



# Executive Summary

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The 2020 Resources Planning Act (RPA) Assessment is the sixth report prepared in response to the mandate in the 1974 Forest and Rangeland Renewable Resources Planning Act (Public Law 93–378, 88 Stat 475, as amended). This report addresses lands across all ownerships and summarizes findings about the status, trends, and projected future of U.S. forests, forest product markets, rangelands, water, biodiversity, outdoor recreation, and the effects of socioeconomic and climatic change upon these resources. The results can inform resource managers and policymakers as they develop strategies to sustain natural resources. Important differences are found regionally and locally, and those unique patterns highlight the need for flexible adaptation and management strategies. The Forest Service, an agency of the U.S. Department of Agriculture, will continue to use the results to inform strategic planning and forest planning.

The 2020 RPA Assessment outlook for U.S. resources provides projected futures across four RPA scenarios that contain differing assumptions about U.S. and global population and economic growth, technology change, bioenergy preferences, openness of international trade, wood-energy consumption, and global climate change from 2020 to 2070.

## Land development will continue to threaten the integrity of forest and rangeland ecosystems.

Developed land use in the United States has continued the expansion reported in the 2010 RPA and Update to the 2010 RPA, but this expansion has slowed. Developed land use area is projected to continue expanding in the future—with increases ranging between 42 and 58 percent by 2070 across the four RPA scenarios, from an estimated 97.7 million acres in 2020. These increases in developed land occur at the expense of all other land uses including

forests and rangelands. Although forest land area has been lost to development since 1982, gains to forests from other land uses, primarily from converted pasture, have more than offset these losses, resulting in a net increase in forest land area. These conversions to forest land are also projected to slow. Continued land use conversion, driven principally by increased developed land use, is ultimately projected to lead to net losses of forest land of between 1.9 and 3.7 percent by 2070 and net rangeland losses of between 1.0 and 2.3 percent. The greatest increases in developed land use by 2070 are projected for the RPA South Region. Resulting loss of forest land is projected to be highest in the RPA South Region, while rangeland loss is highest in the Pacific Coast.

As developed land area has expanded, the juxtaposition of developed land with rural and natural lands has also increased. The “wildland-urban interface”—the area where developed and natural land uses meet or intermix—increased by 33 percent between 1990 and 2010, to cover 10 percent of all land and 14 percent of forest land in 2010. Although future projections of the wildland-urban interface were not included in this Assessment, the area of landscapes dominated by developed land is projected to increase by 66 to 114 percent between 2020 and 2070. The distribution and density of future development in relation to natural lands can have implications for the resources they provide. In terms of interior forest area (a proxy for the degree of forest fragmentation), the western and Southeast subregions are projected to experience a decrease of interior forest area, while increases are projected in the northern and eastern subregions, suggesting that different locations will experience different effects to the remaining forest lands.

The increasing presence of developed lands in areas formerly dominated by agricultural and natural land uses has the potential to introduce a wide range of threats to forest and rangeland over large areas. The highest rates of forest and rangeland invasion by nonnative plants across the United States have occurred near developed land uses. Risks to

biodiversity from land development include destruction of critical habitats, reduction in connectivity among habitats, and displacement or isolation of wildlife populations. These multiple pressures increase the long-term vulnerability of wildlife and biodiversity to climate change. Land development is projected to be a dominant threat to wildlife and biodiversity across most of the Eastern United States, and a high risk to wildlife and biodiversity in the areas of the Western United States near large urban areas.

Land development pressures on nearby forests and rangelands also reduce their ability to provide ecosystem goods and services such as biodiversity, carbon sequestration, wood and fiber, recreational opportunities, and clean air and water. Although water use has been declining nationally, it is expected to increase in areas experiencing rapid population growth associated with urbanization. These increases in water use are projected to occur largely in the southern and western regions of the country, which are already experiencing water stress. Land development is also projected to lead to increasing strains on the ability of forests and rangelands to provide nature-based outdoor recreation, with declines in per capita recreation availability in locations experiencing land development. In addition, the loss of forest land alters both the amount of total carbon stored in the Nation's forests and the rate at which forests accumulate carbon—because less forest land is available for sequestration.

### The combination and interaction of socioeconomic change, climate change, and the associated shifts in disturbances will strain natural resources and lead to increasing management and resource allocation challenges.

Socioeconomic change, climate change, and natural disturbances will alter the future health and productivity of natural ecosystems. Uncertainty about the magnitude of these changes drives RPA examination of alternative plausible futures. Policymakers and resource managers can use RPA results to identify areas of potential future stress, and to strategically initiate or enhance targeted management and adaptation actions.

By 2070, droughts are projected to occur more often, last longer, and be more intense. In the majority of examined climate futures, droughts are projected to occur most often in forest and rangeland ecosystems of the RPA Rocky Mountain Region and the southern portion of the Pacific Coast Region. Some of the fastest growing regions of the country are projected to become the driest, exposing more people to water shortages. Projected increases in exposure to drought indicate future challenges for managers and

policymakers. Adaptation options such as increasing reservoir storage have limited ability to curtail shortage, and even groundwater mining—the most promising short-term adaption option—has limited availability to curtail shortage in the long term. In many areas, water shortages are already driving transfers of water from agriculture to urban users. Such transfers are likely to become more common.

Future droughts can also lead to reductions in rangeland health and productivity. Recent drought events may be responsible for reduced rangeland health in Arizona, New Mexico, southeast Colorado, northwest Texas, western Oklahoma, and southwest Kansas. In Texas, severe drought in 2011 and 2012 corresponded with widespread reductions in rangeland production, as well as forest mortality. Prolonged droughts in the Southwestern United States and California are creating conditions that have not been experienced since Euro-American settlement. Changes in climate are also expected to shorten the rangeland growing season primarily due to nutrient limitations, leading to decreases in forage availability and associated declines in ungulate success. These novel conditions will create challenges for rangeland managers trying to balance the sustainable production of domestic ungulates with other ecosystem services, such as maintaining forage reserves for native ungulates and other species.

The average annual area burned by large wildfires in forests and rangelands from 2000 to 2017 was more than double the average from 1984 to 1999. The total area of high-severity fires, as well as the volume of trees killed annually by fire, is expected to increase further by 2070. The largest increases in fire-killed tree volumes are projected to happen disproportionately in the Western United States among Douglas-fir, ponderosa pine, and pinyon/juniper forests, as well as woodland hardwoods. Shifts in the fire regime patterns pose threats to those ecosystems, some of which are adapted to lower severity fire. Escalating fire activity also poses threats to human health and property, particularly in the growing wildland-urban interface. In addition, smoke from wildfire influences where and when visitors take outdoor recreation trips. Visitors could choose to avoid fire-prone areas, reducing economic benefits while leading to increased recreation-associated strains and overuse among other forest ecosystems.

As described above, certain forest ecosystems and locations are projected to be disproportionately affected by changing conditions. Dominant forest types in the Rocky Mountain Region including Douglas-fir and ponderosa pine are projected to lose area, growing stock volume, and carbon. These expectations raise concerns about the sustainability of these forests, as well as the wildlife, recreation, and forest product manufacturing sectors that depend upon them. Rising sea levels in the Southern and Eastern United States have already led to transitions of coastal forests

into saltwater marshes. Although not explicitly modeled in this report, further projected increases will continue this transition and increase destruction of residential housing in coastal areas, causing greater pressure for land development away from coasts. Over large areas, such effects could increase demand for wood products for rebuilding, leading to increased timber and product prices as well as increased timber harvesting.

Pressure from future disturbance (including wildfire), forest conversion to developed land, and forest aging, along with rising demand for forest products, is projected to influence carbon futures both in terms of the amount of carbon forests store (carbon stocks) and annual rate at which forests store carbon through forest growth (carbon stock change). Currently, carbon accumulation through growth both in forests and in the amount of carbon stored in harvested wood offsets more than 10 percent of economy-wide carbon emissions annually. However, forest growth rates are projected to slow as forests age, disturbance increases, and forests are converted to other land uses. Under RPA scenarios where demand for wood products and the conversion of forests to other land uses are both high, the forest ecosystem is projected to become a net carbon source. While the increased demand for wood products under these scenarios is projected to lead to a substantial annual increase in carbon stored in harvested wood, this would only partially offset carbon emissions from the forest ecosystem. This partial offset would lead to a reduced sink strength and the likelihood that the forest sector would become a net carbon source.

Biodiversity in the conterminous United States is highest in the North and South RPA Regions; however, projections for the coming decades indicate that these regions are the most vulnerable to the stress of land use change in the form of land conversion to development, expansion of agricultural areas, and development of energy infrastructure and mining. The relatively small federally managed land base in the North and South Regions, which can serve as conservation refugia to some biodiversity, is unlikely to counteract any widespread biodiversity losses in those regions in the coming decades. Although the Pacific Coast and Rocky Mountain Regions have expansive areas of Federal lands, their associated biodiversity is projected to be under high climate stress, in part due to their locations at high elevations. Climate change may compromise the ability of federally managed lands to provide climate refugia, and may force land managers to consider modifying management approaches to account for warmer temperatures, increased intensity of precipitation events, and the potential for greater numbers of extreme events such as drought, heat, and wildfire.

Although per capita participation in outdoor recreation activities was relatively stable in the years leading up to 2020, population growth has led to an increase in the number of participants, and this growth is expected to continue under

most future scenarios. However, the per capita area available for forest recreation is projected to shrink in most regions by 2070. When combined with increasing participation, existing forest recreation areas in these locations will be in high demand. Developed recreation sites and recreation infrastructure are particularly likely to face high demand because activities that require developed infrastructure—for example, historic site visitation, picnicking, motorized boating, developed skiing, and day hiking—are projected to see large gains in recreation consumption. In addition, increased frequency and severity of disturbance associated with climate change may reduce the availability and condition of recreation opportunities, with recreationists opting to recreate in different seasons or in different locations to avoid disturbance.

## Land management and adoption of conservation measures can reduce pressure on natural resources.

Management actions can play key roles in avoiding or mitigating the impacts of disturbances and changing climate in some ecosystems at local and landscape scales. In some forests, treatments such as thinning and prescribed fire have been effective at ameliorating drought impacts and have shown the potential to reduce the occurrence of high-severity fires. Active forest management has also been used to improve forest growth and health, including the development of forest plantations, which focuses timber production on a smaller land base. Continued improvements in management techniques and the use of genetically improved planting stock in forests managed for timber can increase the amount of timber available for forest products and reduce harvesting pressure on other forests.

Technological advances and adoption of technology and other conservation measures have led to decreases in water use, even as human population has increased. From 2005 to 2015, surface freshwater withdrawals decreased in 64 percent of counties nationwide. During the same period, domestic withdrawals for household use fell by 10 percent nationally despite an 8-percent increase in population. Many of these gains in efficiency have been driven by technological advances such as requirements for low-flow toilets and community regulations that prohibit nonessential turf or incentivize their removal. Recent efficiency increases in irrigation for agriculture and cooling methods for thermoelectric power plants, especially in water-scarce regions, have led to a 7-percent decrease in irrigation withdrawals and a 34-percent decrease in thermoelectric withdrawals over this same time period. These and other advances in efficiency are key components of social adaptation to water scarcity and could help to mitigate some impacts on society under projected drier conditions and increasingly frequent drought.

Policy changes can also lead to natural resource improvements. The Clean Air Act Amendments of 1990 have resulted in substantial sulfur and nitrogen emissions reductions, with the highest reduction in the North Region. These reductions have enabled some ecosystems to recover from years of impacts from acid rain and eutrophication, increasing resilience to climate change and providing improved wildlife habitat. Some ecosystems have even recovered to the point of allowing the reintroduction of previously extirpated species, including brook trout in the Adirondack Mountains in New York. Projections developed outside of RPA indicate continued reduction of sulfur and nitrogen deposition through 2070 across the United States.

Shifts in urbanization patterns have led to slowdowns in certain trends that were projected in the 2010 RPA, with an associated reduction in resource impacts over what was previously expected. The conversion rate to developed land use increased from 1982 to 1997, then declined until 2012. Land cover data suggest that this rate continued to decline after 2012. Although the area of developed land continues to increase, the declining rate of transition shows a lower rate of impacts to natural areas than was projected. Similarly, although forest cover fragmentation increased from 2001 to 2016 in all RPA regions over a wide range of spatial scales, the rate of forest cover loss and fragmentation decreased after 2006 in all regions. The interior forest area actually increased in the South Region after 2006. Under the new projections, although the overall forest area is expected to decrease across all scenarios, the share of more-contiguous forest is projected to increase in the South Central, Northeast, and North Central Subregions.

## Looking Forward

The RPA legislation recognizes the importance of forests and rangelands in contributing to the American public's well-being and quality of life. Maintaining forests and rangelands that are productive and provide a range of ecosystem services starts with continual monitoring and analysis of the effects of changing socioeconomic trends and a changing climate on these resources. Across all futures evaluated in

this Assessment, a growing economy and shifts in land use are projected to lead to increased pressures on U.S. forests and rangelands, and greater demand for the goods and services they provide. Projected climate change, in concert with associated changes in interacting disturbances such as wildfire and drought, directly affects natural ecosystems and will present new challenges for resource managers.

The futures presented in this report are based on a continuation of current U.S. natural resource management policies in the face of projected changes in climate, demographic and economic conditions, and social values. Our results highlight a number of areas in which policymakers and land managers may experience pressure to change current policies or develop new approaches. The negative effects on the environment, economy, and society portrayed by many of the scenarios in this RPA Assessment are not foregone conclusions. Some of the negative effects can be modified or reduced by timely actions from policymakers and land managers and by advanced management approaches that emerge from investments in science and technology. The RPA Assessment also points to several areas in which changes in choices or technology have recently reduced pressure on natural resources. Additionally, some of the futures may present opportunities for new and improved resource uses and management approaches.

Forests and rangelands exist within broader and dynamic societal and ecological contexts. The many land uses, economic sectors, and competing and changing resource demands across the United States complicate how governments, organizations, and landowners allocate the scarce economic resources they manage. The RPA Assessment seeks to improve understanding of the multiple and interacting factors that have created current trends and how we expect these factors and others to affect renewable natural resources in the future. This focus is a unique contribution that provides important information to policymakers and resource managers as they develop strategies for sustaining the Nation's renewable natural resources.