



Site Type Initiative Phase 1 Progress Report: Species Max SDI Model V2.0

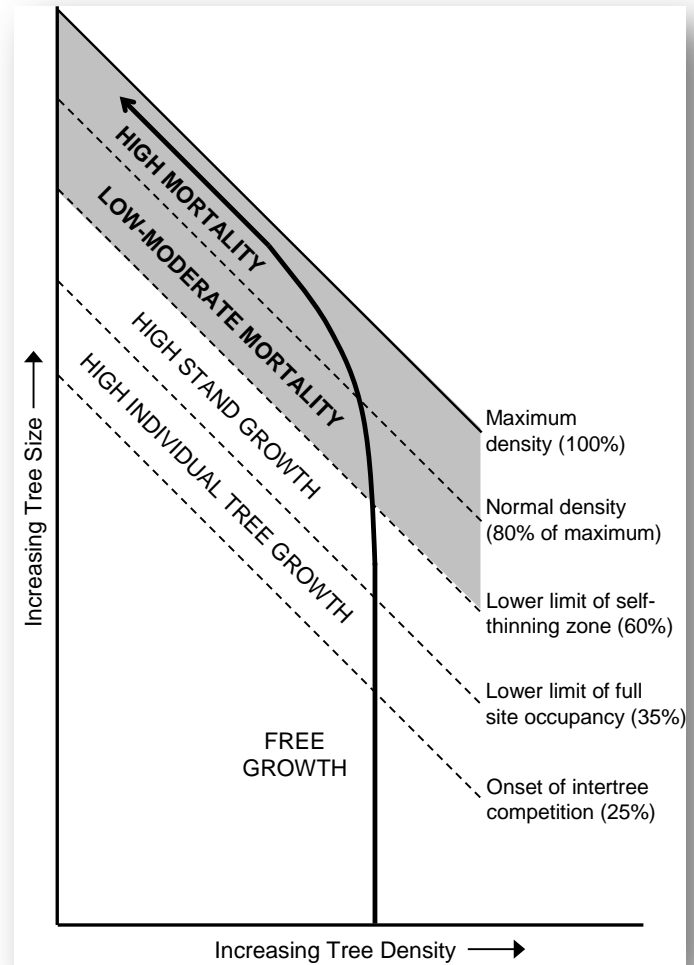
IFTNC Annual Meeting

Mark Kimsey
4/01/2014

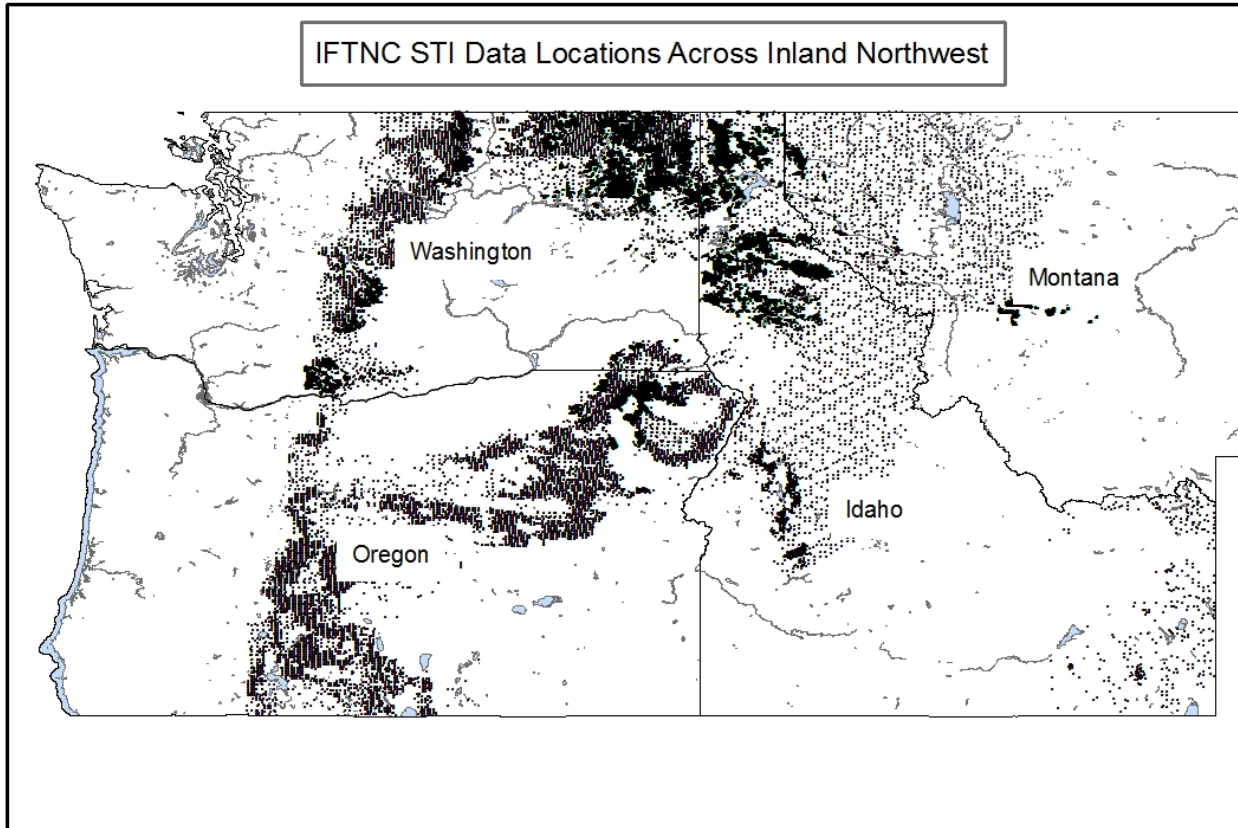


Stand Density Index Review

- For a given average tree size, there is a limit (maximum) to the number of trees per acre that may coexist in a stand
- % of max SDI an index of intra-tree competition for site resources
- Shifts in the slope & intercept reflect changes in site carrying capacity - site quality?
- Used to define upper and lower limit management zones



STI Database



Dataset:

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

Associated Input:

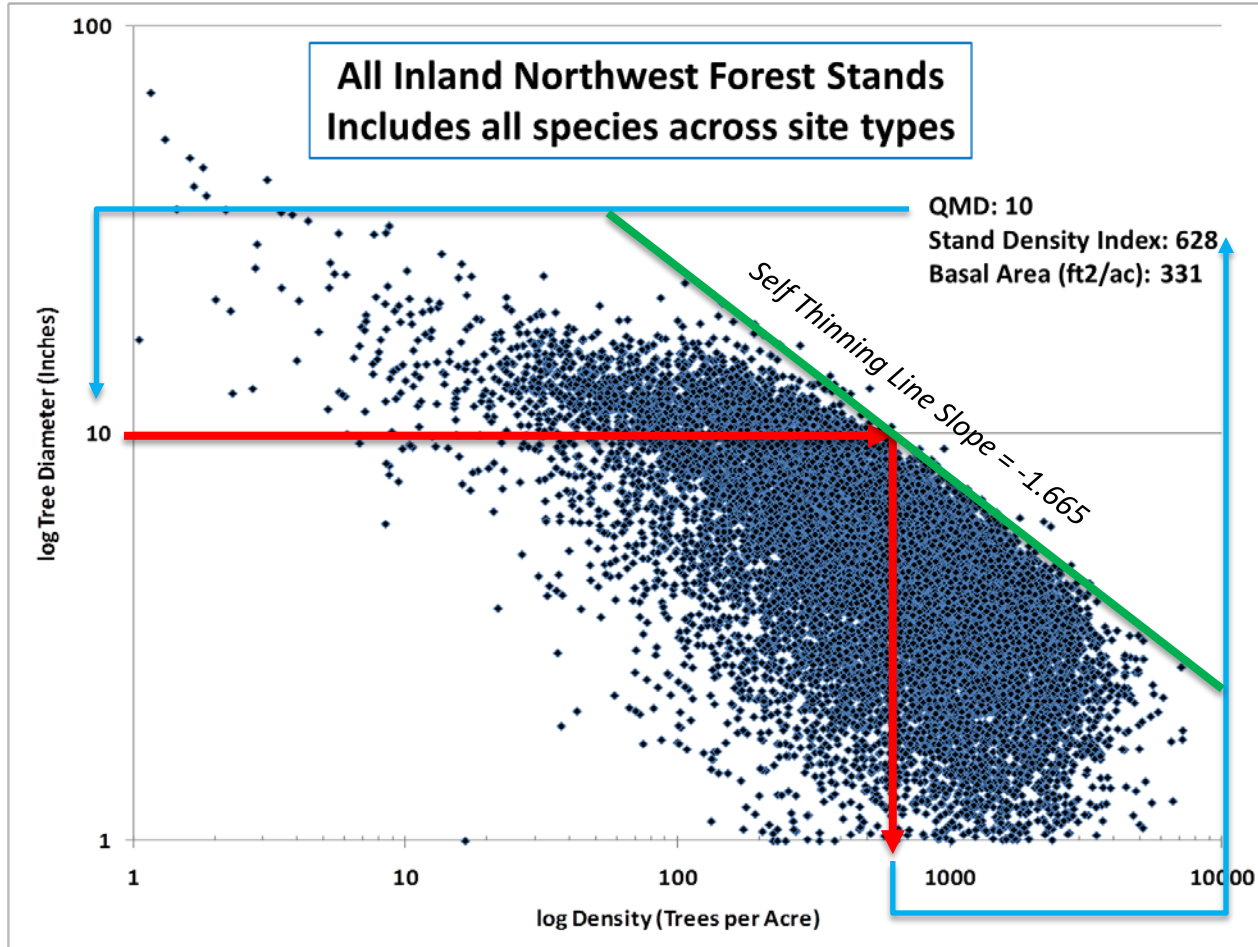
100 variables: stand/tree
level, climate, geology,
topography

Cooperator Data Suppliers:

USFS-FIA/CVS, BLM, WA DNR, IDL, Forest Capital, Stimson, Hancock, Inland Empire Paper, Bennett Lumber



SDI: Inland Northwest Forests



Green line = Inland NW maximum biological carrying capacity

Self thinning line slope statistically the same to Reineke's (1933) slope of -1.605

Max SDI (TPA) is indexed to a QMD of 10 inches

Max SDI = 628 TPA



Max SDI V1.0 Models: Stochastic Frontier Regression

- PP max SDI factors
 - Basal area (-), Rock Type (var), Elev (+), ADI (+)
- DF max SDI factors
 - Basal area (-), Rock Type (var), Elev (-), N/S aspect (+), ADI (-)
- GF max SDI factors
 - Basal area (-), Rock Type (var), N/S aspect (+), ADI (-)

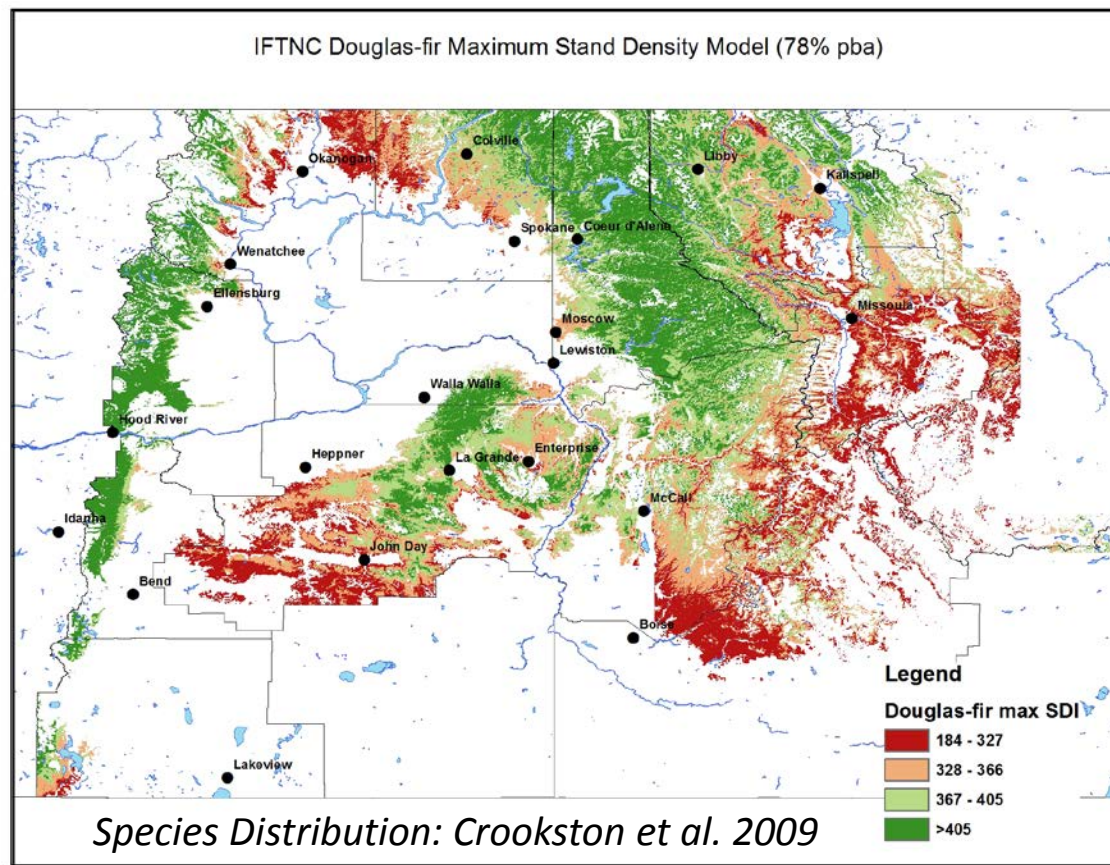


Geospatial Species Max SDI Models

$$SDI_{max} = f(QMD, Aspect, Annual\ Dryness\ Index, Elevation, Species\ Basal\ Area, Rock\ Type)$$

Similar maps for:

Grand Fir
Ponderosa Pine
Western Larch



V1.0 Limitations - Soil Water

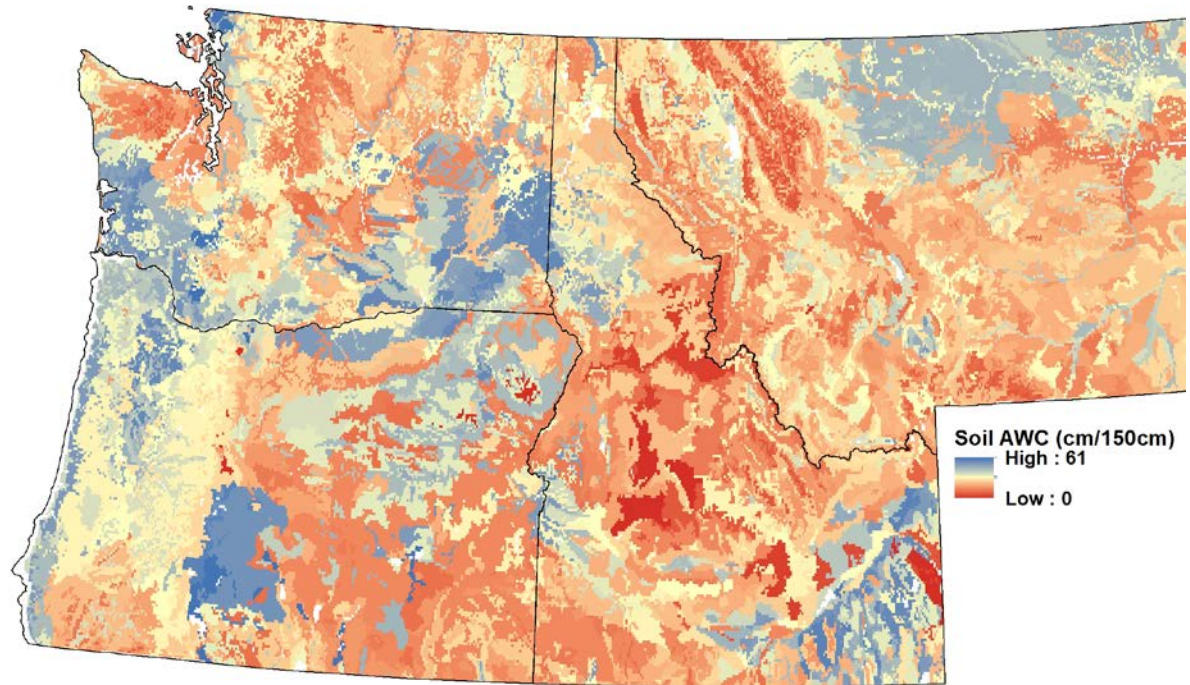


- Rock type a proxy for nutrition and subsurface soil characteristics
- Does not capture eolian surficial soil effect on soil water holding capacity - particularly volcanic ash soils
- Volcanic ash is well known to increase site AWC, thus hypothetically ash-influenced soils should be less moisture limited - increasing site biomass



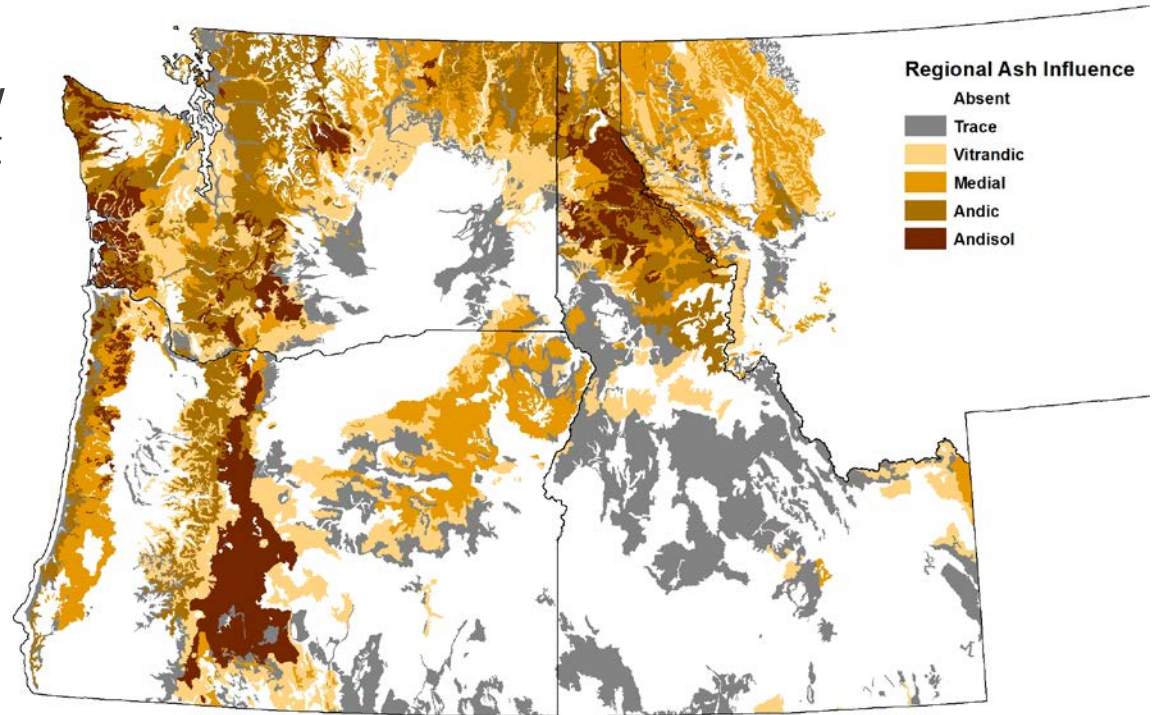
Northwest CONUS Soil Water Layer

- Available soil water to 60 inches or restrictive layer
- Data layer derived from STATSGO (1:250K) surveys
- Regional scale, not applicable at the hillslope level, but capable of capturing trends across the landscape



Northwest Volcanic Ash Layer

- Concerned soil development processes at higher elevations may mask volcanic ash effect
- Collaborated with Steve Campbell at the NRCS West National Technology Support Center to develop a Northwest scale ash layer
- Data layer derived from both SSURGO (1:24K) & STATSGO (1:250K) surveys



Stochastic Frontier Regression (SFR)

- Econometrics fitting technique used to study production efficiency, cost and profit frontiers
- SFR Model:
 - $\ln(TPA) = a + \beta \ln(QMD) + v - u$
 - v = two-sided random error (OLS error)
 - u = non-negative random error (Frontier error)
 - Maximum likelihood techniques are used to estimate the frontier
- Fitting performed using PROC QLIM



SFR Species Max SDI Factors

Black - V1.0, Black + Brown - V2.0, Grey - NS in V1.0 or 2.0

PP Factors

- Basal Area (-)
- Rock Type (var)
- Ash (+)
- ASWC (NS)
- Elevation (-)
- Aspect (NS)
- ADI (+)
- DD5 (-)
- FFP (-)
- MTCM (-)
- SMRSPRPB (-)

DF Factors

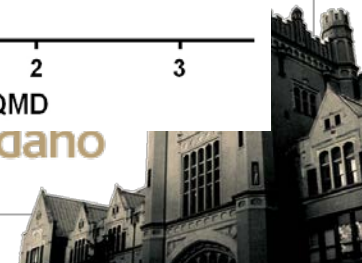
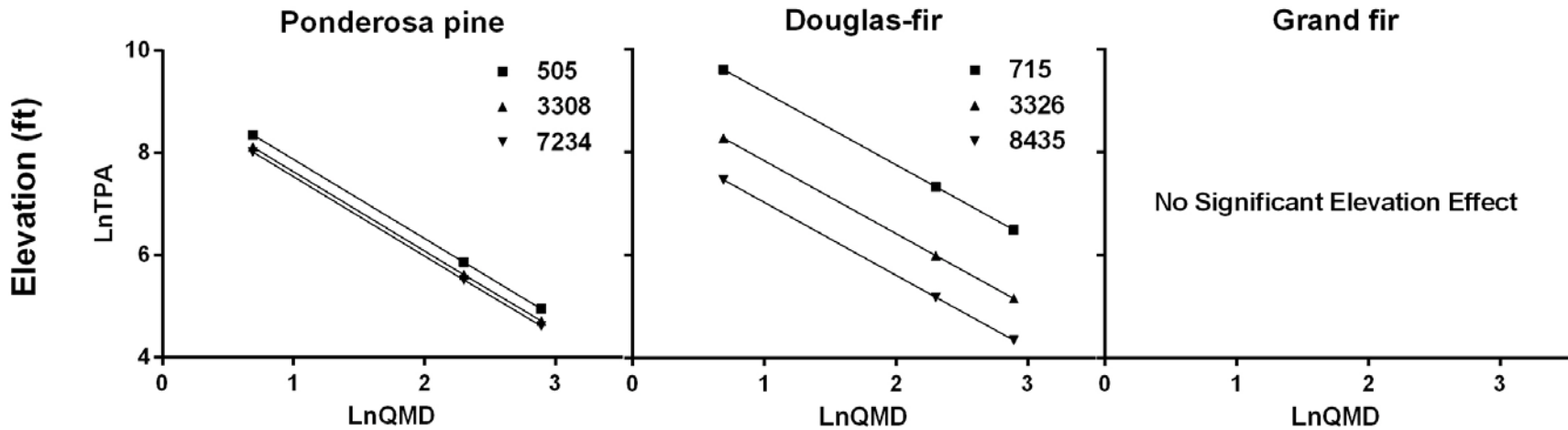
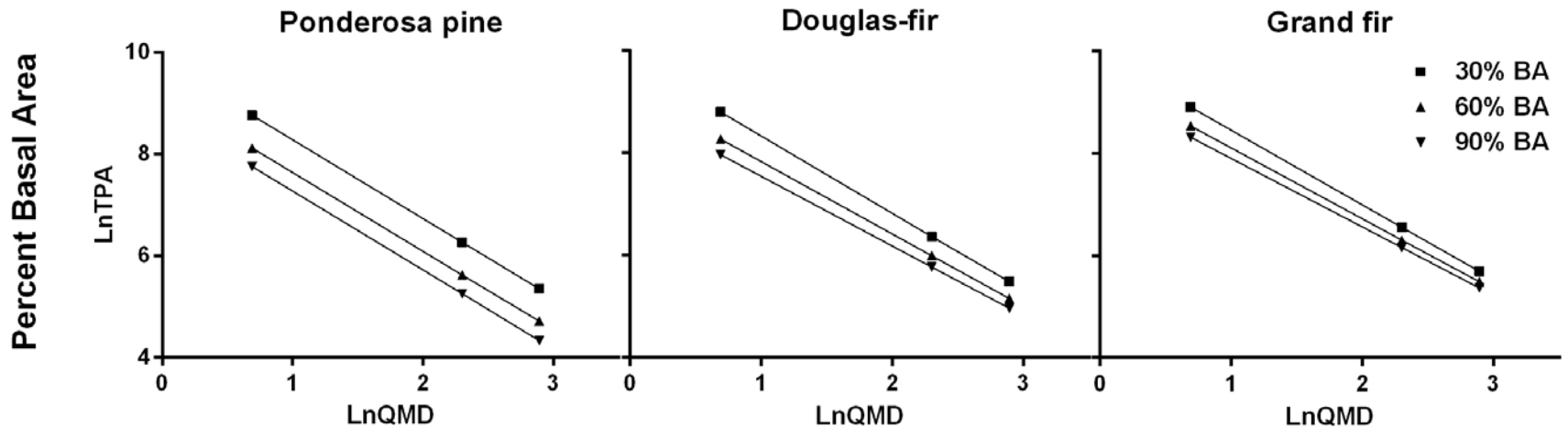
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- Rock Type (var)
- Ash (+)
- ASWC (NS)
- Elevation (-)
- Aspect (+)
- ADI (-)
- DD5 (-)
- FFP (+)
- MTCM (-)
- SMRSPRPB (+)

GF Factors

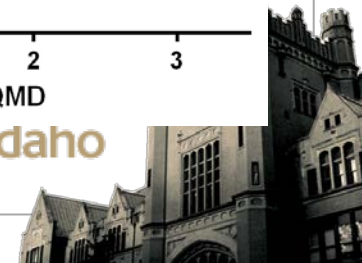
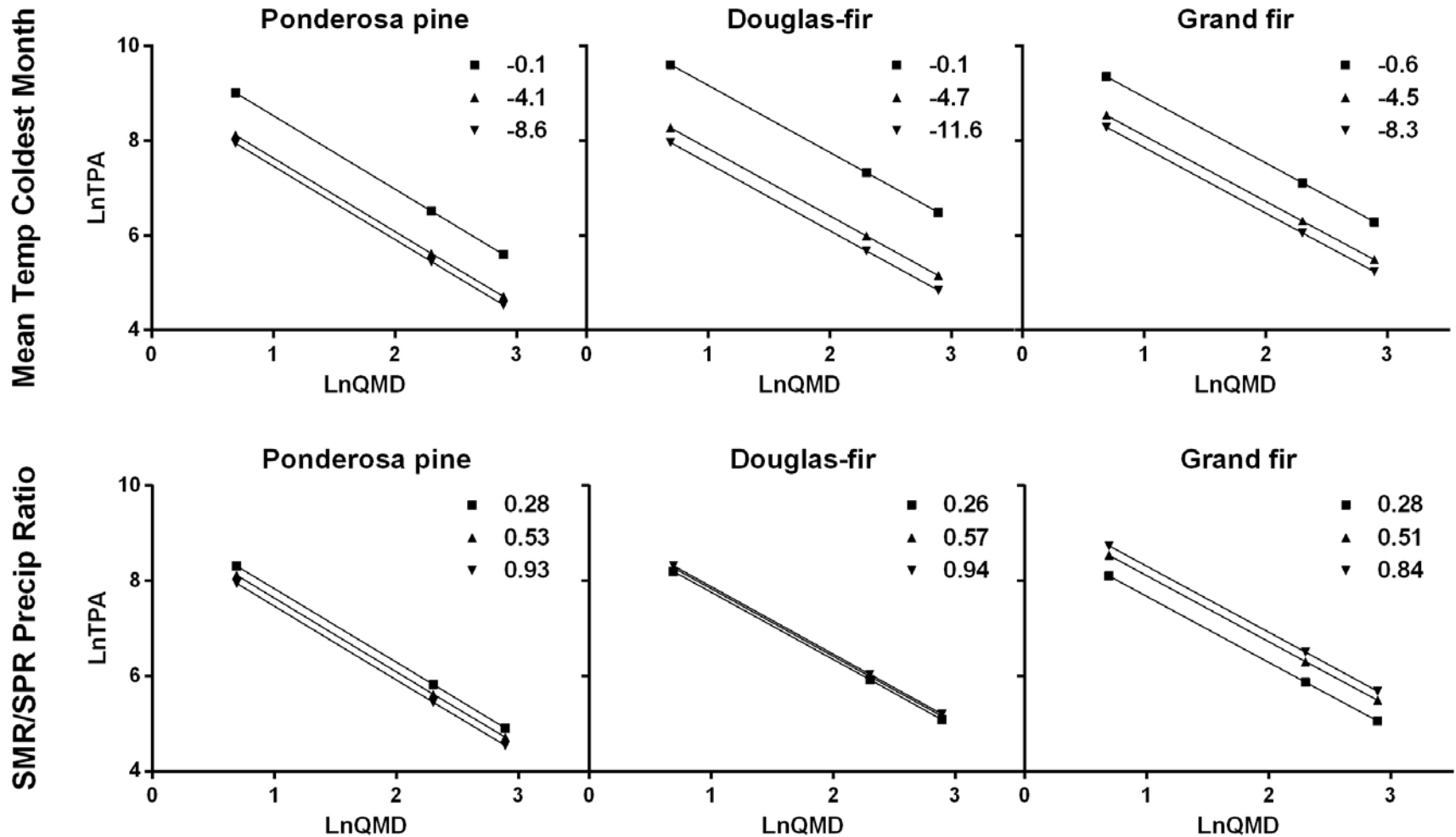
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- Ash (+)
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- Aspect (+)
- ADI (-)
- DD5
- FFP (-)
- MTCM (-)
- SMRSPRPB (+)



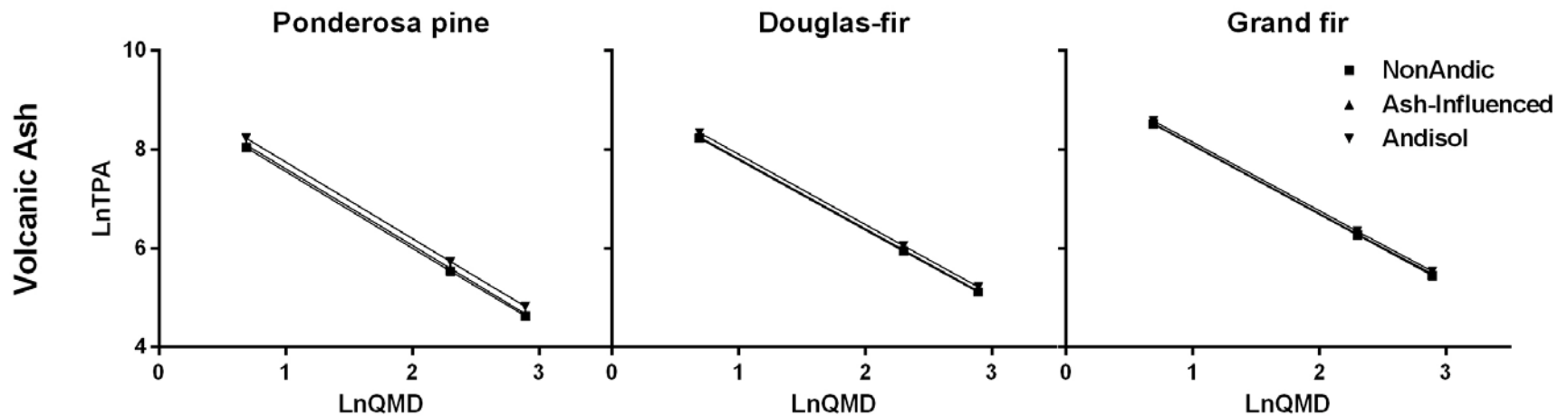
Variable Effect on Species max SDI



Variable Effect on Species max SDI



Ash Effect on Species max SDI

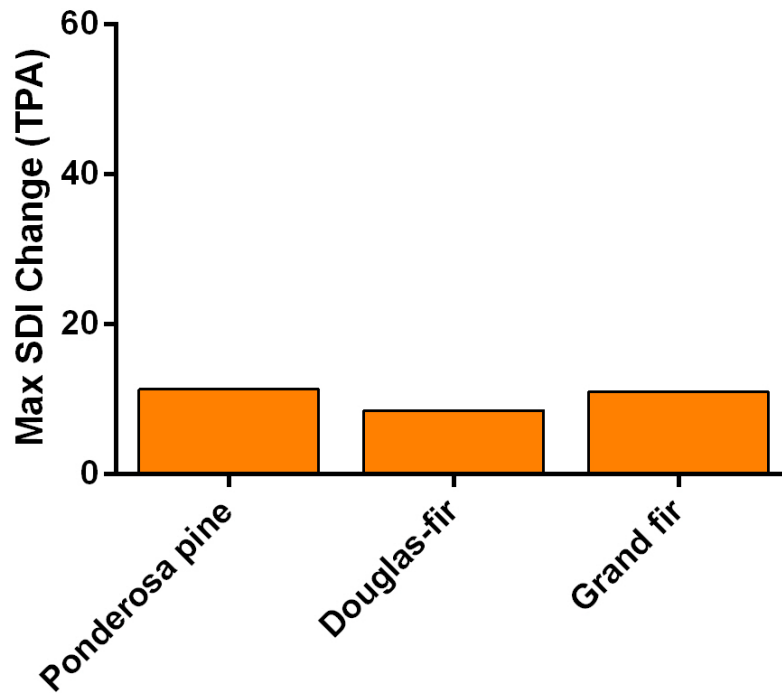


Beware of the Log effect

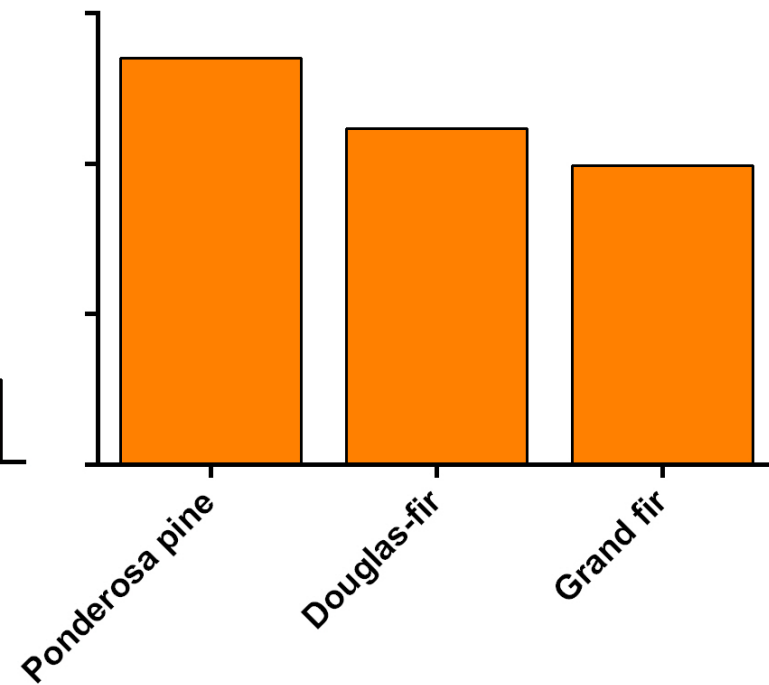


Volcanic Ash Effect

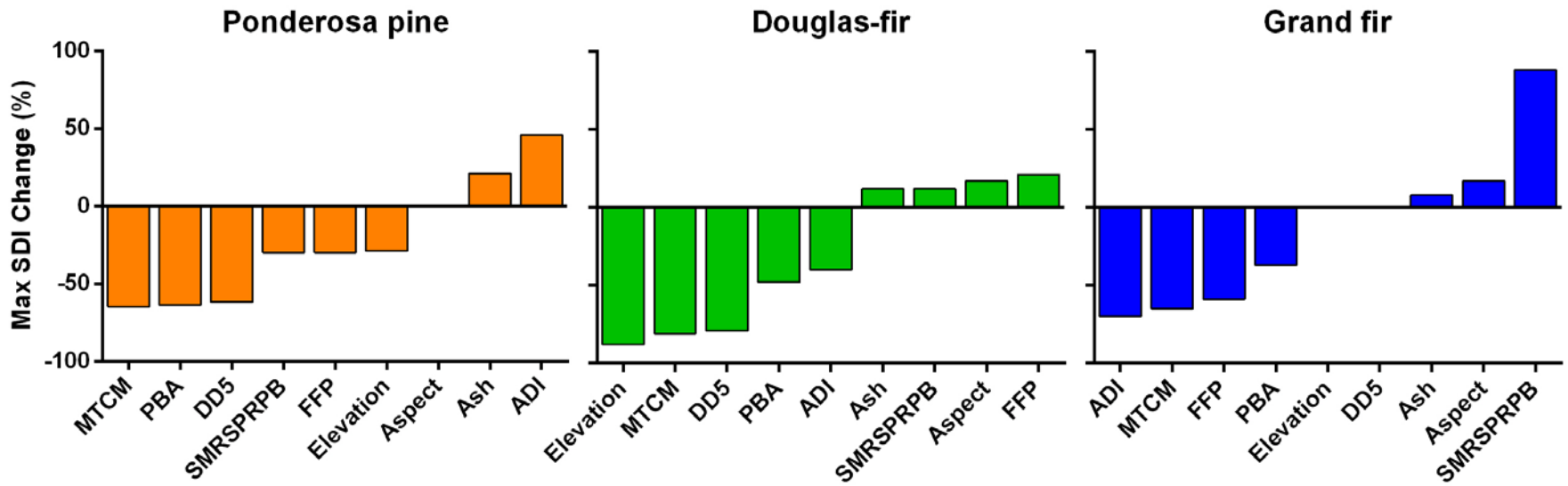
Mean Effect of Ash-Influenced Soils



Mean Effect of Andisols



Species Max SDI V2.0 - Shifts in Density by Factor



Integrating AWS + Climate

	Warm/Dry	Cool/Moist
Low AWS	Low productivity/ High summer drought stress	Reduced productivity/ Summer drought stress
High AWS	Reduced productivity/ Summer drought stress	High productivity/ No growing season drought stress

Current max SDI inputs are proxies for the integrative processes in this matrix

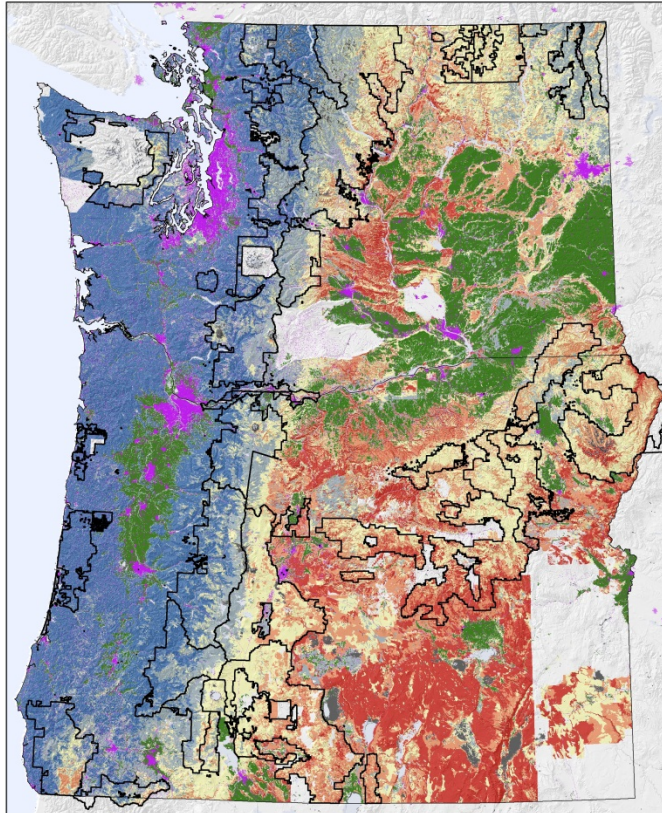
Holding nutrition aside, plant productivity is a function of available site moisture ability to meet plant and soil evapotranspiration demand

Objective: Develop a process based model that integrates these factors to answer quantitatively how, why, when and where climate and soils impact growth

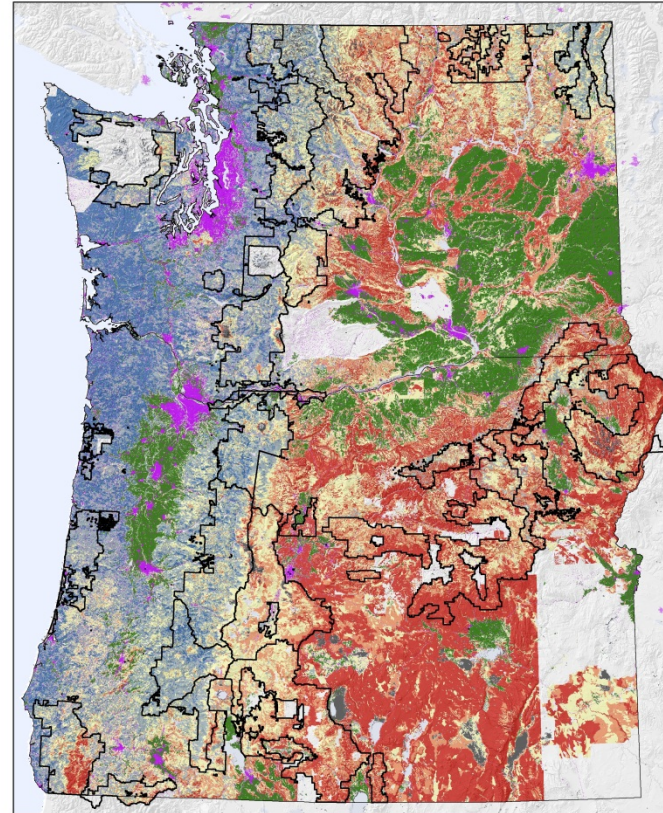


The Beginning: Droughty Soils Index

Droughty soils index: $f(\text{evapotranspiration} + \text{available soil water})$



Droughty Soils Index, April-May-June
Low stress ■ ■ ■ ■ ■ High stress



Droughty Soils Index, July-August-September
Low stress ■ ■ ■ ■ ■ High stress

**K. Bennett
2013
USFS**



Review

- Geospatial V2.0 max SDI species models available (soon)
- Climate and soil impacts captured more effectively
- We need SSURGO wall to wall - or access to point data for model development
- Site evapotranspiration models are needed to further refine max SDI equations



Questions

Mark Kimsey

Intermountain Forest - Tree Nutrition Cooperative

University of Idaho

Moscow, ID 83844

(208) 885-7520

<http://www.cnr.uidaho.edu/iftnc/>

