Reshaping Nature: Climate Change in the Blue Mountains and Beyond

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Weather vs. Climate

• Weather refers to day-to-day changes in temperature, precipitation, etc. at a specific location.

• Climate refers to the average of these variables over long time periods.

  “You pick your vacation destination based on the climate, but you pack your bag based on weather.”

• Individual weather events, especially extreme events, do not prove or disprove climate change.
It’s all about this thin layer
Greenhouse gases (water vapor, CO$_2$, CH$_4$, N$_2$O) play a critical role in determining global temperature. Rapid increases in greenhouse gases are changing this natural balance.
Carbon dioxide is increasing

Atmospheric CO$_2$ is now 400 ppm.

It was 260 ppm in 1850.

source - http://www.esrl.noaa.gov/gmd/ccgg/trends
1.6 Watts
X 500 trillion
Average annual temperature has increased +1.5°F since 1920.

Almost every station shows warming.

Extreme cold conditions have become rarer.

Low temperatures rose faster than high temperatures.
Projected Temperature in Pacific Northwest

TMEAN (Jan–Dec), 42–50°N, 110–124°W

Departure From 1950–2005 Mean (°C)

Departure From 1950–2005 Mean (°F)
What will future climate feel like?

La Grande average temperature (°F)

<table>
<thead>
<tr>
<th>Month</th>
<th>Current</th>
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<tbody>
<tr>
<td>July</td>
<td>70</td>
</tr>
<tr>
<td>January</td>
<td>31</td>
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What will future climate feel like?

La Grande *average* temperature (°F)

<table>
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<tr>
<th></th>
<th>Current</th>
<th>Future</th>
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<tbody>
<tr>
<td>July</td>
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What will future climate feel like?

La Grande *extreme* temperature (°F)

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<tr>
<td>July (hi)</td>
<td>85</td>
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<td>January (lo)</td>
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La Grande *extreme* temperature (°F)

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What will future climate feel like?

Cities whose current temperature equals future La Grande temperature

July
Knoxville, TN
Omaha, NE
Salt Lake City, UT
What will future climate feel like?

Cities whose current temperature equals future La Grande temperature

**July**
- Knoxville, TN
- Omaha, NE
- Salt Lake City, UT

**January**
- Nashville, TN
- Portland, OR
- Tulsa, OK
This is what we know…

There is a natural greenhouse effect.

Humans are increasing the greenhouse effect by adding greenhouse gases to the atmosphere.

Effects of a changing climate are already apparent.

There will be more global warming to come.
Nearly every glacier in the Cascade and Olympic Mountains has retreated during the past 50-150 years.

South Cascade Glacier, 1928 (top) 2009 (right)
Nearly every glacier in the Cascade and Olympic Mountains has retreated during the past 50-150 years.

Since 1900, glacial area in the North Cascades has decreased by 46%.

*South Cascade Glacier, 1928 (top) 2009 (right)*
Snowpack is changing

Less snow in winter, and more rain on snow

April 1 snow water equivalent, since 1950
Less snow will alter streams

Winter floods will be more frequent, higher.
Less snow will alter streams

Winter floods will be more frequent, higher.

Summer stream flows will be lower.

Stream temperature will be higher.
Stream temperature, recent

Summer Stream Temperatures

1 kilometer resolution

1993-2011 Composite

Coming soon
Stream temperature, 2040s

Summer Stream Temperatures

1 kilometer resolution

2040’s A1B

Developed for same future periods & using same CIG 10 model GCM ensemble as VIC flow scenarios
Stream temperature, 2080s

Summer Stream Temperatures

1 kilometer resolution

2080’s A1B

Developed for same future periods & using same CIG 10 model GCM ensemble as VIC flow scenarios
How will forests grow in a warmer climate?

Losers: low elevation
Ponderosa pine, Douglas-fir, western larch, western juniper
How will forests grow in a warmer climate?

Losers: low elevation
Ponderosa pine, Douglas-fir, western larch, western juniper

Winners: high elevation
Subalpine fir, Engelmann spruce, limber pine
Altered disturbance regimes will overwhelm gradual changes in ecosystems
Extremes matter!

Frequency, extent, and severity of disturbances may be affected by climate change, altering the mean and *variability* of disturbance properties.

A shift in *distribution* of fire properties has a larger relative effect at the *extremes* than near the mean.

A shift of 1 standard deviation changes a 1 in 40 yr event to a 1 in 6 yr event.
Interacting disturbances?

Recent Disturbance

- Fire area (since 1984)
- Insect and disease area (since 1997)
Climate change affects insects

*Mountain pine beetle*

Warmer temperature has favored MPB by:

- Increasing its reproductive rate
- Allowing an expanded geographic range
Total acres with tree mortality from mountain pine beetle, by year

10 million acres

Area with tree mortality from mountain pine beetle

- 2000-10
- 2011

Mountain pine beetle (actual size)

Source: Forest Health Technology Enterprise Team, USDA Forest Service

Beetle photo: Erich G. Vallery, USDA Forest Service

Graphic by: Ryan Morris
Provincial-Level Projection of the Current Mountain Pine Beetle Infestation

Cumulative percentage of pine killed:
observed 1999 to 2011
projected 2012 to 2020
Does climatic variability affect wildfire?
Does climatic variability affect wildfire?
Area burned in 11 Western states, 1916-2012

Period of post-settlement fire

Period of active fire suppression and fuel accumulation

Period of fire increase
Wildfire area burned, 2050
Wildfire area burned, 2050

In the Northwest, for a 2°F increase, annual area burned will be at least 2-3 times higher.
How do we manage for resilient ecosystems in a warmer climate?
Responding to Climate Change in National Forests:
A Guidebook for Developing Adaptation Options

David L. Peterson, Constance I. Millar, Linda A. Joyce,
Michael J. Furniss, Jessica E. Halofsky, Ronald P. Neilson,
and Toni Lyn Morelli
Adaptation option 1

Increase biological diversity

Plant nursery stock from warmer locations than specified by genetic guidelines.

Plant mixed genotypes (and species?), with emphasis on fire resistant species where appropriate.
Adaptation option 2

Increase landscape diversity

Diversify spatial distribution of forest age and structure

Implement thinning and fuel treatments across large landscapes.

Orient the location of treatments in large blocks to modify fire severity and spread.
Adaptation option 3

Treat large disturbances as an opportunity

Develop management strategies and on-the-ground actions for implementation following wildfire and insect outbreaks.

Include long-term experimentation.

Get the plans approved.
The challenge: Managing large landscapes to increase resilience
Vulnerabilities and adaptation

VEGETATION
Vulnerabilities and adaptation

VEGETATION

Vulnerability

• Wildfire will burn more area and over a longer fire season
Vulnerabilities and adaptation

VEGETATION

Vulnerability
• Wildfire will burn more area and over a longer fire season

Adaptation option
• Accelerate hazardous fuel treatment, stand density management
Vulnerabilities and adaptation
WATER
Vulnerabilities and adaptation

WATER

Vulnerability

• Higher peak flows in fall and winter
Vulnerabilities and adaptation

Vulnerability
• Higher peak flows in fall and winter

Adaptation option
• Design roads and culverts to accommodate higher peak flows
Vulnerabilities and adaptation
FISHERIES
Vulnerabilities and adaptation

FISHERIES

Vulnerability

• Higher stream temperatures will degrade habitat
Vulnerabilities and adaptation

FISHERIES

Vulnerability

• Higher stream temperatures will degrade habitat

Adaptation option

• Restore and maintain cold-water habitat
What is the Blue Mountains Adaptation Partnership?

A science-management partnership:

- Malheur, Umatilla, and Wallowa-Whitman NFs
- Pacific Northwest Region
- PNW Research Station, Rocky Mountain Research Station
- Oregon State University, Climate Impacts Research Consortium (funding from NOAA)
What is the Blue Mountains Adaptation Partnership?

Focus on key resources:

- Hydrology, water use, and infrastructure
- Fisheries
- Vegetation and ecological disturbance
Blue Mountains Adaptation Partnership (BMAP)

BMAP is a Forest Service science-management collaboration with the goals of:

1. Increasing climate change awareness;
2. Assessing vulnerability of cultural and natural resources; and
3. Developing science-based adaptation strategies and incorporating them into management of federal lands in the Blue Mountains.

Staying up to date with BMAP
The BMAP General Technical Report is currently being developed.

Funding
This project is supported in part by funding from the National Oceanic and Atmospheric Administration to the Pacific Northwest Climate Impacts Research Consortium and Oregon State University.

http://adaptationpartners.org/bmap
What is the BMAP process?

• Develop vulnerability assessment for key resources
• Convene workshop – April 23-24
• Discuss the assessment, develop adaptation options
• Compile a USFS General Technical Report (peer reviewed)
Thank you!
Questions?