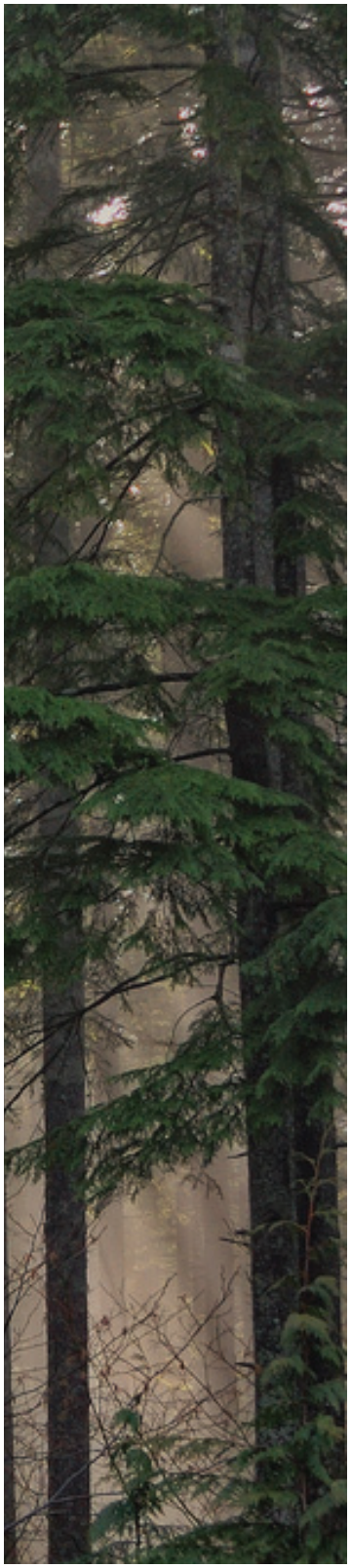
9. Forests



9. Forests

Climate change is expected to affect Washington's forested landscapes in multiple ways. Forests cover 22 million acres in Washington, or over half of the total area of the state. Approximately 44 percent of forest land is in federal ownership; 13 percent is in state and local ownership; and 43 percent is privately owned.[139]

Washington's forests, timber supply and forest-related industries contributed approximately $16 billion to Washington's economy in 2005 and employed 45,000 people with a total payroll of $2 billion. [140] Forestry is the major employer in many rural communities in the state. The Washington State Department of Natural Resources manages about 2.1 million acres of forested state trust lands, producing about $200 million each year in revenue for designated public beneficiaries such as schools, universities, counties, and other public institutions.

Forests provide environmental and social benefits that Washington residents value, including clean water and air, fish and wildlife habitat, natural open space, and recreation opportunities. Forests also absorb and store carbon dioxide, and timber practices can produce biomass for energy production, in addition to primary forest products.

Biomass fuel:

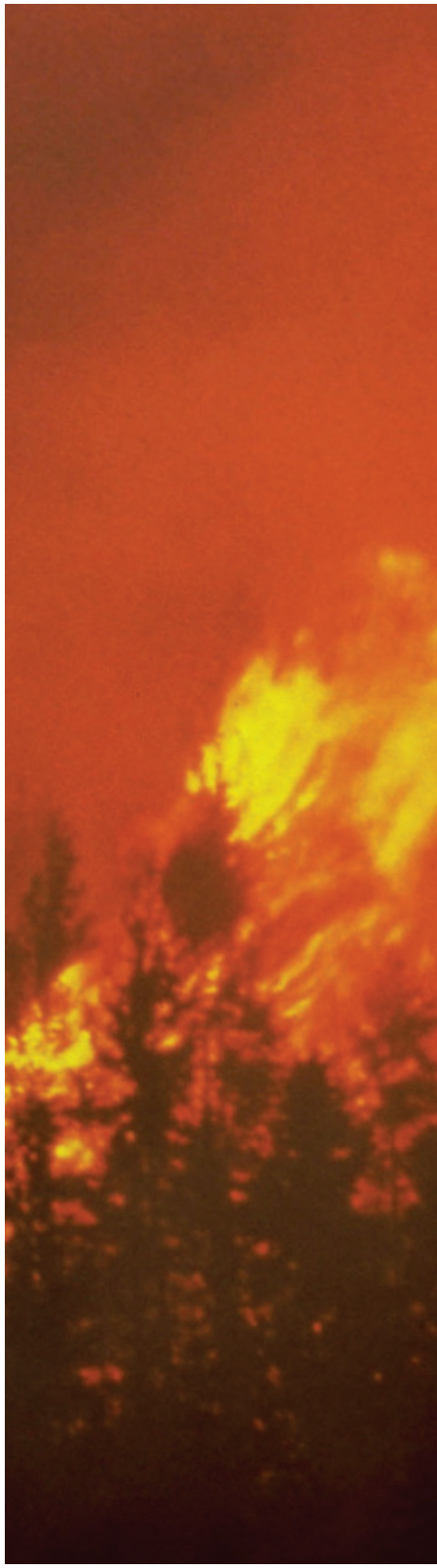
Plant material, wood, vegetation, or agricultural waste used as a fuel or energy source.

Forests are sensitive to climate variability and change. Warmer temperatures, earlier spring snowmelt, changes in precipitation patterns, and more frequent and severe extreme weather events are expected to change patterns of fire, insects, tree growth, and regeneration in the state. Understanding and accounting for future climate helps support long-term planning to manage and preserve healthy forests and the economic and environmental benefits they provide.

The following sections describe the scientific understanding of the impacts of climate change on Washington's forests and outline key strategies to support state and local efforts to protect forests and lower risks to our communities and ecosystems.

[139] Campbell *et al.* (2010).
[140] Partridge and MacGregor (2007).

Impacts of Climate Change on Forests



Climate change could fundamentally change the nature of forests in Washington, particularly in ecosystems where water shortages are greatest. Disturbances such as droughts, insects, disease, and fire are a natural part of ecosystem dynamics, and some disturbances are integral to maintaining healthy ecosystems. Climate change is affecting when and how often disturbances occur and how large they are, however. These events are likely to significantly alter many forest ecosystems and the animals that depend on them. Climate change is likely to reduce forest health and productivity and alter the geographic range of certain tree species.

Many impacts will likely occur first in forests on the east side of the Cascade mountains, but forests west of the Cascades also will likely experience significant changes in disturbances and species distribution before the end of the 21st century. Human factors—such as changes in land use patterns, population growth, and land and water management practices—also affect forests and could increase the vulnerability of forests to the impacts of climate change.

The key impacts of climate change on forests include:

- Larger and more frequent wildfires.
- Increase in mountain pine beetle outbreaks.
- Changes in geographic range, growth, and productivity.

1 Larger and more frequent wildfires

Fire plays a critical ecological role in many of Washington's forest types, particularly in the fire-adapted dry forests east of the Cascades. However, over a century of fire suppression, extensive logging, and overgrazing have resulted in forest conditions in many areas that are currently at an increased risk of unnaturally severe and extensive disturbance from fire, insects, and disease.[141]

[141] Hessburg and Agee (2003); Hessburg *et al.* (2005); Franklin *et al.* (2008).

Drier, hotter conditions are expected to increase the frequency and magnitude of wildfires. The annual area burned by fire in the Columbia Basin is projected to double or triple from an average of about 425,000 acres annually (1916–2006) to:

- 800,000 acres in the 2020s.
- 1.1 million acres in the 2040s.
- 2.0 million acres in the 2080s.[142]

Widespread areas of dead or damaged trees due to insect infestations make forests vulnerable to large, severe forest fires.

Fire regimes in different ecosystems in the Pacific Northwest have different sensitivities to climate. In forested ecosystems such the western and eastern Cascades, Okanogan Highlands, and Blue Mountains, the area burned is projected to increase by a factor of 3.8 by the 2040s, compared to 1980-2006.[143] In some drier areas, the year-to-year variation will also likely increase. In wetter regions in western Washington, the relationship between fire and climate is weaker, and future fire projections are less certain. However, rising summer temperatures, lower soil moisture, and higher evaporation rates could result in large disturbances in western Washington forests that have not traditionally been considered "fire-prone."[144]

Large, severe wildfires have serious economic and social consequences. On average, $26 million is spent annually (2002-2011) suppressing wildfires in Washington.[145] The true costs of such wildfires may be from 2 to 30 times greater, however, if we account for the myriad adverse environmental and social impacts.[146]

[142] Littell *et al*. (2010).
[143] Jamison (2012).
[144] Littell *et al*. (2010).
[145] Cline (2010), as cited in DNR (2010).
[146] WFLV (2010).

Impacts of wildfires to plants, wildlife, rivers, human health, and property

Increases in fire frequency could result in shifts in vegetation toward more fire-tolerant species or otherwise alter plant communities that depend on a given fire regime to persist.[147] These shifts could disturb wildlife populations that depend on affected forest habitats, and key wildlife migration corridors may be cut off.

Increased incidence of fire could also reduce the land's ability to absorb and slowly release rainwater, increasing erosion and sediment in rivers. Forest fires could also contribute to human health problems, primarily smoke inhalation, and to damage to houses and public facilities.

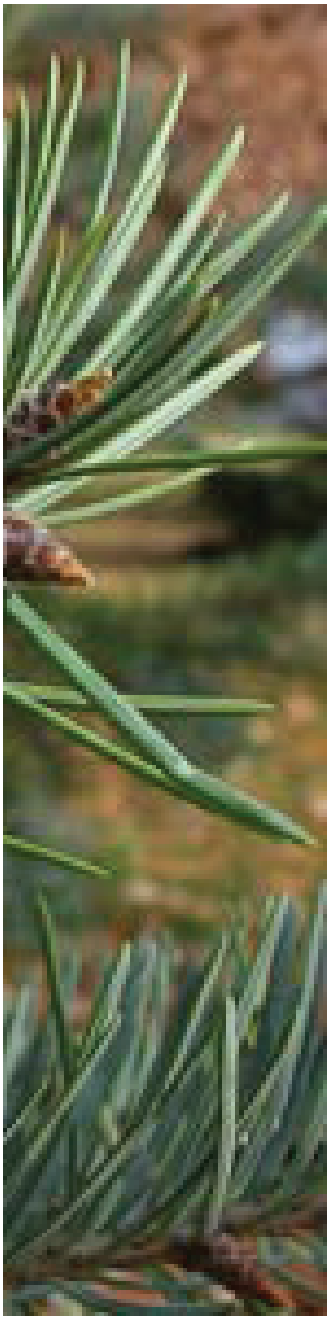
2 Mountain pine beetle outbreaks

Mountain pine beetle outbreaks in Washington's lodgepole pine and whitebark pine forests are of particular concern because they are spreading rapidly and migrating to higher elevation trees, killing trees in their path. Temperatures currently leave forests vulnerable to mountain pine beetle outbreaks in large areas of the Olympic Mountains, northern Rocky Mountains, in a mid-elevation band on the west and east sides of the Cascade Mountains, and to a lesser degree in the Blue Mountains of southeastern Washington.[148]

With warmer temperatures and more drought stress, mountain pine beetle outbreaks are projected to increase in frequency. Warmer temperatures allow for more winter survival of insects and pathogens as well as faster insect growth. Warmer conditions also shift their ranges, and drought stress makes trees more susceptible to attack. Mountain pine beetle outbreaks will reach higher elevations as temperatures warm. At lower elevations, the mountain pine beetle could become less of a threat, however, and the total susceptible area for outbreaks could decline. Other insect species may emerge in areas that are no longer suitable for the mountain pine beetle.[149]

[147] Noss (2001).
[148] Littell *et al*. (2010).
[149] Littell *et al*. (2010).

3 Changes in geographic range, growth, and productivity



With increases in temperature and decreases in water availability, the climate will become unsuitable for certain tree species. Conifers such as Douglas-fir, yellow cedar, and western hemlock dominate Washington's landscape, and climatic and elevation gradients strongly influence their distribution. Growth and vigor is expected to decline in Douglas-fir, lower-elevation ponderosa pine, and western hemlock forests.

Douglas-fir: Douglas-fir productivity varies with climate across the region and will potentially increase in wetter parts of the state during the first half of the 21st century, but productivity is expected to decrease in the driest parts of its range. The area that can support Douglas-fir in Washington is projected to shrink by 32 percent by the 2060s and by 55 percent by the 2080s.[150] This decline will be most pronounced at lower elevations, especially in the Okanogan Highlands and the south Puget Sound/southern Olympics.

Pine forests: About 85 percent of the current habitat for pine will shift outside the climatically suitable range for one or more pine species.[151] This shift will be especially apparent in pine forests in the Columbia Basin and eastern Cascades as early as the 2040s, particularly in parts of the Colville National Forest, Colville Reservation, and central Cascades.[152]

The area of severely water-limited forests is projected to increase by at least 32 percent in the 2020s and an additional 12 percent in the 2040s and 2080s. Geographic patterns of forest productivity will likely change; statewide productivity may initially increase due to warmer temperatures but will then decrease due to increased drought stress.[153]

[150] Littell *et al*. (2010). Actual quote: About 32% of the area currently classified as appropriate climate for Douglas-fir would be outside the identified climatic envelope by the 2060s, and about 55% would be in the 50%-75% range of marginal climatic agreement among models. Only about 13% of the area currently suitable for Douglas-fir would be suitable in >75% of the statistical species models.
[151] Littell *et al*. (2010).
[152] Littell *et al*. (2010).
[153] Littell *et al*. (2010).

Recommended Adaptation Strategies and Actions—Forests

Washington's forests and rangelands provide a significant source of revenue to the state, along with tremendous environmental, social, and ecological benefits such as watershed protection, wildlife habitat, recreation, carbon storage, and biomass for energy production. Forests reduce erosion, recharge aquifers, regulate streamflows, moderate water temperatures, and protect water quality. Urban forests play a significant role in protecting public health from rising temperatures, air and water pollution, flooding, and precipitation runoff. Climate change will not only affect forest health and productivity—it will also affect our ecosystems and the range of goods and services they provide. The following four strategies focus on ways to protect, manage, and restore our forests.

Strategy F-1. Conserve and restore healthy, resilient forests across ownership boundaries and large geographic ranges to minimize the threats from climate change and extreme weather events.

Actions:

1. Develop a comprehensive approach that integrates objectives and actions for preservation of working forests, wildfire management, insects and diseases control, and forest health protection and restoration. Developing the integrated approach needs to occur in partnership with tribal, federal, state, and local resource protection agencies; public land management agencies (Department of Natural Resources, U.S. Forest Service, Bureau of Land Management and others); private forest landowners; nongovernmental organizations; and other stakeholders.

2. Develop a coordinated plan for fire hazard reduction and suppression for at-risk forests to assist policymakers, communities, and jurisdictions with land-management decisions so that forest fire threats are reduced. Information on existing and projected forest health and fire hazard conditions should be widely shared with forest landowners, managers, decision makers, and the public.

Statewide Forest Resource Assessment and Strategy

The 2008 federal Farm Bill required state forestry agencies to conduct a Statewide Forest Resource Assessment and Strategy as a condition of receiving forest landowner assistance funds. Washington State Department of Natural Resources (DNR) completed the forest resource assessment and strategy in June 2010. The assessment identified wildfire hazard reduction and forest health restoration as major issues, with the greatest risk of wildfire in eastern Washington, mountain gap wind zones, and the San Juan Islands.

DNR recently completed its 2010-2014 Strategic Plan (see box on the next page) to guide the agency's focus and new initiatives. Several issues identified in the Statewide Forest Resource Assessment are addressed in the Strategic Plan and can be seen as an expression of agency-wide priorities.

www.dnr.wa.gov/Publications/em_wa_statewide_a_cover_contents_intro_section.pdf

3. Reduce development pressures on forestlands by working with local governments to protect forestlands from conversion, such as through zoning and transfers of development rights. Facilitate implementation of best practices, and engage private landowners through market and investment opportunities.

4. Secure sustainable funding and expand financial and technical assistance to forest landowners. Use an "all-lands" approach for allocating public funding to forest landowners to implement new and modified practices that reduce risks from:
   - *Forest fires.*
   - *Pests and diseases.*
   - *Erosion and sediment loads into rivers.*
   - *Loss of habitat.*
   - *Loss of soil moisture.*

Transfer of development rights (TDR) allows owners of property zoned for low-density development or conservation use to sell development rights to other property owners located in "receiving" zones, such as designated urban areas, that can accept additional density.

5. Advocate at the federal level for:
   - *Increased funding for the Land and Water Conservation Fund, Forest Legacy Program, and Environmental Quality Incentives Program, which will benefit several states including Washington.*
   - *Passage of the Community Forestry Conservation Act, a bill to authorize tax-exempt revenue bonds for working forest conservation.*

DNR's 2010-2014 Strategic Plan: The Goldmark Agenda

The DNR Strategic Plan, known as the Goldmark Agenda, identifies preserving forest cover and protecting working forests from conversion as major goals for the Department. DNR has established several initiatives to support small forest landowners to maintain their land as working forests, advance policies and incentives to maintain private working forest lands and associated jobs, consolidate DNR-managed working forests into strategically positioned blocks that help provide compatible management for neighboring forest lands, and permanently maintain DNR-managed working forests at greatest risk of conversion.

Biodiversity and **habitat conservation** connect with the agency's strategic priorities for **natural area conservation** and **climate adaptation**. In addition, **upland water quality, quantity, and Puget Sound restoration** are central to DNR's responsibilities to regulate forest practices and manage state trust lands sustainability.

www.dnr.wa.gov/Publications/em_strategic_plan_2010_goldmark_agenda.pdf

Strategy F-2. Maintain and protect forest species and genetic diversity across the landscape to ensure long-term conservation of our forest genetic resources and help buffer against impacts of climate change.

Phenology:
Study of periodic biological phenomena, such as breeding, flowering, and migration, especially as related to climate.

Actions:

1. Ensure forest landowners continue to manage for native species and structural diversity. Use current reforestation practices to maintain species and genetic diversity across their forest lands.

2. Build disease resistance in five-needle pines and other tree species with serious disease issues, in cooperation with existing U.S. Forest Service efforts.

3. Maintain and expand participation in tree breeding, testing, and selection programs, such as those operated by the Northwest Tree Improvement Cooperative and the Inland Empire Tree Improvement Cooperative. Ensure that testing by cooperative members incorporates greater geographic diversity and adaptive traits such as cold-hardiness and drought-tolerance.

4. Create a gene conservation plan for tree species in Washington based on vulnerability assessments to climate change of various eastern and western Washington tree species. The U.S. Forest Service has completed a vulnerability assessment for western Washington.

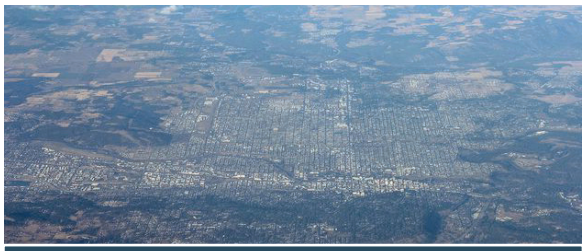
5. Create a cooperative tree seed bank within Washington State Department of Natural Resources to provide for recovery from large-scale disturbances, such as fire or insect outbreaks. This effort may begin with a "virtual" seed bank created with cooperative agreements among landowners who maintain seed inventories and are willing to make their seed available in the event of major disturbance.

6. Build on existing monitoring and evaluation programs to detect problems with tree growth, phenology, reproduction, or tree health.

Strategy F-3. Protect, expand, and manage urban forests to help communities reduce impacts of rising temperatures and extreme precipitation runoff events.

Actions:

1. Expand the Urban Forests Assistance Program (authorized under the Washington State Urban and Community Forestry Act) to help mitigate the impacts of climate change, such as the following:
   - *Airborne pollution.*
   - *Higher water temperatures in urban streams.*
   - *Urban heat island.*
   - *Heat waves.*
   - *Severe stormwater runoff.*
   - *Flooding.*
   - *Erosion.*



Urban Heat Island:
A metropolitan area that is significantly warmer than its surrounding rural areas.

2. Secure sustainable funding sources to build the Urban Forest Assistance Program's capacity to increase participation by cities, towns, and communities in planting and sustaining healthy trees and vegetation in urban areas.

3. Support cities and towns in developing education and community programs to enhance community awareness of the benefits that trees provide—including public health, environmental, ecological, and economic improvements. Support communities in adopting sound tree protection and management ordinances in all communities faced with threats from heat waves, flooding, and landslides.

4. Promote urban forests by engaging cities, communities, neighborhoods, local and state park officials, and volunteers in:
   - *Planting trees more tolerant of heat and drought conditions.*
   - *Implementing effective options for tree watering and maintenance.*
   - *Selecting pest- and disease-resistant trees.*
   - *Removing invasive species.*
   - *Monitoring the health of the trees.*

Strategy F-4. Build capacity and support for maintaining, enhancing, and restoring resilient and healthy forests.

Actions:

1. Build on existing or create new pilot projects, experiments, and research to better understand how forests are likely to respond after severe disturbance events. For example, would a combination of thinning and prescribed fires help vulnerable forests better adapt to fire?

2. Strengthen existing partnerships and build new collaborations across jurisdictions to share knowledge and information on climate change impacts and adaptation across all sectors and across broad landscapes of varying ownerships and jurisdictions. This approach is referred to as an all-lands approach.

3. Increase coordination and collaboration with federal and tribal governments, the scientific community, and private conservation groups to ensure that research and management strategies address Washington's forest needs and recognize the important social, economic, and environmental benefits of forests.

4. Improve forest health and reduce forest hazard conditions by providing information to landowners, policymakers, and the public about wildfires, pests, and diseases—and benefits that forest ecosystem services provide.

5. Improve understanding and communication of impacts and adaptation responses by engaging all levels of government, stakeholders, and the public in adaptation planning and decision-making affecting forests.

6. Integrate messages about the benefits of forest ecosystem services into education programs and curriculum related to natural resources management, environmental protection, urban planning, economics, and other programs.

7. Coordinate development and maintenance of integrated long-term, large-scale monitoring of early-warning indicators of species responses, including range shifts, population status, and changes in ecological systems functions and processes.