Tree Mortality in Forests of the Lake Tahoe Basin from 1985-2010: Influences of Tree Density, Forest Type, and Climatic Variability

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Project Background
-Fire exclusion & 19th century logging led to unnaturally dense forests
-High density leads to mortality: increased competition, increased transfer pests & pathogens
How does stand density influence mortality risk?

Is this relationship variable over larger spatial scales and longer time series?
Remote Sensing

Mortality: Binary

Vegetation Indices

Stocking Level: Continuous

http://tahoe.usgs.gov/images/maps
Spectral Signature of Canopy Mortality

3. Gray Attack
Red to Needle Drop, exposing gray branches

2. Red Attack
Lime-Green/Yellow to Red

1. Green Attack
Green-Lime Green-Yellow

Photo: USFS Forest Insect & Disease Leaflet 2, Reprinted 1990
Defining Mortality

Different levels due to:
- mortality/damage agent
- outbreak v non-outbreak
- spatial spread spread throughout 30m pixel

Spectral signatures we see are discrete steps in one mortality event.

Did not use pixels showing canopy mortality events in previous four years.
Legend
2010 Stocking Level
Value
High : 1
Low : 0
2005-2006 LTBMU Treatments
USA Topo Maps

Stocking = .3

Stocking = .75
Climate & Tree Mortality Trends

The graph shows the percent annual mortality of different tree species over the years. The x-axis represents the years from 1980 to 2008, and the y-axis represents the percent annual mortality. The green line and bars represent Pine, while the red line and bars represent Red Fir. The blue dashed line indicates the snow departure from 30-year norm. There are fluctuations in mortality rates, with Red Fir showing higher peaks compared to Pine.
Strength of Density Dependent Mortality

Snow: Annual Departure from 30 yr norm

Odds Ratio

Year


Snow: Departure from Norm

Pine
Strength of Density Dependent Mortality

[Graph showing the strength of density dependent mortality with data points spanning from 1990 to 2010 for Pine and Red Fir species.]
Finer-Scale Variation in Density Dependent Mortality
How does stand density influence mortality risk?
• On average, weakly increases risk of mortality

Is this relationship variable over larger spatial scales and longer time series?

Climate
• Variable within and between drought periods

Forest Type
• Difference in magnitude between Pine and Red Fir
Role of Density Dependent Mortality
• “Natural Thinning”

Controls on Mortality
• Bottom-up v. Top-down
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