How Climate Shapes Yellow-cedar in Alaska: Use of Inventory Plots to Evaluate Broad-Scale Occurrence, Cedar Decline, and Migration

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FHM Evaluation Monitoring Project: WC-EM-09-02

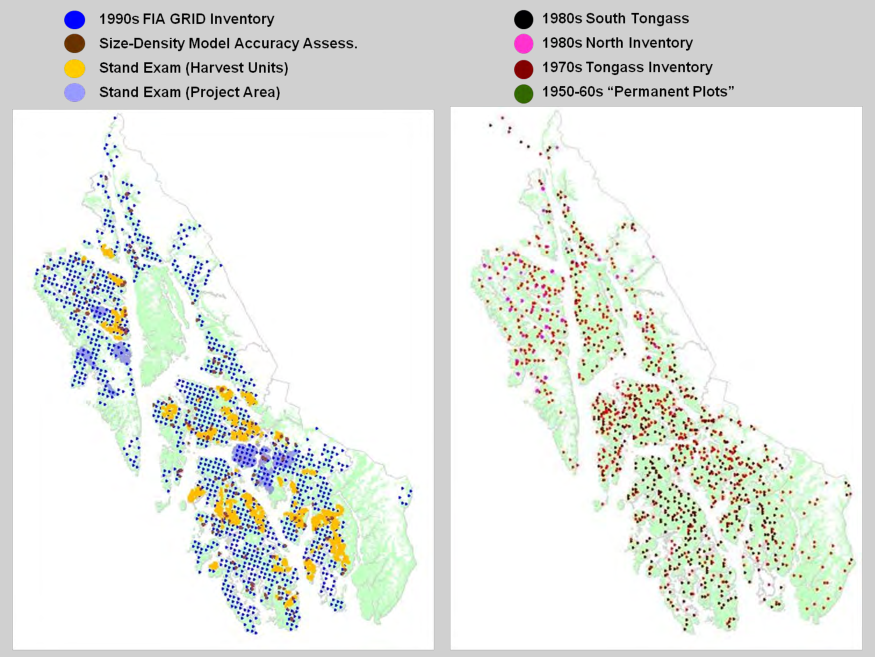
The valuable yellow-cedar has been detected dead and dying by aerial survey on more than 500,000 acres. Research on yellow-cedar decline implicates a climate-induced seasonal freezing injury to tree roots on poorly drained sites, and shows how snow protects cedars from this injury.

Efforts using aerial survey and other forms of remote sensing have been unable to produce a GIS layer or map of the distribution of healthy yellow-cedar in Alaska, however. This spatial information is needed to put the decline problem into context . Thus, in this project we rely on inventory data to analyze habitat features of cedar that is healthy, dying, and regenerating. Our goal is to produce maps of suitable and unsuitable cedar habitat as the foundation of a conservation-management strategy.

Our project has three phases: recovery of inventory plot data, analysis, and mapping.

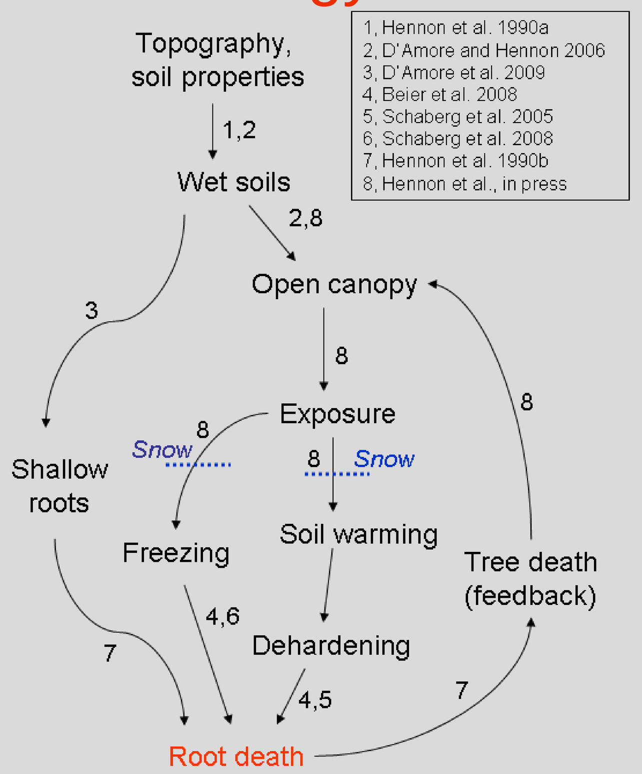
Recovery of Inventory Plot Data

1990s FIA GRID	~4,000 plots
1980s North Tongass	~2,000 plots
1980s South Tongass	~2,000 plots
Tongass Stand Exam	~30,000 plots
Size-density model	~2,000 plots

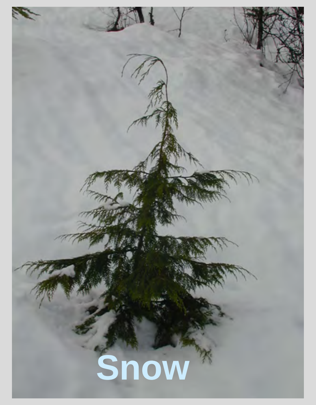


The 5 inventories listed above are ready for use in analysis and mapping; we are working with partners to recover the older inventories.

Etiology



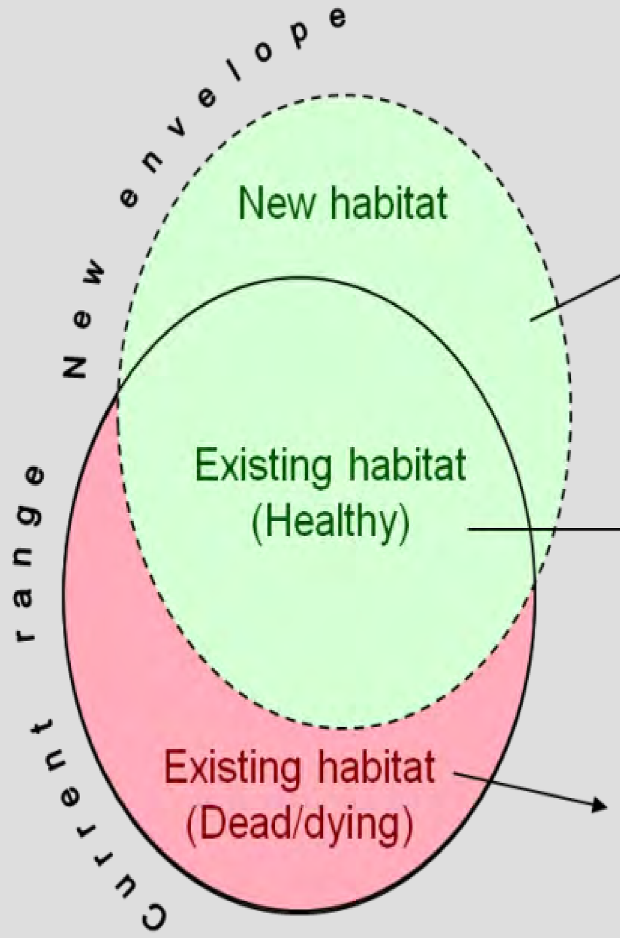
Risk Factors



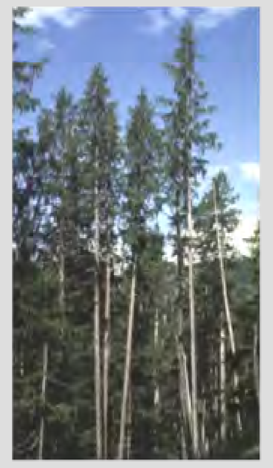
Although the cause of cedar decline is complex, it can be reduced to two risk factors for landscape analysis: **snow** and **soil drainage**.

Bioclimatic Envelopes

We use the bioclimatic envelope concept to interpret the health and management of yellow-cedar in the context of climate. As favorable climate shifts away from the current distribution of yellow-cedar, three zones are formed: 1) areas where it is maladapted to climate, 2) areas where it exists and the climate is favorable, and 3) new potential habitat beyond its range. A management challenge for adapting to climate change is to identify future suitable habitat through landscape analysis and modeling.

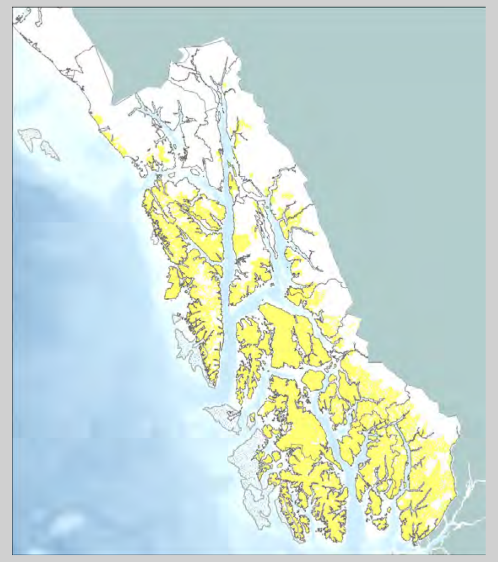


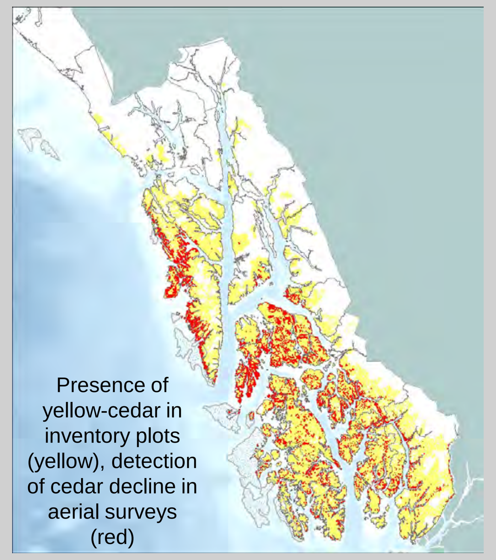

Migration


“Stable”


Maladapted

Mapping





An early version of our yellow-cedar distribution map (center) puts the decline problem into context (right). Also, this map is the basis for a current (2009-2010) widespread genetics study to test the hypothesis that yellow-cedar's current distribution can be explained by survival in Pleistocene refugia (left) and slow subsequent Holocene migration to current locations. Maps produced the second year of this project will be fully downscaled and will represent both potential and occupied habitat.

Mapping in 2010: *Potential habitat: Snow + Drainage*
Occupied habitat: Snow + Drainage + Proximity (to inventory plot)

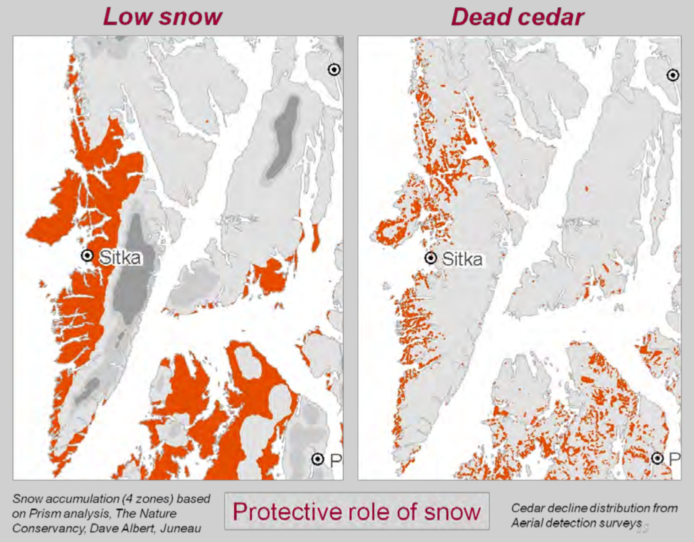
www.yellow-cedar.net

Analysis

We are using principle components analysis with landscape and site factors to model the distribution of yellow-cedar and its decline. Most of the inventories have data on live trees, dead trees, and seedling/saplings; thus, we can use these as separate response variables (see mid scale below for one example). Interestingly, the input variables that define cedar habitat are also decline risk factors, although their values differ. Climate and geomorphic input variables are somewhat interchangeable; we use climate, particularly snow, in forecasting scenarios.

Broad scale: Latitude, maritime/continental

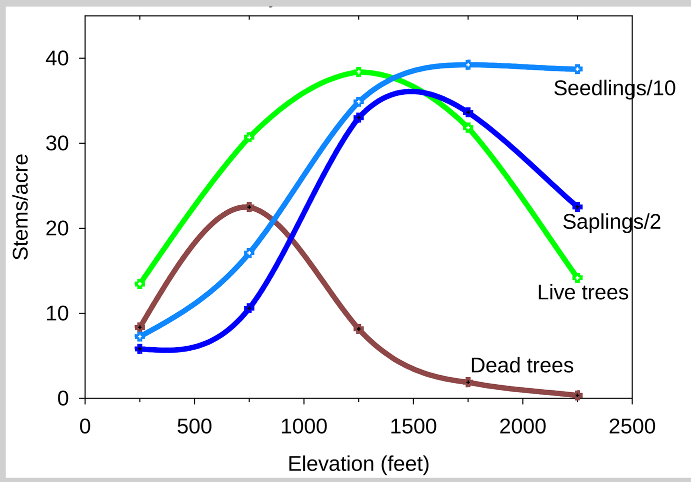
Risk Factor: Snow
(model with PRISM)

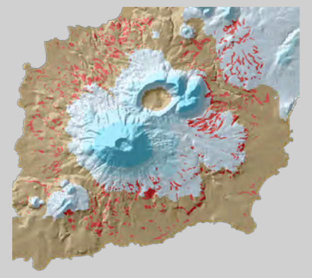


The broad distribution of yellow-cedar is shaped by historic and current climate, expressed on the landscape by latitude, maritime / continental gradient, and proximity to Pleistocene refugia. Low snow accumulation (left in red) is a major risk factor leading to yellow-cedar decline (right).

Mid scale: Elevation

Risk Factor: Snow
(model with PRISM, downscaling with “Elevational Adjustment”)



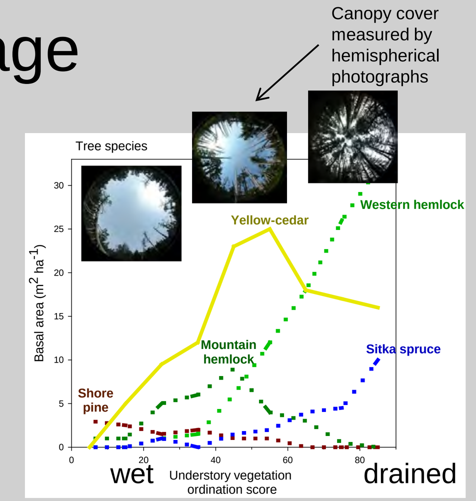


Our previous EM project demonstrated the relationship between decline and snow on Mt Edgecumbe and ability to project suitable habitat in the future with climate models.

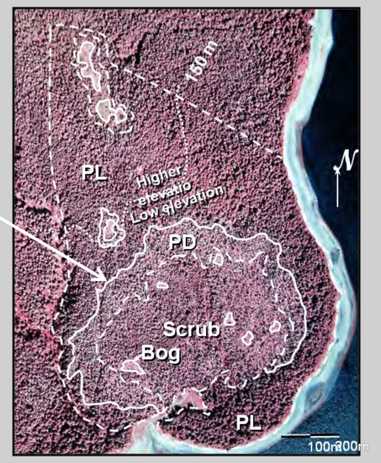
From inventory data: The abundance of live yellow-cedar trees, dead trees, and regeneration are all influenced differently by elevation. This indicates a tree species in flux following the bioclimatic envelop concept: maladapted at low, stable at mid, and thriving at high elevations.

Fine scale: Drainage

Risk Factor: Drainage
(model with remotely-sensed canopy cover surrogate)



Yellow-cedar has been competitive on moderately drained soils, with death on a subset of wetter soils. Rooting here is shallow, and less canopy cover allows greater extremes in microclimate to promote root freezing injury.



PD=productive dead zone,
PL= productive live zone

Literature

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