

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

**LOCATION:** Southeast Alaska, primarily Tongass National Forest

**DATE:** 2009

**DURATION:** Year 1 of 2-year project    **FUNDING SOURCE:** Base

**PROJECT LEADER:** Paul Hennon, Pathologist, 907-586-8769, phennon@fs.fed.us

**COOPERATORS:** John Caouette, Statistician, The Nature Conservancy, Juneau, AK; Dustin Wittwer, GIS and aerial survey specialist, FHP, Juneau, AK

**FHP SPONSOR/CONTACT:** Paul Hennon, Pathologist, 907-586-8769, phennon@fs.fed.us

**PROJECT OBJECTIVES:**

1. Develop a new host distribution map and GIS layer for yellow-cedar and an associated model with independent variables related to climate (latitude, elevation, and projected snow accumulation) and dependent variables that reflect tree response (trees/ac, QMD, basal area/ac). This modeling effort will benefit the next national risk map effort by the development of a needed host (cedar) GIS layer, and, for the first time, will incorporate climate variables and future projections of climate.

2. Explore and graphically display how climate factors latitude, elevation, and snow have influenced:

- General occurrence (species distribution)
- Mortality (the decline problem)
- Regeneration (migration)

3. Using PRISM <sup>1</sup>output, construct a new snow model, and include it with #2 above to produce a map and GIS layer that display areas of southeast Alaska that are suitable/unsuitable for yellow-cedar conservation and active management now, and in the next 100 years given projected climate warming scenarios.

**JUSTIFICATION:**

- a. **Linkage** This project has origins in the annual aerial detection survey where cedar decline is mapped each year. FIA and other ground-based inventory information will be used to verify trends identified in the aerial survey on how landscape patterns, especially the interaction of latitude and elevation, are associated with the occurrence of yellow-cedar decline. These inventories go a step further, however, because they will yield information on healthy (green) cedar forests which are not detectable by aerial survey or remote sensing.

---

<sup>1</sup> PRISM provides climate models of monthly temperature and precipitation values in spatial GIS environment based on weather station data

- b. **Significance** Yellow-cedar is invaluable commercially and culturally (to Native people), but is dying on over 500,000 ac of southeast Alaska from a climate-induced forest decline
- c. **Biological impact** Species diversity is threatened because high latitude forests contain so few tree species. Cedar decline affects a large, but unknown percentage of the cedar resource.
- d. **Scientific Basis/Feasibility** Our team has built a strong case in the scientific literature for the role of climate change in the cause of yellow-cedar decline. The proposed approach of using inventory data has a great chance of success because many of the inventories are ready for analysis, preliminary analysis shows important encouraging trends, and our team has strong skills in statistics, data management, GIS, and climate modeling.
- e. **Priority Issues** addressed from Request for Proposals. Climate change.

**DESCRIPTION:**

**a. Background:** Yellow-cedar is of great value commercially, ecologically, and culturally in southeast Alaska. FHP aerial detection surveys reveal that a forest decline affects the species on over 500,000 acres. Survey results indicate that the distribution of mortality has been influenced by climate factors, essentially limiting tree death by latitude and elevation. Our recently published research on yellow-cedar decline implicates a climate-induced seasonal freezing injury to tree roots, and shows how snow protects cedars from this injury. The lack of information on the occurrence and distribution of healthy (green) cedar forests (not detectable from aerial surveys) has repeatedly hampered our ability to estimate the proportion of the cedar resource affected by this decline, and to provide advice about where cedar conservation and management efforts should be directed. Despite the importance of this tree species, currently there is no suitable map or GIS layer that depicts the distribution of yellow-cedar in southeast Alaska.

**b. Methods:** Our proposed approach is to move beyond aerial detection survey and remote sensing to use ground-based inventory plot information. We have been amassing vegetation inventory plot information for the last few years to remedy this problem, creating one of the richest sets of vegetation plot data available anywhere. Some plot inventories are now available for use; we are still working with partners to recover the oldest inventories. For FIA plots, we are working directly with Tara Barrett (FIA Anchorage) on this project.

Plot inventories available now:

1990s FIA GRID inventory	~4,000 plots
1980s North Tongass (Chatham) inventory	~2,000 plots
1980s South Tongass (Stikine and Ketchikan) inventory	~2,000 plots
Tongass Stand Exam plots	~30,000 plots
Size-density model	~2,000 plots

Inventory plot data to become available in 2009:

Composite 1950-1970s inventory	~4,000 plots
--------------------------------	--------------

(note: this last inventory is critical because it covers spatial gaps (in designated wilderness areas) not covered by the other inventories)

We propose to analyze plots to establish both maps and GIS layers for yellow-cedar occurrence. Separate maps/GIS layers will be produced to show general occurrence, dead cedar forests, and actively regenerating cedar forests. This is possible because these inventories contain data on dead tree species and data on seedlings, saplings, or very small trees. These inventory data will then be analyzed to determine the influence of latitude, elevation, and a snow model on the general yellow-cedar occurrence, dead forests, and regenerating forests. We anticipate strong climate signals on all three.

In a previous EM project, our team used PRISM and an elevational adjustment (Wang UBC) to develop a new snow model for the landscape around Mount Edgecumbe. (Does that snow model have a name? It would help if it did.) It showed remarkable agreement between the pattern of snow and the distribution of yellow-cedar decline. For the project proposed here, the Mt. Edgecumbe snow model will be expanded for broad-scale use in southeast Alaska. This model uses two variants (A2, B2) of the HADCM3 global circulation model to project future snow zones to the date 2100.

Our team is well suited to address this issue: John Caouette is a statistician, a SAS expert, and is familiar with each of these inventories; Dustin Wittwer is expert with GIS analysis and with PRISM models, and Paul Hennon is a leading authority on the ecology of yellow-cedar and its decline. We work closely with FIA (Tara Barrett in Anchorage) and frequently seek expert advice on PRISM and global circulation models.

**c. Products:** A new distribution (host) model and GIS layer will be produced for yellow-cedar. This GIS layer, and interpretation of climate effects and projections mentioned below, will be the basis for the next risk map analysis for cedar decline. Another specific use of this map will address local cedar resources in proximity to each southeast Alaska Native villages.

Beyond maps, this project will clarify how climate variables have shaped and continue to shape yellow-cedar with a focus on 1) the distribution of the tree, 2) distribution of the decline problem, and 3) areas where yellow-cedar is actively regenerating (and potentially migrating). Integration of all three will aid the Tongass NF in the development of a yellow-cedar conservation and management strategy by identifying areas in Alaska where cedar is now maladapted to climate and areas where it is and will be well-adapted to future projected climatic conditions.

**d. Schedule of Activities:**

Year 1:

- Use existing inventory data (see above) to produce yellow-cedar maps and GIS layers for general occurrence, mortality, and regeneration.
- Establish relationships of occurrence, mortality, and regeneration with latitude, elevation, and secondary components such as soil drainage.

- Construct a snow model for all of southeast Alaska using new PRISM tool and HADCM3 general circulation models based on the preliminary Mt Edgecumbe snow model.
- Present findings at international symposium on redcedar and yellow-cedar (July 2009)
- Recover and prepare data from older inventories (1950s -1970s) for use in year 2.

Year 2:

- Revise maps and GIS layers, from year 1 using complete compliment of inventories
- Integrate GIS layers, including the 100-year snow model projection to produce a final map and GIS layer that identifies areas of southeast Alaska that are suitable and unsuitable for yellow-cedar conservation and active management into the future.
- Synthesize all findings into a publication and promote to forest managers and policy makers.

**e. Progress/Accomplishments: N/A**

**COSTS:**

	<b>Item</b>	<b>Requested FHM EM Funding</b>	<b>Other-Source Funding</b>	<b>Source</b>
<b>YEAR 1</b>				
<b>Administration</b>	Salary			
	Overhead	2,000	3,000	TongNF/TNC
	Travel	2,000	3,000	“
Procurements	Contracting	10,000	15,000	“
	Equipment		1,000	“
	Supplies	1,000	2,000	“
<b>Total</b>		<b>\$15,000</b>	<b>\$24,000</b>	“

	<b>Item</b>	<b>Requested FHM EM Funding</b>	<b>Other-Source Funding</b>	<b>Source</b>
<b>YEAR 2</b>				
<b>Administration</b>	Salary			
	Overhead	2,000	3,000	TongNF/TNC
	Travel	2,000	3,000	“
Procurements	Contracting	10,000	15,000	“
	Equipment		1,000	“
	Supplies	1,000	2,000	“

<b>Total</b>		\$15,000	\$24,000	“
--------------	--	----------	----------	---

We have been promoting this project to the Tongass National Forest (TongNF) and expect to receive “other source funding” shown above in FY09 and FY10. Contracted amount is primarily to support John Caouette, statistician, The Nature Conservancy (TNC). The mix of funds from these two outside sources is expected to be 70:30, respectively.