

Appendix 1 Materials and methods

Study background

Previous research in southeast Alaska examined the complex dynamics of land-use change, societal feedbacks, and management regimes (Beier et al. 2008). The area's mixed cash-subsistence economy is highly reliant on both extractive (logging, fisheries, and mining) and non-extractive (tourism) uses of natural resources. The increase in regional mean annual temperature between 1948 and 1999 (Stafford et al. 2000) is approximately double that of global mean temperature increase since the mid-20th century (IPCC 2013). This regional trend is associated with warmer winters (Wolken et al. 2011) and precipitation occurring as more rainfall rather than snow (Markon et al. 2012).

People throughout southeast Alaska have long used and valued yellow-cedar trees. For millennia, Native people of the Pacific Northwest have used these trees for clothing, shelter, tools, and transportation, as well as for artistic, ceremonial, and spiritual activities (Stewart 1984). A controversial 50-year boom-bust cycle of industrial logging in the latter 20th century primarily targeted spruce and hemlock species for pulp production (Nie 2006, Beier 2011). Yellow-cedar has since increased in economic value, and currently holds the highest market value of any Alaskan tree species (Beier 2011). Yellow-cedar losses, therefore, may have important ecological, economic, and cultural implications, with resulting human-system responses.

Interview protocol

We chose an empirical method that allowed us to explore patterns in the sample frame between the knowledge that individuals had already obtained and adaptations they had already adopted to ecological changes that had already occurred. Our semi-structured interview protocol elicited self-reported data, but enabled us to assess processes of adaptation underway in an impacted ecosystem. Alternative methods to our interview approach, such as introducing knowledge of causal mechanisms to those unaware of the dieback in a controlled comparison and studying their responses over time, would have been infeasible in the remote archipelago for participant recruitment and follow-up. Additionally, our narrative interview approach enabled us to explore the web of factors known to motivate environmentally responsible behaviors to examine its relevance to individual adaptation.

Five pilot interviews helped refine the semi-structured interview protocol; two of those pilot interviews that used the final interview protocol were included in the dataset for analyses. We provide the protocol here in its entirety, which was administered verbally.

[Interview begins.]

Interviewer:

I'm interested in talking with you about yellow-cedar forests and learning more from your knowledge and experience in this region. I'd just like to start with some more general background questions about you and then we'll delve into deeper conversation.

These first background questions should go relatively quickly and take 5 to 10 minutes. Then we can spend more time in discussion so that I can understand your perspective on forest issues here in southeast Alaska. I anticipate your involvement will take 1 to 2 hours, but of course, you can decide how much time you'd like to spend.

Your participation in this study is completely voluntary. You are free to decline to participate, to end participation at any time for any reason, or to refuse to answer any individual question. Also, you are free to request deletion of any material from my study records, in written or audio form. With your verbal consent, I will record our discussion together.

[Interviewer reviews confidentiality agreement and obtains consent for participation, according to Stanford University IRB, Protocol #24164.]

Introduction

Interviewer:

This is an exploration and conversation, and there are no right or wrong answers. Thank you for taking the time to talk with me.

[Interviewer starts the digital recording device.]

Interviewer:

What year were you born and where?

How long have you lived in Alaska? In southeast Alaska? In your current town?

How many years have you been an Alaskan resident?

If you were not born in state, what attracted you to move to Alaska? Can you tell me more about your motivations for moving/coming to Alaska?

Are you currently working, between jobs, or a student?

If you work, what is your occupation?

- *[If appropriate]:* How did you come to have your position at X organization/company/agency? How did you come to do the work you do?
- *[If appropriate]:* Can you tell me if and/or why your involvement in X organization/company/agency is important to you?

Do you have any children? Who lives in your household?

Do you participate in subsistence activities? If yes, what kinds of activities?

In terms of your relationship to Alaska's forests, with which of these groups do you most identify:

- Native Customary and Traditional Use
- Non-Native Subsistence
- Resource Management
- Recreation and Tourism
- Conservation
- Science and Naturalism
- Commercial Logging
- Mixed-Use [*Probe: Which of the groups that I just listed describe your mixed-use?*]

Do you consider yourself a forest user or manager?

Section 1: Background

Interviewer:

I'm interested in your personal perspective today. I want to learn from your personal experience in southeast Alaska and your knowledge of the forests here.

How would you describe your relationship with coastal forests in southeast Alaska?

Has your interest or involvement in issues related to southeast Alaska's forests changed over time? If so, how?

Section 2: Knowledge

Interviewer:

I'd like to spend a good bit of time today talking about yellow-cedar forests in particular.

[Note to Interviewer: For clear mutual understanding and interpretation throughout the discussion, the interviewer may need to explore language used early with the interviewee: "yellow-cedar forest" refers to a "forest with yellow-cedar in it."]

Do you distinguish a forest with yellow-cedar trees from other forested areas? In what ways?

What kinds of human activities and natural disturbances do you feel have altered yellow-cedar forests specifically in southeast Alaska?

Have you seen forests surrounding your town or in southeast Alaska that appear dead or dying? Could you tell me what's happening to these forests or if there are specific species impacted? [*Probe, if appropriate: What's causing these changes you have observed?*]

Are there other changes occurring in southeast Alaska that appear to be altering these yellow-cedar forests? In what ways?

Where do you get information about forests in southeast Alaska?

[Probe, if appropriate: You mentioned yellow-cedar decline, but can you tell me what that means to you? Where do you get information about what may be causing these patches of dead trees?]

Section 3: Healthy Forests, Attachment, and Use Values Derived from Forests Unaffected by the Dieback

Interviewer:

What does a “healthy yellow-cedar forest” mean to you specifically? How would you describe that forest and its ecological community?

In what ways do you value these healthy yellow-cedar forests?

What about old growth and young growth? Do you value a yellow-cedar tree differently based upon its age? If so, in what way(s)?

Do you think of yourself and these yellow-cedar forests as connected in any ways? If so, can you describe that personal link? *[Probe: How does that link work? How do you know it exists? How strong is that link?]*

In what ways do yellow-cedar forests contribute to your well-being and the well-being of your community? What about their economic contribution?

[Note to Interviewer: Use maps of southeast Alaska and local area to facilitate discussions of specific locations.]

Can you identify some places locally where there are healthy yellow-cedar forests? What activities do you do related to these forests?

Describe for me the ways you have used yellow-cedar forests. *[Probe: personal uses versus professional work.]*

Section 4: Forests Affected by the Dieback

Interviewer:

I'd like to focus for a bit on yellow-cedar decline.

[Note to Interviewer: If necessary, based upon previous knowledge exploration, explain the term “yellow-cedar decline” to clarify with “death,” “mortality,” “patches of dead yellow-cedar trees on the landscape,” and/or “dieback.”]

What does “yellow-cedar decline” mean to you specifically? How would you describe the ecological or natural community affected by decline? *[Probe, if necessary, with various terms for decline, such as patches of dead yellow-cedar trees or widespread tree death.]*

Let’s revisit the values you thought about with healthy yellow-cedar forests. Imagine yourself standing in a declining yellow-cedar forest and think about these values.

Does yellow-cedar decline influence how or in what ways you value these forests?

What ways do you value dead yellow-cedar trees?

[Note to Interviewer: Use maps of southeast Alaska and local area to facilitate discussions of specific locations.]

Can you identify some places locally where there are dead yellow-cedars? What activities do you do related to these forests?

Describe for me the ways you have used yellow-cedar forests affected by the dieback. *[Probe: personal uses versus professional work.]*

Section 5: Attitudes about the Impacts Occurring

Interviewer:

When you think about yellow-cedar decline and these trees dying, how do you feel about these changes?

Do you consider yellow-cedar decline a forest disturbance? *[Probe, if appropriate: In what ways?]*

Do you think the process of change the forest undergoes creates other opportunities and resources? *[Probe, if appropriate: feelings about changes, if they emerge.]*

Do you think the process of change the forest undergoes creates losses? *[Probe, if appropriate: feelings about changes, if they emerge.]*

Section 6: Experience in Forests (Unaffected versus Affected Forests)

Interviewer:

I’d like to talk with you about your experience in these forests. We’ll talk about both healthy yellow-cedar forests and also the forests with widespread tree death.

Have you spent time in any of the yellow-cedar forests affected by the dieback?

[Note to Interviewer: If “yes,” then continue.]

Are there yellow-cedar forests that are important to you because of what you gain from them? Are these gains different from healthy forests versus those affected by decline?

[Note to Interviewer: If intangible values arise from the participant, probe with follow-up questions.] What do you feel from your experience in a healthy forest and how does that compare to what you feel from your experience in a forest affected by decline? Tell me about the non-material gains.

[Probe, if appropriate: Feel free to use stories about your experiences in these places, if that helps. These can be things specific to you or your family or community. They can be recent or historical.]

Section 7: Comparing Use Values between Forests Unaffected and Forests Affected by the Dieback

Interviewer:

Do your uses differ between live yellow-cedar trees and dead?

Has yellow-cedar decline altered your use of these forests? If yes, provide some examples of the ways your activities in or around forests affected by decline may differ from your activities in or around healthy or live forests?

What are your thoughts on potentially harvesting dead cedar? Would you support or oppose this practice? For what reasons? *[Probe protected areas versus managed lands: What are the trade-offs between harvesting dead, as opposed to live, cedar trees?]*

Section 8: Management

Interviewer:

What types of uses do you prioritize for management of yellow-cedar forests? Have these priorities changed over time? In what ways?

I've heard a lot about "multiple uses" on the Tongass. Can you explain what managing forests for multiple uses means to you?

How do you envision forest management of the Tongass in the future?

When you think about managing yellow-cedar forests in the future, how would you prioritize the uses or values we've discussed?

Are there specific things you think could be done to (better) manage yellow-cedar forests? What are they and why do they matter? Feel free to recommend or think out loud about anything that's important to you. *[Probe if necessary, recalling notes taken: You've*

mentioned several issues that ought to be addressed to improve forest management. Can you elaborate on which you feel are most important?]

What are your thoughts on planting yellow-cedar trees? Would you support or oppose this practice? For what reasons? [*Probe: protected areas versus managed lands*]

Do you think there are management opportunities for dead yellow-cedar forests?

In what ways do you think forests affected by the decline may create new uses for humans, fish, or any wildlife?

Section 9: Conservation

Interviewer:

Let's talk about ideas like conservation and sustainability for a bit.

I often hear talk about "sustainability" or "sustainable forest communities." What does sustainability mean to you?

If you think about harvesting trees, how do you consider tree age? What about dead versus live yellow-cedar trees?

How do you think sustainability applies to the values and uses we've discussed?

Do you consider conservation to focus on avoiding harvesting alone, or do conservation priorities include consideration of yellow-cedar decline?

What kinds of conservation interests do you consider important for the Tongass forests?

When you think about yellow-cedar harvests in the future, do you think managers should consider increasing protections, such as limiting harvests where they may be more likely to survive, or shifting or expanding protected areas? Would you support or oppose these practices? For what reasons? [*Probe: protected areas versus managed lands.*]

Section 10: Protected Areas versus Managed Lands

Interviewer:

If you knew the decline was going to spread into other areas in southeast Alaska or north to Glacier Bay National Park, would you want to see yellow-cedar forests managed differently? [*Probe: protected areas versus managed lands.*]

Section 11: Environmental Concern, Outlook, and Nature Connection

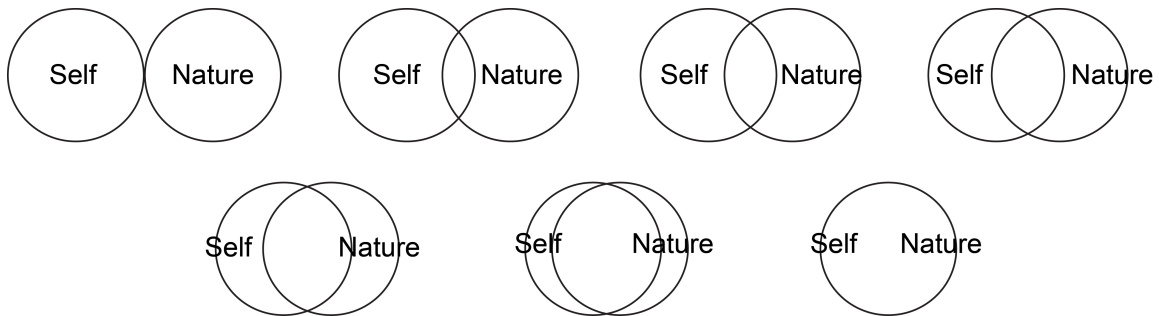
Interviewer:

What is the environmental issue or problem that concerns you most and why?

When you think about the environmental problems that concern you today, where do you place yourself on this scale?



Please circle the picture below that best describes your relationship with the natural environment. How interconnected are you with nature? (Schultz 2001) Would you explain your choice to me?



Closing

Interviewer:

Thank you so much for your time. Those are all the questions I have for you. Do you have any questions for me?

[Note to Interviewer: Provide interviewee with contact information according to approved IRB Protocol.]

Sample frame and characteristics

All pre-identified forest managers identified themselves as managers, together with three interviewees employed in the non-profit conservation sector. Interviewees self-identified with the pre-assigned participant categories, but many also identified with additional groupings, such as recreation and tourism, conservation, sport hunting, and non-Native residents engaging in subsistence activities. We maintained our stratification of users and managers based upon our definition of managers (i.e., individuals working within the Tongass governance system or managing Alaska Native land) in subsequent analyses.

Data analysis

In addition to the methods described for analyzing knowledge, we used *a priori* and emergent coding for explanatory variables: learning, attitudes, attachment, and use values. We used *a priori* coding for “active” learners (Fonseca and Chi, 2011), who gained knowledge of the causal mechanisms through direct, place-based learning and let other, indirect learning processes emerge (e.g., acquiring information through social channels, such as news media, published studies, or community members). “Concern,” “lack of self-efficacy,” “pragmatic,” and “utilitarian” were used as *a priori* codes for attitudes (Schultz 2001, Moser 2014, Kellert 1996); others emerged from the interviewees.

A distinction between functional and emotional attachment was determined *a priori*, but scales of attachment (i.e., southeast Alaska, forest ecosystem, and species) emerged from the data. One example of content coded for emotional attachment at the fine-scale species-level follows: “...Also, it turns out that yellow-cedar is one of my favorite conifers. So why am I kind of drawn to them? I still always enjoy going to South Pass or North Pass, going towards the coast. That's where you kind of enter the real perennial yellow cedar country. It has certain smells to it...I seem to be kind of in love with the yellow cedar. They feel soft. They look kind of sleepy, and they smell good.” In contrast, an example of content coded as functional attachment at the species-level includes: “My business relies upon the forest...and yellow-cedar is a big part of that.” Also: “It is very much a specific tree. Unfortunately for us, it's not common. The timber is worth twice as much as others, in general.”

For use values, we identified *a priori* themes from our review of regional forest management documents (USDA Forest Service 2008): customary and traditional, education, economic, forest products and personal, recreation, ecological, and sport hunting and gathering. In our results, we report additional themes of use values that emerged from the data, along with the emergent distinction between direct use values and intangible values that interviewees derived from the forests both affected and unaffected by the dieback.

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