Washington’s Future Forests

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Overview

• Principles
• Baseline
• Climate Change
• Humans and the Forest
• Shaping the Future Forest
Principles

• Ecosystems are composed of species and plant species primarily respond to climate.
• Dominant trees are keystone species.
• The major forest stressors are: drought, fire, pests, pathogens, climate change, invasives, and exploitation.
• Environment and ecosystem change never ends; there has never been a “once upon a time.”
Baseline: Past Forests
Keystone Tree Species

- Douglas-fir (33)
- Black cottonwood (31)
- Lodgepole pine (28)
- Western redcedar (25)
- Western hemlock (22)
- Bigleaf maple (21)
- Red alder (21)
- Ponderosa pine (19)
- Oregon white oak (14)
- Sitka spruce (13)

(Parentheses) = No. of Washington’s 39 counties where found (USDA PLANTS).
Current Forests

Source: USDA Forest Service (2017a, 2017b)
Climate Change
Principles

- *Greenhouse gases* change the amount of sunlight absorbed by the atmosphere, changing the weather, which has always been driven by the transport of heat from the equatorial towards the polar regions.
- Climate scenarios are based on science, data, and *computer models*.
- Scenarios depend on certain assumptions about *human behavior*, mainly, how rapidly greenhouse gases accumulate.
- Climate change is effectively *irreversible* at human timescales.
Transport of Heat

source: NASA
Principles

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Scenarios

Future CO2 emissions scenarios featured in CMIP6, as well as historical CO2 emissions (in black). The shaded area represents the range of no-policy baseline scenarios. Data from the SSP database; chart by Carbon Brief using Highcharts.
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## CLIMATE CHANGE SUMMARY (CMIP6)

<table>
<thead>
<tr>
<th>Variable</th>
<th><strong>WESTERN WASHINGTON</strong></th>
<th><strong>EASTERN WASHINGTON</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>2040</td>
</tr>
<tr>
<td>Summer temperature</td>
<td>59°F</td>
<td>up 3°F</td>
</tr>
<tr>
<td>Days above 95°F</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Summer rainfall</td>
<td>5.1 in.</td>
<td>down 8%</td>
</tr>
<tr>
<td>Annual precipitation</td>
<td>65 in.</td>
<td>down 2%</td>
</tr>
<tr>
<td>Annual snowfall</td>
<td>11 in.</td>
<td>down 20%</td>
</tr>
</tbody>
</table>

Baseline era is 1981 to 2010

W WA = Average of Snohomish and Olympics grid cells

E WA = Average of Spokane and Okanogan grid cells


Values based on SSP2 and SSP3 scenarios, i.e. small GHG emission reductions
Forecast: Drought

- *Increased atmospheric drought*: less rain, less snow, warmer thus higher vapor pressure deficit
- *Increased soil drought*: less summer rain, less snow, earlier snowmelt
- *Heat stress*: higher vapor pressure deficit, increased but also impaired plant metabolism
Source: Dong et al. 2019, modeling responses of an old-growth DF forest in WWA
Forests, Drought, and the 2021 Heat Wave

• Heat wave in late June 2021
• Many locations over 108°F (42°C); maxima 118°F (48°C)
• Widespread foliage death in OR and WA
• Multiple conifer species

The “Death Spiral” of drought
source: Mantova et al. 2021
Photosynthesis
Metabolism
Cell death

source: OSU 2021
Heat Wave Findings

• Heat waves comparable to the 2021 event are likely under all climate change scenarios
• All our forests are vulnerable, especially ponderosa and Douglas-fir dominated forests
• Risk factors include species, drought, duration, slope/aspect, and phenology
Biotic Effects of Climate Change

• Pests and pathogens
  – Trees more vulnerable when stressed by heat, drought, etc.
  – Disease may move into areas with previously unsuitable climate
• Altered phenology
Future Forest Fire Forecasts

- Effects related to climate change: hotter, drier
- Effects related to management: suppression
- Derivative ecological effects: productivity, mortality, competition
- Forecasts are based on modeling of these effects
Fire Model Forecasts

source: Sheehan et al. 2015
Habitat Suitability for Major Trees

• Altered suitability for all dominant species
• Changes are species-specific
  – Responses related to climate, physiology, ecological relationships, disturbance regimes
• Spatial scale exceeds seed dispersal distances
Climate Change Sensitivity of Dominant Trees

source: Case and Lawler 2016
Humans and the Forest
Principles: History

• The human relationship to the forest has historically been one of exploitation or neglect
• Exploitation has focused on harvest, neglect has focused on preserves
• Neglect has become harmful; the future requires ecosystem management in all forests
Source of Future Impacts

- Climate change, as discussed earlier
- Changes in forest landscape pattern and age structure due to
  - Land conversion
  - Timber harvest
  - Fire suppression
- New, non-native pests and pathogens
More People - Land Use Change

source: US Census Bureau
Fire Suppression: Evidence and Results

sources: Swetnam et al. 2016; Hagmann et al. 2021 (Van Pelt)
Fire Severity Changes

ca. 1800  Modern

source: Hagmann et al. 2021 after Hessburg et al. 2005
Pests & Pathogens

White pine blister rust impacts on all 5-needle pines of western North America (except *P. longaeva*).

Tree inventory data taken from the Panhandle National Forests (Idaho) illustrates the decline of white pine relative to its companion species.

sources: Schoettle 2019, Neuenschwander et al. 1998
Shaping the Future Forest
Climate Change Adaptation

• The most promising programs include vision, goals, and tactics
  – Vision defines the problem
  – Goals define a desired future condition (a constantly changing target)
  – Tactics are tools especially useful for achieving goals
Vision

Manage forests to optimize ecological services
• Priority One: Minimize risks of catastrophic failure
• Create habitat connectivity on the landscape
• Designate and defend ecological refugia
• Leverage disturbance! That is the best time to realign vegetation with climate
Goals

- Retain biological diversity (species, genetic, structural)
- Protect special ecosystems (aquatic, talus, etc.)
- Maintain habitat (fish, game, threatened species)
- Provide timber
- Control fire (e.g., WUI)
- Preserve hydrologic functions
- Provide for recreational use
- others?
Tactics

- Scientific, e.g. geospatial data and modeling to evaluate the alternatives and track progress
- Law, policy, and society, e.g.
  - Forest thinning programs
  - Assisted migration programs
  - Conservation reserve designation and management
- Existing laws provide for most tactical approaches, but funding is scarce.
Assisted Migration

We can do it with trees.

What about the species that depend on those trees?

sources: Williams and Dumroese 2013, Richardson et al. 2009
Conclusions

- Washington’s future forests will be much different from those we have known
- They will be hotter, drier, and support less biomass
- We have options to manage the changes and minimize their harm
- We have a limited time to develop the science, policies, regulations, and funding structures to meet this challenge


Citations 2


Washington Department of Natural Resources. 2020. Safeguarding our lands, waters, and communities: DNR’S plan for climate resilience. Washington Department of Natural Resources, Olympia, WA.


