Beetle-killed trees in the Crescent River/Polly Cr drainages, north of Tuxedni Bay. Beetles were active in this area in the late 1990s.

Tree-ring reconstruction of historic insect outbreaks, Lake Clark National Park and Preserve

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Ed Berg and Matt Bowser, USFWS, examine spruce bark beetle damage in Lake Clark.

Abstract

In spite of current widespread spruce bark beetle damage on the Kenai and Alaska Peninsulas, we know little about the history of insect disturbance in the Southwest Alaska Network (SWAN). As part of this multi-year project, we are using tree-ring records to determine whether bark beetle outbreaks occurred historically in Lake Clark and Katmai NPP. We collected tree cores from nine sites in and adjacent to Lake Clark NPP in 2005. The oldest cores were from Two Lakes and dated to the early 1600s, providing us with an approximately 400-year record. Preliminary analyses suggest insect activity at multiple time periods between the early 1800s and present, although the exact dates, magnitude of growth changes, and synchroneity of patterns are currently being analyzed. In 2007, we will expand our sampling to several sites in Katmai NPP.

Introduction

The spruce bark beetle has killed over 532,000 ha (1.3 million acres) of spruce forest on the Kenai and Alaska Peninsulas. Forests north of Lake Clark NPP experienced substantial beetle kill in the 1970s, with the outbreak entering the Park in the 1990s. Areas of more recent beetle damage (late 1990s to present) include Lake Iliamna (Pedro and Pile Bay) and older stands around Naknek and Brooks Lake, in Katmai NPP.

Project objectives:

1. Reconstruct the historic frequency and occurrence of spruce bark beetle outbreaks in Lake Clark and Katmai NPP.

2. Evaluate the relationship between insect outbreaks and regional climate using existing climate chronologies and long-term instrument records.

Methods

We collected 814 cores from live and dead trees in July 2005, from seven sites in Lake Clark NPP and two sites adjacent to Lake Iliamna (Fig. 1). We cored trees in relatively homogeneous, mature, closed-canopy stands of white spruce (*Picea glauca*), below tree-line and away from areas of obvious disturbance, using standard techiques (Stokes & Smiley 1968; Fritts 1970; Cook et al. 1990). Sites were chosen based on the location and extent of current spruce bark beetle infestation, and the location of previous sampling efforts, if applicable. The stand at Polly Creek, approximately 56 km (35 miles) north of Chinitna Bay, was sampled in 2000 by Ed Berg.

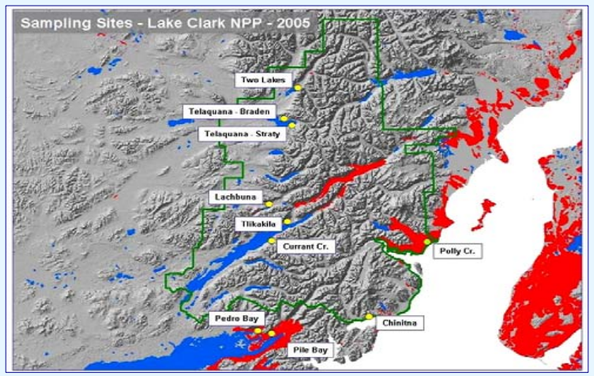

Figure 1. Sampling sites, Lake Clark NPP and Lake Iliamna (2005).

Variation in tree-ring widths indicate growth pulses caused by thinning of the forest by beetle kill. When younger trees in the understory are released from competition (hereafter referred to as a "release"), they grow rapidly for 60 to 80 years until the canopy closes again and competition for light slows their growth.

Ring-width measurements are used to relate inter-annual variation in tree growth (i.e., releases and suppressions) to insect activity and climate variability. Ring-widths for all cores are being measured and recorded, and ring-width series are currently being run through COFECHA (Holmes et al. 1986), a statistical program to detect variations in ring width. The series are then are cross-dated and the growth releases analyzed using the JOLTS program. Our methodology follows a protocol used previously for spruce stands on the Kenai Peninsula.

A student at U. Hawaii measures ring widths on a tree core.

Preliminary Results

We have dated cores from all sites and measured tree ring widths for six of the nine sites (Chinitna Bay, Currant Creek, Telaquana Lake – Braden and Straty, Tlikakila River, and Pile Bay).

The oldest cores are from Two Lakes and date to the early 1600s, providing us with an approximately 400-year record.

At least five sites (Two Lakes, Telaquana-Braden, Telaquana-Straty, Tlikakila, Currant Cr.) show mild to moderate releases beginning in the early 1900s, suggesting a regional outbreak at this time. Release dates from three of these sites are shown in Figures 2-4. The exact dates and magnitude of the releases are currently being analyzed.

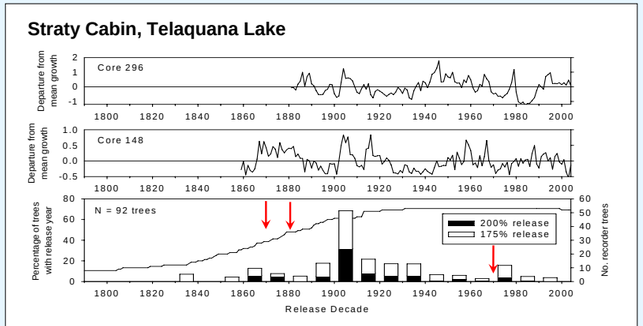

Figure 2. Release dates from tree cores collected south of Straty Cabin, Telaquana Lake. The top two panels show individual trees that illustrate releases in growth as the departure from mean growth (horizontal line). The bottom panel shows the frequency of trees that showed a release in a given decade. A 200% departure from the mean (black bar) and 175% departure are shown. Cumulative sample number is shown by the curve (Y axis, right). Red arrows indicate corresponding major release periods on the Kenai Peninsula.

Straty Cabin – The Straty site showed a stand-level release from 1900-1910 (Fig. 2) with over 60% of the trees showing a release in growth of 175% or more. Other less severe release periods were evident in individual tree cores (top two graphs; Fig. 2), but the 1900-1910 release was the only stand-level response we observed. Based on our tree-ring reconstruction methodology, we interpret the 1900-1910 release to be a likely response to a spruce beetle outbreak.

Approximately 100-year old trees at the Straty Cabin site, Telaquana Lake.

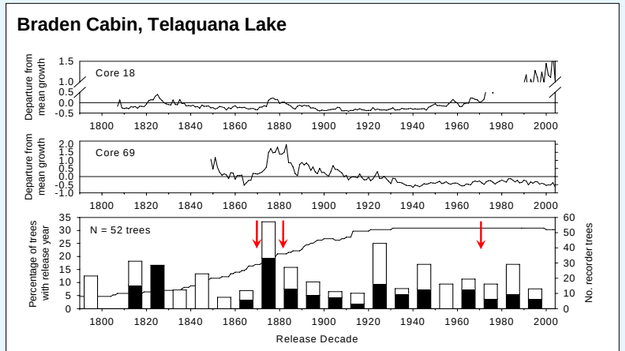

Figure 3. Release dates from cores collected at Braden cabin, Telaquana Lake. Graphs are formatted as in Fig. 2.

White spruce and dwarf birch near the Braden Cabin site, Telaquana Lake.

Braden Cabin – The Braden site (Fig. 3) showed more isolated release events than the Straty site. Accurate dating of release events is still underway for this stand, but we interpret these events as potentially due to spruce beetle damage. Differences in the tree-core record between the Braden and Straty sites are likely due to stand-level differences: Braden is a more open, patchy stand, whereas Straty has a denser, more homogeneous canopy.

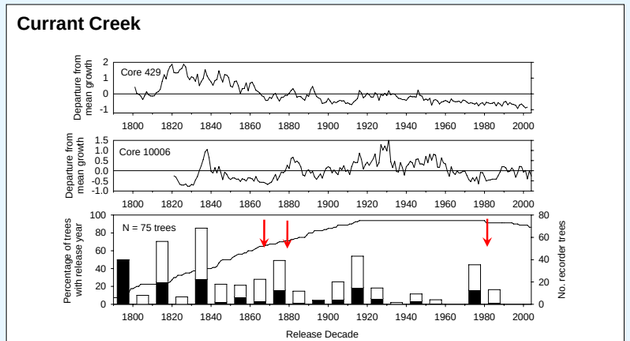

Figure 4. Release dates from tree cores collected at Currant Creek. Graphs are formatted as in Fig. 2.

Currant Creek – The Currant Cr. site showed release dates in the early 1800s (Fig. 4). The 1810-20s and 1830-40s showed moderate to severe stand disturbance, with over 75% of the trees showing a release. Less severe stand-level releases are also evident in the 1870s, 1910s and 1970s.

View of the Currant Creek site from Lake Clark.

Implications

On the southern Kenai, visible growth releases date to the 1870-80s and 1970s (Figs. 2-4), with more subtle growth releases occurring in the 1760s, 1810-20s, and 1910-20s. Although spruce bark beetles may not have as severely impacted the forests in Lake Clark NPP, preliminary analyses suggest that there were similar periods of insect activity in the park. Further analyses (2007-2008) should determine whether, and when, past outbreaks occurred synchronously across the Alaska Peninsula.

Our results are intended to provide information both on baseline conditions in these forested stands, and a historic context for long-term monitoring of forested ecosystems in the parks.

2007 Work Plans

- Complete analyses on cores from Lake Clark NPP
- Initiate sampling in Katmai NPP and process cores
- Initiate a comparison of disturbance chronologies with climate chronologies and existing 20th century climate data (instrument record)

In FY06, this project was extended to include sites in Katmai National Park and Preserve. Ring-width chronologies acquired from Katmai will broaden our understanding of historic disturbance regimes on the Alaska Peninla by incorporating data from spruce stands at the southernmost extent of their range. Field work in Katmai is scheduled for July 2007 (Fig. 5).

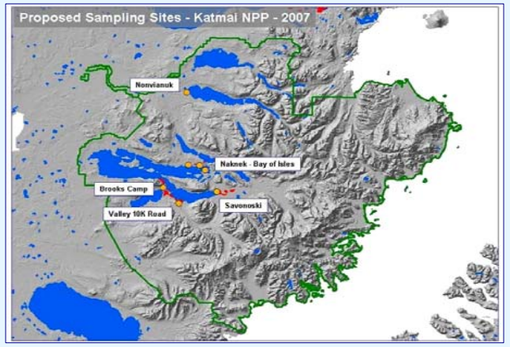

Figure 5. Proposed sampling sites, Katmai NPP (2007). Three to five sites will be visited following an overflight reconnaissance of stands.

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