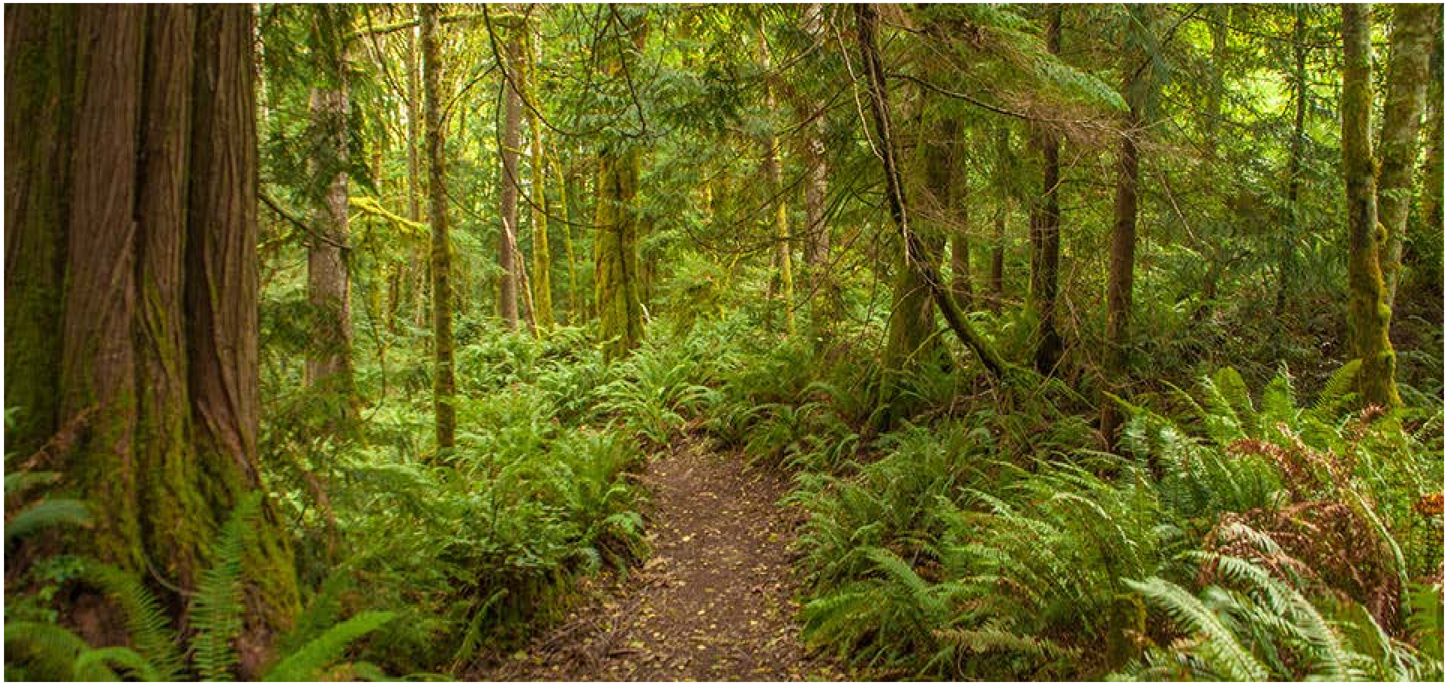
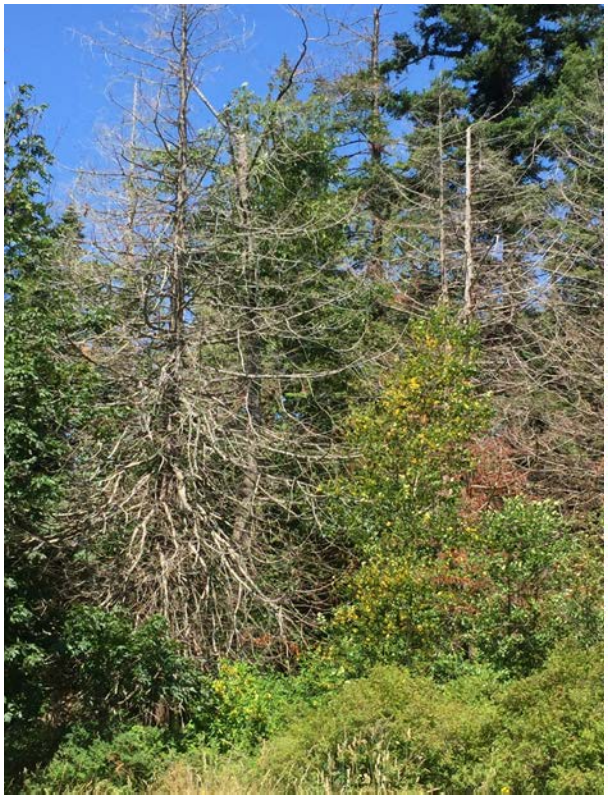
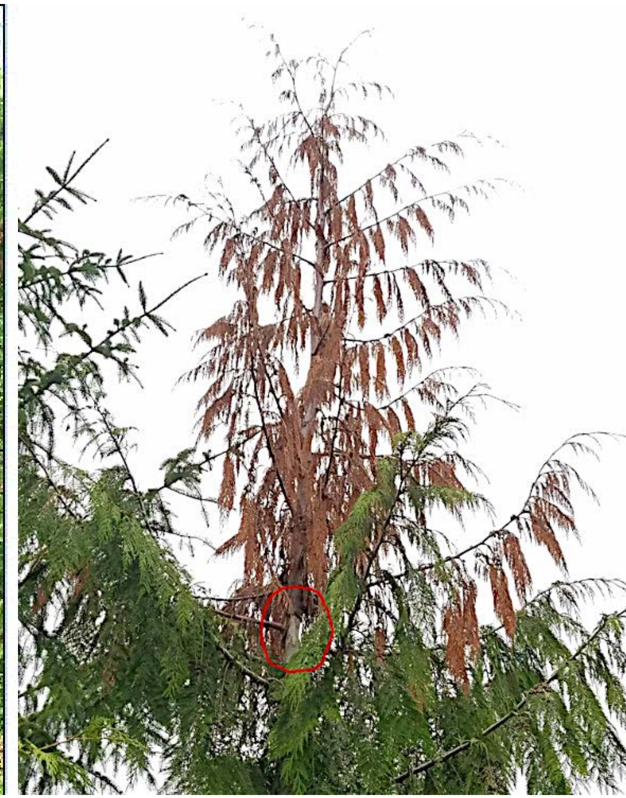
Climate change effects on forests in the Pacific Northwest



Dave Peterson
University of Washington
School of Environmental and Forest Sciences

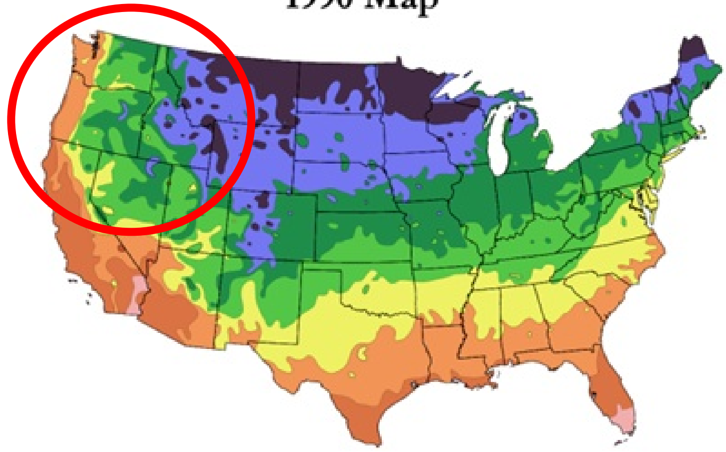
Recent observations?





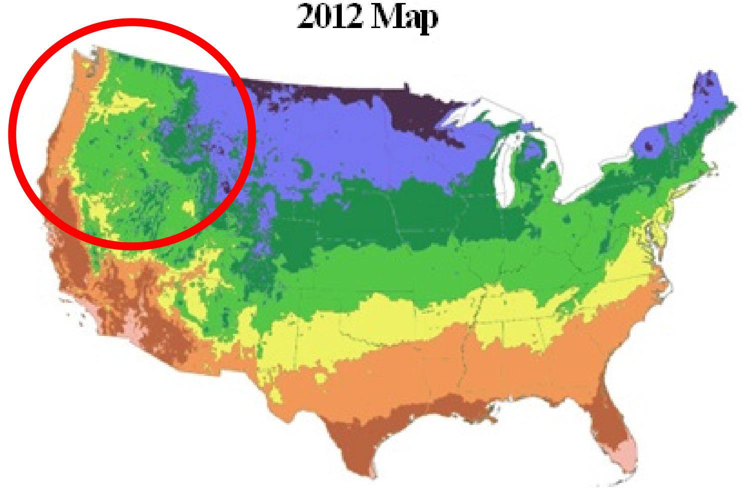
USDA plant hardiness zones

1990 Map



After USDA Plant Hardiness Zone Map, USDA Miscellaneous Publication No. 1475, Issued January 1990

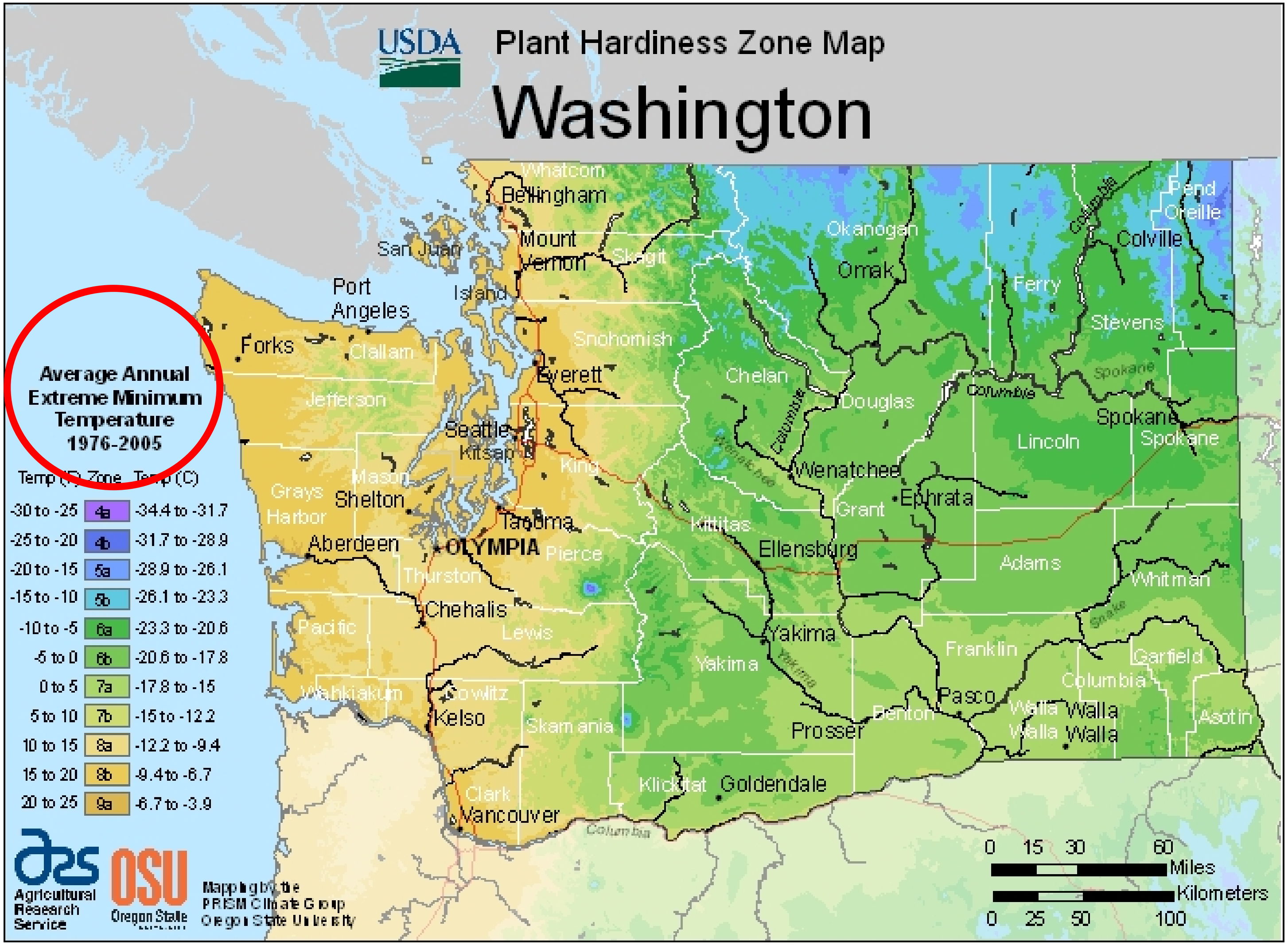
2012 Map



Re-colored version of the 2012 USDA Plant Hardiness Zone Map (available at: http://planthardiness.ars.usda.gov/PHZMWeb/)

Zone

Washington plant hardiness zones



Context

- Over 90% of all primary forests at lower elevation have been harvested at least once.
- Most forest landscapes have been fragmented by timber harvest, agriculture, urbanization, and roads, thus altering connectivity.
- Some forests have a significant complement of non-native plant species, insects, and pathogens.
- Droughts have been uncommon in the Pacific Northwest since the 1930s.
- Beavers have been extirpated since the 1800s (but making a comeback?).

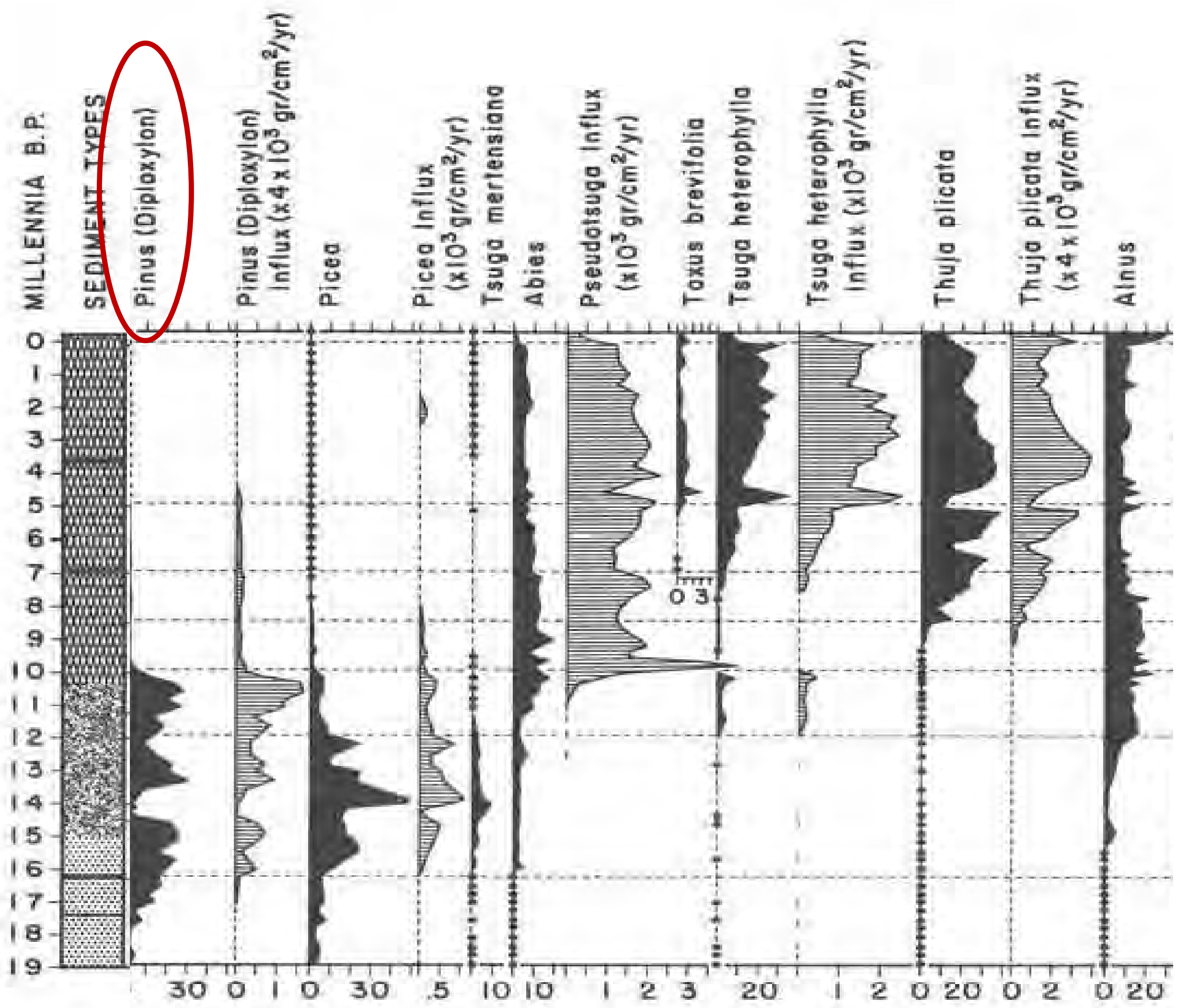
How will distribution and abundance of species change?

Three sources of scientific information:

- Paleoecological data
- Vegetation modeling
- Species rankings based on life history

Paleoecological evidence

PINE

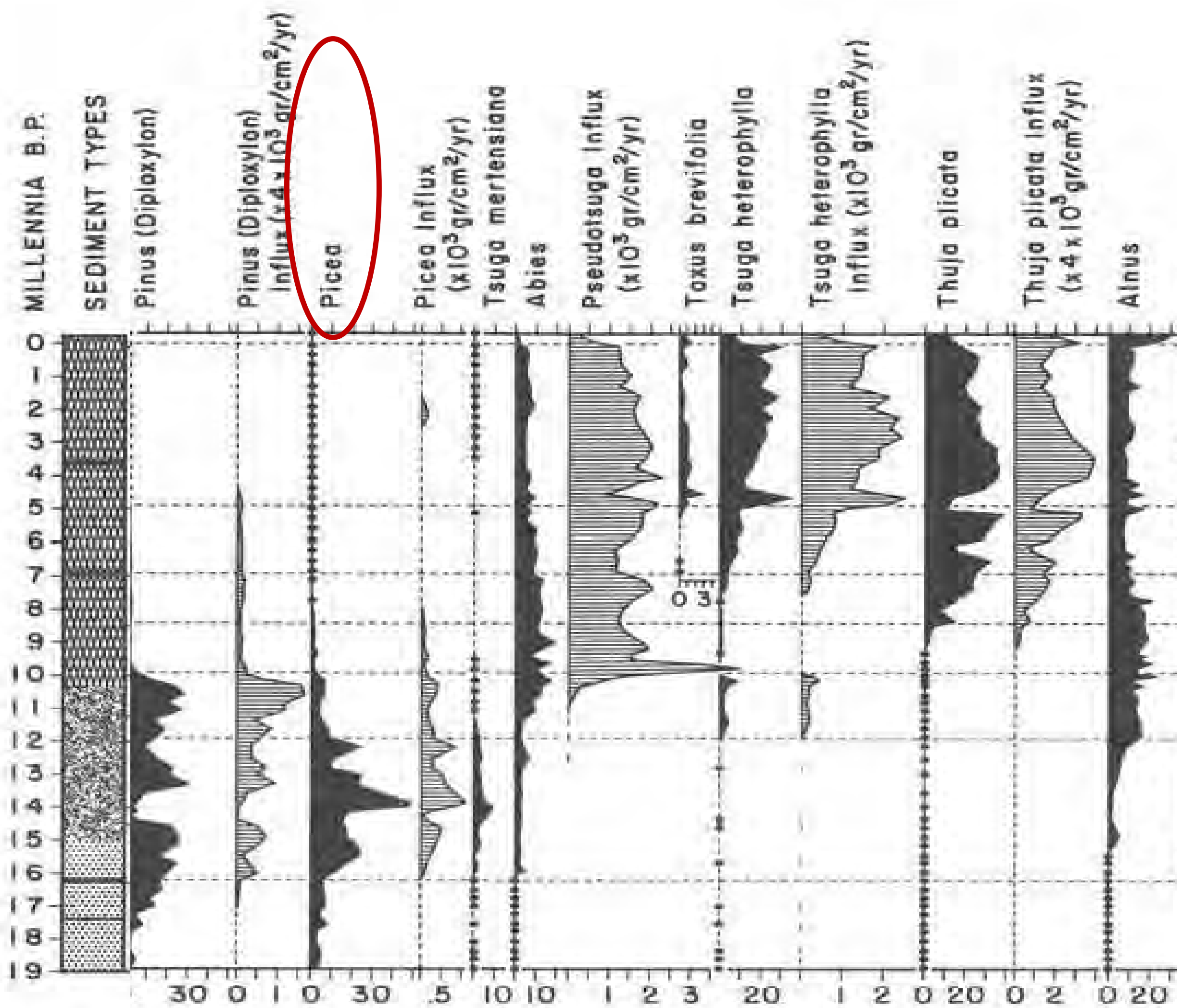


Mineral Lake, WA

From Tsukada et al. (1981)

Paleoecological evidence

SPRUCE

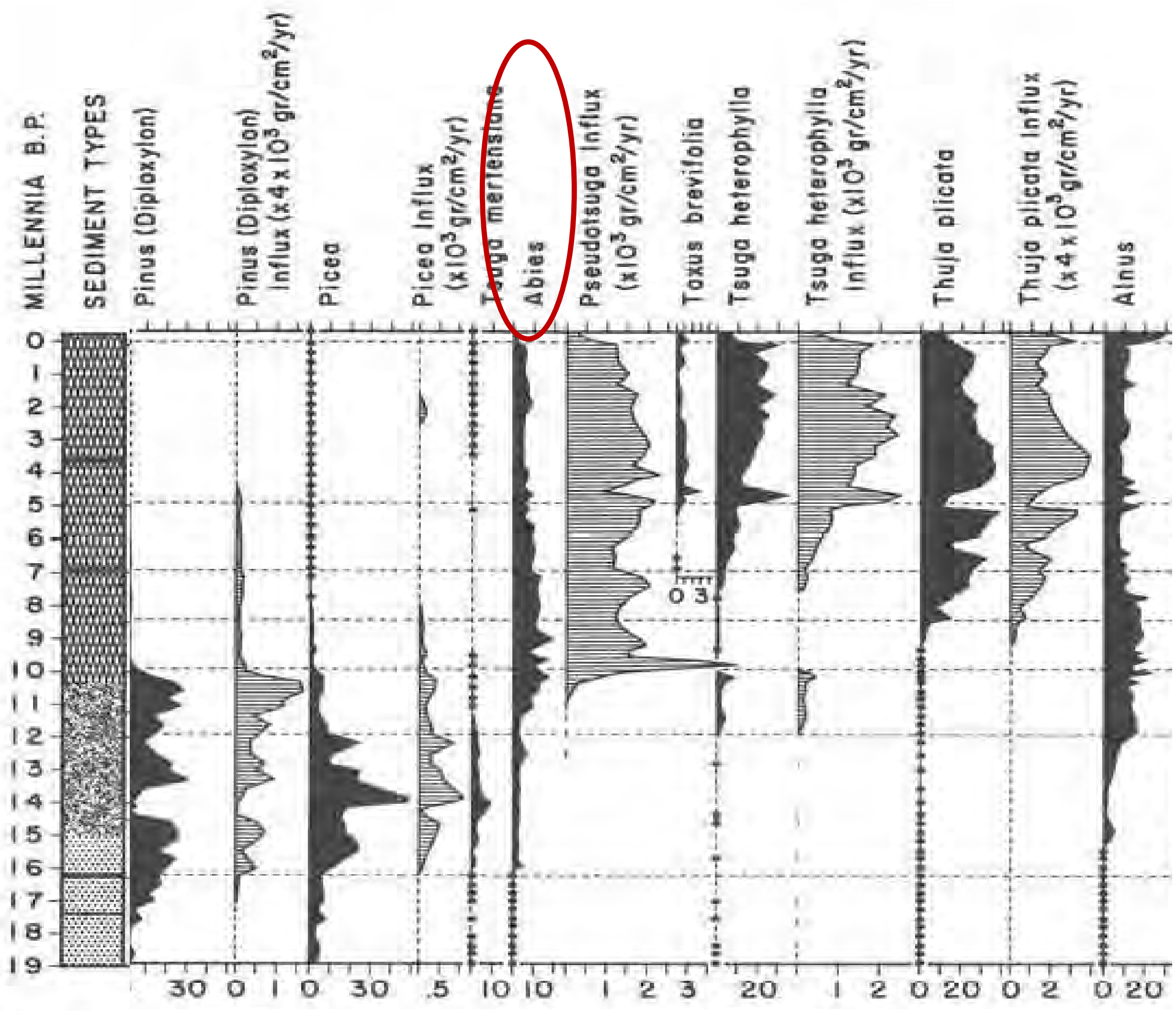


Mineral Lake, WA

From Tsukada et al. (1981)

Paleoecological evidence

FIR

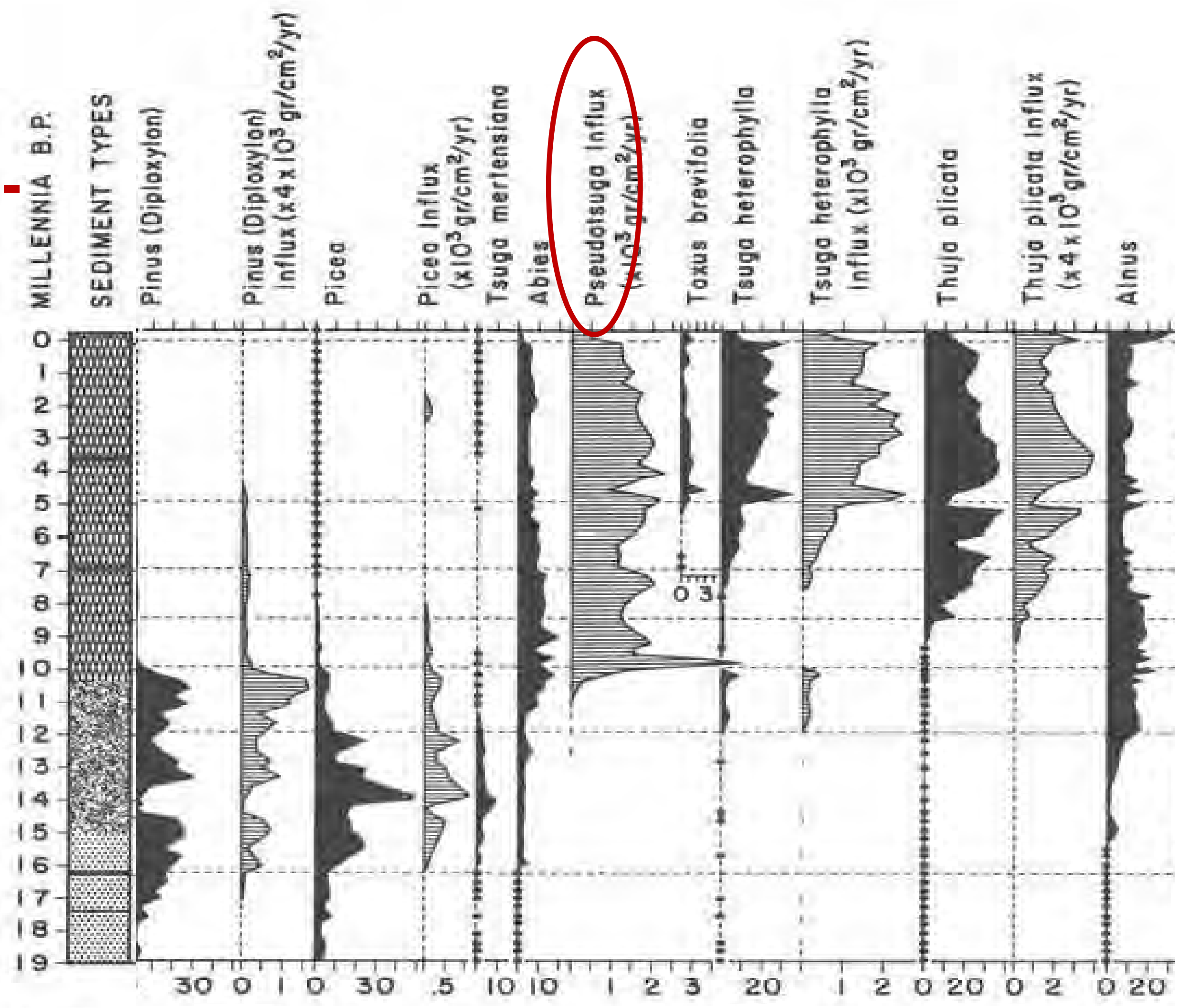


Mineral Lake, WA

From Tsukada et al. (1981)

Paleoecological evidence

DOUGLAS-FIR

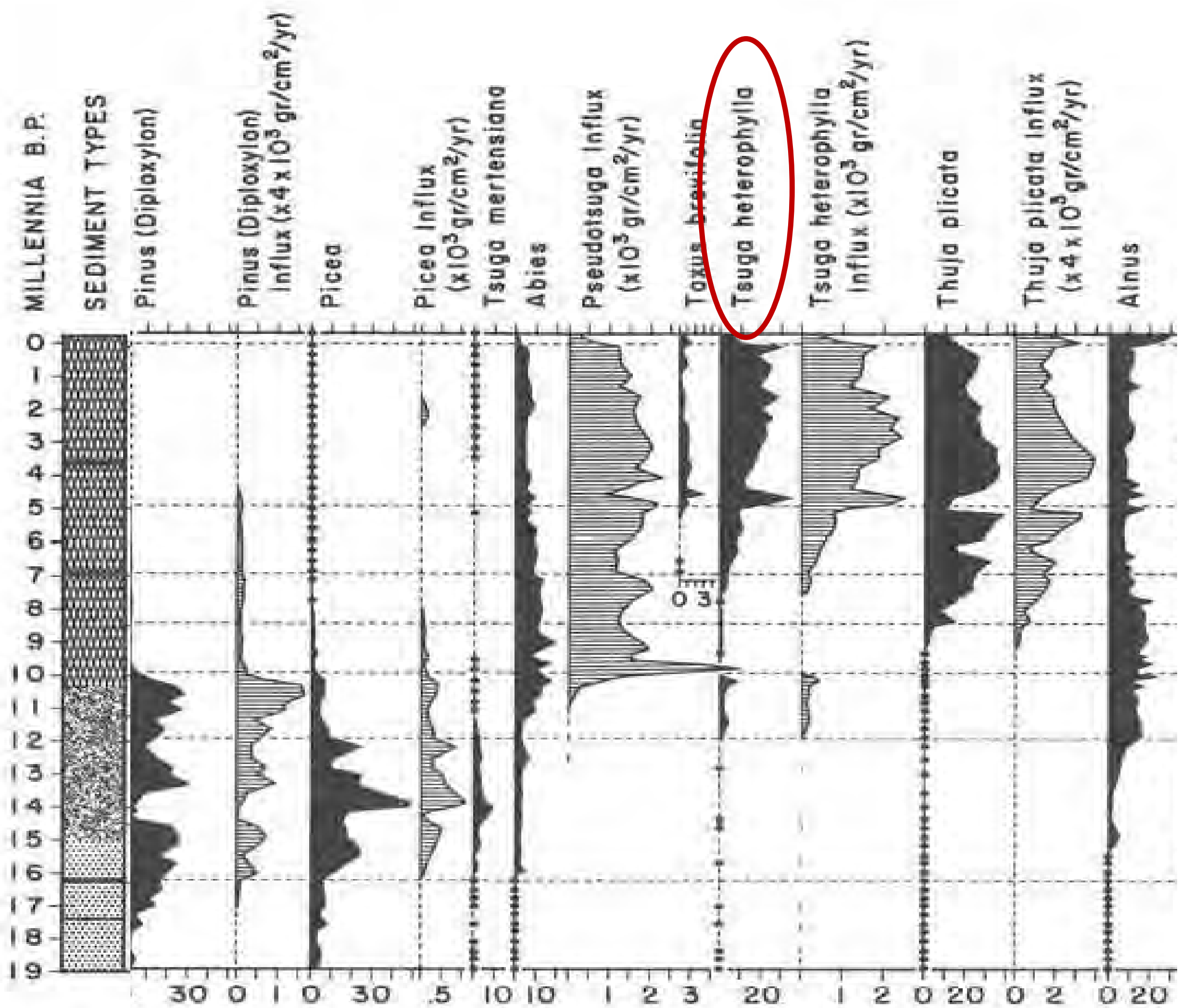


Mineral Lake, WA

From Tsukada et al. (1981)

Paleoecological evidence

HEMLOCK

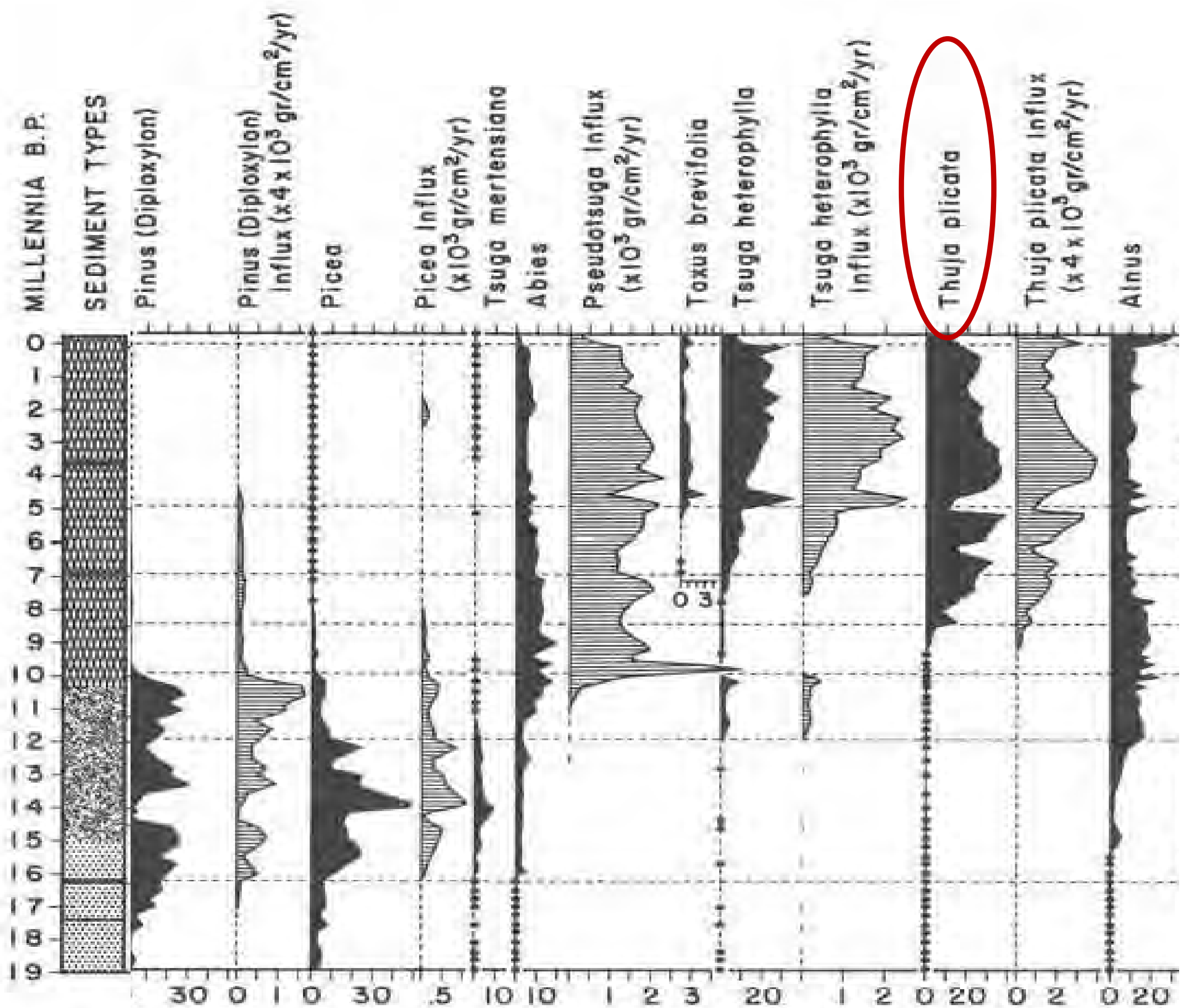


Mineral Lake, WA

From Tsukada et al. (1981)

Paleoecological evidence

CEDAR

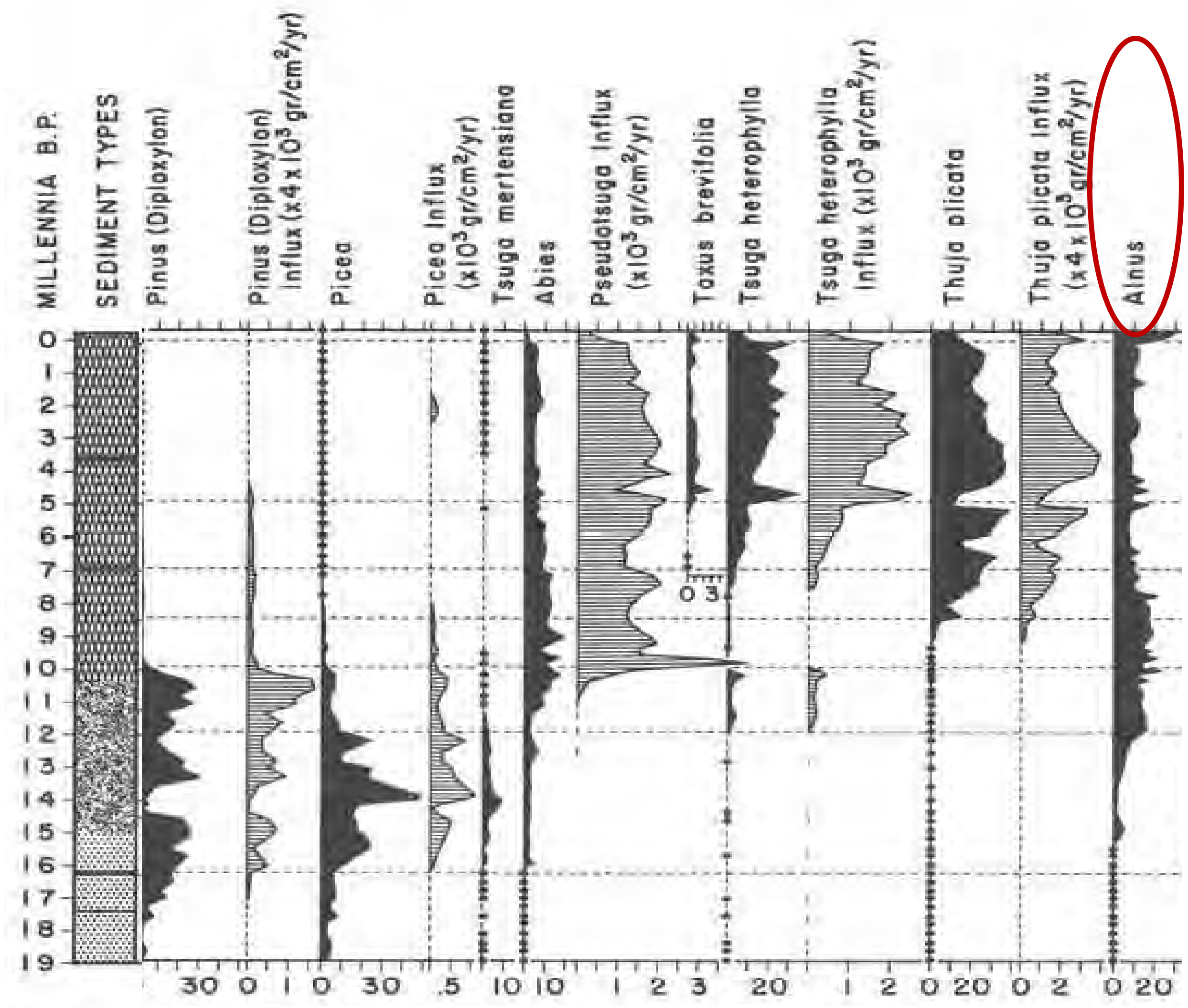


Mineral Lake, WA

From Tsukada et al. (1981)

Paleoecological evidence

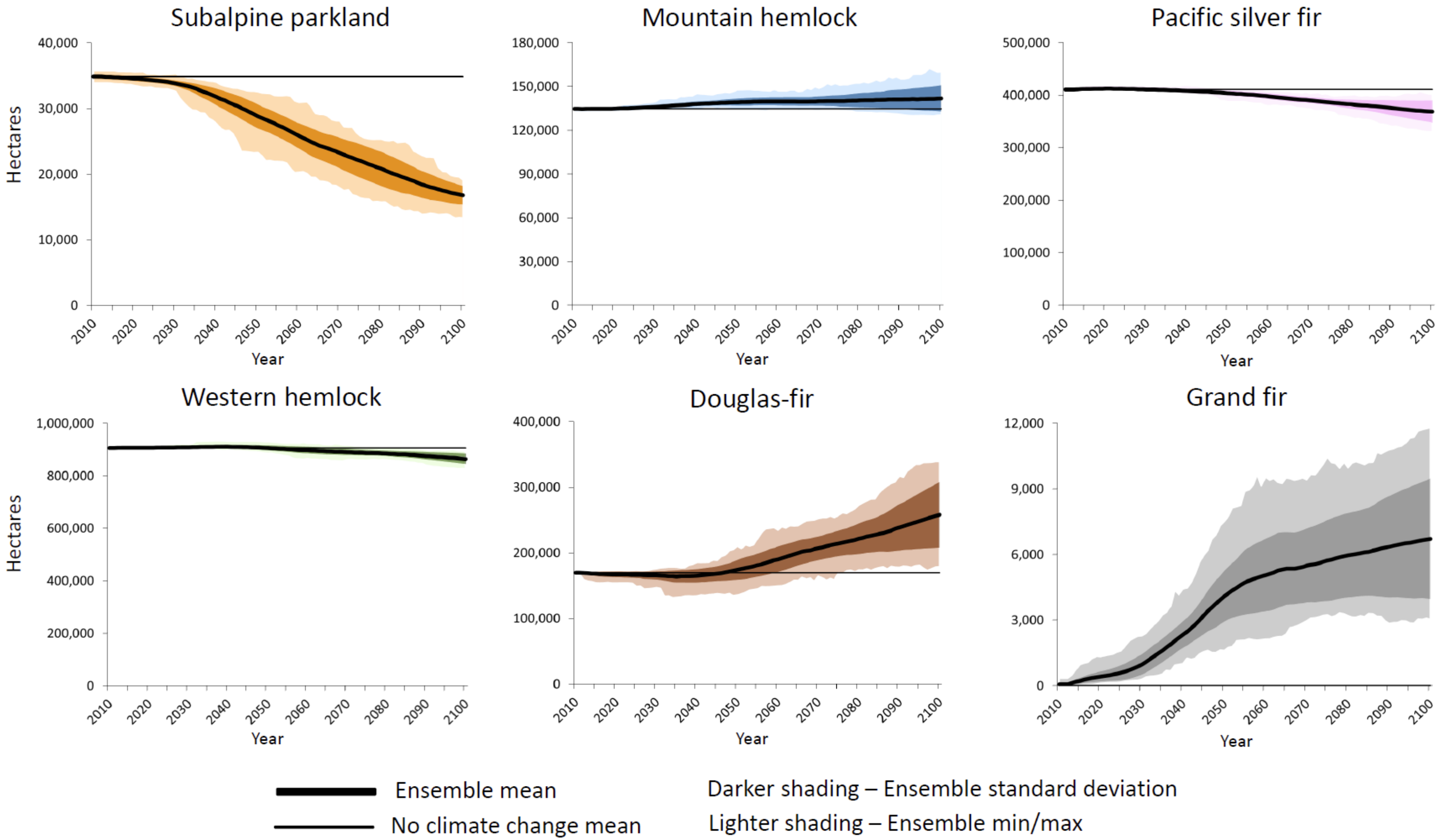
ALDER



Mineral Lake, WA

From Tsukada et al. (1981)

Vegetation modeling



Southwest Washington

From Hudec et al. (in press)

Species rankings

	Distribution	Reproductive capacity	Habitat affinity	Adaptive genetic variation	Insects and diseases	SCORE
Pacific silver fir	19[b]	100	100	100	86	81
Subalpine fir	38	67	65	84	100	71
Engelmann spruce	100	67	54	84	25	66
Noble fir	59	67	50	100	31	61
Grand fir	57	67	4	50	92	54
Mountain hemlock	38	33	88	67	31	51
Alaska yellow-cedar	63	67	58	67	0	51
Western white pine	83	33	15	0	58	38
Douglas-fir	0	67	8	50	28	31
Bigleaf maple	35	0	15	50	47	29
Black cottonwood	63	0	23	34	20	28
Sitka spruce	57	33	39	0	3	26
Western redcedar	44	67	0	17	3	26
Western hemlock	13	0	39	34	25	22
Red alder	19	0	19	50	14	20

Southwest Washington

From Devine et al. (2012)

Which characteristics do climate-tolerant species have?

High production of seeds and other propagules

High seed dispersal or vegetative propagation

Tolerant of low soil moisture

Tolerant of high air temperature

Tolerant of wildfire

High competitive ability

Broad environmental tolerance

High genetic diversity

How will trees grow in a warmer climate?

Low elevation, westside forest

Moisture limited

Growth will <u>decrease</u>:

- Douglas-fir
- Western hemlock
- Western redcedar
- Sitka spruce

How will trees grow in a warmer climate?

Eastside coniferous forest

Moisture limited

Growth will <u>decrease</u>:

- Ponderosa pine
- Douglas-fir
- Western larch

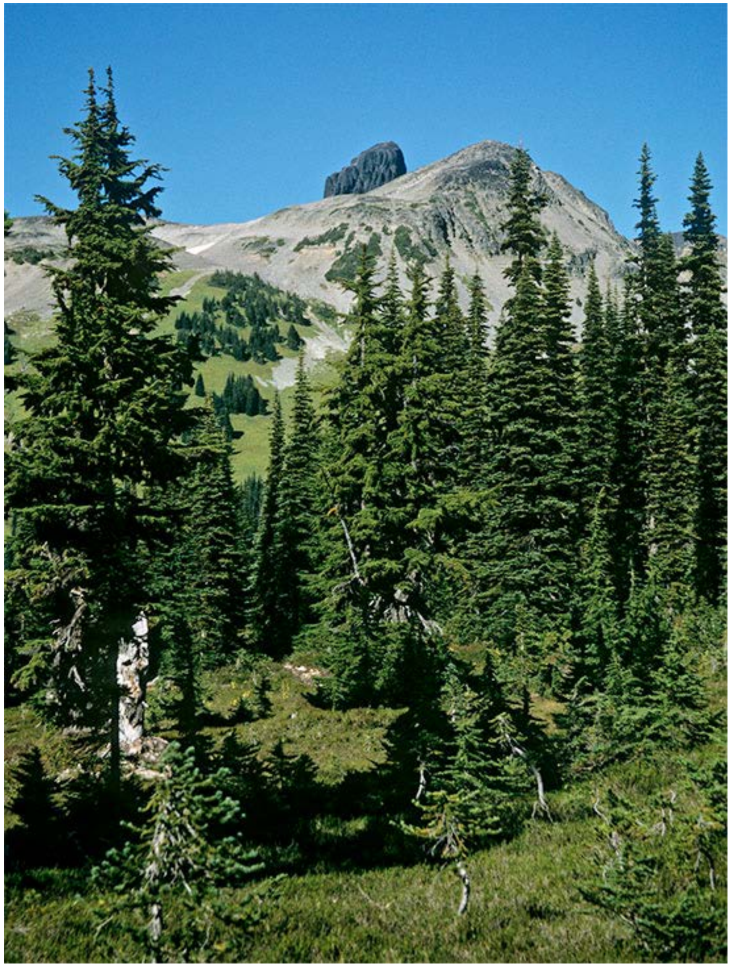
How will trees grow in a warmer climate?

High-elevation coniferous forest

Energy limited

Growth will <u>increase</u>:

- Subalpine fir
- Mountain hemlock
- Lodgepole pine



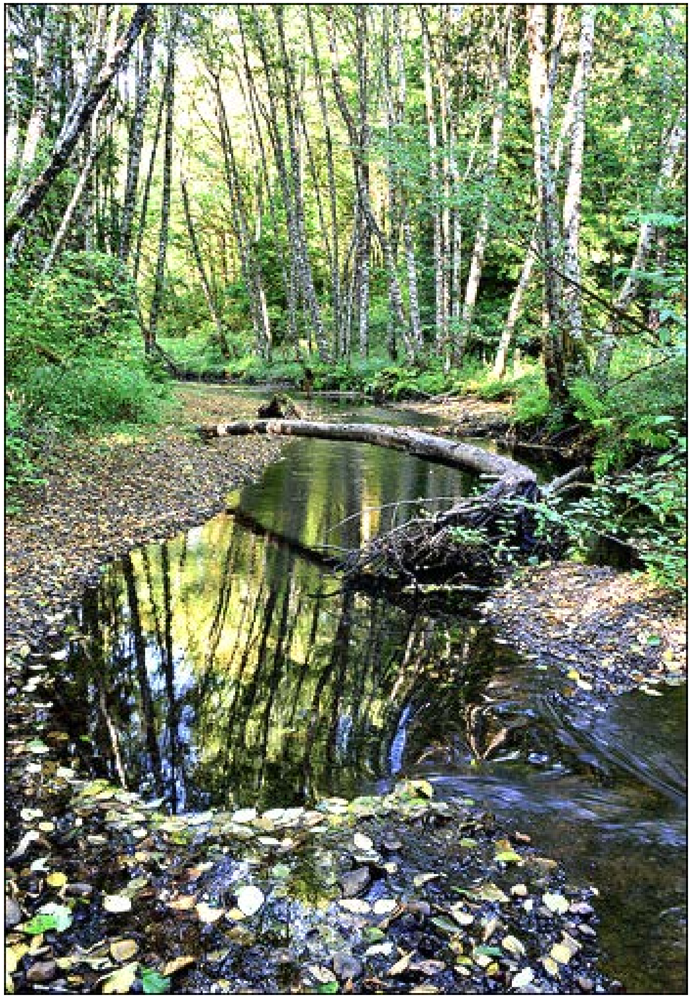
How will plants grow in a warmer climate?

Riparian areas, wetlands, groundwater-dependent systems

Water controlled

Growth and regeneration will change:

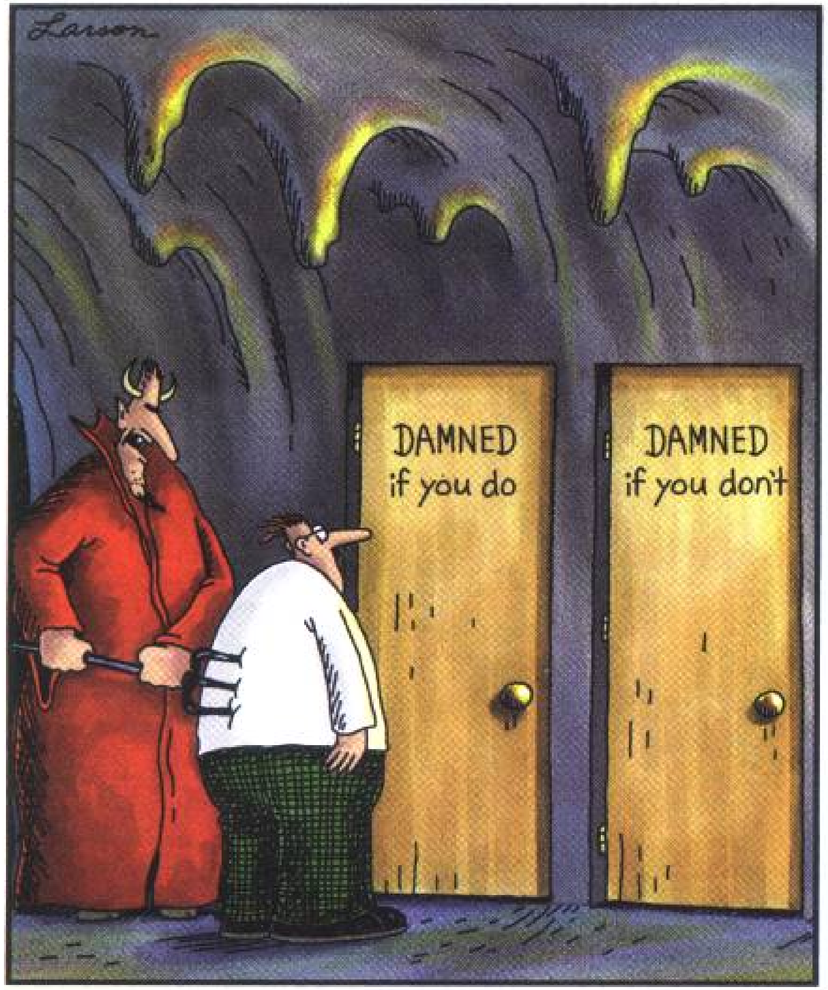
- Bogs, fens
- Species composition
- Fire susceptibility



What is climate change adaptation?

An effort to reduce the potentially negative consequences of climate change

AND transition species and ecosystems to a warmer climate.



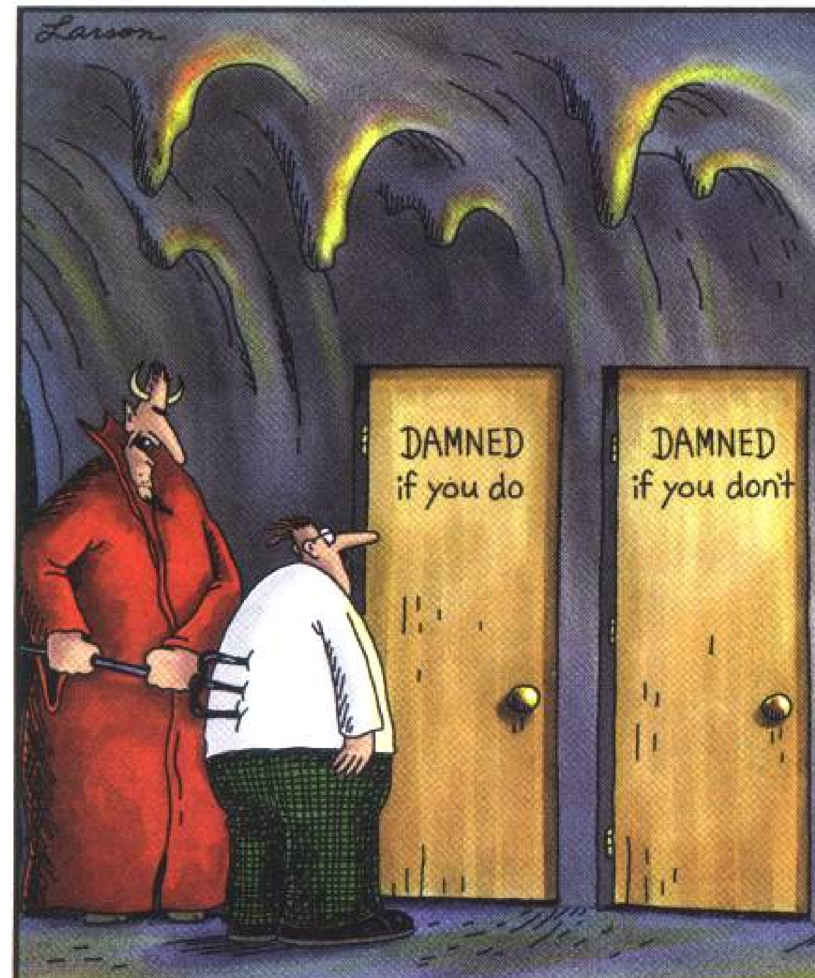
"C'mon, c'mon – it's either one or the other."

What is climate change adaptation?

Fine tuning and prioritizing current planning and management

Component of *sustainable resource management*

A form of *risk management*



"C'mon, c'mon – it's either one or the other."


How do we manage for resilient forests in a warmer climate?

Change the restoration paradigm

Old concepts

- Natural (historic) range of variation as a guide
- Species as targets for success
- Typically done at small spatial scales

Change to resilience building

New concepts

- Incorporate climate change information in planning and management
- Use future range of variation as a guide
- Implement across large spatial scales

Regeneration is a critical stage

Tree establishment following disturbance will determine winners and losers in a warmer climate

National Park Service

Seedlings must cope with variation in temperature and moisture at the soil surface

Oregon Forests and Industry Council

GOOD PRACTICE
Pamper seedlings and saplings

Retain soil moisture
for summer growth

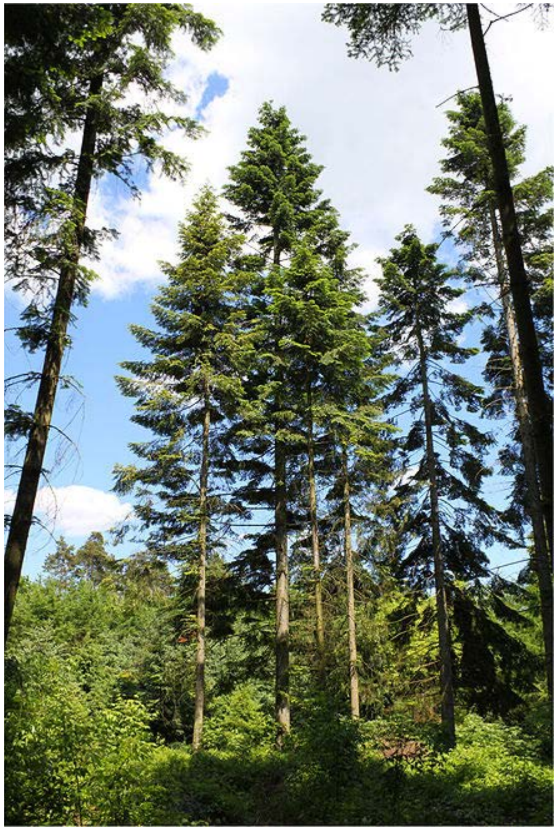
WSU Extension
Forestry

Protect trees
from herbivory

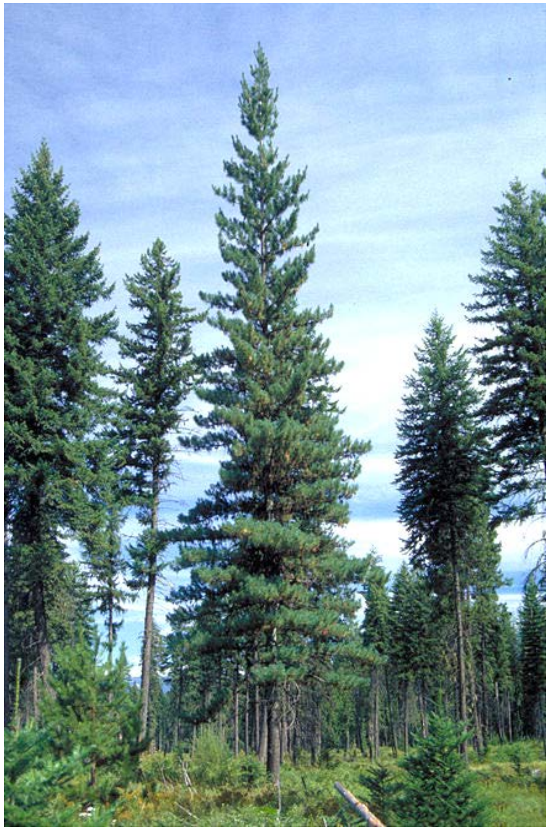
Jones' Farmer Blog

GOOD PRACTICE
Select drought tolerant species where possible

Douglas-fir



Grand fir



W. white pine

West-side species that tolerate low soil moisture

Pacific madrone

Oregon white oak

Ponderosa pine

Douglas-fir

Grand fir

Lodgepole pine

Western white pine

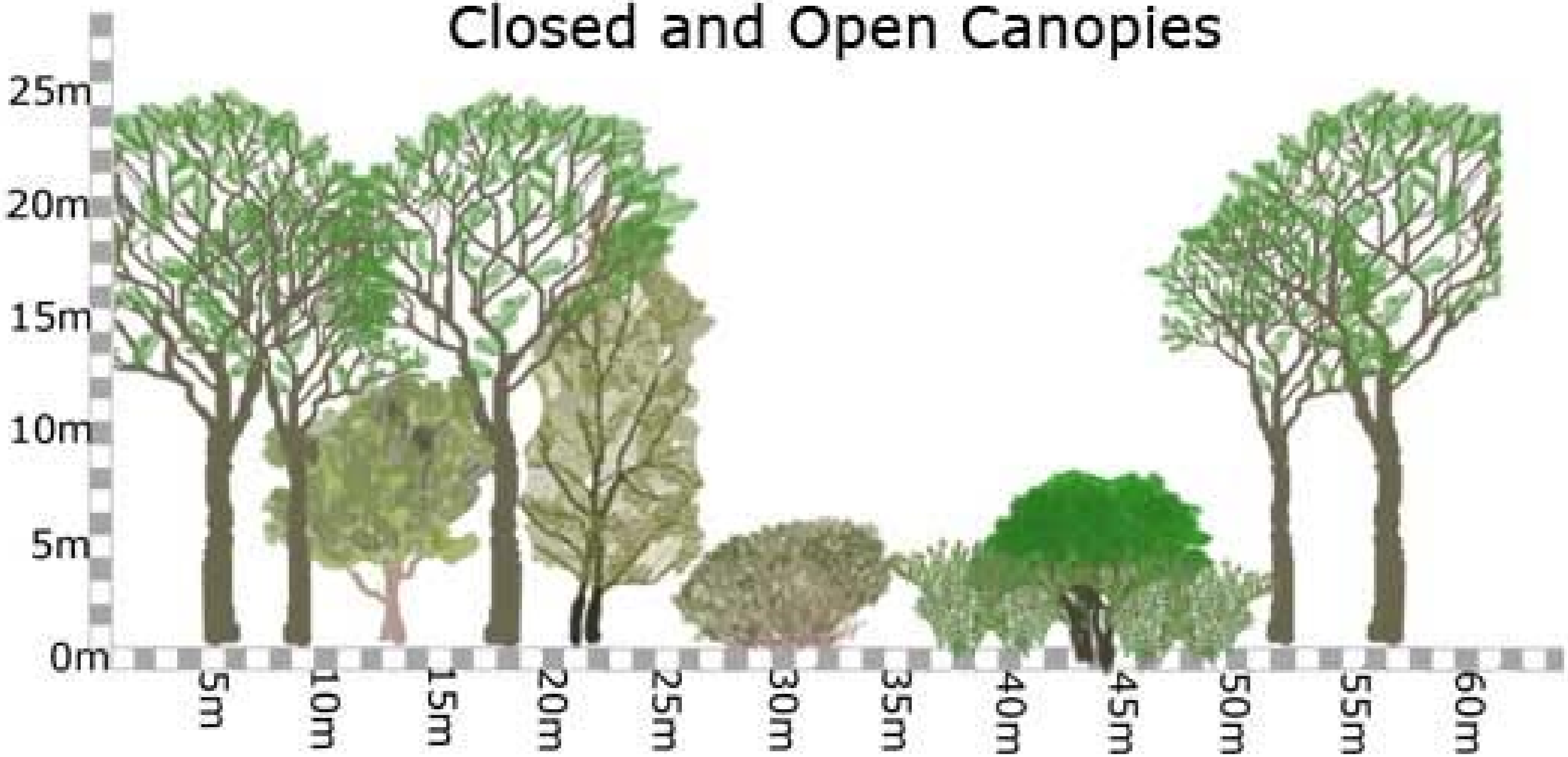
Red alder

In praise of hardwoods

- Hardwoods add diversity, especially in riparian areas
- Wildlife habitat
- Red alder and bigleaf maple have high value for wood products
- Firewood
- Resistance to conifer diseases
- Red alder fixes nitrogen
- Can underplant western redcedar and grand fir

GOOD PRACTICE
Select drought tolerant understory and edge species

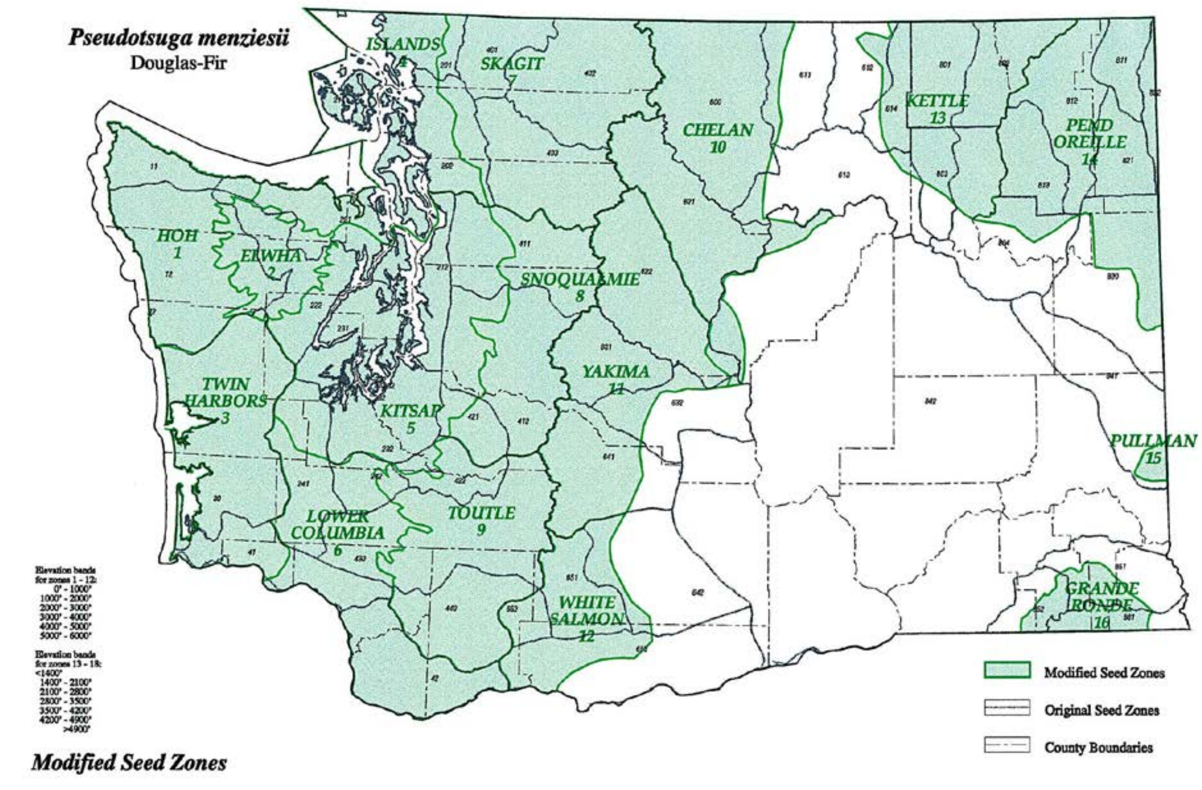
GOOD PRACTICE
Increase species diversity and structure



GOOD PRACTICE

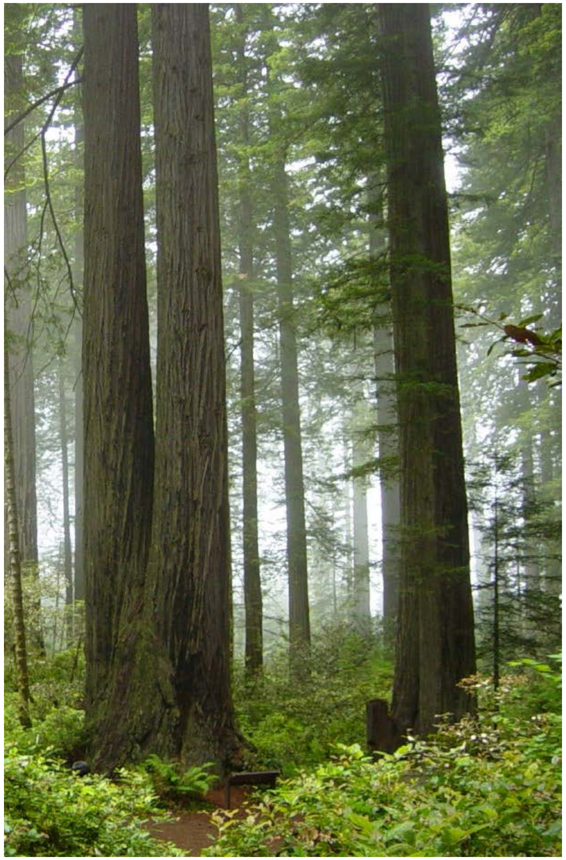
Diversify landscape pattern: partition species by water needs

GOOD PRACTICE
Be more flexible with seed zones



Douglas-fir seed zone map

Plant species from other regions?
(assisted migration/managed relocation)



GOOD PRACTICE
Keep forests healthy: Manage stand density (and fuels)

Thin dense stands to reduce competition ("too many straws in the glass")

Consider removing surface and understory fuels to reduce fire intensity

Manage forest density and fuels across landscapes
-- Collaborate with neighbors

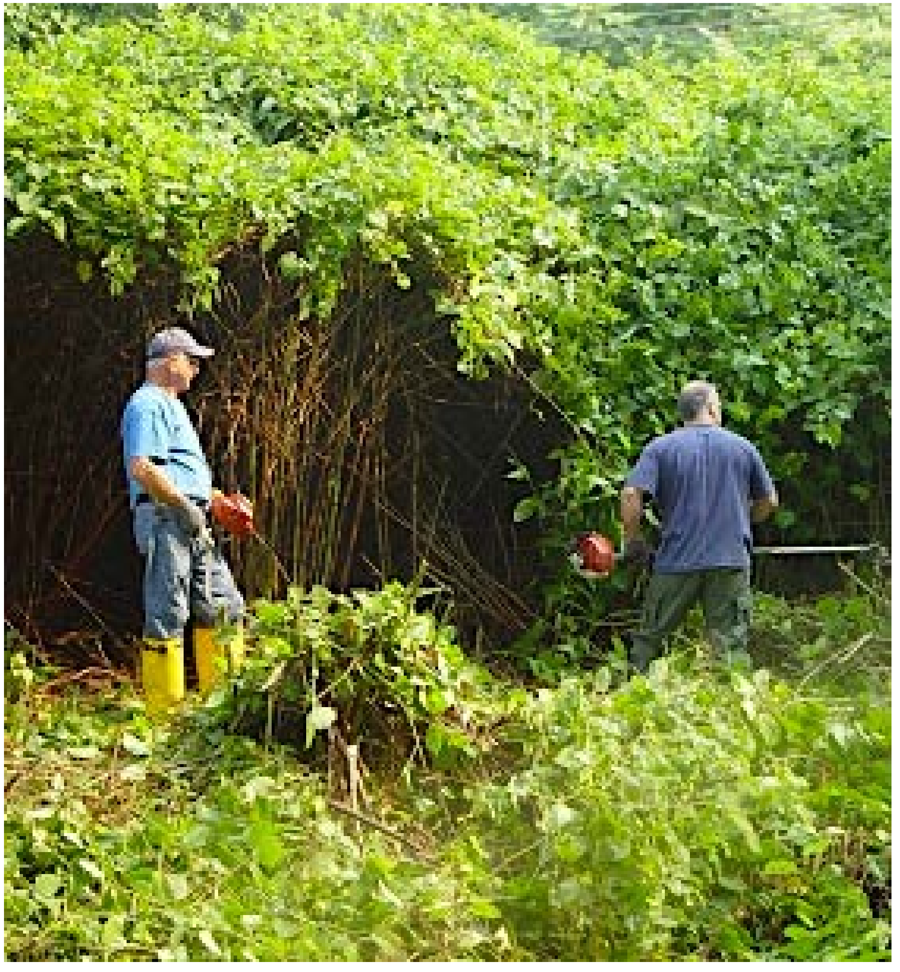
GOOD PRACTICE
Variable density thinning

Various spatial patterns of different tree densities

Target:
20% open stands
20% dense stands
60% standard thin

This can vary –
there are no rules.

GOOD PRACTICE
Keep vegetation healthy, remove stressors quickly



In summary — What can be done

- Manage for 30 years from now: warmer temperatures, higher extremes.
- Diversify plant species, genotypes, and spatial patterns.
- Use disturbances as an opportunity for changing trajectories and experimenting.
- Implement risk assessment and risk management.
- Monitor, learn, and adjust as needed.