What Happens Next? Understanding Ecological Responses to Yellow-Cedar Decline

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We had less than an hour remaining on the marine battery, the only power source left with juice for running my Toughbook computer in the tent. I didn't think we'd make it. Then, with the final strike of a key, we synthesized days of boat survey data into a list of 40 randomized plot locations across 83km of coastline in the West-Chichagof Yakobi Wilderness. We had completed the field work required to determine the plot positions and the geographic structure of our study's experimental design. Paul, my field technician, loaded the GPS units with the magic waypoints. We sat there in our wet wool looking at the full scope of sites across a map of Slocum Arm and Klag Bay. "So there it is." I exclaimed. "Now it's one heck of a treasure hunt." In the months that followed, we measured plants, trees, saplings, and seedlings to study the process of forest development post-decline and document the spread of yellow-cedar mortality at the northern extent of its range. Four of us spent weeks at a time, base-camped in Southeast's remote wilderness, kayaking and hiking to each plot (Figure 61). We installed temperature sensors. We collected tree cores.

In southeast Alaska, much research has focused on understanding the climatic drivers of yellow-cedar decline. Widespread forest mortality related to climate has been observed recently on all six plant-covered continents and in all biomes and plant functional types (Allen & Breshears 2007; Allen et al. 2010). Impacts extend beyond the single species in decline. Landscapes can be radically transformed by forest mortality events that can have severe effects on ecosystem function and ecosystem services provided to humans (Dale et al. 2000). I want to understand what happens after the yellow-cedars die and what these shifts in forest communities mean for long-term management and conservation. I am drawing upon a variety of methods from ecology and geography and collaborating with a team of community members, assistants, and researchers to tackle these questions.

Working from Slocum Arm – already an area with high cedar mortality – northward towards healthier forests in Glacier Bay National Park, we established a "chronosequence" of plots this summer across stands that have died off at various times (~early 1900s-present). This method will allow me to study the process of succession by using a "space-for-time" substitution. Critiques of the use of chronosequences are that there may not be predictable links between sites and there may be differences in the rates at which characteristics actually change over time (del Moral 2007). To address these concerns, we plan to draw upon historical Forest Inventory Analysis (FIA) data to examine if these processes of succession apply to a broader, regional context.

Aerial surveys conducted by Forest Health Protection during the summer of 2010 helped to identify the general south-to-north trend of yellow-cedar mortality in the study area, so our groundwork started this season to systematically document mortality levels (Figure 62) and characteristics across forest stands. We traveled from the base of Slocum Arm north, classifying forest type (old to recent mortality, and live) every 100m by dominant snag classes (Table 9 and Figure 63). From this survey, we were able to document the mortality-spread pattern and stratify our sampling across forests with yellow-cedar decline that initiated at different times. With 10 plots selected per strata, our hunt began, along with the hard work of collecting all the measurements, and scrambling our way through the thick forests.

Current analysis focuses on comparing community compositions and both overstory and understory dynamics across strata to understand succession. This research will continue north into Glacier Bay next summer, where our preliminary study show relatively healthy yellow-cedar forests, compared to the live, but stressed forests at the northern edge of the Slocum/Klag study area. We are currently working to develop a plan to ensure long-term monitoring of these sites. Later stages of research will focus on understanding human perceptions of these shifting forests and implications for management. Changes in these forests could also have repercussions for bird and wildlife populations, habitat management for deer, and long-term conservation planning for healthy yellow-cedars at higher elevations. ◘

Figure 61. Early Morning at Flat Cove, heading off to work. Photo by Lauren Oakes.

Figure 62. Illustration of a live, "stressed" yellow-cedar with a dead-top. By Kate Cahill (2011).

References

Allen CD & DD Breshears. (2007) Climate-induced forest dieback as an emergent global phenomenon. *Eos Trans*. AGU 88:47.

Allen CD, et al. (2010) Climate-induced forest mortality: a global overview of emerging risks. *Forest Ecology and Management* 259:660–684

Dale VH, Joyce LA, McNulty S, & Neilson RP (2000) The interplay between climate change, forests, and disturbances. *The Science of the Total Environment* 262(3):201-204.

Hennon, P.E. et al. (1990) Dating decline and mortality of *Chamaecyparis nootkatensis* in Southeast Alaska. *Forest Science* 36 (1): 502-515.

del Moral, R. (2007) Limits to convergence of vegetation during early primary succession. *Journal of Vegetation Science*, 18, 479–488.

Table 9. Forest types in yellow-cedar study area. Average time since death is 4, 14, 26, 51, and 81 yrs, respectively, for snags in Class I (foliage retained), Class II (twigs retained), Class III (secondary branches retained), Class IV (primary branches retained) and Class V (bole intact, but no primary branches retained).

Survey Category Forest Type	Strata – Snag Classes / Live Trees Observed
Old Mortality	Dominated by Classes IV, V, VI
Mid Mortality	Dominated by Class III, but Classes II and/or IV may be present
Recent Mortality	Dominated by Classes I and/or II, but III may be present
Live	Dominated by live cedar (but trees may show some signs of stress with Class I mortality present)
Non-cedar	Cedar not present, or a minor component of the forest
Uncategorized	Cedar and cedar mortality present, but mortality ranges too varied to be typified by a single survey category

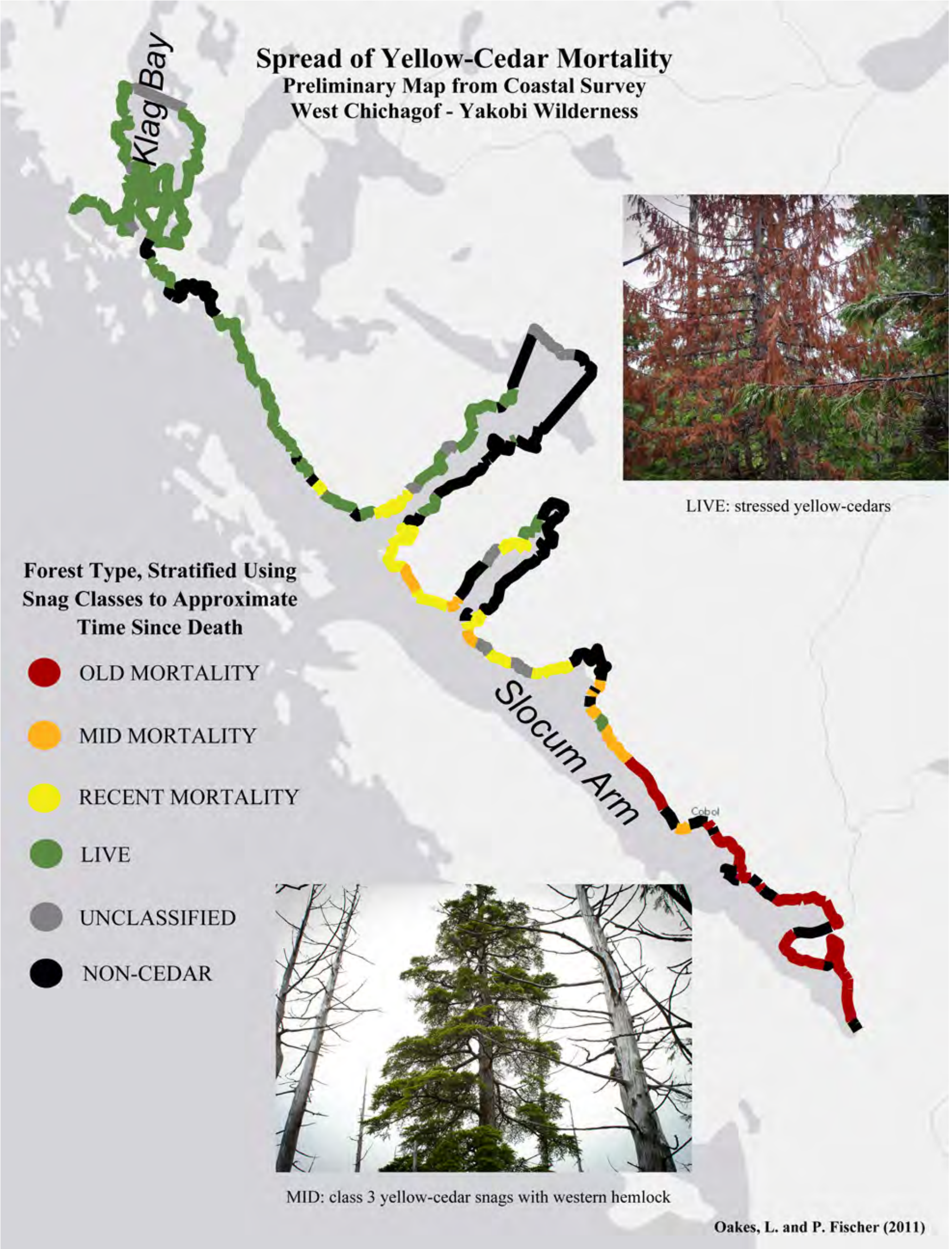

Figure 63. Distribution of yellow-cedar mortality classes. Preliminary map from coastal survey of Chichagof-Yakobi Wilderness in 2011.