

University of Idaho

College of Natural Resources



MODELING **SITE-SPECIES EFFECTS** ON SDI_{MAX}

APPLIED EARLY STAND SILVICULTURE IN THE INLAND NORTHWEST WORKSHOP SPOKANE, WA

DECEMBER 13, 2018

MARK KIMSEY **IFC FOREST RESEARCH SCIENTIST**





WHAT IS WITHIN OUR CONTROL? **SILVICULTURE & GROWTH FACTORS**

LIGHT – Species Selection, Density Management

MOISTURE – Species Selection, Vegetation Management, Density Management

TEMPERATURE – Species Selection, Vegetation Management, Density Management

NUTRIENTS – Fertilization, Slash Management, Vegetation Management, Density Management









LET'S DIG DEEPER INTO DENSITY MANAGEMENT

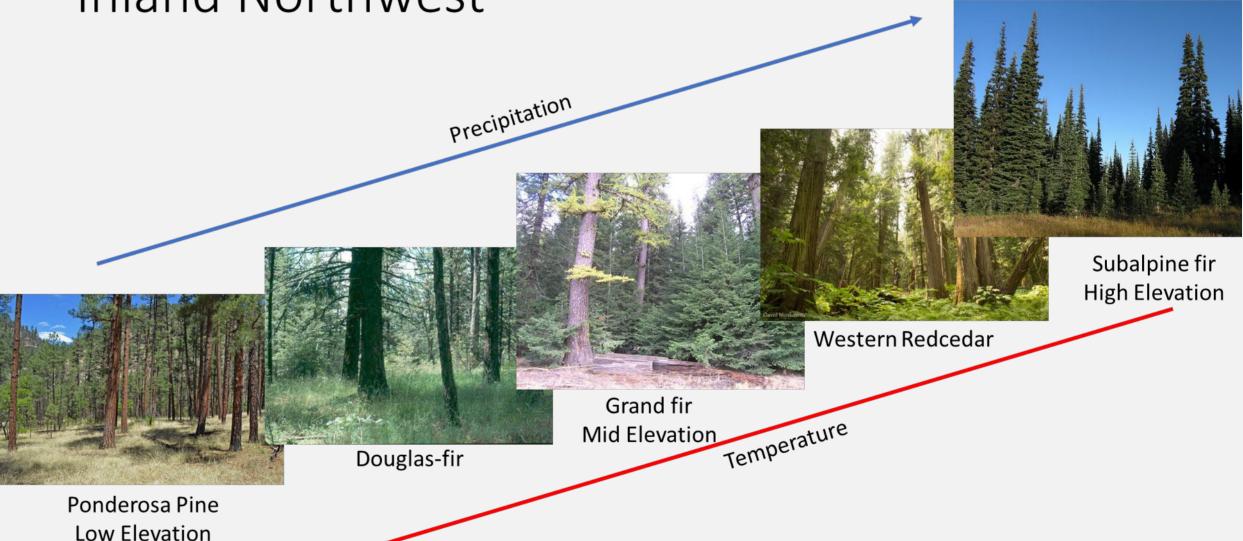
How does species physiology affect desirable stocking rates?

What density – species mix do I manage for in light of current and projected climate?

How does site factors modify optimal stand density by species?



Forest Community Succession – Inland Northwest







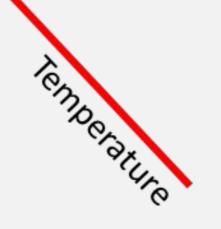
ASKING THE QUESTION HOW DOES SITE AFFECT SPECIES MAXIMUM DENSITY



Pinus ponderosa ssp. ponderosa



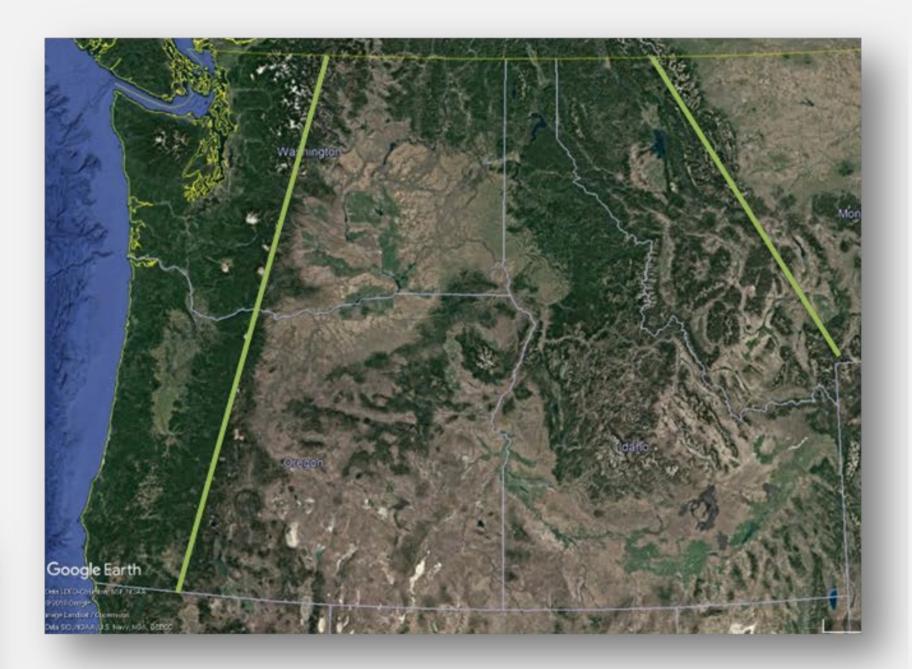
Pseudotsuga menziesii var. glauca





Abies grandis ssp. idahoensis







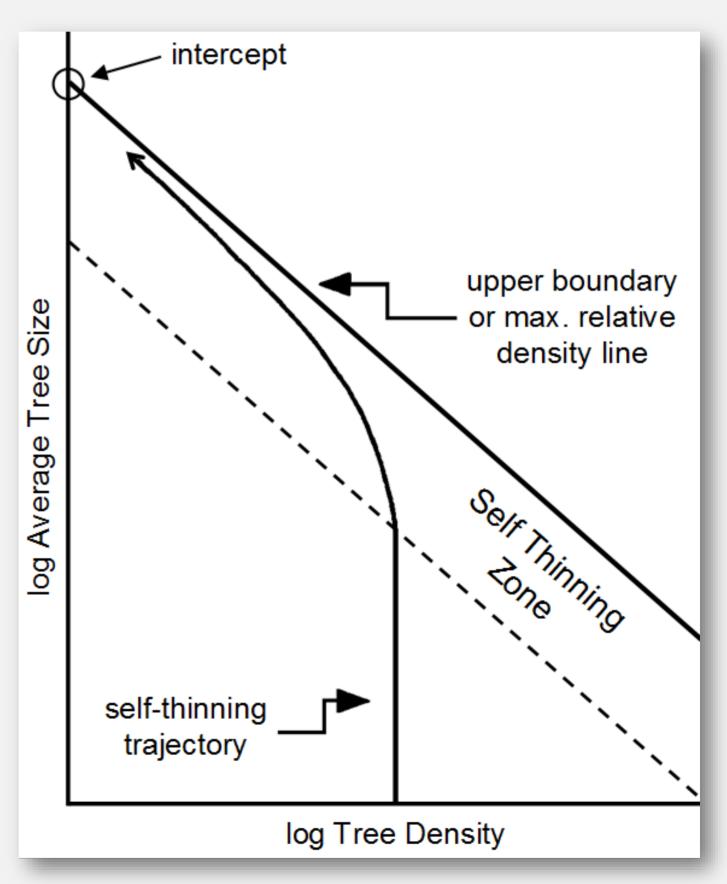


IFC SDI_{MAX} RESEARCH **CARRYING CAPACITY OF INLAND NORTHWEST FORESTS**

- A Basic Primer on Maximum Stand **Density Index**
 - For a given average tree size, there is a limit (maximum) to the number of trees per acre that may coexist in a stand
 - Independent of Age and Height

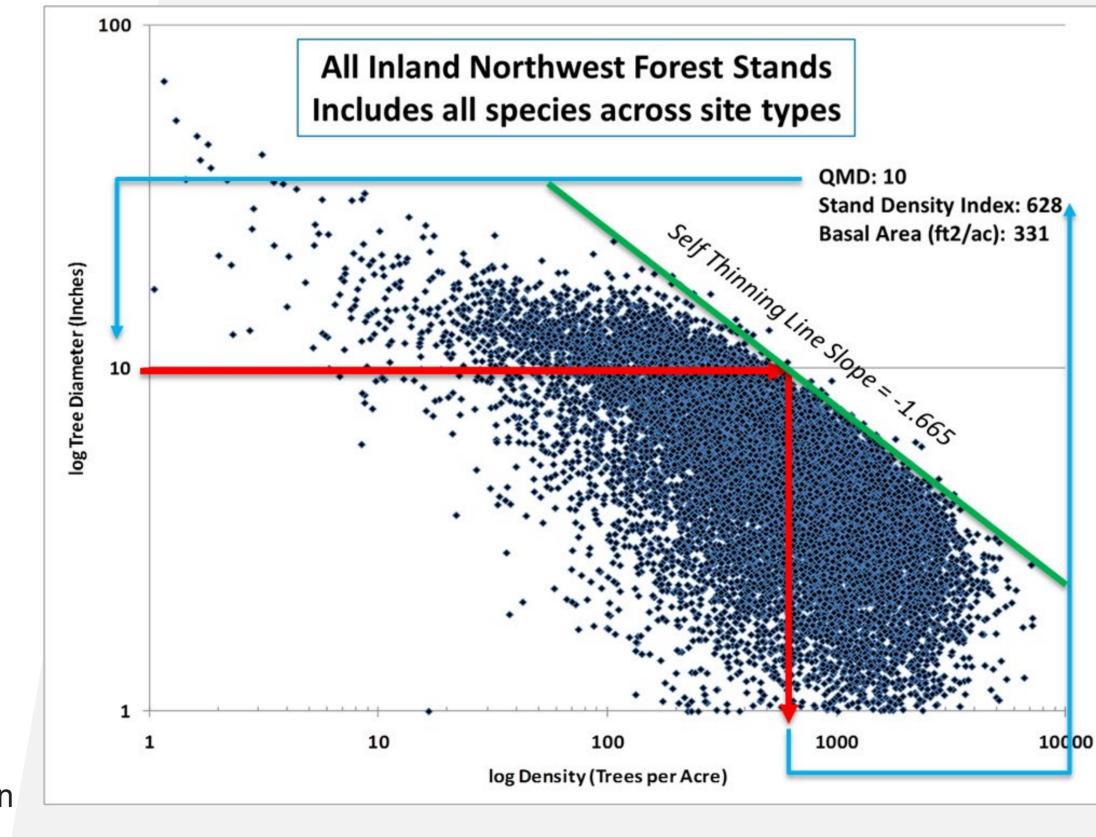








REAL WORLD EXAMPLE TYPICALLY SPECIES SPECIFIC – SITE INVARIANT







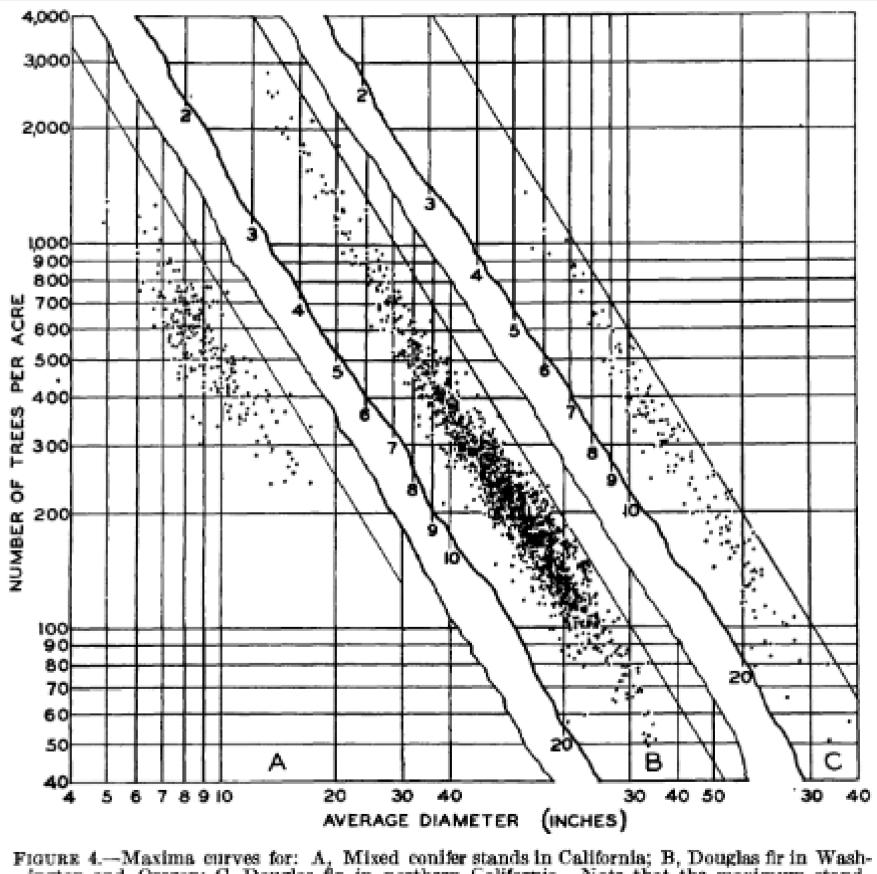
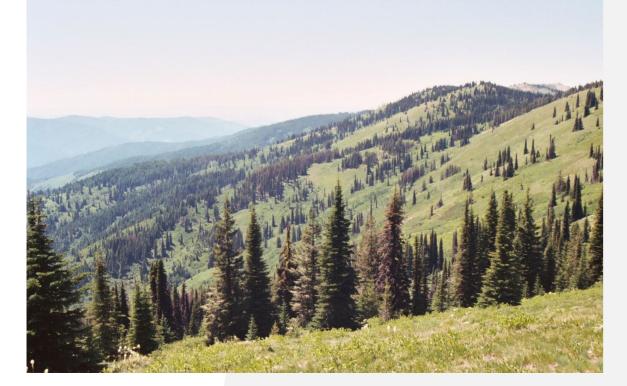


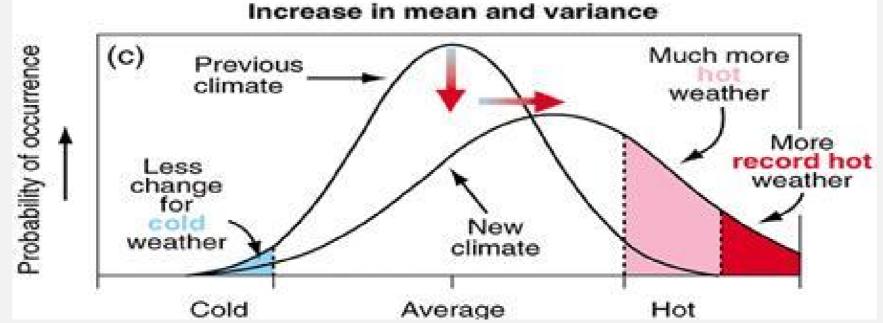
FIGURE 4.—Maxima curves for: A, Mixed conifer stands in California; B, Douglas fir in Wash-ington and Oregon; C, Douglas fir in northern California. Note that the maximum standdensity index is almost identical (approximately 595) for both groups of Douglas fir



CLIMATE – PAST, PRESENT, AND FUTURE CLIMATE AND THE BELL CURVE

Cold, wet climate Spruce/SA Fir forests







Cool, moist climate Mixed conifer forests



Warm, dry climate Pine, grassland forests





CLIMATE ASSESSMENTS

TEMPERATURE & PRECIPITATION

- Over 200 climate variables available
 - Annual
 - Seasonal
 - Monthly

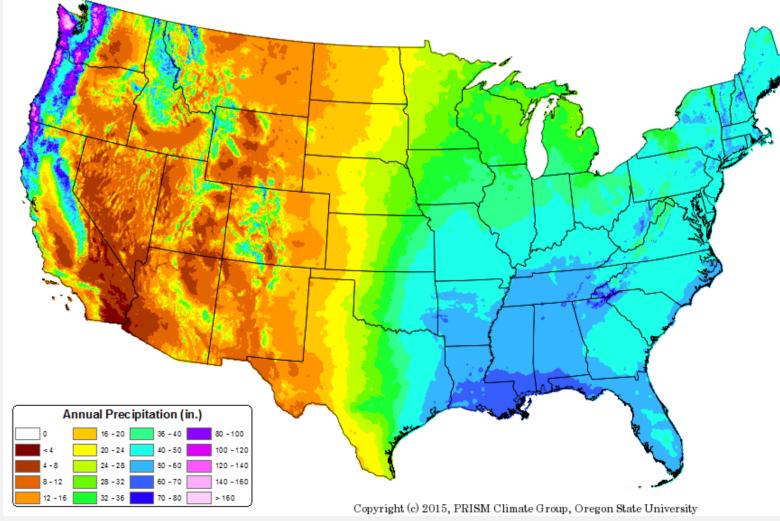
Five climate variables can represent all climate variables

- Annual Dryness Index (ADI, DD5/MAP)
- Degree Days >5 C (DD5)
- Summer/Spring Precipitation Balance (SSPB)
- Frost Free Period (FFP, Days)
- Mean Temperature in Coldest Month (MTCM, degree C)



30-yr Normal Mean Temperature: Annual Period: 1981-2010 Copyright (c) 2015, PRISM Climate Group, Oregon State Universit

30-yr Normal Precipitation: Annual Period: 1981-2010





MODIFIERS OF PRODUCTIVITY IT'S COMPLEX

- **I** Hillslope Position
- Geology
- Soils

Modifiers affect:

- Plant available water
- Nutrition



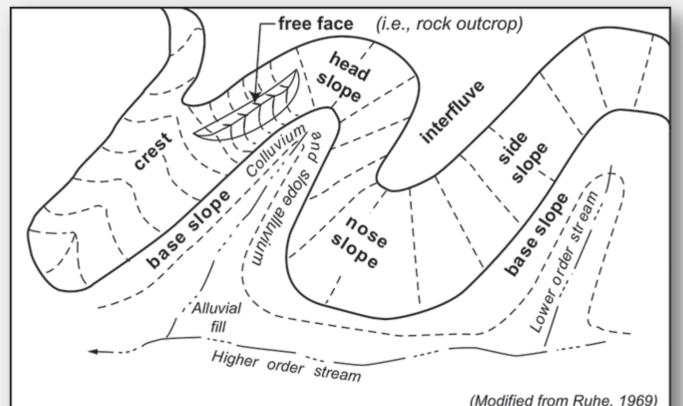
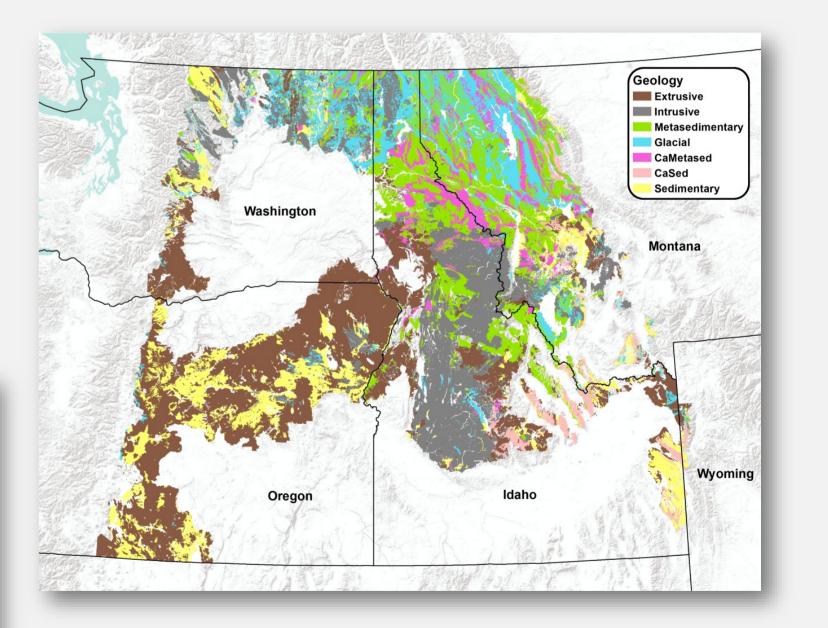






 Image: Construction of the second second





GEOLOGY AND SOILS IMPORTANT DRIVERS OF FOREST GROWTH











GLACIATION OF NORTHERN TIER RESHAPED THE LANDSCAPE OF WA, ID, AND MT





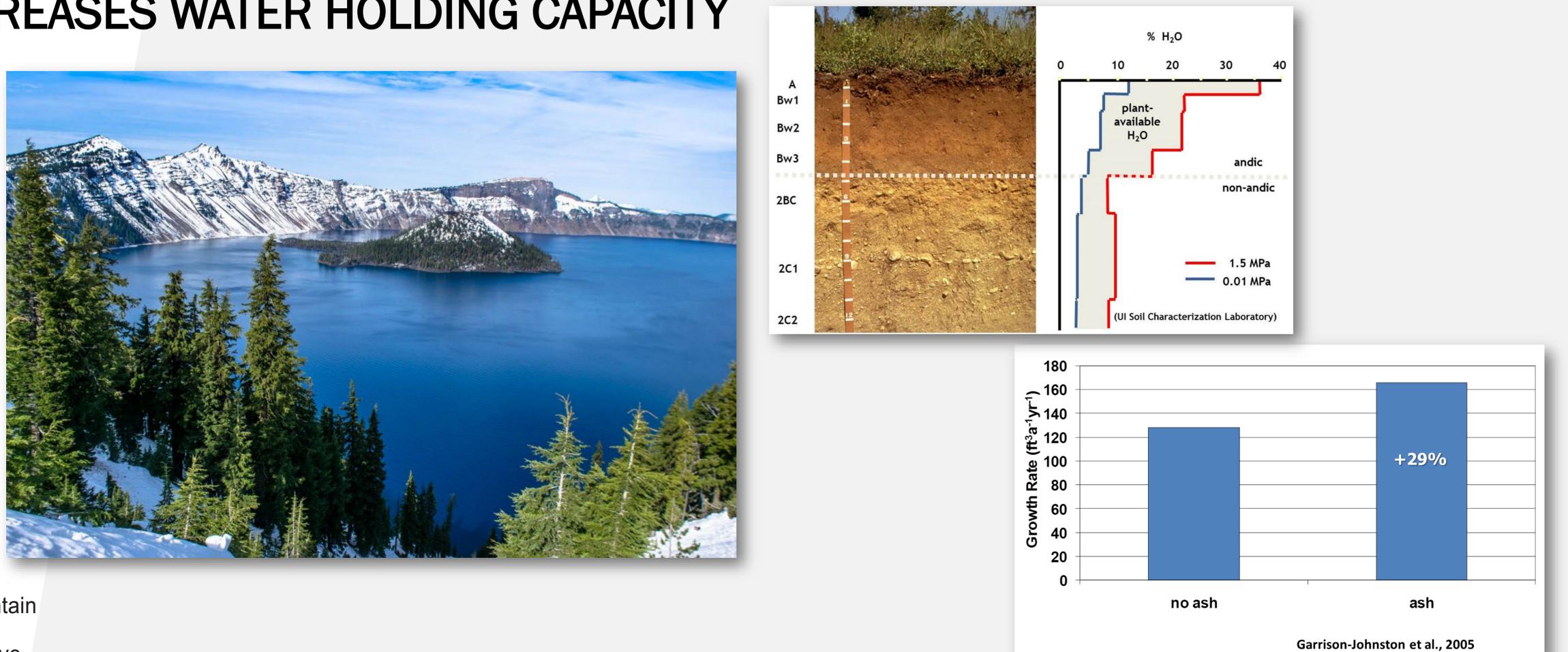








VOLCANIC ASH INCREASES WATER HOLDING CAPACITY









MODELING SDI_{MAX} DATA INTENSIVE

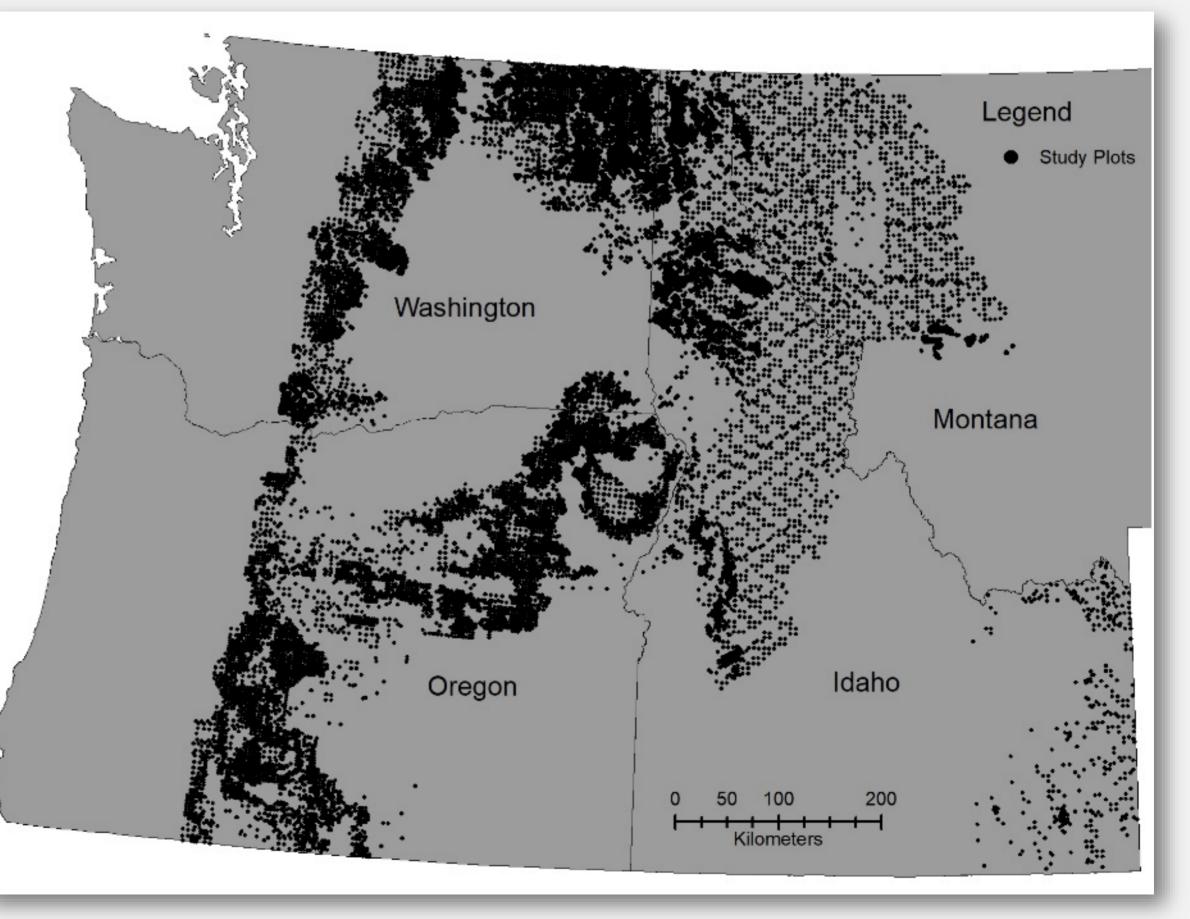
Dataset: >150,000 plots; 4+ million trees; 28 tree species

Data sources: Bennett Lumber, Inland Empire Paper, Potlatch, Stimson, Hancock, IDL, WA DNR, BLM, USFS FIA





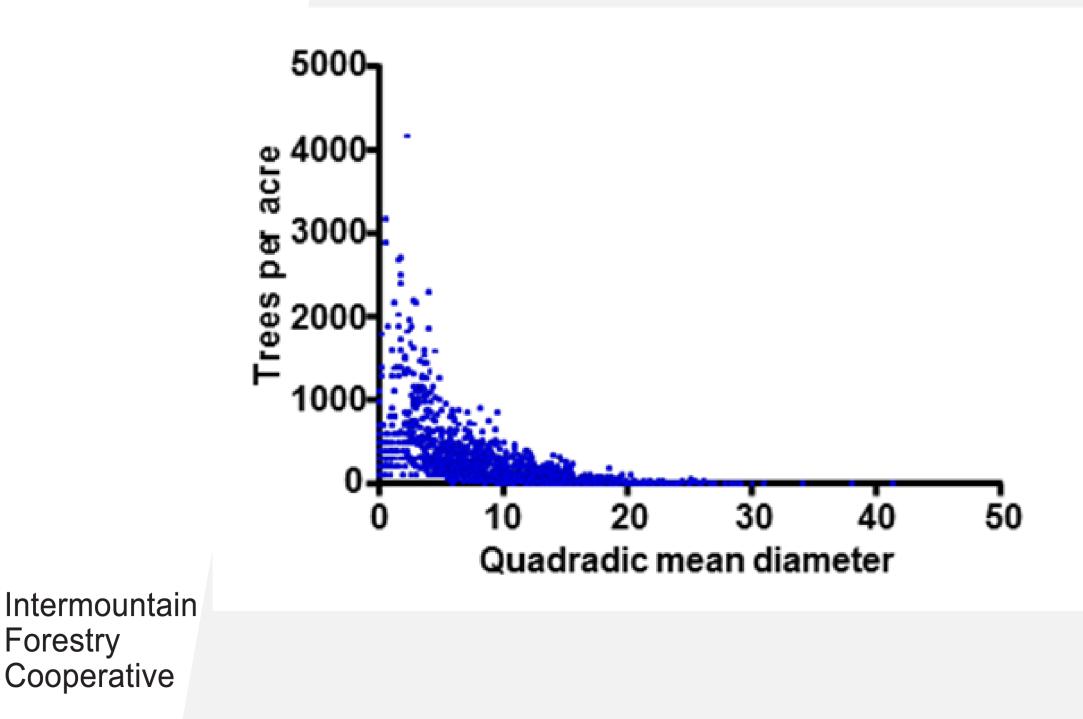
IFC Inland Data locations



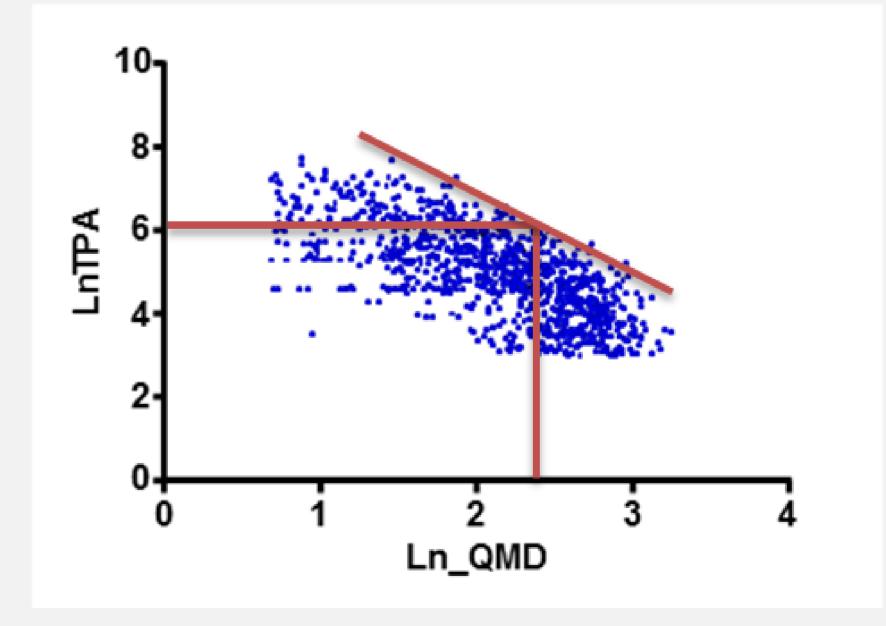


THE SIZE-DENSITY FUNCTION CLASSIC MODEL

 $y = \beta_0 e^{\beta_1 x}$



$ln(TPA) = \beta_0 + \beta_1 ln(QMD)$





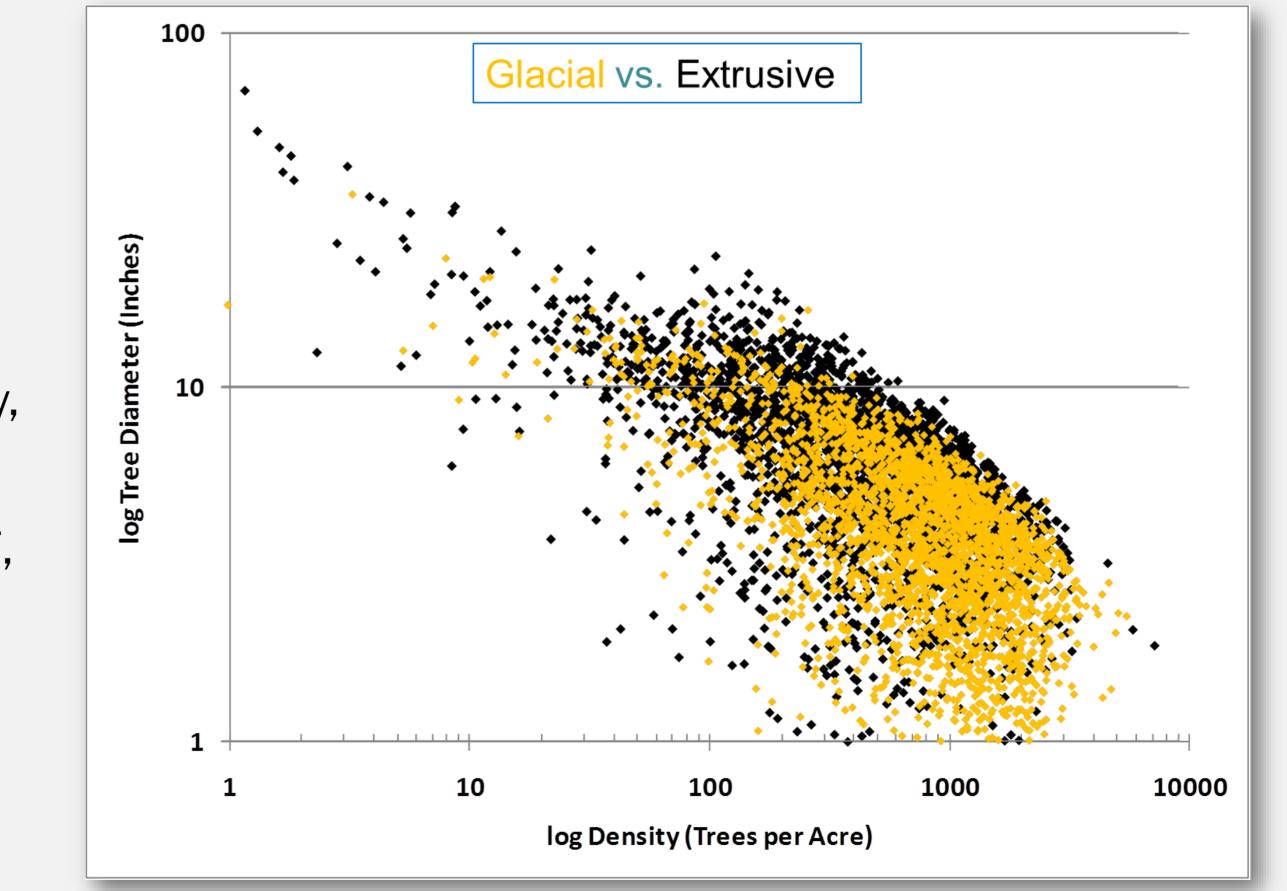
MODIFYING FOR SITE FACTORS ECONOMETRICS IN SILVICULTURE

Modeled using Stochastic Frontier Regression

- $Ln(TPA) = \beta_0 + \beta_1 * Ln(QMD) + \beta_n * Factor_n + v u$
- SDImax models a function of:
 - Dominant species basal area, climate, topography, geography, and soil parent material
- Developed individual species SDImax models for GF, DF, WL, PP, LP









SPECIES-SITE MARGINAL EFFECTS ON SDI_{MAX}

QMD = Quadratic Mean Diameter

PBA = Species Basal Area Proportion

ADI = Annual Dryness Index (DD5/MAP)

SSPB = Spring:Summer Precip Balance

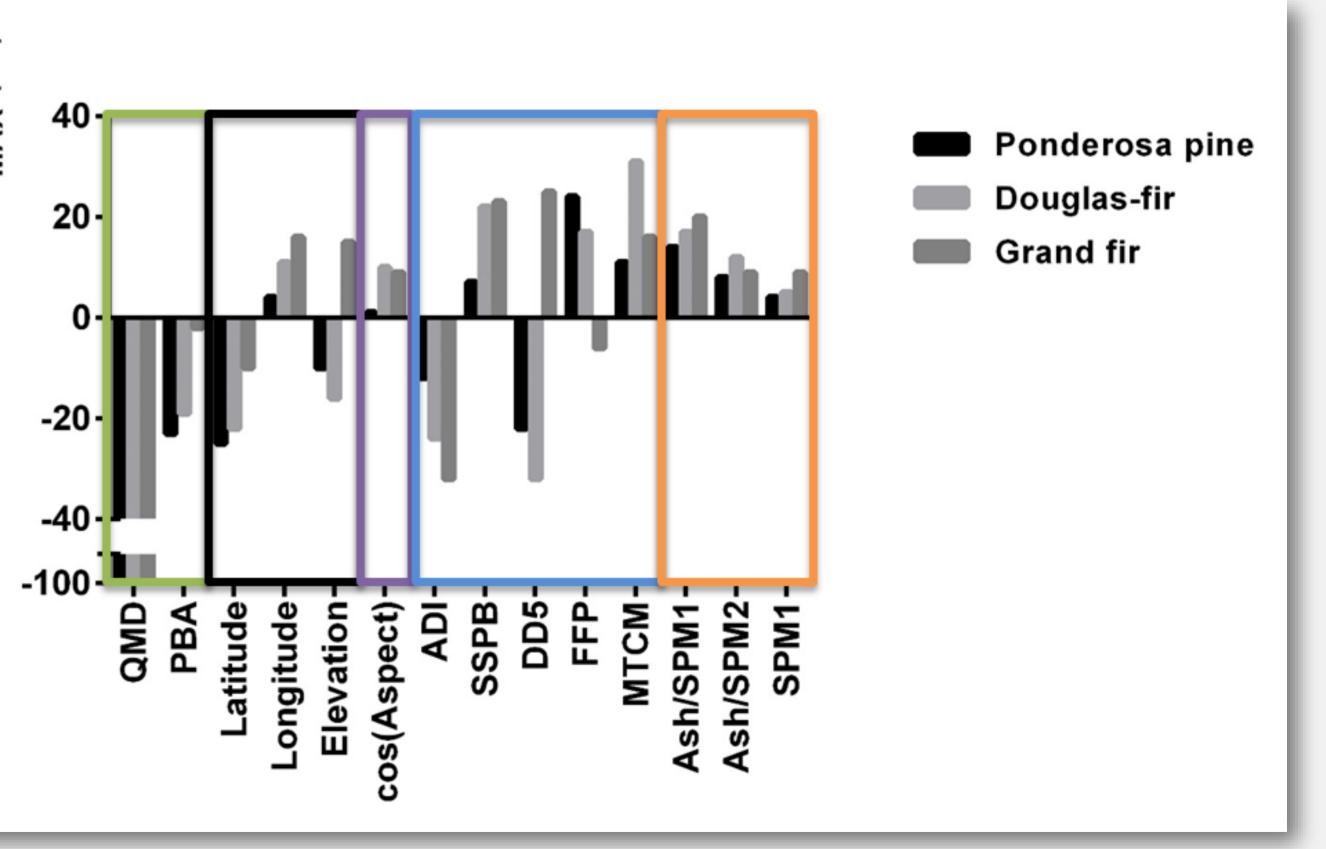
DD5 = Degree Days >5°C

FFP = Frost Free Period (Days)

MTCM = Mean Temperature in Coldest Month (°C)

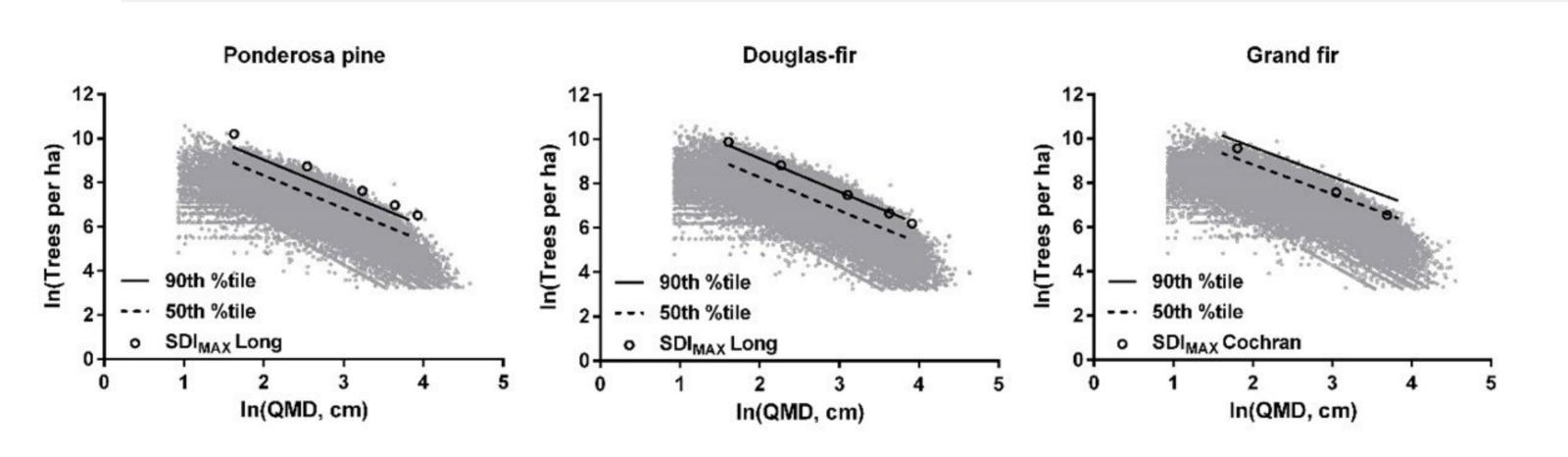


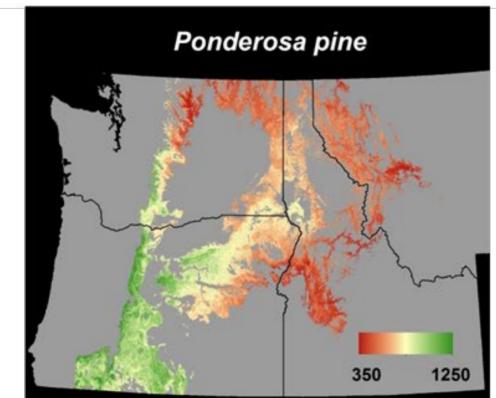


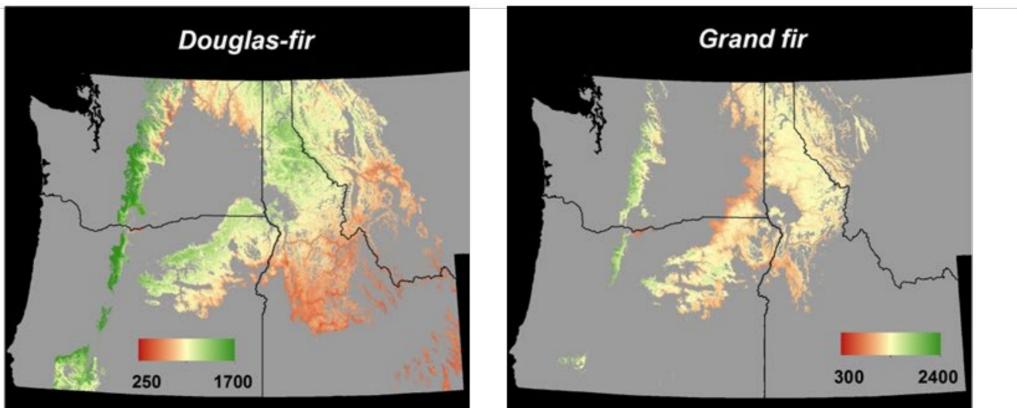




VISUALIZING SPECIES-SITE DENSITY SPATIAL MODELING













ARCGIS – IFC SDI_{MAX} RASTER LAYER

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MODEL UTILITY DESIGN STAND STOCKING GUIDELINES BASED ON 200 25 **DESIRED FUTURE STAND CONDITION** 150 -20 ¹⁰⁰ -15 I Pleasant Mountain – SDImax = 550 50 -10 DFC: 14 inch QMD DIAMETER (inches) Stand not to exceed 60% of SDImax (330 SDI) Solve SDI equation for TPA: **Pleasant Mtn** $330 = TPA * (14/10)^{1.45} = 202$ 550 SDImax RCI stems per acre 50 100 200 400 600 1000 2000 TREES PER ACRE 14 ft spacing Lost Prairie Ridge ver. 4.2 10/31/05 450 SDImax











SPECIES-SITE EFFECTS EXPLAINED QUANTIFIED COMMON SENSE

- Density diameter relationship primary driver of forest carrying capacity
- Shade tolerant species and mixed conifer stands pack more biomass per unit area
- North facing slopes carry more biomass than southerly
- Low annual dryness index, high summer precipitation, warm winters, presence of deep volcanic ash soils all promote higher biomass production
- Ponderosa pine and Douglas-fir dominated forest stands increase stand density with longer frost-free periods
- Increasing temperature, with no increase in moisture, results in decreased stand densities regardless of species





