



Forest Service
U.S. DEPARTMENT OF AGRICULTURE

Northern Research Station | Resource Bulletin NRS-128 | December 2022

Iowa Forests 2018: Summary Report



Citation

Goff, Thomas C.; Albright, Thomas A.; Butler, Brett J.; Crocker, Susan J.; Gormanson, Dale D.; Kurtz, Cassandra M.; Lister, Tonya W.; Meneguzzo, Dacia M.; Morin, Randall S.; Nelson, Mark D.; Piva, Ronald J.; Riemann, Rachel; Schanning, Sjana; Walters, Brian F.; Westfall, James A.; Woodall, Christopher W. 2022. **Iowa forests 2018: summary report**. Resour. Bull. NRS-128. Madison, WI: U.S. Department of Agriculture, Forest Service, Northern Research Station. 17 p. [plus interactive report]. <https://doi.org/10.2737/NRS-RB-128>.

Abstract

This summary report provides an overview of findings from the fourth annualized inventory of Iowa forests based on data collected from 2012 to 2018. Forest land area remained stable at 2.9 million acres, and 69 percent of forest land is in the oak/hickory forest-type group. Forests in the State continue to mature, with 72 percent in large diameter stands and 50 percent in stands older than 60 years of age. Total live-tree net volume on timberland is 4.4 billion cubic feet, and 69 percent of that volume is in growing-stock trees. Decreases in gross growth (7 percent) and mortality (2 percent) between 2012 and 2018 resulted in a 14 percent decrease in annual net growth of growing-stock trees to 61 million cubic feet. Additional information on land use change, fragmentation of forest land, ownership, urban forests, species composition, stand structure, forest carbon, down woody material, regeneration, invasive plants, forest pests, tree health, and timber products output are also presented. A detailed interactive report is available at <https://doi.org/10.2737/NRS-RB-128-INT>, and supplemental information, including (1) tables summarizing quality assurance, (2) a core set of tabular estimates for a variety of forest resources, and (3) user and database guides for P2 and P2+ protocols, can be accessed at <https://doi.org/10.2737/NRS-RB-128>.

KEY WORDS: inventory, land use, fragmentation, forest land, timberland, forest ownership, urban forests, volume, growth, removals, mortality, carbon, forest regeneration, invasive plants, forest health, forest products

Acknowledgments

The authors would like to thank all who contributed to this report. The dedicated field staff who collected the data on which this report is based are Todd Bixby, Tyler Camfield, Brian Clennon, Brian Gasper, Glenda Hefty, Dan Huberty, Dan Kaisershot, Dominic Lewer, Mike Maki, Grant Nielsen, Benjamin Nurre, Sjana Schanning, and Brad Totten. Additional thanks to the Northern Research Station's Forest Inventory and Analysis staff for their support, especially Chuck Barnett, Dale Gormanson, Mark Hatfield, Todd Roffe, Paul Sowers, and Jeff Wazenegger. We are also grateful for the insight of our reviewers, Tivon Feely (Iowa Department of Natural Resources) and Dacia Meneguzzo (USDA Forest Service).

Cover photo: Loess Hills State Forest. Photo by Iowa Department of Natural Resources, used with permission.

Manuscript received for publication March 2021

Published by:
USDA Forest Service
One Gifford Pinchot Drive
Madison, WI 53726
December 2022

Visit our homepage at: <https://www.nrs.fs.usda.gov>

Iowa Forests 2018: Summary Report

Thomas C. Goff, Thomas A. Albright, Brett J. Butler, Susan J. Crocker, Dale D. Gormanson, Cassandra M. Kurtz, Tonya W. Lister, Dacia M. Meneguzzo, Randall S. Morin, Mark D. Nelson, Ronald J. Piva, Rachel Riemann, Sjana Schanning, Brian F. Walters, James A. Westfall, Christopher W. Woodall

Contact Author:

Thomas C. Goff

thomas.c.goff@usda.gov

573-845-5341

About the Authors

Thomas C. Goff is a forester with the Forest Inventory and Analysis (FIA) program, Northern Research Station, Columbia, MO.

Thomas A. Albright is a forester with the FIA program, Northern Research Station, Williamsport, PA.

Brett J. Butler is a research forester with the FIA program, Northern Research Station, Amherst, MA.

Susan J. Crocker, Dacia M. Meneguzzo, and Mark D. Nelson are research foresters with the FIA program, Northern Research Station, St. Paul, MN.

Dale D. Gormanson is a retired forester with the FIA program, Northern Research Station, St. Paul, MN.

Cassandra M. Kurtz, Ronald J. Piva, and Brian F. Walters are foresters with the FIA program, Northern Research Station, St. Paul, MN.

Tonya W. Lister, Randall S. Morin, and James A. Westfall are research foresters with the FIA program, Northern Research Station, York, PA.

Rachel Riemann is a research forester and geographer with the FIA program, Northern Research Station, Durham, NH.

Sjana Schanning is an ecologist with the FIA program, Northern Research Station, Hayward, WI.

Christopher W. Woodall is a research forester with the FIA program, Northern Research Station, Durham, NH.

Foreword

This report highlights the current status, ongoing trends, and future direction of Iowa forests during 2012–2018. The Iowa forest inventory is conducted as a cooperative program between the Iowa Department of Natural Resources and the Forest Inventory and Analysis program of the U.S. Department of Agriculture, Forest Service. Previous inventories of Iowa forests were conducted in 1954, 1974, 1990, 1999–2003, 2004–2008, and 2009–2013.

Results from this inventory show Iowa forests continue to grow more wood than is being harvested, providing an essential element to our State's economy, the wood industry, and individual woodland owners. Iowa forests also continue to provide fine-quality hardwood products, habitat for wildlife, clean water and air, protection of soil from erosion, and additional ecosystem services.

Iowa's total forest land area is relatively stable at 2.91 million acres, with increasing volume as trees become larger and net growth exceeds removals. There are also causes for serious concern about Iowa forests, including the increasing presence of nonnative invasive woodland plant species, the increasing impact of insect and disease pests such as emerald ash borer and bur oak blight, and the loss of young oak and early successional forest stands from the Iowa landscape.

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.

Tivon Feeley

Forest Health Program Leader

Iowa Department of Natural Resources

Contents

Highlights 1

An Overview of Forest Inventory 2

Forest Features 4

Forests and People 6

Forest Attributes 7

Volume Trends..... 11

Forest Sustainability..... 14

Regeneration 14

Literature Cited 16

Interactive Report Online at <https://doi.org/10.2737/NRS-RB-128-INT>

Iowa Forests Summary Tables Online at <https://doi.org/10.2737/NRS-RB-128>

Additional Resources Online at <https://doi.org/10.2737/NRS-RB-128>



Forest giving way to cropland. Photo by Iowa Department of Natural Resources, used with permission.

Highlights

On the Plus Side

- Forest land and timberland have remained relatively stable since 2013 with estimated areas of 2.91 million acres and 2.77 million acres, respectively.
- Trees outside forests, an important ecological and economic resource, contribute almost 1 million acres of additional tree-covered land across the State.
- Sound volume on forest land increased to 5 billion cubic feet, indicating a gain of 4 percent since 2013; sound volume on timberland accounted for 94 percent (4.7 billion cubic feet) of total sound volume, an increase of 3 percent over the same time period.
- The incidence of poor crown condition was observed on less than 5 percent of trees for most species across the State. Tree damage was recorded on 28 percent of trees, similar to neighboring Illinois (27 percent) and Minnesota (26 percent).
- Black walnut, the State's most valuable species, increased 7 percent in sawtimber volume from 2013 to 2018 and over half of that volume qualified for high-quality (grade 1 and grade 2) tree grades.
- The statewide net growth-to-removals ratio for growing stock on timberland is 2.4:1, indicating that net growth volume was more than two times the removal volume.
- Total forest ecosystem carbon stocks in Iowa are an estimated 241 million tons, which has remained relatively unchanged since 2013; carbon density is an estimated 83 tons per acre of forest land.

Issues to Watch

- Forest stand-age distribution continues to shift, with decreasing area in younger forests (less than 60 years), and increasing area in forests over 60 years of age.
- Growing-stock volume on timberland was 69 percent of total net volume in 2018 and that proportion has decreased steadily since 2003.
- The top three species in the State by net volume on timberland (bur oak, silver maple, and white oak) had ratios of growth to harvest removals near or below 1:1.
- Invasive plant species were observed on 92 percent of monitored plots in 2018, a higher percentage than neighboring Illinois, Missouri, and Minnesota.
- Driven by a decrease in gross growth (7 percent) and an increase in mortality (2 percent), annual net growth of growing-stock trees on timberland decreased 14 percent from 2013 to 2018.
- A majority of forest land (85 percent) in the State is privately owned, yet only 15 percent of private landowners with 10 or more acres of forest land received advice on forest management or had a written management plan.
- Most of the change in forest area in Iowa is to and from agriculture and pasture/rangeland, with largely offsetting effects; future policies and economic conditions may alter the net effects of these land use changes.

- Statewide, ash species had a ratio of mortality to gross growth of 0.52 in 2018 and average annual mortality as a percentage of total volume was 2.2 percent. Ash mortality is expected to increase as emerald ash borer persists and populations spread.
- The ratio of mortality to gross growth for bur oak increased from 0.35 in 2013 to 0.94 in 2018; this rise is due to an increase in mortality of large diameter trees. Many of Iowa's bur oaks occur on upland sites, increasing their risk for bur oak blight. As bur oak trees continue to mature, their mortality as a result of this pathogen is likely to increase.

An Overview of Forest Inventory

What is this Report?

This report summarizes findings of the 2018 survey of Iowa forest resources. Data for this survey were collected from 2012 through 2018 and are referred to as the 2018 inventory throughout this report. The inventory was conducted by the U.S. Department of Agriculture's Forest Service, Forest Inventory and Analysis program in cooperation with the Iowa Department of Natural Resources. More-detailed results and additional resource materials are provided in an interactive digital StoryMap collection available online at <https://doi.org/10.2737/NRS-RB-128-INT>. Supplemental information, including (1) tables summarizing quality assurance, (2) a core set of tabular estimates for a variety of forest resources, and (3) user and database guides for P2 and P2+ protocols, can be accessed at <https://doi.org/10.2737/NRS-RB-128>.

The results presented in the interactive StoryMap collection are divided into sections that focus on different forest aspects, such as carbon, sustainability, health, and timber trends (Fig. 1). Graphics, including interactive maps, charts, and dashboards, summarize data and illustrate trends that make it easy for readers to compare between inventory periods, geographic locations, or ecological divisions. This document offers a short summary of select results.

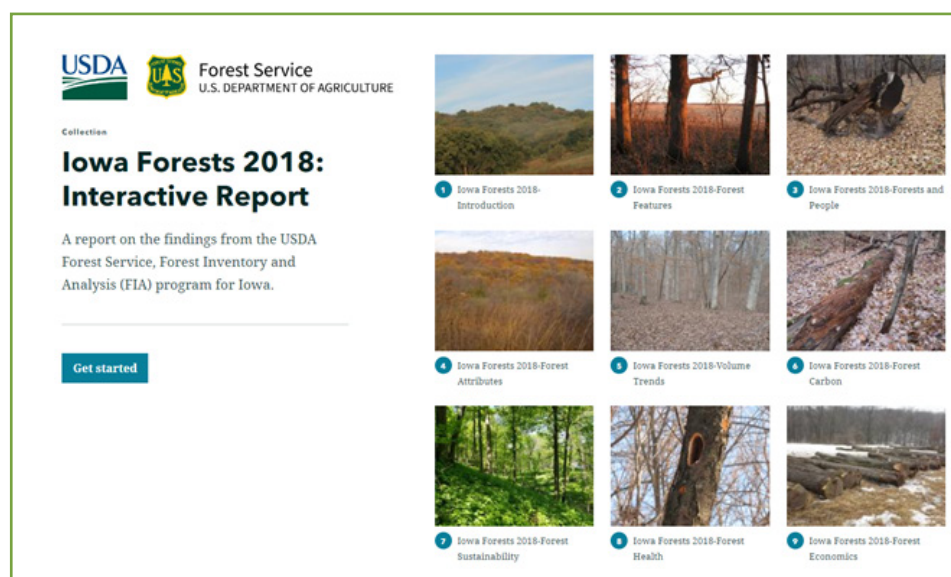


Figure 1.—The Iowa Forests 2018 StoryMap collection contains a series of StoryMaps that focus on different forest aspects. Click on “Get started” to enter the collection or click on one of the photos to view an individual StoryMap within the collection.

What is FIA?

The USDA Forest Service's Forest Inventory and Analysis (FIA) program is often referred to as the Nation's forest census. FIA is a national program that conducts and maintains a comprehensive inventory of forest resources in the United States and its territories. For more-detailed information on key definitions, data collection methods, and estimation procedures, see "Statistics and Quality Assurance for the Northern Research Station Forest Inventory and Analysis Program" (Gormanson et al. 2018) and supplemental resources available online at <https://doi.org/10.2737/NRS-RB-128>.

Iowa Forest Inventories

FIA has been conducting inventories of Iowa forest resources since 1954. Prior to 1999, inventories were conducted periodically, or approximately once every 10 to 20 years. Periodic inventories were completed in 1954 (Central States Forest Experiment Station 1956), 1974 (Spencer and Jakes 1980), and 1990 (Leatherberry et al. 1992). In 1999 an annual inventory system was implemented, wherein a percentage of plots were measured each year and an entire inventory cycle completed every 5 years. Previous annual inventories were completed in 2003 (Leatherberry et al. 2006), 2008 (Nelson et al. 2011), and 2013 (Nelson et al. 2016). In 2014 FIA went from a 5-year cycle completing 20 percent of the plots annually to a 7-year cycle completing 14 percent of the plots annually. FIA maintains a 5-year reporting period and each report covers a full data cycle. This creates a yearly moving window of 5-year cycles, composed of plots from up to 7 years, which are identified by the last year in a given full cycle. For this report, plots measured from 2012 through 2018 are collectively referred to as the 2018 inventory.

For the 2018 inventory, 6,067 plots in Iowa were selected for measurement. From that selection, 623 contained forest land, 5,373 were nonforest, and 71 were not sampled due to various reasons preventing access. Current estimates of forest area, composition, volume, and other statistics are based on 5,996 sampled plots. Estimates of change (e.g., forest area change, growth, mortality, and removals) are based on 5,971 plots that were measured during both the 2018 cycle and the previous cycle, which ended in 2013.

Forest Features

Area and Land Use

Iowa forests provide many benefits, including a wide range of forest products, recreational opportunities, wildlife habitat, watershed protection, and carbon sequestration. Accurate estimates of forest land area are critical for monitoring trends in the health, quantity, and quality of Iowa forests.

The FIA program defines land use by several categories. Tracking changes in land use is important for analyzing factors affecting forest loss (diversion) and forest gain (reversion). To accomplish this, land use is compared on plots remeasured on two separate occasions. This report is based on plots measured during 2012–2018 and previously measured during 2009–2013 (and earlier), hereafter referred to as 2018 and 2013 inventories.

The first forest inventory of Iowa in 1954 estimated 2.35 million acres of forest land. Forest land reached an all-time low of 1.56 million acres in 1974, increased to a peak of 3.03 million acres in 2008, and has declined slightly since then (Fig. 2). The current estimate of 2.91 million acres in 2018 is a 1.8 percent decrease from the 2013 estimate of 2.97 million acres. Timberland, which accounts for 95 percent of forest land in the State, also decreased in area by 1.8 percent between 2013 and 2018.

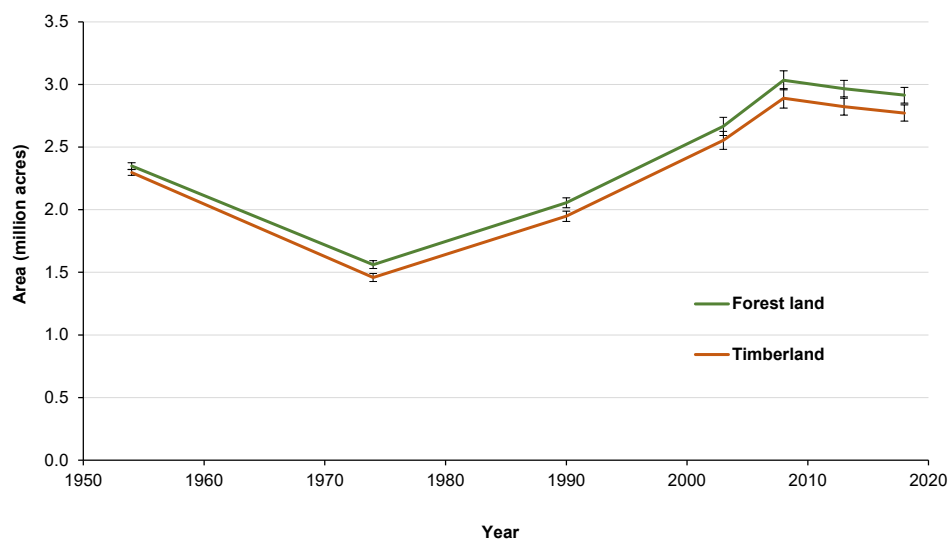


Figure 2.—Forest land and timberland area by inventory year, Iowa. Error bars represent a 68 percent confidence interval.

Forest diversions slightly outpaced forest reversions during this period (Fig. 3). Trends in forest land area resulting from land use change can be more closely examined by limiting the comparison to only plots that were measured at both times (2013 and 2018 inventories). Most of the land in Iowa remained either nonforest (91.5 percent) or forest (7.7 percent), with the remaining land diverting from (0.5 percent loss) or reverting to (0.3 percent gain) forest land (Fig. 3).

Most of the forest change in Iowa has been to and from agriculture and pasture/rangeland, which are the most prevalent land uses in the State. Agricultural land use combined with pasture/rangeland accounted for 74 percent of forest loss, and 72 percent of forest gain. Developed land use and water accounted for 10 and 12 percent of forest losses, and 16 and 7 percent of forest gains, respectively, with other land uses contributing less area to forest change.

After increasing for several decades, Iowa forest land area has since leveled off and although recent decreases are within the margin of error they suggest a declining trend. A similar pattern is observed for timberland. Commodity prices, landowner objectives, and land values all drive land use change and therefore affect forest land directly and indirectly. For now, it appears that forest loss and gain, to and from agriculture and pasture/rangeland, continue to largely offset each other.

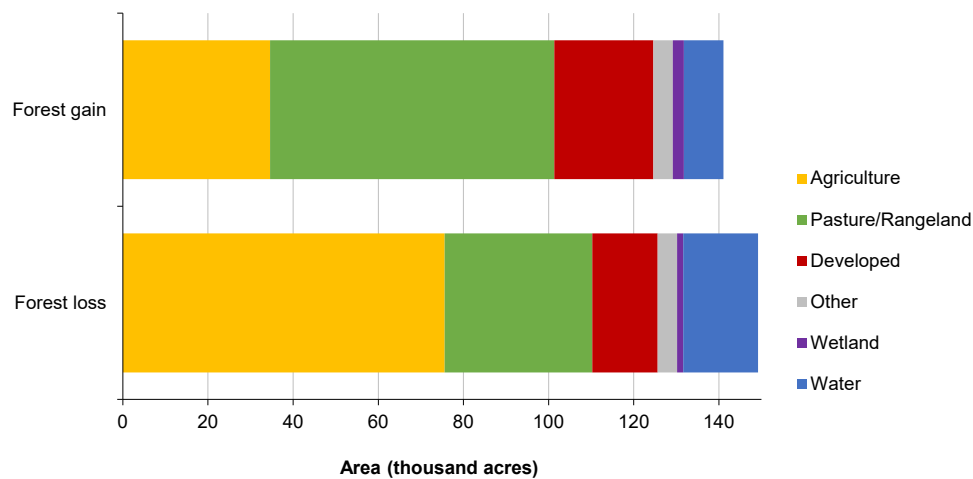


Figure 3.— Forest area loss and gain, by land use category, Iowa, 2013 to 2018.

Forests and People

Forest Ownership

To a large extent, landowners determine the quantity and quality of forest resources, including recreational opportunities, timber supply, and wildlife habitat. By understanding the priorities of forest landowners, the forest conservation community can better help owners meet their needs, and in so doing, help conserve the State's forests for future generations. FIA's National Woodland Owner Survey (NWOS) studies private forest owners' attitudes, management objectives, and concerns with a focus on the families, individuals, and other unincorporated groups collectively referred to as "family forest ownerships." The NWOS results reported here are from studies completed in 2006 (Butler 2008), 2013 (Butler et al. 2016), and 2018 (Butler et al. 2020).

Eighty-five percent of Iowa forest land is privately owned (Fig. 4). The vast majority of these private acres, an estimated 2.3 million acres, are family forests. Corporations own an estimated 160,000 acres across the State. Other private owners, including conservation organizations and unincorporated clubs and partnerships, own an additional estimated 64,000 acres. Federal, State, and local governments are responsible for the other 15 percent of the forest land in Iowa. An estimated 8,000 acres of forest land are tribally owned across the State (not depicted in figure). The largest changes in forest ownership between 2013 and 2018 are a decrease in area of family forest land and increases in the area of local and other private forest land.

The fate of the forests lies primarily in the hands of those who own and control the land. It is therefore critical to understand forest owners and what policies and programs can help them conserve the forests for current and future generations. Looking particularly at family forest ownerships—the group that is the least understood and the owners of land whose fate is arguably the most uncertain—we see that they own their land primarily for amenity reasons, but many are actively doing things with their land. The percentage of ownerships that have received advice and that have written forest management plans is well under 50 percent and there are significant opportunities to help owners increase their engagement and stewardship of their lands. Another important trend to watch is the aging of the family forest owners. Given the average age of family forest owners in the State, 64 years, many acres of land will be passing on to the next generation in the not too distant future.

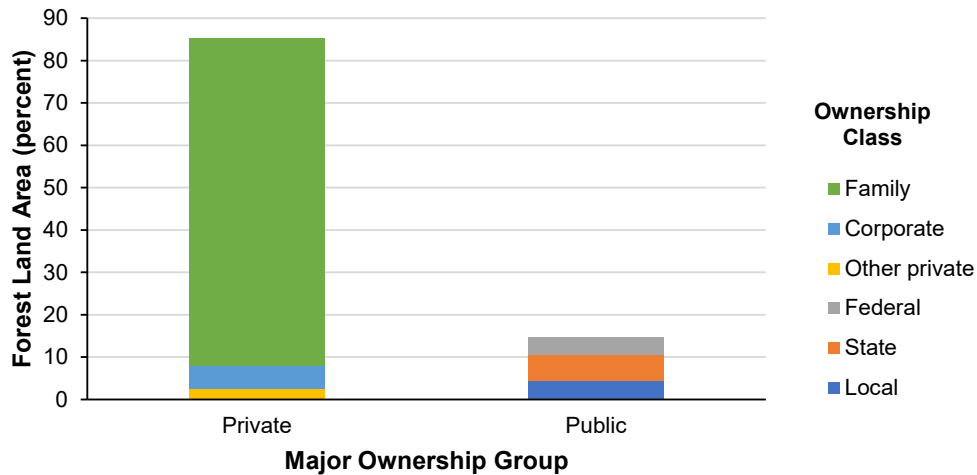


Figure 4.—Percentage of forest land area by major ownership group and ownership class, Iowa, 2018.

Forest Attributes

Species Composition

Several factors contribute to the species composition of a forest. Site characteristics like slope, aspect, soil type, and water availability determine which species grow where. Management practices such as timber stand improvement and harvesting and disturbances like fire, weather events (e.g., flooding, drought, high winds), insects, and disease all play a role in shaping forest composition. The frequency and severity of these events, over time, created the forests that we see today.

The composition of forests can be described at varying levels, from the numbers of individual species of seedlings, saplings, and trees, to a broader view of the resource categorizing land based on shared characteristics. The broad-scale delineation of forest land is expressed as forest types which comprise tree species that generally coexist in a forested setting. Similar forest types are collectively known as forest-type groups.

Ninety percent of the 2.9 million acres of forest land in Iowa is classified into only two forest-type groups, oak/hickory at 68.5 percent and elm/ash/cottonwood at 21.6 percent (Fig. 5). No other forest-type group represents at least 5 percent of forested area statewide. Of the 2 million acres that fall in the oak/hickory forest-type group, nearly two-thirds are made up of the white oak/red oak/hickory (683,000 acres) and mixed upland hardwoods (587,000 acres) forest types. Over one-quarter of biomass in the oak/hickory group consists of just two species, bur oak and white oak, and no single species had more than 15 percent of the total biomass. Conversely, the elm/ash/cottonwood forest-type group is much less diverse and the species with the most biomass was not even an elm, ash, or cottonwood. Silver maple alone accounts for 32 percent of biomass in this group, followed by eastern cottonwood (18 percent) and hackberry (12 percent).

Shifts in the extent of forest-type groups are generally very slow. Looking back over the last two inventories does show some change, albeit minor. Collectively, the oak/hickory group and elm/ash/cottonwood group are slightly less dominant now than in 2008, when they accounted for more than 91 percent of forest land.

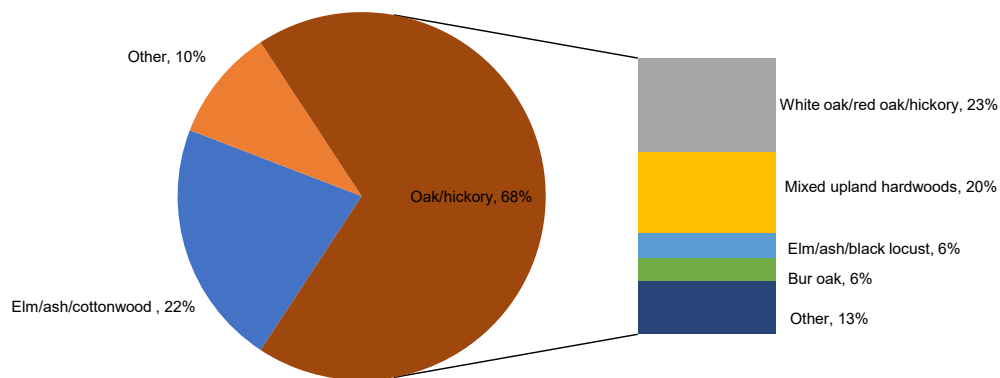


Figure 5.—Percentage of forest land area by forest-type group and forest type, Iowa, 2018.

Stand Structure

The relationships between stocking, stand size, and stand age provide insight into overall forest structure. Although stand size and stand age are often closely related, when examined separately they can each provide valuable information about different aspects of a forest.

Stand Size

Stand size is the classification of a stand based on the diameter of the trees that occupy the majority of that stand, and FIA categorizes them by three classes. Iowa forest land continues to be dominated by large diameter stands. Large diameter stands occupied 2.1 million acres in 2018, or 72 percent of total forest land area, up from 65 percent in 2008 (Fig. 6). Over that same time period, medium diameter stands decreased from 19 percent to 17 percent and small diameter stands decreased from 13 percent to 11 percent.

The overwhelming proportion of area in large diameter stands is further evidence of a maturing forest resource. This trend is most pronounced in oak-dominated forests, which make up most of the forest land in the State. While this indicates that there is a greater amount of volume available for utilization, it also emphasizes a lack of size-class diversity, which, in turn, could indicate a lack of sustainability. The steady increase of acreage in large diameter stands coupled with the decrease in small diameter stands suggests that very few stands are experiencing treatments or disturbances at levels necessary to return them to earlier successional stages.

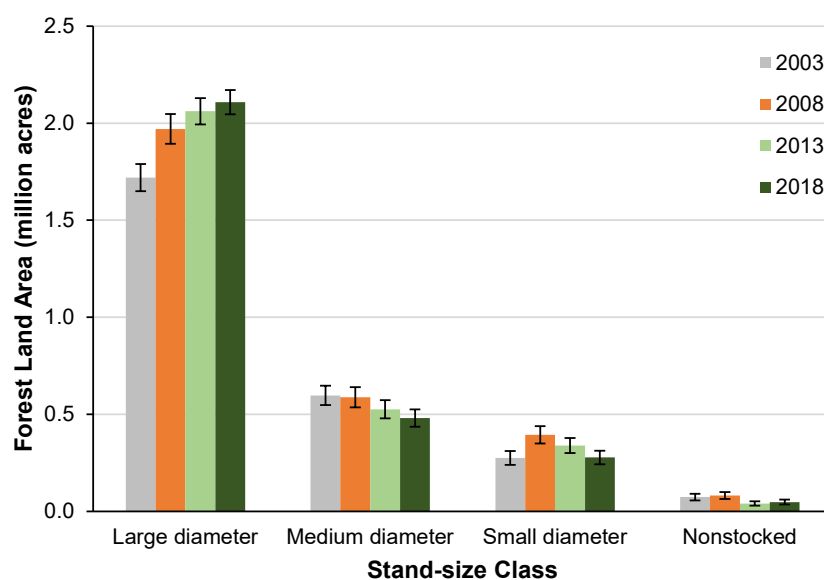


Figure 6.—Forest land area by stand-size class and inventory year, Iowa. Error bars represent a 68 percent confidence interval.

Stand Age

Stand age is a reliable predictor of forest health and vigor, suitability for wildlife, and availability of timber resources. FIA assigns stand age by determining the average age of the dominant and co-dominant trees in the stand that make up the plurality of stocking. An examination of trends and current conditions can provide an overview of changing forest dynamics related to succession, disturbances, and forest management.

Half of Iowa forests have a stand age over 60 years (Fig. 7). The 41–60 year stand-age class continues to be the dominant age class, but shifts are evident. In 2008, 65 percent of forest land was 60 years or younger, compared to 50 percent in 2018. While the area of forest land in the 21–40 year and 41–60 year age classes decreased over that time period, the area in the 61–80 and 81–100 year classes increased. If this trend continues, we should expect the 61–80 year age class to overtake the 41–60 year age class as the most dominant in the State at the next 5-year reporting interval (2023).

Iowa forests continue to shift into older age classes, especially the oak-dominated forest types, which are common throughout the State. If this trend continues, Iowa's oak/hickory forests will be increasingly susceptible to insect- and disease-related mortality. Although older stands are typically associated with less disturbed conditions and greater diversity, some older stands with a history of understory removals (e.g., from grazing or mowing) may struggle to produce the seedling and sapling understory necessary to regenerate future forests.

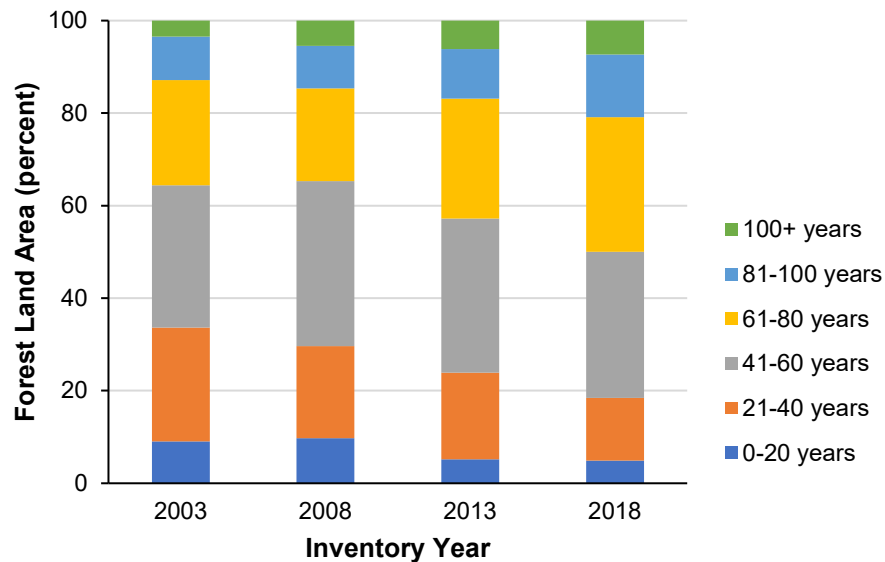


Figure 7.—Proportion of forest land area by stand-age class and inventory year, Iowa.

Volume Trends

Tree Volume

The assessment of the volume of live trees provides information on trends in the resource, the potential uses of that wood, and its economic value. Current volumes and changes in volume over time can characterize forests and reveal important resource trends. FIA reports volume for trees at least 5 inches diameter at breast height (d.b.h.) by several categories, including sound, net, growing stock, and sawtimber. Sound volume is the total volume less deductions for rotten and unsound wood. Net volume is sound volume minus additional deductions for roughness and form defects and is computed for the central stem from the 1-foot stump to a 4.0-inch top diameter. Growing-stock volume excludes rough or rotten cull trees and noncommercial species. Volume estimates for sound, net, and growing stock are reported in cubic feet. Trees classified as rough cull either have two-thirds of their volume not meeting merchantable requirements with the majority of that volume being rough cull, or are not a commercial species. Rotten cull trees have two-thirds of their volume as cull and the majority is unsound or rotten cull. While rough and rotten cull trees may not be available for timber utilization, they provide critical wildlife habitat and carbon storage. Estimates of sawtimber volume are reported in board feet (International ¼-inch), from stump for hardwoods, minimum 11.0 inches d.b.h. to a 9-inch top diameter, and from stump for softwoods, minimum 9.0 inches d.b.h. to a 7-inch top diameter.

Sound volume on forest land increased 4 percent to 5 billion cubic feet from 2013 to 2018, and 99 percent of that volume was in hardwood species. Timberland accounted for 94 percent (4.7 billion cubic feet) of total sound volume, an increase of 3 percent over the same time period. Sound volume on reserved forest land increased 19 percent to 273 million cubic feet and was 5 percent of total sound volume. The remaining 1 percent of sound volume was on lands not meeting minimum productivity standards (other forest land). Net volume on timberland was 4.4 billion cubic feet, an increase of 3 percent since 2013 (Fig. 8). Growing-stock volume was 3 billion cubic feet (69 percent) of net volume, with the balance in rough cull (30 percent) and rotten cull (1 percent). Growing stock volume decreased 1 percent from 2013 to 2018 while rough cull volume increased by 13 percent and rotten cull volume decreased by 10 percent.

Net volume on timberland has increased since the first annual survey in 2003, but the rate of increase is declining. Net volume increased 9 percent from 2003 to 2008, 7 percent from 2008 to 2013, and only 3 percent from 2013 to 2018. The declining rate of volume accumulation can be largely attributed to a long-term trend of increasing average annual mortality volume, although some of the decrease is no doubt due to the loss of timberland acreage from 2008 to 2018.

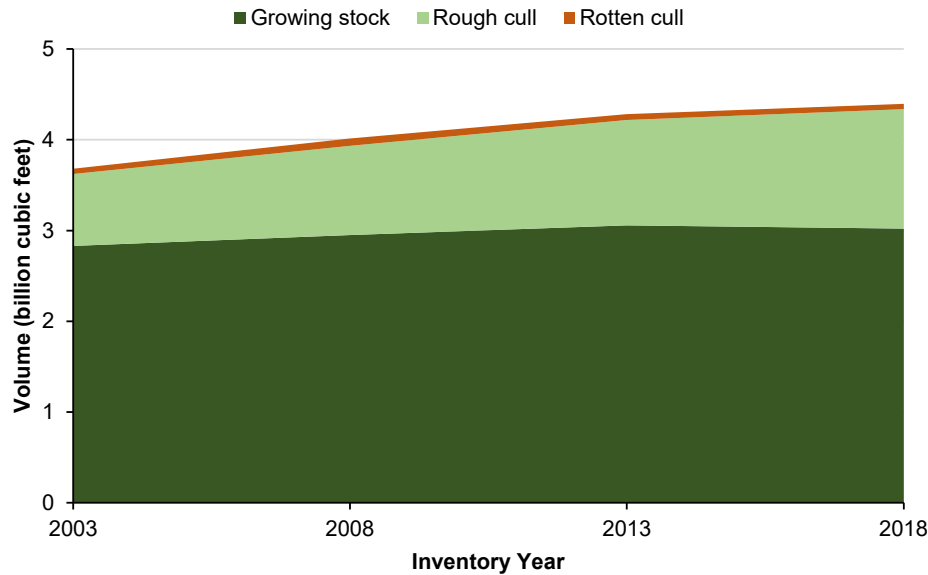


Figure 8.—Net volume of live trees on timberland by tree class and inventory year, Iowa.

Growth, Removals, and Mortality

Forests are a renewable resource when they are managed to provide a constant supply of useful products without diminishing long-term productivity. The rate of growth is an indicator of the overall condition of a stand and of forest health, successional stage, and tree vigor.

Mortality is a natural part of stand development in healthy forest ecosystems. Many factors contribute to mortality, including competition, succession, insects, disease, fire, human activity, and severe weather events. Mortality is often initiated by one causal agent (inciting factor) that is followed by other contributing stress factors, making it difficult to identify the underlying cause. Although mortality is a natural event in a functional forest ecosystem, dramatic increases in mortality can be an indication of forest health problems. Average annual growing stock mortality estimates represent the average cubic-foot volume of sound wood that dies each year between inventories.

Average annual net growth (gross growth minus mortality) is calculated by measuring trees at two points in time and determining the average annual change over the time period. Negative net growth occurs when mortality exceeds gross growth. Negative net growth is indicative of a serious forest health issue and results in a reduction of total inventory volume. Average annual net growth estimates are based on the change in volume of growing stock on timberland between inventories. The terms average annual net growth and net growth are used interchangeably. A useful measure to assess growth is the ratio of annual net growth to current inventory volume.

Since 2008, average annual net growth of growing stock on timberland and average annual removals have decreased in Iowa while average annual mortality increased. Net growth of growing-stock trees on timberland was an average of 61 million cubic feet annually as of 2018, and the ratio of net growth to removals (2.4:1.0) decreased from what was reported for 2008 (2.7:1.0) (Fig. 9).

Due to increasing mortality, net growth of growing stock on timberland has continued to decrease since 2008 after increasing substantially between 1990 and 2008. Tree mortality rates in Iowa are slightly higher than those in many surrounding states. Some of the mortality can be explained by stand dynamics (e.g., competition and succession) and the impacts of insects and diseases that affect specific species (e.g., emerald ash borer on ash species). American elm has been heavily impacted by Dutch elm disease for many decades, but recently its mortality rate decreased. In contrast, emerald ash borer impacts are increasing, so the mortality of ash species can be expected to continue to increase.

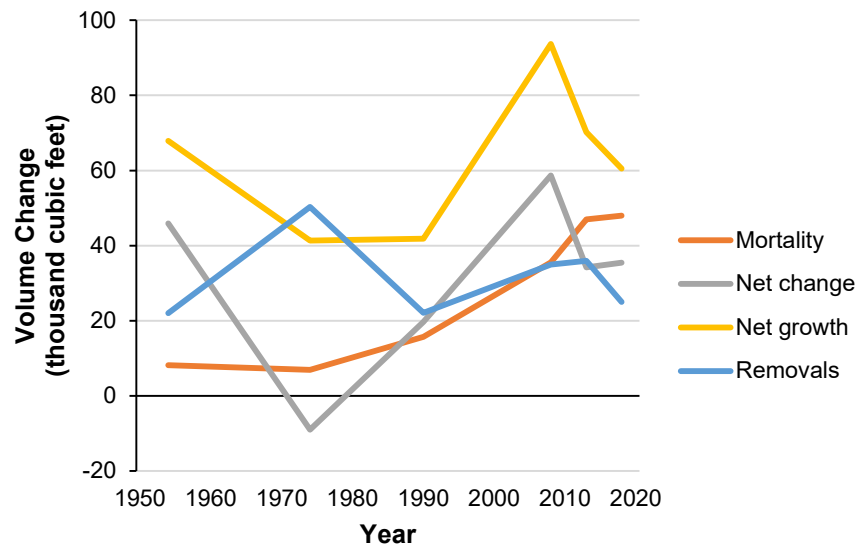


Figure 9.—Net growth, total removals, mortality, and net change of growing stock on timberland by year, Iowa. Estimates include land use change.

Forest Sustainability

Regeneration

The species composition, abundance, and structure of tree regeneration are an important indicator of the future sustainability and trajectories of numerous forest ecosystem attributes such as live tree stocking and resilience to disturbance events. Various facets of the FIA program can quantitatively address tree regeneration, including the abundance of advanced tree regeneration on all plots and the abundance of all seedlings measured on a subset of plots (McWilliams et al. 2015).

Over the past 10 years the percentage of Iowa forest classified as young (less than 20 years old) has declined from roughly 10 percent to the current level of less than 5 percent (Fig. 10). At the same time, the abundance of advanced tree seedlings (less than 1 inch d.b.h. and at least 6 inches in length for softwoods and 12 inches in length for hardwoods) has declined to approximately 1,200 per acre, about 8 percent lower than the 2008 estimate.

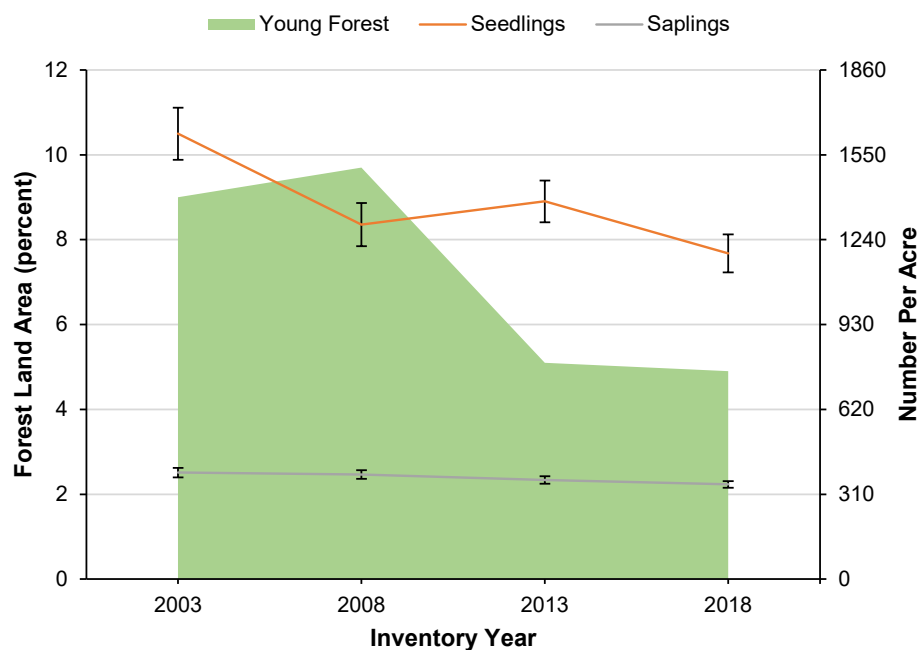


Figure 10.—The percentage of young forest (less than 20 years old) and abundance of advanced tree regeneration (at least 6 inches and at least 12 inches in length for softwoods and hardwoods, respectively) and saplings (1 to 4.9 inches d.b.h.) by inventory year, for forest land in Iowa. Error bars represent a 68 percent confidence interval.

Similar to many states in the eastern United States, there is a lack of young forests across Iowa despite a relatively abundant understory of seedlings. Additionally, an appreciable portion of Iowa forests have experienced moderate to heavy animal browsing of tree seedlings, which can impede effective tree regeneration. The abundance of seedling species across height classes can indicate a variety of dynamics at the forest-stand level, such as stand senescence or changing successional directions. Only eastern hophornbeam appears to have abundant populations of the smallest seedlings with recruitment into the larger height classes. In contrast, species like white ash, silver maple, green ash, and black maple have considerable abundance of the smallest seedlings but hardly any larger sized seedlings. Overall, the lack of young forest and moderate levels of browse will remain problematic for select forest types that depend on relatively open conditions or disturbance (or both) for regeneration, such as white oak/red oak/hickory.

Literature Cited

- 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. 73 p. <https://doi.org/10.2737/NRS-GTR-27>.
- Butler, B.J.; Butler, S.M.; Caputo, J.; Dias, J.; Robillard, A.; Sass, E.M. 2020. **Family forest ownerships of the United States, 2018: results from the USDA Forest Service, National Woodland Owner Survey**. Gen. Tech. Rep. NRS-199. Madison, WI: U.S. Department of Agriculture, Forest Service, Northern Research Station. 56 p. <https://doi.org/10.2737/NRS-GTR-199>.
- Butler, B.J.; Hewes, J.H.; Dickinson, B.J.; Andrejczyk, K.; Butler, S.M.; Markowski-Lindsay, M. 2016. **USDA Forest Service National Woodland Owner Survey: national, regional, and state statistics for family forest and woodland ownerships with 10+ acres, 2011-2013**. Resour. Bull. NRS-99. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 39 p. <https://doi.org/10.2737/nrs-rb-99>.
- Central States Forest Experiment Station, The Forest Survey Organization. 1956. **Iowa forest statistics**. Forest survey release no. 20. U.S. Department of Agriculture, Forest Service, Central States Forest Experiment Station. 58 p.
- Gormanson, D.D.; Pugh, S.A.; Barnett, C.J.; Miles, P.D.; Morin, R.S.; Sowers, P.A.; Westfall, J.A. 2018. **Statistics and quality assurance for the Northern Research Station Forest Inventory and Analysis program**. Gen. Tech. Rep. NRS-178. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 25 p. <https://doi.org/10.2737/NRS-GTR-178>.
- 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 p.
- Leatherberry, E.C.; Moser, W.K.; Perry, C.; Woodall, C.W.; Jespen, 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. <https://doi.org/10.2737/NC-RB-266>.
- McWilliams, W.H.; Westfall, J.A.; Brose, P.H.; Dey, D.C.; Hatfield, M.; Johnson, K.; Laustsen, K.M.; Lehman, S.L.; Morin, R.S.; Nelson, M.D.; Ristau, T.E.; Royo, A.A.; Stout, S.L.; Willard, T.; Woodall, C.W. 2015. **A regeneration indicator for forest inventory and analysis: history, sampling, estimation, analytics, and potential use in the midwest and northeast USA**. Gen. Tech. Rep. NRS-148. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 74 p. <https://doi.org/10.2737/NRS-GTR-148>.

- Nelson, M.D.; Barnett, C.J.; Brewer, M.; Butler, B.J.; Crocker, S.J.; Domke, G.M.; Gormanson, D.D.; Kurtz, C.M.; Lister, T.W.; Matthews, S.; McWilliams, W.H.; Meneguzzo, D.M.; Miles, P.D.; Morin, R.S.; Piva, R.J.; Riemann, R.; Smith, J.E.; Walters, B.F.; Westfall, J.A.; Woodall, C.W. 2016. **Iowa Forests, 2013**. Resour. Bull. NRS-102. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 124 p. <https://doi.org/10.2737/NRS-RB-102>.
- Nelson, M.D.; Brewer, M.; Woodall, C.W.; Perry, C.H.; Domke, G.M.; Piva, R.J.; Kurtz, C.M.; Moser, W.K.; Lister, T.W.; Butler, B.J.; Meneguzzo, D.M.; Miles, P.D.; Barnett, C.J.; Gormanson, D.D. 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]. <https://doi.org/10.2737/NRS-RB-52>.
- 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.

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at http://www.ascr.usda.gov/complaint_filing_cust.html and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by: (1) mail: U.S. Department of Agriculture, Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410; (2) fax: (202) 690-7442; or (3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.



Northern Research Station

<https://www.nrs.fs.usda.gov>