USDA Forest Service
U.S. DEPARTMENT OF AGRICULTURE

Bureau of Land Management
U.S. DEPARTMENT OF THE INTERIOR

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Introductory Report

Analysis of Threats to Mature and Old-Growth Forests on Lands Managed by the Forest Service and Bureau of Land Management

Fulfillment of Executive Order 14072, Section 2.c.ii

Overview

Executive Order (EO) 14072–*Strengthening the Nation's Forests, Communities, and Local Economies*–instructed the U.S. Department of the Interior, Bureau of Land Management (BLM) and U.S. Department of Agriculture (USDA), Forest Service to implement a set of actions focused on the health of the Nation's forests. Section 2.c.(ii) directed the agencies to analyze the threats to mature and old-growth forests on Federal lands, including from wildfires and climate change. To fulfill this direction, the agencies are creating a full report that will be available in early 2024. This introductory report summarizes initial key findings.

As recognized in section 1 of EO 14072, old-growth forests have decreased significantly from what existed historically. Understanding what threatens mature and old-growth forests is imperative to conserving and managing these forests and protecting their ecological, social, cultural, and economic value.

What Constitutes a Threat?

For this analysis, shaped by technical experts and feedback from the public, a threat is defined as a current or projected disturbance or stressor that may contribute to the enduring loss or degradation of the characteristic conditions, functions, or values of existing mature and old-growth forests. Disturbances resulting in a decline in the abundance of mature and old-growth forests, or enduring loss of conditions, functions, or values were considered negative outcomes, and are thus threats. Disturbances that resulted in neutral or beneficial outcomes, such as no change in abundance, or an increase in abundance of mature and old-growth forests, were not considered threats.

Defining Mature and Old Growth

According to the Mature Forest Narrative Framework, mature forests are delineated ecologically as the stage of forest development immediately before old growth. The mature stage of stand development generally begins when a forest stand moves beyond self-thinning, starts to diversify in height and structure, and/or the understory begins to reinitiate. Structural characteristics that mark the transition from an immature to mature forest are unique to each forest type; they may include but are not limited to: abundance of large trees, large tree stem diameter, stem diameter diversity, horizontal canopy openings or patchiness, aboveground biomass accumulation, stand height, presence of standing and/or downed boles, vertical canopy layers, or a combination of these attributes.

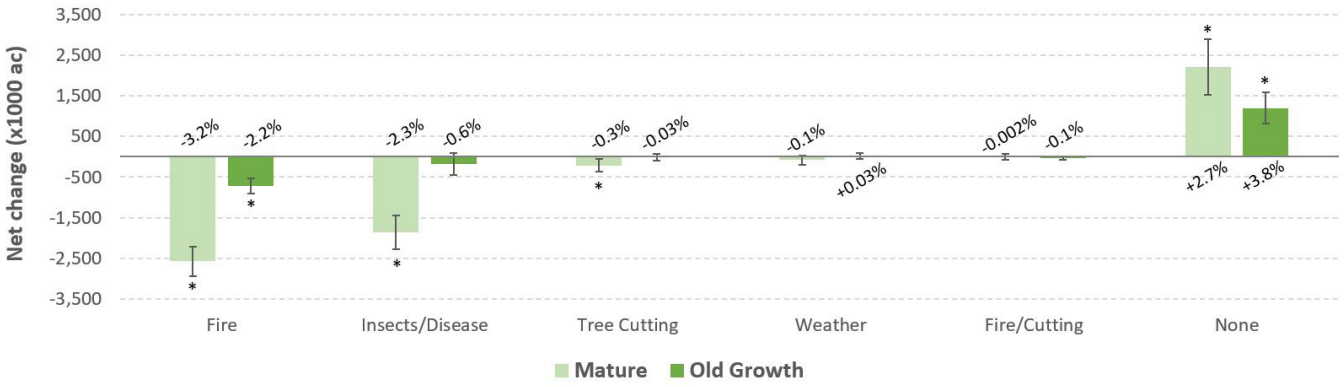
Mature and old-growth forests come in all shapes and sizes and can often be abundant. Mature and old-growth forests offer biological diversity, carbon sequestration, wildlife and fisheries habitat, recreation, aesthetics, soil productivity, and clean water. These special forests also reflect diverse Tribal, social, and cultural values.

Key Findings

The initial threat analysis found that mature and old-growth forests have high exposure to a variety of threats and climate and disturbance projections show this exposure will likely increase. Currently, wildfire, exacerbated by climate change and fire exclusion, is the leading threat to mature and old-growth forests, followed by insects and disease. Tree cutting (any removal of trees) is currently a relatively minor threat despite having been a major disturbance historically. The analysis also found that two thirds of mature forests

and just over half of old-growth forests are vulnerable to these threats. Climate change has increased the level of these threats and is likely altering where, and what types of mature and old-growth forests can persist. Over the next five decades, the growth of younger and mature forests is projected to result in an increase of mature and old-growth forests despite increasing disturbances. However, gains lessen with each passing decade and the expanding wildland-urban interface complicates mitigation of threats.

Since 2000, wildfires resulted in a decrease of an estimated 2.57 million acres of mature and 712,000 acres of old-growth forests on National Forest System (NFS) and BLM lands. Insects and disease caused a decrease of 1.86 million acres of mature and 182,000 acres of old growth. Tree cutting by the BLM and Forest Service resulted in a decrease of 214,000 acres of mature forests and 9,000 acres of old growth. Where no forest disturbances have occurred, mature forests increased by 2.21 million acres and old-growth forests by 1.20 million acres. Combined, there has been a 2.51-million-acre net decline of mature forests, with about a tenth of this becoming old growth (a 0.28-million-acre net increase in old growth).



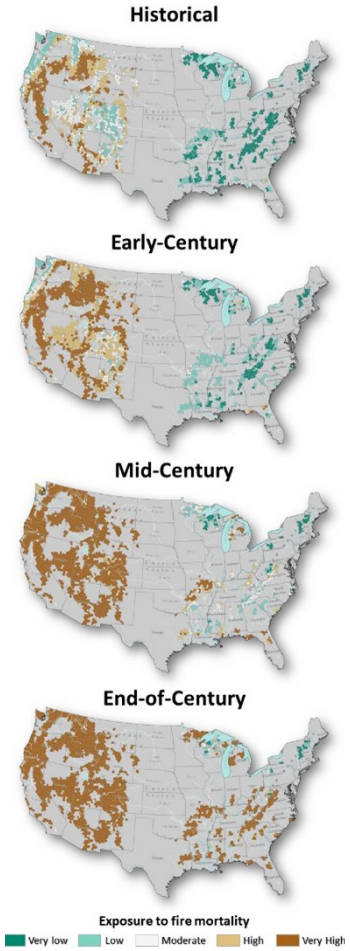
A total of 30,864 Forest Inventory and Analysis (FIA) plots, representing 81.5 million acres of mature and 31 million acres of old growth, were measured twice between 2000 and 2020. Net changes in mature and old-growth area (based on the definitions used in the mature and old-growth inventory) are shown above. Error bars represent 95 percent confidence intervals and asterisks indicate a statistically significant change.

Fire

Fire (wildfire, cultural burning, or other prescribed fire) is a disturbance that can have positive, neutral, or negative outcomes, with frequent, low-severity fire driving natural ecological processes in many forest types, often maintaining mature and old-growth characteristics. Some forests experience less frequent, but high-severity fire that removes mature and old-growth forest, reinitiating forest development. Adverse effects from fire depend on forest type, fire severity, fire extent, and the forest's condition following the fire, including ecological, social, economic, and cultural impacts.

This century, wildfires have been increasing in frequency and extent, accounting for most of the losses of mature and old-growth forests on NFS and BLM lands. Historically, less than half of inventoried mature and old-growth forests had high exposure to mortality from fire. High exposure equates to about 0.1 to 0.3 percent of the area will experience moderate-to-high severity fire annually. Very high exposure is about 0.5 percent each year. Currently, 70-80 percent are considered at high exposure. Climate change projections predict greater than 90 percent of inventoried mature and old-growth forests will be at very high exposure to wildfire-caused mortality by the end of the century. However, increasing exposure does not mean loss of mature and old-growth forests, but that an increasing proportion will experience fire, and, depending on conditions, may incur adverse effects. Forest Inventory and Analysis (FIA) plot remeasurements illustrate this point: a total of 7.1 million acres of mature and 1.7 million acres of old-growth forests have burned since 2000. Slightly over 60 percent of that still met mature and old-growth forest definitions.

The recent USDA Forest Service Resources Planning Act (RPA) assessment estimated that the largest increases in fire will occur disproportionately in the West among Douglas-fir, ponderosa pine, and piñon-juniper forests, as well as woodland hardwoods. In the East, fire-related mortality in the oak/hickory forest type group is projected to at least double (by volume) by 2070. However, an increase in fire may be beneficial to these oak/hickory forests if it signals more fire overall and an end to fire exclusion.

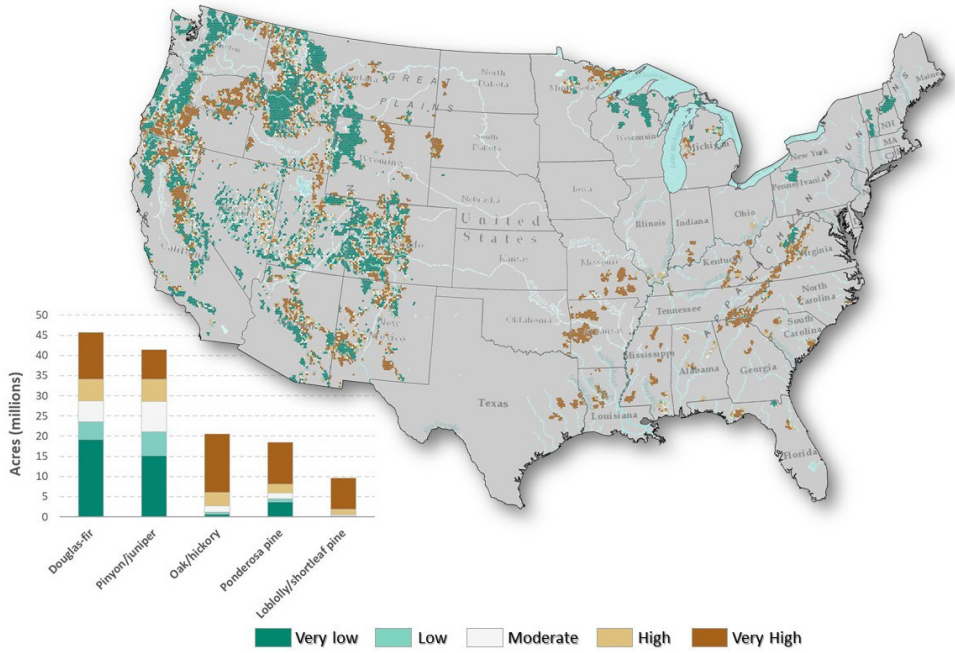


This series of maps portrays exposure of mature and old growth to wildfire threats historically and through the end of the century based on past records and future climate predictions.

Fire Exclusion

Fire exclusion began centuries ago, as European colonization disrupted frequent Tribal burning practices that maintained open forests and favored fire-tolerant trees. The wildfire suppression policies of the 20th century exacerbated fire exclusion. Removing fire from forest types that are adapted to relatively frequent fire can increase the probability of high-severity fire and stand replacement as stands become dense with smaller trees that facilitate canopy fire spread. Fire exclusion can also lead to adverse ecological outcomes such as high-density, fire-sensitive, shade-tolerant understories that prefer moderate amounts of moisture.

FIA plot remeasurements, published climate change projections, and fire exclusion history tell us that a third of mature and a quarter of old-growth forests have a fire deficit. Oak/hickory, ponderosa pine, and loblolly/shortleaf pine forest type groups have the most mature and old-growth forests in fire deficit. The fire exclusion signature can also be seen through deeper analysis of FIA plots that meet old-growth inventory definitions—when a plot is classified as old growth due to large tree densities, but also includes high densities of fire-sensitive small trees (such as red maple).



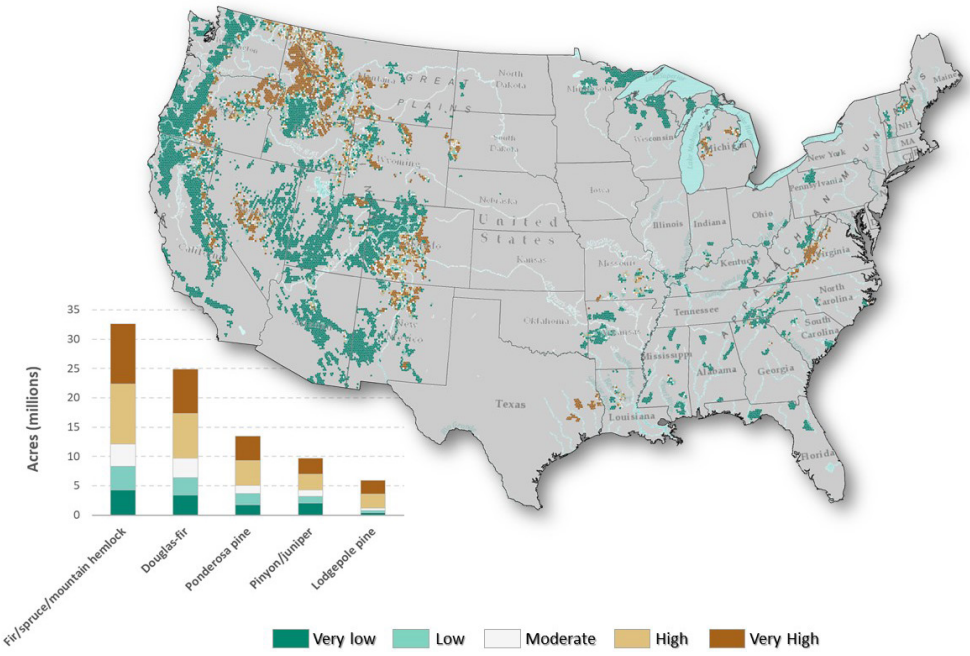
Fireshed Registry[1] project area map (about 25,000 acres each) of wildfire deficit. The bar chart highlights the top five forest type groups from largest area of mature and old-growth forests to lowest with the high amounts of fire deficit.

[1] Firesheds are units of roughly 250,000 acres used to evaluate wildfire management and risks to local communities. For this effort and the maps displayed, firesheds have no wildfire context but are simply used as map units.

Insects and Disease

Tree mortality from native insects and tree diseases sometimes results in substantial loss of mature and old-growth forest stands. In contrast, non-native insects and disease have caused extensive mortality of dominant overstory trees in several areas, sometimes moving mature and old-growth forests to earlier stages of forest development. Increased frequency of drought and more damaging wind or ice storms due to climate change may increase the vulnerability of forests to threats from both native and non-native forest insects and disease. Even when mature and old-growth forests remain after infestations, the changes to these forests may have substantial negative social, cultural, and economic impacts.

Evidence from FIA plot remeasurement suggests a net loss of 1.9 million acres (2.3 percent) of mature forest and 134,000 acres (0.4 percent) of old-growth forest to insect and disease. The overall severity of the effects of insect and disease was mostly low in 67 percent of mature and 73 percent of old-growth plots, resulting in no significant change in mature forests but a significant net gain in old-growth forest. This is likely due to increases in dead trees with elements of old growth definitions for some forest types. The current potential threat from insects and disease was highest in lodgepole pine (81 percent), fir/spruce/hemlock (63 percent), ponderosa pine (63 percent), Douglas-fir (61 percent), and piñon-juniper (56 percent).



Fireshed registry project area map (about 25,000 acres each) of current risk to forests from insects and disease. Bar chart highlights the top five forest type groups from largest area of mature and old growth to lowest with high exposure.

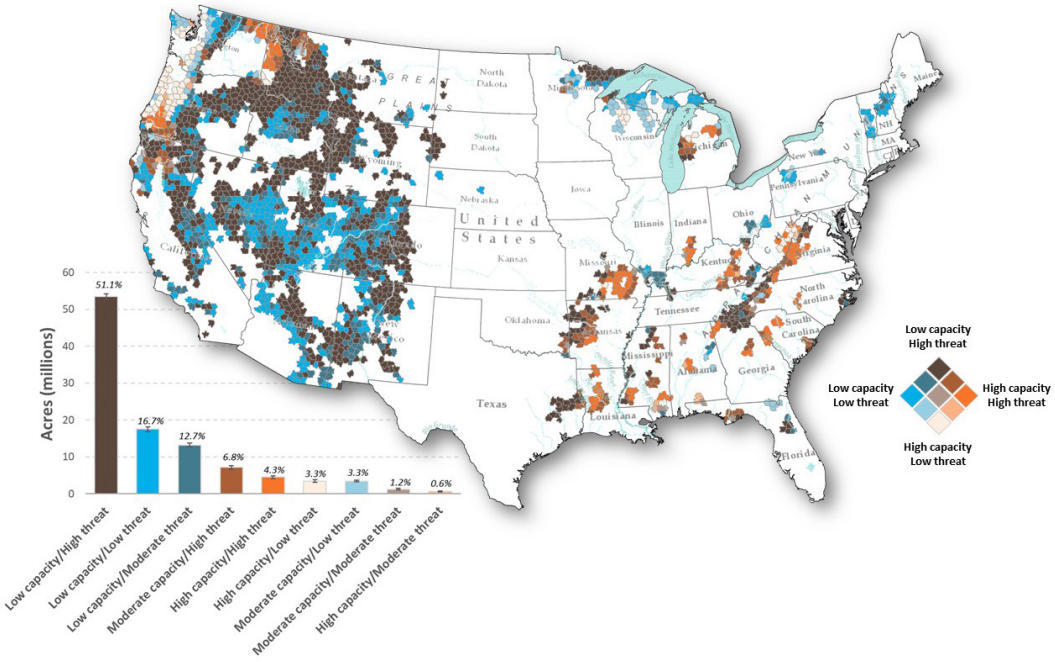
Tree Cutting

Tree cutting ranges from removal of individual trees for specialized use or safety to removal of many trees for structural lumber or habitat creation. From 1950 through 1990, tree cutting was the number one disturbance, removing substantial areas of mature and old-growth forests; however, this is no longer the case as agency policy has since changed significantly. The economic, social, and ecological dimensions of tree cutting are complex, thus creating both potential threats and opportunities for mature and old-growth forest composition.

The latest remeasurement of FIA plots showed that 2.1 million acres of mature forest and 400,000 acres of old growth experienced tree cutting effects. This comprised 2.5 percent of mature forests and 1.3 percent of old-growth forests. In general, management improved or maintained these stands. In total, 200,000 acres (0.3 percent) of mature forest and 9,000 acres (0.03 percent) of old growth were converted to other forest conditions by this tree cutting.

Mill Infrastructure

Mills play a critical role in processing logs from activities aimed at reducing risk from fire, insects, and disease, but were also identified as a threat due to the relationship between mills and loss of mature and old growth due to timber harvest. The vast majority (81 percent) of mature and old-growth forests are in firesheds with low timber processing capacity. Capacity was highest in the Pacific Northwest and Southeast regions of the country. Almost half of inventoried mature and old-growth forests are in firesheds where wood processing capacity is low, but current threats, including severe fire, are high. This suggests these areas may struggle to practice active management to reduce such threats.



This fireshed map combines mill capacity with threats to mature and old-growth forests. More than half of mature and old-growth forests are in firesheds where the threat of wildfire, insects/disease, and wildfire deficit are high, but mill capacity is low.

Climate Change

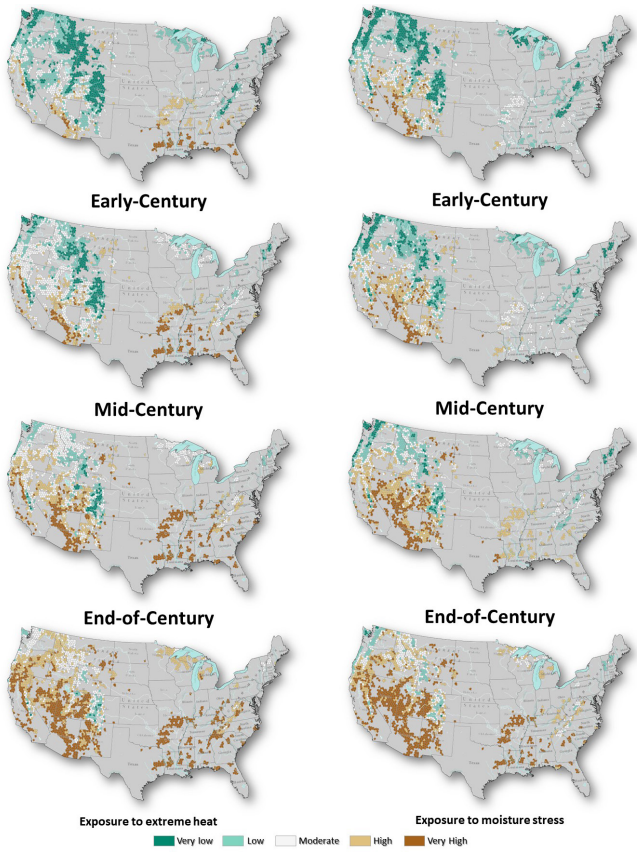
Climate change is a complex stressor with a variety of short and long-term outcomes, interacting with and exacerbating other stressors or threats (such as fire or insects). Consequences will take different forms in different regions and forest types. In virtually every scenario, the broad consequences of climate change mean that the ecosystem services and values with which various communities engage are likely to change too. Exposure to high temperatures and drought are two aspects of climate change that threaten mature and old-growth forests.

The year 2023 marked the hottest year on record globally. For mature and old-growth forests, this climate metric means exposure to high temperatures can have direct, adverse effects on mature and old-growth forests. It also means secondary effects from other impacts of heat, such as drought, results in increased stress to trees.

Historically, about one-third of the mature and old-growth forests in the conterminous United States rarely exceeded 90 °F in any given year (less than one day per year; very low exposure). Depending on estimated climate change scenarios, roughly 15–32 percent of inventoried mature and 11–32 percent of old-growth forests may experience two or more months of extreme heat by the end of this century. Based on the current trajectory, less than 1 percent will not experience less than one day per year of extreme heat. Higher temperatures are expected to cause changes in the distribution and abundance of dominant forest species, with heat-tolerant species becoming more competitive. In forests located near streams and rivers, hotter temperatures will accelerate the drying of soils through evaporation as vegetation takes up water earlier and faster during the growing season.

According to the National Oceanic and Atmospheric Administration (NOAA), geographically extensive and long-duration drought conditions across the United States set several records in 2022. The time series maps, representing a three-decade climate normal, illustrate how climatic water deficit (a measure of drought) has already changed and may change into the future. Drought sensitivity varies by forest type and environmental factors such as elevation, latitude, and topography. The amount of mature forest area that historically had very low exposure to drought has already decreased by about half and old growth by about 43 percent (based on the RCP8.5 climate models). By the end of the century, less than 1 percent of inventoried mature and old-growth forests will have very low exposure.

According to the most recent RPA assessment, recent exposure to drought was higher in the West than the East, and drought exposure for forests is expected to increase by 2070, with the largest increases in the Southwest. Climate change projections indicated levels of drought exposure will far exceed recent exposure for many forest type groups. By mid-century, over half of the piñon-juniper, woodland hardwoods, aspen/birch, and ponderosa pine type groups are projected to exceed the historical median exposure to severe or extreme drought.



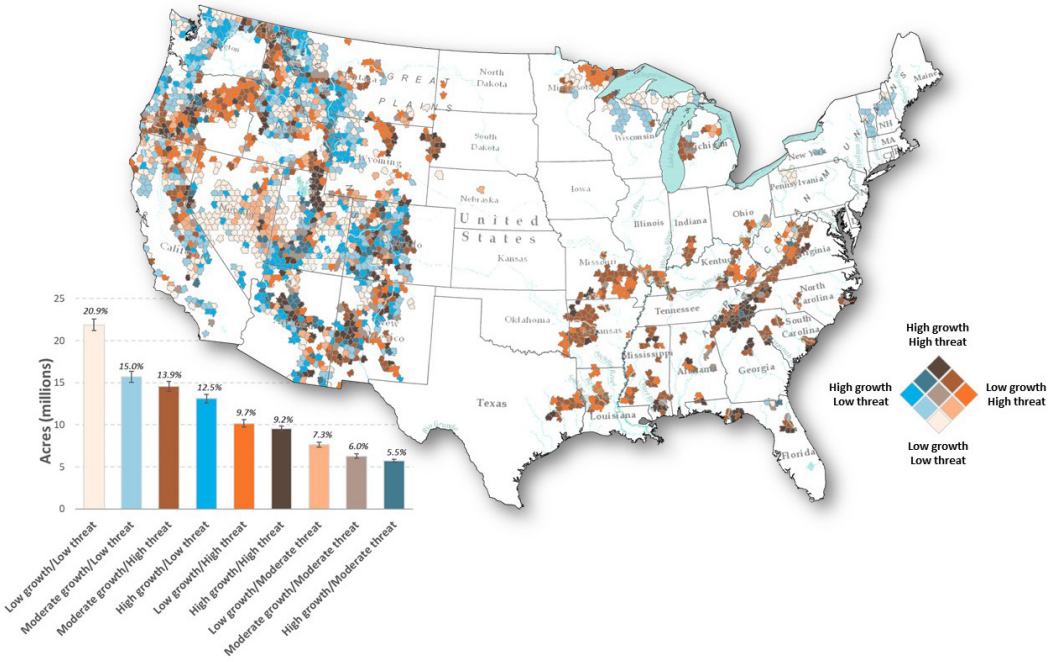
This series of maps portrays exposure of mature and old growth to extreme heat and moisture stress historically and through the end of the century based on past records and future climate predictions.

Challenges to Managing Mature and Old-Growth Forests

The wildland-urban interface, where housing meets forests, presents challenges to managing mature and old growth. According to census data, housing units have grown by 43 percent in mature and old-growth firesheds from 1990 to 2020. The social and ecological dynamics created by having housing in and around forested lands are complex, creating both potential threats and opportunities.

The proximity of humans and housing to forests can increase the risk of wildfire ignitions, limit opportunities for prescribed fire use, and increase pressure to create fuel breaks, all of which could have negative impacts to mature and old-growth forests. Alternatively, increased investment through tools like Community Wildfire Defense Grants, could provide the opportunity for more targeted maintenance and restoration efforts, with positive impacts to mature and old-growth forests.

Sunset view of the Salt Lake Valley (middle left) next to the Wasatch National Forest (mountains to the right), early October 2023. As people and businesses migrate into Utah, housing continues to expand into forested areas, as can be seen here by the Suncrest community nestled on top of the Traverse Mountains in Draper, Utah, part of the Wasatch Wildfire Crisis Strategy Landscape located between the Salt Lake and Utah valleys. USDA Forest Service photo by Nick Cieslak.



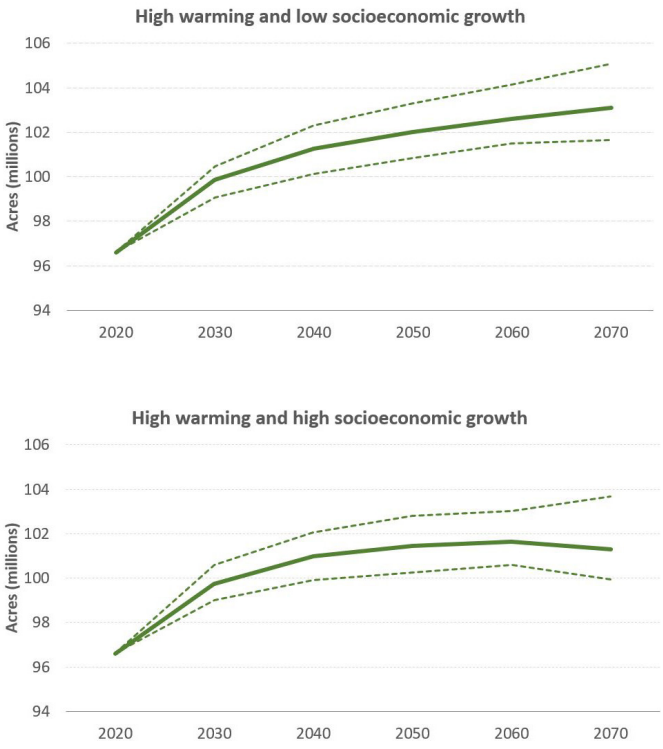
This fireshed map combines housing growth with threats to mature and old-growth forests from wildfire deficits. More than half of mature and old-growth forests are in firesheds where housing growth is high and the threat from wildfire is also high.

The Future of Mature and Old-Growth Forests

Despite the threats highlighted in this analysis, the RPA assessment predicted an increasing trend in the amount of mature and old-growth forests on NFS and BLM lands until at least mid-century (2070), as the large amount of younger and mature forest age into older forests. This trend begins to decrease by mid-century under some shared socioeconomic and climate change scenarios.

Projections of increasing mature and old-growth forests are tempered by the reality that American forests are entering uncharted territory with climate change. As our understanding of the implications of climate change evolves, so will understanding the places and methods to best steward and conserve our Nation's older forests.

In the meantime, existing younger and mature forests provide the building blocks for future mature and old growth. A sound management approach will help ensure that older forest species composition and structure fits its environment (such as future fire patterns, climate, and locations least likely to burn). A deep understanding of ecological, social, and cultural dynamics must play a role. Most importantly, the environment of the predicted future, and not that of the past, should guide policy considerations related to mature and old-growth management.



Modeled trends of mature and old-growth forests that account for forest disturbances under different future scenarios.

Conclusion

This introductory threat analysis should be considered a first step towards understanding the myriad of interacting factors (biophysical and social) that threaten the persistence of older forests on public lands across the Nation, now and into the future. Monitoring the status and trend of these forests, coupled with monitoring forest disturbances, will inform understanding the causality for observed patterns and changes.

Details related to this introductory report are also outlined in the mature and old growth section of the Forest Service's online Climate Risk Viewer (CRV) tool, which illustrates a variety of map layers and climate assessment resources.

See the Forest Service 2020 Resources Planning Act Assessment: Future of America's Forests and Rangelands for a summary about the status, trends, and projected future of the Nation's forests and rangelands. The 2020 RPA assessment specifically focuses on the effects of both socioeconomic and climatic change on the U.S. land base, disturbance, forests, forest product markets, rangelands, water, biodiversity, and outdoor recreation.

See the Forest Inventory and Analysis: Fiscal Year 2022 Business Report for authoritative data about forest carbon, forest products and services, biomass availability, economic development opportunities, land cover and land use change, incidence of nonnative invasive species, impacts of pests and diseases, and wildfire risk, and to support the sustainable management and conservation of forests, water resources, and biodiversity.

See a preliminary report, Mature and Old-Growth Forests: Definition, Identification, and Initial Inventory on Lands Managed by the Forest Service and Bureau of Land Management for additional information.

Old-growth forest, Mitkof Island, Tongass National Forest. USDA Forest Service photo by Karen L. Dillman.