January 27, 2016

Climate-FVS across western Oregon

Growth Model User Group Meeting
Portland, OR

David Diaz, Forestry Program Manager

ecotrust

01 *How climate affects growth-and-yield in Climate-FVS*

MAIN CHANGES TO BASE FVS MODEL IN CLIMATE-FVS

Species-level growth and mortality:

- Species suitability scores based on Random Forests model prediction of presence/absence using FIA and recent down-scaled climate history
- RF model provides a score for future climatic conditions
- Increasing/decreasing score relates to growth multiplier.
- Thresholds used to trigger additional mortality.

Carrying capacity (Maximum Stand Density Index):

- Proportional change in max SDI based on weighted suitability scores of species present at current time and next timestep of suitability scores

Site productivity (Site Index):

- Proportional change in site index calculated as a function of climate (using RF)

Natural regeneration (optional):

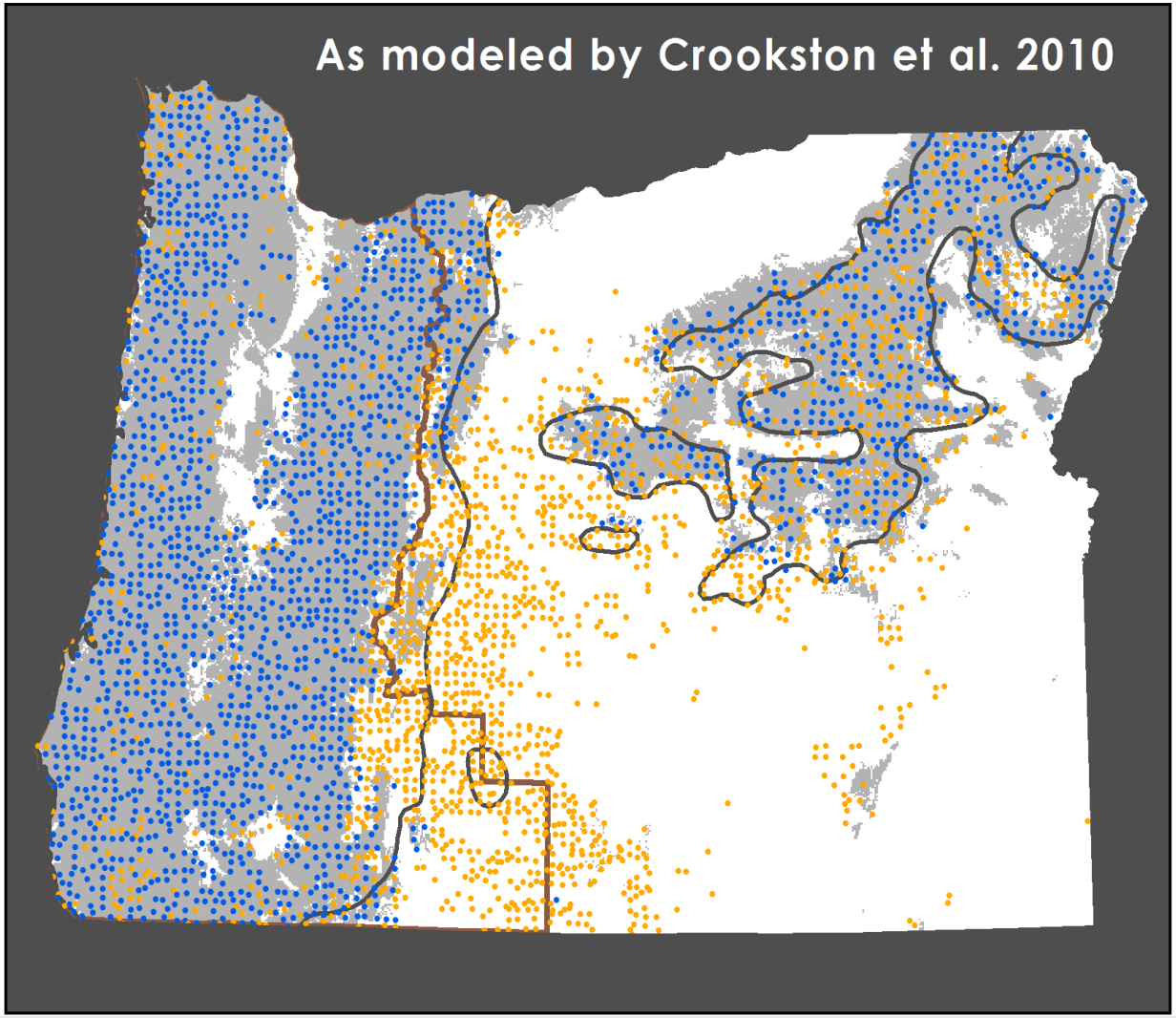
- When a stand passes below a pre-defined % of max SDI, automatically regenerate X number of species at Y density by selecting species with highest climatic suitability scores

02 *Bioclimate envelopes and suitability scores*

Douglas-fir

Current Climatic Suitability

FIA plot, species present
FIA plot, species absent
Species distribution according to Little (1971)
Modeled climatic suitability
BLM study region



Douglas-fir

Predicted Climatic Suitability

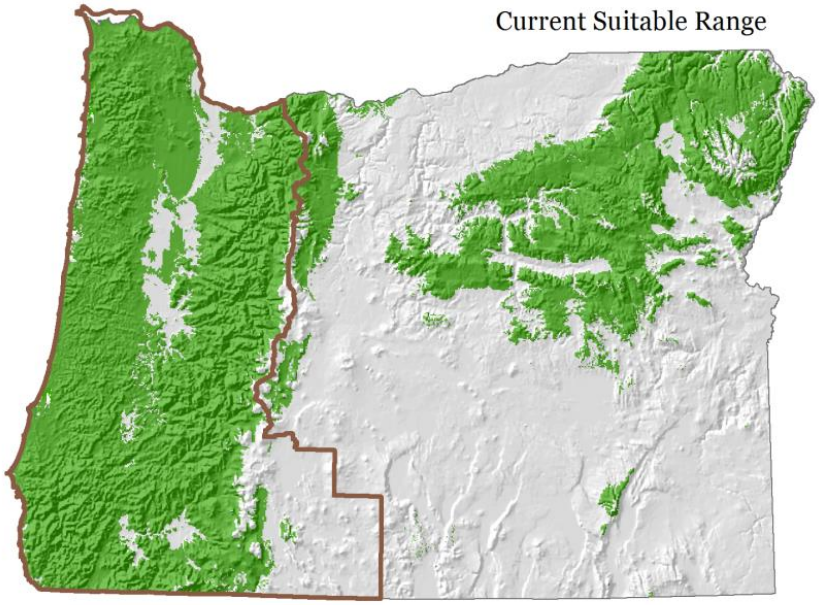
Suitability ratings derived by RandomForest regression approach trained with current FIA plots (Crookston et al., 2010)

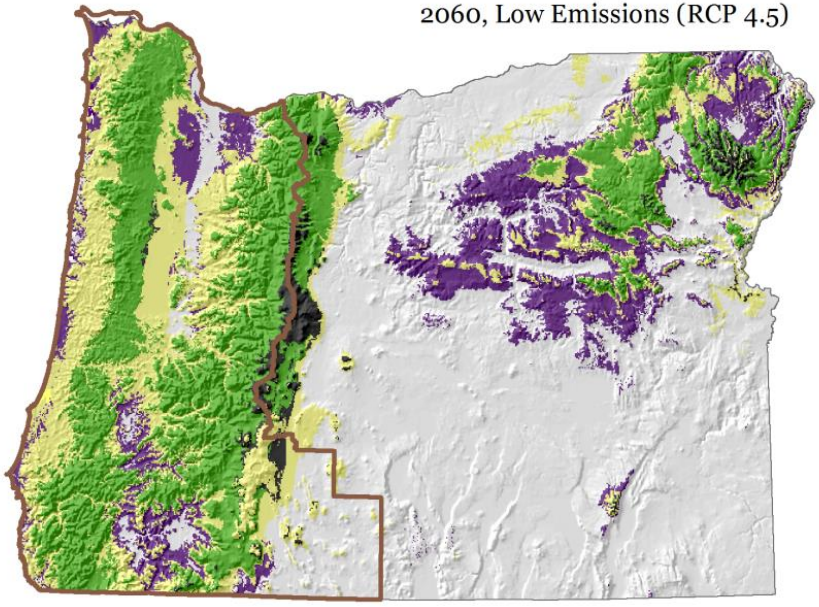
Future projections incorporate climate data from four General Circulation Models:

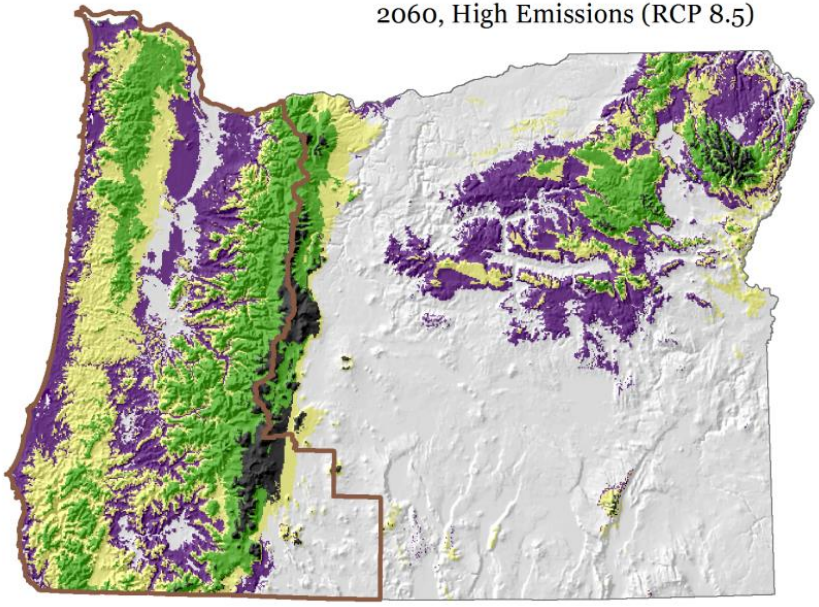
- Canadian Center for Climate Modeling and Analysis
- Geophysical Fluid Dynamics Laboratory
- Hadley Center/Met Office
- Ensemble

Agreement among models

- Unanimous agreement: unsuitable climate
- Disagreement among models
- Unanimous agreement: suitable climate
- Unanimous agreement: expansion of suitable climatic range







Western hemlock

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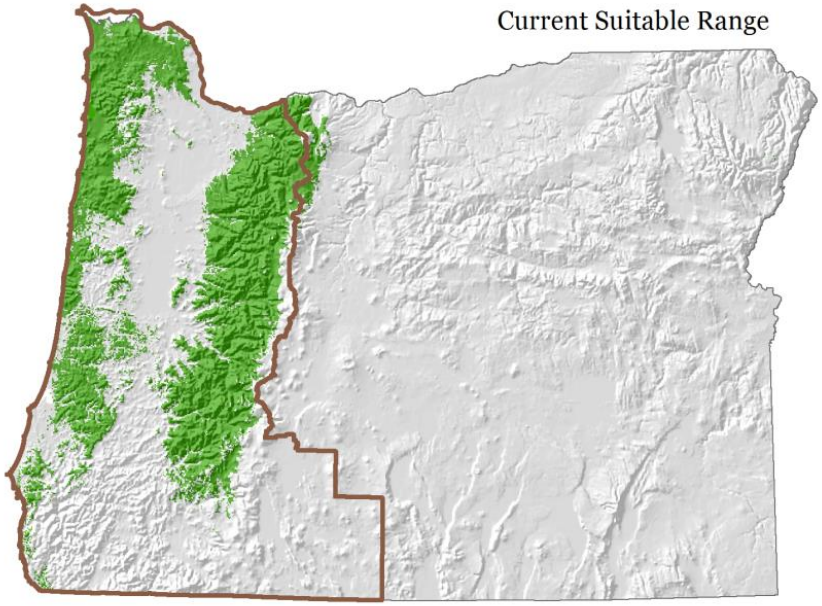

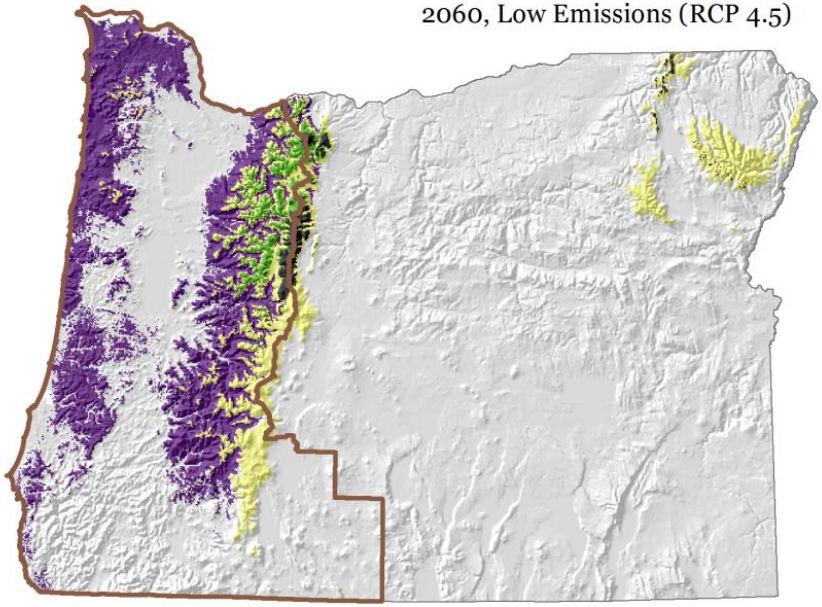

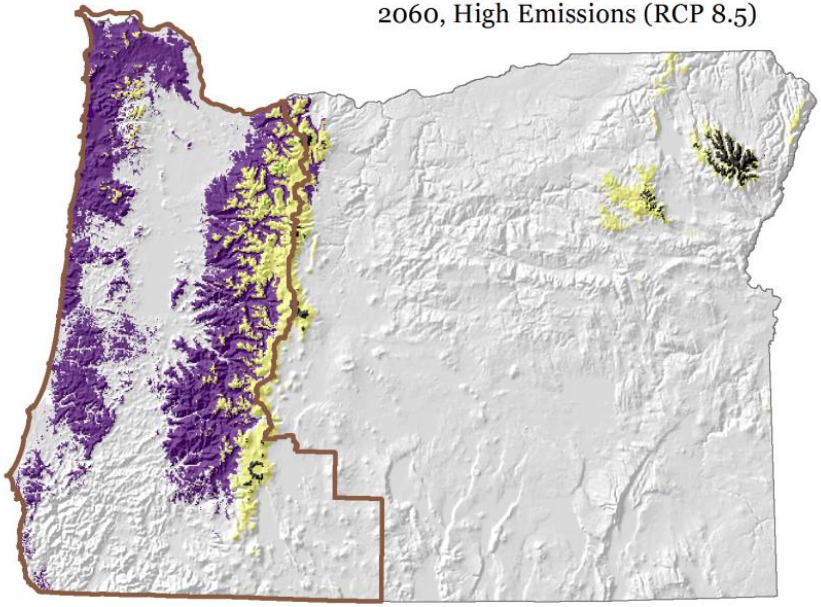

Western red cedar

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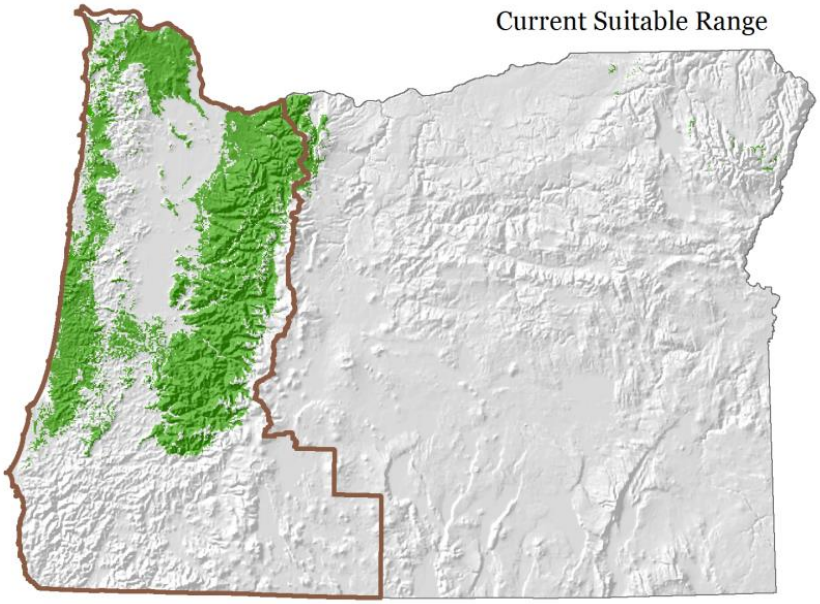

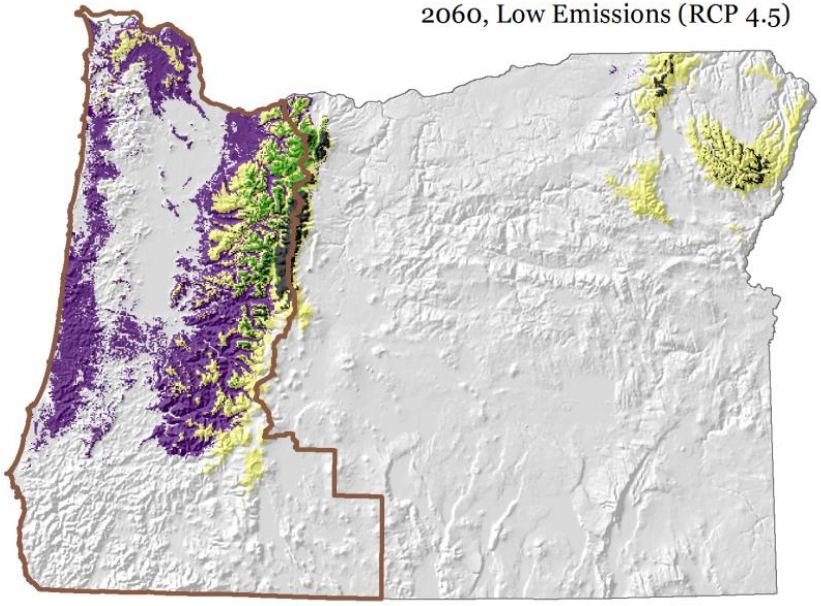

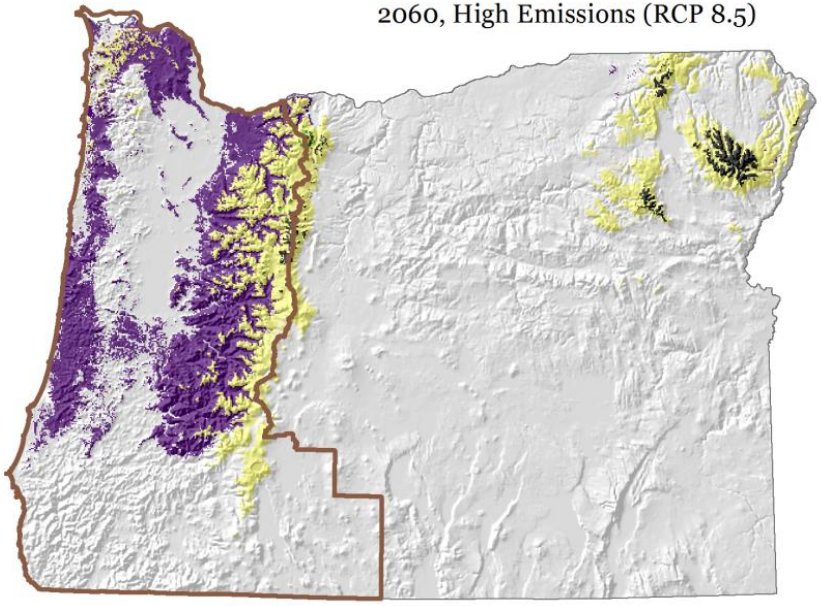

Ponderosa Pine

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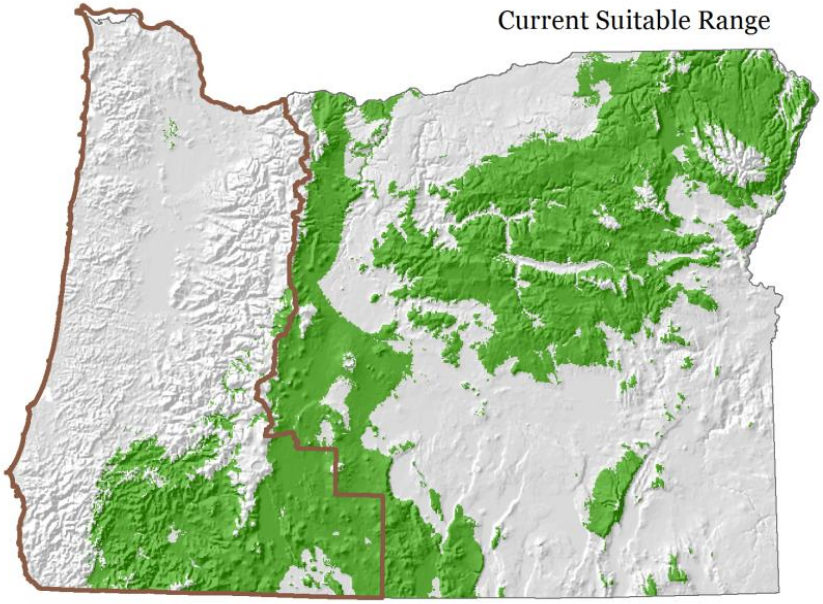
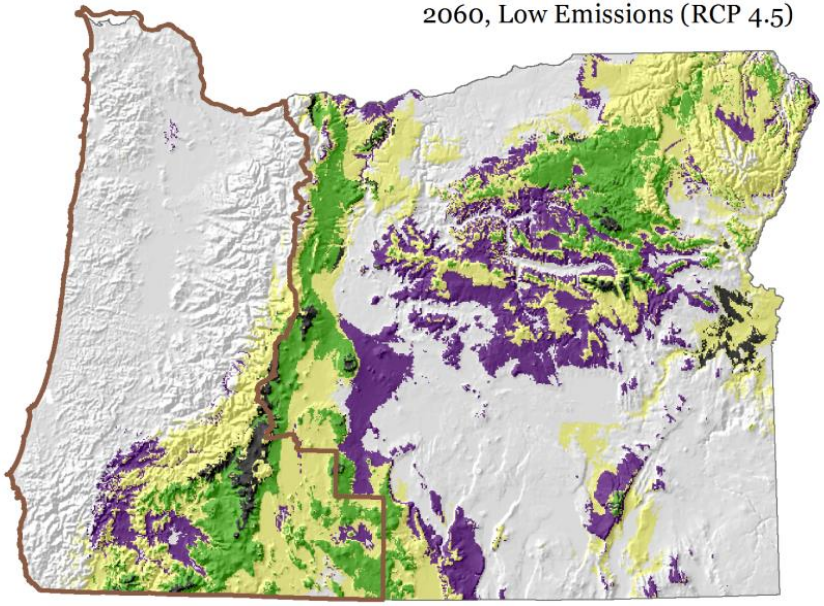
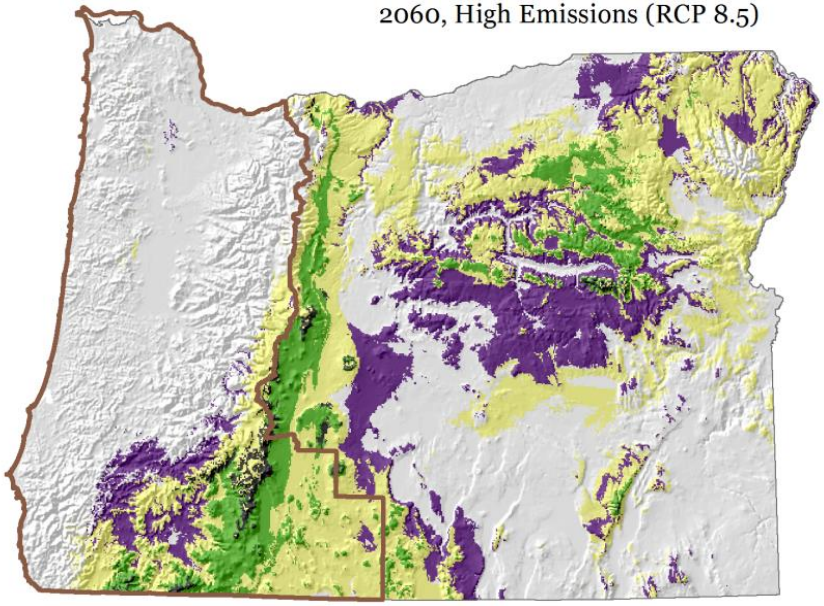
Current Suitable Range



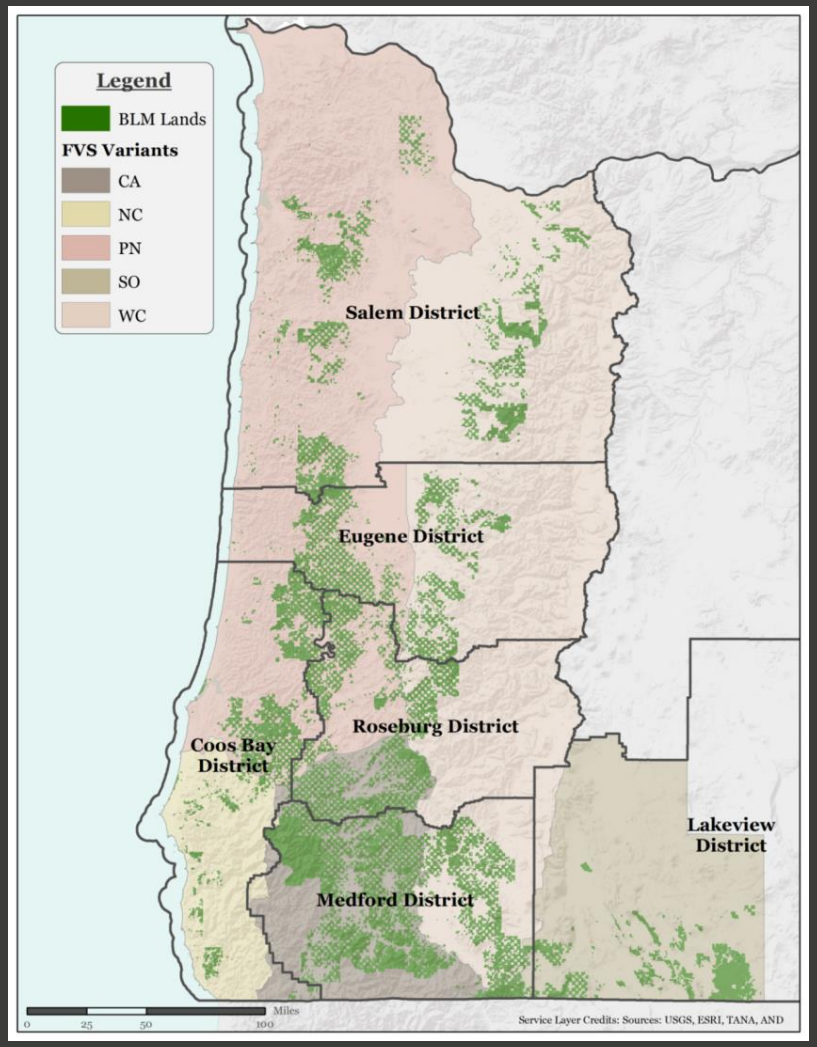
2060, Low Emissions (RCP 4.5)



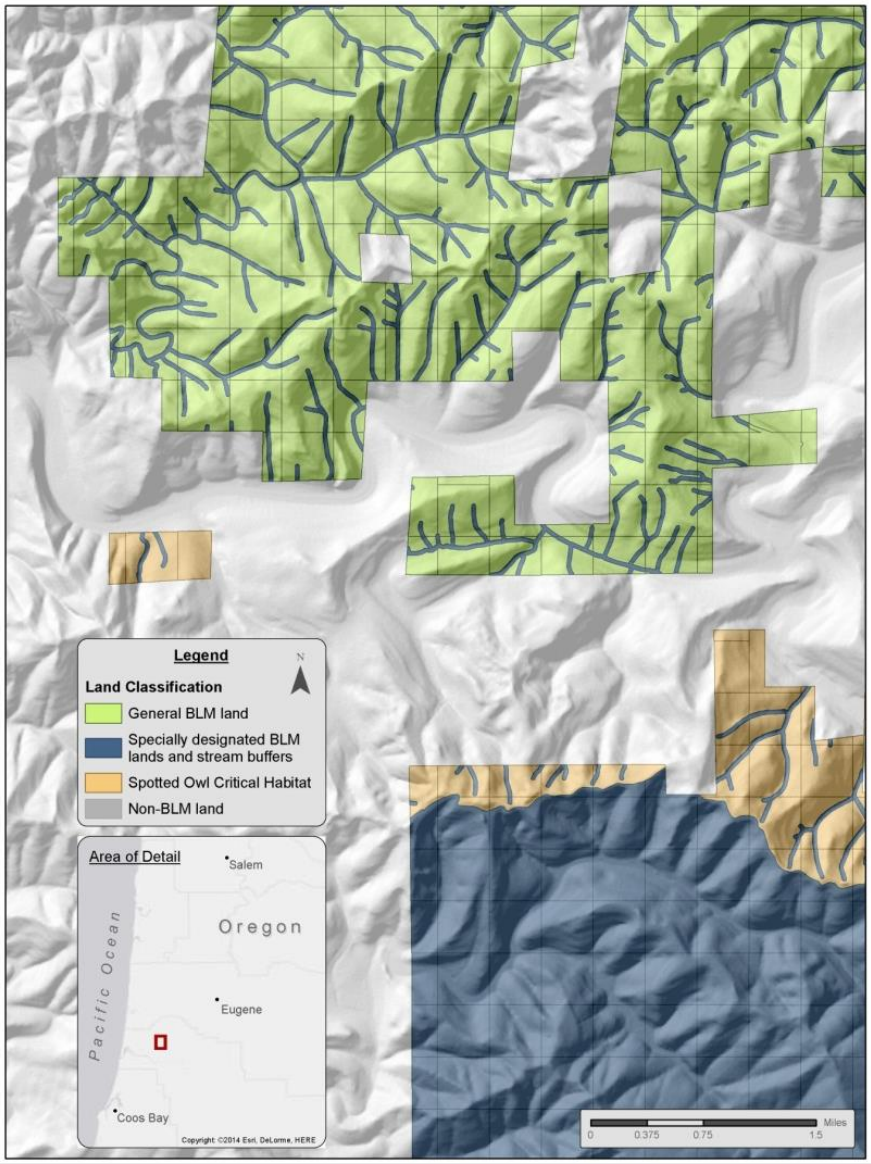
2060, High Emissions (RCP 8.5)

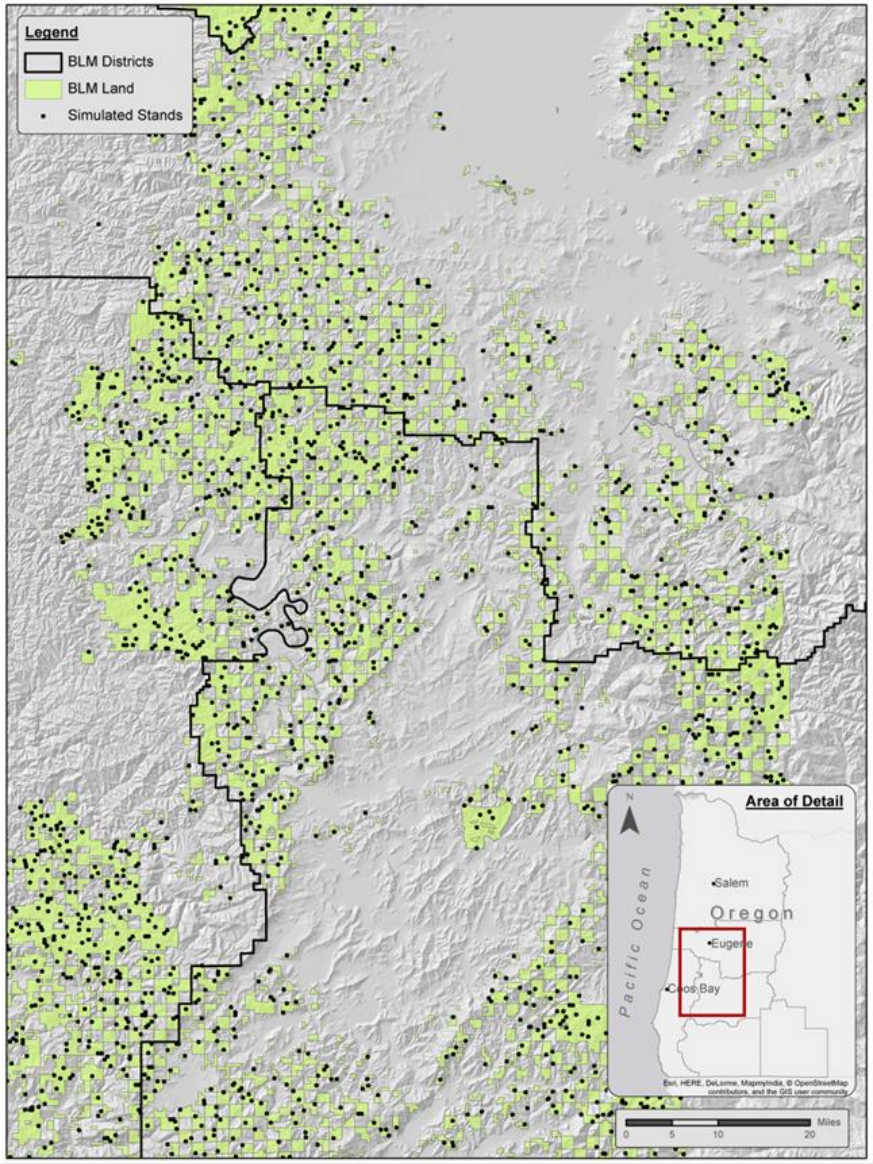


03 *Sampling from BLM Lands in Western Oregon*

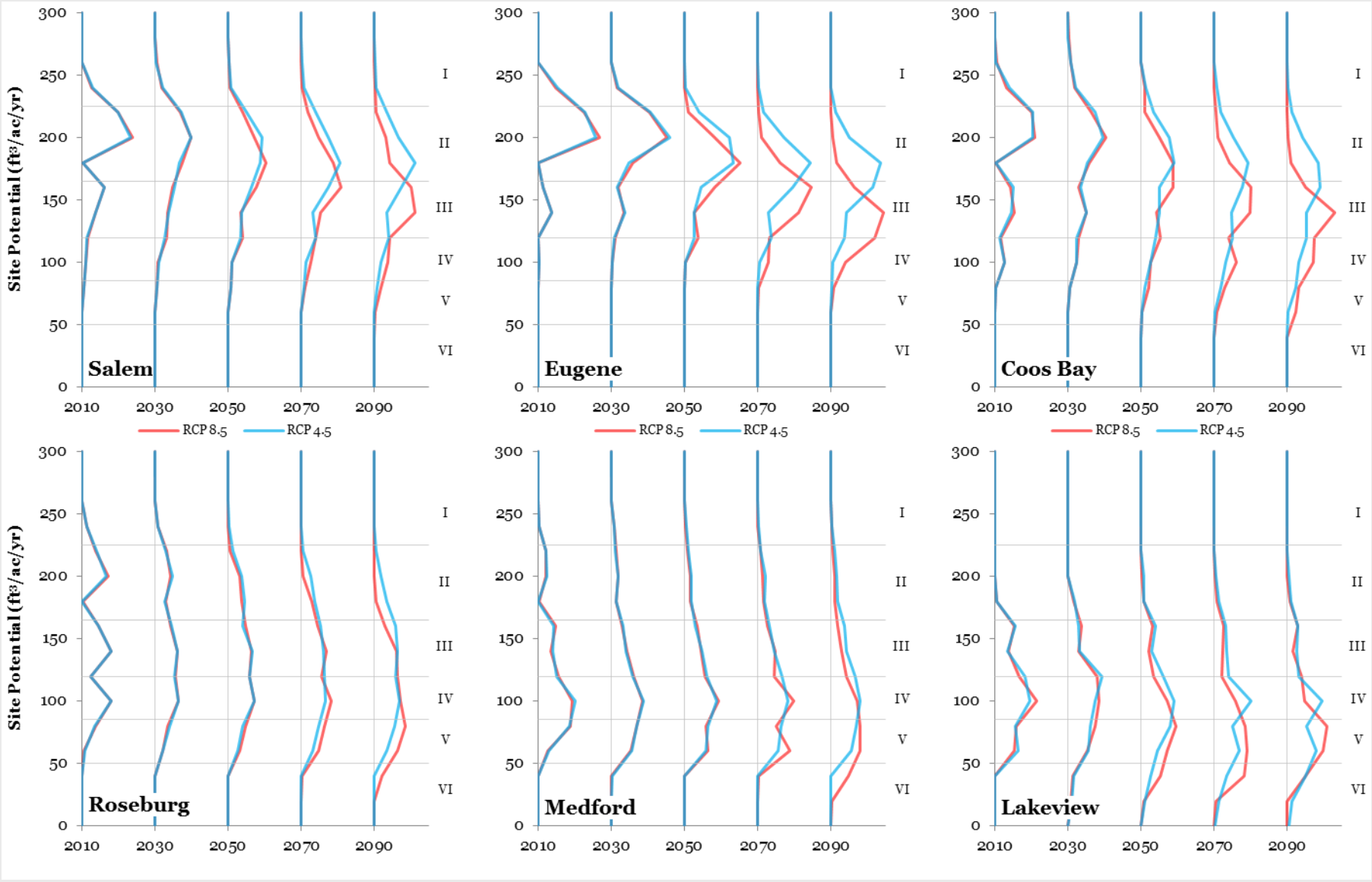


Land classifications, stratified sampling of stands for simulation



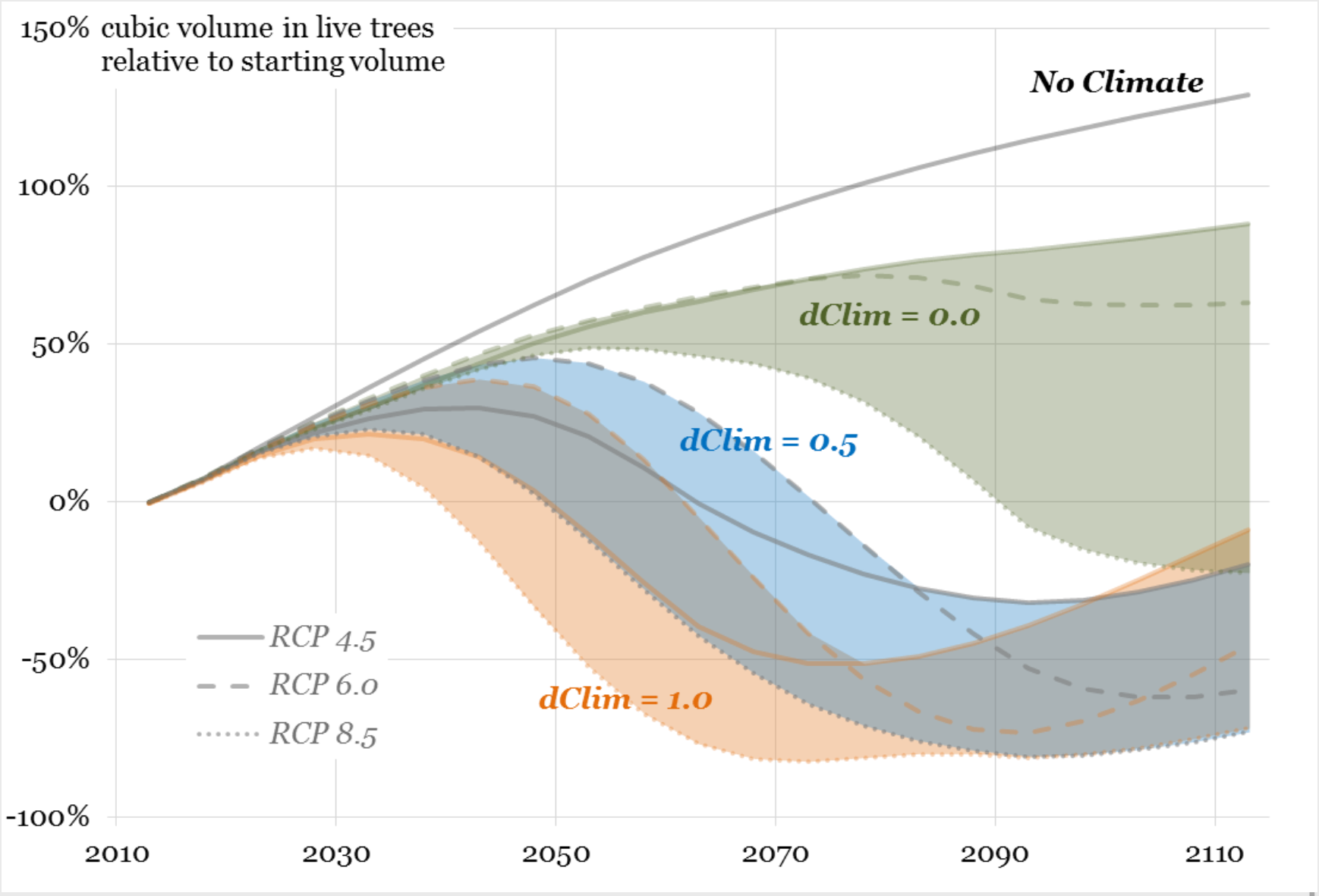


Shifts in site productivity for BLM lands in western Oregon in low and high emissions scenarios (Ensemble GCM)



04 *Sensitivity to the dClim mortality parameter*

Grow-only runs under the Ensemble GCM



05 *Growth-and-yield and optimization*

Management prescriptions used in Climate-FVS simulations

Grow only	- No active management
80-year rotation	- Regeneration harvest at age 80, retaining 15 trees per acre (TPA) in WC and PN variants, 7 TPA all others - Pre-commercial thin (PCT) at age 15-20 (WC and PN variants) or 25-30 (all other variants); PCT retains 150 TPA for pine stands, 225 TPA for all others - Commercial thin at age 30-35 (PN and WC variants) and 50-55 (all variants) to 35% of maximum SDI - Several species were given higher priority for retention and removal in CA, NC, and SO variants - All slash piled and burned following thins and regeneration harvests (all variants) - Replant with 450 TPA apportioned based on abundance of commercial timber species present prior to harvest (CA, NC and SO variants), otherwise or if no commercial species present, using pre-defined commercial species mix.
100(+)-year rotations	- Regeneration harvest at age 100, 120, 140, or 160 for Site Classes 1-2, 3, 4, and 5, respectively, retaining 15 TPA in WC and PN variants, 7 TPA all others - Pre-commercial thin (PCT) at age 15-20 (all variants) retaining 150 TPA for pine stands, 225 TPA for all others - Commercial thin to 35% of maximum SDI at ages 40 & 70, 50 & 80, 50 & 90, or 50 & no second commercial thin for Site Classes 1-2, 3, 4, and 5, respectively - Species priorities for retention and removal and replanting same as for 80-yr rotation - All slash piled and burned following thins and regeneration harvests (all variants)
Thin every 20-25 years	- Thin throughout diameter distribution every 20 years (WC and PN variants) or 25 years (all other FVS variants) down to 35% of maximum SDI, beginning at age 30 - Species priorities for retention and removal same as for 80-yr rotation - All slash piled and burned following thins (all variants)
Complex structure thinning	- Thin triggered every 25 years to 50% of maximum SDI, targets uneven-aged structure with J-shaped diameter distribution (5” diameter classes, q-value=1.3) - No slash treatment following thinning
Patch cut	- Remove 1/8 of stand every 25 years (≤ a 5-acre patch cut). FVS does not implement this as a patch cut, but rather removes 1/8 of trees throughout the stand, comparable to a commercial thinning, although modifications were made to increase height growth and decrease mortality slightly for naturally regenerating trees (no tree planting following harvest) - All slash piled and burned following harvest (all variants)

THE OBJECTIVES TO BE (NEAR-)OPTIMIZED

- **Timber yield:**
  even-flow + *6x weight* (minimize deviation from 502 MMBF per year across all western Oregon BLM Districts)

- **Harvest and transportation cost proxy** (boardfoot volume removed multiplied by slope): *minimize*

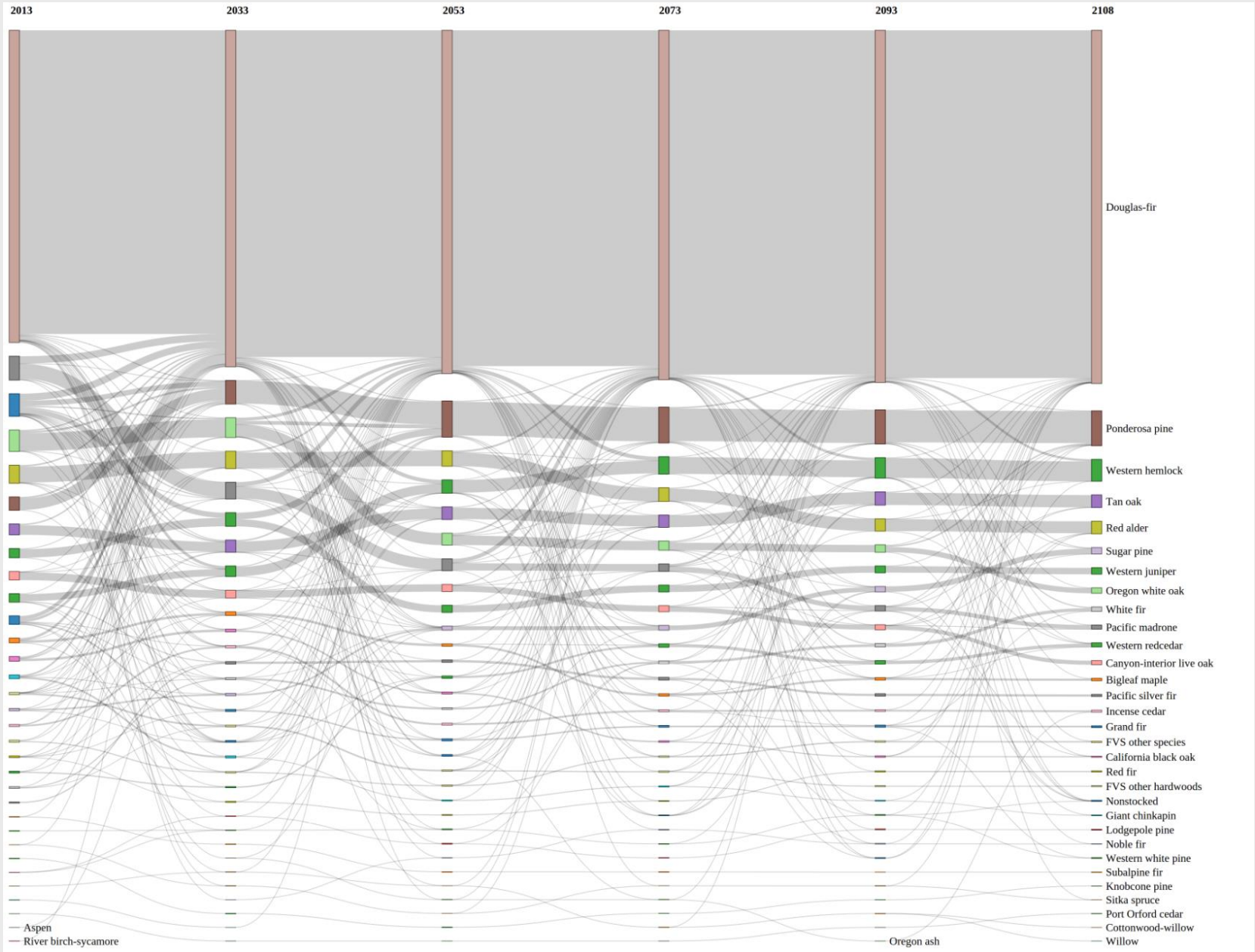
- **Carbon storage**:
  maximize

- **Acres of high fire hazard**:
  minimize

- **Acres structurally suited for Northern spotted owl habitat**:
  maximize

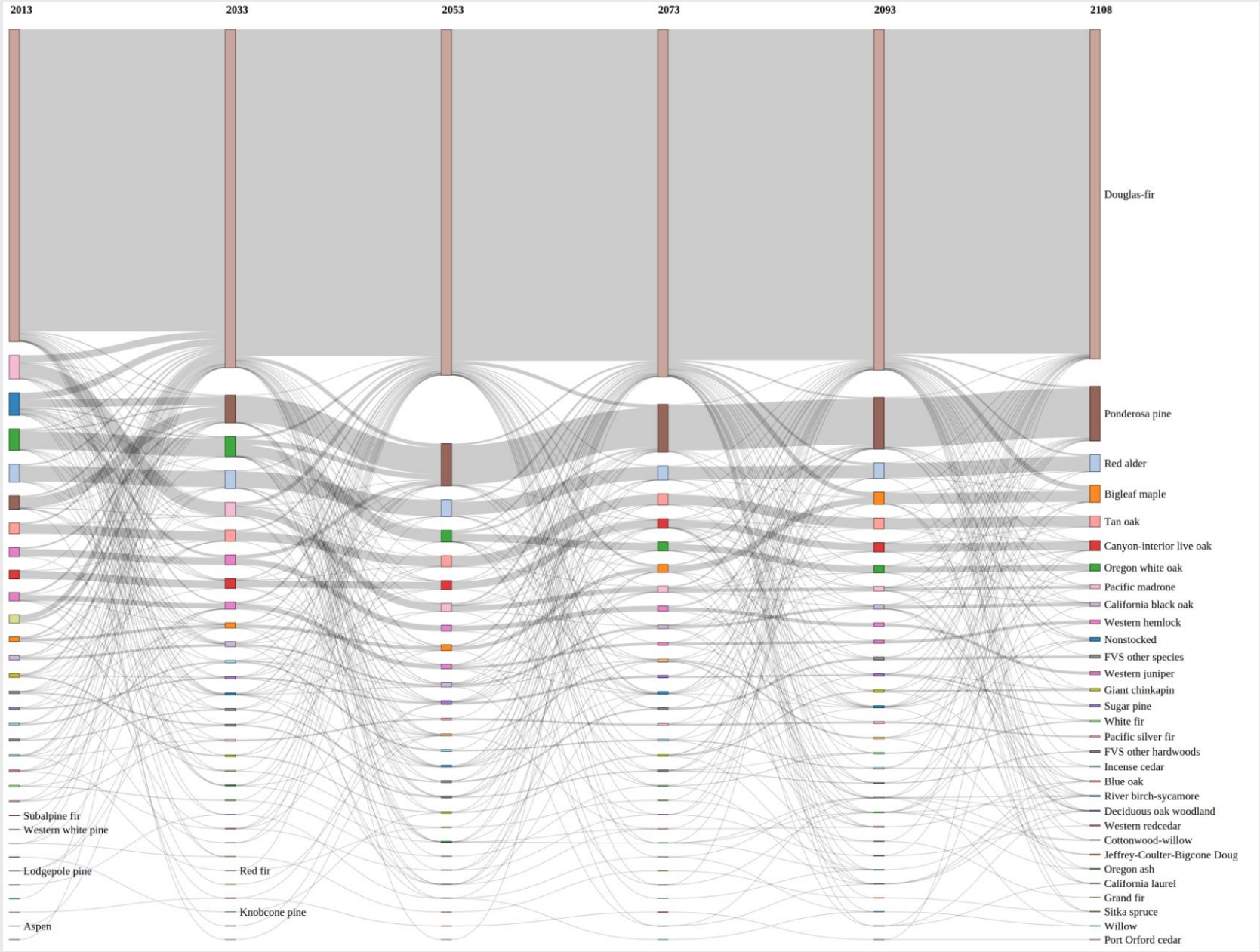
Shifts in forest composition

No Climate Change



Shifts in forest composition

Low Emissions (RCP 4.5)



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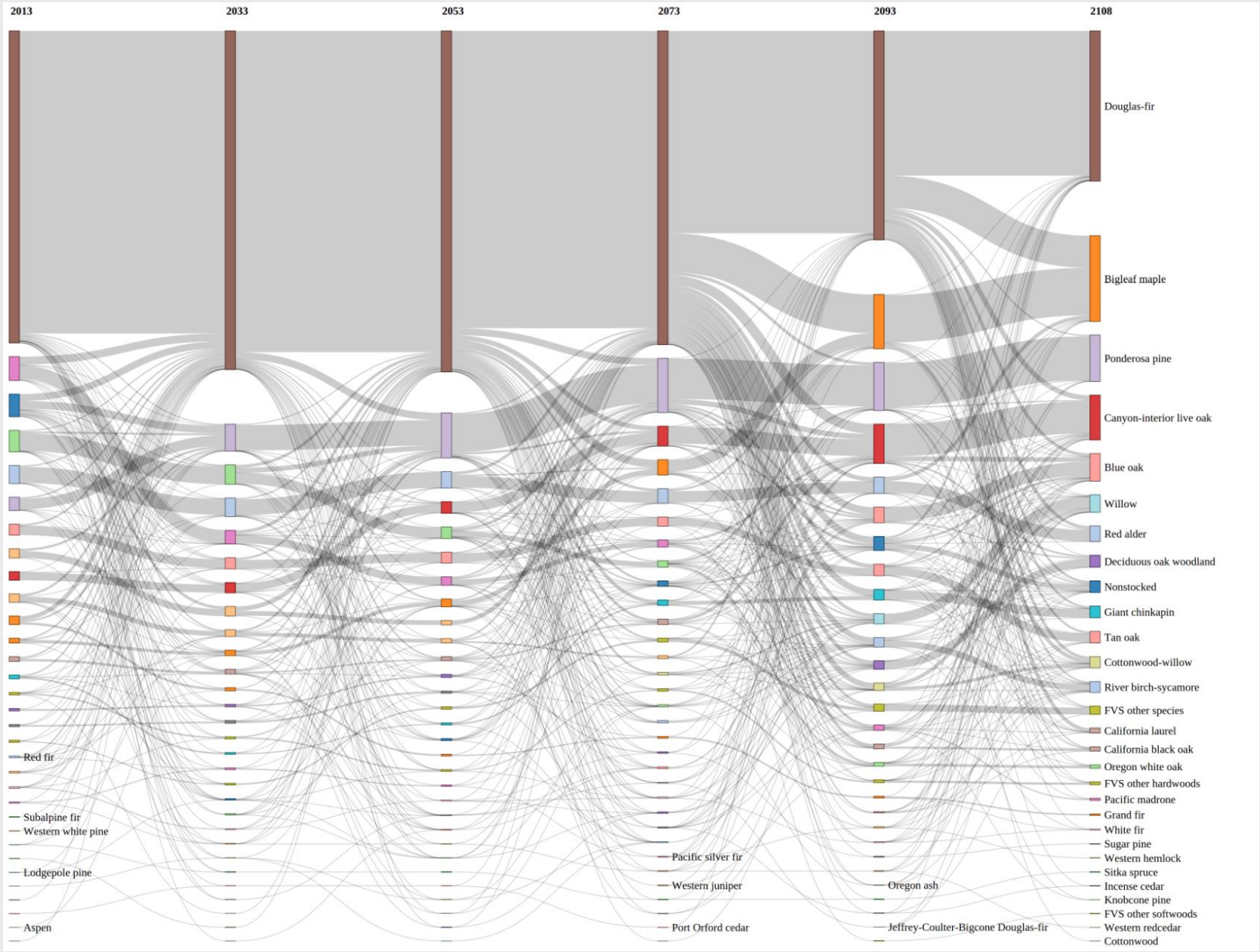
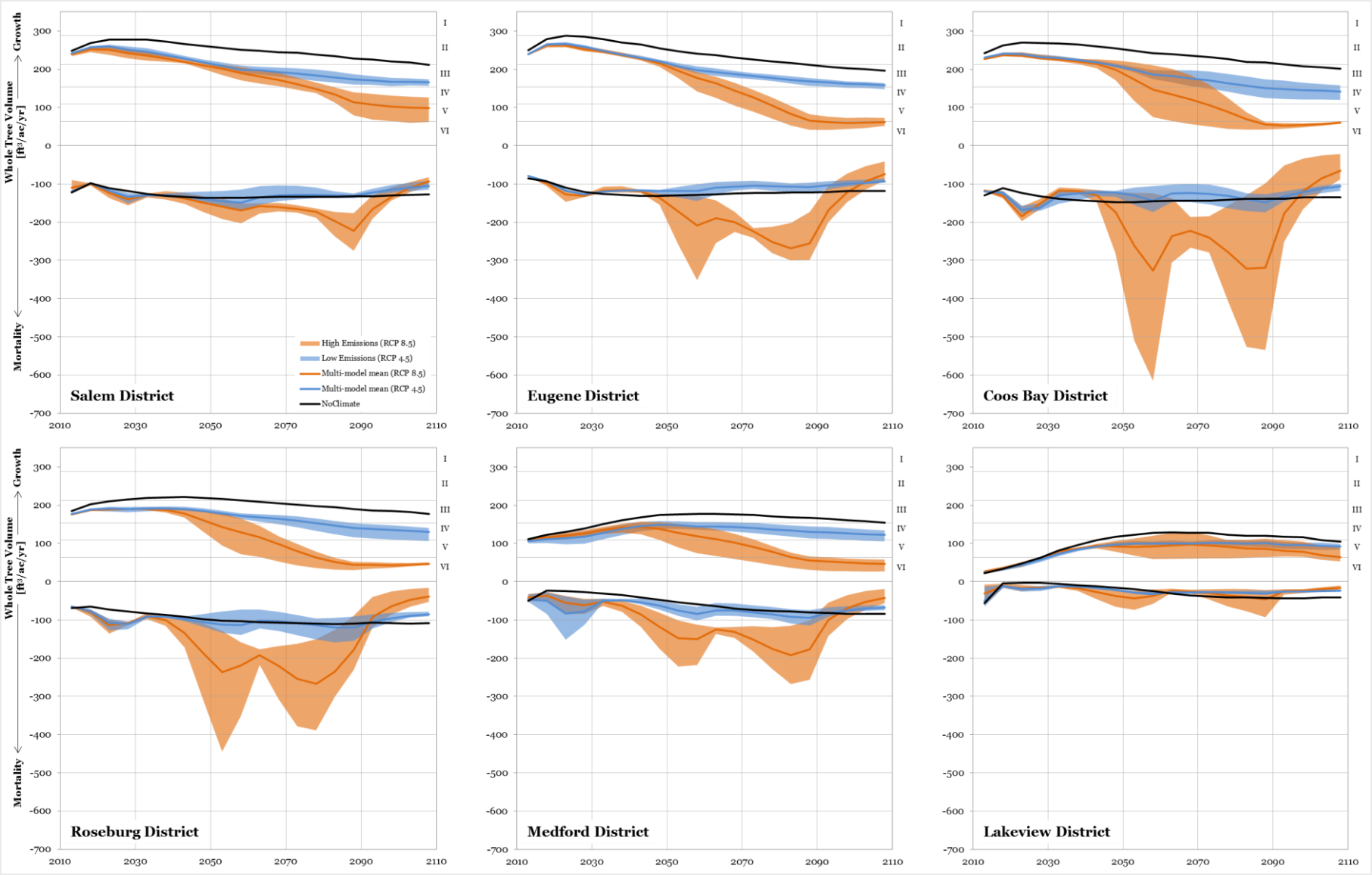
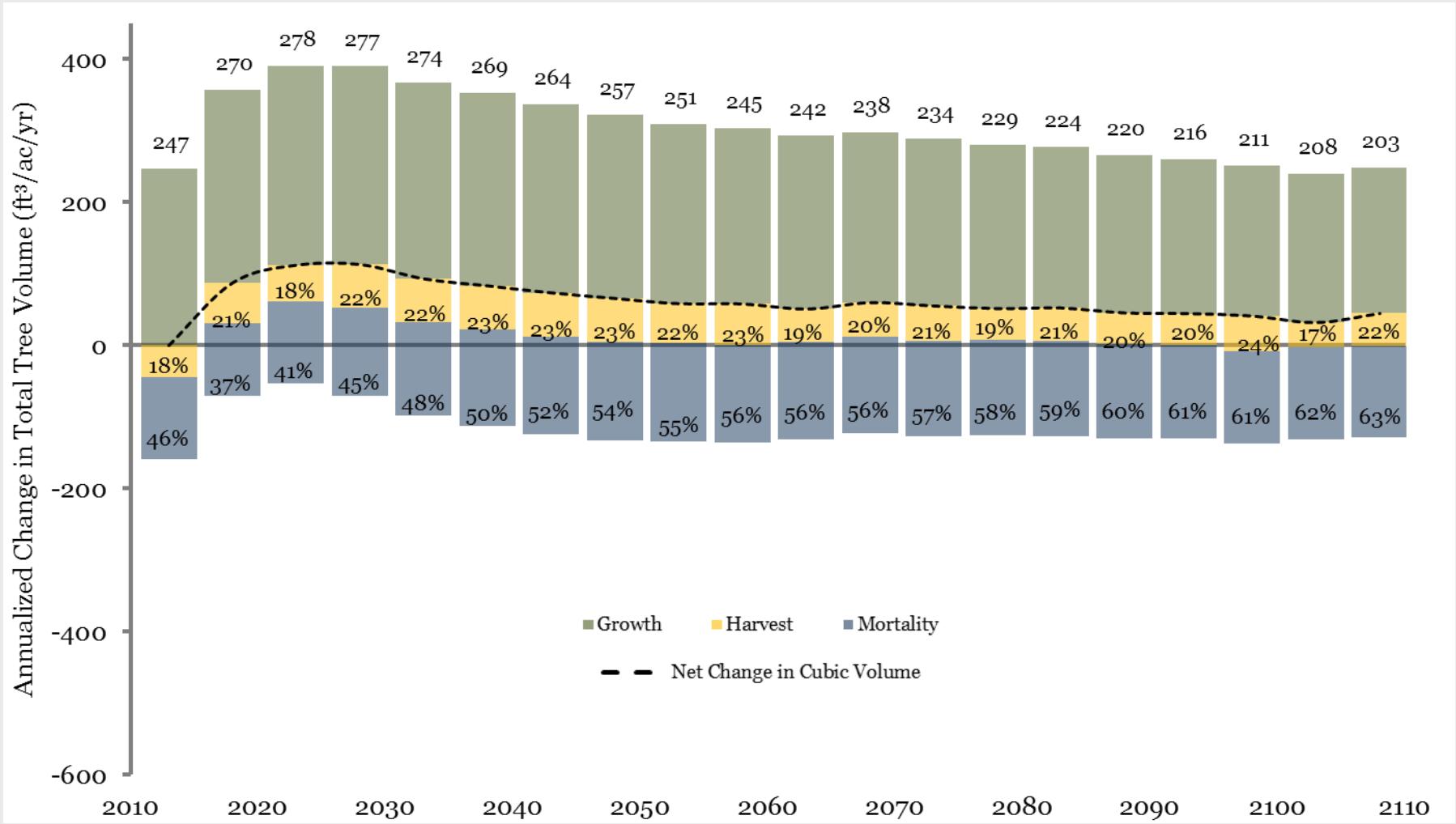


Changes in volume accretion and loss through mortality for each district



Growth, Harvest, and Mortality rates
North/Moist Districts (Salem, Eugene, & Coos Bay)



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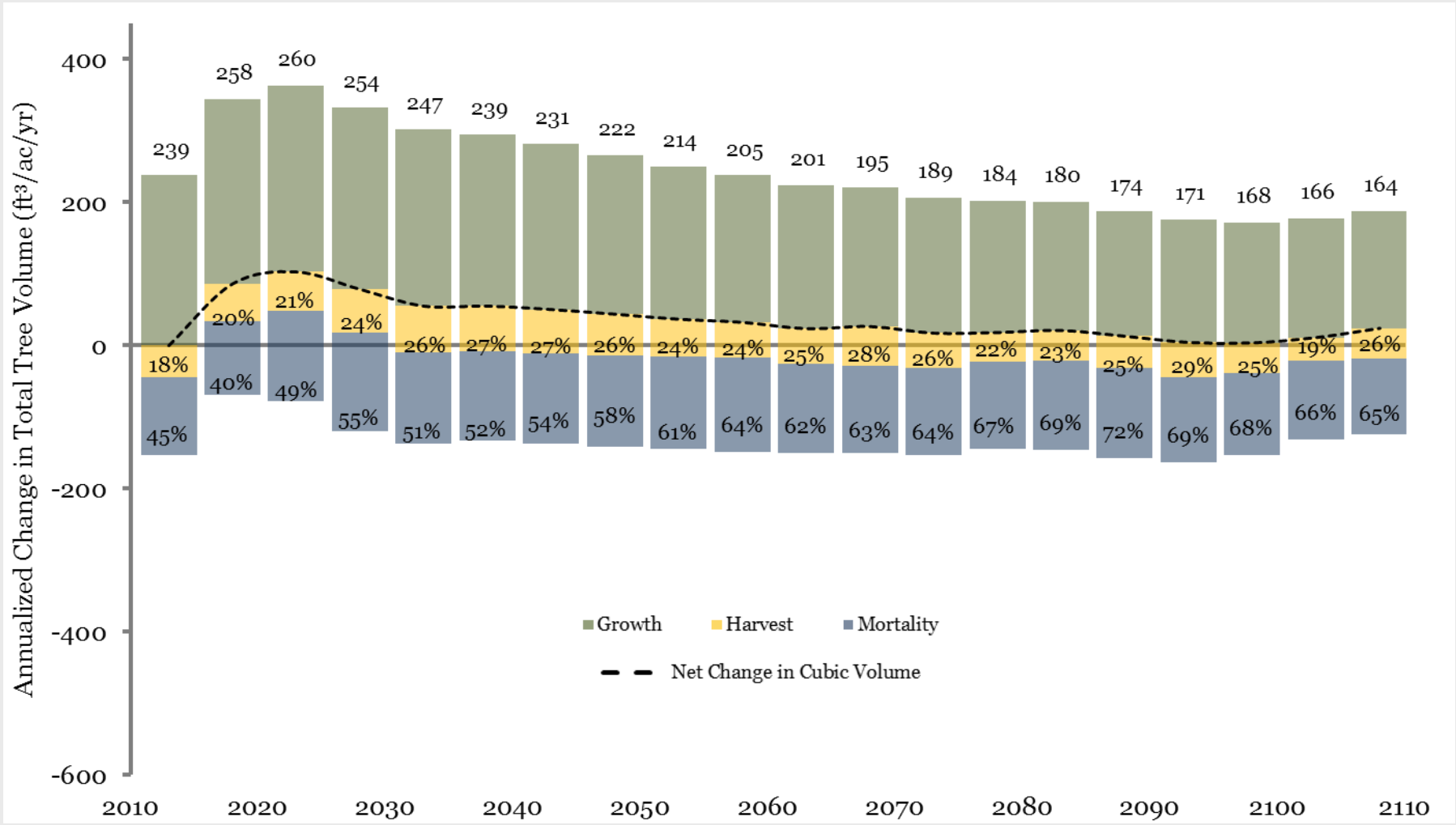

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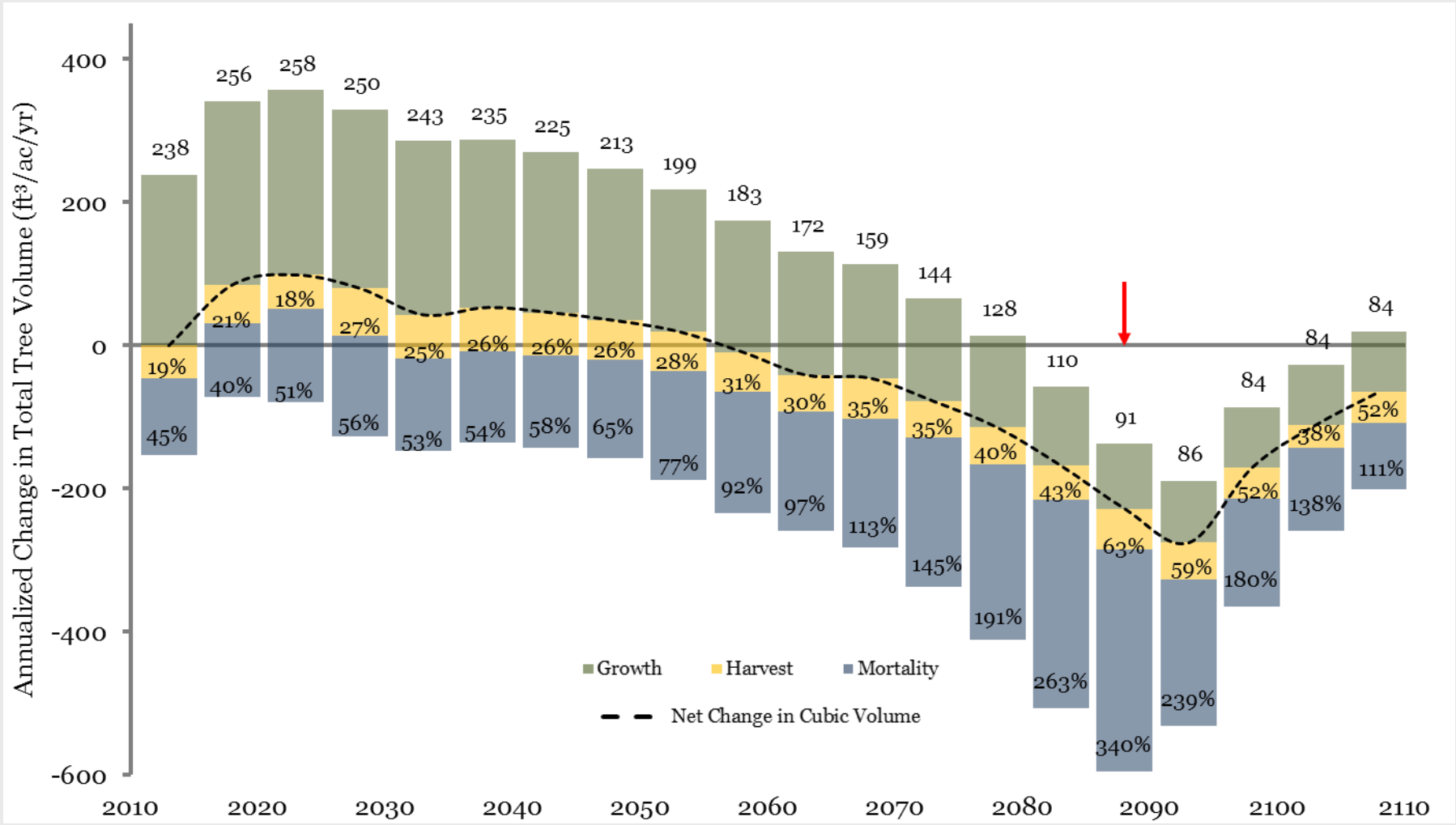
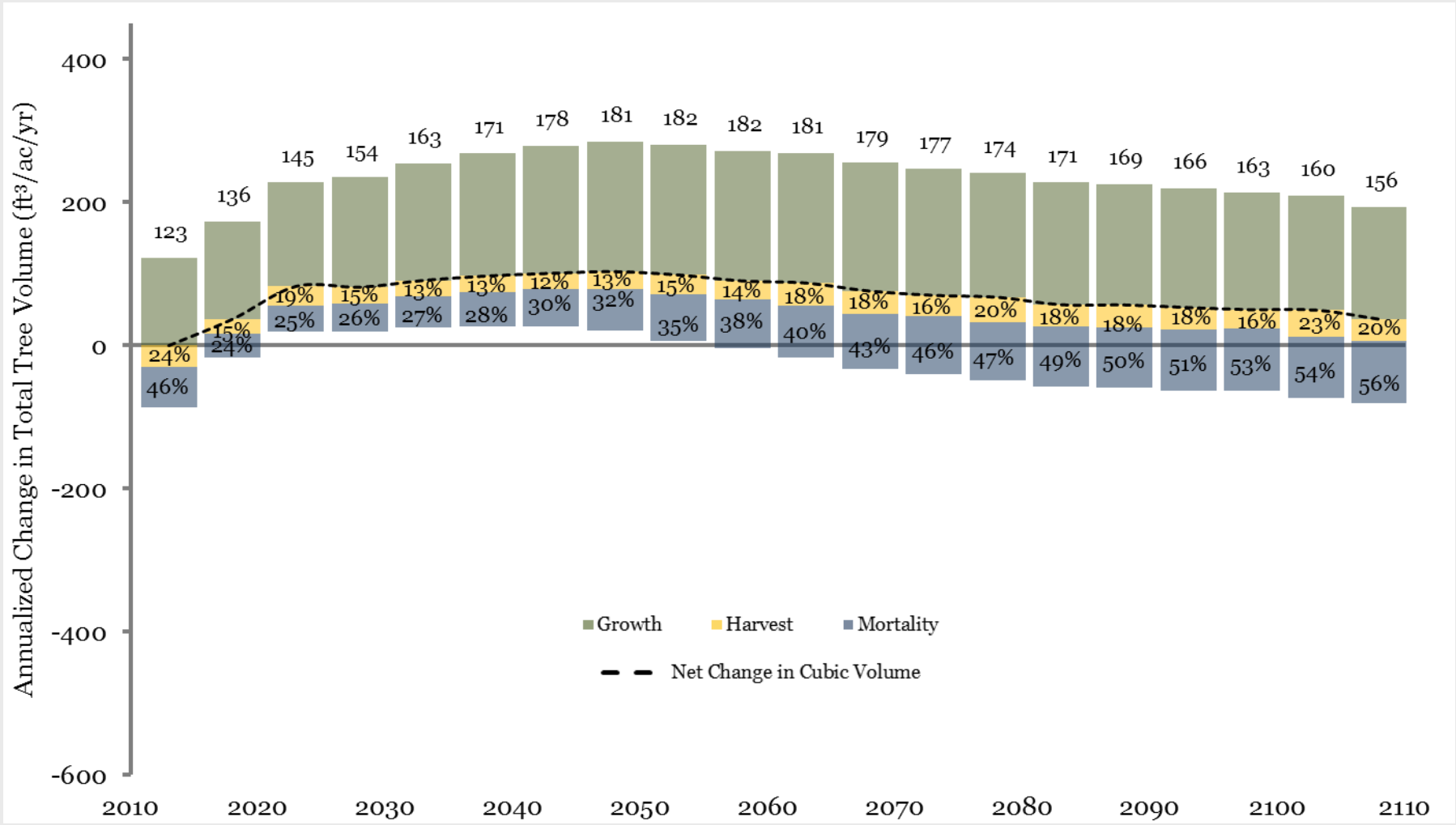


High Emissions (RCP 8.5)

Growth, Harvest, and Mortality rates
South/Dry Districts (Roseburg, Medford, & Lakeview)



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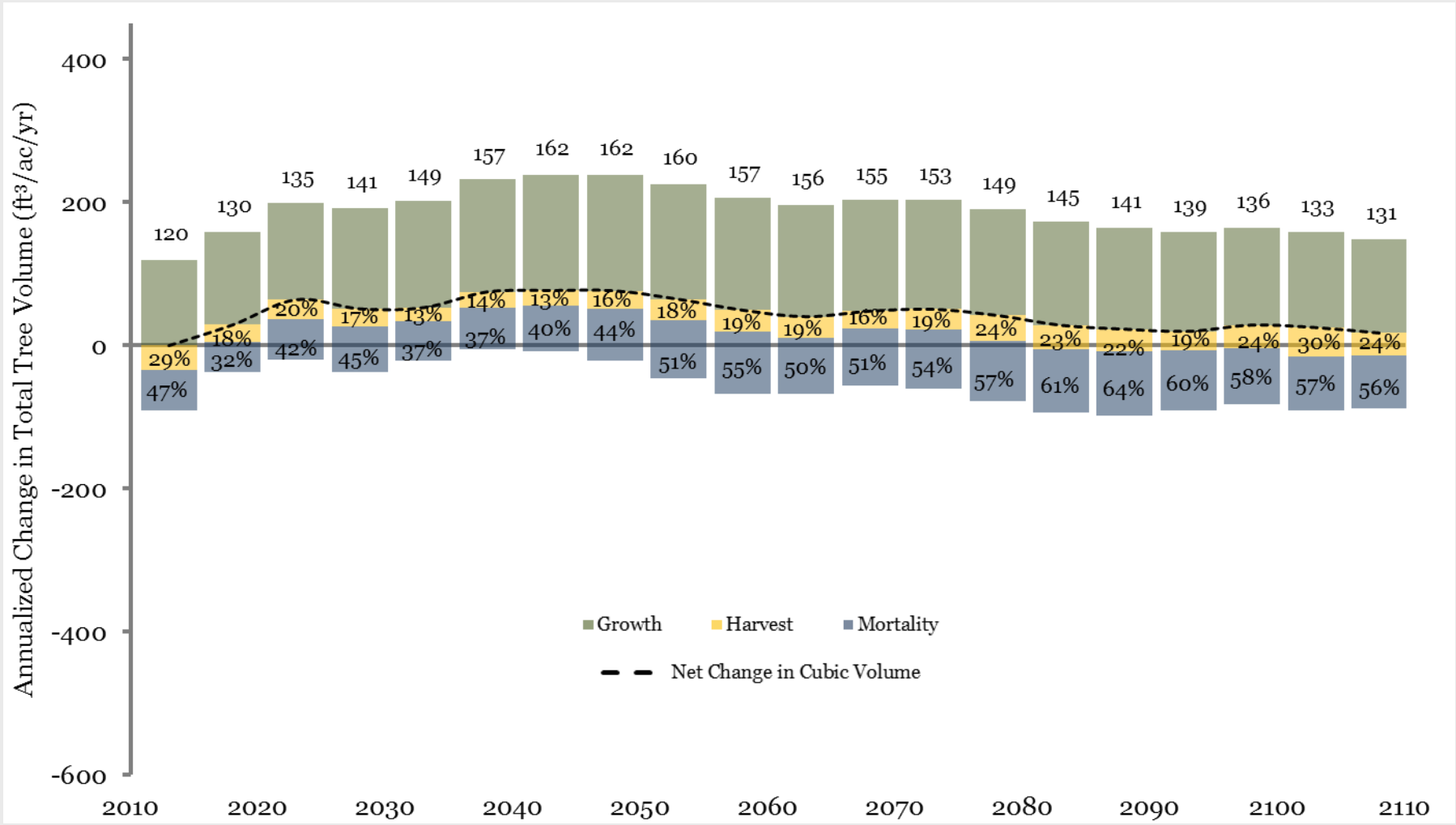

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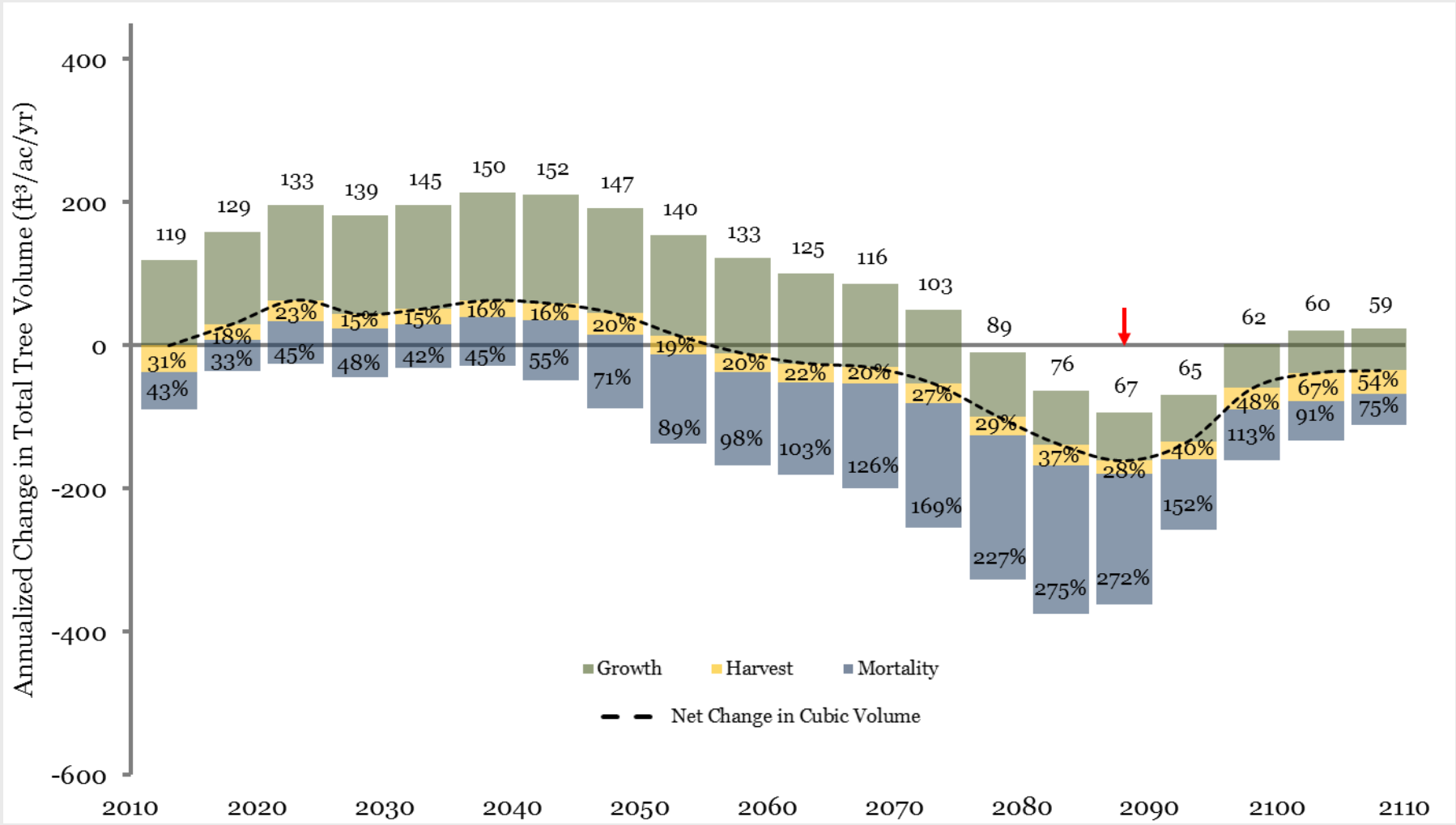
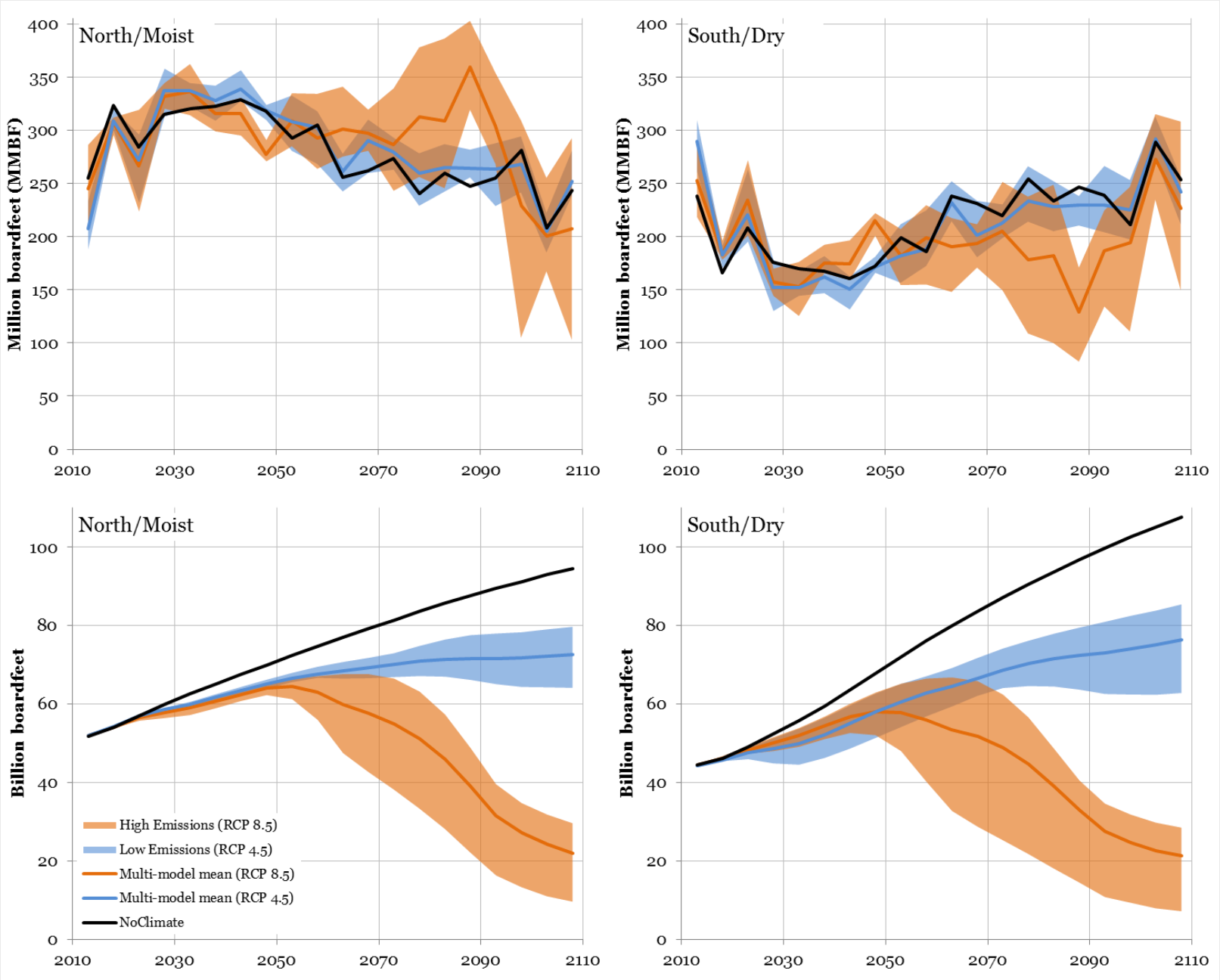
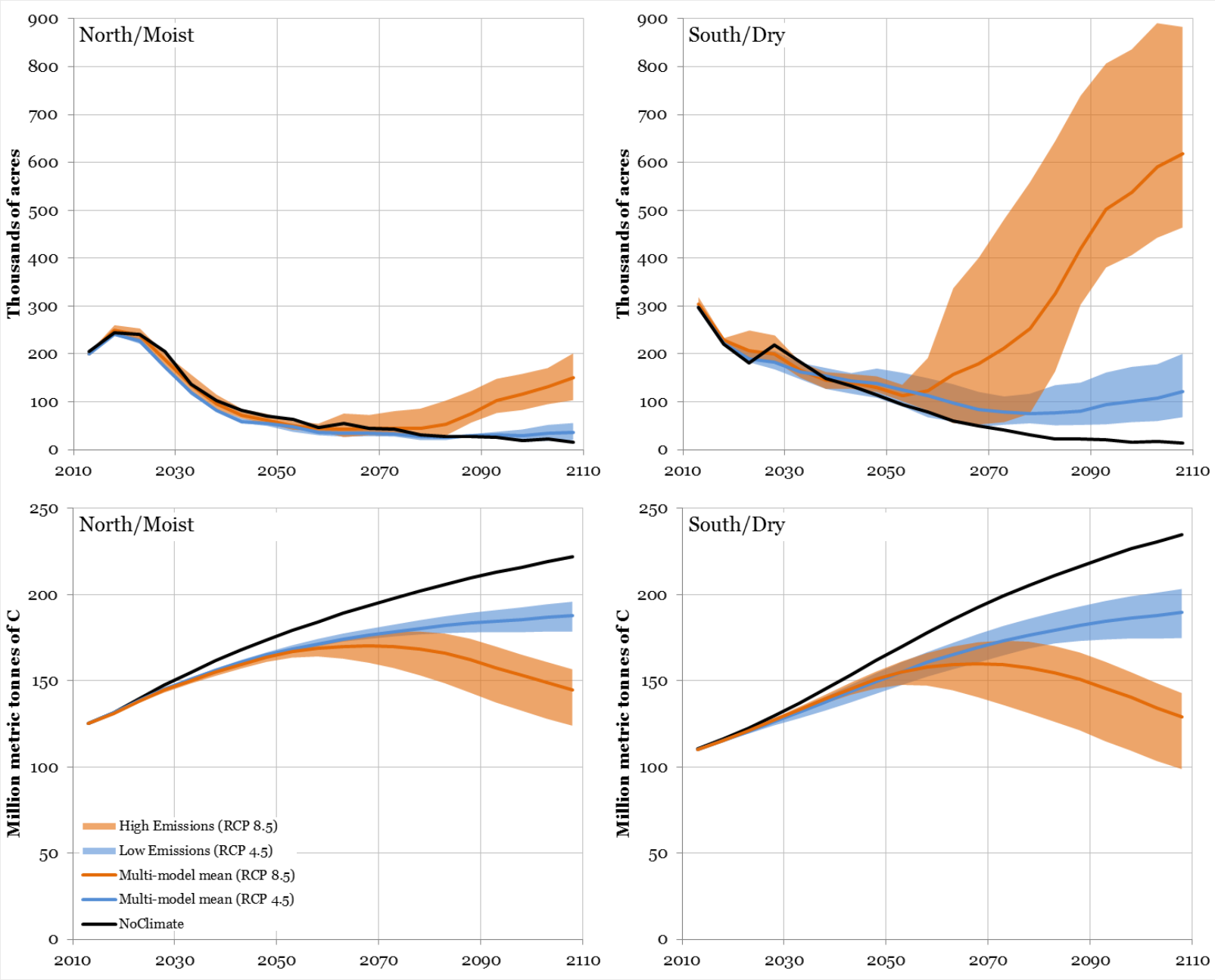


High Emissions (RCP 8.5)

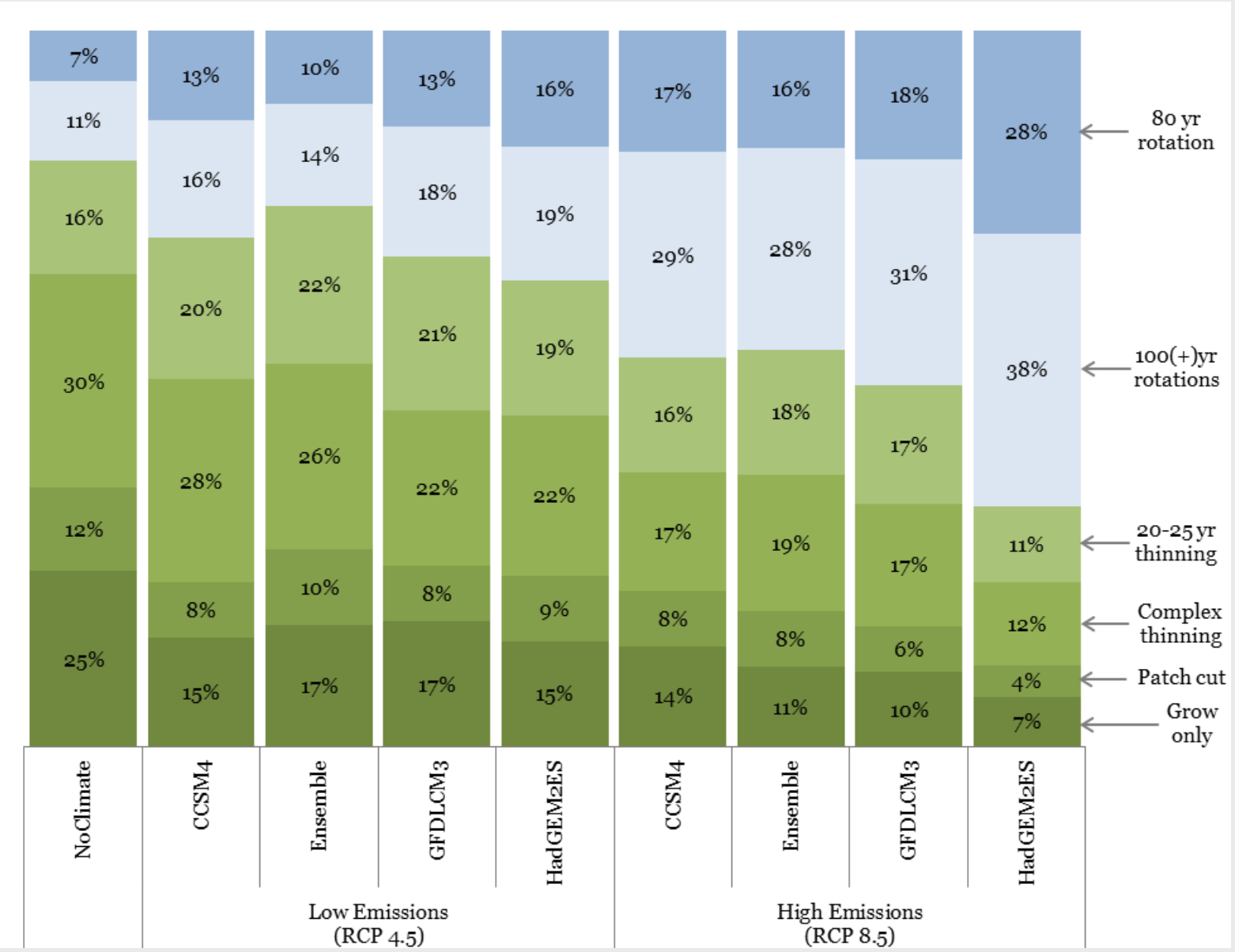
Timber Yield (top row) and Stocking (bottom row)



Fire Hazard (top row) and Carbon Storage (bottom row)



Optimization model's guess at "climate-conscious" silviculture to meet objectives, % of unrestricted lands under each management regime



Thank you.

Process models as an alternative source for suitability scores, carrying capacity, and site productivity

Douglas-fir

Current Climatic Suitability

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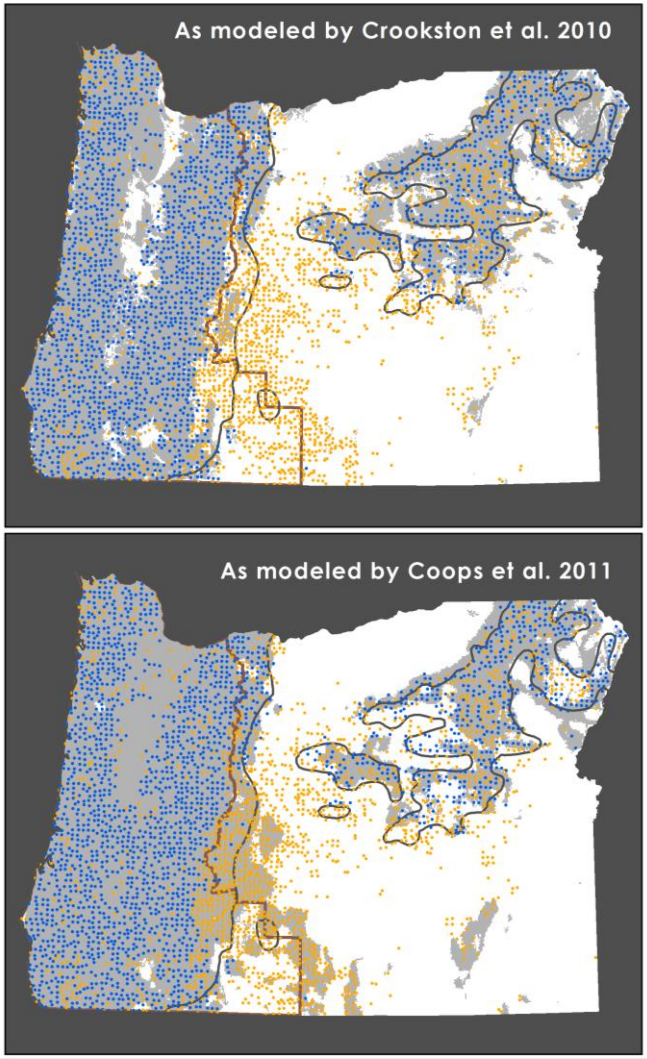
FIA plot, species absent
Species distribution according to Little (1971)
Modeled climatic suitability
BLM study region



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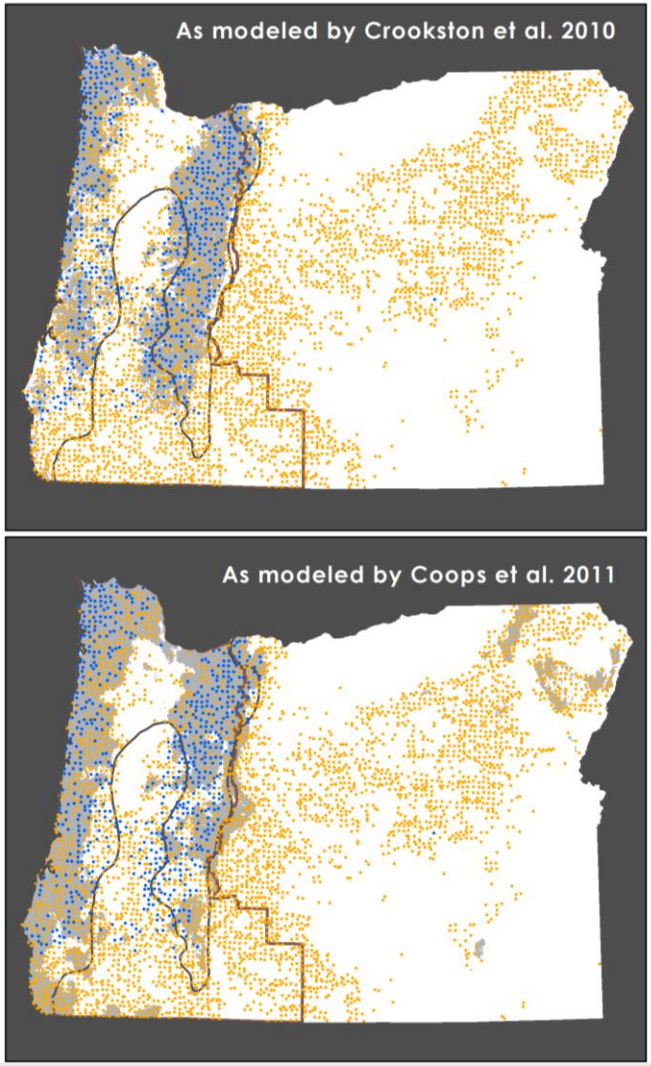

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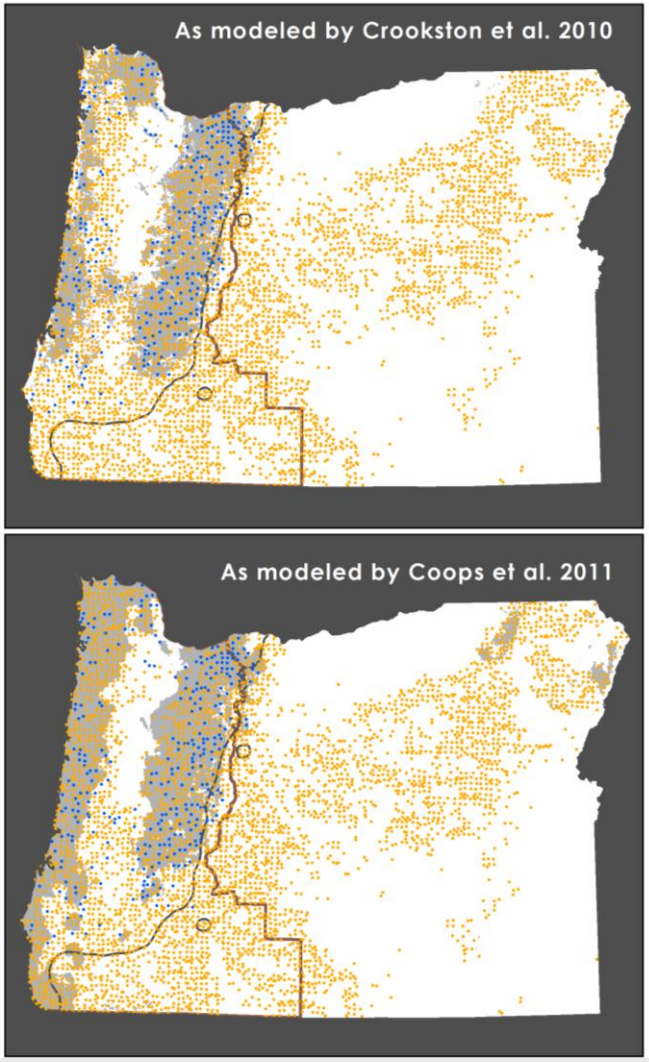

Ponderosa Pine

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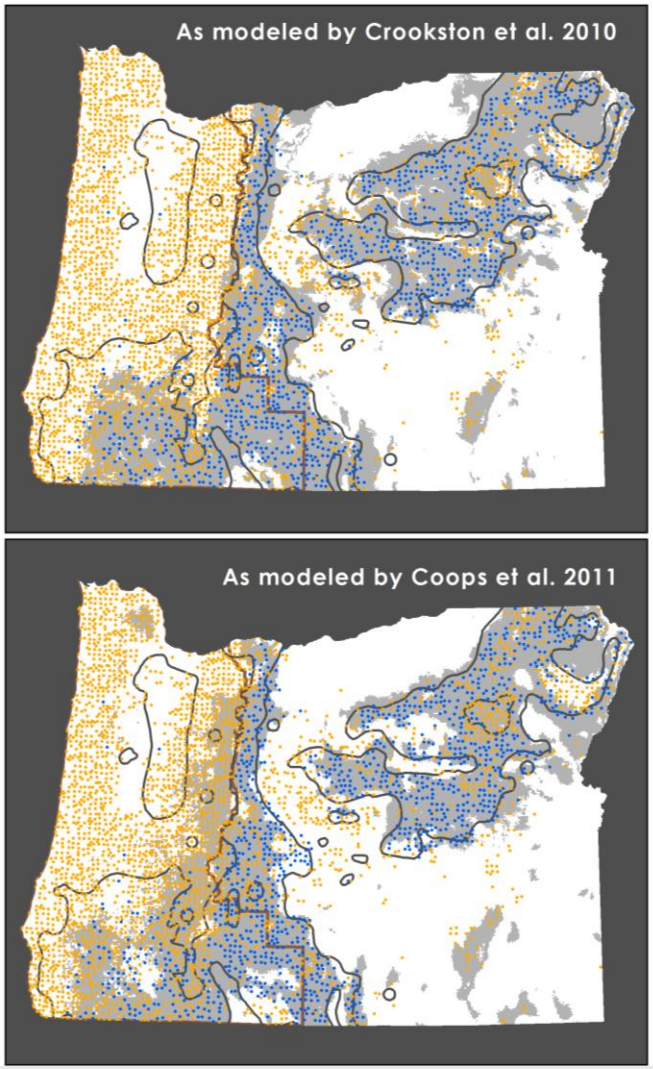
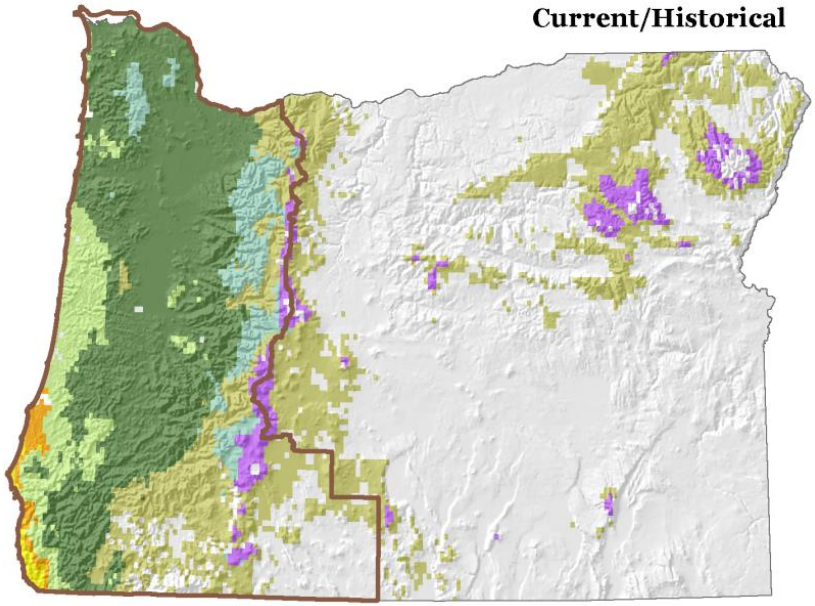


MC2: Potential Shifts in Forest Vegetation

Forest Vegetation Types

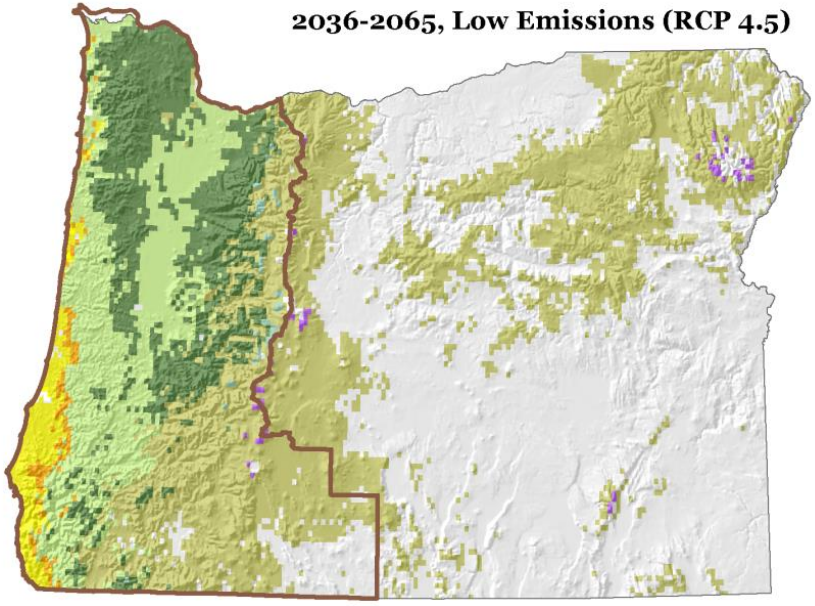
- Subalpine Forest
- Maritime Evergreen Needleleaf Forest
- Temperate Evergreen Needleleaf Forest
- Temperate Cool Mixed Forest
- Temperate Warm Mixed Forest
- Subtropical Mixed Forest
- Cool Needleleaf Forest

Current/Historical

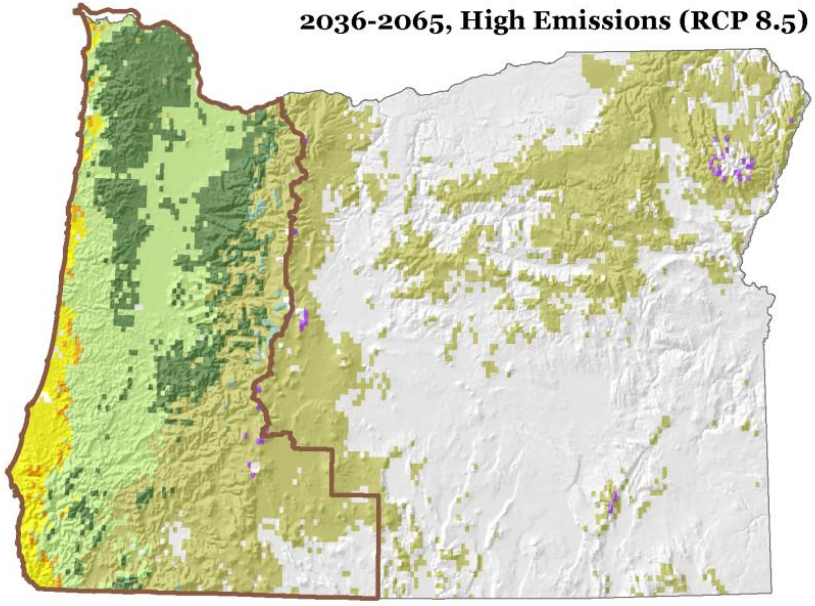


Future Potential Vegetation Types represent the majority type predicted by MC2 simulations of 10 GCMs (Bachelet, 2014)

2036-2065, Low Emissions (RCP 4.5)

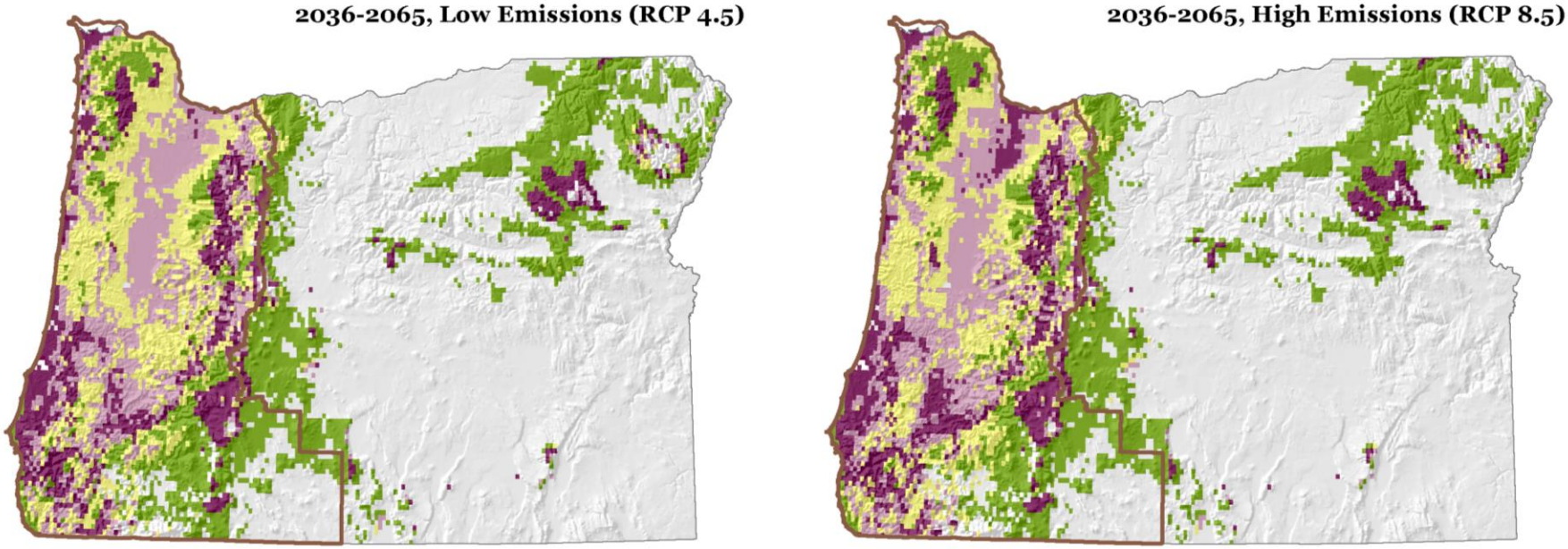


2036-2065, High Emissions (RCP 8.5)



MC2: Shifts in Potential Vegetation

Predicted changes in potential vegetation by 2065 based on 10 GCMs (CMIP5)



Agreement among models

- Unanimous agreement: potential vegetation type changes
- Majority agreement: potential vegetation type changes
- Unanimous agreement: potential vegetation type does not change
- Disagreement: no concensus on potential vegetation type changes

Data from Bachelet (2014)