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

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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

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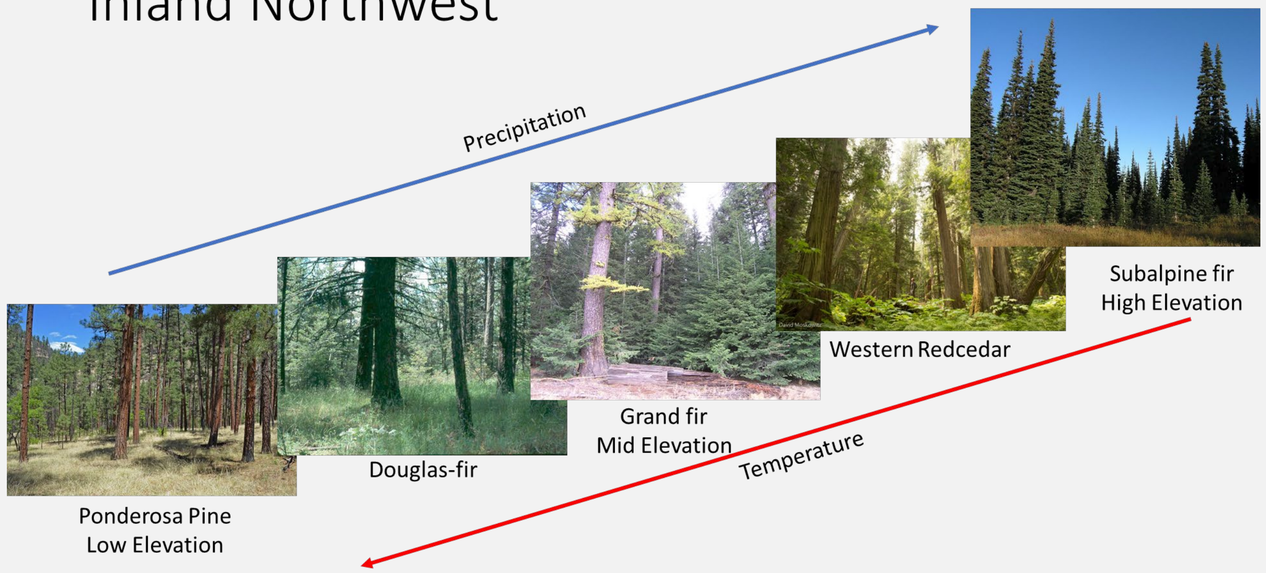
LET'S DIG DEEPER

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



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ASKING THE QUESTION

HOW DOES SITE AFFECT SPECIES MAXIMUM DENSITY

Pinus ponderosa ssp. *ponderosa*

Pseudotsuga menziesii var. *glauca*

Abies grandis ssp. idahoensis

Temperature

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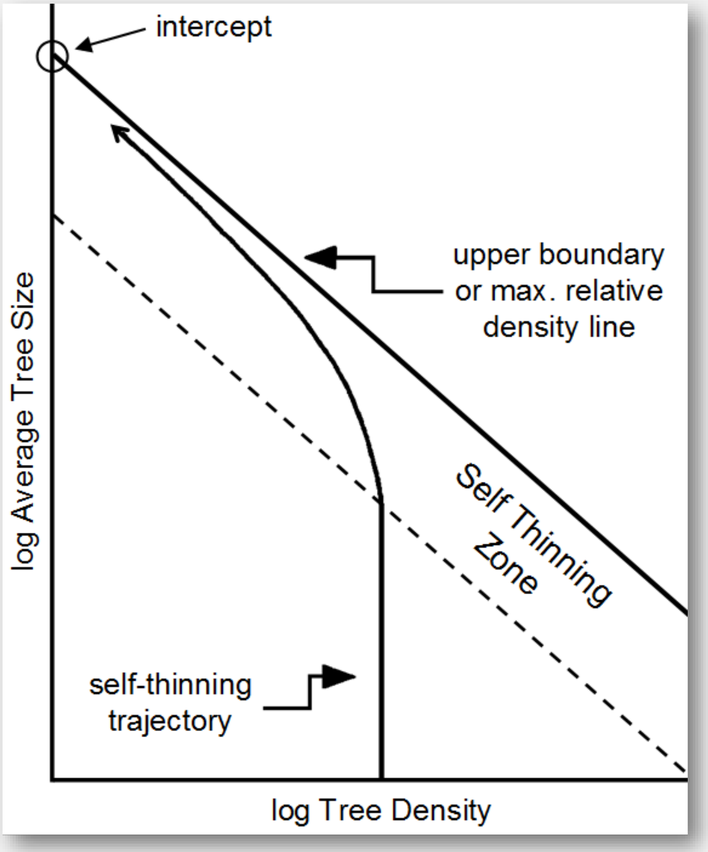
IFC SDI_{MAX} RESEARCH

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



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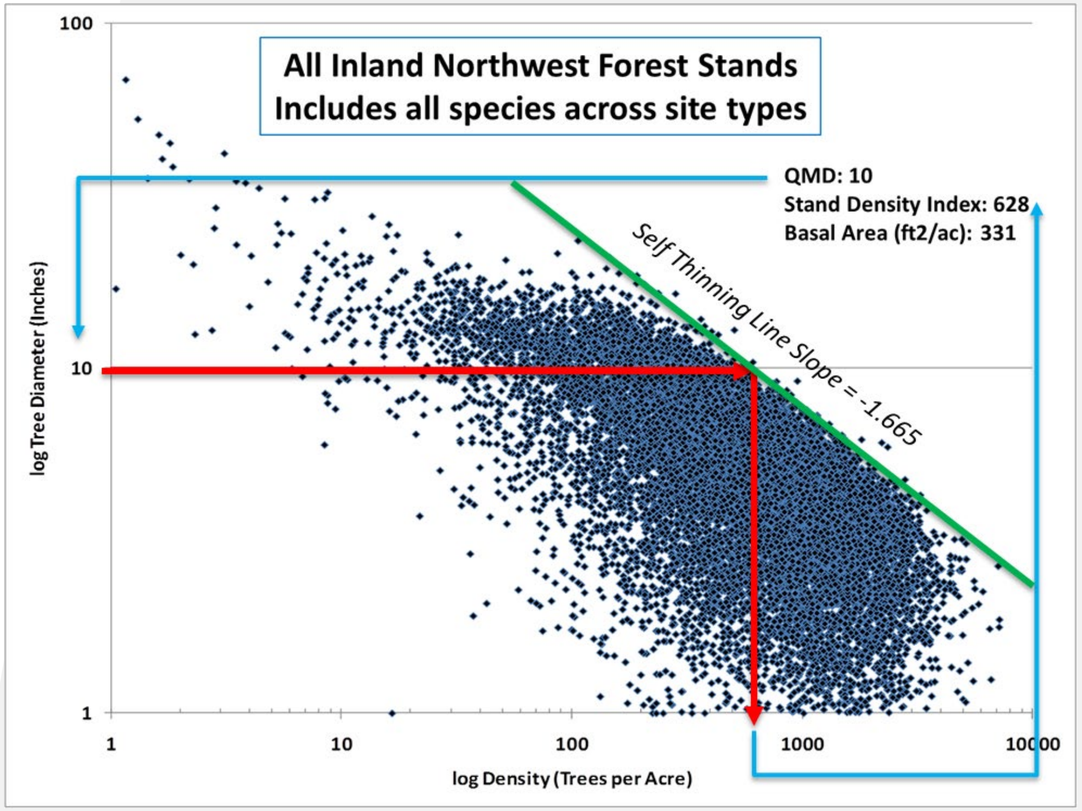
REAL WORLD EXAMPLE

TYPICALLY SPECIES SPECIFIC – SITE INVARIANT



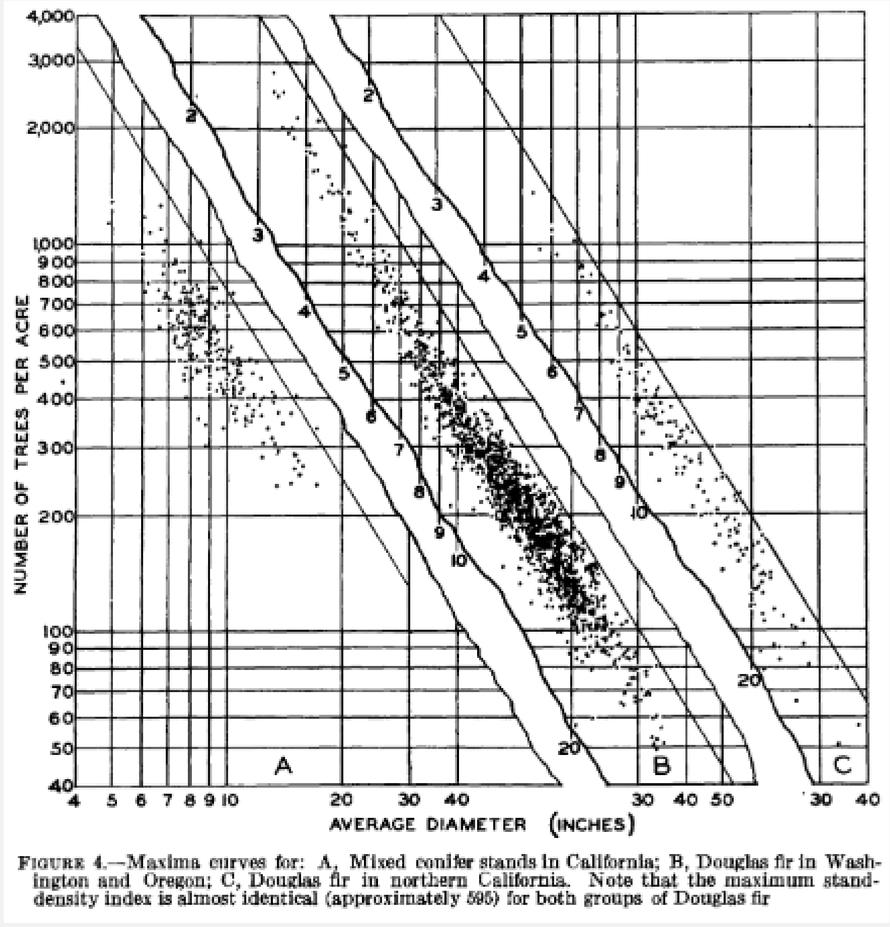


FIGURE 4.—Maxima curves for: A, Mixed conifer stands in California; B, Douglas fir in Washington and Oregon; C, Douglas fir in northern California. Note that the maximum stand-density index is almost identical (approximately 595) for both groups of Douglas fir

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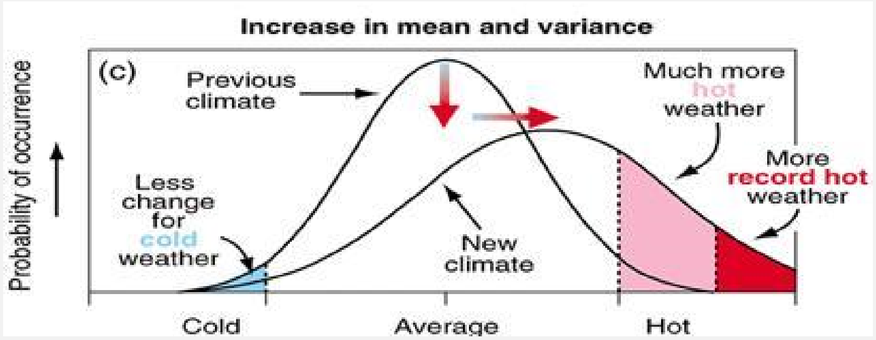
CLIMATE – PAST, PRESENT, AND FUTURE

CLIMATE AND THE BELL CURVE

Cool, moist climate
Mixed conifer forests

Cold, wet climate
Spruce/SA Fir forests



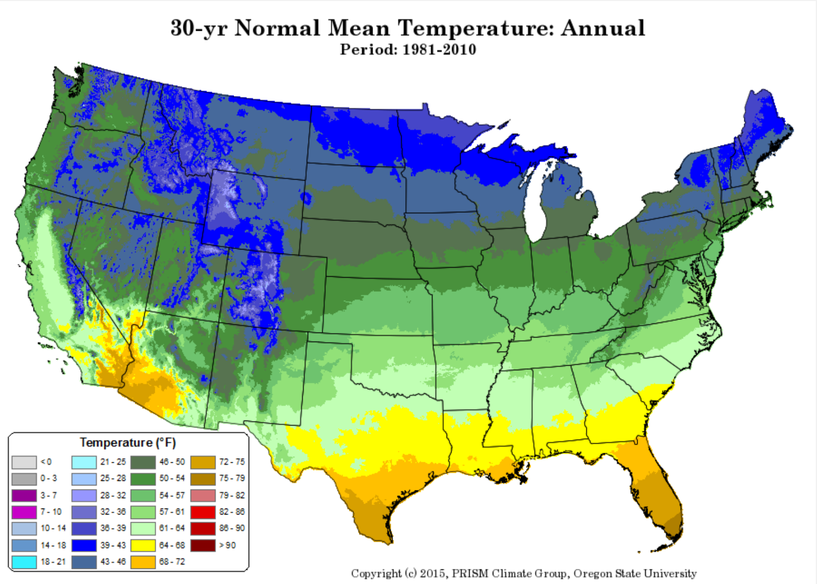
Warm, dry climate
Pine, grassland forests

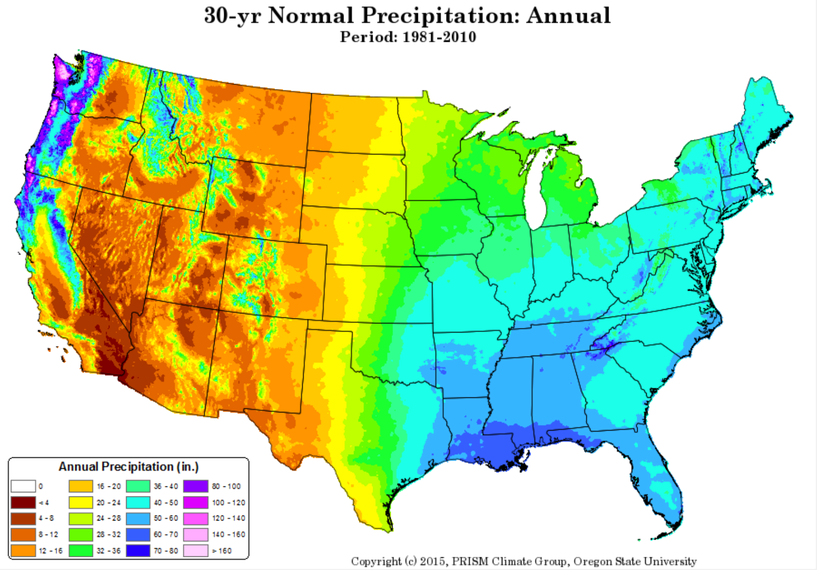
CLIMATE ASSESSMENTS

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)





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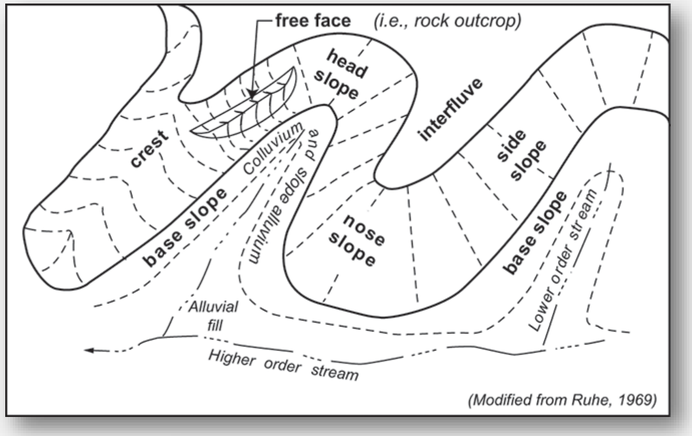
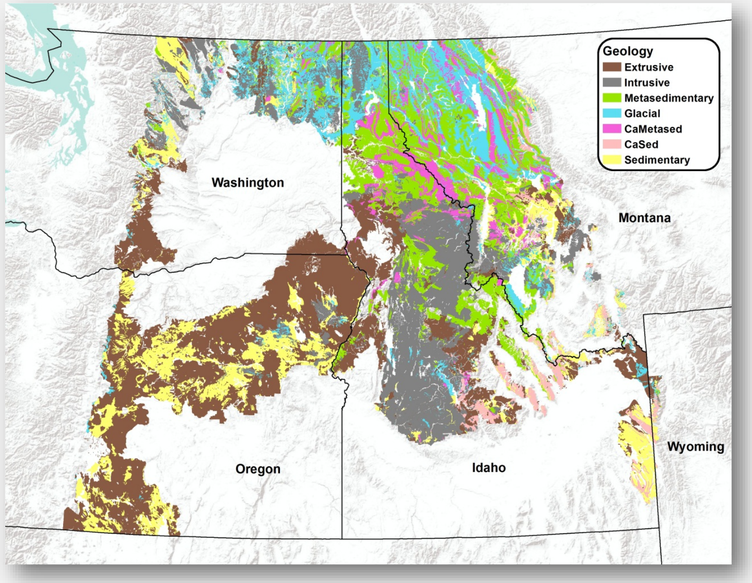
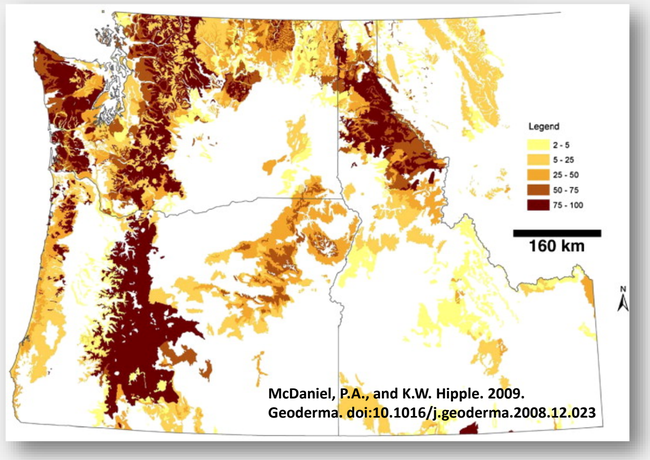
MODIFIERS OF PRODUCTIVITY

IT'S COMPLEX

- Hillslope Position
- Geology
- Soils







Modifiers affect:

- Plant available water
- Nutrition

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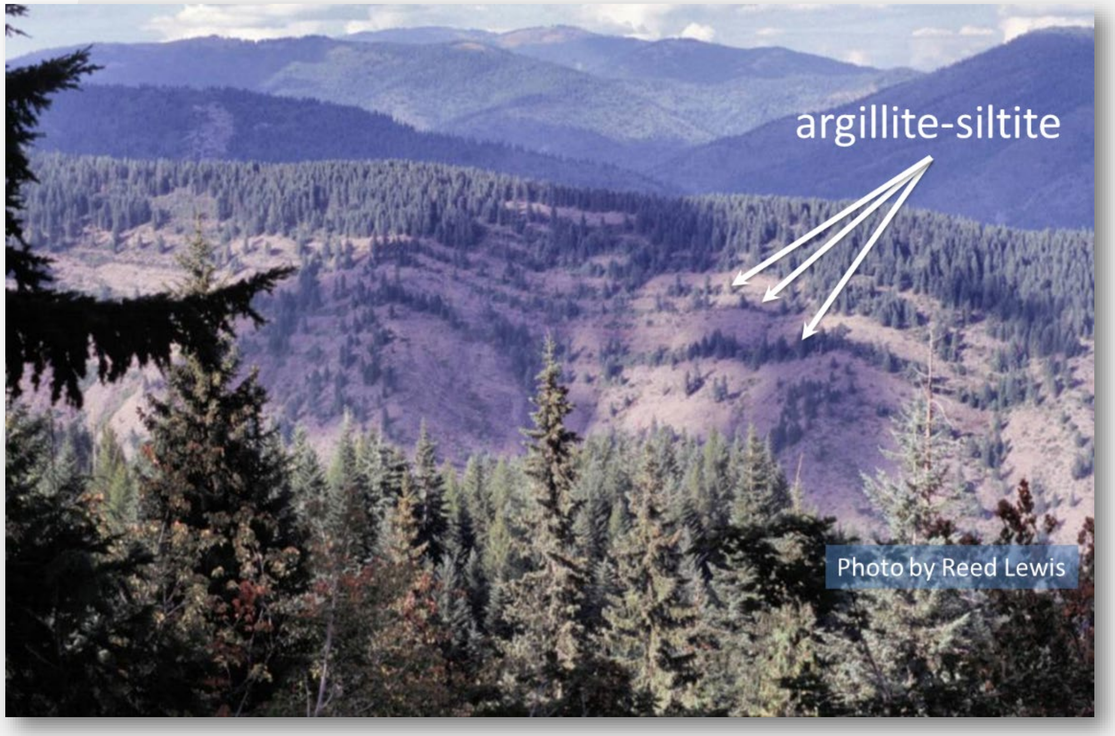
GEOLOGY AND SOILS

IMPORTANT DRIVERS OF FOREST GROWTH



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GLACIATION OF NORTHERN TIER

RESHAPED THE LANDSCAPE OF WA, ID, AND MT

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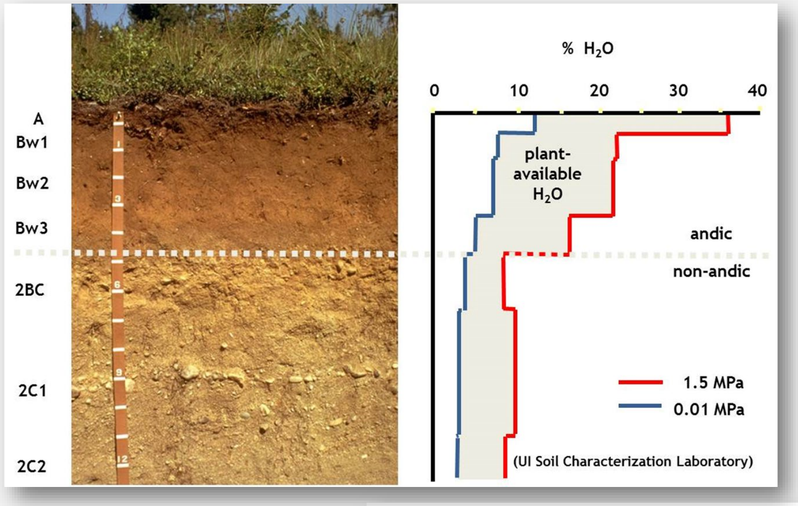
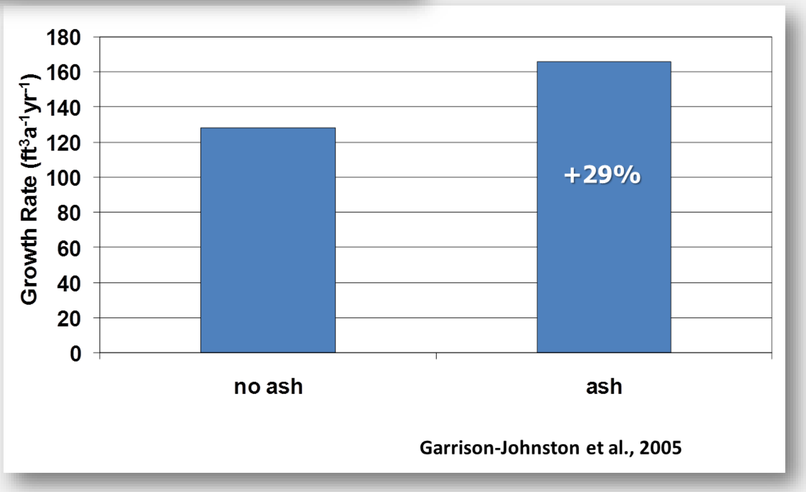
VOLCANIC ASH

INCREASES WATER HOLDING CAPACITY





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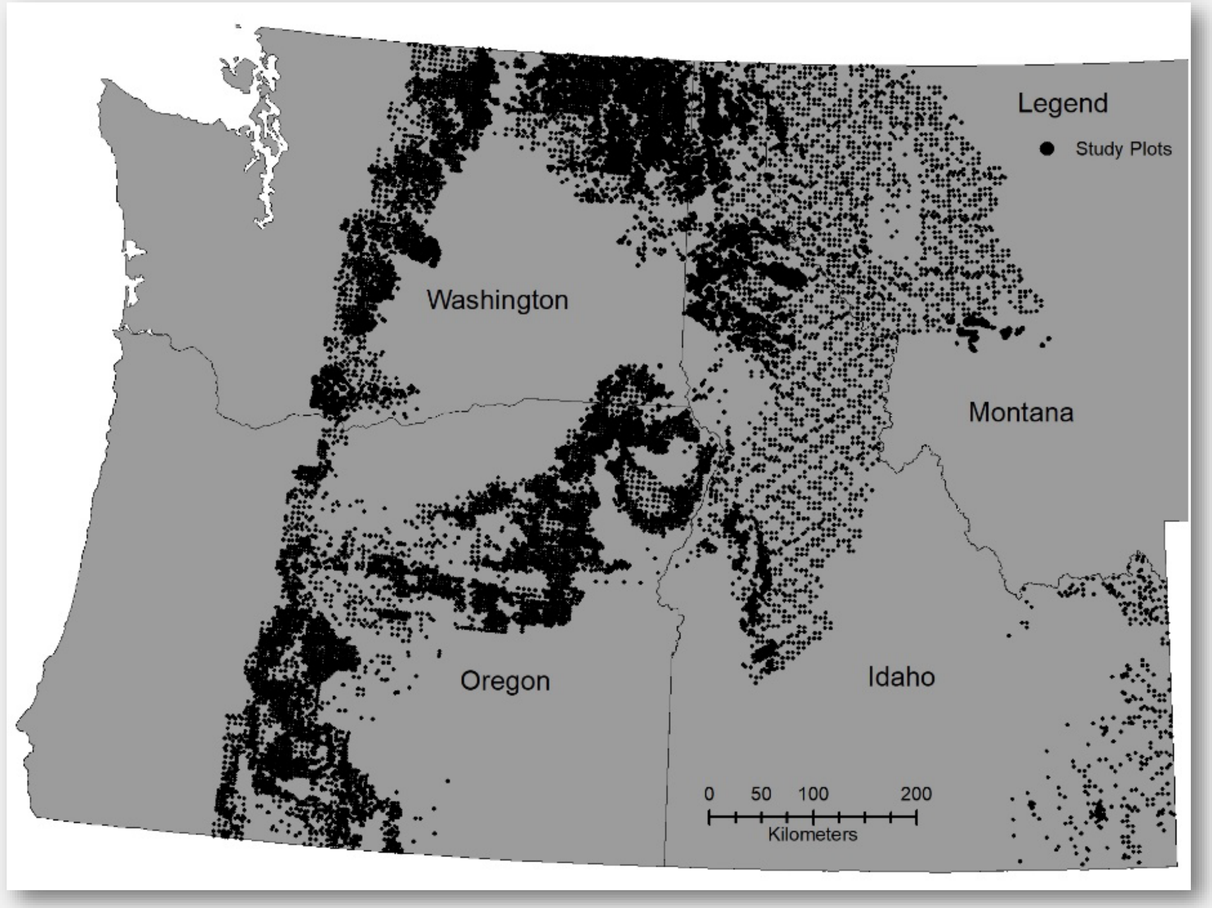
MODELING SDI_{MAX}

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



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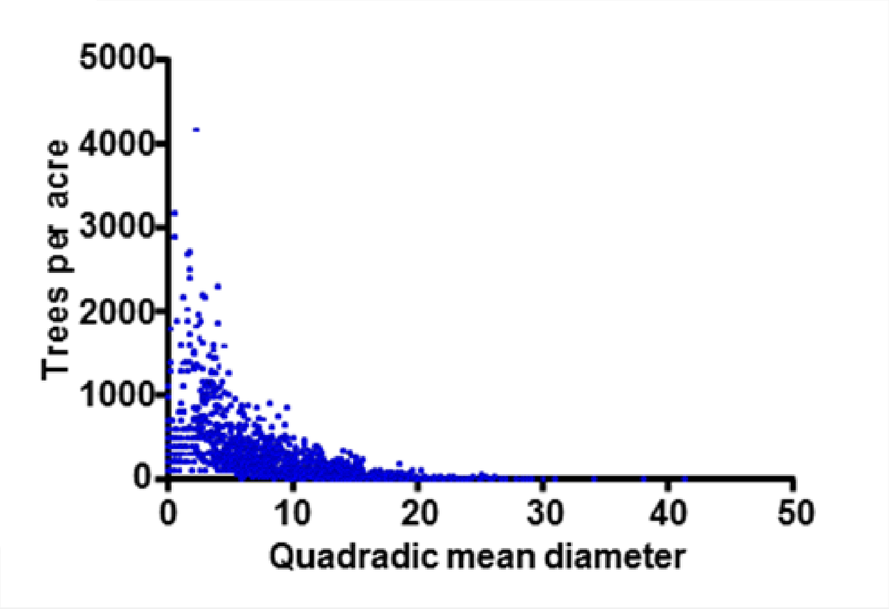
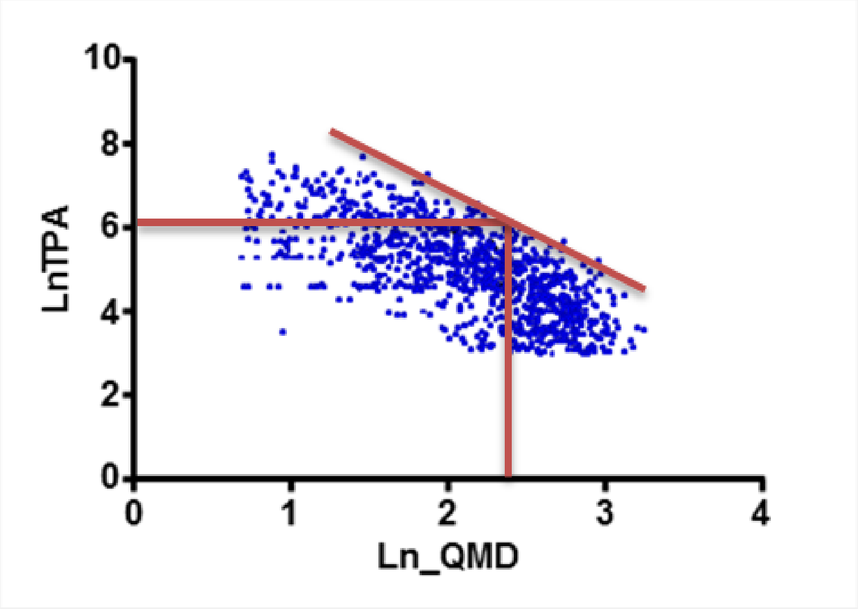
THE SIZE-DENSITY FUNCTION

CLASSIC MODEL

$$y = \beta_0 e^{\beta 1 x}$$



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



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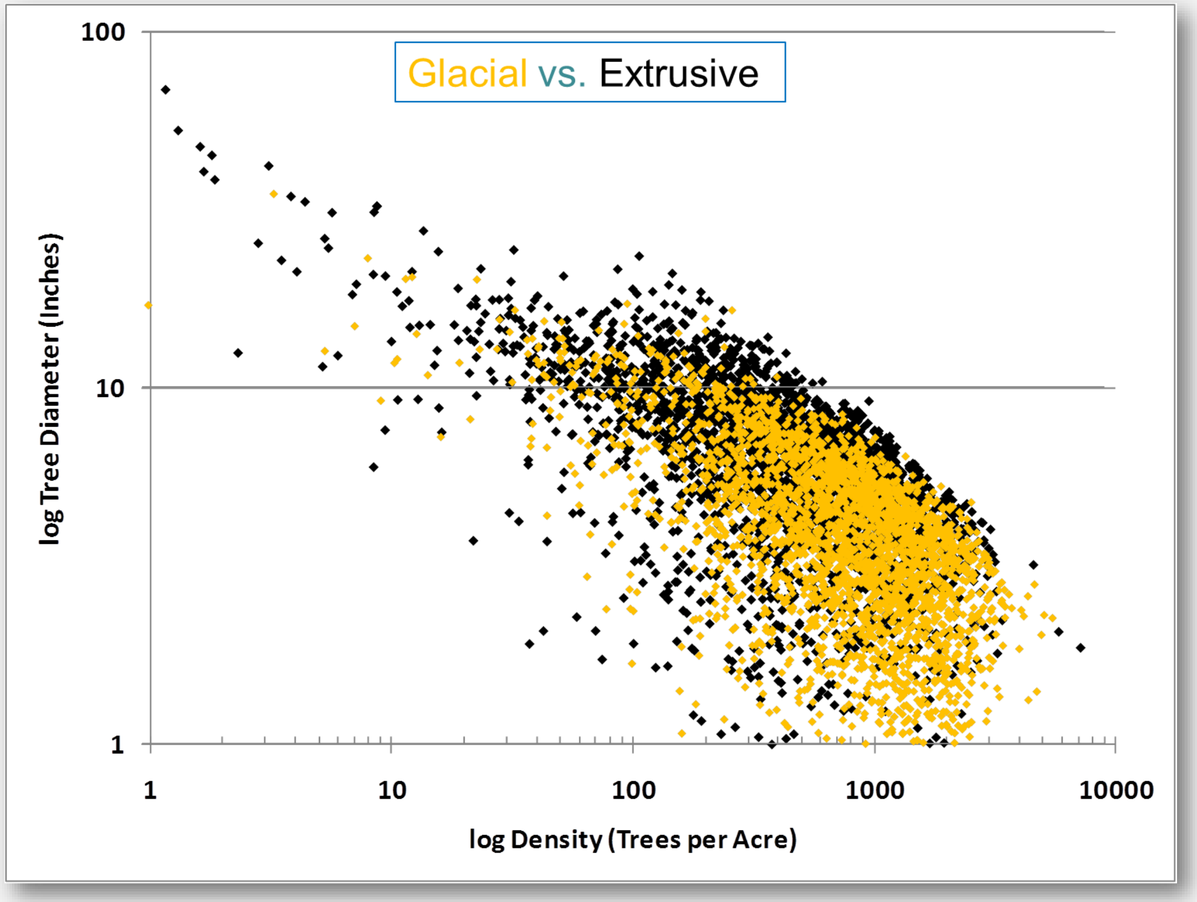
MODIFYING FOR SITE FACTORS

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



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SPECIES-SITE MARGINAL EFFECTS

ON SDI_{MAX}

QMD = Quadratic Mean Diameter

PBA = Species Basal Area Proportion

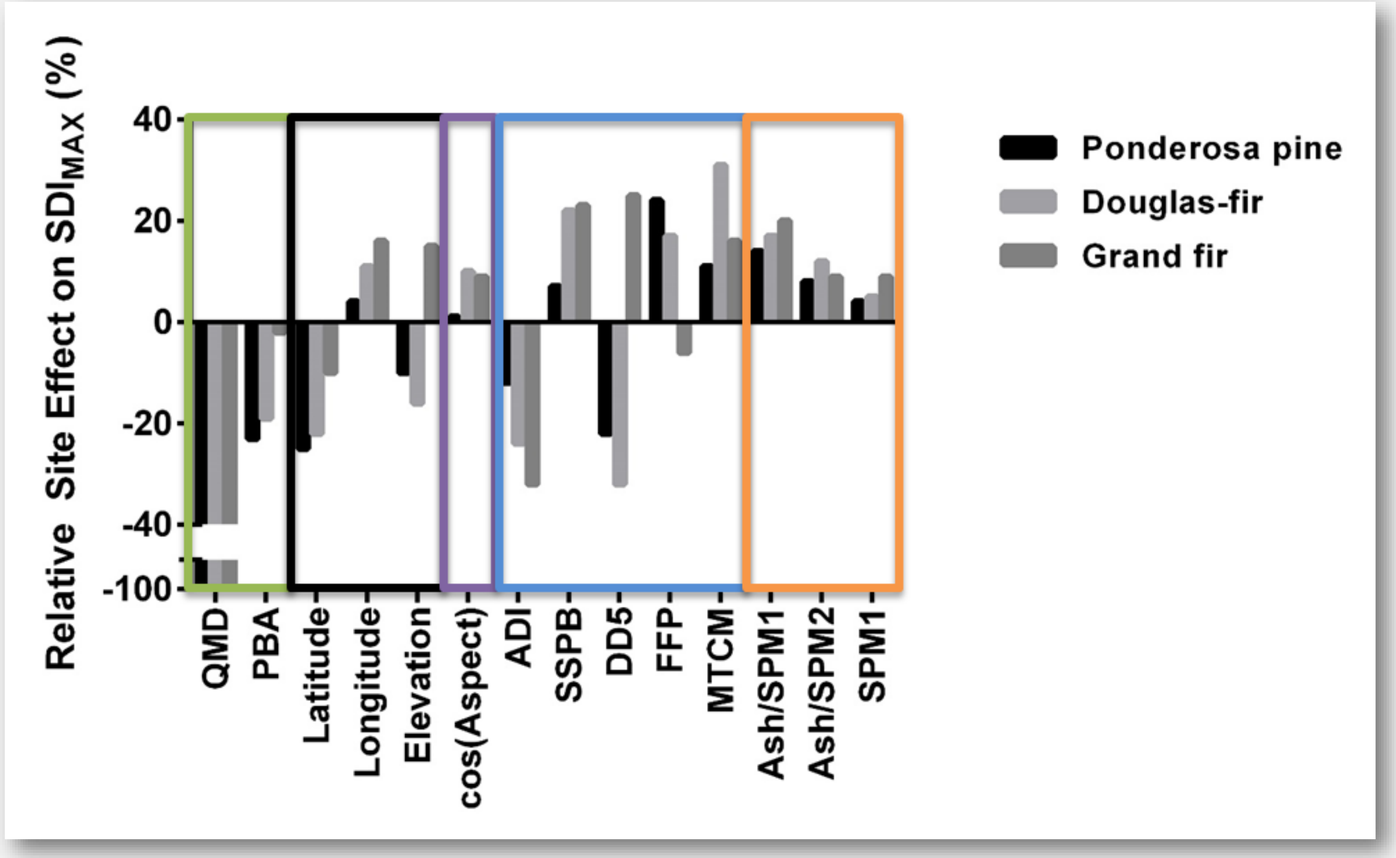
ADI = Annual Dryness Index (DD5/MAP)

SSPB = Spring:Summer Precip Balance

DD5 = Degree Days >5°C

FFP = Frost Free Period (Days)

MTCM = Mean Temperature in Coldest Month (°C)



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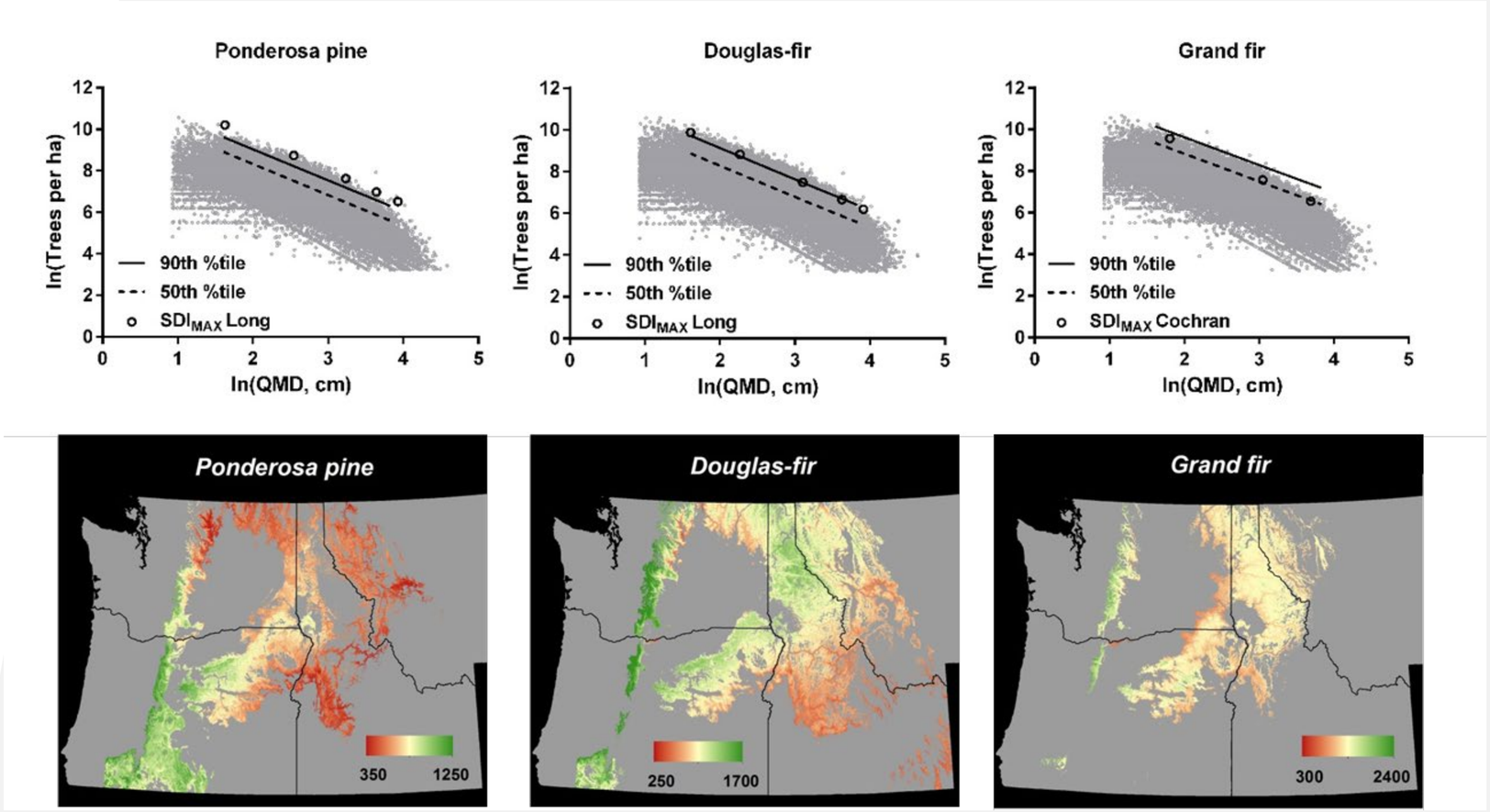
VISUALIZING SPECIES-SITE DENSITY

SPATIAL MODELING



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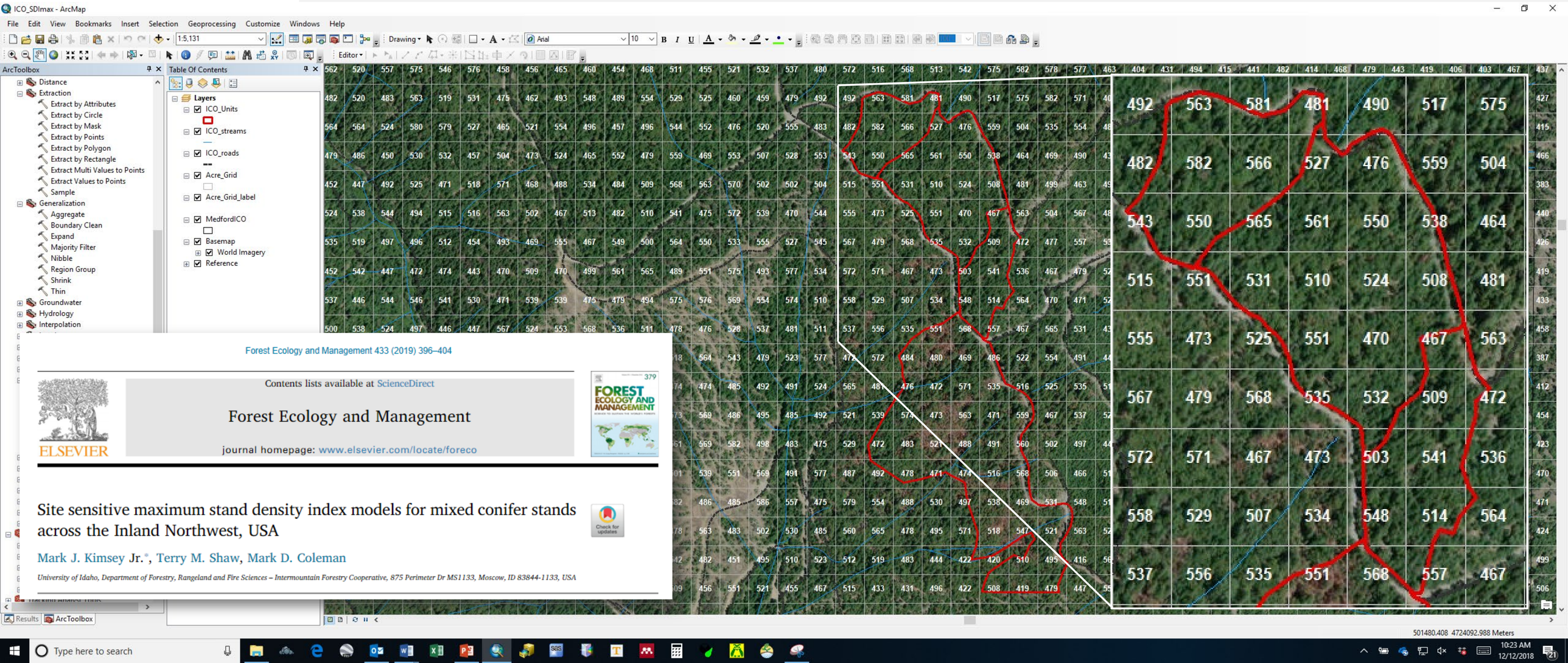
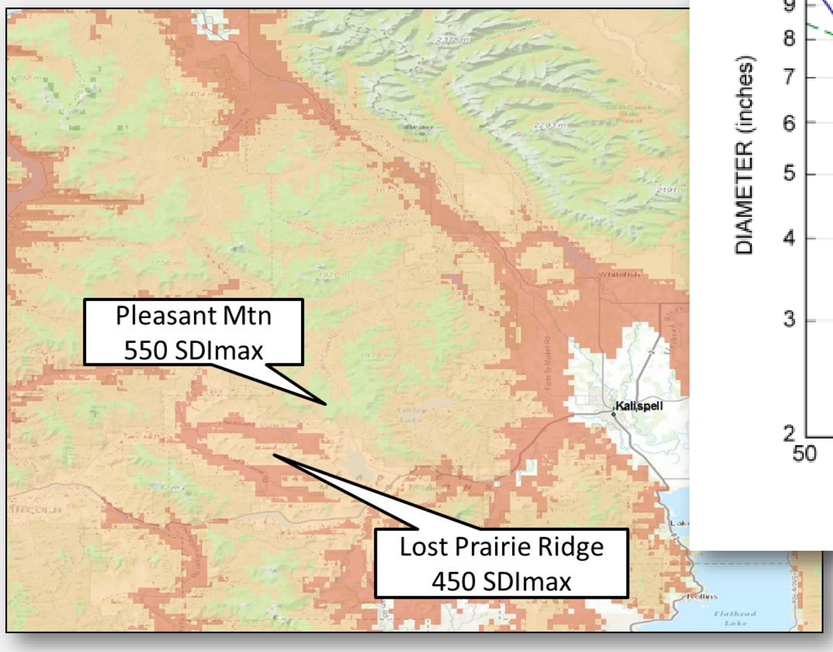
ARCGIS – IFC SDI_{MAX} RASTER LAYER

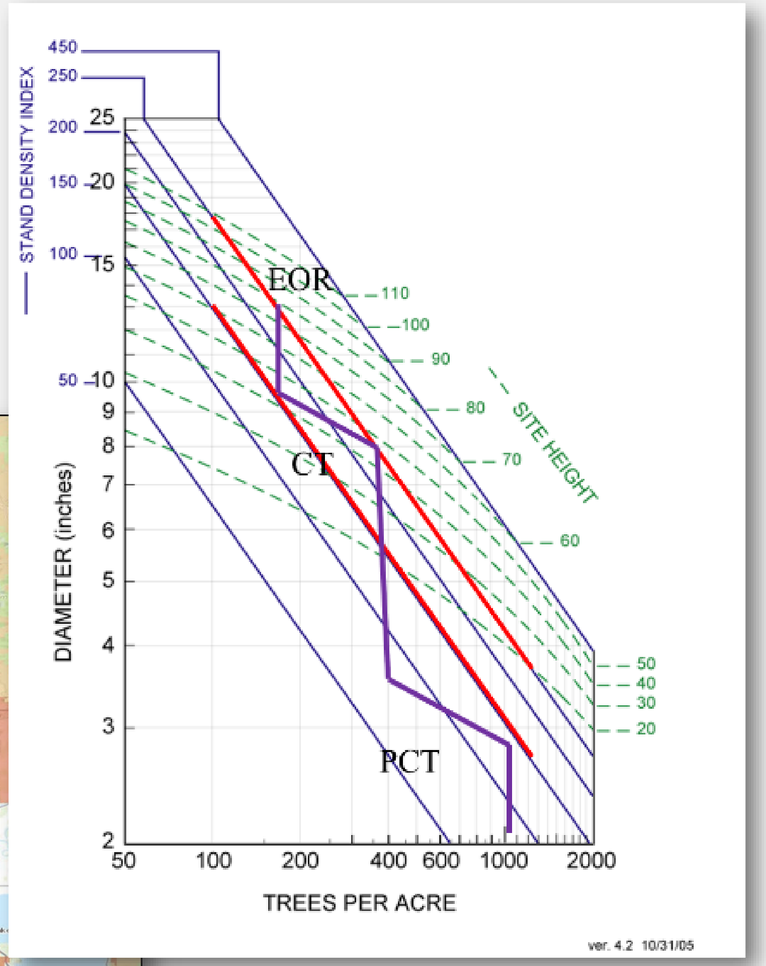


MODEL UTILITY

DESIGN STAND STOCKING GUIDELINES BASED ON DESIRED FUTURE STAND CONDITION

- Pleasant Mountain – SDImax = 550
  - DFC: 14 inch QMD
  - Stand not to exceed 60% of SDImax (330 SDI)
- Solve SDI equation for TPA:
  - $330 = TPA * (14/10)^{1.45} = 202$ stems per acre
  - 14 ft spacing





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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

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