Mapping Forest Attributes in the Interior Western States using FIA data, MODIS imagery and other geospatial layers

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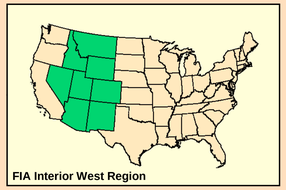
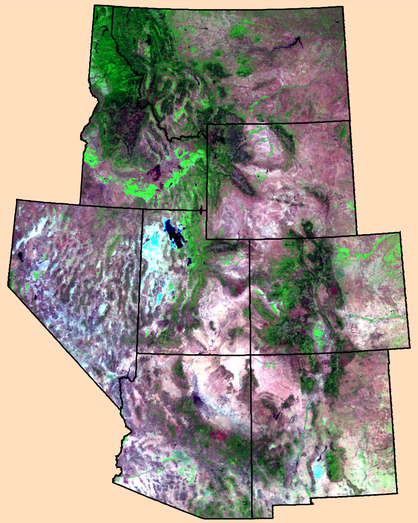
MODIS imagery for the Interior Western States

False Color Composite using MODIS bands 7 (R), 2 (G), and 1 (B)

This Moderate Resolution Imaging Spectroradiometer (MODIS) imagery was obtained from the USDA Forest Service's Remote Sensing Applications Center (RSAC). This image was acquired on August 13, 2002, and is being displayed using MODIS bands 7, 2, 1 (SWIR, NIR, Red).





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Problem: Extensive forest inventory data, like those collected by the Forest Inventory and Analysis (FIA) program in the United States, have historically been used to produce estimates of forest population totals over large geographic areas. Recent emphasis has been placed on expanding the traditional uses of these data by merging them with satellite-based information to produce regional maps of forest characteristics for use in a variety of forest management applications. These applications include broad-scale activities like mapping wildlife habitat, assessing resource loss due to fire, identifying lands suitable for timber harvest, and locating areas at high risk for insect and disease outbreaks.

Process: A set of 250-meter resolution maps of key forest attributes were recently developed for the FIA Interior West Region. Several forest characteristics, collected on FIA plots as recent as 2004, were modeled as functions of spectral information from MODIS and other ancillary geospatial layers. The predictor variables included elevation, transformed aspect and slope, unclassified spectral data from the MODIS instrument, and a variety of spatial data layers derived from the National Land Cover Dataset (NLCD 1999). Predictive models of forest attributes were built with See5 and Cubist software, which use tree-like nonparametric models. Predictive performance of the models were evaluated using an independent test set that contained a 10% random selection of the available plots.
The maps of predicted forest characteristics were developed with ArcGIS software and ERDAS Imagine software packages.

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Products: This poster displays a subset of 250-meter resolution core maps for the FIA Interior West Region, illustrating: forest growth, forest tree height, forest type groups, and stand age regionwide. Additional forest attributes were also modeled, which included: forest mask, forest probability, forest types, forest type subgroups, live tree basal area, Ponderosa Pine mask, basal area of Ponderosa Pine, live tree biomass, crown cover, quadratic mean diameter (QMD), stand density index (SDI), trees per acre (TPA), and live tree volume.

Accuracy Assessment: Based on a 10% hold-out test set, model performances ranged from average dominant tree height (relative error of 0.53, correlation coefficient of 0.76) to quadratic mean diameter (relative error of 0.93, correlation coefficient of 0.33). The authors believe that the weaker modeling results are due to scale differences, date inconsistencies, and difficulty in modeling very site-specific information. With additional investigation some of these issues can be overcome, some cannot. The maps should be used with caution, particularly in small geographic areas.

Comparison of IW-FIA Regional Models

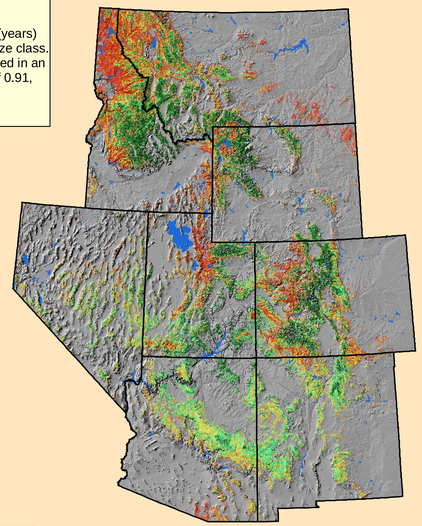
Discrete Variables	Presence	Absence	Overall
Forest Mask (%)	81.03	95.20	91.92
P. Pine Mask (%)	90.88	78.20	80.49
Forest Types -- 32 types (%)			57.60
Forest Type Groups -- 14 groups (%)			64.20
Forest Type Subgroups -- 21 subgroups (%)			56.50
Continuous Variables	**Avg Error**	**Rel Error**	**Corr Coeff**
Age (yrs)	44.80	0.91	0.41
Basal Area (sf/A)	44.38	0.84	0.47
Basal Area, PP (sf/A)	26.08	0.79	0.57
Biomass (tons/A)	14.98	0.68	0.63
Crown Cover (%)	15.80	0.82	0.52
Growth (cf/A)	17.37	0.63	0.66
Height (wt by BA, ft)	11.35	0.53	0.76
QMD (inches)	3.03	0.93	0.33
SDI	78.48	0.83	0.50
TPA	304.50	0.83	0.43
Volume (cf/A)	836.31	0.70	0.62

Stand Age (years)

This map shows the average total age (years) of the trees in the predominant stand-size class. Ten percent of selected FIA plots resulted in an average error of 44.8, a relative error of 0.91, and a correlation coefficient of 0.41.

Predicted Stand Age, years (quantile class breaks)

- > 113
- 102 - 113
- 92 - 101
- 79 - 91
- < 79
- Nonforest Mask
- Lakes or Reservoirs
- State Boundaries



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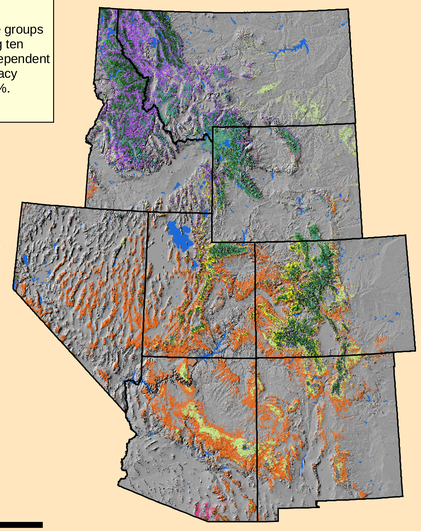
Forest Type Groups

This map displays predicted forest type groups for the FIA Interior West Region. Using ten percent of selected FIA plots as an independent test set, the overall classification accuracy across 14 forest type groups was 64.2%.

Predicted Forest Type Groups

- Pinyon/Juniper Group
- Douglas-fir Group
- Ponderosa Pine Group
- Western White Pine Group
- Fir/Spruce/Mountain Hemlock Group
- Lodgepole Pine Group
- Hemlock/Sitka Spruce Group
- Western Larch Group
- Other Western Softwoods Group
- Oak/Hickory Group
- Elm/Ash/Cottonwood Group
- Aspen/Birch Group
- Western Oak Group
- Other Western Hardwoods Group
- Nonforest Mask
- Lakes or Reservoirs
- State Boundaries



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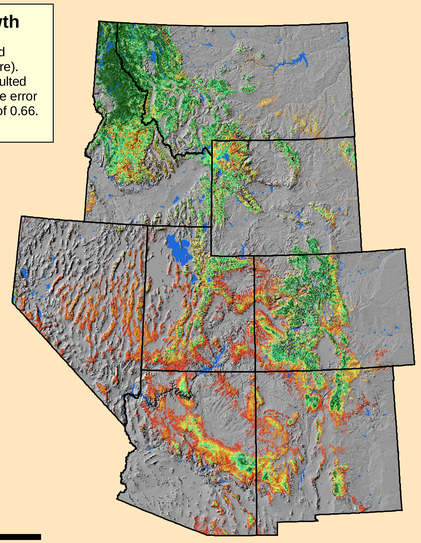
Predicted Forest Growth

This map shows the net annual sound growth of live trees (cubic-foot per acre). Ten percent of selected FIA plots resulted in an average error of 17.37, a relative error of 0.63, and a correlation coefficient of 0.66.

Predicted Forest Growth, net cubic foot growth per acre (quantile class breaks)

- > 45
- 33 - 45
- 18 - 32
- 8 - 17
- < 8
- Nonforest Mask
- Lakes or Reservoirs
- State Boundaries



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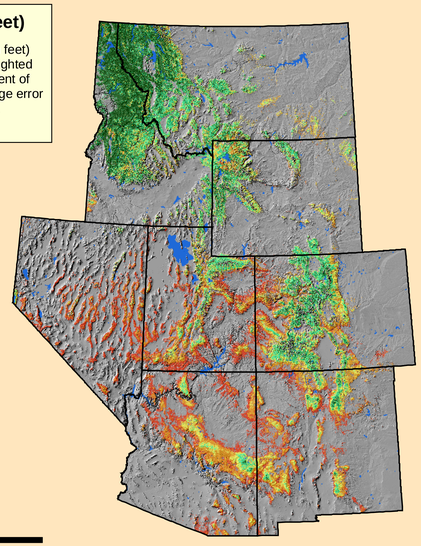
Average Tree Height (feet)

This map shows the average height (in feet) of dominant and codominant trees, weighted by their basal area per acre. Ten percent of selected FIA plots resulted in average error of 11.35, a relative error of 0.53, and a correlation coefficient of 0.76.

Predicted Forest Height, weighted height in feet (quantile class breaks)

- > 55
- 47 - 55
- 33 - 46
- 18 - 32
- < 18
- Nonforest Mask
- Lakes or Reservoirs
- State Boundaries

note: height is weighted by the ratio of (BA * TPA) / (overall condition BA/A)



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