Adaptive Management in Response to Climate Change: A Synthesis of Research Findings and Observations from the Pacific Northwest Forests

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The Pacific Northwest Region

The Pacific Northwest (PNW) region of North America is loosely defined, and its boundaries vary depending upon the subject matter of the reference and the author's perspective. To establish context, all future references to the PNW refer to forested areas within the US states of Oregon and Washington, the coastal region of northern California, and the Canadian province of British Columbia.

Forests in the PNW are distinct among the Northern Hemisphere temperate forests in their species composition and high productivity. Composed mostly of conifers, these forests are adapted to the wet mild winters and warm-dry summers typical of the region.

Forest Management in the PNW

Forest management is an important sector in the PNW and has a significant and direct impact on the economy, as well as the health and well-being of its citizens by providing timber products, freshwater, wildlife habitat and recreation. PNW forests will continue to be an important part of the regional economy and play a significant role in carbon (C) sequestration and climate change mitigation.

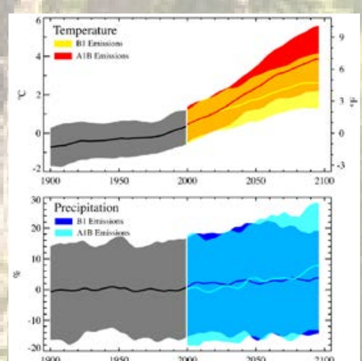
Projected Changes to Climate in the PNW

Temperature

- Temperature in the PNW region has warmed 0.7-0.9 C since 1920
- It is expected to warm a further 0.8–2.9 C by 2050 and 1.6–5.4 C by the end of the century
- It is likely to be greater inland than near the coast, and more pronounced in summer (3.9 C on average) than in winter (average of 2.7 C)

Precipitation

- Projected changes in regional precipitation are less certain than those for temperature
- Overall, small decreases in summer precipitation and small increases in winter precipitation are projected
- More winter precipitation will likely fall as rain compared to snow resulting in increased runoff and greater streamflows
- Summer runoff is likely to decrease and consequently reduce streamflows

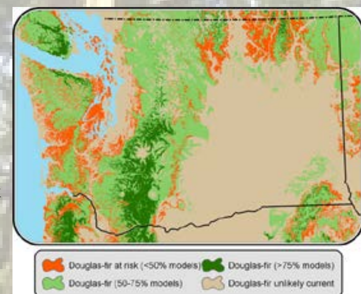


The figure above graphically shows the historical changes in both temperature and precipitation for the PNW, and the projected changes under different modeling scenarios.

Effects of Climate Change on Forests in the PNW

Increased Temperatures & Growth

- Warming may result in more frequent and severe heat events that expose trees to heat injury
- At low elevation sites where moisture is limited, increased summer temperatures may lead to higher rates of evapotranspiration, which could decrease growth in Douglas-fir and Western Hemlock forests
- In high elevation e.g., Subalpine Fir, Mountain Hemlock forests where moisture levels are adequate, growth may be increased by extending the duration of temperatures favourable for growth



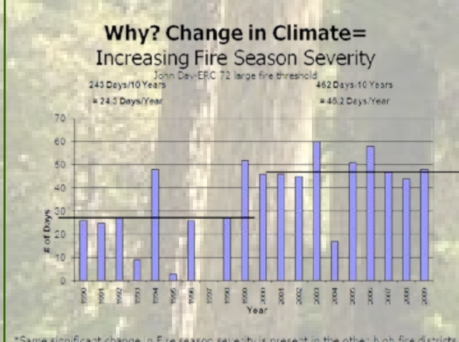
The figure above assesses the degree to which climate will change from currently suitable to unsuitable for the growth of Douglas fir by 2060. Tan indicates areas where climate is currently unsuitable whereas all other colors indicate locations where climate is currently suitable. The percentages refer to the number of statistical models which predict that the future climate in 2060 will remain suitable for Douglas fir.

Different Precipitation Regimes

- Projected decreases in snowpack, earlier snowmelt, and increases in the frequency of heavy precipitation events, may increase the frequency of flood-related injuries
- The consequences of flooding, however, will depend on the timing and duration of the flood, and the quality of water

Climate Change & Wildfire in the PNW

- An increase in fire activity is expected for all major forest types in the PNW. This, in part, is due to evidence suggesting increasing lightening activity under climate change, as well as high temperatures and expected drought conditions
- For a mean temperature increase of 2 C, the annual area burned by wildfires in western states is expected to increase by a factor of 1.4–5



The figure to the left shows the number of days the John Day forest unit in Oregon has spent at an ERC—or energy release component value—of 72. ERC is the relationship between weather and the volatility of forest fuels, and 72 is the threshold at which large fires occur. In the last 10 years, there has been a marked increase in the number of days at this higher level of risk for large and costly fires. This trend holds statewide, though each area has different numbers

Adaptive Management Practices in Response to Climate Change

Silvicultural and genetic practices can be employed to assist in forest adaptation to climate changes, principally by influencing stand structure and species composition throughout stand development

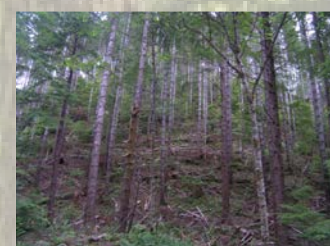
Case Study 1 – Olympic National Forest

- **Resistance strategy** – use early detection/rapid response to control exotic and invasive species

An example of an outbreak of Tansy Ragweed (Senecio jacobaea) beside a road. A rapid response to control the weed within this locality may prevent its spread into adjoining areas.

An example of stockpiling soil in situ from bridge replacement excavations because of the presence of an invasive weed in the area. The weed has since been removed but the soil will not be re-spread until the land managers are sure there is no chance of a reemergence.

- **Resilience strategy** - increase the amount of restoration thinning in young stands across large landscapes to reduce competition and drought stress, increase tree growth and vigor, insect resistance, structural complexity and species diversity



The photo to the left is from the "Two Flat" Douglas fir thinning site. The 55-60 year old stand was thinned using the variable density method. Prior to harvest, each cutting unit is assessed by forestry specialists to determine the best approach to promote old growth structure and form. The operation involves removing trees to create a stand of different species, age classes and size, thereby improving biodiversity and increasing the presence of hollow bearing trees.

- **Response strategy** - protect and conduct restoration treatments in riparian areas to provide corridors for species movement

Examples of riparian restoration following a bridge replacement across a stream. A major objective of this project was the restoration of aquatic habitat. Old trees, complete with their root-balls, were maneuvered into position as coarse woody debris along the channel (photo left). Planting of riparian understory species was also undertaken for ecological enhancement and bank stabilization (photo right).

Case Study 2 – Assisted Migration Adaptation Trial

- The primary focus of AMAT is to develop an understanding of the adaptation of seedlots from seed orchards, across a range of climatic and latitudinal environments
- The project involves testing 48 seed sources representing 15 commercial tree species across 48 field test sites located between central Yukon and northern California
- Growth, health and wood quality will be measured every five years
- An intent is to push these trees to their survival limits, perhaps even killing some, to gain a better understanding of when productivity declines and sickness sets in

Three plots established in Washington (left and right) and British Columbia, Canada (centre) as part of the trial

Key Silvicultural Lessons Learnt for Victoria, Australia

1. Developing an inventory of high quality seed for a range of tree species, including rare species
2. Increase the amount of thinning in young stands to reduce competition, stress, and fire hazard, and improve growth and insect/disease resistance
3. Increase the level and detail of provenance testing amongst seed-lots such that families adapted to a drier climate are identified and collected in larger volumes
4. The establishment of an assisted migration trial for the major commercial eucalypt species
5. The restoration of riparian areas when the installation and/or replacement of bridges and culverts are undertaken. This includes the planting of riparian species and the use of woody debris in improving fish habitat.
6. Working with the land management regulator to revise seed transfer guidelines to allow greater movement of seed-lots and hence an improved adaptability to a rapidly changing climate

Conclusions

Through a partnership of scientific research and on ground management, the probability of implementing successful programs can be enhanced by:
- identifying resilience thresholds for key species and ecosystem processes
- determining which thresholds are likely to be exceeded
- prioritising projects with a high probability of success
- identifying species and vegetation structures tolerant of increased disturbance

Dynamic and adaptive thinking needs to be integrated into the way we make planning and management decisions, including our learning from changing conditions.

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