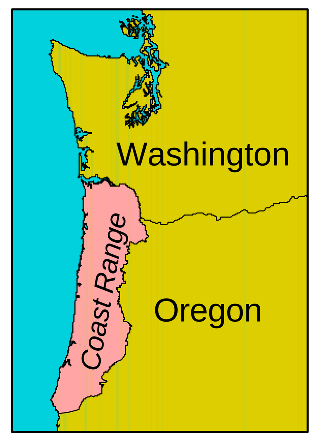
INTRODUCTION

Forest landscapes in the Douglas-fir region of western North America have changed considerably since the early 20th century. Fires and timber harvesting have reduced the amount of old growth in the landscape, leading to concern for the survival of native species associated with late-successional habitats. Quantitative assessments of these landscape transformations are needed to measure the amount of change, and to elucidate the processes that drive landscape dynamics. We integrated historical forest survey data with modern vegetation maps derived from satellite imagery to examine spatial patterns of forest landscape change in the Oregon Coast Range from 1936 to 1996. Our major objectives were to:

1. Quantify changes in the distribution of major forest types by landowner class and ecoregion
2. Examine the influences of land ownership, topography, and climate on landscape change over a range of spatial scales

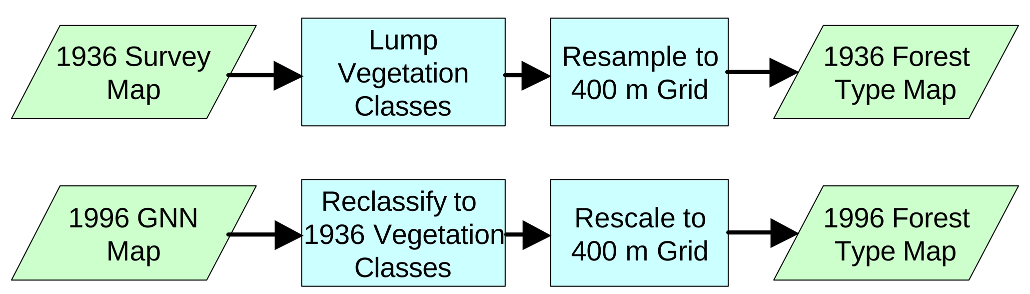
STUDY AREA

The Oregon Coast Range encompasses over 30,000 km² in western Oregon. Climate is relatively mild, with cool wet winters and warm dry summers. Physiography is characterized by deeply dissected terrain with steep slopes and high stream densities. Douglas-fir (*Pseudotsuga menzeisii*) is the major tree species across most of the region, with Sitka spruce (*Picea sitchensis*) and western hemlock (*Tsuga heterophylla*) dominant at many of the wetter coastal sites. The land base is a mosaic of federal, state, private industrial, and private non-industrial ownerships.

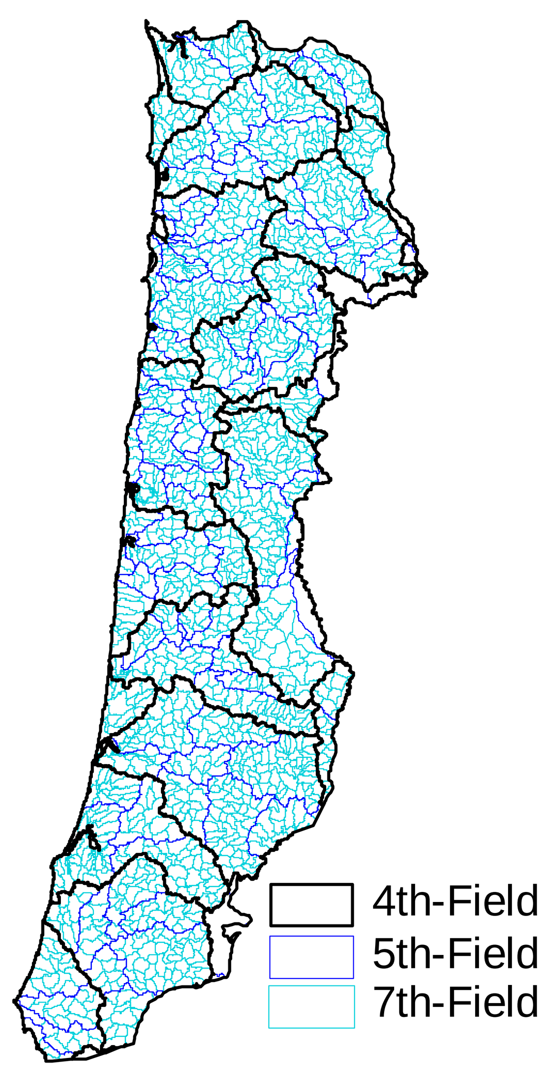


METHODS

- Forest patterns in 1936 were obtained from a historical Forest Survey map developed from field data and aerial photographs by the USDA Forest Service.
- Forest patterns in 1996 were mapped using the Gradient Nearest Neighbor method. Landsat TM imagery and environmental GIS layers were used to produce a digital map in which each grid cell was associated with a forest inventory plot and its detailed tree-level measurements.



- Based on documentation of the 1936 Survey, pixels in the 1996 map were assigned to 1936 vegetation classes based on stand age, stand density, and volume by species and size class.
- The vector coverage of the 1936 map was converted to a 16 ha (400 m) grid, and the 25 m resolution 1996 map was rescaled to a 400 m grain to match the spatial resolution of the 1936 map.
- 1936 and 1996 forest type maps were integrated into a GIS database to examine changes in forest type distribution by landowner class and ecoregion.
- Correlations between change in late-successional forest cover and potential explanatory variables were examined at three spatial scales: 4th field watersheds (mean size = 240,000 ha), 5th field watersheds (mean size = 29,000 ha), and 7th field watersheds (mean size = 2000 ha).
- Explanatory variables included the percentage of private land, mean slope, and the mean moisture stress index (MSI) computed as mean summer temperature divided by mean summer precipitation.



Watershed Boundaries

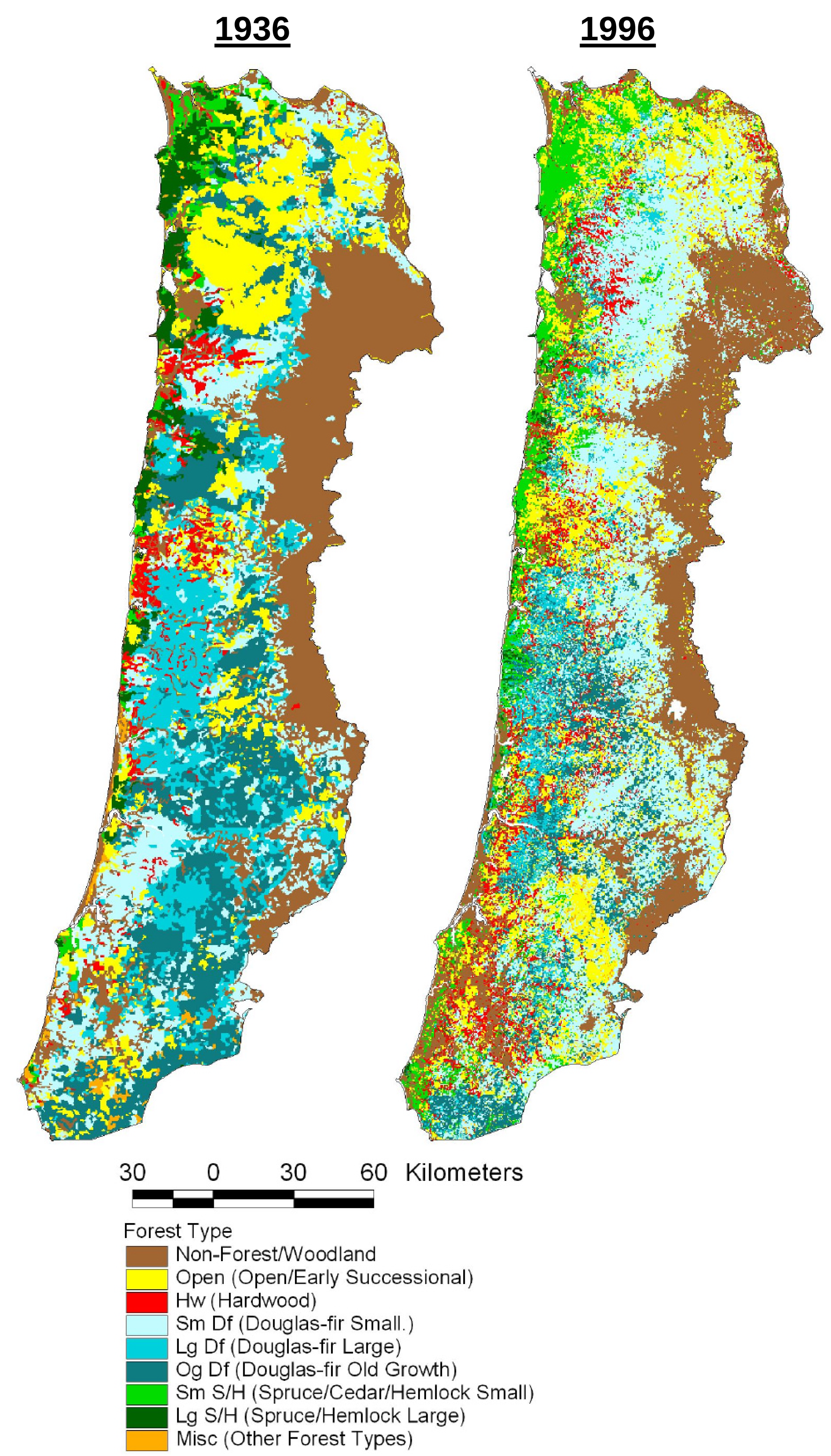
METHODS

Map classes used in the analysis

Forest Type	Code	1936 Vegetation Classes	1996 Mapping Criteria[1]
Non-Forest/ Woodland	Nf	(1) Nonforest (2) Agriculture (3) Subalpine and Noncommercial (22) Oak/Madrone	Non-forest map derived from satellite imagery, topography, and ownership *OR* > 60% oak or madrone
Open/Early-Successional	Open	(23) Recent Cutover (24) Non-Restocked Cutover (25) Deforested Burn	Age < 16 *OR* Density < 100 tph *OR* Volume < 2000 ft^3/acre
Hardwood	Hw	(21) Hardwood	> 60% alder, ash, or maple
Douglas-fir Small	Sm Df	(8) Douglas-fir Small Second-Growth (9) Douglas-fir Seedling/Sapling	> 60% Douglas-fir <= 22 in. dbh
Douglas-fir Large	Lg Df	(7) Douglas-fir Large Second-Growth	> 60% Douglas-fir > 22 in. dbh *AND* Age <= 150
Douglas-fir Old-growth	Og Df	(6) Douglas-fir Old Growth	> 60% Douglas-fir > 22 in. dbh *AND* Age > 150
Spruce/ Hemlock/ Cedar Small	Sm S/H	(11) Spruce/Hemlock/Cedar Small	> 50% Sitka spruce<= 24 in. dbh *OR* > 50% Western Hemlock <=20 in. dbh *OR* > 40% Western Redcedar <= 24 in. dbh *OR* > 40% Port Orford cedar <= 30 in. dbh *OR*
Spruce/ Hemlock Large	Lg S/H	(10) Spruce/Hemlock Large (12) Cedar/Redwood Large	> 50% Sitka spruce > 24 in. dbh *OR* > 50% western hemlock > 20 in. dbh *OR* > 40% western redcedar > 24 in. dbh *OR* > 40% Port Orford cedar > 30 in. dbh *OR*
Other Forest Types	Misc	All Other Forest Types	All other forest types

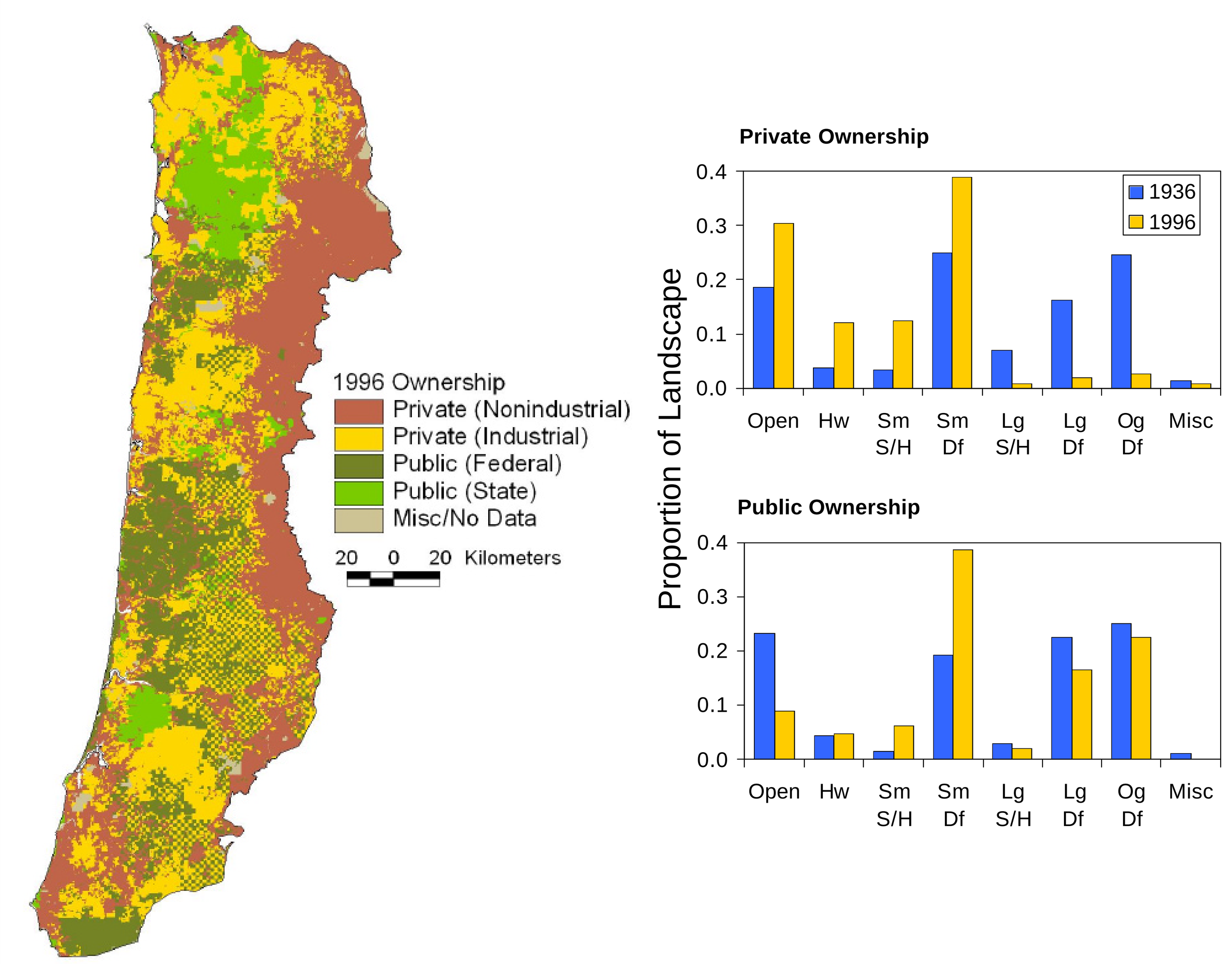
[1]1996 forest vegetation was reclassified to 1936 vegetation classes based on stand age, stand density, and the percentage of total volume in various species and size classes

Reclassified and Rescaled Forest Type Maps



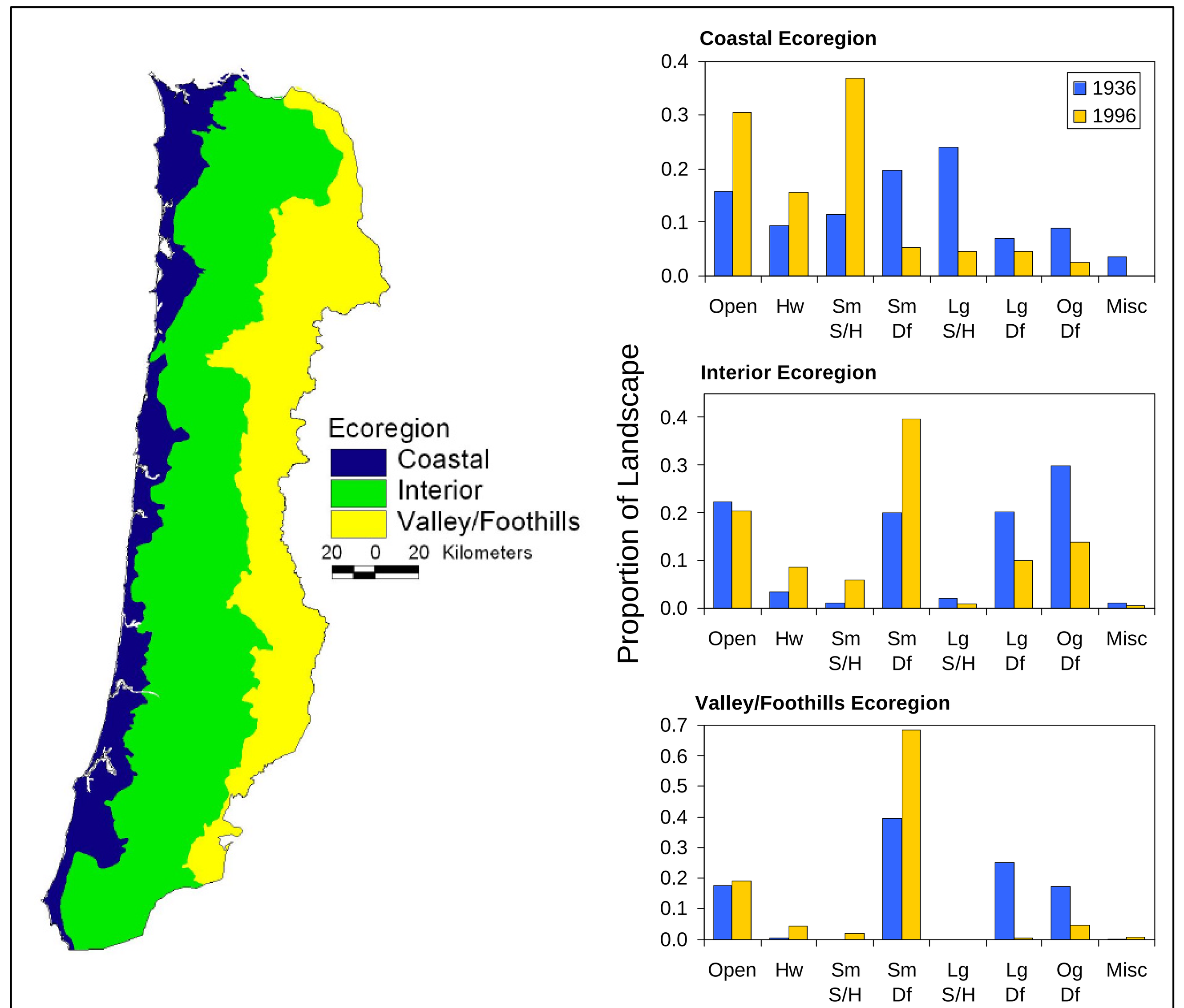
RESULTS

Landscape Change by Ownership



- Distributions of forest types on private and public lands were similar in 1936.
- Large shifts occurred on private lands between 1936 and 1996, with considerable decreases in the large conifer classes and increases in the small conifer, hardwood, and open classes.
- Decreases in the large conifer classes were less pronounced on public lands.
- Decreases in open areas on public lands reflect regeneration of areas burned in the early 20th century.

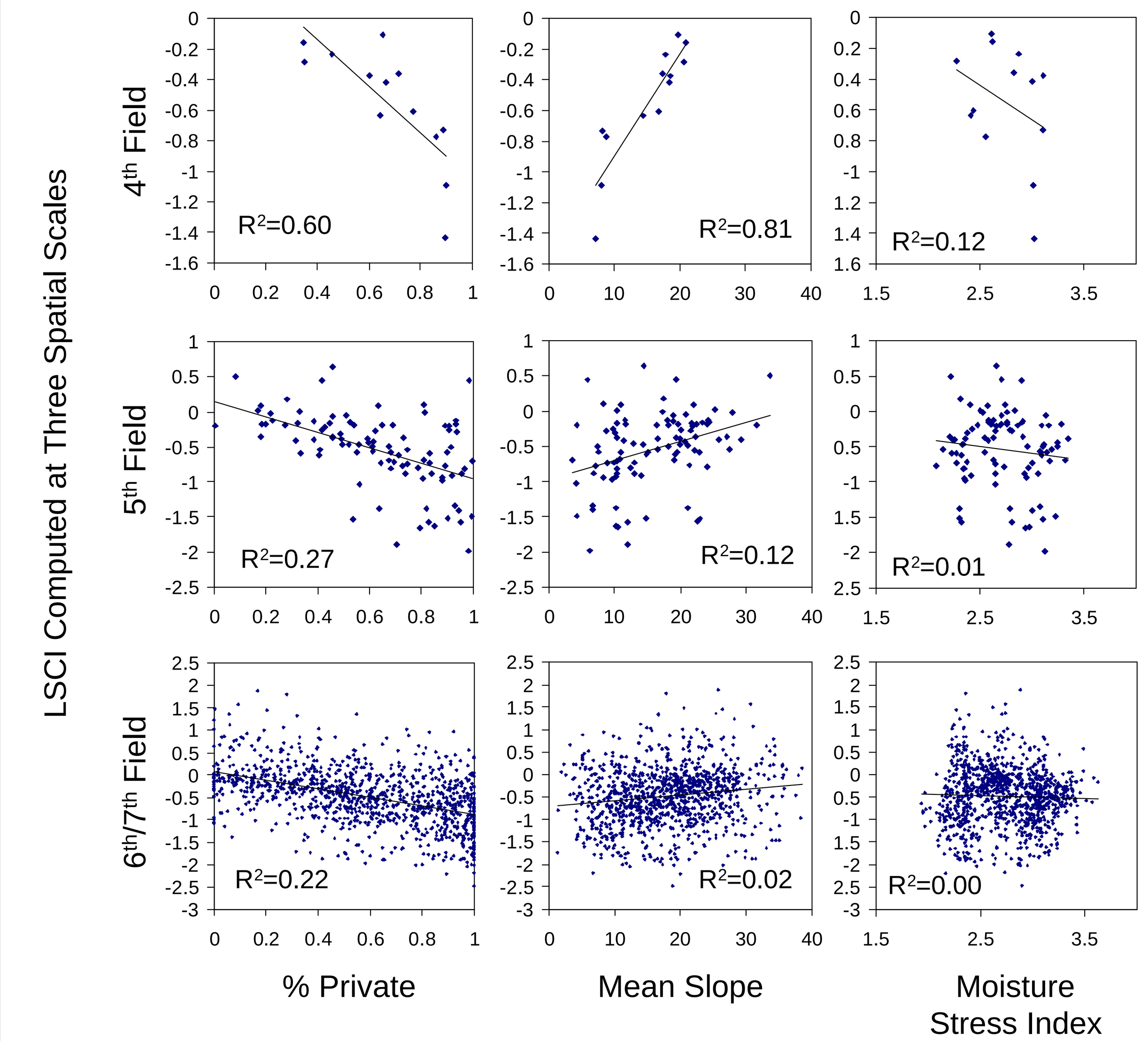
Landscape Change by Ecoregion



- In the coastal ecoregion, open, hardwood, and small spruce-hemlock forests increased while large spruce-hemlock and all Douglas-fir forest types decreased.
- In the interior ecoregion, hardwood, and small conifer forests increased while large conifer forests decreased.
- Changes in the valley/foothills ecoregion were similar to those in the interior, with large decreases in the proportions of large and old-growth Douglas-fir and increases in small Douglas-fir.

RESULTS

Changes in Late-Successional Forest Cover



- Vegetation within each watershed was summarized as a late successional forest change index:

$$LSCI = \ln(lg96/lg36)$$

where lg96 and lg36 were the proportions of each basin covered by large conifer forest (Lg S/H + Lg DF + Og Df) in 1996 and 1936.
- Late-successional forests decreased in all 4th-field watersheds.
- Decreases were greatest in 4th-field watersheds dominated by private land, and with relatively gentle topography.
- Change in late-successional forest cover were also negatively correlated with percent private land in 5th- and 7th-field watershed.
- Correlations with mean slope were relatively weak in 5th- and 7th field watersheds, and correlations with MSI were weak at all three spatial scales.

KEY FINDINGS

- The predominant trend was a shift from late-successional to small conifer dominance of the forest landscape mosaic.
- Decreases in late-successional forests were greater on private than on public lands, reflecting different histories of forest management and natural disturbance.
  – Rates of timber harvest on private lands increased rapidly after the World War II, and current management practices on many private industrial ownerships involve clearcut harvests at 50-year or shorter rotations.
  – Although significant cutting also occurred on public lands, rates of harvest were generally lower than on private lands.
  – Public lands also included large areas burned in the early- to mid- 20th century that were too young to harvest over most of the study period.
- With the exception of mean slope at the 4th-field watershed scale, topographic and climatic variables were poor predictors of change in late-successional forest cover.
- Results of this historical analysis corroborate previous findings
  – Field studies have concluded that patterns of late-successional forest structure are strongly correlated with disturbance history, but only weakly related to environmental heterogeneity.
  – Landscape simulation models predict that future forest vegetations patterns will be highly constrained by land ownership patterns.
- Future work will assess the sensitivity of results to potential biases arising from reclassification and rescaling of the 1996 map, and develop multivariate statistical models of landscape change over a range of spatial scales.

Spatial Patterns of Forest Landscape Change in the Oregon Coast Range Between 1936 and 1996

Coastal Landscape Analysis and Modeling Study

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