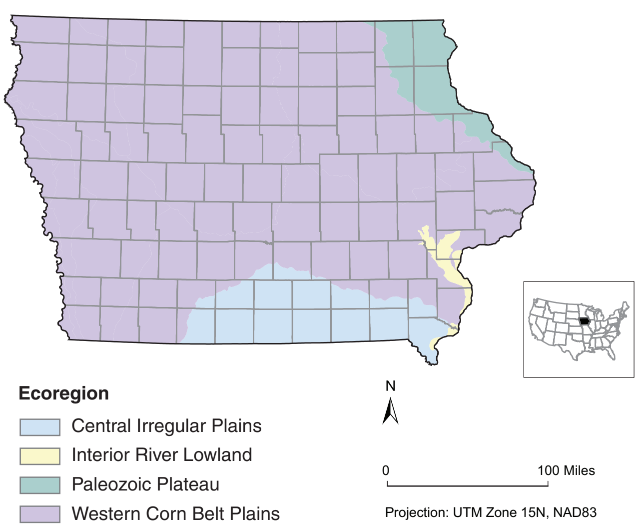


Figure 1.—Ecoregions of Iowa. Data sources: Ecoregions - GIS Section of the Iowa Geological and Water Survey, Iowa Department of Natural Resources; Inset – ESRI Data & Maps.

What we found

Iowa forest land area is most concentrated in the northeastern and southern counties (Fig. 2). After declining from 2.3 million acres in 1954 to a low of 1.6 million acres in 1970s, area of forest land has increased at a steady rate, reaching a current estimate of approximately 3 million acres (Fig. 3). Almost all (98 percent) of Iowa's forest land is timberland; 1 percent is reserved forest land, and 1 percent is other forest land.

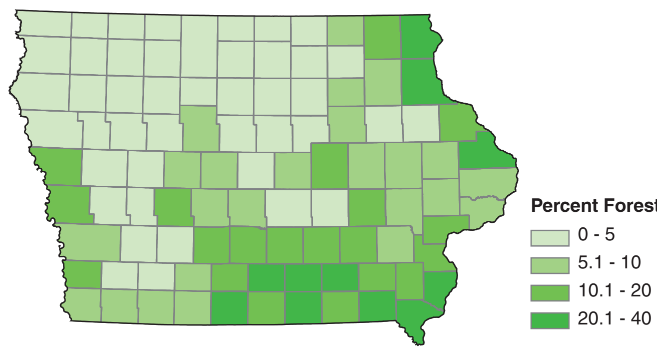


Figure 2.—County-level forest land area as a percent of total land area, Iowa, 2008.

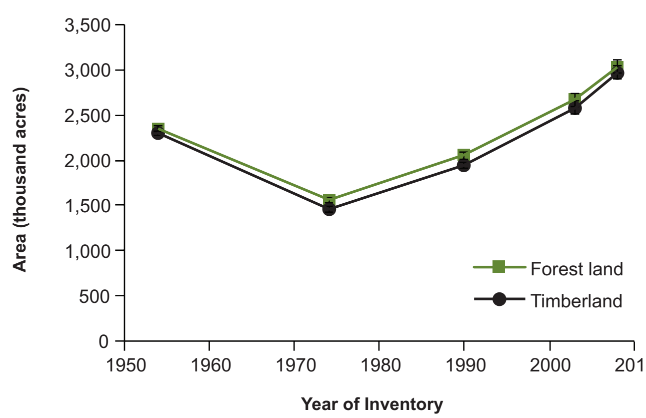


Figure 3.—Total forest land and timberland area, Iowa, 1954-2008. Error bars represent 1 standard error (68 percent confidence interval) around estimate.

What this means

At the state level, Iowa's forest land and timberland areas have been gradually increasing since the 1970s. Because nearly all forest land in Iowa is timberland, subsequent sections of this report that refer to estimates on timberland likely are representative of all forest land within the State. Relatively large sampling errors are associated with the FIA inventory estimates at sub-state scales, so care should be given when monitoring forest land or timberland area changes at these scales.

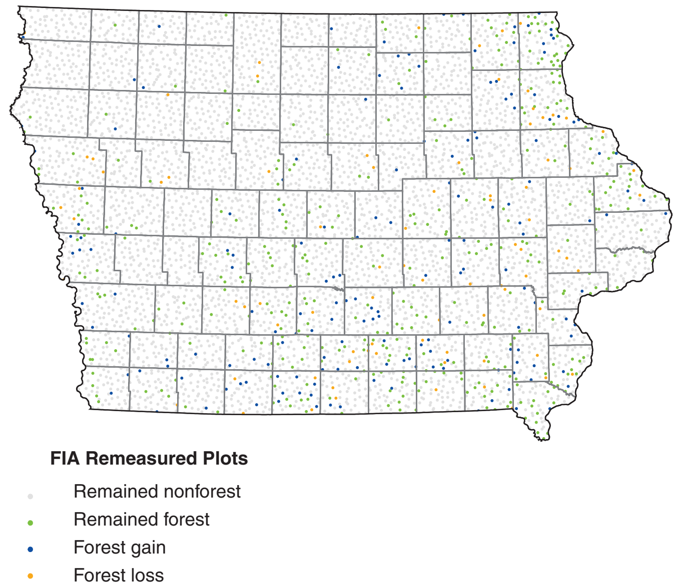


Figure 4.—Distribution of remeasured inventory plots showing plots that remained forest or nonforest and those that changed to and from forest between 2003 and 2008, Iowa. Depicted FIA plot locations are approximate.

Land-use Change

Background

Iowa's land base is not static through time but is subject to ebbs and flows. Although total area of forest land has shown overall increases over time (Fig. 3), a larger "net" difference is occurring due to both reversions (gains) and diversions (losses) of forest land (Fig. 4). As some forest land is converted to uses such as suburban development, other areas of nonforest, such as former agricultural land, is reverting back to forest land. Monitoring the sustainability of Iowa's forest resources requires information on trends in land use and resulting effects on forest resources.

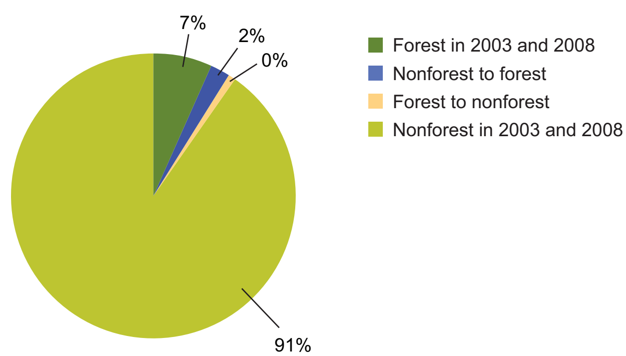


Figure 5.—Land use status and change, Iowa, 2003 to 2008.

What we found

Ninety-one percent of Iowa land was nonforest during both 2003 and 2008, with 7 percent of all land being forested during both time periods (Fig. 5). Very little land changed from forest to nonforest, but 2 percent of land changed from nonforest to forest during this period. Of lands that were forested in 2003, over 96 percent persisted as forest land in 2008. An estimated 120,000 acres of forest land diverted to nonforest in 2008, but almost 495,000 acres of nonforest reverted to forest. While some fraction of this 'change' may be an artifact of changes in inventory methodology, the trend suggests that more land reverted to forest than was being diverted from forest. Agricultural land, which dominates Iowa's landscape, is the predominant source of forest reversions and diversions (Fig. 6). Large diameter (sawtimber) stand-size class predominates forest land diversions, but large, medium (poletimber), and small (seedling/sapling) stand-size classes all contributed substantially to forest land reversions (Fig. 7).

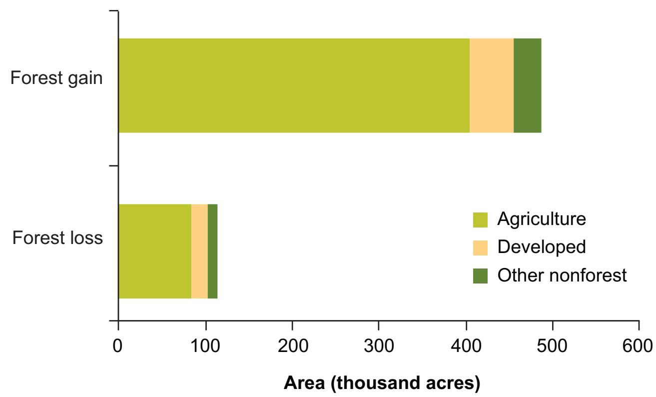


Figure 6.—Other land-use types contributing to gross forest loss (diversions) and forest gain (reversions), Iowa, 2003 to 2008.

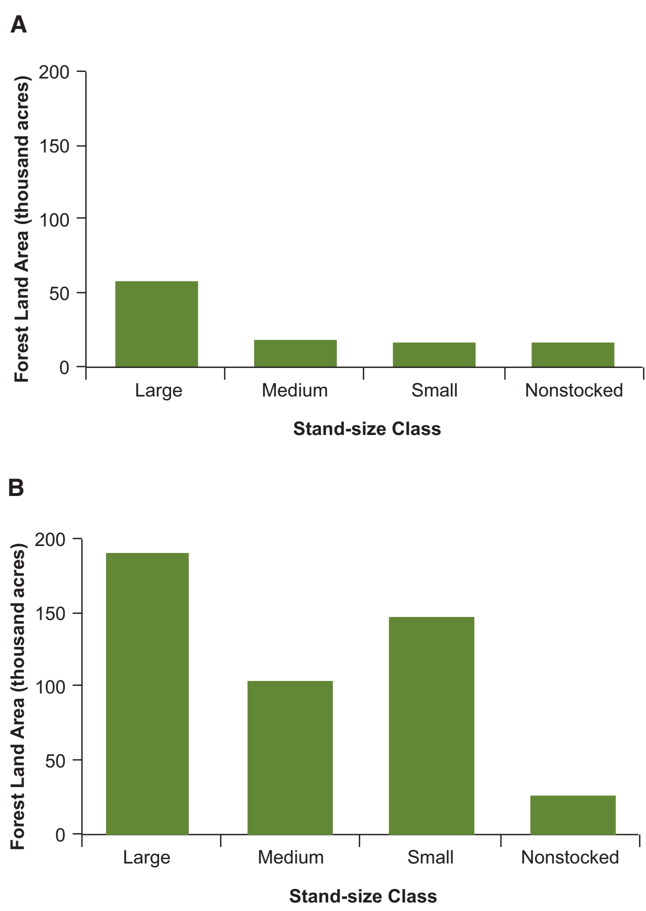


Figure 7.—Forest stand-size classes contributing to gross forest loss (A; diversions) and forest gain (B; reversions), Iowa, 2008.

What this means

Patterns of Iowa land-use changes over the past 10 years indicate that Iowa has a stable or increasing forest land base. For every acre of forest land lost to nonforest diversion, approximately 4 more new acres reverted to the forest land base. This consistent net increase in the Iowa's total forest land area suggests that conservation of the State's forest land area is continuing.

Forest Ownership

Background

Ownership patterns are important because forest owners ultimately control the forest resources and decide how they will be managed. Family forest owners – families, individuals, and other unincorporated groups – comprise a dominant, diverse, and dynamic group of owners in Iowa. By understanding these owners, we can better help them meet their forest management needs, and in so doing, help conserve Iowa forests for generations to come.

What we found

From the Missouri River blufflands in the west, through the small woodlots in the State's agricultural heartland, to the deeply dissected Driftless Area near the Mississippi River to the east, forest ownership varies across Iowa (Figs. 8, 9). A total of 147,000 family forest owners control 85 percent of the forest land in Iowa. To better understand who these people are, why they own forest land, and how they use it, the Forest Service conducts the National Woodland Owner Survey (Butler 2008). According to the results of this survey, the average size of the forested holdings of these owners is 17 acres (Fig. 10). The primary reasons for owning forest land are related to aesthetics, the land as part of their farm, and nature protection (Fig. 11). Although timber production is not an important ownership objective, 43 percent of the family forest land is owned by people who have commercially harvested trees. Eight percent of the land is owned by people who have a written management plan, and 27 percent of the land is owned by people who have received forest management advice. The owners' major concerns are related to trespassing, keeping land intact for future generations, and threats from invasive plants. Although most family forest owners plan to do little or nothing with their land in the next 5 years, 1 in 3 acres is owned by someone who plans to harvest firewood, 1 in 5 by someone who plans to harvest timber, and 1 in 10 by someone who plans to pass the land on to heirs or sell it.

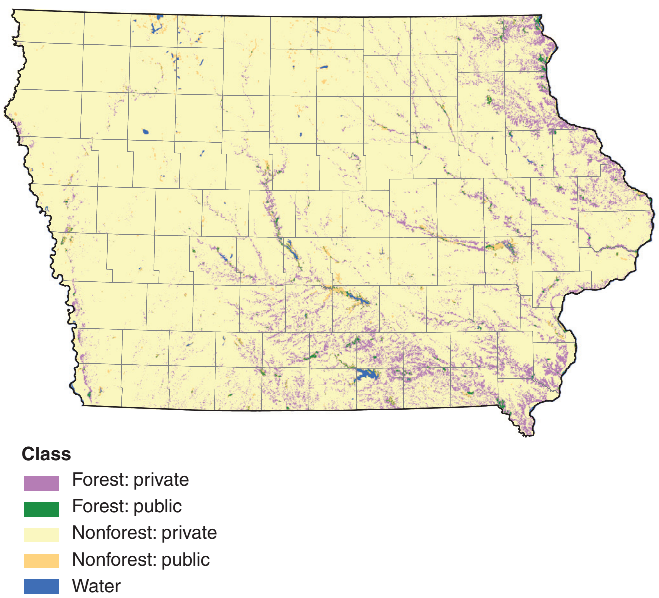


Figure 8.—Private and public forest land in Iowa, 2001. Data source: ForestOwn_v1 (Nelson et al. 2010).

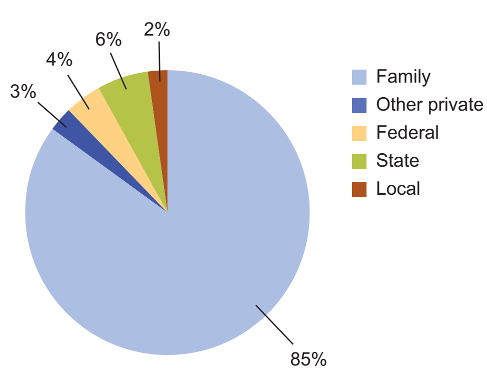


Figure 9.—Distribution of forest land by public and private ownership, Iowa, 2006.

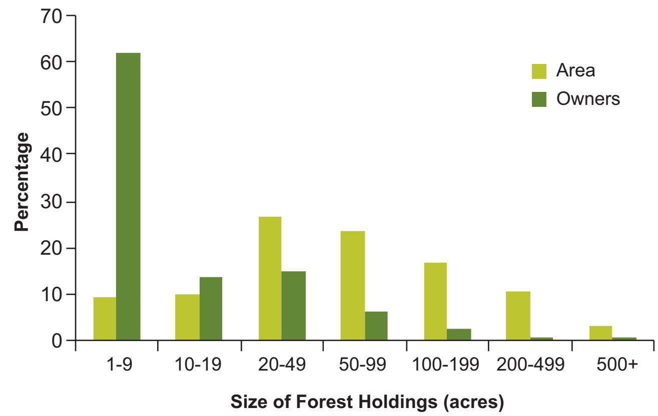


Figure 10.—Area and number of family forests in Iowa by size of forest landholdings, Iowa, 2006.

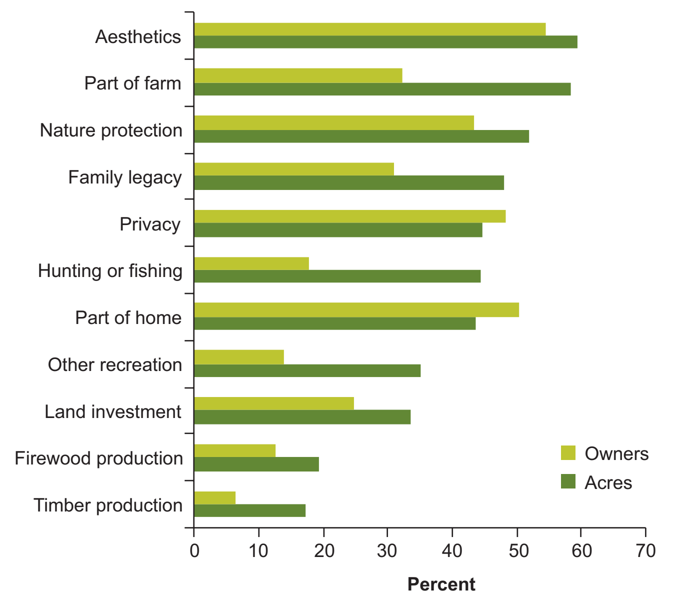


Figure 11.—Percentage by area and number of family forests by reason for owning forest land, Iowa, 2006. (Percent refers to portion of landowners who ranked each objective as very important or important on a seven-point Likert scale.)

What this means

The average parcel size is decreasing and much land will soon be changing hands. Family legacy is an important ownership objective and also a major concern. What can be done to help the landowners and the land? It is clear that timber production is not on the forefront of landowners' concerns, but it is also clear that many landowners are not adverse to harvesting and other activities in the woods. How can natural resource professionals better communicate with family forest owners and help them better manage their woods? As Iowa's forest is diverse, so too are the people who own it. It is important to provide information that meets the landowners' needs. General statistics are good for a broad overview, but we need to better understand the different types of owners, their attitudes, and their behaviors, as well as effective and efficient ways of communicating with them. One such attempt at learning more about landowners is through the "Sustaining Family Forests Initiative" (SFFI). (For more information, see www.sustainingfamilyforests.org.)

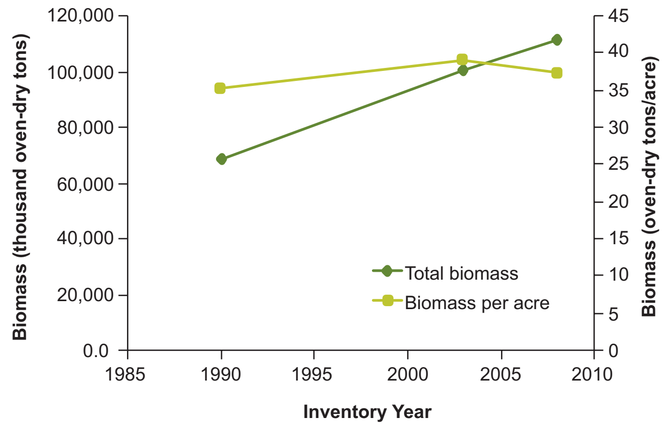


Figure 12.—Live-tree and sapling biomass (oven-dry tons) on timberland, Iowa, 1990, 2003, and 2008.

Biomass

Background

Measures of total biomass and its allocation among stand components (e.g., small-diameter trees, limbs, stumps), help us understand the components of a forest stand and the resources available for different uses (e.g., biofuels, wildlife habitat, carbon sequestration).

What we found

The quantity of live biomass on Iowa timberland has increased at a steady rate since 1990, exceeding 100 million oven-dry tons by 2008 (Fig. 12). This increase corresponds to an increase in timberland area, with biomass per acre remaining nearly constant (Fig. 12). Most forest biomass in 2008 is in tree boles (72 percent), followed by tops and limbs, saplings, and stumps (Fig. 13). The largest amounts of Iowa forest biomass are located in the northeast, southeast, and south-central portions of the State (Fig. 14).

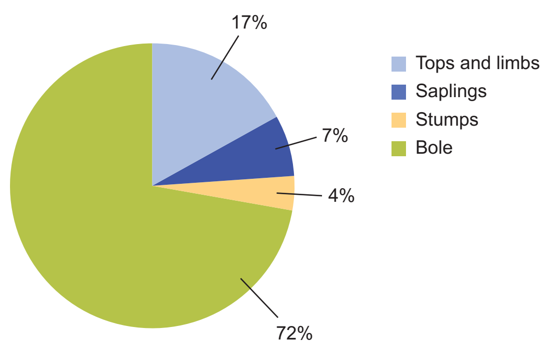


Figure 13.—Tree biomass on timberland by tree component, Iowa, 2008.

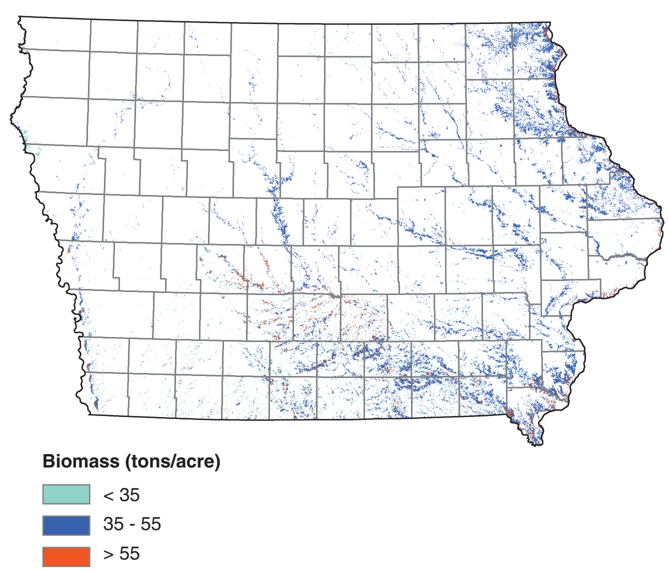


Figure 14.—Distribution of aboveground live-tree biomass on forest land, Iowa, 2001. Data source: Blackard et al. (2008).

What this means

The steady rates of increase in forest and timberland area and forest growth have resulted in a sustainable statewide resource of total forest biomass. Because timberland tree boles contain the most tree biomass, the management of private forest land strongly influences the future of not only the biomass resource but also the carbon cycles and future wood availability. Given the increasing desire to manage forest biomass components for both carbon and bioenergy use, the monitoring of Iowa's forest biomass becomes even more critical.

Tree Species Composition

Background

Tree species composition within forests is constantly changing, influenced by the presence or absence of disturbances such as timber management, recreation, wildfire, prescribed burning, extreme weather, and invasive species. As a result, the composition of species in a forest is an indicator of forest health, growth, succession, and need for stand improvement, or other management. Knowledge of the distribution of species allows for the measurement and prediction of change.

What we found

At least 61 tree species were observed on Iowa forest land in 2008. In terms of the total number of trees statewide, American elm and eastern hophornbeam were the two most numerous species, each estimated to have more than 100 million trees (Fig. 15). There were no oak or hickory species in the 12 most numerous species. However, several oak species are included among the top 12 in terms of the total statewide live-tree volume on forest land, with bur oak being the top oak in terms of volume, exceeded only slightly by silver maple, with each species containing nearly half a billion cubic feet of volume (Fig. 16). Due to large sampling errors associated with estimates for some individual tree species, comparisons across time are made for groups of related species. Most species groups had little or no change in total statewide live-tree volume between 2003 and 2008, but substantial increases in volume occurred for most species groups between 1990 and 2008 (Fig. 17).

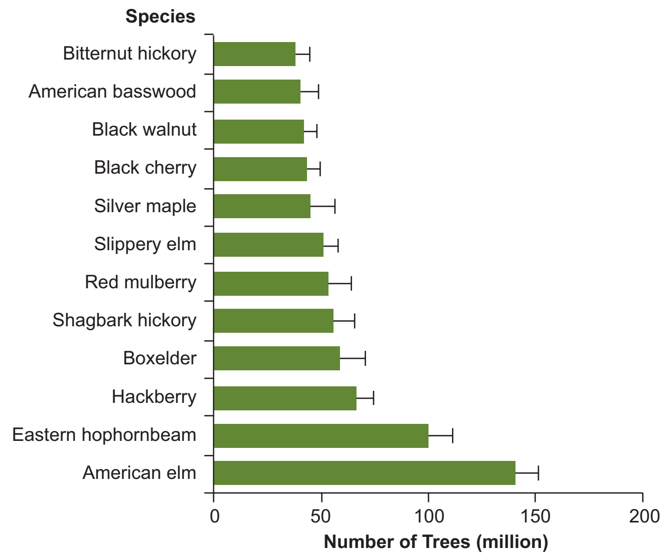


Figure 15.—Top 12 tree species in terms of number (million) of live trees on forest land, Iowa, 2008. Error bars represent 1 standard error (68 percent confidence interval) around estimate.

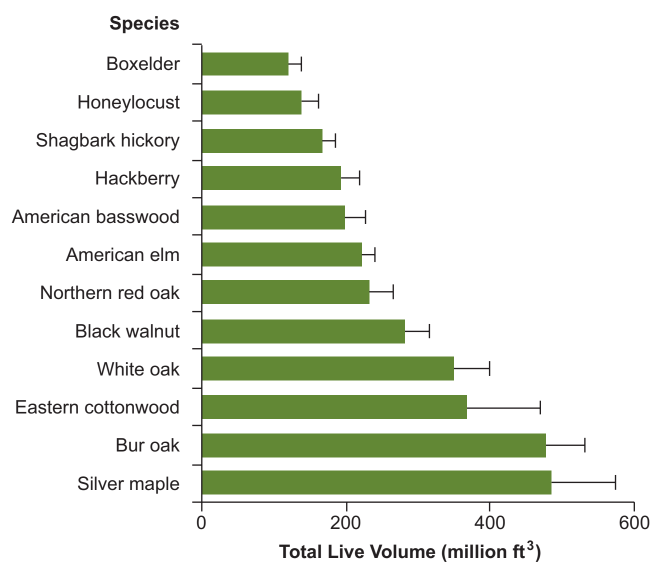


Figure 16.—Top 12 tree species in terms of volume (million cubic feet) of live trees on forest land, Iowa, 2008. Error bars represent 1 standard error (68 percent confidence interval) around estimate.

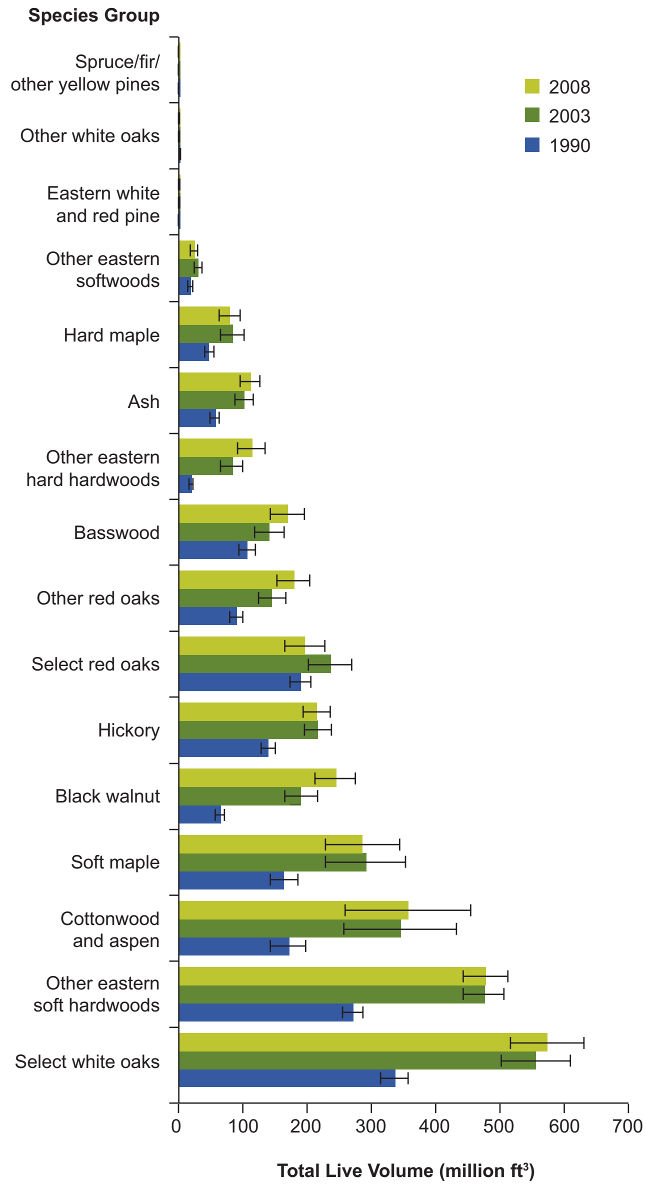


Figure 17.—Change in growing-stock volume on timberland between 1990, 2003, and 2008 by tree species group, Iowa. Error bars represent 1 standard error (68 percent confidence interval) around estimate.

What this means

Iowa possesses a great diversity of tree species that will undoubtedly fill niches vacated by other species as forest ecosystems continue to evolve through the decades. As a group, select white oaks dominate the State in terms of total volume, even though no individual species of oak is represented among the top dozen species according to tree counts. This shows that many of the oak trees are large in size, indicating a maturing forest resource with sparse regeneration. In contrast, eastern hophornbeam, the second most numerous tree species, was not even listed among the top 12 species in terms of volume. Repeated inventories reveal that species composition of Iowa's forests is changing, with some species increasing their dominance while others are decreasing.

Tree Density, Size, and Stocking

Background

Tree density is the ratio of the number of trees to a specific area, e.g., trees per acre. Tree size typically is referred to in terms of height or diameter. Height is affected by a combination of tree species, age, and the productivity of a site. Tree diameter is also affected by species and age, with tree density or stocking being the other major determinant of diameter. Tree diameter is easily and accurately measured and is used to assign stand-size class. Here, stand-size refers not to the area of a forest stand, but to the diameter of trees within a stand. Stand-size classes are defined as large—where a plurality of stocking is in hardwoods 11 inches d.b.h. and larger and softwoods 9 inches d.b.h. and larger; medium—where a plurality of stocking is in softwood trees from 5 inches to 9 inches and hardwood trees from 5 to 11 inches; or small—where a plurality of stocking is in trees less than 5 inches d.b.h. Tree diameter also can be used to compute tree basal area—the cross sectional area of a tree bole at breast height.

Stocking provides information on the degree of occupancy of land by trees compared with a desired level for balanced health and growth. Stocking levels are calculated using a combination of number of trees, species, sizes, and spacing. Stocking is very important for determining and assessing forest management practices. A fully stocked stand indicates full utilization of the site. In stands of trees greater than 5 inches d.b.h., a fully stocked stand would typically have a basal area of greater than 80 square feet per acre. In a seedling/sapling stand a fully stocked stand would indicate that the present number of trees is sufficient to attain a basal area of 80 square feet per acre when the trees are more than 5 inches in diameter.

What we found

The density of Iowa's timberland trees increased from fewer than 100 growing-stock trees per acre during the 1950s to just over 300 in 1990, then declined slightly to a relatively stable density which now measures about 275 trees per acre (Fig. 18). Basal area of growing-stock trees per acre of timberland increased from about 43 in 1954 to 62 in 2003, then decreased slightly to the current measure of 57.

Nearly two-thirds (65 percent) of forest land in Iowa is in large diameter stand-size class, 19 percent is medium diameter, and the remaining 16 percent is in either small diameter or nonstocked classes. Just over one-third (36 percent) of Iowa's forest land is fully stocked or overstocked, 42 percent is medium-stocked, and 22 percent is poorly stocked or nonstocked. By combining these two classifications we see that large diameters comprise the majority of all stocking classes in Iowa, with the greatest percentage of large diameters in fully stocked stands (about 75 percent). Small diameters are most prevalent in overstocked stands, and the largest percentages of medium diameters are in medium and poorly stocked stands (Fig. 19).

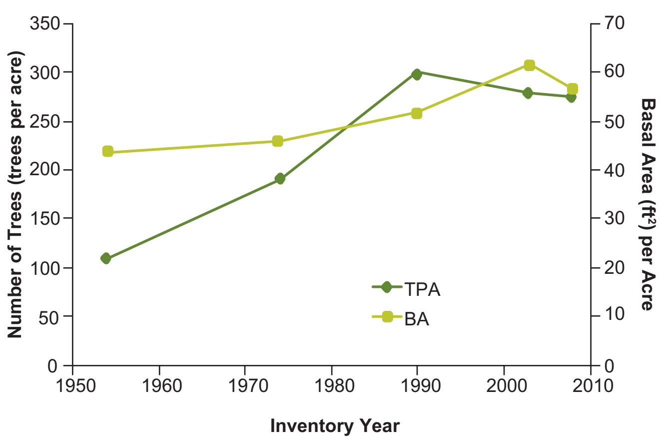


Figure 18.—Average number of growing-stock trees per acre and basal area per acre on timberland in Iowa, 1954-2008.

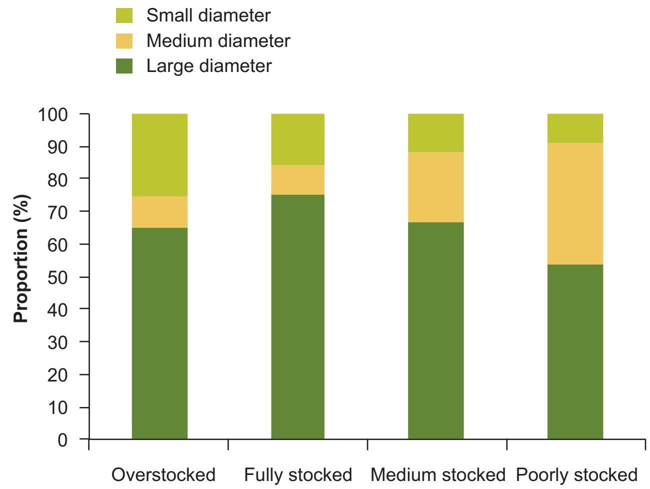


Figure 19.—Proportion of forest land area by stocking class and stand-size class Iowa, 2008.

What this means

The density and diameter of trees across Iowa provides information on the stages of forest stand development and stocking levels. Since 1954, both the number of trees per acre and basal area per acre increased substantially, reflecting positive stewardship and conservation of Iowa's forest resources. The dynamics between the number of trees per acre and average diameter or basal area per acre presents evidence of a maturing forest resource across Iowa. This trend should be expected to continue until stands reach a state of senescence or when affected by disturbances, either human-induced (e.g., removals) or naturally occurring (e.g., windstorm, fire). However, nearly a quarter of forest land in Iowa is understocked or nonstocked, presenting an opportunity for additional management.

Growth

Background

A stand's capacity for growth, i.e., for trees to increase in volume, is an indication of the overall condition of the forest and more specifically of tree vigor, forest health, and successional stage. Forest growth is reported as net growth, where net growth is equivalent to gross growth minus mortality. Average annual net growth represents an average for the annual change in volume between the two most recent inventories, 2003 and 2008.

What we found

Average annual net growth of growing-stock trees on Iowa's timberland decreased from about 68 million cubic feet per year in 1954 to approximately 41 million cubic feet in both 1974 and 1990, followed by a large increase during the past decade to the current estimate of nearly 105 million cubic feet in 2008 (Fig. 20). The top five species groups in terms of average annual net growth were select white oaks, soft maple, black walnut, cottonwood, and other eastern soft hardwoods, all of which exceeded 10 million cubic feet per year (Fig. 21). Other eastern hard hardwoods, ash, black walnut, and soft maple species groups all had ratios of annual net growth to volume exceeding 5 percent, with hard maple and cottonwood exceeding 3 percent, and values of less than 3 percent for oaks (Fig. 22).

Figure 20.—Average annual net growth of growing stock on timberland acreage in Iowa, 1954-2008. Error bars represent 1 standard error (68 percent confidence interval) around estimate, available only since 1990.

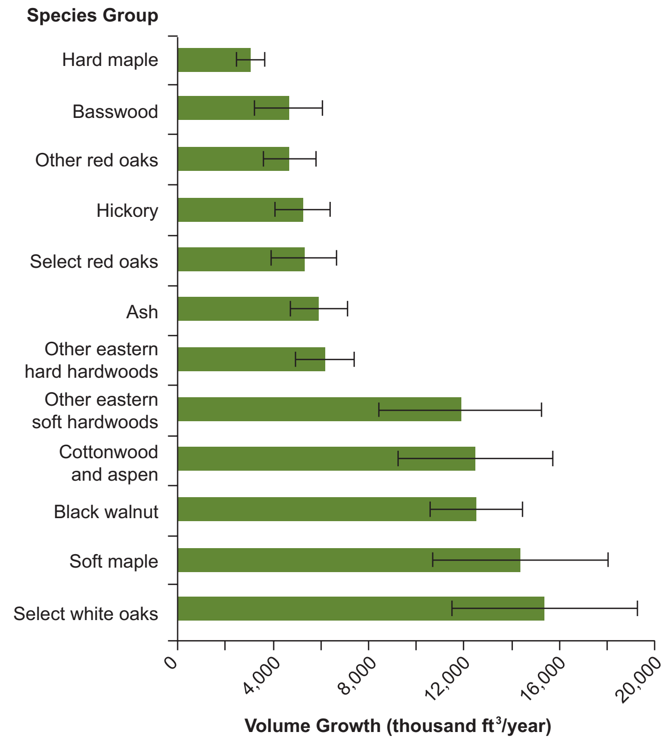


Figure 21.—Top 12 species groups in terms of average annual net growing-stock volume growth on timberland in Iowa, 2008. Error bars represent 1 standard error (68 percent confidence interval) around estimate.

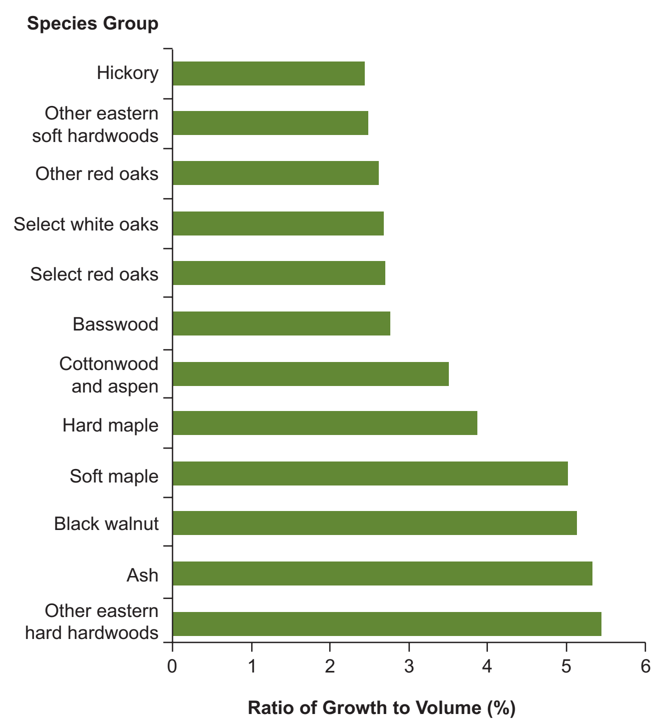


Figure 22.—Top 12 species in terms of average annual net volume growth expressed as a percent of total growing-stock volume on timberland in Iowa, 2008.

What this means

The net growth of Iowa's forests has increased in recent decades. Many of the economically desirable tree species, such as oaks, maples, and walnut, continue to accrue tremendous annual growth. However, other eastern hard hardwoods and ash show more growth relative to their total volume while oaks show comparatively less relative growth.

Mortality

Background

Tree mortality influences a number of forest characteristics including health, vigor, and rate of accretion and depletion. Mortality can be caused by insects, disease, adverse weather, succession, competition, fire, old age, or human or animal activity either alone or in combination. Although timber utilization and land clearing also result in tree mortality, those actions are accounted for separately as 'harvest removals' and 'other removals', respectively (see Removals, page 18). Growing-stock mortality estimates represent the average cubic foot volume of sound wood in growing-stock trees that died each year as an average for the years between inventories.

What we found

The rate of average annual growing-stock volume mortality on Iowa's timberland was fairly level during 1954 and 1974 at about 0.6 percent, but has since increased to its current level of 1.2 percent (Fig. 23). In terms of total statewide average annual mortality, the "other eastern soft hardwoods" species group had almost 20 million cubic feet, the largest, by far, of any species group (Fig. 24). Select white oaks, cottonwood, and hickory followed with 3.3, 2.9, and 2.5 million cubic feet, respectively. Compared to total growing-stock volume on timberland for each species group, other eastern soft hardwoods had the largest percentage of mortality at 4 percent. All other species had much lower percentages of mortality, with hickory, other red oaks, select red oaks, basswood, and cottonwood all near 1 percent (Fig. 25).

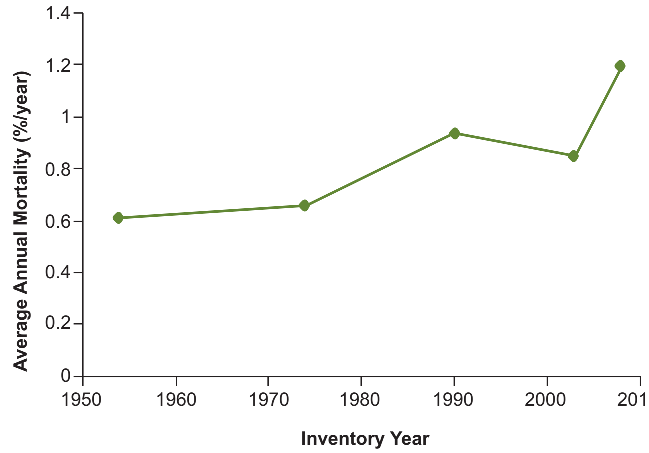


Figure 23.—Average annual net growing-stock volume mortality by total statewide growing-stock volume on timberland in Iowa, 1954-2008.

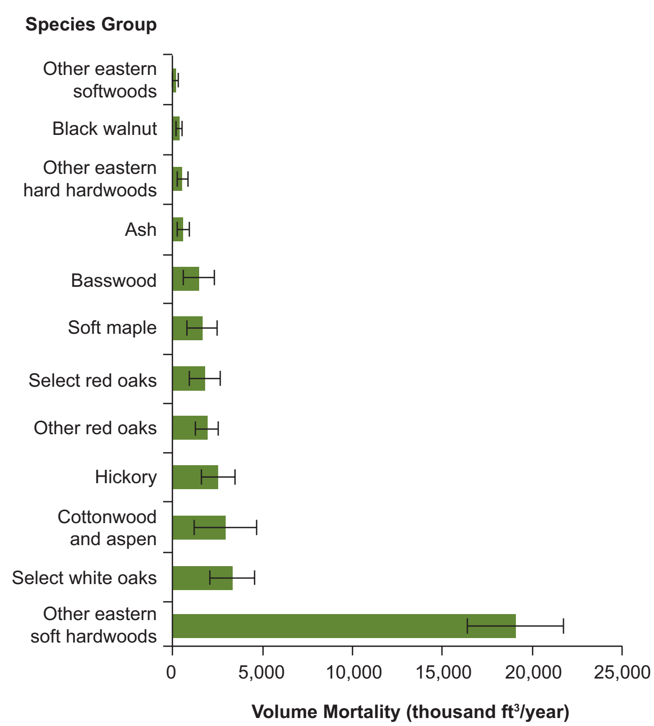


Figure 24.—Top 12 species groups in terms of average annual net growing-stock volume mortality on timberland in Iowa, 2008. Error bars represent 1 standard error (68 percent confidence interval) around estimate.

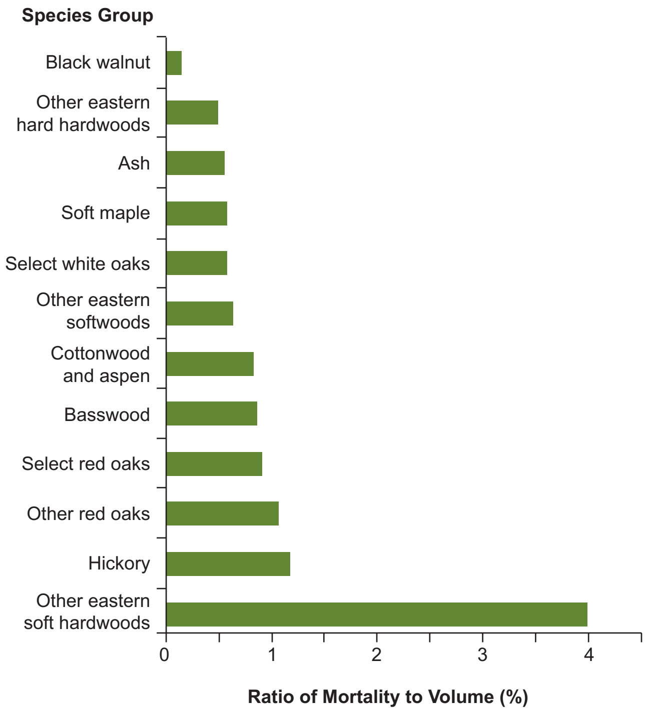


Figure 25.—Top 12 species groups in terms of average annual net growing-stock volume mortality as a percent of total growing-stock volume on timberland in Iowa, 2008.

What this means

The levels of tree mortality across Iowa are double the rate during the 1950s. Mortality is a natural process in forest stands as they develop and change over time. However, recent invasions by nonnative pests are increasing rates of mortality. Rate of mortality for 'other eastern soft hardwoods' species group is slightly higher than rate of growth. The most numerous tree species within this group is American elm; Dutch elm disease is a likely culprit affecting this high mortality rate. For all other species groups, however, rates of growth exceed rates of mortality, often by a substantial margin. Tree mortality is a crucial component of overall forest health and thus should be monitored into the future.

Removals

Background

Trees are removed from timberland to meet a variety of objectives. Changes in the quantity of growing stock removed help to identify trends in land-use change and forest management. Average annual removals of growing-stock volume on timberland can be classified as either 'harvest removals' or 'other removals'. As the name implies, the category 'harvest removals' refers to trees harvested for timber products or for other forest management purposes, but the long-term land use does not change. In contrast, 'other removals' refers to a change in either land use or protection status, either from actual diversion of forest land to a nonforest land use or from the reclassification of forest land from timberland to 'reserved' or 'unproductive' forest land. Historical inventories were limited to timberland, and estimates of removals were limited to 'annual cut' of sawtimber or growing stock. Because removals generally occur on only a small number of plots during each inventory, the estimates for removals show greater variance than those for growth, mortality, or area which are recorded on nearly every plot. Like forest growth, the rate at which trees are removed represents the average annual growing-stock removals that occurred between 2003 and 2008.

What we found

Average annual growing-stock removals as a percent of total statewide volumes was about 1.6 percent in 1954, increasing to 4.8 percent in 1974, and returning to earlier levels in the current inventory, at 1.5 percent (Fig. 26). Most of the removals were focused on species groups of select white oaks, soft maple, other eastern soft hardwoods, select red oaks, black walnut, and other red oaks, all of which had removals in excess of 2 million cubic feet per year (Fig. 27). Average annual growing-stock harvest removals as a percent of total statewide volumes were greatest for hard maple, at 2.3 percent, with select red oaks, other eastern hard hardwoods, other red oaks, and soft maple species groups all exceeding

1 percent per year (Fig. 28). Average annual growing-stock 'other removals' (associated with land-use change) was largest for soft maples, at 3.8 percent, with all other species groups below 1 percent (Fig. 29).

Figure 26.—Average annual removals of growing stock as a percent of total statewide growing-stock volume on timberland in Iowa, 1954-2008.

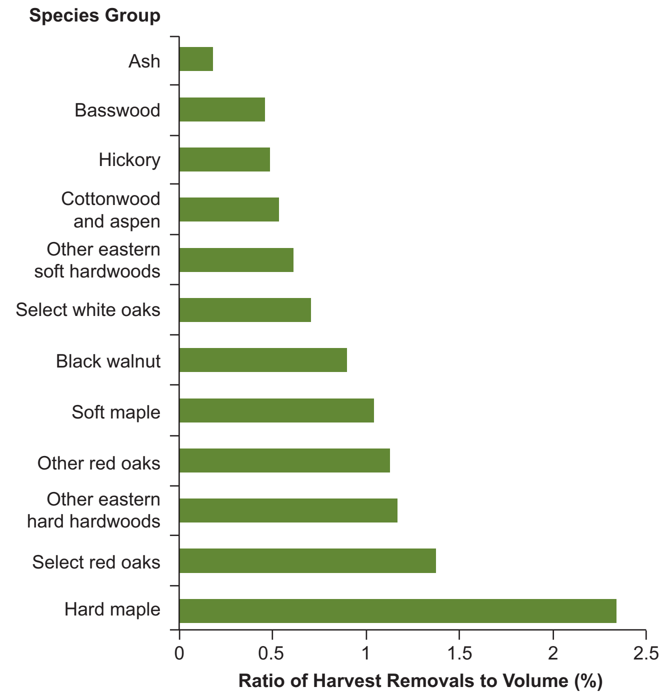


Figure 28.—Top 12 species in terms of average annual net volume 'harvest removals' as a percent of total growing-stock volume on timberland in Iowa, 2008.

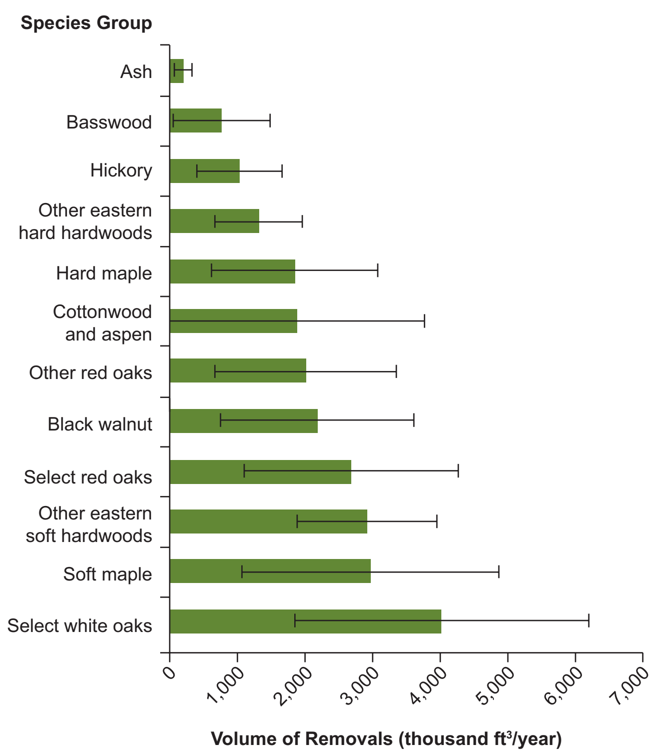


Figure 27.—Top 12 species groups in terms of average annual net growing-stock volume removals per acre of timberland in Iowa, 2008. Error bars represent 1 standard error (68 percent confidence interval) around estimate.

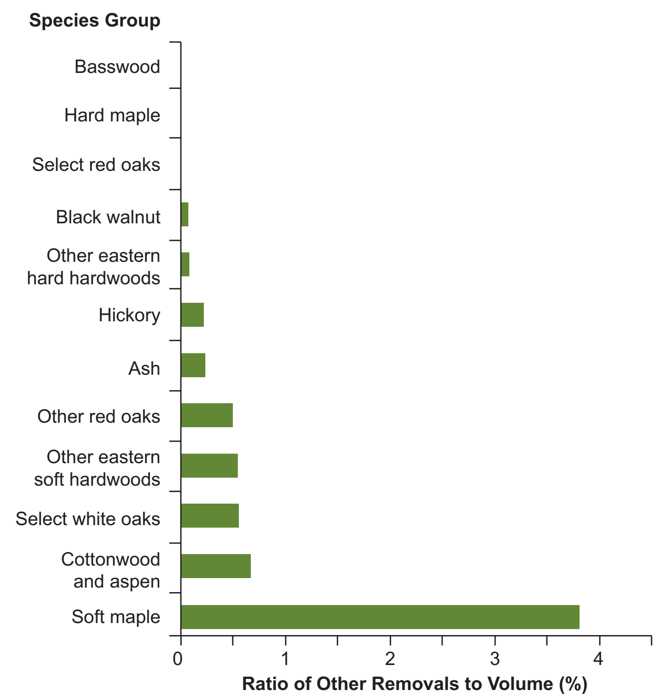


Figure 29.—Top 12 species in terms of average annual net volume 'other removals' (land-use change) as a percent of total growing-stock volume on timberland in Iowa, 2008.

What this means

Removal rates are indicative of both harvest and land-use change. Average annual rate of removals for all species groups combined (1.5 percent per year) is similar to that of mortality (1.2 percent per year). Net growth typically averages 3.4 percent, which exceeds the sum of removals and mortality. At these rates, it appears as though total volumes will continue to increase in Iowa. However, this may not apply to local scales or for specific species like silver maple, which predominates the soft maple species group and is the most prevalent species statewide. There is an ongoing need to monitor removals on a species-by-species basis.

Forest Patterns

Background

The fragmentation of forest land areas continues to be a major ecological issue worldwide. Fragmentation is the process by which large, contiguous tracts of forest land are broken down into smaller, more isolated forest patches surrounded by nonforest land uses such as agriculture or urban development. Furthermore, fragmentation results in a loss of interior forest conditions and an increase in edge habitat, benefitting some species, but having negative effects on others, including the loss of native species and increased populations of nonnative invasive species.

What we found

Land cover classification data from the National Land Cover Database 2001 (NLCD 2001) (Homer et al. 2007) was reclassified to create a five-class map of Iowa (Fig. 30). Using this map, forest pixels were characterized based on their proximity to developed edges, or edges due to urban development and agricultural land uses. Environmental differences along forest edges, also referred to as edge effects, can penetrate into a forest patch some distance (Collinge 1996). A commonly used threshold for edge effects is 100 to 300 ft, or approximately 30 to 90 m, after which forest exhibit interior conditions (Riemann et al. 2008). Using the high end of 90 m, forest pixels were classified as being within 90 m of a developed edge or greater than 90 m from a developed edge (Fig. 31). According to this analysis, nearly three-fourths (72 percent) of Iowa's forest land is subject to edge effects and lacks interior forest conditions.

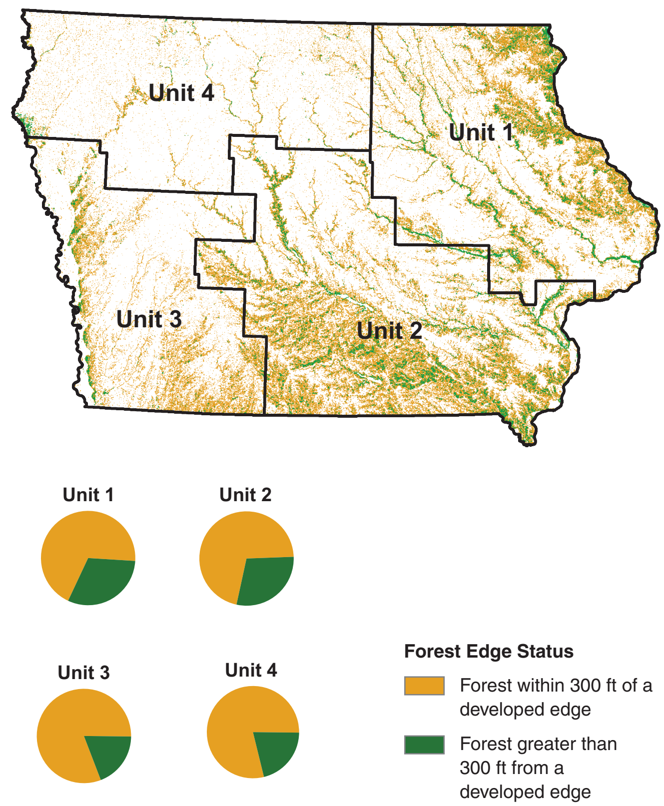


Figure 31.—Forest edge status in Iowa, 2001. Data source: National Land Cover Database, 2001 (Homer et al. 2007).

Figure 30.—Iowa land cover, 2001. Data source: National Land Cover Database, 2001 (Homer et al. 2007).

What this means

Overall, forest makes up approximately 8 percent of Iowa's land base. How this forest land is arranged across the landscape affects ecological processes. Based on the map pixel analysis (Fig. 30), the majority of forest was classified as edge rather than interior forest, indicating that the forest land in Iowa is heavily fragmented. While much of the interior forest is found along stream and river corridors, the overall forest pattern is not consistent across the State. An assessment by FIA unit found that Units 1 and 2 contain the bulk of the forest land (84 percent) and more interior forest, which is critical for maintaining biodiversity and healthy populations of native plants and wildlife. On the other hand, a higher percentage of the forest land in Units 3 and 4 was classified as edge habitat and is, therefore, more heavily fragmented. This has more serious implications for these forest patches, such as higher susceptibility to invasion by nonnative invasive species and other negative edge effects.

Forest Indicators

Linda Haugen, U.S. Forest Service, combats garlic mustard *(Alliaria petiolata)*, a nonnative invasive plant, on a family forest in northeastern Iowa. Photograph by Dennis Haugen, U.S. Forest Service.

Young Forest Habitat

Background

Iowa forests provide habitat for numerous species of mammals, birds, reptiles, and amphibians, as well as for fish, invertebrates, and plants. Several indicators of wildlife habitat abundance can be derived from FIA data. Forest composition and structure affect the suitability of habitat for each species. Some species require interior forest, which is discussed previously in 'Forest Patterns'. Other species depend upon early successional forests or the ecotone (edge) between different forest stages. Many species require multiple structural stages of forests to meet different phases of their life history needs. Abundance and trends in these structural and successional stages serve as indicators of population carrying capacity for wildlife species (Hunter et al. 2001). According to the Iowa Wildlife Action Plan (IWAP; Iowa Dept. of Nat. Res. n.d.), "[Iowa] habitats for birds that inhabit mature forests (warblers and thrushes) appear to be increasing at the expense of species requiring earlier successional stages (woodcock and ruffed grouse)." Both of these species are included among the IWAP's species of greatest conservation need.

What we found

Peak distribution of small-diameter stand-size class, which is an indicator of early successional stages, occurred during 1974 (19 percent), falling to a low of 10 percent of all forest land during the 2003 inventory, and increasing moderately to a rate of 13 percent in 2008 (Fig. 32). Concurrently, distribution of large-diameter stand-size class increased from about 40 percent during 1954 to about 60 percent during the most recent inventories, with medium-diameter forest decreasing from about 30 percent during 1954 to about 20 percent in the current inventory (Fig. 32). The majority of Iowa forest land is in stand-age classes over 40 years. Small diameter stand-size class predominates young forests (0-20 years), but there is more total area of small diameter stand-size class in forests older than 20 years (Fig. 33).

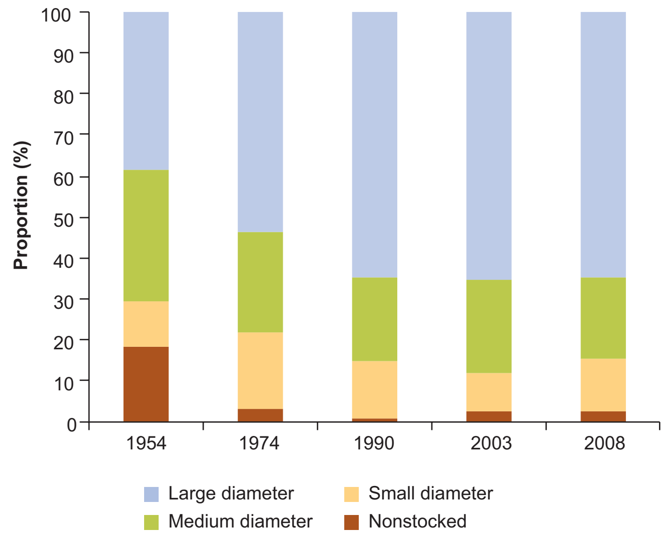


Figure 32.—Area (percent) of forest land by stand-size class, Iowa, 1954-2008.

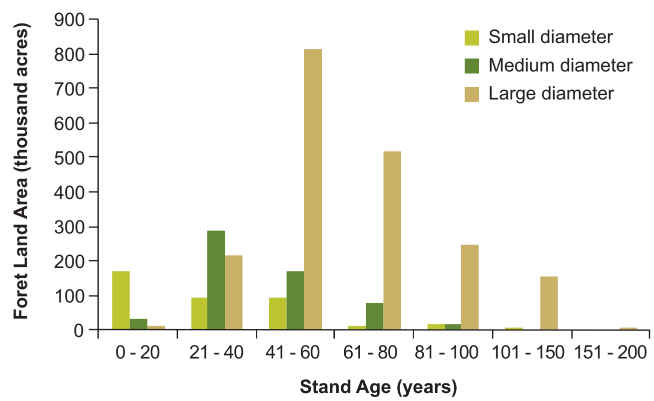


Figure 33.—Area of forest land by age class and stand-size class, Iowa, 2008.

What this means

Increasing abundance of both small- and large-diameter stand-size classes is providing habitat for wildlife species at both ends of the successional-structural continuum, offset by declining abundance in medium-diameter class. Estimates of early successional forest area in Iowa provide indicators of habitat abundance for ruffed grouse (*Bonasa umbellus*), a permanent resident, and American woodcock (*Scolopax minor*), a migratory species.
Iowa Department of Natural Resources has increased management of early successional habitat for these and other associated species, which appears to be reflected by

the recent increase in fraction of small-diameter stand-size class in the State. While both stand-size class and stand-age class provide indicators of early successional forests, the two attributes are not interchangeable and are best used in combination.

Standing Dead Trees

Background

Specific features, like nesting cavities and standing dead trees (at least 5 inches d.b.h.) provide critical habitat components for many forest-associated wildlife species. Standing dead trees contain significantly more cavities than occur in live trees (Fan et al. 2003). Standing dead trees that are large enough to meet habitat requirements for wildlife are referred to as 'snags'. Standing dead trees serve as important indicators of wildlife habitat and past mortality events and also provide carbon storage. And, they serve as sources of down woody material (discussed elsewhere in this report), which also provides habitat features for wildlife. The number and density of standing dead trees, together with decay classes, species, and sizes, define an important wildlife habitat feature across Iowa's forests.

What we found

During the 2008 inventory, FIA collected data on standing dead trees of numerous species and sizes in varying stages of decay. According to the current inventory data, an estimated 36 million standing dead trees are present on Iowa forest land, at a density of 12.6 per acre on public land, 11.6 per acre on private land, and an overall average of 11.8 per acre of forest land, compared to an overall average of 10 standing dead trees per acre in 2003. Half of these standing dead trees are in 'other eastern soft hardwoods' species group (Fig. 34). Relative to the total number of live trees in each species group, select and other white oaks, other red oaks, and select red oaks topped the list with 8.1, 6.2, and 5.8 standing dead trees per 100 live trees (Fig. 35). The majority of standing dead trees were between 5 and 6.9 inches d.b.h.—the smallest diameter class—with progressively fewer numbers in the larger diameter classes (Fig. 36). The greatest number of standing dead trees were estimated for the class of least decay, except for the larger diameter classes (15 inches d.b.h. or greater), where standing dead trees in intermediate decay classes predominated (Fig. 36).

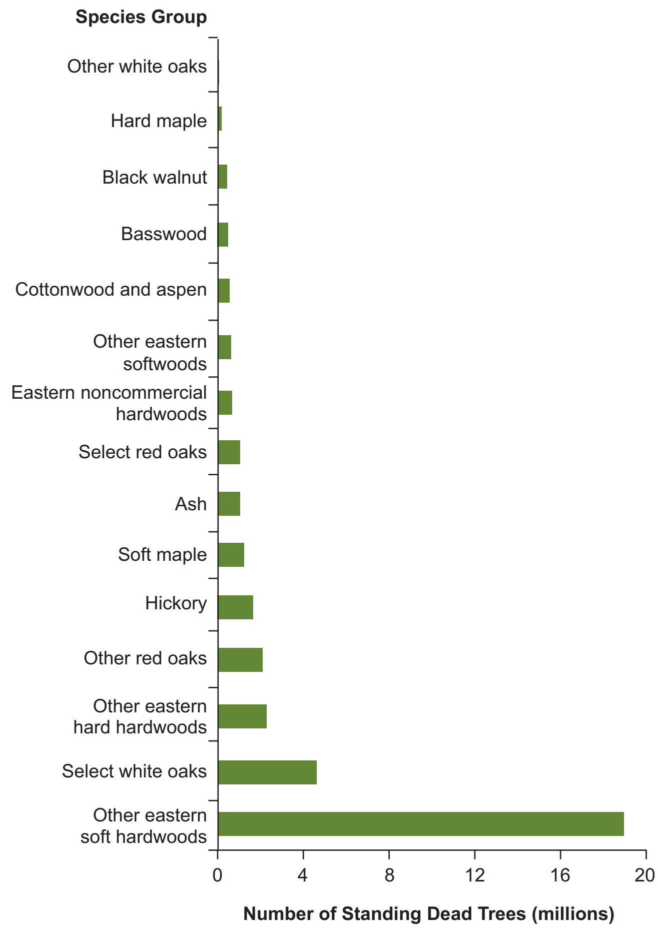


Figure 34.—Number of standing dead trees by species group for the 12 most common standing dead tree species groups, Iowa, 2008.

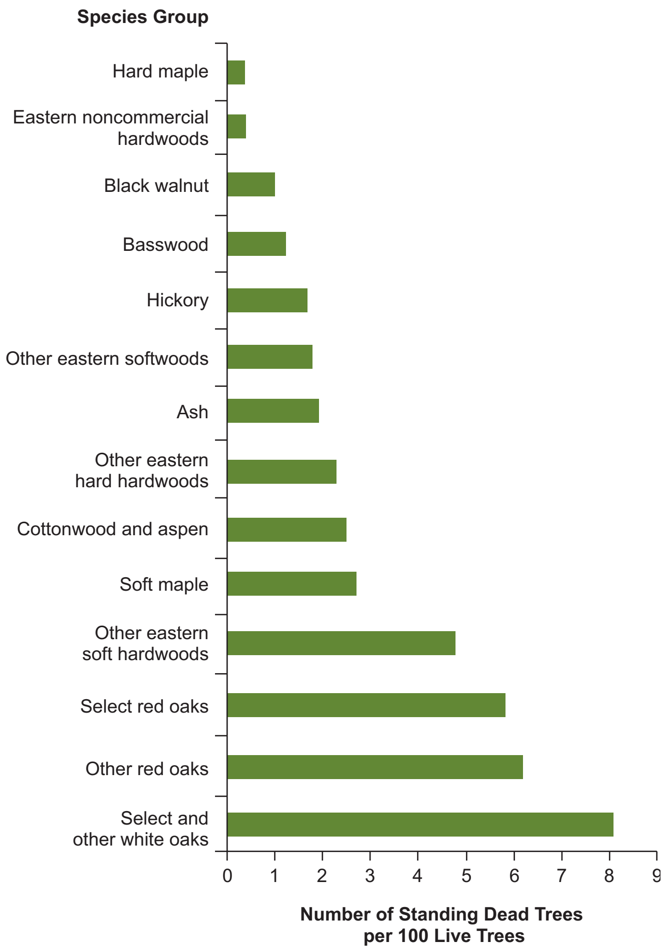


Figure 35.—Number of standing dead trees per 100 live trees for the 12 most common standing dead tree species groups, Iowa, 2008.

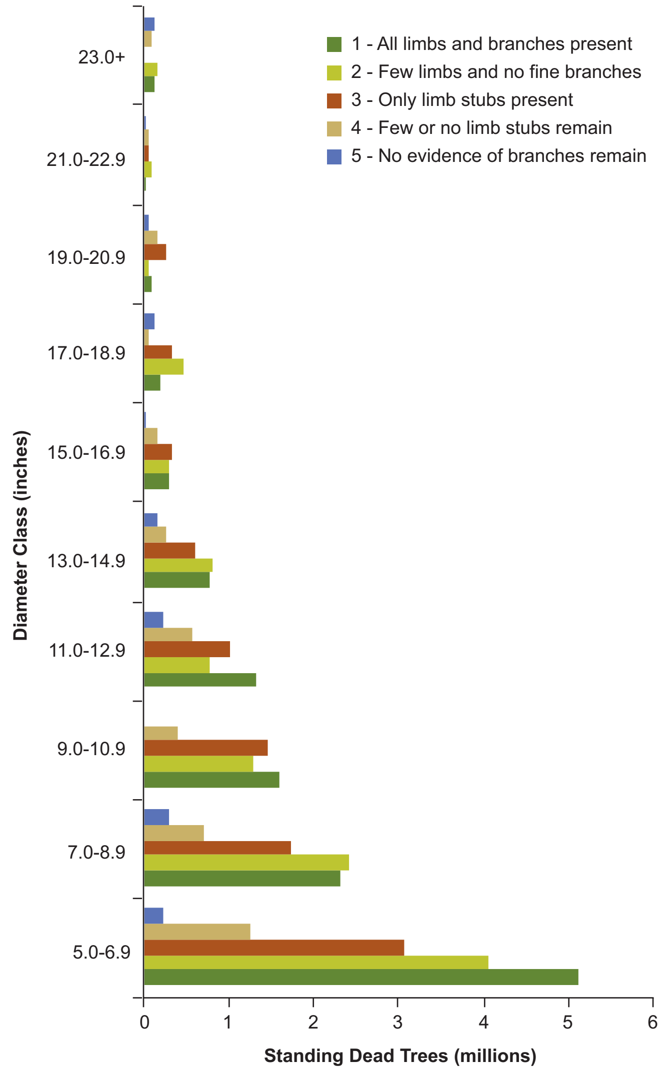


Figure 36.—Distribution of standing dead trees by decay and diameter classes for all dead trees in Iowa, 2008.

What this means

Standing dead trees result from a variety of causes, including diseases and insects, weather damage, fire, flooding, drought, and competition, and other factors. The dominance of standing dead trees in 'other eastern soft hardwoods' may be attributed to American elm, the most numerous species in the State, which has been severely impacted by Dutch elm disease. On a per-live-tree basis, however, standing dead trees are more dominant in the oak species groups, likely due their slower rate of decay and longer persistence. Standing dead trees provide areas for foraging, nesting, roosting, hunting perches, and cavity excavation for wildlife, from primary colonizers such as insects, bacteria, and fungi to birds, mammals, and reptiles. Most cavity nesting birds are insectivores that help to control insect populations. The state and federally endangered Indiana bat (*Myotis sodalis*), which has been recorded in 15 southern counties and one northeastern Iowa county, roosts primarily in the cavities and under exfoliating bark of snags of oak and hickory species groups. Providing a variety of forest structural stages and retaining specific features like snags on both private and public lands are ways that forest managers maintain the abundance and quality of habitat for forest-associated wildlife species in Iowa.

Crown Conditions

Background

Tree crown condition is one indicator of tree health. Full, dense crowns support vigorous tree growth, while sparse crowns suggest poor growth conditions. Factors affecting crown condition include disturbances such as disease, insect activity, and adverse weather; and unfavorable site conditions such as nutrient deficiency, overcrowding, and moisture stress or excess. Three components of crown condition are monitored by FIA: crown density, crown dieback, and sapling crown vigor (Schomaker et al. 2007). Crown density is an estimate of crown fullness and represents the amount of foliage, branches, and reproductive structures that block light through the crown. Dieback is a measure of twig and branch mortality within the crown. Sapling crown vigor is an estimate of the crown condition and health of saplings. Crown vigor is based on estimates of crown ratio, dieback, and condition of foliage.

What we found

The frequency distribution of tree crown density across Iowa is normally distributed around a weighted mean of 39 percent, indicating a slight increase from the previous inventory (32 percent; Fig. 37). Crown density of 30 percent or more is an indicator of good tree vigor. The frequency distribution of crown dieback in Iowa's tree crowns is dominated by the 0- to 5-percent class, with fewer than 12 percent of Iowa trees exhibiting more than 10 percent dieback (Fig. 38). From 2003 to 2008, the frequency distribution of crown dieback was relatively stable with only slight shifts within dieback classes (Fig. 38). The vast majority of tree saplings have crown vigor of 'good' (75 percent) or 'fair' (23 percent), with an apparent slight decrease in vigor since the previous inventory (Fig. 39).

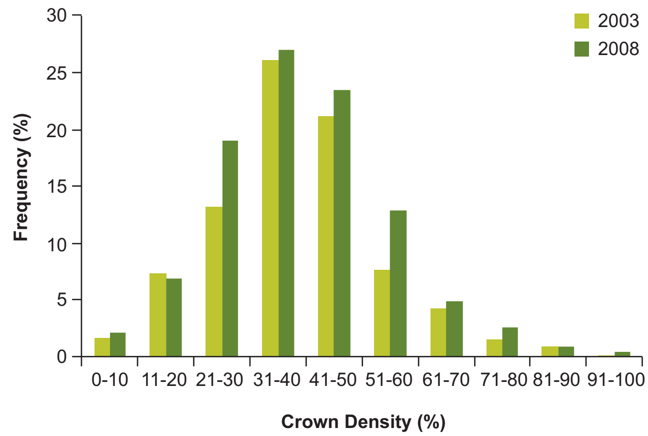


Figure 37.—Crown density frequency distribution, Iowa, 2003 and 2008.

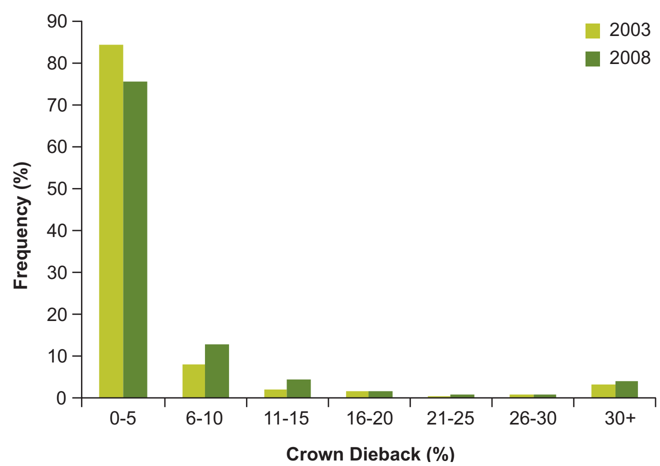


Figure 38.—Crown dieback frequency distribution, Iowa, 2003 and 2008.

Figure 39.—Crown sapling vigor distribution, Iowa, 2003 and 2008.

What this means

The overall health of tree crowns across Iowa appears stable, as indicated by low levels of crown dieback and moderate levels of crown density. Because the condition of tree crowns is often the first indicator of impending forest health issues, we might conclude that health of individual trees is good in Iowa. Given the relatively sparse tree crown sample size, specific conclusions on individual species or species groups cannot be made. The condition of Iowa's tree crowns should continue to be monitored to assess effects of smaller scale forest health issues (e.g., recent invasion of emerald ash borer) on Iowa's forest land area.

Down Woody Materials

Background

Down woody materials (DWM), in the form of fallen trees and branches, fulfill a critical ecological niche in Iowa's forests. Down woody materials provide valuable wildlife habitat in the form of coarse woody debris, but also contribute towards forest fire hazards via surface woody fuels. Components of DWM include fine and coarse woody debris, slash piles, duff, litter, and shrub/herbs cover and height, which are sampled using the line-intersect method, point sampling, and fixed-radius sampling (Woodall and Monleon 2008).

What we found

Fuel loadings of down woody materials (time-lag fuel classes) are not exceedingly high in Iowa (Fig. 40). When compared to the nearby states of Illinois and Missouri with similar forest ecosystems, Iowa's fuel loadings of all time-lag fuel classes are not substantially different (Woodall and Monleon 2008). The size-class distribution of coarse woody debris appears to be heavily skewed (77 percent) toward pieces less than 8 inches in diameter at point of intersection with plot sampling transects (Fig. 41A). With regards to decay-class distribution of coarse woody debris, there appears to be moderate stages of coarse woody decay across the State (decay classes 2, 3, and 4, totaling 91 percent; Fig. 41B). These decay classes are typified by moderate to heavily decayed logs that are sometimes structurally sound but missing most/all of their bark with extensive sapwood decay. There is no strong trend in coarse woody debris volumes per acre among classes of live tree density (basal area per acre). Most of Iowa's forests appear to have more than 200 cubic feet of coarse woody debris per acre (Fig. 42).

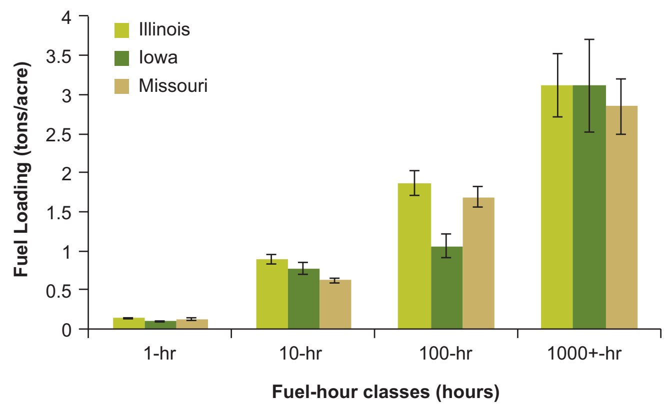


Figure 40.—Mean fuel loadings (tons/acre, time-lag fuel classes) on forest land in Iowa and two neighboring states, 2008. Error bars represent 1 standard error (68 percent confidence interval) around estimate.

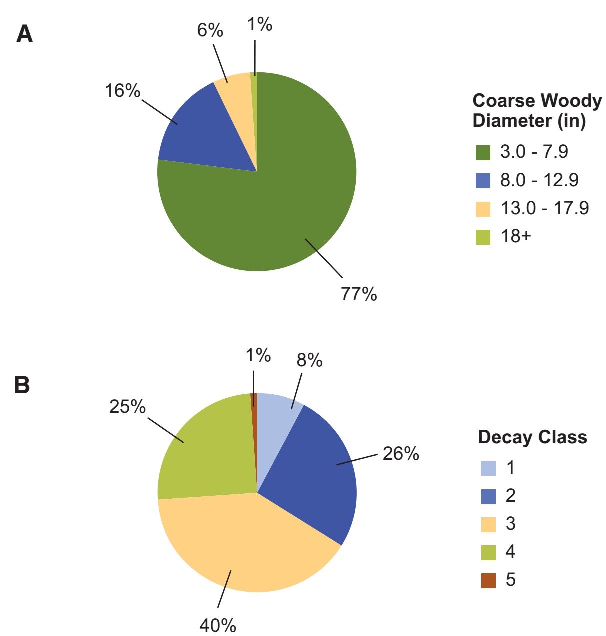


Figure 41.—Mean proportions of coarse woody debris total pieces per acre by transect diameter (inches - A) and decay classes (B) on forest land, Iowa, 2008. See Fig. 36 for definitions of decay classes.

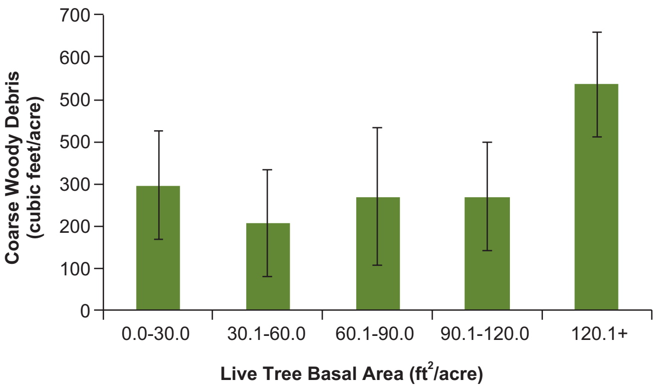


Figure 42.—Mean coarse woody debris volumes (cubic feet/acre) by live tree basal area (square feet/acre) class on forest land, Iowa, 2008.

What this means

The down woody fuel loadings in Iowa's forests are not exceedingly different from those in nearby states. Only in times of extreme drought would these fuel loadings pose a hazard across the state. Of all down woody components, coarse woody debris (i.e., 1,000+-hr fuels) comprised the largest amounts. However, coarse woody debris volumes were still relatively low and were represented by small, moderately decayed pieces. The scarcity of large coarse woody debris resources may also indicate a lack of high quality wildlife habitat for some species. Overall, because fuel loadings are not exceedingly high across Iowa, possible fire dangers are outweighed by the benefits of down woody material to wildlife habitat and carbon sinks.

Soils

Background

The soils that sustain forests are influenced by a number of factors, including: climate; the trees, shrubs, herbs, and animals living there; landscape position; elevation; and the passage of time. Climate-soil interactions are one significant way that humans influence the character and quality of the soil and indirectly affect the forest. For example, industrial emissions of sulfur and nitrogen oxides lead to "acid rain." The deposition of acids strips the soil of important nutrients, notably calcium (Ca) and magnesium (Mg). The loss of calcium and magnesium results in a shifting balance of soil elements toward aluminum (Al) and manganese (Mn). We can use the ratios of these elements as a measure of the impact of acid deposition on forest soils and tree health.

What we found

A specific example helps to illustrate the knowledge gained by linking trees to their underlying soil, even when these linkages only are sampled on a small number of Phase 3 (P3) plots (see documentation on the DVD at the back of this bulletin). The uncompacted live crown ratio is determined by dividing the live crown length by the actual tree length. Larger values are associated with healthier trees; low values of this ratio can be related to self pruning and shading from other tree crowns, but other reasons include defoliation due to dieback, and loss of branches due to breakage or mortality. (See also the previous section on Crown Conditions.) In Iowa, of many different variables available, tree diameter and height show the strongest relationship with live crown ratio (Fig. 43); smaller trees (in diameter and height) have larger live crown ratios. The next strongest predictors of live crown ratio are a series of soil parameters including the molar ratios of Mg:Mn, Ca:Al, and Mg:Al, and the total amount of Al and nitrogen (Fig. 43). These soil predictors are more important than traditional measures of competition and productivity such as basal area and stand-size code. Finally, it is important to put Iowa's forests in the context of others around the country. While it is possible to identify linkages with soil parameters, and the indicators of soil acidification have important predictive power for canopy health, these relationships are relatively weak in comparison with other states. For example, when states are ranked by median Ca:Al ratio, Iowa is near the bottom of the list. Iowa's forests are growing on rich, productive soil, less affected by atmospheric pollution than other parts of the country.

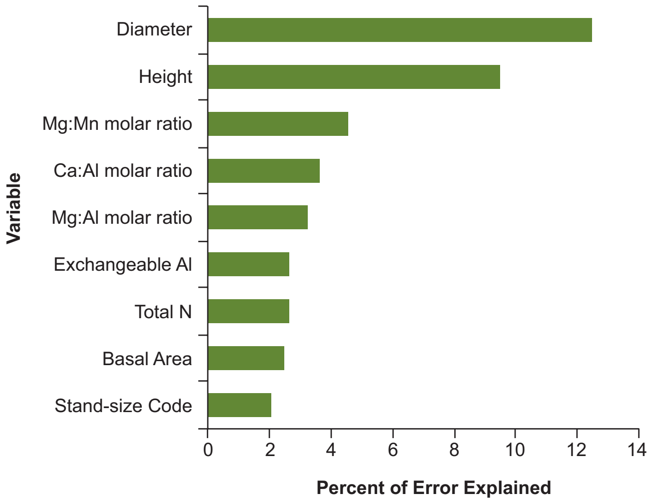


Figure 43.—Percent of error in measurements of uncompacted live crown ratios explained by various predictors.

What this means

Tree species occupy different niches in the landscape. This provides a competitive advantage for colonization, growth, and reproduction. Atmospheric deposition of different compounds changes the soil substrate through additions and/or removals of nutrients and pollutants. These changes in the soil influence the ability of existing trees to thrive and reproduce in their current locations, as well as the ability of other trees to colonize new landscapes. It is important to document and understand natural and anthropogenic processes in the soil since they profoundly influence the current forest and success of future forest management plans. By studying the trees species found on P3 plots, it is possible to evaluate tree:soil interactions with some statistical rigor. The number of P3 plots in Iowa is small, so the power of this evaluation it limited. However, the data are consistent with observations in other states. The level of soil acidification in Iowa is low, particularly in comparison to many eastern states.

Understory Vegetation: Species Diversity and Nonnative Invasive Plants

Background

Trees dominate the overstory of Iowa's forested ecosystems, but understory vegetation also plays a critical role in aiding the regulation of microclimate, helping to limit runoff, and providing wildlife habitat cover and forage. Collecting data on understory vegetation can assist managers in assessing soil nutrient and moisture availability, habitat quality, and stand structure. Furthermore, the data provide information on the presence of invasive or nonnative species. The plant community is invaluable for forest fauna, especially those wildlife species requiring the presence of a host plant species for survival. To further our understanding of plant communities, FIA assessed data from plant communities in Iowa from 2007 through 2008 on P3 plots (approximately 6.25 percent of field plots) and from 2007 through 2008 on Phase 2 (P2) 'Invasive' plots (approximately 20 percent of field plots).

What we found

P3 vegetation data were collected in 2007 through 2008 from 15 P3 plots, where 301 plant species were observed. Classified species were categorized based on the classification system of the USDA Natural Resources Conservation Service (NRCS) PLANTS database (USDA NRCS 2011). The greatest number of classified species were categorized as forbs/herbs (196), followed by graminoids (grass or grass-like plants; 33) (Table 1). Analyzing broader growth habit categories, there were 41 trees, 22 shrubs, and 19 vines. Of the 301 plant species, 220 (73.1 percent) are native to the United States and 55 (18.3 percent) are introduced (Table 2). The most commonly observed plant species was common dandelion (13 plots) followed by common hackberry, American elm, and eastern prickly gooseberry, which were each observed on 12 plots (Table 3). Table 4 provides a list of common and scientific names for 43 invasive plant species inventoried on FIA P2 Invasive plots across the

Table 1.—Number of species on Iowa P3 plots by growth habit (USDA NRCS 2011), 2007-2008.

Growth Habit	Number of Species or Undifferentiated Genuses	Percent
Forb/herb	169	56.1
Graminoid	33	11.0
Shrub	9	3.0
Shrub, subshrub, vine	3	1.0
Subshrub, forb/herb	3	1.0
Subshrub, shrub	3	1.0
Subshrub, shrub, forb/herb	4	1.3
Tree	21	7.0
Tree, shrub	18	6.0
Tree, shrub, subshrub	2	0.7
Vine	2	0.7
Vine, forb/herb	12	4.0
Vine, shrub	1	0.3
Vine, subshrub	2	0.7
Vine, subshrub, forb/herb	2	0.7
Unclassified	17	5.6
Total	301	

Table 2.—Number of species in Iowa on P3 plots by domestic or foreign origin (USDA NRCS 2011), 2007-2008.

Origin	Number of Species	Percent
Cultivated or not in the U.S.	1	0.3
Introduced to the U.S.	55	18.3
Native and Introduced to the U.S.	8	2.7
Native to the U.S.	220	73.1
Probably introduced to the U.S.	1	0.3
Unclassified	16	5.3

NRS region. Of the 33 most commonly observed species in Iowa, nine were trees and included none of the 43 invasive species of interest (Table 4). Common dandelion was determined to be the most commonly occurring nonnative plant species (13 plots), followed by stinging nettle (10 plots) and Kentucky bluegrass (8 plots; Table 5). The majority of nonnative plant species fell in the forb/herb category and only two of these species were of woody growth form. (Scientific names of invasive species are listed in Table 4.)

Table 3.—The 33 most numerous plant species or undifferentiated genera found on Iowa P3 plots, the number of plots found on (in parentheses), and the mean number of tree seedlings and saplings per acre on those plots, 2007-2008.

Species	Tree seedlings per acre	Tree saplings per acre
Common dandelion (13)	1,724	310
Common hackberry (12)	1,643	364
American elm (12)	1,657	265
Eastern prickly gooseberry (12)	1,674	376
Sedge (11)	1,608	292
Riverbank grape (11)	1,724	369
Violet (11)	1,587	350
Virginia creeper (11)	1,792	397
Bristly greenbrier (10)	1,581	404
Stinging nettle (10)	1,766	375
Bitternut hickory (9)	1,452	347
Eastern redcedar (9)	1,968	438
Pennsylvania pellitory (9)	1,795	391
Slippery elm (9)	1,632	399
Common yellow oxalis (9)	1,398	342
White avens (9)	1,852	254
Great ragweed (8)	1,348	328
Littleleaf buttercup (8)	2,217	279
Kentucky bluegrass (8)	1,385	356
Blackseed plantain (8)	1,133	276
Canadian clearweed (8)	778	310
Stickywilly (8)	1,565	186
Green ash (8)	1,538	288
Canadian honewort (7)	1,585	169
American basswood (7)	1,759	345
Eastern waterleaf (7)	2,071	246
American lopseed (7)	2,007	364
Red mulberry (7)	1,510	460
Coralberry (7)	1,925	400
Black walnut (7)	1,681	459
Fragrant bedstraw (7)	1,889	236

Table 4.—Invasive plant species target list for NRS Forest Inventory and Analysis P2 Invasive plots, 2007 to present.

Tree Species
Acer platanoides (Norway maple)
Ailanthus altissima (tree-of-heaven)
Albizia julibrissin (silktree)
Elaeagnus angustifolia (Russian olive)
Melaleuca quinquenervia (punktree)
Melia azedarach (Chinaberry)
Paulownia tomentosa (princesstree)
Robinia pseudoacacia (black locust)
Tamarix ramosissima (saltcedar)
Triadica sebifera (tallow tree)
Ulmus pumila (Siberian elm)
Woody Species
Berberis thunbergii (Japanese barberry)
Berberis vulgaris (common barberry)
Elaeagnus umbellata (autumn olive)
Frangula alnus (glossy buckthorn)
Ligustrum vulgare (European privet)
Lonicera x. *bella* (showy fly honeysuckle)
Lonicera maackii (Amur honeysuckle)
Lonicera morrowii (Morrow's honeysuckle)
Lonicera tatarica (Tatarian honeysuckle)
Rhamnus cathartica (common buckthorn)
Rosa multiflora (multiflora rose)
Spiraea japonica (Japanese meadowsweet)
Viburnum opulus (European cranberrybush)
Vine Species
Celastrus orbiculatus (Asian bittersweet)
Hedera helix (English ivy)
Lonicera japonica (Japanese honeysuckle)
Herbaceous Species
Alliaria petiolata (garlic mustard)
Centaurea biebersteinii (spotted knapweed)
Cirsium arvense (Canada thistle)
Cirsium vulgare (bull thistle)
Cynanchum louiseae (Louise's swallow-wort)
Cynanchum rossicum (European swallow-wort)
Euphorbia esula (leafy spurge)
Hesperis matronalis (dames rocket)
Lysimachia nummularia (creeping jenny)
Lythrum salicaria (purple loosestrife)
Polygonum cuspidatum (Japanese knotweed)
Polygonum x. *bohemicum* (P. cuspidatum/P. sachalinense hybrid)
Polygonum sachalinense (giant knotweed)
Grass Species
Microstegium vimineum (Nepalese browntop)
Phalaris arundinacea (reed canarygrass)
Phragmites australis (common reed)

Table 5.—The 21 most commonly occurring nonnative plant species found on Iowa P3 plots, 2007-2008 the number of plots found on (in parentheses), and the mean number of tree seedlings and saplings per acre on those plots. Some plots may have multiple nonnative plant species and thus may be counted more than once.

Species	Tree seedlings per acre	Tree saplings per acre
Common dandelion (13)	1,724	310
Stinging nettle (10)	1,766	375
Kentucky bluegrass (8)	1,385	356
Smooth brome (5)	2,686	459
Lambsquarters (5)	915	390
Garlic mustard (4)	1,267	341
Lesser burdock (4)	1,195	169
Curly dock (4)	1,136	567
Multiflora rose (4)	1,897	352
Ground ivy (4)	413	76
Garden yellowrocket (3)	151	101
Common mullein (3)	1,389	705
White clover (3)	525	50
Red clover (3)	575	400
Common chickweed (3)	551	101
Common buckthorn (3)	1,593	225
Catnip (3)	1,489	405
Common motherwort (3)	1,181	446
Nodding plumeless thistle (3)	965	406
Common yarrow (3)	575	400
Common hop (3)	1,958	118

For 2007 through 2008, FIA collected data from 39 P2 "Invasive" plots in Iowa, on which multiflora rose was the most commonly observed species (17 plots; Table 6; Fig. 44). Reed canarygrass was the second most common invasive species, occurring on 12 plots (30.8 percent of P2 Invasive plots). Seven of the top 10 invasive species observed were of woody growth form. The high percentage of woody plants is likely influenced by the high proportion of the 43 target species (Table 4) that are of woody growth form. A large number of nonnative and invasive plants were detected on forested plots in the state of Iowa. Comparing Iowa with neighboring Missouri, 18.3 percent of the species on P3 plots in Iowa were introduced (Table 2) versus 10.6 percent of the species in Missouri (Raeker et al., in press). The spatial distribution of multiflora rose and 14 other species on P2 Invasive plots is portrayed in Figure 45.

Table 6.—Invasive species found on Iowa P2 Invasive plots, 2007-2008. Fifteen of the 43 invasive species FIA monitors were found in Iowa and are listed with the number of plots found on (in parentheses) and the mean number of tree seedlings and saplings per acre on those plots, 2007-2008.

Species	Tree seedlings per acre	Tree saplings per acre
Multiflora rose (17)	368	2,386
Reed canarygrass (12)	286	1,236
Garlic mustard (7)	297	1,870
Amur honeysuckle (7)	385	2,578
Common buckthorn (5)	204	2,171
Autumn olive (4)	176	3,343
Morrow's honeysuckle (4)	281	1,570
Japanese barberry (3)	613	1,459
Dames rocket (2)	37	187
Siberian elm (2)	66	3,156
Showy fly honeysuckle (2)	173	3,039
Oriental bittersweet (1)	565	404
Bull thistle (1)	150	375
Tatarian honeysuckle (1)	132	4,738
Spotted knapweed (1)	0	1,574

Figure 44.—Multiflora rose (*Rosa multiflora*). Photograph by James H. Miller, U.S. Forest Service, Bugwood.org.

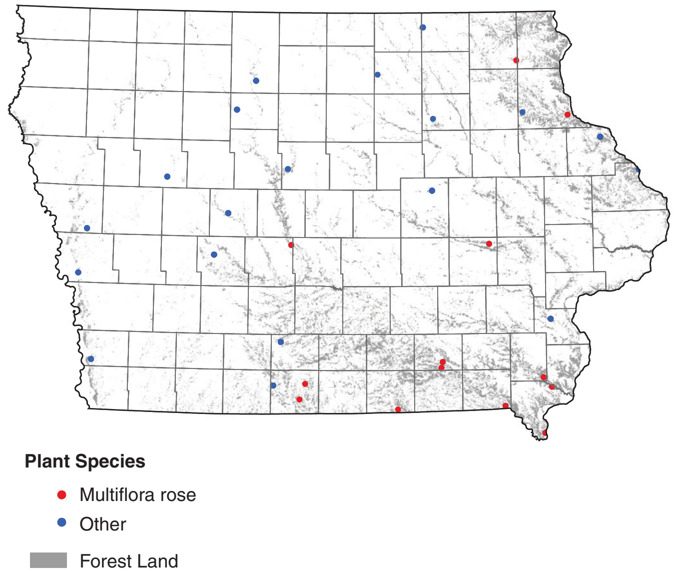


Figure 45.—Distribution of multiflora rose (*Rosa multiflora*) and other invasive plant species, Iowa, 2007-2008.

What this means

Iowa's forests possess a diverse understory with plant species spread across five growth habits (forb/herb, graminoid, shrub, tree, and vine). The presence of nonnative plant species in these forests causes concern as they are able to alter forested ecosystems by displacing native species and impacting the animal inhabitants that depend upon them. A contributing factor to the invasion of the forests is likely the high level of fragmentation (see Forest Patterns section, page 20) and anthropogenic influence. When invasive plant species outcompete native tree regeneration, they can negatively affect the carbon budget by reducing future tree cover. Furthermore, the establishment of and dominance by invasive plants can cause negative economic implications by reducing timber yields. Remeasurement of the P2 Invasive and P3 plots may discern influential site and regional trends. Understanding the importance of these characteristics will enable concerned individuals to better understand the forest understory, evaluate the threat of invasion, and determine future ecosystem response. Future remeasurement of these plots will help determine biotic and abiotic trends that influence the presence of the invasive plant species. This ongoing work will allow forest managers and concerned individuals to focus their prevention and control efforts on areas of increased invasion risk.

Forest Economics

Maple timber harvest, northeastern Iowa. Photograph by Linda Haugen, U.S. Forest Service.

Growing-Stock Volume

Background

Growing-stock volume is the amount of sound wood in live, commercial tree species for trees of at least 5 inches d.b.h. and free of defect. This measure has long been used to assess wood volume available for commercial use, which is an important consideration in economic planning and evaluations of forest sustainability.

What we found

Total growing-stock volume on Iowa's timberland has more than doubled since the 1954 and 1974 inventories, to a current statewide estimate of over 3 billion cubic feet (Fig. 46). Almost all economically important species groups have shown significant increases since 1990, with the exception of select red oaks species group, which appears to be fairly stable (Fig. 47). There appear to be no significant differences in growing-stock volumes between 2003 and 2008 inventories, with the possible exception of black walnut species group, which appears to have a slight increase. By viewing changes in growing-stock volume by d.b.h. classes, we can see more differences between selected species groups (Fig. 48). In general, diameter distributions from the 2003 and 2008 inventories are similar, with more substantial changes occurring between 1990 and the two most recent inventories. Increase in the smallest diameter class (5.0-10.9 inches) is most noticeable for 'other eastern soft hardwoods' species group, which is predominated by elms and hackberry species. Black walnut, soft maple, other eastern soft hardwoods, and hickory species groups all showed substantial increases within the 11.0-16.9 inch diameter class. Cottonwood and aspen, and select white oaks exhibit the largest increase in the largest diameter class, 23.0+ inches (Fig. 48).

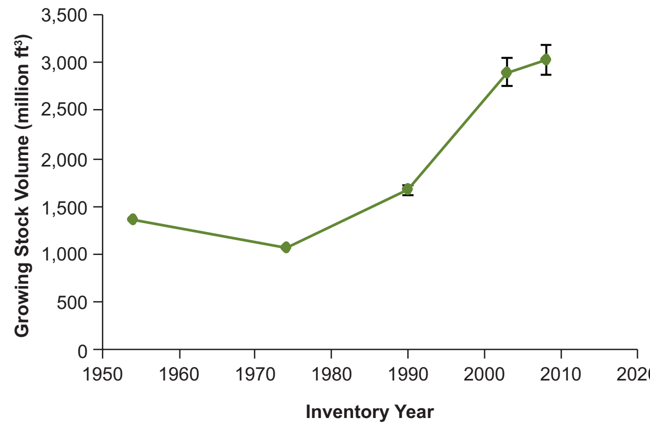


Figure 46.—Total growing-stocking volume (million cubic feet) on timberland, Iowa, 1954-2008. Error bars represent 1 standard error (68 percent confidence interval) around estimate, available only since 1990.

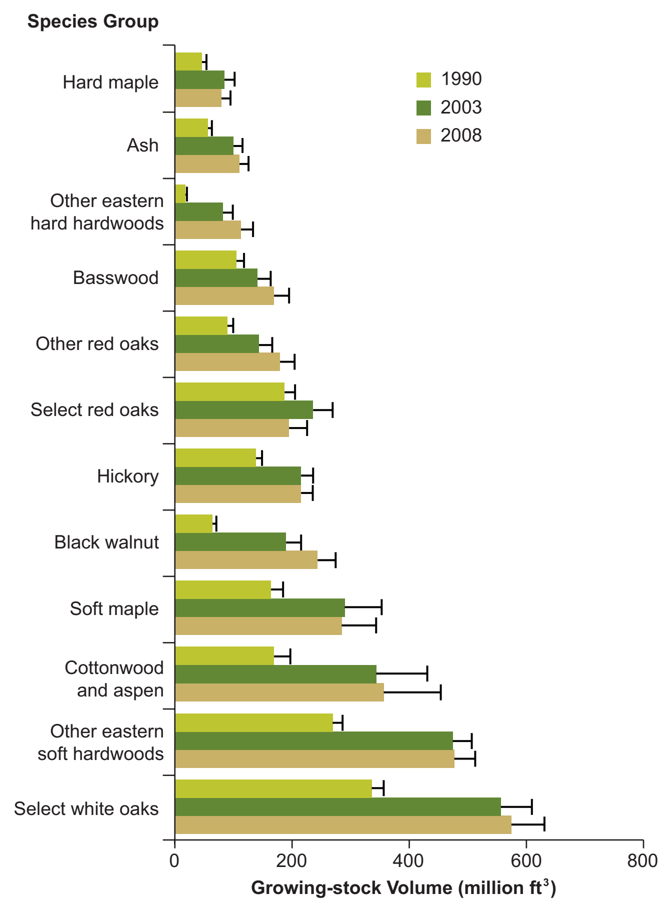


Figure 47.—Total growing-stock volume on timberland by selected species groups, Iowa, 1990-2008. Error bars represent 1 standard error (68 percent confidence interval) around estimate.

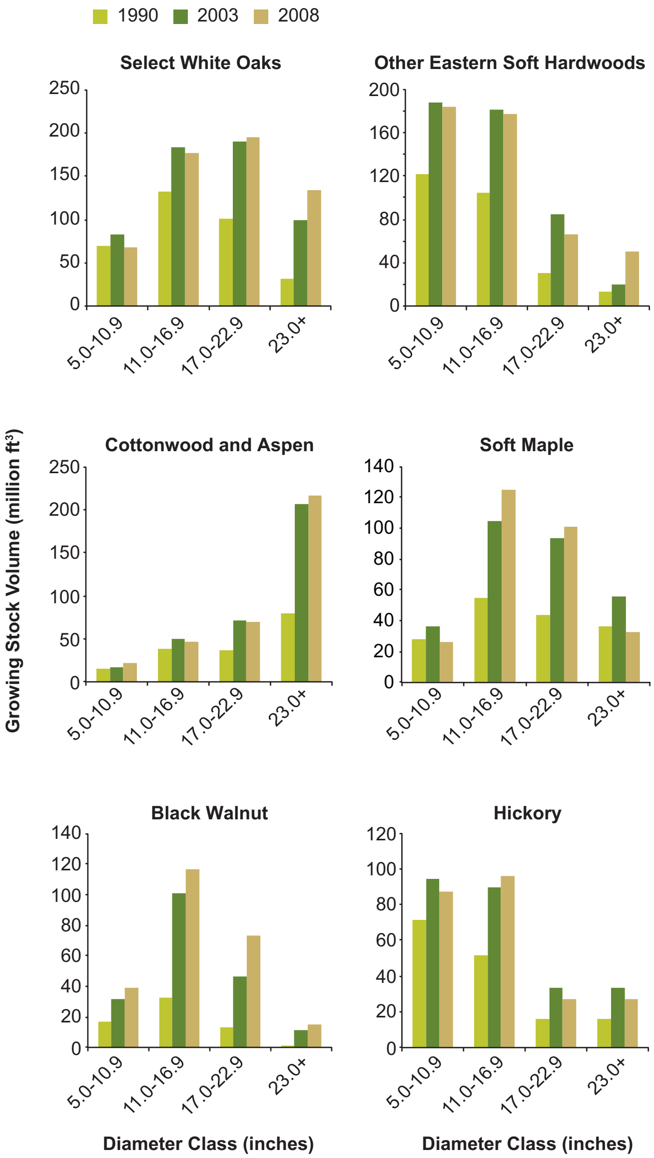


Figure 48.—Growing-stock volume by 6-inch d.b.h. classes on timberland, Iowa, 1990-2008, for top six species groups: select white oaks, other eastern soft hardwoods, cottonwood and aspen, soft maple, black walnut, and hickory.

What this means

Growing-stock volume of economically critical species groups on timberland has increased substantially since Iowa's earliest statewide inventories in 1954 and 1974. None of the top 12 species groups in terms of volume shows significant volume decreases. Volume increases vary both by species group and diameter class. Sustainability issues (e.g., regeneration) of mature forest stands containing economically vital tree species should continue to be monitored into the future.

Sawtimber Volume

Background

Sawtimber trees are live trees of commercial species that contain either one 12-foot or two noncontiguous 8-foot logs that are free of defect. Hardwoods must be at least 11 inches d.b.h. and softwoods must be 9 inches d.b.h. to qualify as sawtimber. Sawtimber volume is defined as the net volume of the saw log portion of live sawtimber, measured in board feet, from a 1-foot stump to minimum top diameter (9 inches for hardwoods and 7 inches for softwoods). Estimates of sawtimber volume, expressed as board feet (International ¼-inch rule), are used to determine the monetary value of wood volume and to identify the quantity of merchantable wood.

What we found

Total statewide board-foot volume of sawtimber on timberland decreased slightly from 1954 to 1974, increased slightly in 1990, then increased substantially to the current inventory estimate of over 11 billion board feet (Fig. 49). Almost all of the nine most prevalent species groups in terms of total sawtimber volume demonstrated tremendous gains since 1990 (Fig. 50). Black walnut sawtimber increased most, followed by seven other species groups, all with increases exceeding

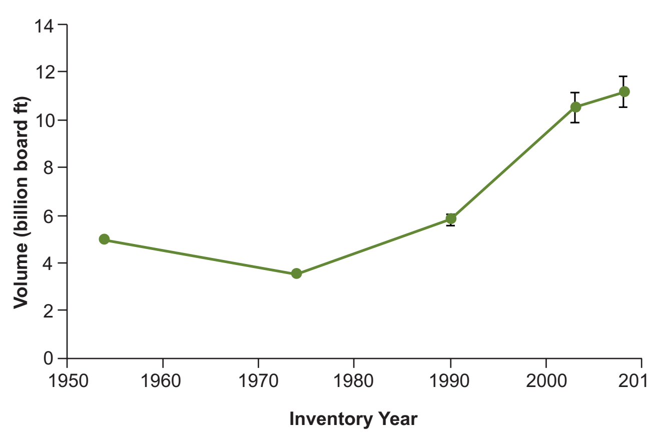


Figure 49.—Volume of sawtimber on Iowa's timberland, 1954 to 2008. Error bars represent 1 standard error (68 percent confidence interval) around estimate, available only since 1990.

50 percent, and select red oaks showed the smallest increase. Relative to total sawtimber volume on timberland, net annual growth dropped from a high of 4.5 percent in 1954 to a low of 2.3 percent during 1974, followed by a return to previous levels in subsequent inventories, with a current rate of 3.8 percent. Removal rates reveal an opposite pattern, with an increase in 1974 followed by a substantial decrease to the current level of 1.6 percent. During this same period, average annual mortality has increased gradually from a low of 0.5 percent in 1954 to the current rate of 1.1 percent (Fig. 51).

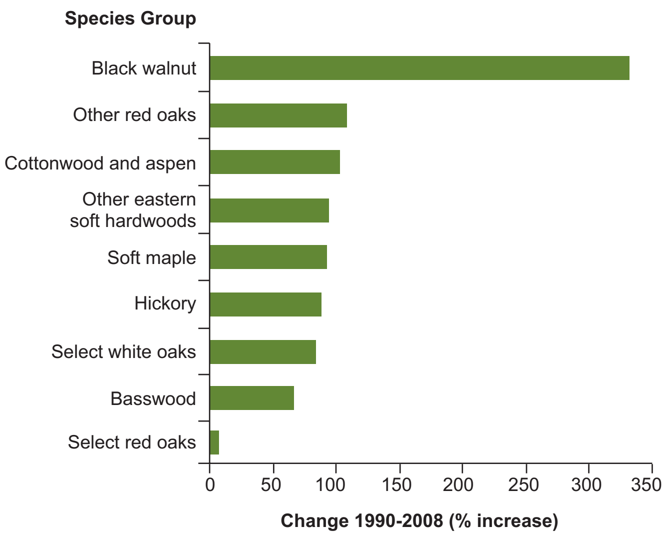


Figure 50.—Percent change in total sawtimber volume on timberland for nine most prevalent species groups in Iowa, 1990 to 2008.

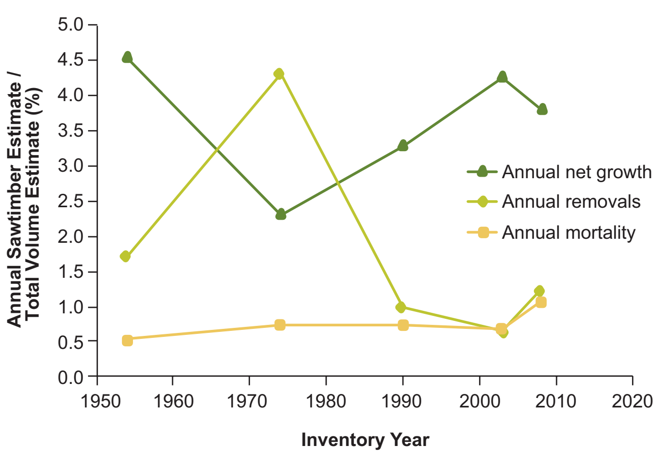


Figure 51.—Total average annual net growth, removals, and mortality as a percent of total sawtimber volume on Iowa's timberland, 1954 to 2008.

What this means

Sawtimber volume resources on Iowa's timberland have increased steadily since 1974, with annual rates of net growth exceeding mortality and removals combined, resulting in an overall annual rate of increase exceeding 1 percent since 1990. This dynamic indicates that sawtimber on timberland is a sustainable component of the forest ecosystem. If current trends were to continue, one would expect increasing sawtimber volumes into the foreseeable future. However, this assumption may not hold locally, or following unexpected catastrophic forest disturbances (e.g., storms or future mortality from invasive insects or diseases).

Sawtimber Quality

Background

The economic value of Iowa's sawtimber lies not only in its absolute amount (volume) but also in its quality. The high quality of hardwood sawtimber across the State indicates its value and supports Iowa's forest products industries.

What we found

Although grading techniques have changed since previous inventories, it appears that Iowa's forests have had a major increase in total volume of high quality sawtimber in recent decades.

The distribution of sawtimber appears to have increased within the highest tree grade (grade 1), from 13 percent in 1990 to 20 percent in the current inventory (Fig. 52). Other tree grades have shown more moderate fluctuations. Comparisons of recent volumes by grade to inventories from 1990 and earlier are challenging because some sawtimber was not graded during those earlier inventories. Sawtimber in grades 1 and 2 combined totaled 4.7 billion board feet during both the 2003 and 2008 inventories, with stable or decreasing volumes for some species groups, but increasing volumes for others species groups, e.g., other red oaks and hickory (Fig. 53).

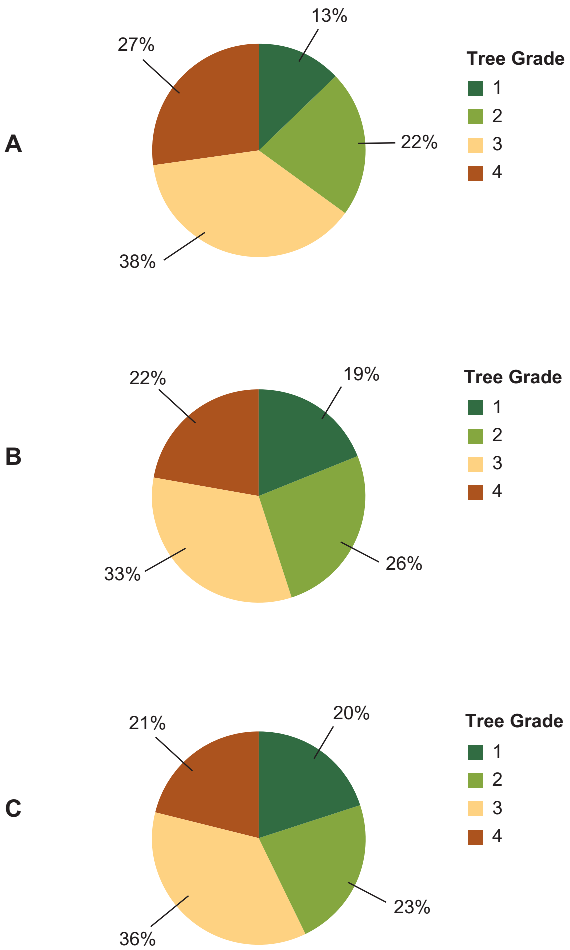


Figure 52.—Distribution of sawtimber volume on timberland by tree grade (percent), Iowa, 1990 (A); 2003 (B); and 2008 (C).

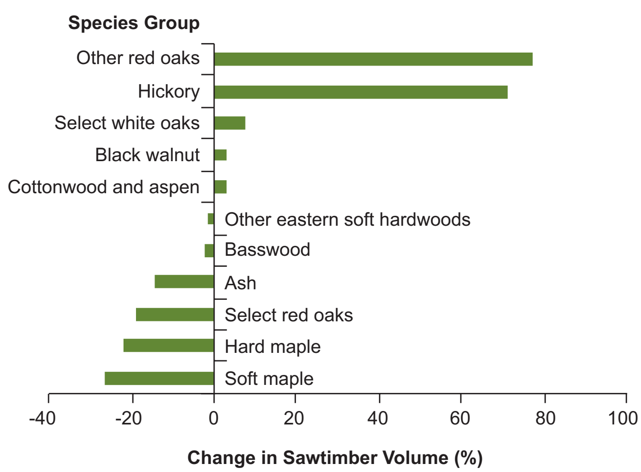


Figure 53.—Percent change in high grade sawtimber volume (grades 1 and 2) for selected hardwood species groups on timberland in Iowa between 2003 and 2008.

What this means

Iowa's sawtimber quality has been increasing for decades, with substantial increases in the amount of higher grade sawtimber. In recent inventories, changes in sawtimber grades have varied among species groups, with gains likely due to individual tree growth increasing the sawtimber volume and tree grades. Overall, it appears that the quality of Iowa's sawtimber resource has increased from past decades and is currently stable.

Carbon stocks

Background

Collectively, forest ecosystems represent the largest terrestrial carbon sink on earth. The accumulation of carbon in forests (known as sequestration) helps to mitigate emissions of carbon dioxide to the atmosphere from sources such as forest fires and burning of fossil fuels. The FIA program does not directly measure forest carbon stocks in Iowa. Instead, a combination of empirically derived carbon estimates (e.g., standing live trees) and models (e.g., soil organic carbon based on stand age and forest type) are used to estimate Iowa's forest carbon stocks. Estimation procedures are detailed by Smith et al. (2006). Understory above- and belowground estimates include the carbon mass (tons per acre) of seedlings, shrubs, and bushes.

What we found

Carbon stocks have increased substantially in Iowa over the last several years from 152 million tons in 2003 to more than 170 million tons in 2008. Soil organic matter (SOM) represents the largest forest ecosystem carbon stock in the state at almost 76 million tons, followed by live tree and sapling carbon at 68 million tons (Fig. 54). Within the live tree and sapling pool, merchantable boles contain the bulk of the carbon (41 million tons) followed by roots (11 million tons) and tops and limbs (10 million tons). The majority of Iowa's forest carbon stocks are found in relatively young stands aged 41-60 years (Fig. 55). Early in stand development, the majority of forest ecosystem carbon is in the SOM and belowground tree components. As forest stands mature, the ratio of above- to belowground carbon shifts and by age 61-80 years the aboveground components represent the majority of ecosystem carbon. This trend continues well into stand development as carbon accumulates in live and dead aboveground components. A look at carbon by forest-type group on a per-unit-area basis found that the elm/ash/cottonwood group contains the most carbon per acre of the types represented in Iowa (Fig. 56). Not surprisingly, the majority of carbon in each forest-type group was in the SOM followed by carbon in live biomass.

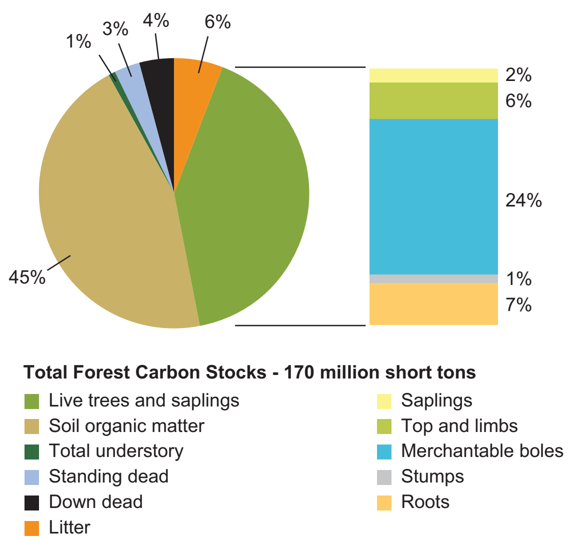


Figure 54.—Estimated total carbon (C) stocks on forest land by forest ecosystem component, Iowa, 2008.

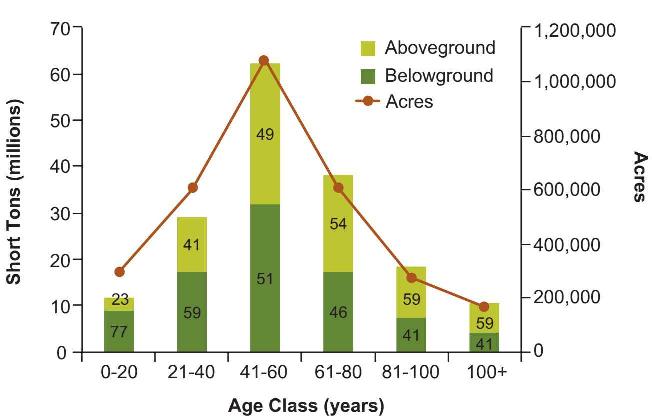


Figure 55.—Estimated percentage of above- and belowground carbon (C) stocks by stand-age class, Iowa, 2008.

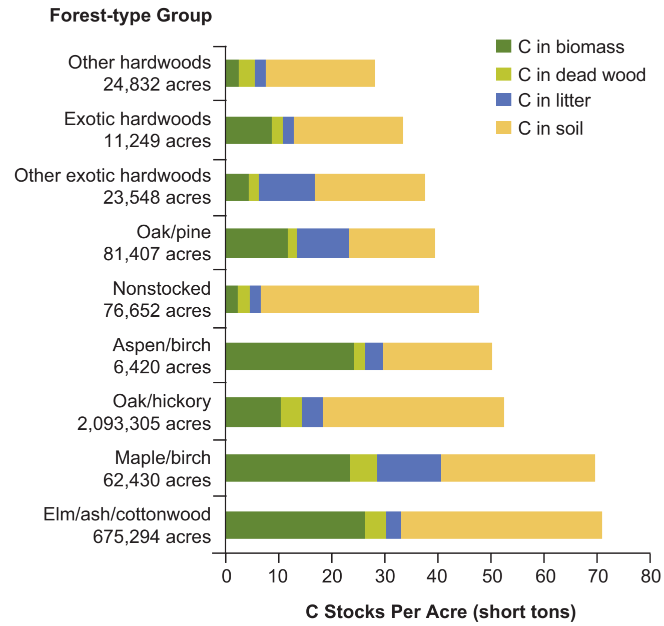


Figure 56.—Estimated carbon (C) stocks on forest land by forest-type group and carbon pool per acre, Iowa, Estimated above- and belowground carbon stocks by stand age class, Iowa, 2008.

What this means

Carbon stocks in Iowa's forests have increased substantially over the last several decades. The majority of forest carbon in the State is found in relatively young stands dominated by moderately long-lived species. This suggests that Iowa's forest carbon will continue to increase as stands mature and accumulate carbon in above- and belowground components. Given the age-class structure and species composition of forests in Iowa, there are many opportunities to increase forest carbon stocks. That said, managing for carbon in combination with other land management objectives will require careful planning and creative silviculture beyond simply managing to maximize growth and yield.

Timber Products Output

Background

The harvesting and processing of timber products produces a stream of income shared by timber owners, managers, marketers, loggers, truckers, and processors. In 2007, the wood products and paper manufacturing industries in Iowa employed 15,833 people, with an average annual payroll of $648 million (U.S. Census Bureau 2007). To better manage the State's forests, it is important to know the species, amounts, and locations of timber being harvested.

What we found

Surveys of Iowa's wood-processing mills are conducted periodically to estimate the amount of wood volume that is processed into products. This is supplemented with the most recent surveys conducted in surrounding states that processed wood harvested from Iowa. In 2005, 27 active primary wood processing mills were surveyed to determine the species that were processed and where the wood material came from (Haugen and Michel 2010). These mills processed 118.5 million board feet of saw logs, veneer logs, and cooperage.

In 2005, 16.1 million cubic feet of industrial roundwood was harvested from Iowa's forest land. Saw logs accounted more than 90 percent of the total industrial roundwood harvested (Fig. 57). Other products harvested were veneer logs, cooperage, and industrial fuelwood. White and red oaks accounted for almost 40 percent of the total industrial roundwood harvest (Fig. 58). Other important species groups harvested were maples, black walnut, and cottonwood.

In the process of harvesting industrial roundwood, 11.5 million cubic feet of harvest residues were left on the ground (Fig. 59). Seventy percent of the logging residue came from nongrowing-stock sources such as crooked or rotten trees, nonforest trees, tops and limbs, and dead trees. The processing of industrial roundwood in the State's primary wood-using mills generated another

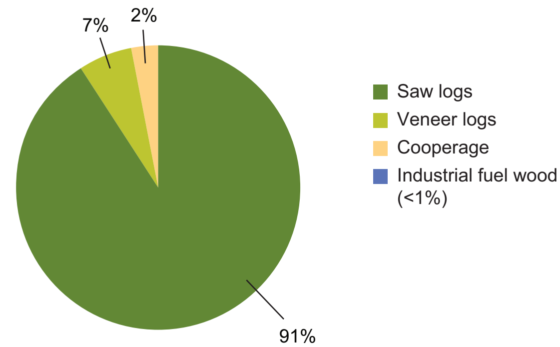


Figure 57.—Industrial roundwood and fuelwood production by product and softwoods and hardwood, Iowa, 2005.

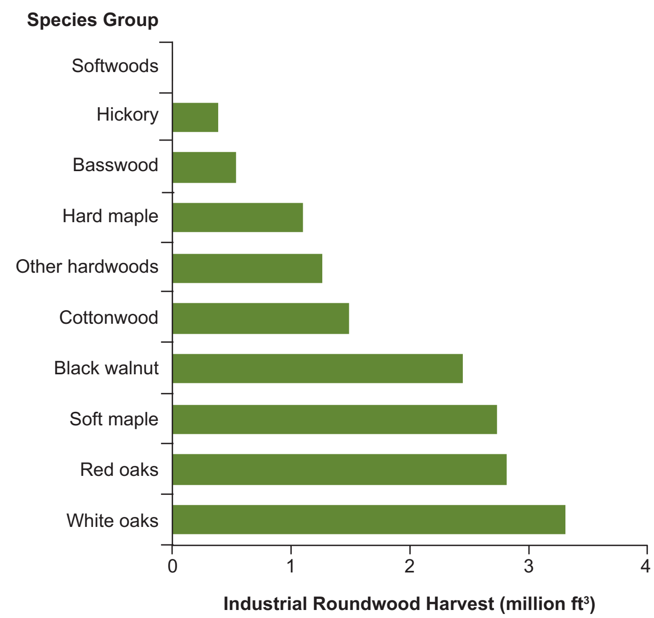


Figure 58.—Industrial roundwood harvested by species group, Iowa, 2005.

301,000 dry tons of wood and bark residues. More than 80 percent of the mill residues generated were used for miscellaneous products such as mulch or animal bedding. Another 15 percent of the mill residues were used for industrial and residential fuelwood. Less than 1 percent of the mill residues were not used for other products (Fig. 60).

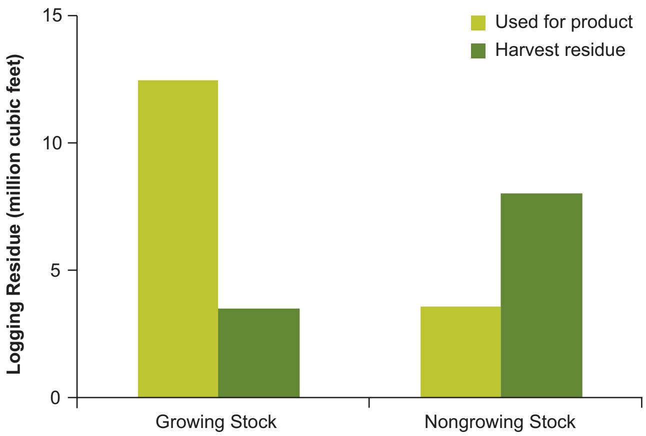


Figure 59.—Harvest residue generated by industrial roundwood harvesting by growing stock and nongrowing stock, and used for product and harvest residue, Iowa, 2005.

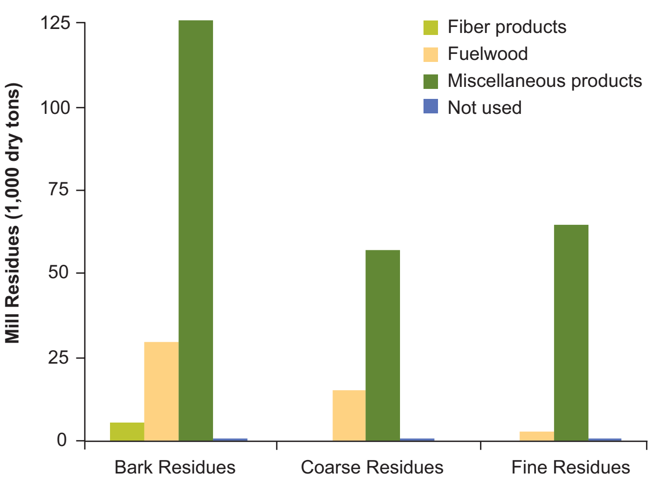


Figure 60.—Disposition of mill residues generated by primary wood-using mills, Iowa, 2005.

What this means

The demand for wood products is likely to increase, placing a greater demand on the resource. An important consideration for the future of the primary wood-products industry is its ability to retain industrial roundwood processing facilities. The number of wood-processing mills has been steadily declining. The loss of processing facilities makes it harder for landowners to find markets for the timber harvested from management activities on their forest land.

Another important issue is the volume of harvest residues that are generated in the State that go unused. More than 30 percent of the harvest residue is from growing-stock sources (wood material that could be used to produce products). Iowa's primary forest products industry is the processing of saw logs. This leaves a large volume of usable, small dimension wood material above the saw log top. Industrial fuelwood or pulpwood markets could lead to better utilization of merchantable trees. The use of logging slash for industrial fuelwood at cogeneration facilities and pellet mills could also result in better utilization of the forest resource.

Data Sources and Techniques

Loess Hills, western Iowa. Photograph courtesy of Lisa Schulte-Moore, Iowa State University.

Forest Inventory

Information on the condition and status of forests in Iowa was obtained from the Northern Research Station's Forest Inventory and Analysis (NRS-FIA) program. Previous inventories of Iowa's forest resources were completed in 1954 (Thornton and Morgan 1959), 1974 (Spencer and Jakes 1980), 1990 (Leatherberry et al. 1992), and 2003 (Leatherberry et al. 2006). Data from Iowa's forest inventories can be accessed electronically on the DVD included with this report, or at: http://www.nrs.fs.fed.us/fia/. For detailed information on inventory methods, see section "Statistics, Methods, and Quality Assurance" on the DVD.

National Woodland Owner Survey

Information about family forest owners is collected through the U.S. Forest Service's National Woodland Owner Survey (NWOS). The NWOS was designed to increase our understanding of owner demographics and motivation. Individuals and private groups identified as woodland owners by FIA are invited to participate in the NWOS. Data presented here are based on survey responses from randomly selected families and individuals who own forest land in Iowa. For additional information about the NWOS, visit: www.fia.fs.fed.us/nwos.

Timber Product Output Inventory

This study was a cooperative effort of the Division of Forestry of the Iowa Department of Natural Resources and the U.S. Forest Service's Northern Research Station (NRS). Using a questionnaire designed to determine the size and composition of Iowa's forest products industry, its use of roundwood (round sections cut from trees), and its generation and disposition of wood residues, Iowa Division of Forestry personnel visited all "known" primary wood-using mills within the state. Completed questionnaires were sent to NRS for processing and analyses. As part of data processing and analyses, all industrial roundwood volumes reported on the questionnaires were converted to standard units of measure using regional conversion factors. Timber removals by source of material and harvest residues generated during logging were estimated from standard product volumes using factors developed from logging utilization studies previously conducted by NRS.

Literature Cited

Bechtold, W.A.; Patterson, P.L., eds. 2005. **The enhanced forest inventory and analysis program: national sampling design and estimation procedures.** Gen. Tech. Rep. SRS-80. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 85 p.

Bechtold, W.A.; Scott, C.T. 2005. **The Forest Inventory and Analysis plot design.** In: Bechtold, W.A.; Patterson, P.L., eds. The enhanced Forest Inventory and Analysis Program – national sampling design and estimation procedures. Gen. Tech. Rep. SRS-80. Asheville, NC: U.S. Department of Agriculture Forest Service: 27-42.

Blackard, J.A.; Finco, M.V.; Helmer, E.H.; Holden, G.R.; Hoppus, M.L.; Jacobs, D.M.; Lister, A.J.; Moisen, G.G.; Nelson, M.D.; Riemann, R.; Ruefenacht, B.; Salajanu, D.; Weyermann, D.L.; Winterberger, K.C.; Brandeis, T.J.; Czaplewski, R.L.; McRoberts, R.E.; Patterson, P.L.; Tymcio, R.P. 2008. **Mapping U.S. forest biomass using nationwide forest inventory data and moderate resolution information.** Remote Sensing of Environment. 112(4): 1658-1677.

Butler, B.J. 2008. **Family forest owners of the United States, 2006.** Gen. Tech. Rep. NRS-27. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 72 p.

Collinge, S.K. 1996. **Ecological consequences of habitat fragmentation: implications for landscape architecture and planning.** Landscape and Urban Planning. 36: 59-77.

Conservation Biology Institute. n.d. Protected areas database. Corvallis, OR: Conservation Biology Institute. Available at: http://databasin.org/protected-center. (Accessed 18 August 2011).

DellaSala, D.A.; Staus, N.L.; Strittholt, J.R.; Hackman, A.; Iacobelli, A. 2001. **An updated protected areas database for the United States and Canada.** Natural Areas Journal. 21(2): 124-135.

Fan, Z.; Shifley, S.R.; Spetich, M.A.; Thompson, F.R., III.; Larsen, D.R. 2003. **Distribution of cavity trees in midwestern old-growth and second-growth forests.** Canadian Journal of Forest Research. 33: 1481-1494.

Griffith, G.E.; Omernik, J.M.; McGinley, M. 2008. **Ecoregions of the United States-Level III (EPA).** In: Cleveland, C. J., ed. Washington, DC: Environmental Information Coalition, National Council for Science and the Environment. Available at: www.eoearth.org/article/Ecoregions_of_the_United_States-Level_III_(EPA). (Accessed 22 Feb. 2011).

Hahn, J.T. 1984. **Tree volume and biomass equations for the Lake States.** Res. Pap. NC-250. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 10 p.

Haugen, D.E.; Michel, D.D. 2010. **Iowa timber industry—an assessment of timber product output and use, 2005.** Resour. Bull. NRS-38. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 62 p.

Homer, C.; Dewitz, J.; Fry, J.; Coan, M.; Hossain, N.; Larson, C.; Herold, N.; McKerrow, A.; VanDriel, J.N.; Wickham, J. 2007. **Completion of the 2001 national land cover database for the conterminous United States.** Photogrammetric Engineering & Remote Sensing. 73(4): 337-341.

Huang, C.; Yang, L.; Wylie, B.; Homer, C. 2001. **A strategy for estimating tree canopy density using Landsat 7 ETM+ and high resolution images over large areas.** In: Third international conference on geospatial information in agriculture and forestry; 2011 November 5-7; Denver, Colorado. Ann Arbor, MI: ERIM Interational, Inc. [CD-ROM].

Hunter, W.C.; Buehler, D.A.; Canterbury, R.A.; Confer, J.L.; Hamel, P.B. 2001. **Conservation of disturbance-dependent birds in eastern North America.** Wildlife Society Bulletin. 29(2): 440-455.

Iowa Department of Natural Resources. n.d. **Iowa wildife action plan.** Des Moines, IA: Iowa Department of Natural Resources. Available at: www.iowadnr.gov/contact.html. (Accessed 21 March 2011).

Iowa Department of Natural Resources. n.d. G**eological and water survey. Iowa City, IA: Iowa Department of Natural Resources.** Available at: www.igsb.uiowa.edu. (Accessed 21 March 2011).

Leatherberry, E.C.; Moser, W.K.; Perry, C.; Woodall, C.; Jepsen, E.; Pennington, S.; Flickinger, A. 2006. **Iowa's forests 1999-2003 (Part A).** Resour. Bull. NC-266A. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station. 84 p.

Leatherberry, E.C.; Roussopoulos, S.M.; Spencer, J.S., Jr. 1992. **An analysis of Iowa's forest resources, 1990.** Resour. Bull. NC-142. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 67.

McRoberts, R.E. 1999. **Joint annual forest inventory and monitoring system, the North Central perspective.** Journal of Forestry. 97(12): 27-31.

McRoberts, R.E. 2005. **The enhanced Forest Inventory and Analysis Program**. In: Bechtold, W.A.; Patterson P.L., eds. The enhanced Forest Inventory and Analysis Program – national sampling design and estimation procedures. Gen. Tech. Rep. SRS-80. Asheville, NC: U.S. Department of Agriculture Forest Service: 1-10.

Miles, P.D.; Smith, W.B. 2009. **Specific gravity and other properties of wood and bark for 156 tree species found in North America.** Res. Pap. NRS-38. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 35 p.

Montreal Process. 1999. **Criteria and indicators for the conservation and sustainable management of temperate and boreal forests: the Montreal process.** 2nd ed. Ottawa, Canada: Natural Resources Canada, Canadian Forest Service. 19 p.

Nelson, M.D.; Liknes, G.C.; Butler, B.J. 2010. **Forest ownership in the conterminous United States: ForestOwn_v1 geospatial dataset.** Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. Available at: http://www.fs.usda.gov/rds/archive/data/open/RDS-2010-0002/RDS-2010-0002.aspx

Raeker, Gus; Moser, W. Keith; Butler, Brett J.; Fleming, John; Gormanson, Dale D.; Hansen, Mark H.; Kurtz, Cassandra M.; Miles, Patrick D.; Morris, Mike; Treiman, Thomas B. In press. **Missouri's Forests 2008.** Resour. Bull. NRS. Newtown Square, PA; U.S. Department of Agriculture, Forest Service, Northern Research Station.

Riemann, R.; Lister, T.; Lister, A.; Meneguzzo, D.; Parks, S. 2008. **Development of issue-relevant state level analyses of fragmentation and urbanization.** In: 2008 Forest Inventory and Analysis (FIA) symposium; 2008 October 21-23; Park City, UT. Gen. Tech. Rep. RMRS-P-56CD. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 1-24. [CD-ROM].

Schomaker, M.E.; Zarnoch, S.J.; Bechtold, W.A.; Latelle, D.J.; Burkman, W.G.; Cox, S.M. 2007. **Crown-condition classification: a guide to data collection and analysis.** Gen. Tech. Rep. SRS-102. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 78 p.

Smith, W.B. 1991. **Assessing removals for North Central forest inventories.** Res. Pap. NC-299. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 48 p.

Spencer, J.S., Jr.; Jakes, P.J. 1980. **Iowa's forest resources, 1974.** Resour. Bull. NC-52. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 90 p.

Thornton, P.L.; Morgan, J.T. 1959. **The forest resources of Iowa.** Forest Survey Release 22. Columbus, OH: U.S. Department of Agriculture, Forest Service, Central States Forest Experiment Station. 46 p.

U. S. Census Bureau. 2007. **2007 Economic census.** Washington, DC: U.S. Census Bureau. Available at: http://www.census.gov/econ/census07/. (Accessed 3 November 2010).

USDA Forest Service. 2005. **Forest inventory and analysis field methods for phase 3 measurements, Ver. 3.0.** Washington, DC: U.S. Department of Agriculture, Forest Service. Available at: http://fia.fs.fed.us/library/field-guides-methods-proc/docs/. (Accessed 28 October 2010).

USDA Natural Resources Conservation Service (NRCS). 2011. **The PLANTS database.** Baton Rouge, LA: U.S. Department of Agriculture, Natural Resources Conservation Service, National Plant Data Center. Available at: http://www.plants.usda.gov. (Accessed 22 March 2011).

Woodall, C.W.; Monleon, V.J. 2008. **Sampling protocols, estimation procedures, and analytical guidelines for down woody materials indicator of the Forest Inventory and Analysis Program.** Gen. Tech. Rep. NRS-22. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 68 p.

DVD Contents

Iowa's Forests 2008 (PDF)

Iowa's Forests 2008: Statistics, Methods, and Quality Assurance (PDF)

Iowa's Inventory Database (CSV file)

Iowa's Inventory Database (Microsoft Access file)

Field guides that describe inventory procedures (PDF)

Database User Guides (PDF)

Nelson, Mark D.; Brewer, Matt; Woodall, Christopher W.; Perry, Charles H.; Domke, Grant M.; Piva, Ronald J.; Kurtz, Cassandra M.; Moser, W. Keith; Lister, Tonya W.; Butler, Brett J.; Meneguzzo, Dacia, M.; Miles, Patrick D.; Barnett, Charles J.; Gormanson, Dale. 2011. **Iowa's Forests 2008.** Resour. Bull. NRS-52. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 48 p. [DVD included].

The second full annual inventory of Iowa's forests (2004-2008) reports more than 3 million acres of forest land, almost all of which is timberland (98 percent), with an average volume of more than 1,000 cubic feet of growing stock per acre. American elm and eastern hophornbeam are the most numerous tree species, but silver maple and bur oak predominate in terms of live tree volume. Iowa's forest land is comprised of 65 percent sawtimber, 19 percent poletimber, and 16 percent sapling/seedling or nonstocked size classes. Average annual net growth of growing-stock trees on Iowa's timberland increased during the past decade to the current estimate of nearly 105 million cubic feet. This report includes additional information on forest attributes, land use change, carbon, timber products, and forest health. A DVD included in this report includes 1) descriptive information on methods, statistics, and quality assurance of data collection, 2) a glossary of terms, 3) tables that summarize quality assurance, 4) a core set of tabular estimates for a variety of forest resources, and 5) a Microsoft Access database that represents an archive of data used in this report, with tools that allow users to produce customized estimates.

KEY WORDS: inventory, forest statistics, forest health, FIA

http://www.nrs.fs.fed.us