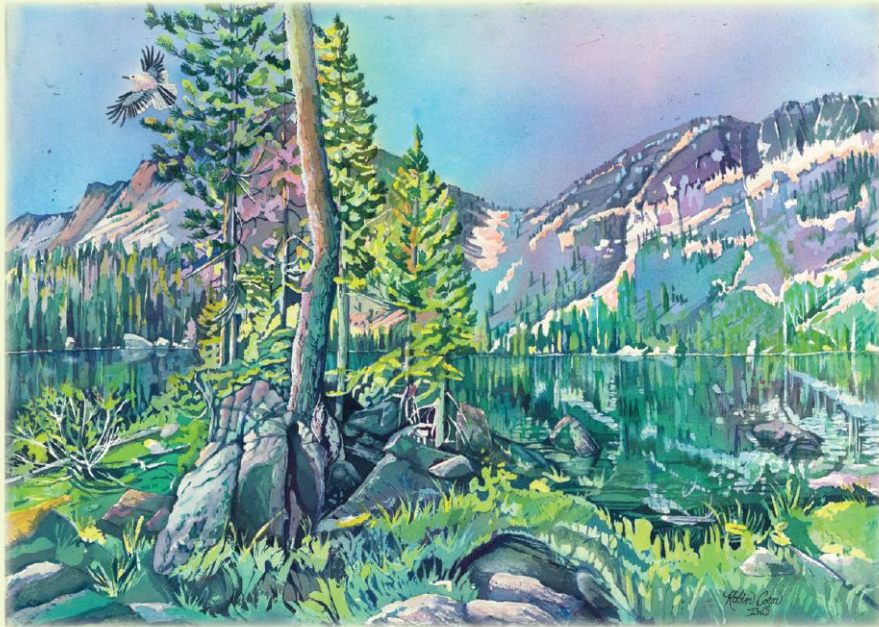


Refugia of the Blue Mountains



Robin Coen

Carbon & Culture Symposium
Ascencion School, Cove, OR

David Mildrexler, PhD
Systems Ecologist
Eastern Oregon Legacy Lands

Sept, 30 2025

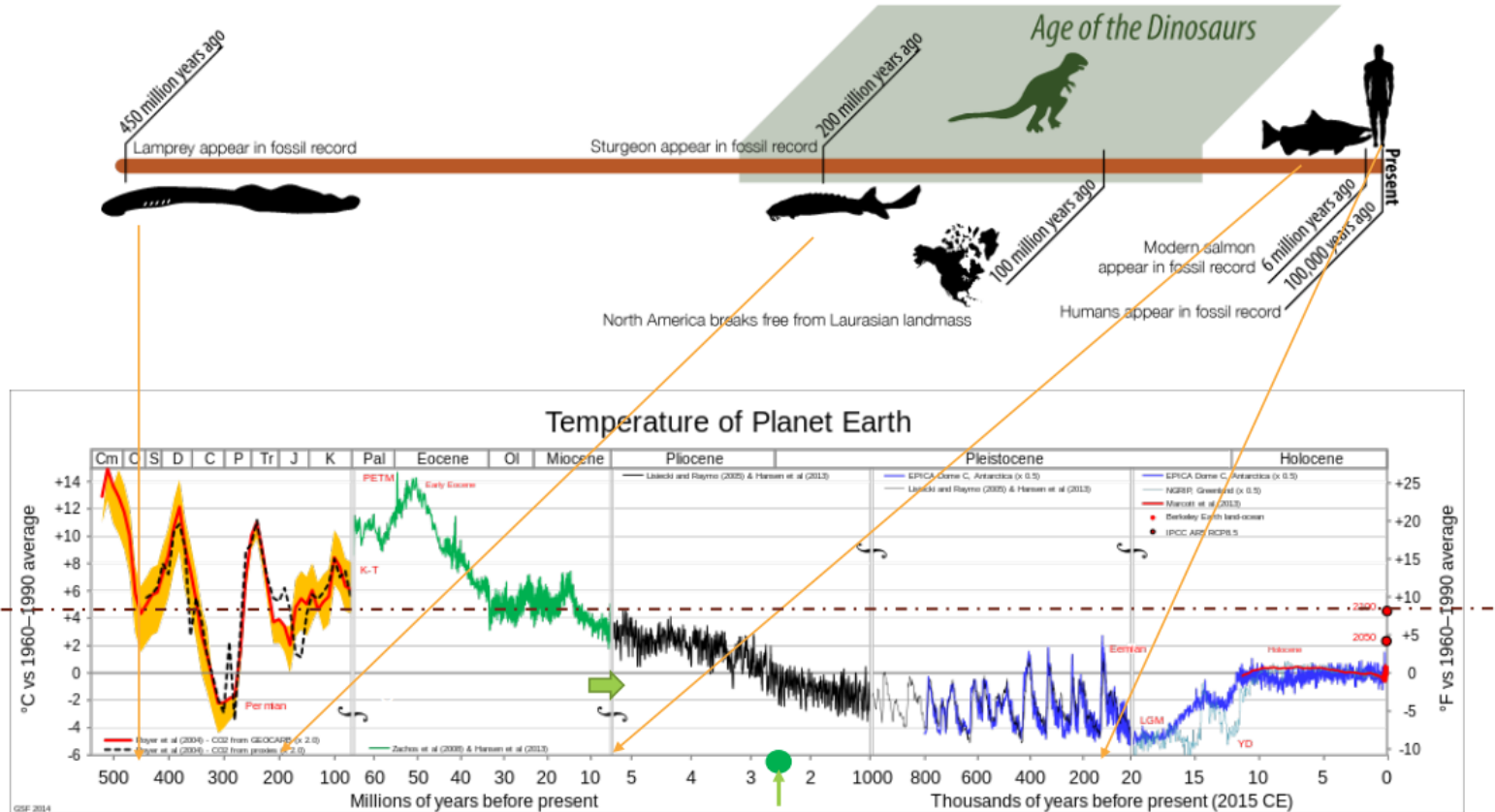


Eastern Oregon
Legacy Lands

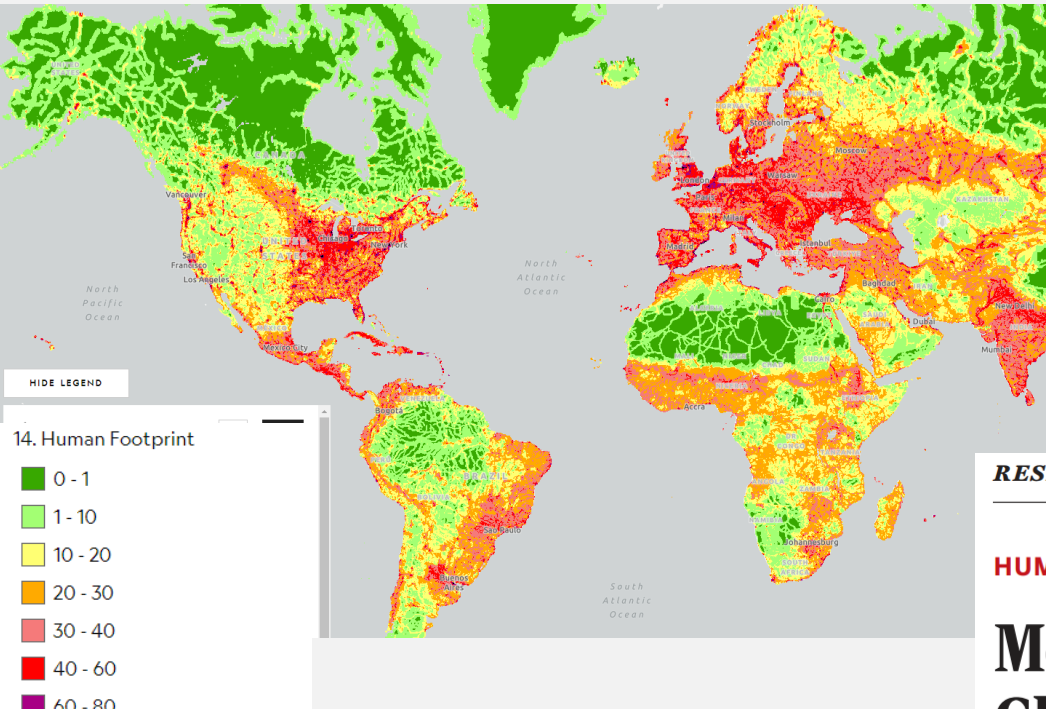
Refuge vs. Refugia

- Refuge- a condition of being safe or sheltered from pursuit, danger, or trouble.
 - *In ecology*: The term has also been used to denote areas protected from anthropogenic disturbance (e.g. reserves)
- Refugia are habitats that components of biodiversity retreat to, persist in and can potentially expand from under changing environmental conditions

Refugia and Climatic Change



Human Footprint



Catastrophic Declines in Wilderness Areas Undermine Global Environment Targets

James E.M. Watson,^{1,2,7,*} Danielle F. Shanahan,¹ Moreno Di Marco,^{1,3} James Allan,¹ William F. Laurance,⁴ Eric W. Sanderson,² Brendan Mackey,⁵ and Oscar Venter⁶

Refugia

- movement/rewilding
- cold water
- forest habitat/climate
- fire refugia

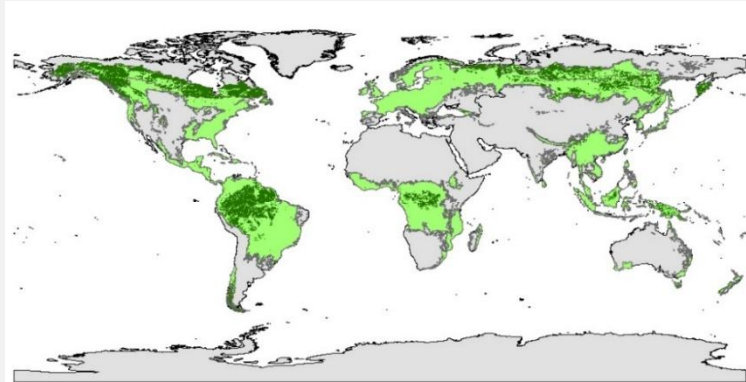
RESEARCH

HUMAN IMPACTS

Moving in the Anthropocene: Global reductions in terrestrial mammalian movements

Intact Forest Landscapes: A Refugia System

- High integrity watersheds
- Strongholds for biodiversity (endangered species)
- Contain most of the remaining old growth forests
- Vital refugia where natural ecological and evolutionary processes operate
- Contain entire natural mosaics of ecosystems
- Buffer and regulate local climate
- Larger areas are of strategic significance but smaller areas are also important especially in temperate forest biome
- Cultural Values



 Original extent
 Remaining extent

nature
ecology & evolution

PERSPECTIVE

<https://doi.org/10.1038/s41559-018-0490-x>

The exceptional value of intact forest ecosystems

James E. M. Watson^{1,2,15*}, Tom Evans^{2,15}, Oscar Venter³, Brooke Williams^{1,2}, Ayesha Tulloch^{1,2}, Claire Stewart¹, Ian Thompson⁴, Justina C. Ray⁵, Kris Murray⁶, Alvaro Salazar¹, Clive McAlpine¹, Peter Potapov⁷, Joe Walston⁸, John G Robinson⁹, Michael Painter², David Wilkie²,



Conservation value of national forest roadless areas

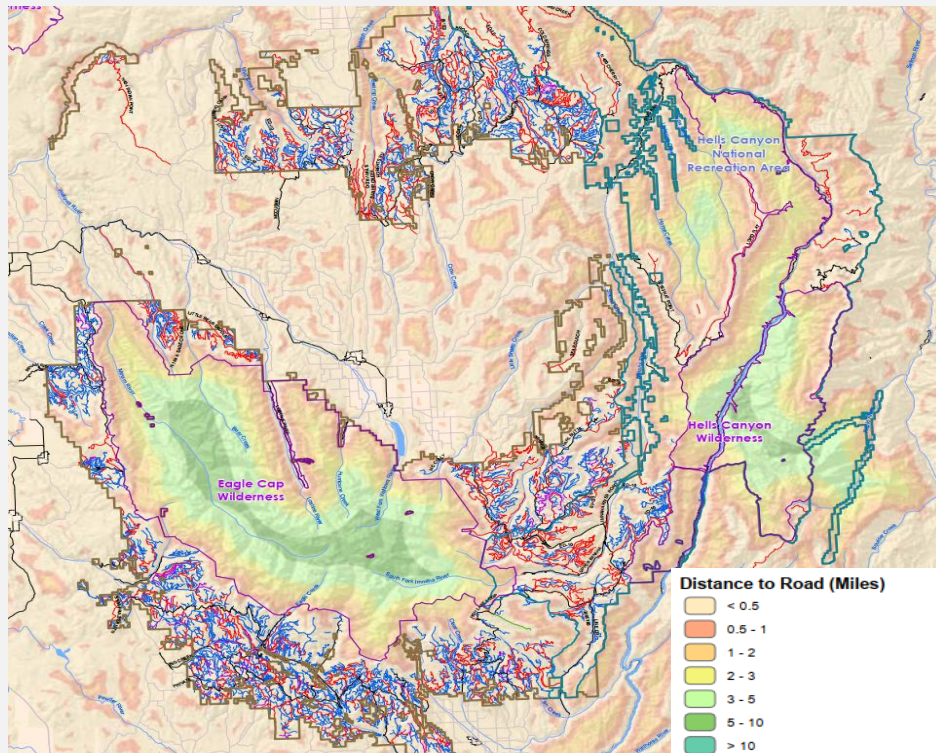
McKinley J. Talty^{1,2} | Kelly Mott Lacroix³ | Gregory H. Aplet⁴ | R. Travis Belote¹

Strategic Forest Reserves can protect biodiversity in the western United States and mitigate climate change

Beverly E. Law¹, Logan T. Berner², Polly C. Buotte³, David J. Mildrexler⁴ & William J. Ripple¹

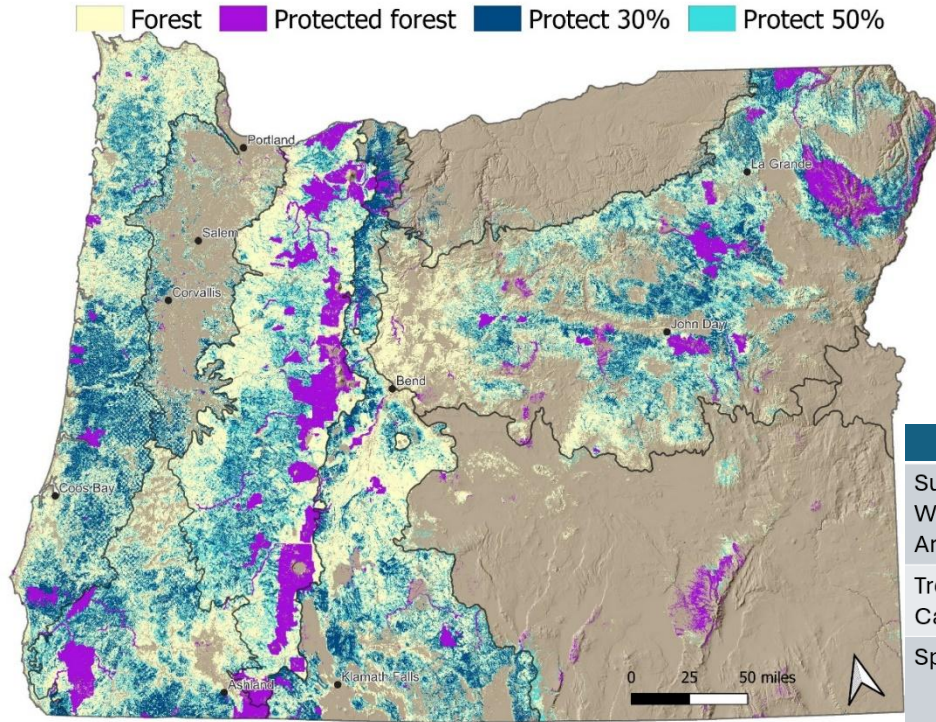
- Shows where protections would be most effective for climate mitigation, conserving biodiversity, and protecting water
- Federal (Public Lands) comprise 61–62% of high preservation priority forest
- Oregon has the largest forest area, but the lowest proportion protected of all eleven states (~10%)
- **Substantial progress could be made by protecting roadless and undeveloped lands**
 - **Inventoried Roadless Areas 24–28% of the high priority Federal lands**

Oregon has more roads, less protected forest



Forest Habitat, Carbon, and Drinking Water

Strategic Forest Reserves for Oregon



Law B.E., Berner L.T., Mildrexler D.J., Bloemers R., and Ripple W.J. (2022) Strategic Reserves in Oregon's Forests for Biodiversity, Water, and Carbon to Mitigate and Adapt to Climate Change. *Frontiers in Forests and Global Change*. <https://www.frontiersin.org/articles/10.3389/ffgc.2022.1028401/>

Map by EcoSpatial Services LLC (2022-11-18)

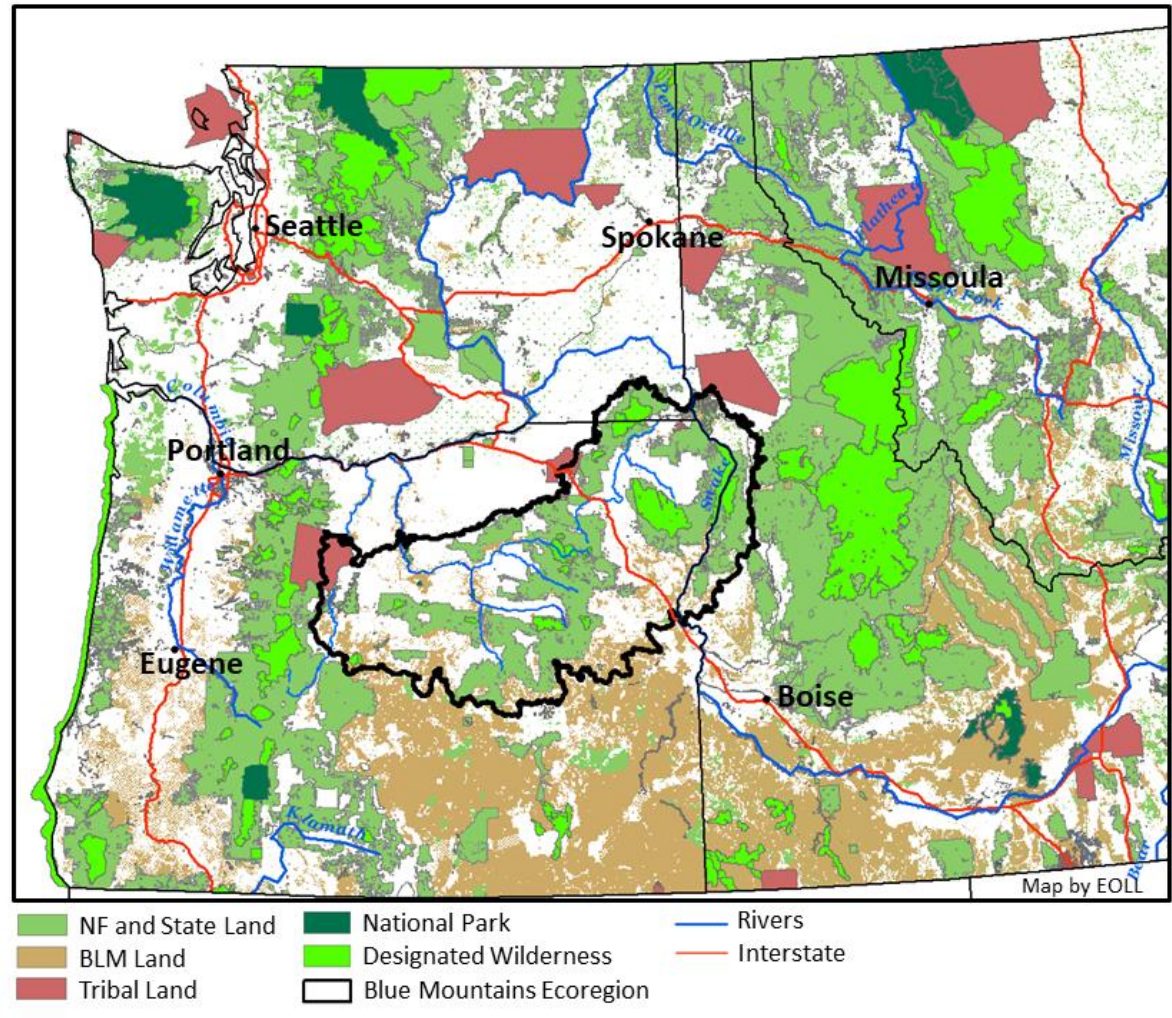
- Includes terrestrial resilience metric

IPCC Report C.3.6 Maintaining the resilience of biodiversity and ecosystem services at a global scale depends on effective and equitable conservation of approximately 30% to 50% of Earth's land, freshwater and ocean areas, including currently near natural ecosystems.

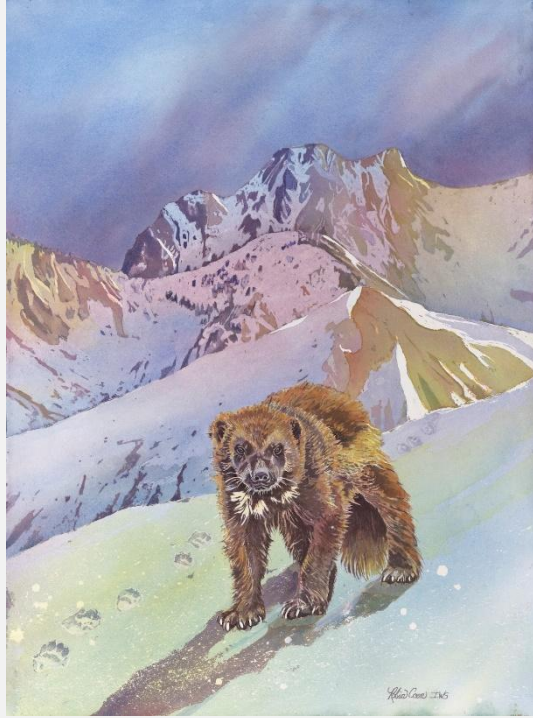
	Current	2030	2050
Surface Drinking Water Source Areas*	9%	27%	48%
Tree Aboveground Carbon	12% (104 Tg C)	45% (405 Tg C)	70% (635 Tg C)
Species habitat	~10%	27-42% (animal taxa) 41% (tree species)	45-63% (animal taxa) 67% (tree species)

The Blue Mountains

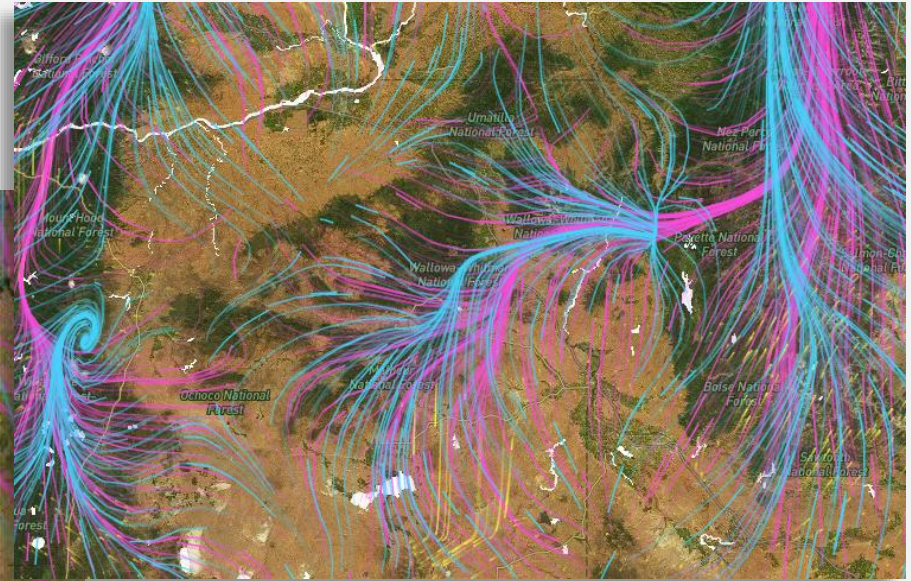
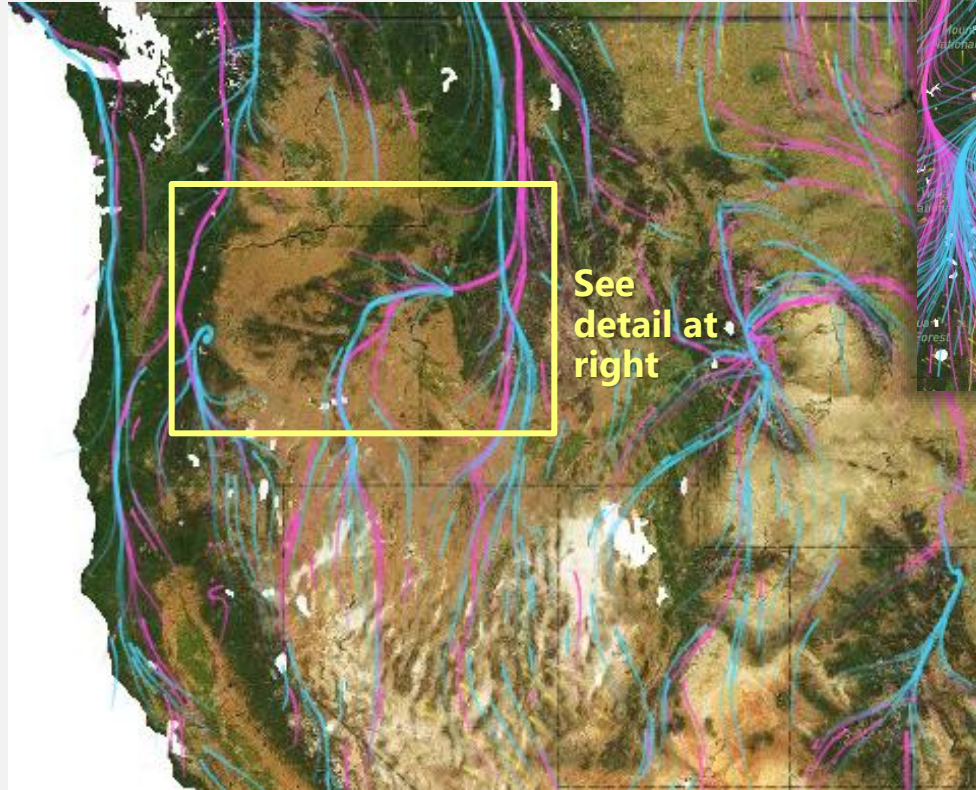
- Oregon's largest ecoregion (most forest area)
- Key connector between Cascades and Rockies
- Important for addressing climate change
- Cultural diversity



Movement and Rewilding Refugia



Blue Mountains: Mega-Wildlife Corridor



Migrations in Motion

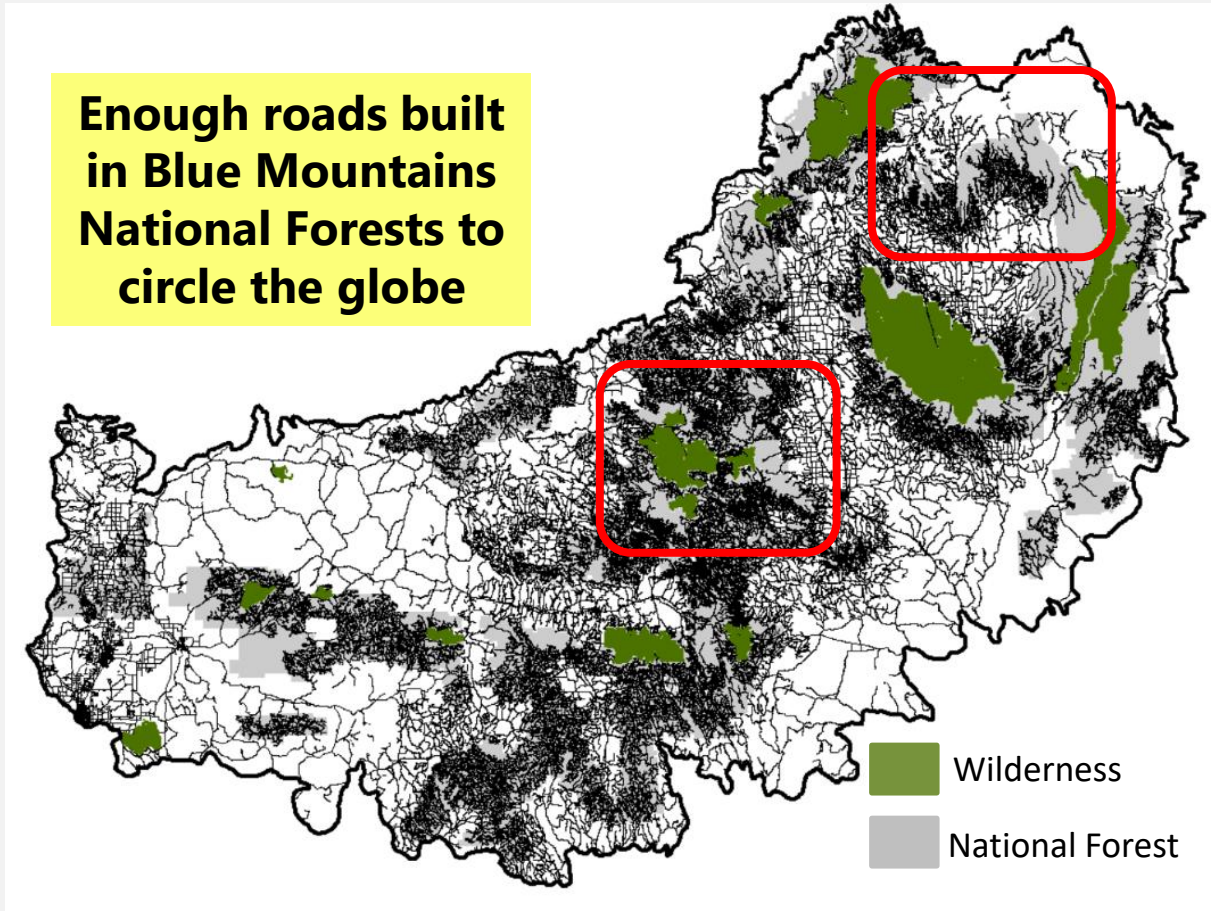
This map shows the average direction that mammals, birds, and amphibians need to move to track hospitable climates as they shift across the landscape.

- *The Nature Conservancy*



Distance between protected areas (miles)

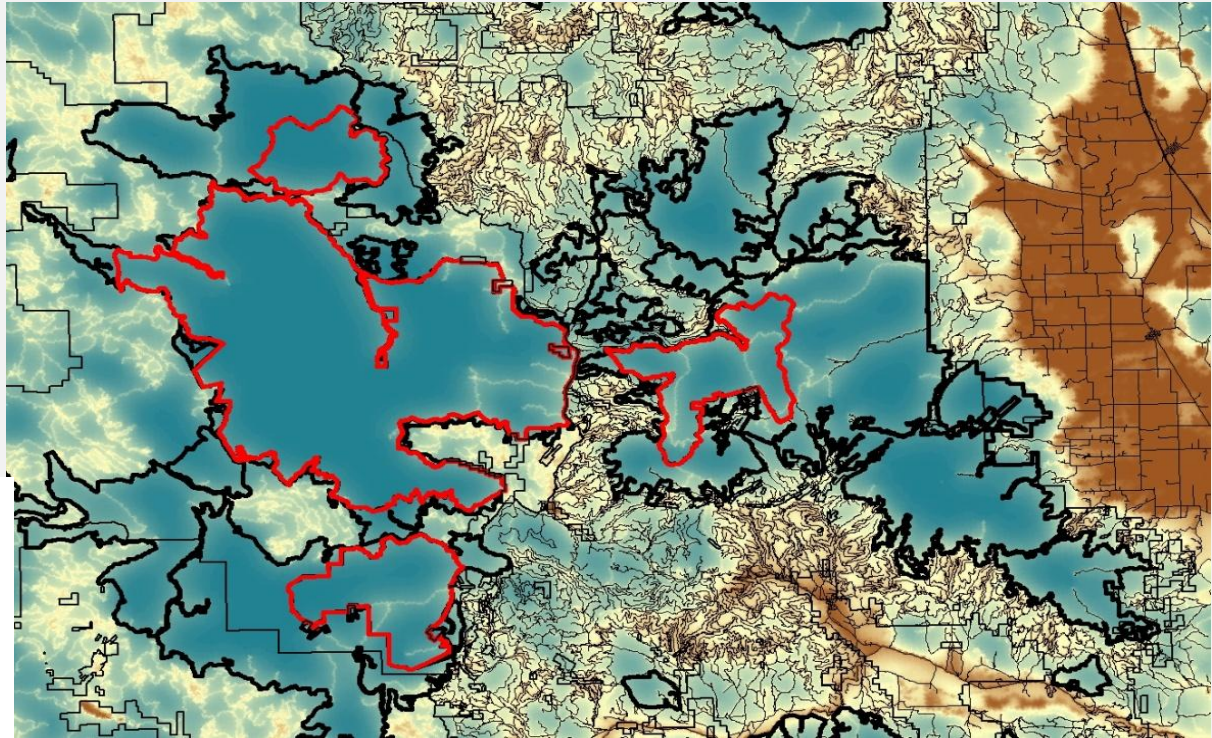
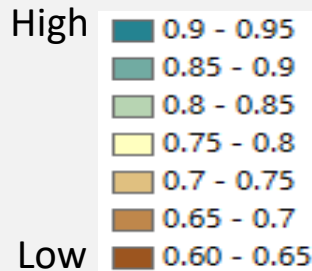
“Because roads crisscross so many forested areas of Eastern Oregon, existing roadless regions have enormous ecological value. Unfortunately, few of these remaining areas are protected.” —Henjum Report 1994



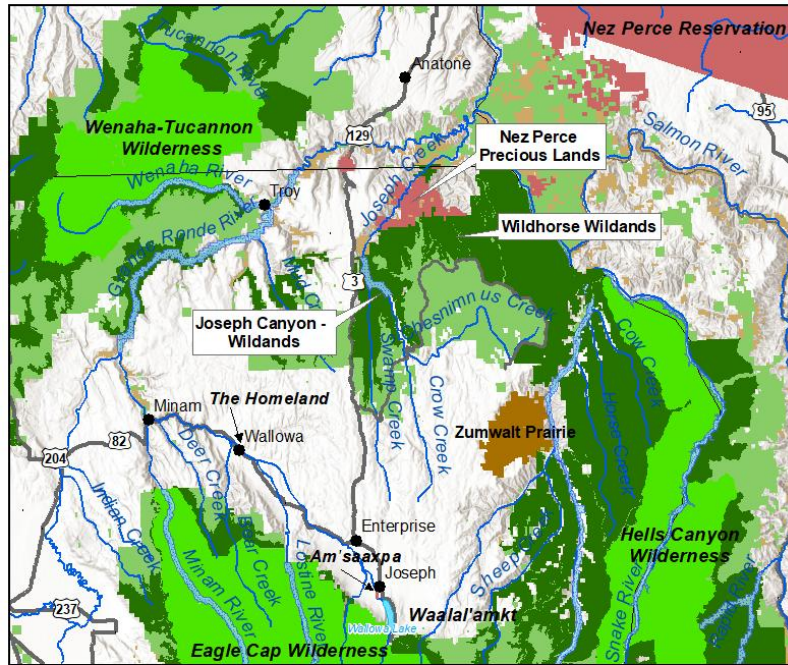
Permeable Pathways

Landscape permeability - a measure of how easily species can move through the landscape

- North Fork John Day Wilderness (red) and roadless areas (bold black).
- Large roadless areas show high permeability equal to Wilderness areas



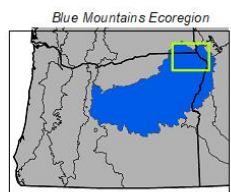
Crucial Connections



- Designated Wilderness
- Designated Wild & Scenic Rivers
- Roadless & Undeveloped Areas
- Nez Perce Tribe Lands
- National Forest & State Lands
- BLM Lands

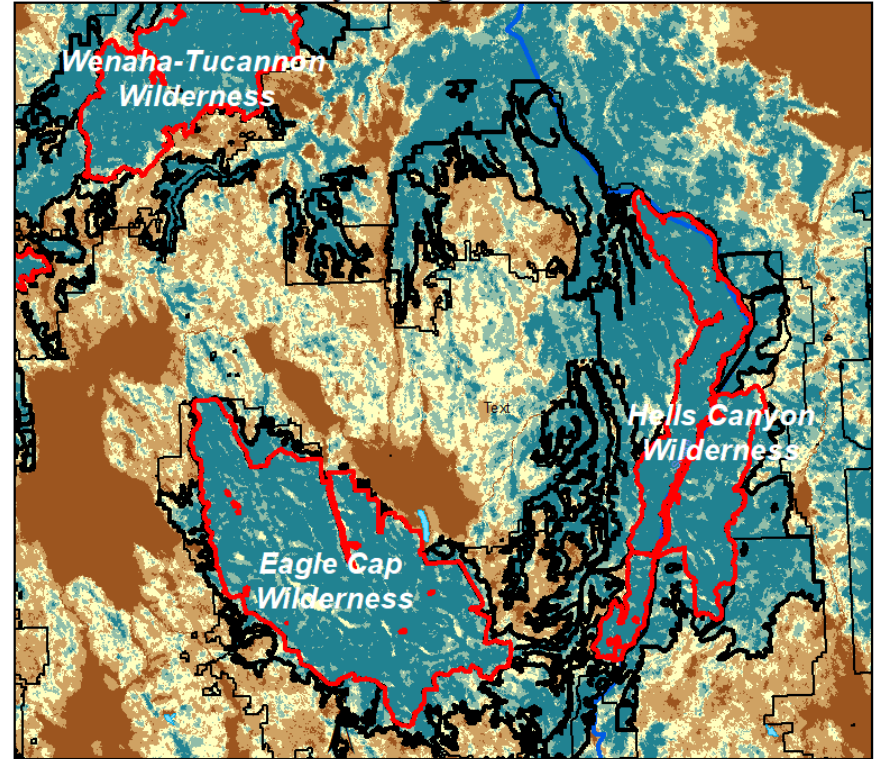


0 9.5 19 Miles



March 2023

Greater Hells Canyon Region Terrestrial Resilience



- Designated Wilderness
- Roadless Areas
- National Forest

Landscape Resilience

High

Low

0 5 10 20 Miles

Ananasocum, Place Where Condors Nested

Growing an Ethical, Inclusive, Adaptive Restoration and Healing Economy...



 **CAMAS to CONDORS**
Climate Change Adaptation Project



Joseph Canyon: Nez Perce Precious Lands

NPTEC Tour July 2022

Eagle Cap - Hells Canyon Connector

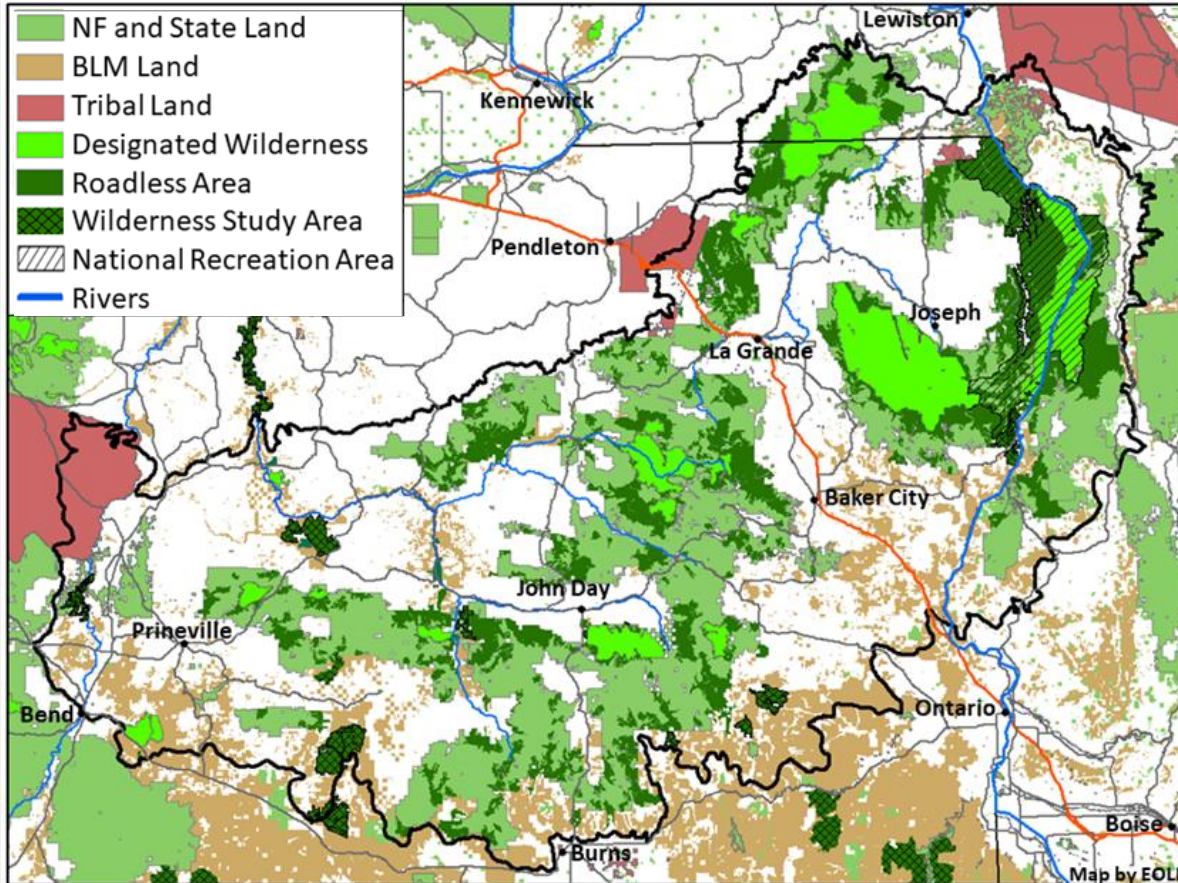


Lake Fork Roadless Area

Blue Mountains Roadless Lands

2.2 million acres of unprotected lands

- High quality wildlife habitats
- Key corridors for plant and animal movement
- Contain old growth forests
- Natural wildfire benefits



The Rewilding Blues



Definitely a surprise to see this wolverine on my camera this morning. NE Oregon, Mt Emily unit in Umatilla County.



AFTER SUCCESS 20 YEARS AGO, NEZ PERCE TRIBE RESTORES COHO SALMON TO 2ND OREGON RIVER



nature climate change

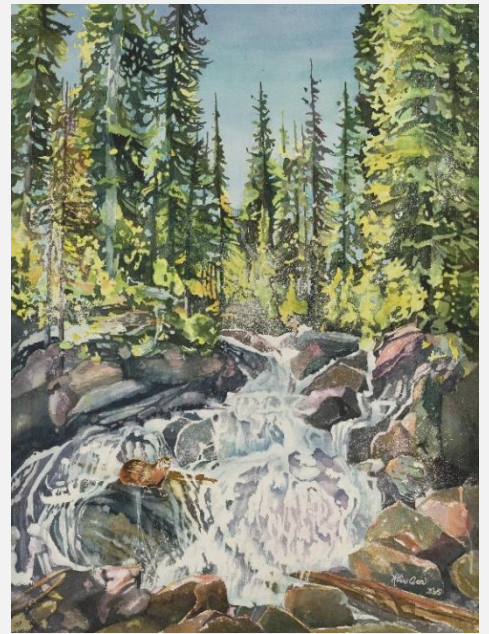
Perspective

<https://doi.org/10.1038/s41558-023-01631-6>

Trophic rewilding can expand natural climate solutions



Cold Water Refugia



Mountains and Clean Cold Water

Topographically complex terrain creates varied microclimates and increases the likelihood that current climates will continue to exist nearby.

Deep snow drifts provide insulation to the surface below and provide water later in the season.

Valleys that harbor cold air pools and inversions can decouple local climatic conditions from regional circulation patterns.

Canopy cover can buffer local temperature maximums and minimums throughout the year.

Cold groundwater inputs produce local cold-water refuges in which stream temperature is decoupled from air temperature.

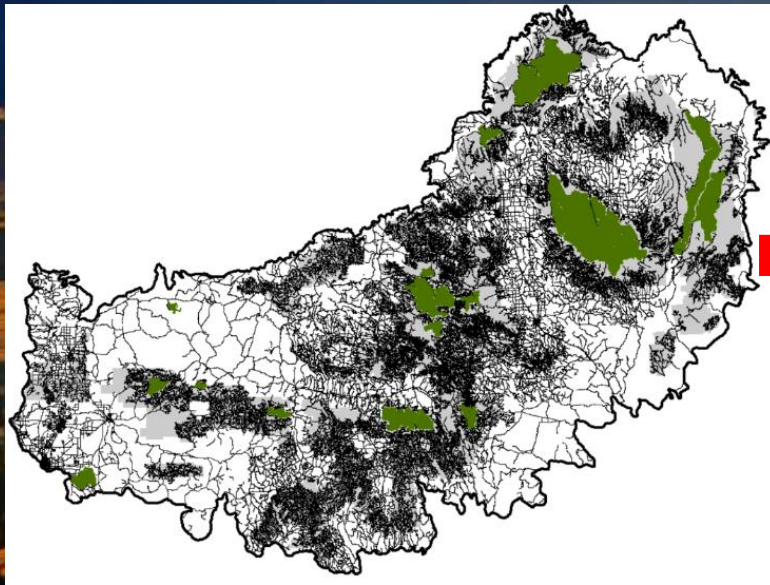
Areas near or in large deep lakes or oceans will warm more slowly due to the high heat capacity of water.

Poleward-facing slopes and aspects result in shaded areas that buffer solar heating, particularly during the low solar angles of winter and early spring.

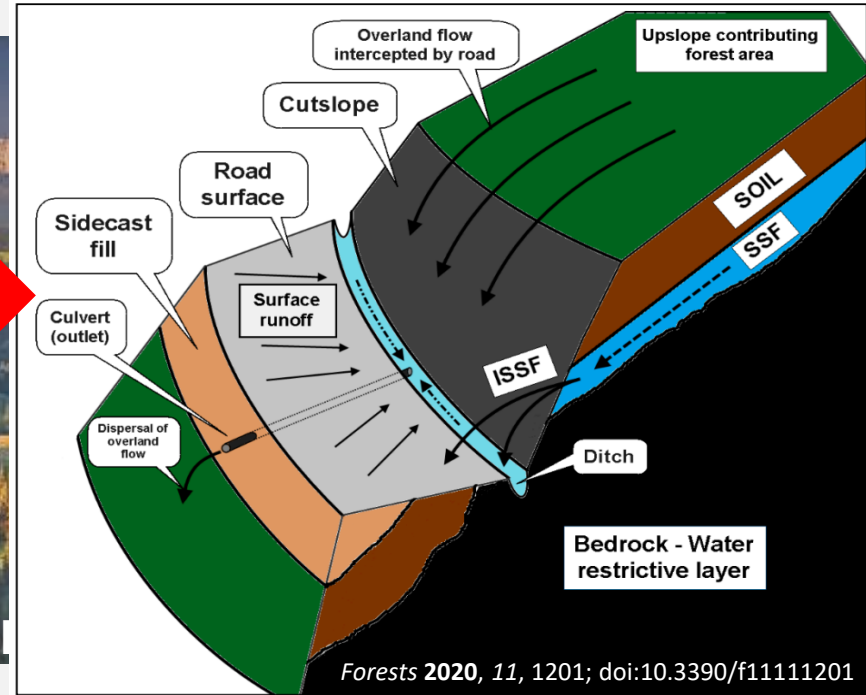


Beaver dams mitigate the effects of climate change on rivers

Blue Mountain Watersheds



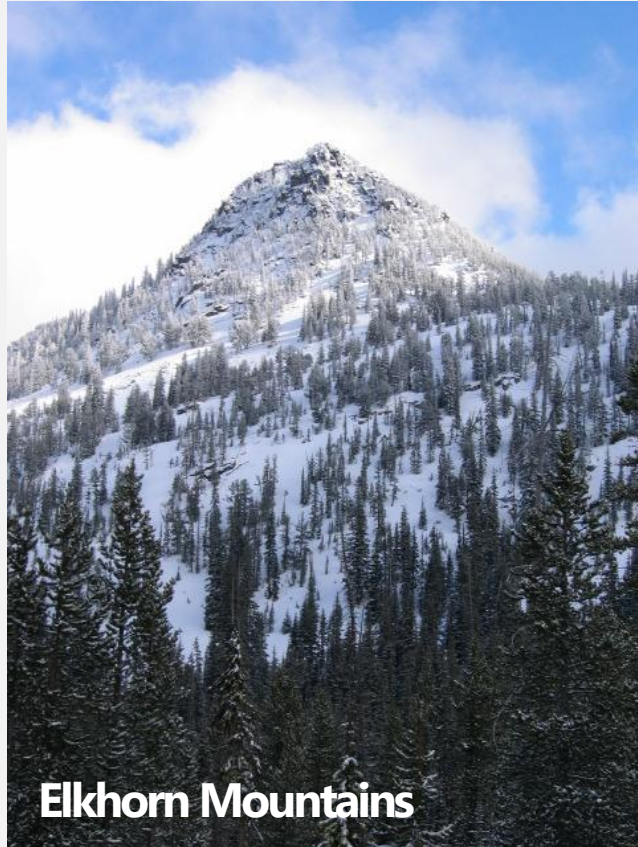
Wallowa



Forests 2020, 11, 1201; doi:10.3390/f11111201

Roads are one of the greatest sources of habitat degradation. Roads significantly elevate onsite erosion and sediment delivery, disrupt subsurface flows essential to the maintenance of baseflows, and can contribute to increased peakflows. Roads within riparian zones reduce shading and disrupt LWD sources for the life of the road. These effects degrade habitat by increasing fine sediment levels, reducing pool volumes, increasing channel width and exacerbating seasonal temperature extremes - Rhodes, et al. 1994. Technical report 94-4. Columbia River Inter-Tribal Fish Commission.

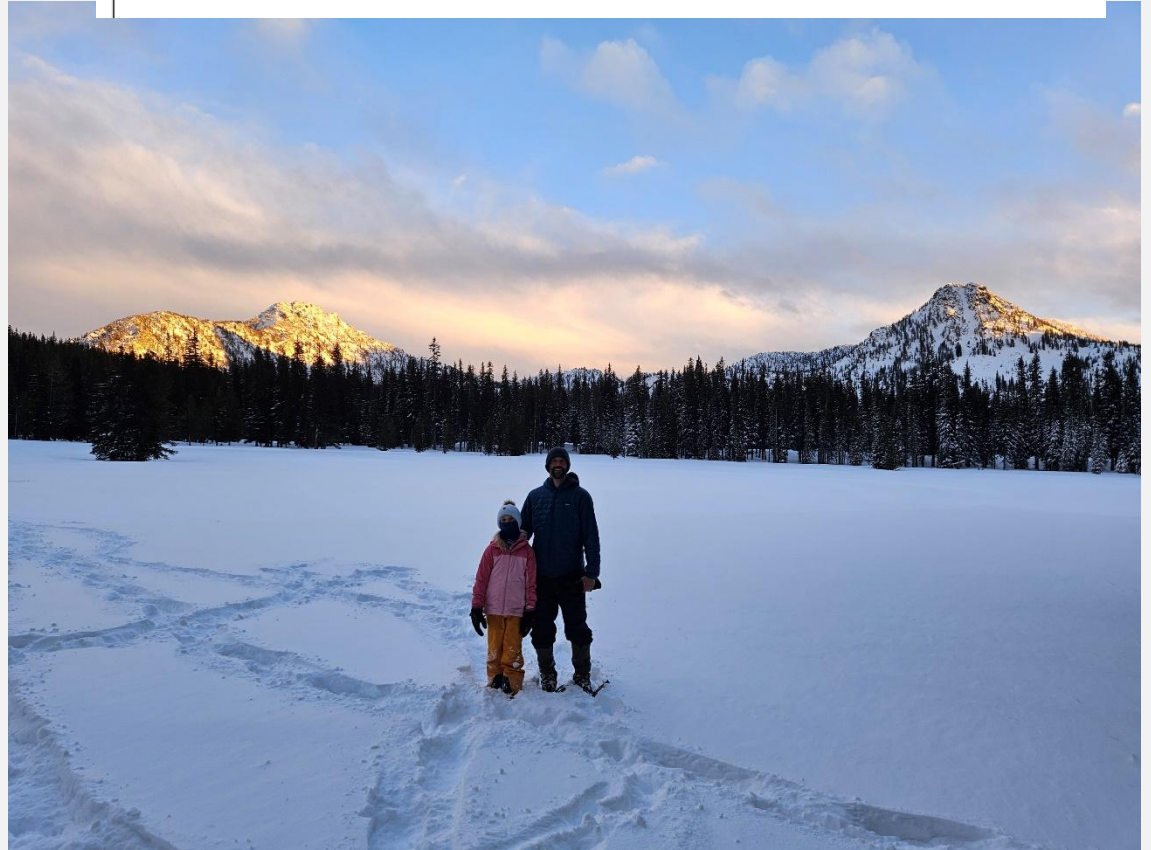
Water Towers



Article

Importance and vulnerability of the world's water towers

364 | Nature | Vol 577 | 16 January 2020



Summer Snowfields and Water Supply



Strawberry and Aldrich Mountains



*National Forest Roadless Areas
and Clean Water*

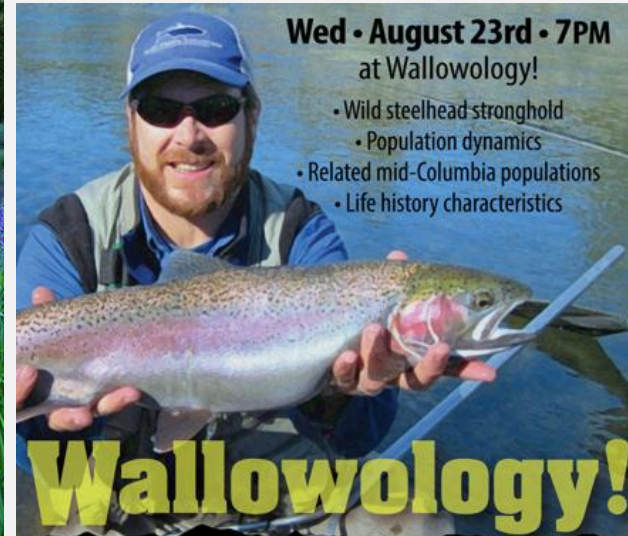
Dominick A. DellaSala, James R. Karr, David Olson,
Richard Nauman and Jessica Leonard

Major River Corridors



Lookingglass Creek has a cooling effect on the Grande Ronde River, decreasing the temperature by about 10°F at their confluence in mid-summer –

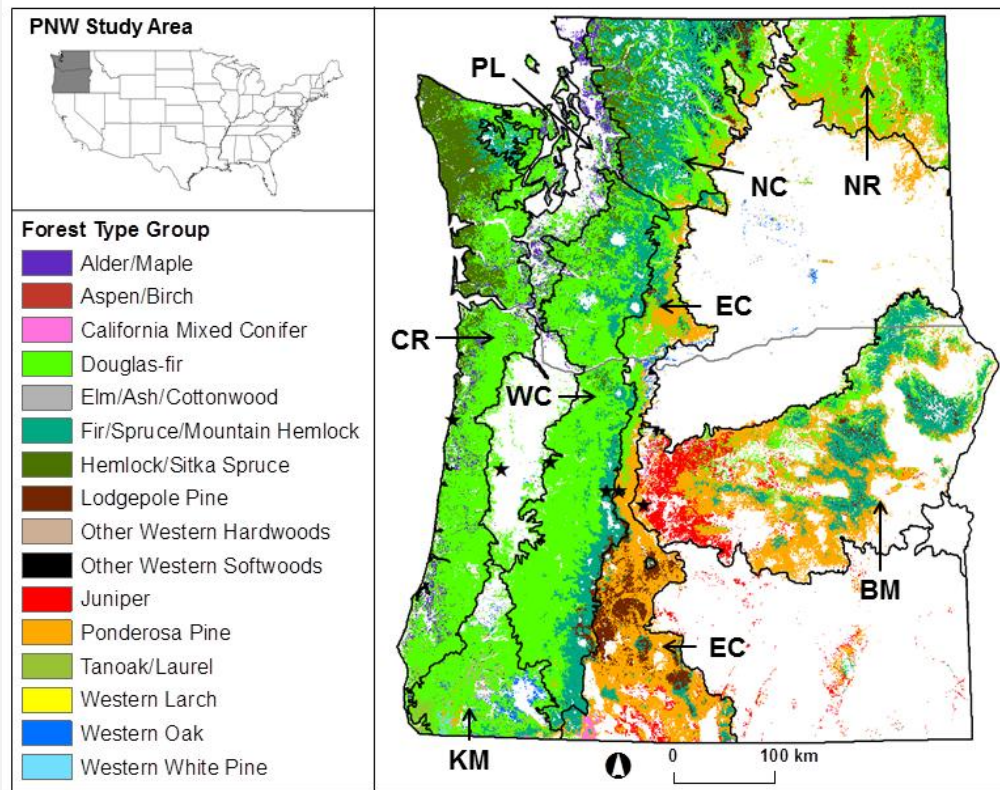
Umatilla National Forest Review of Areas with Wilderness Potential



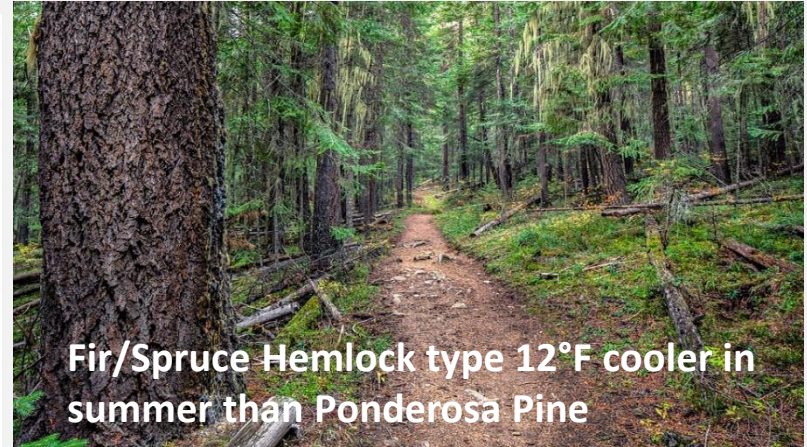
Forest Habitat – Climate Refugia



Blue Mountains Forests are Incredibly Diverse

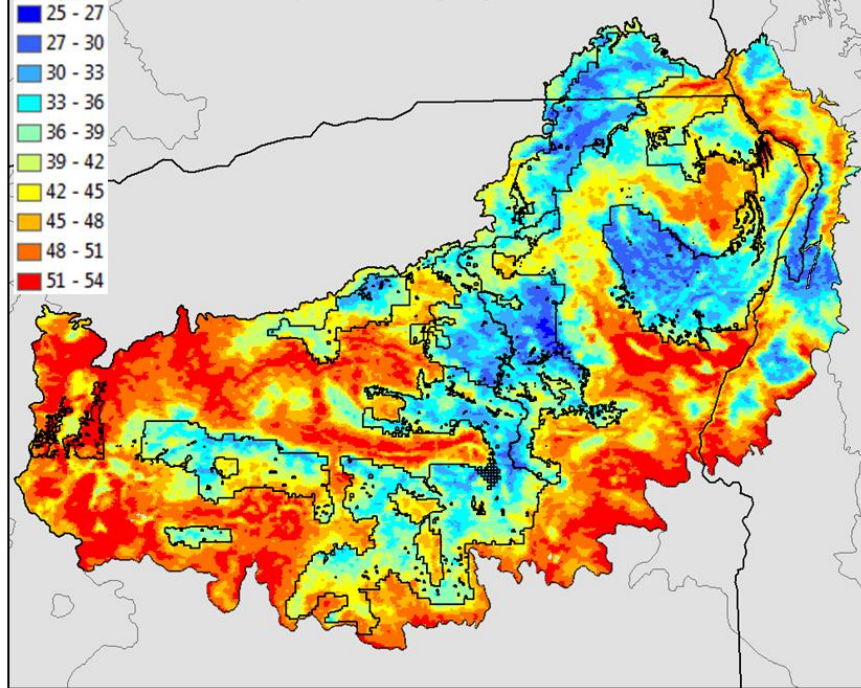


Mildrexler et al. 2016

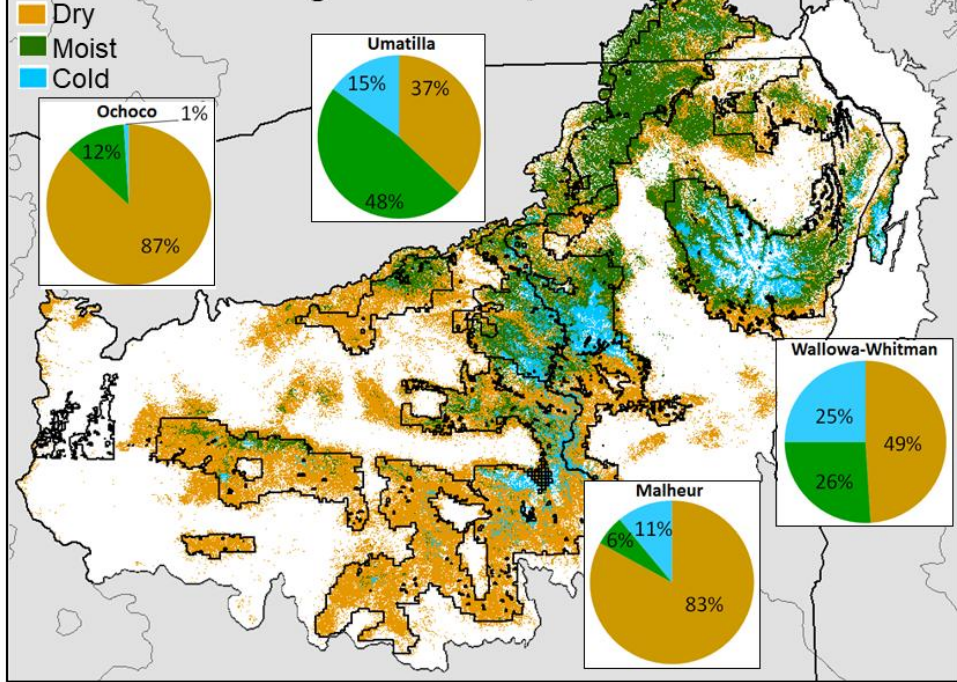


Thermal Refugia

Land Surface Temperature (°C)



Forest Potential Vegetation Group



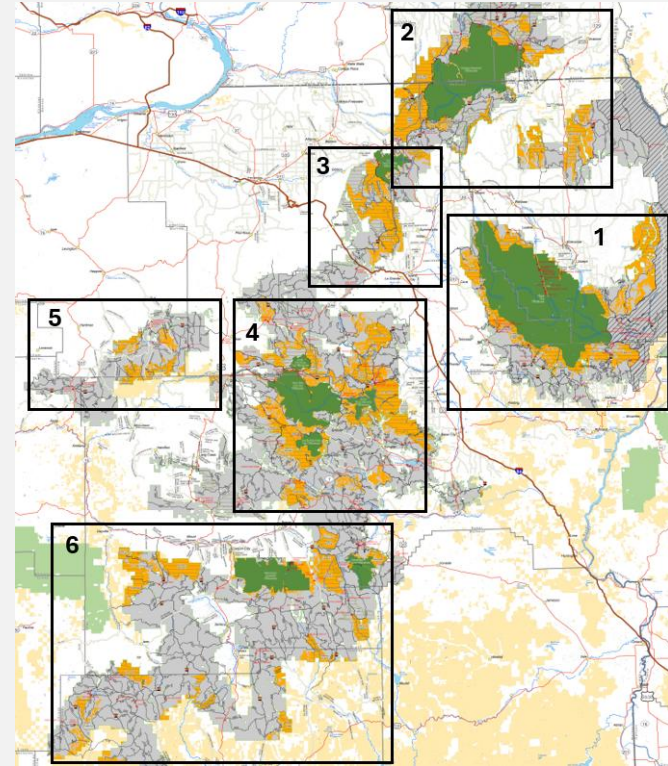
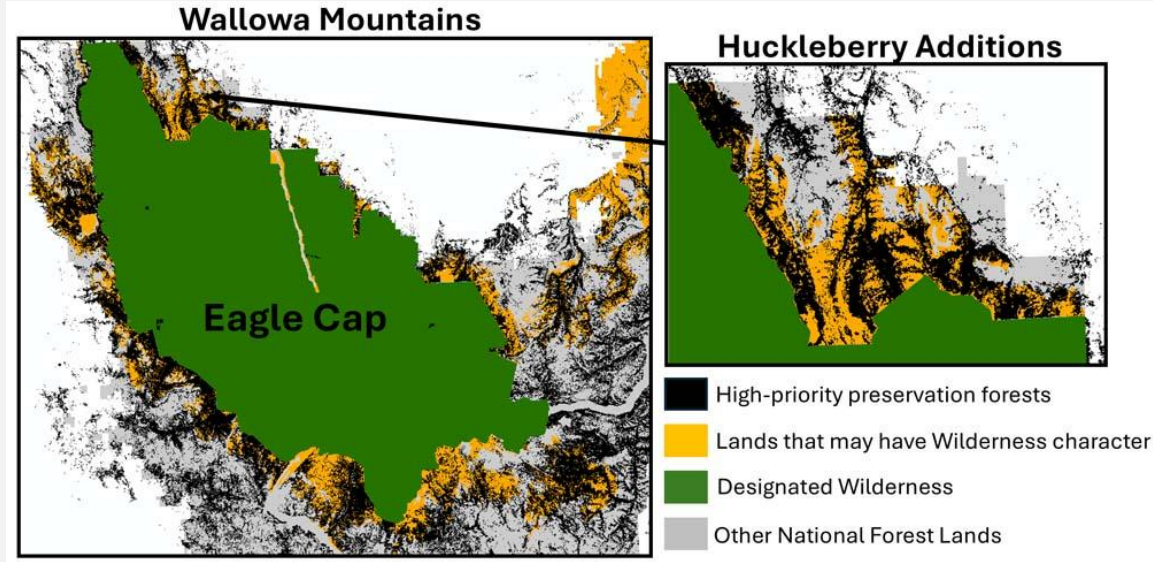
Species and Carbon Rich Forests

Huckleberry Mountain Roadless Area



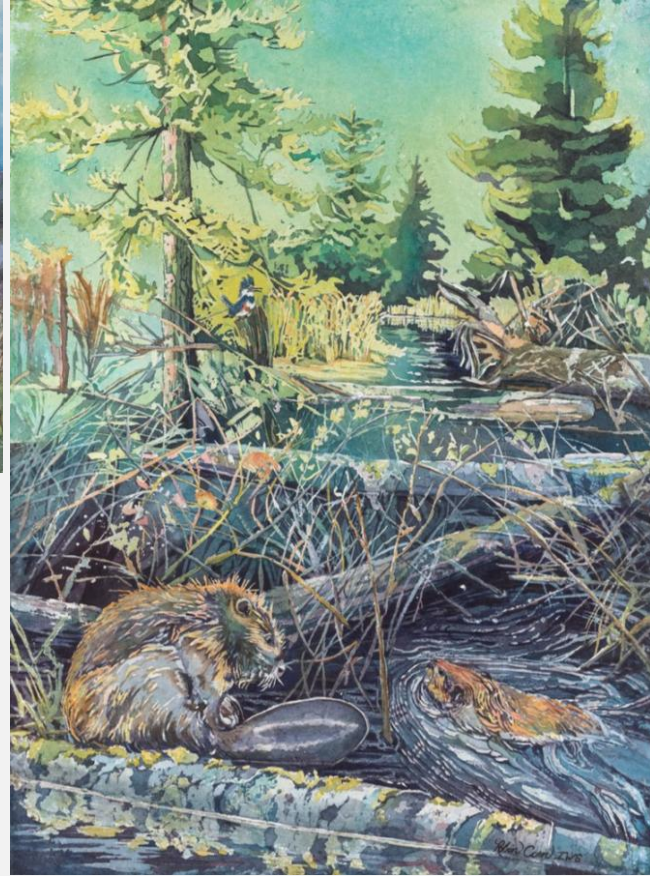
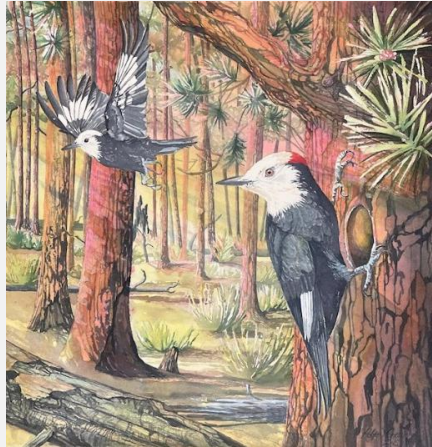
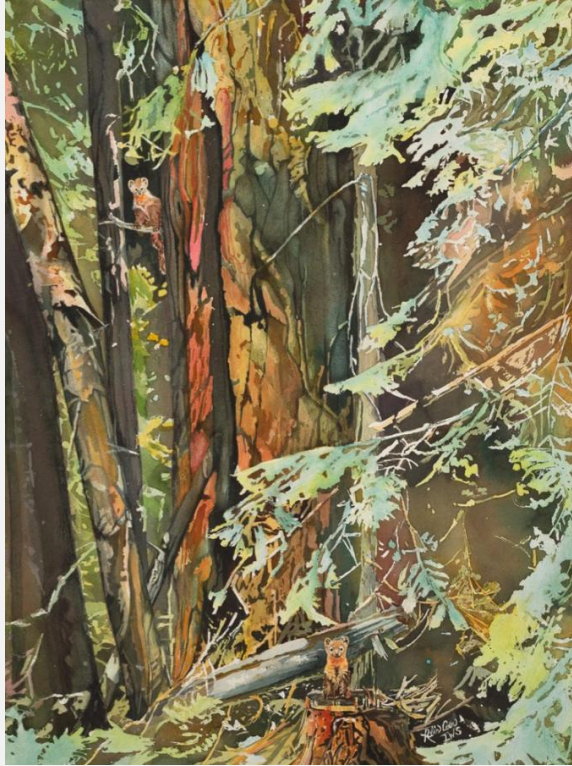
David Jensen

Oregon's Largest Ecoregion is at a Crossroads



<https://columbiainsight.org/oregons-largest-ecoregion-is-at-a-crossroads/>

Fire Refugia



Roads Increase Fire Risk

"One of the most fundamental concepts in fire, especially in terms of fire geography, is that roads are the dominant place where you see ignitions" - Alexandra Syphard, senior research scientist with the Conservation Biology Institute and the director of science for the Global Wildfire Collective

- Fire ignitions from human activities accounted for 84% of all wildfires and 44% of total area burned from 1992 to 2012 (Balch et al., 2017).
 - Change distribution of ignitions
 - Shift seasonality of burning
 - Alter available fuels

The Trump administration wants to build more roads through national forests

AUGUST 29, 2025 · 6:00 AM ET

By Nathan Rott



The Gifford Fire, the largest fire to burn in California so far this year, started near a road. Research shows wildfires are more likely to start within 50 feet of a road than they are farther out.
Benjamin Hanson/Middle East Images/AFP via Getty Images

RESEARCH ARTICLE | SUSTAINABILITY SCIENCE | 



Human-started wildfires expand the fire niche across the United States

Jennifer K. Balch , Bethany A. Bradley , John T. Abatzoglou , , and Adam L. Mahood [Authors Info & Affiliations](#)

Edited by Gregory P. Asner, Carnegie Institution for Science, Stanford, CA, and approved January 6, 2017 (received for review October 20, 2016)

February 27, 2017 | 114 (11) 2946-2951 | <https://doi.org/10.1073/pnas.1617394114>

Hells Canyon National Recreation Area



Imnaha River Headwaters Roadless Area

Climate Change Refugia in Northwest Forests

Cutting-edge research to meet management needs



*Current fire management
be altering or removing
refugia needed for
establishment, persistence
and movement of*



Lower Joe Restoration Project

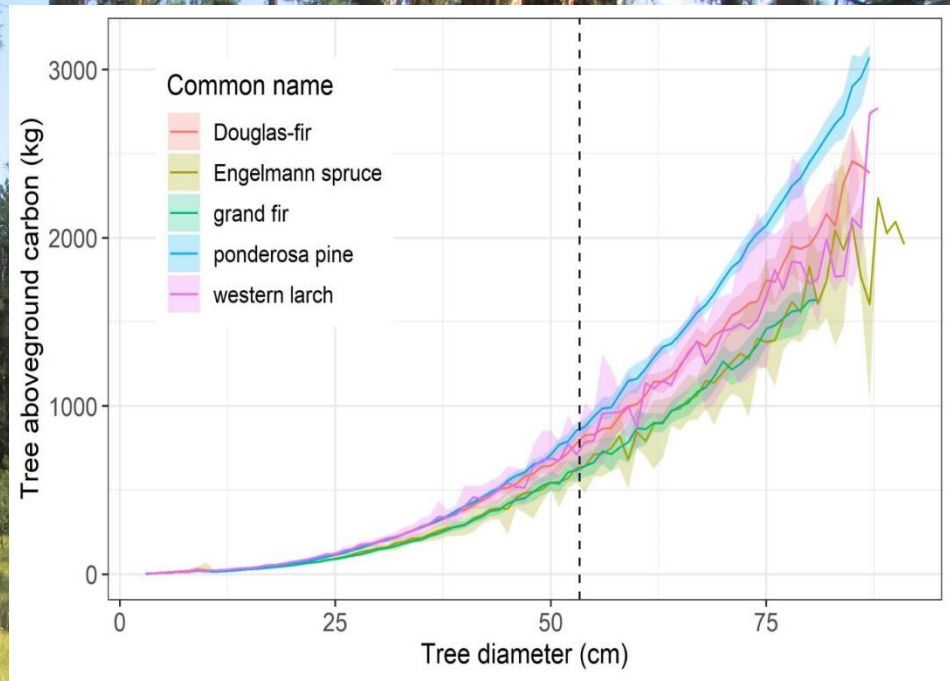
Large Trees Dominate Carbon Storage in Forests East of the Cascade Crest in the United States Pacific Northwest

David J. Mildrexler^{1*}, Logan T. Berner², Beverly E. Law³, Richard A. Birdsey⁴ and William R. Moomaw^{4,5}

¹ Eastern Oregon Legacy Lands, Joseph, OR, United States, ² EcoSpatial Services L.L.C., Flagstaff, AZ, United States, ³ Department of Forest Ecosystems and Society, Oregon State University, Corvallis, OR, United States, ⁴ Woodwell Climate Research Center, Falmouth, MA, United States, ⁵ The Fletcher School and Global Development and Environment Institute, Tufts University, Medford, MA, United States

Big Trees = Big Carbon

Results: Only 3% of trees in Eastern Oregon National Forests are 21 inches or larger, but they hold almost half the overall aboveground carbon.





Stream without Beavers



Drought Conditions

less precipitation, veg relies on groundwater



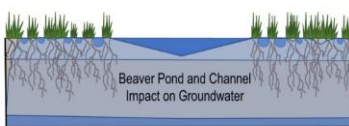
Fire Conditions

dry vegetation ignites/burns



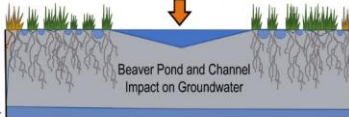
Stream with Beavers

← Infiltrating Precipitation →



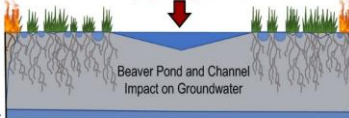
Drought Conditions

less precipitation, veg relies on groundwater



Fire Conditions

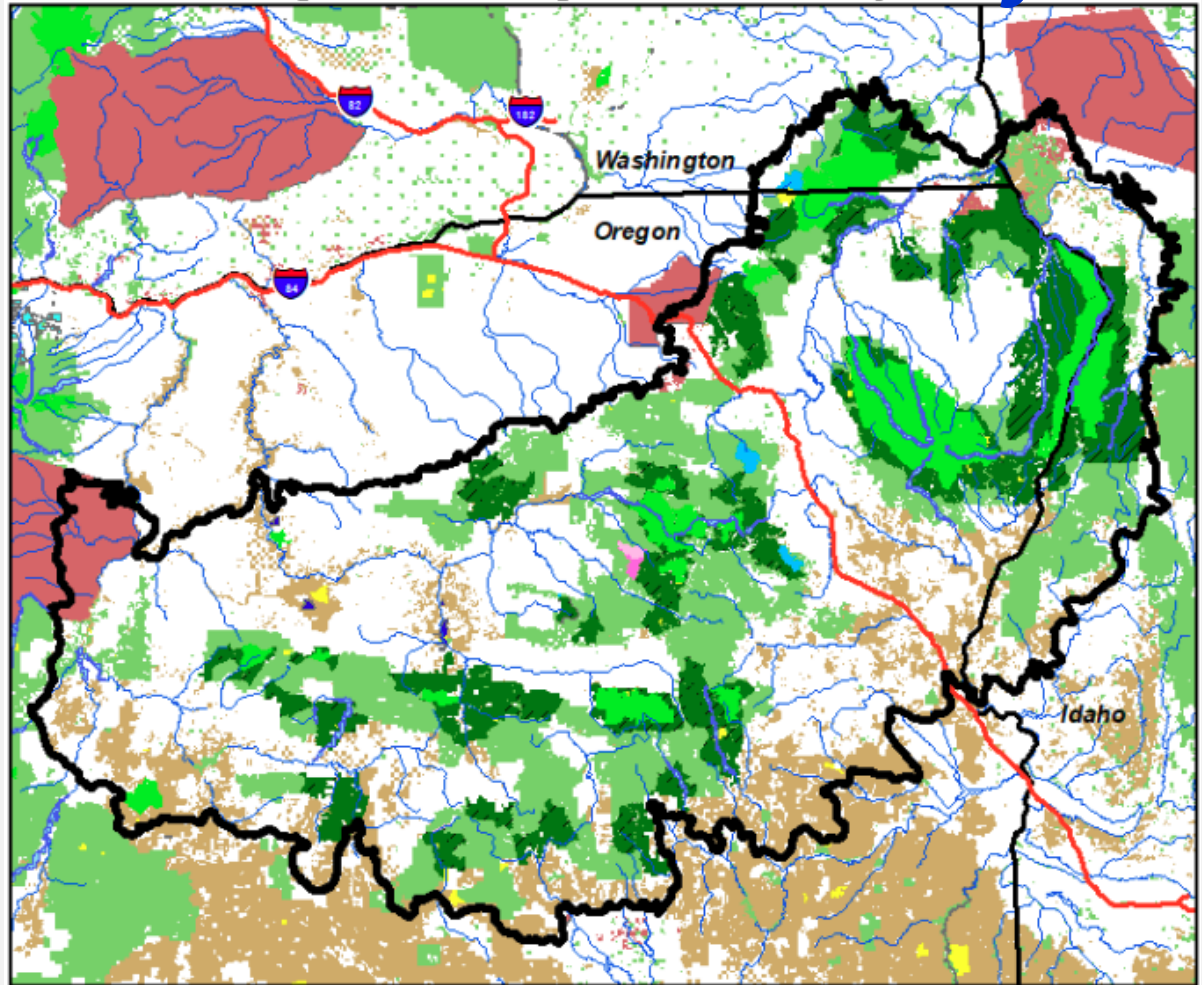
dry vegetation ignites/burns



← Deep Water Table →

A Blue Mountains Reserve System

**Large
Connected
Intact
Landscapes**

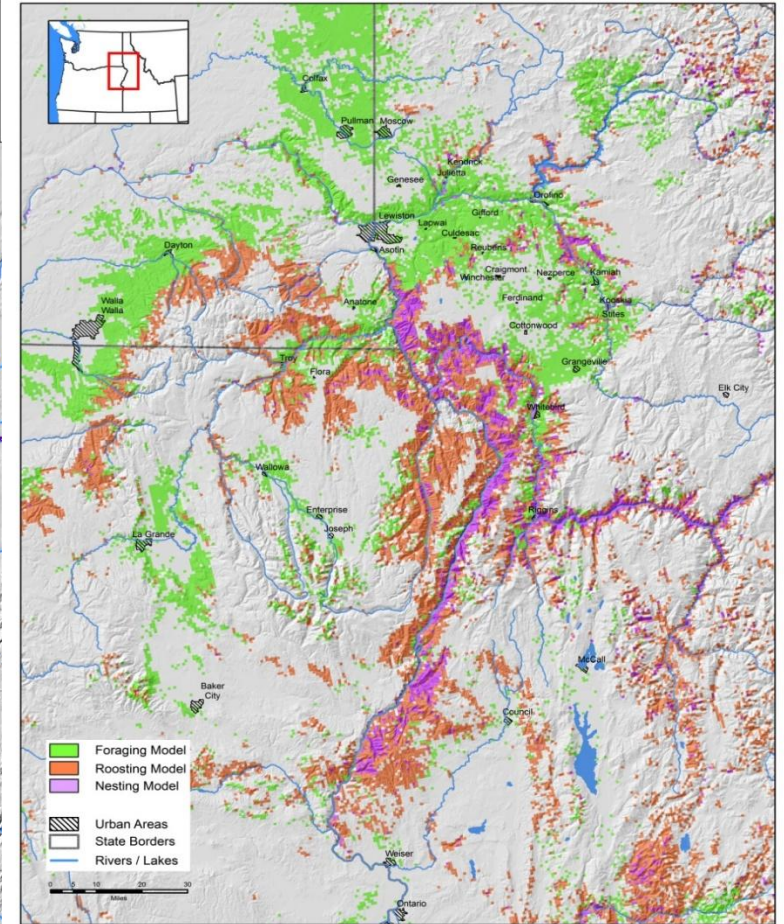
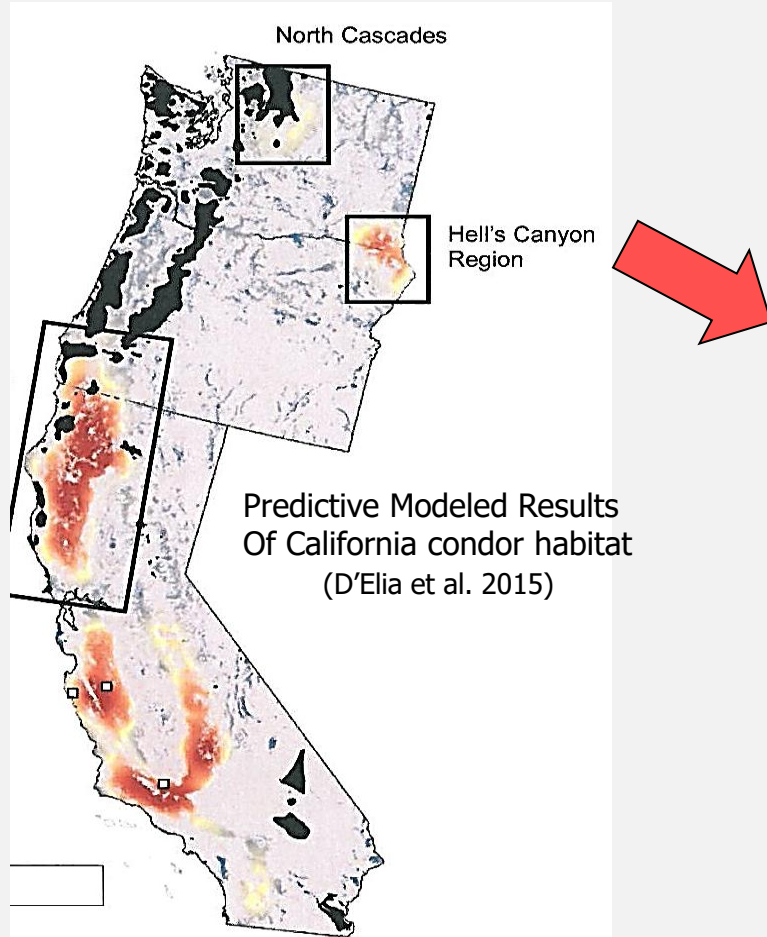


A scenic view of rolling green hills with scattered evergreen trees under bright sunlight. The hills are covered in lush green grass, and the trees are dark green, creating a high-contrast landscape. The lighting is bright, casting long shadows and highlighting the contours of the hills.

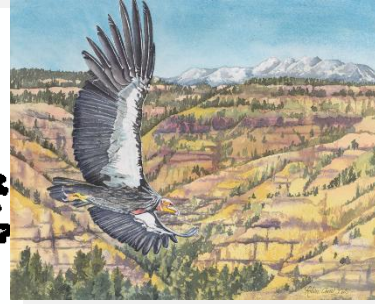
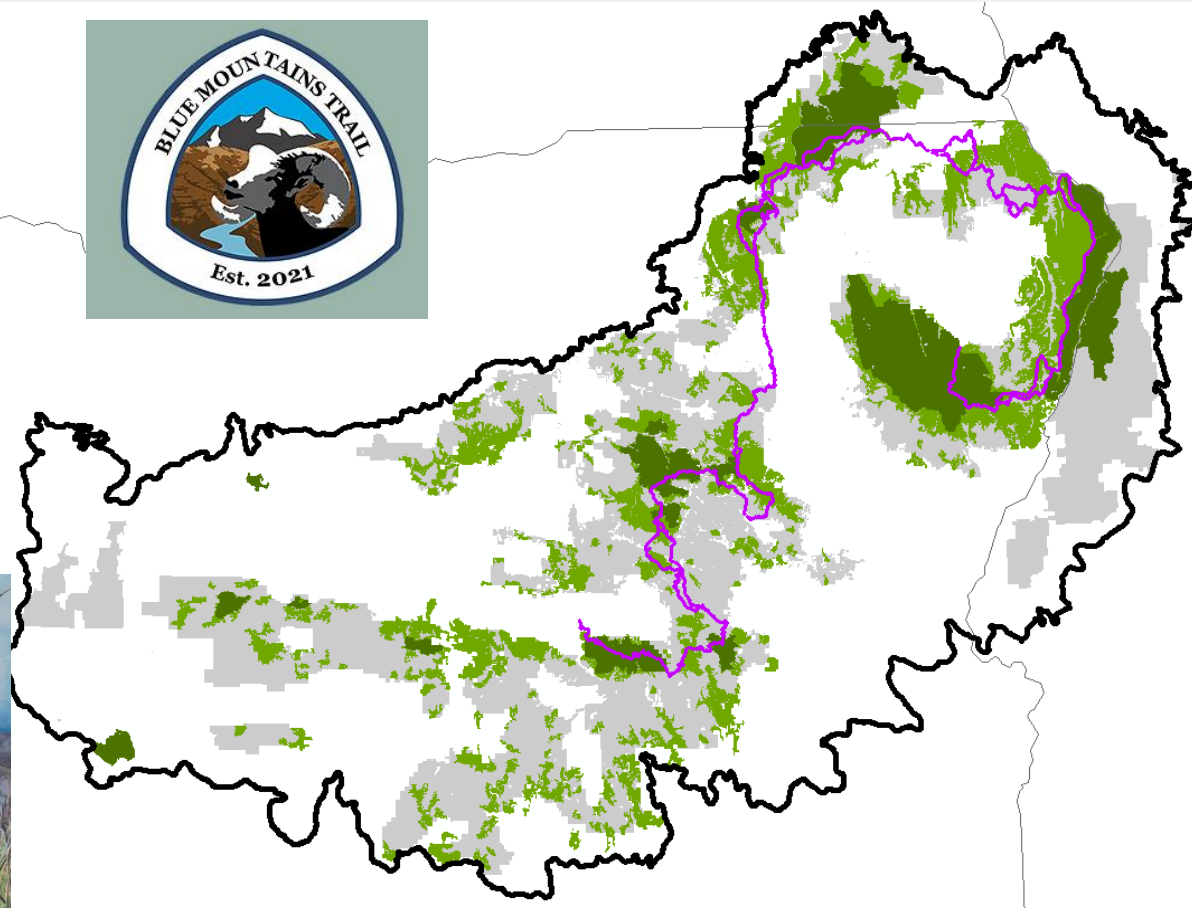
Thank you!

Wallowology!

Condors, Big Trees, and Wildlands



Blue Mountains Trail Connects Reserves and Roadless



The header image features a dark blue background on the left with white text. On the right, there is a vertical strip showing a blurred, long-exposure photograph of a highway at night with light trails from vehicles in orange and white.

AR6 Synthesis Report

Climate Change 2023

The latest IPCC report makes this all very clear...

Urgency of Near-Term Integrated Climate Action

C.1 Climate change is a threat to human well-being and planetary health.

There is a rapidly closing window of opportunity to secure a liveable and sustainable future for all.

The choices and actions implemented in this decade will have impacts now and for thousands of years.

C.3.6 Maintaining the resilience of biodiversity and ecosystem services at a global scale depends on effective and equitable conservation of approximately 30% to 50% of Earth's land, freshwater and ocean areas, including currently near natural ecosystems.

This is the planetary boundary on land

Conservation Legacy



ROCKY MOUNTAIN
ELK FOUNDATION

MINAM RIVER WILDLIFE AREA ACQUISITION WALLOWA COUNTY AND UNION COUNTY, OREGON

PROJECT FACTS

PROJECT SIZE

- 15,573 +/- Acres
- Phase I: 4,609 Acres (close Dec 2021)
- Phase II: 10,964 Acres (close Dec 2023)

ANTICIPATED PURCHASE PRICE

- 2019 Appraised Value: \$18,700,000
- Phase I Value: \$5,508,354
- Phase II Value: \$13,191,646

ANTICIPATED FUNDING

- Phase I:
Pittman-Robertson Funds, RMEF, and others
- Phase II:
Forest Legacy Program, RMEF, and others

PARTNERS

- Oregon Department of Fish and Wildlife (ODFW)
- Rocky Mountain Elk Foundation (RMEF)
- Hancock Natural Resource Group

LOCATION

- Property is along the Minam River, primarily in Wallowa County with a small portion in Union County.
- Property is adjacent to the existing ODFW Minam River Wildlife Area, Oregon Parks and Recreation Department (OPRD) Minam State Recreation Area, USFS Eagle Cap Wilderness, and Bureau of Land Management lands.

LONG-TERM MANAGEMENT

- Managed by ODFW as part of existing State Wildlife Area lands, in partnership with Oregon Department of Forestry (ODF).
- Continued management as a "working landscape," with active forest management and grazing used as a tool to improve and maintain wildlife habitat.

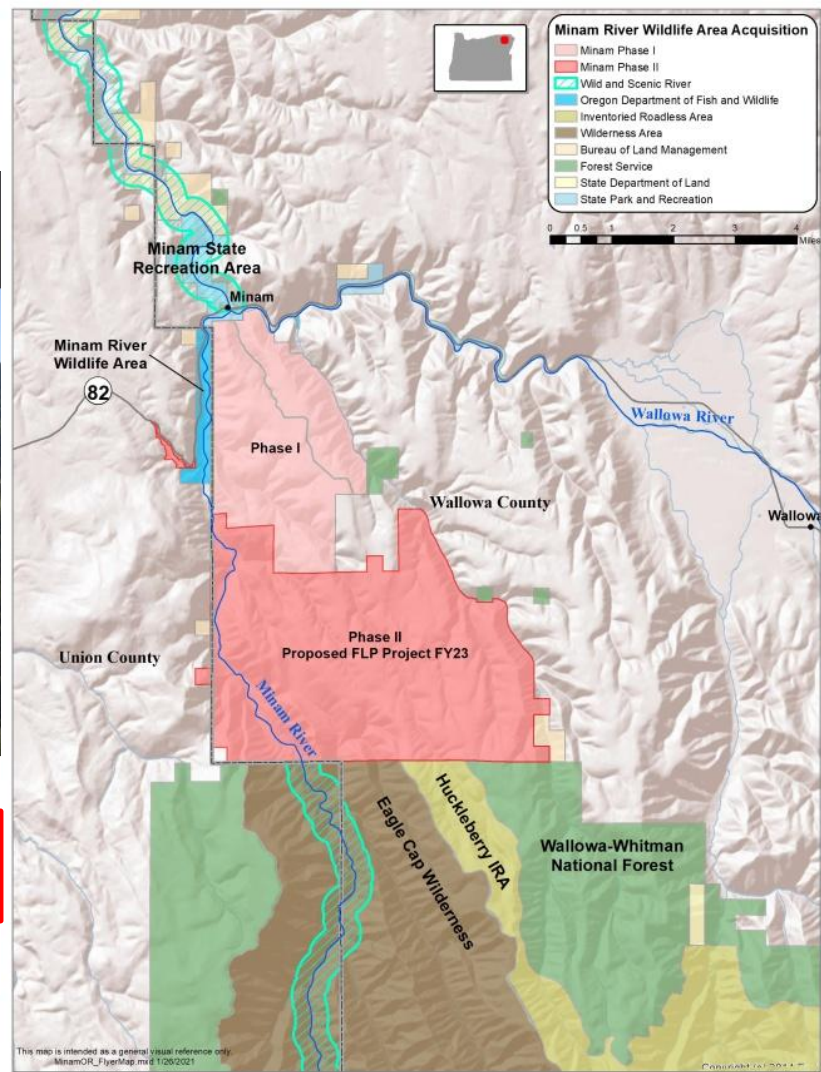


LANDSCAPE CONNECTIVITY

The Minam River Wildlife Area Acquisition will link wildlife habitat from the Wallowa-Whitman National Forest and the federally designated Eagle Cap Wilderness Area to the Minam State Recreation Area at the confluence of the Minam and Wallowa Wild and Scenic Rivers. Property includes numerous Oregon Conservation Strategy habitats and species, federal and state listed species, and species of local economic and cultural importance. Active habitat management on the property will allow various wildlife species to move across elevation gradients, enhancing the resilience of existing populations in the face of climate variability.

CRUCIAL BIG GAME WINTER RANGE

Permanent protection of crucial winter, year-round, and transitional habitat along a migration corridor for elk, mule deer, and other wildlife.



Deep vs. Shallow Pools

- Old forests feature great vertical height (full of water), dead wood holding moisture and epic biomass.
- Plantations are shorter, with little dead wood and lower biomass

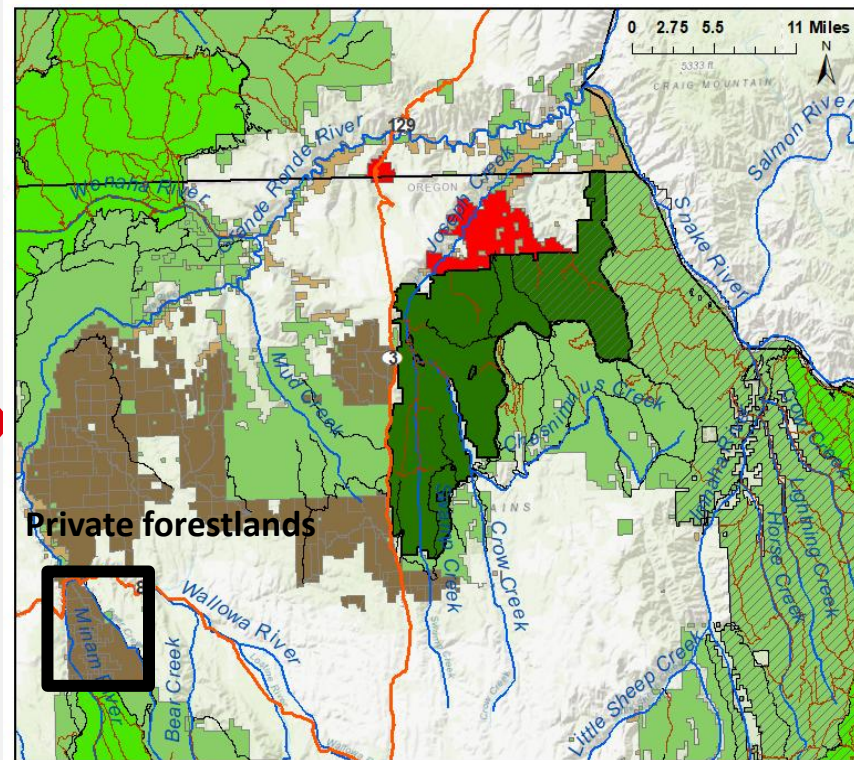
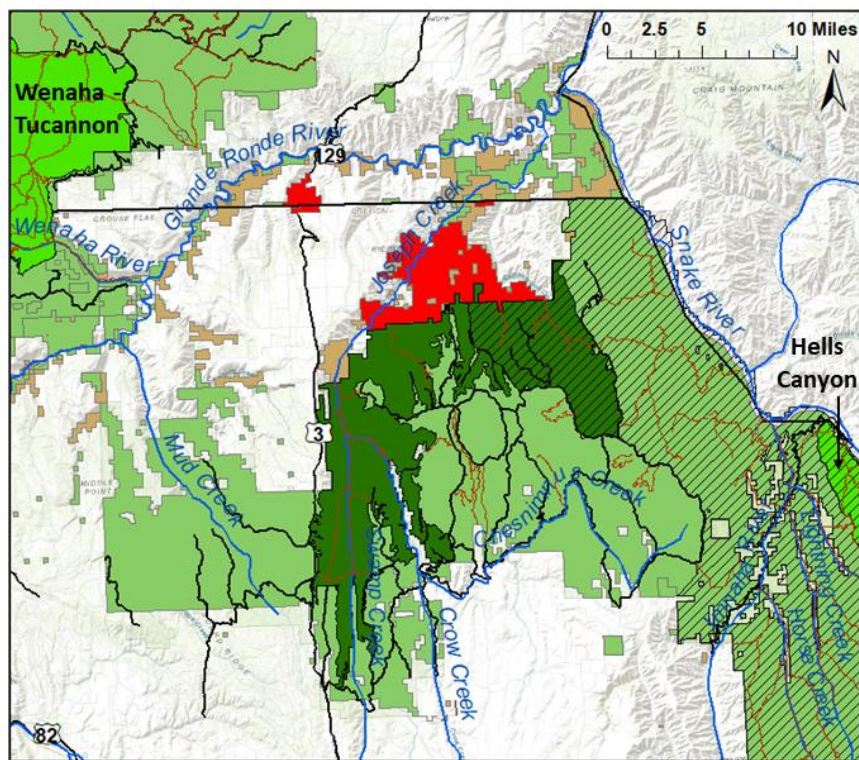
“The high biomass is like a big swimming pool,” Matt Betts, Professor, Oregon State University’s Forest Ecosystems and Society who specializes in forest birds and microclimates.”



Big deep pools stay colder longer than shallow, small ones. That makes older forests more habitable to a wide array of species.



Precision Restoration and Wilderness Manageability



Growing an Ethical, Inclusive, Adaptive Restoration and Healing Economy...

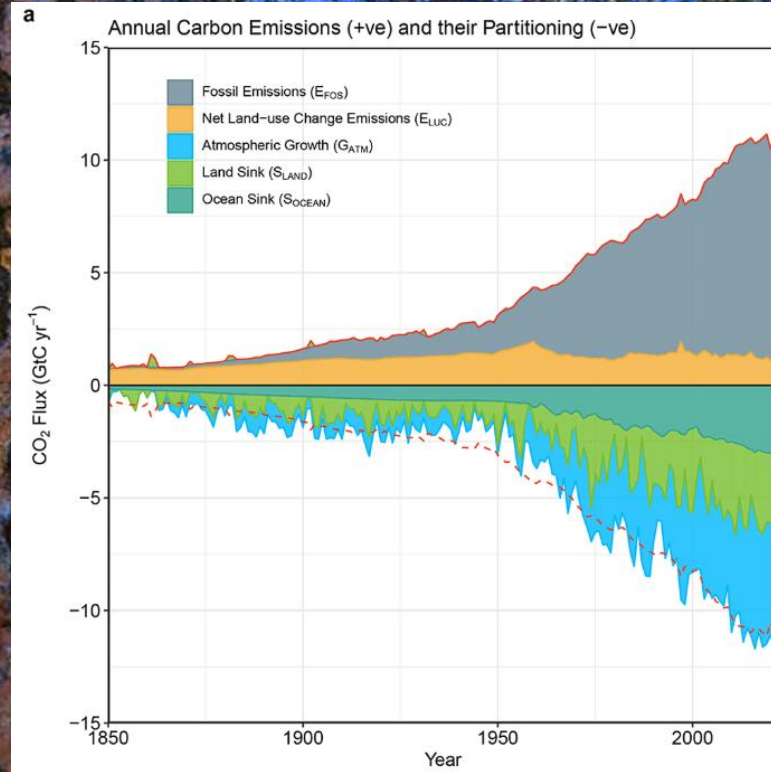
Camas to Condors Partnership Awards (2020 – present)

- C2C Capacity Building - \$5,000 Rising Voices/UCAR
- Indigenous Relations Liaison - \$25,000 Catalyst Fund
- The Seasonal Round Trail: A Cross-Cultural Framework for Climate Adaptation - \$100,000 Salazar Center
- Wéetespeme stewardship program - \$629,000 NSF
- The Seasonal Round: A Cross-Cultural Framework for Climate Adaptation - \$57,500 WCS Climate Adaptation Fund
- Resourcing Community Leadership in the Camas to Condors Partnership - \$25,000 Roundhouse Foundation
- Camas to Condors: Biocultural Restoration Planning for *Ananasocum* - \$2 million America The Beautiful Challenge (2023)



The Global Carbon Budget

Earth's
resilience
has kept our
planet in a
stable state



Forests remove about
30% of the additional
carbon dioxide that we
add to the atmosphere

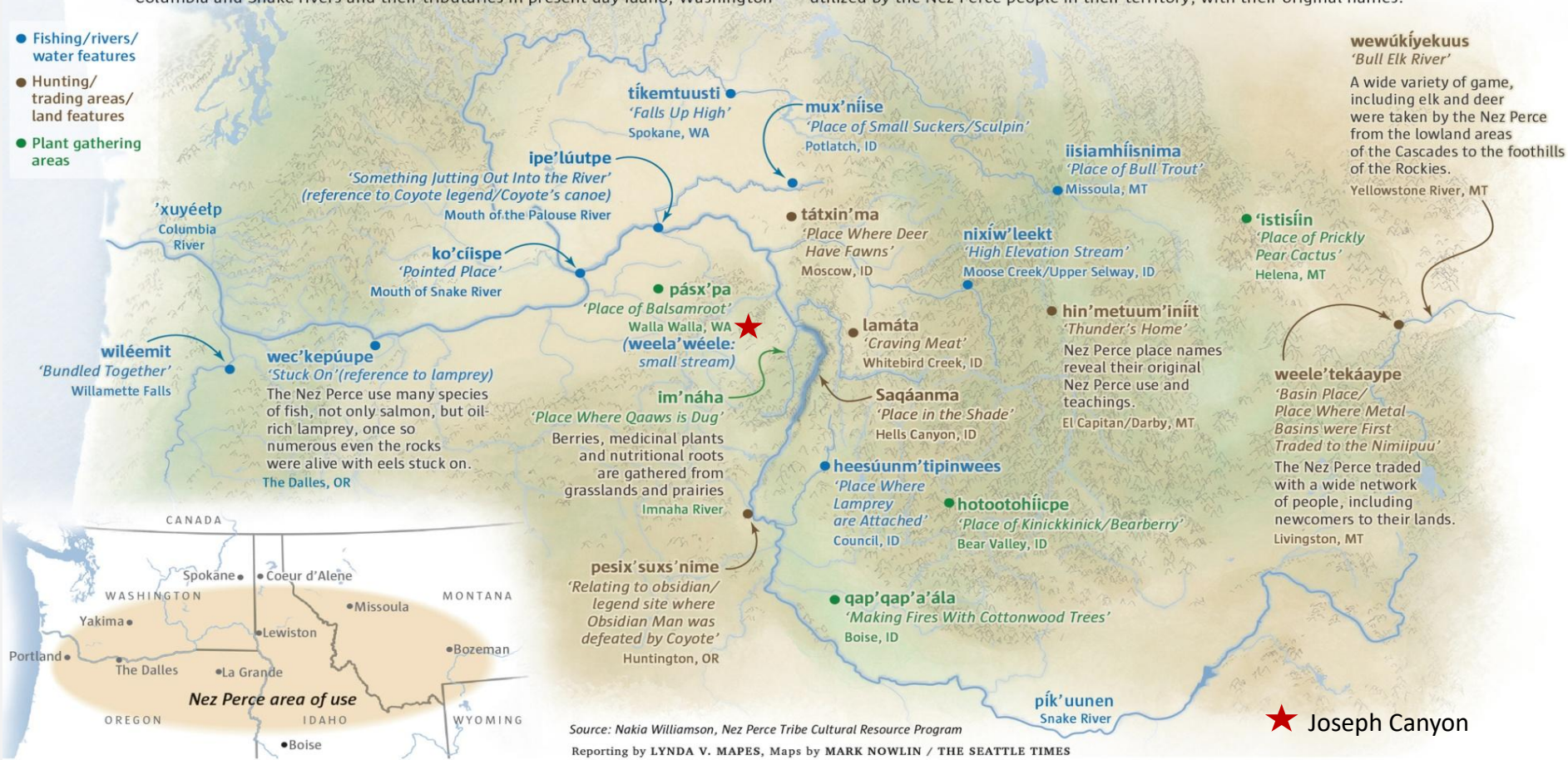
Forests drive the land carbon sink

A vast and abundant territory

For thousands of years the Nez Perce people utilized millions of acres of land and water as well as trade networks with other tribal communities to sustain their thriving culture. The tribe's traditional use area stretched from the buffalo grounds of present day Montana and Wyoming to the salmon country of the Columbia and Snake rivers and their tributaries in present day Idaho, Washington

and Oregon. Medicinal plants, pastures, roots, game and spiritual guides also were sought and used throughout their territory. The Nez Perce reserved their rights to continue these practices in all of their usual and accustomed areas under the Treaty of 1855 made with the United States. This map shows just a few places utilized by the Nez Perce people in their territory, with their original names.

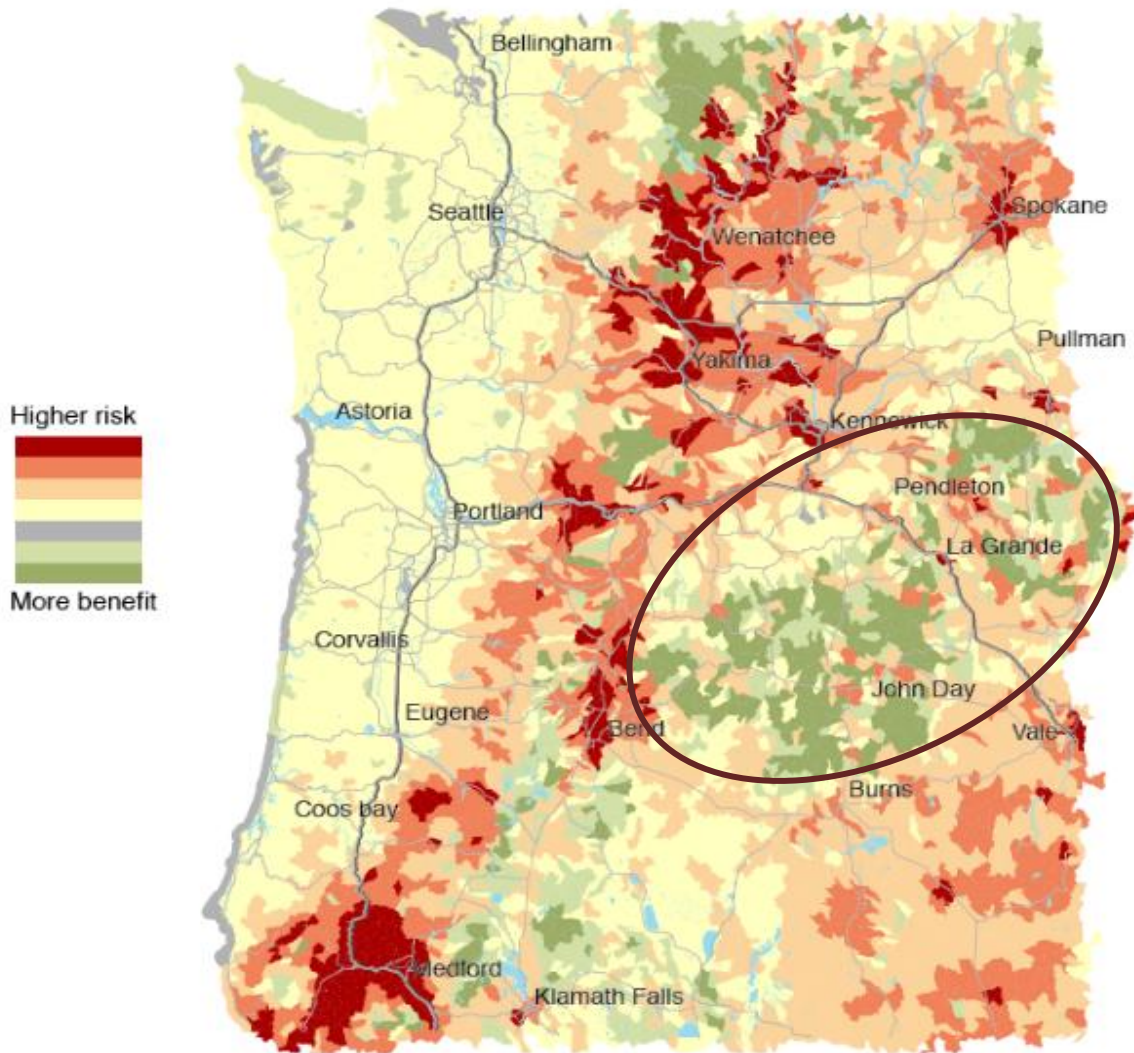
- Fishing/river/water features
- Hunting/trading areas/land features
- Plant gathering areas



Source: Nakia Williamson, Nez Perce Tribe Cultural Resource Program

Reporting by LYNDIA V. MAPES, Maps by MARK NOWLIN / THE SEATTLE TIMES

★ Joseph Canyon



Fire can Benefit the Blues

Wallowology! Hike **FREE!**



A Burning Need?

Restoring fire to the forests of the Blue Mountains

Indigenous peoples used fire to tend the landscape in accordance with natural cycles for millennia. As climate change intensifies, intentionally managing forests with fire can help foster resilience in forests to a warming world.

Forest Protection is Crucial

communications
earth & environment

ARTICLE

<https://doi.org/10.1038/s43247-021-00326-0>

OPEN



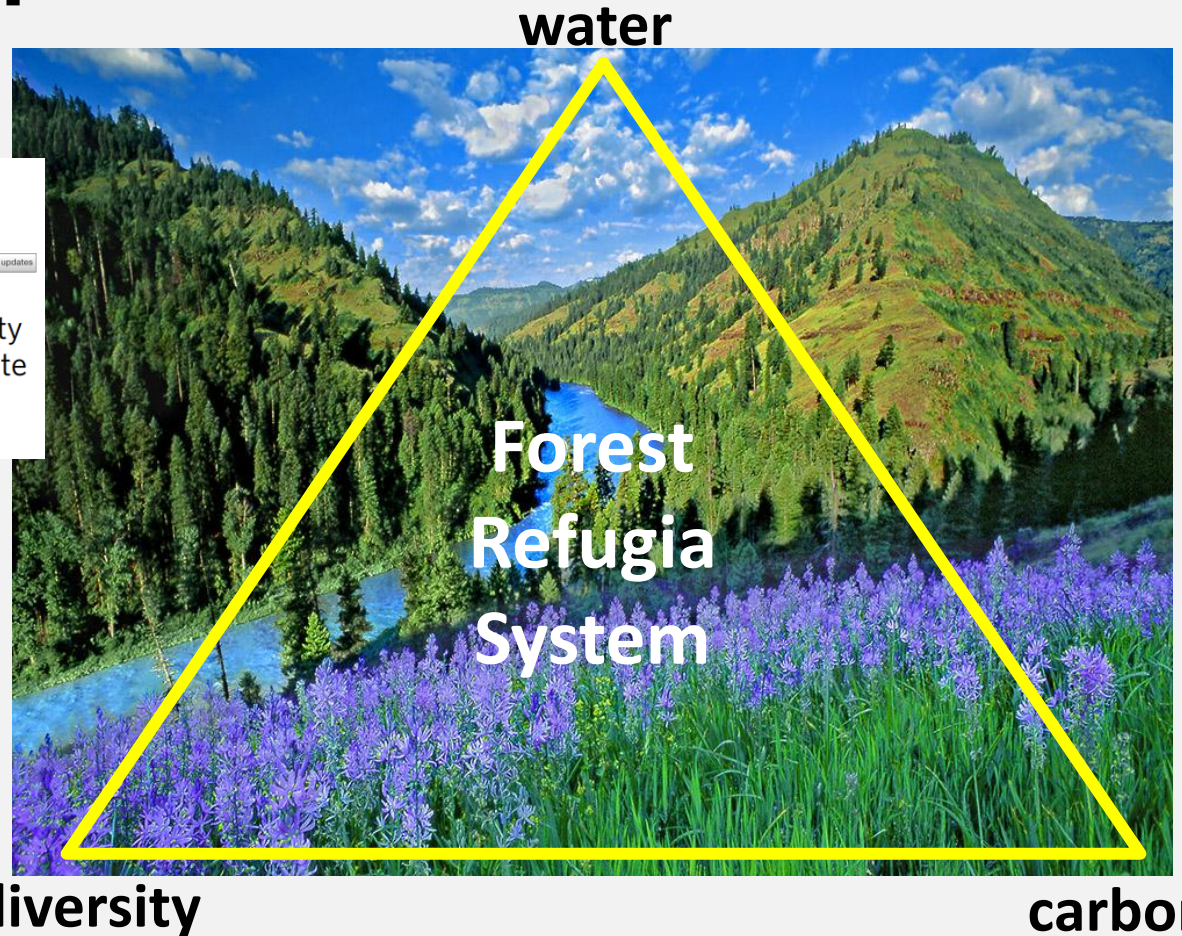
Strategic Forest Reserves can protect biodiversity in the western United States and mitigate climate change

Beverly E. Law¹, Logan T. Berner², Polly C. Buotte³, David J. Mildrexler⁴ & William J. Ripple¹

Urgency of Near-Term Integrated Climate Action

C.1 The choices and actions implemented in this decade will have impacts now and for thousands of years.

C.3.6 Maintaining the resilience of biodiversity and ecosystem services at a global scale depends on effective and equitable conservation of approximately 30% to 50% of Earth's land, freshwater and ocean areas, including currently near natural ecosystems.



Complex Topography and Waterways

