Assessment of the Severity and Impact of Alder Dieback and Mortality in Alaska

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ABSTRACT: Substantial dieback and mortality of thin-leafed alder (*Alnus tenuifolia*) is occurring in riparian areas across south-central and interior Alaska. The dieback has raised concern since alders are considered "keystone species" due to their importance in riparian ecosystems and capacity to fix atmospheric nitrogen. Decline and mortality of alder is expected to alter ecosystem nitrogen accumulation, forest stand development, and likely forage quality for harvestable subsistence species, such as moose. In 2005, two projects were undertaken to assess the severity and impact of alder dieback and mortality: 1. Installation and monitoring of transects, and 2. Assessment of changes to nitrogen fixation rates.

TRANSECT INSTALLATION AND MONITORING

INTRODUCTION

Dieback and mortality of *A. tenuifolia* in riparian areas in Alaska has been reported since 2003. The damage appears recent in most locations, occurring within the last decade, and continuing. We installed transects to:

- Monitor the spread and intensification of dieback and mortality
- Assess site conditions, associated fungi, insect defoliation, and climate factors

METHODS

100-ft permanent transects were installed across south-central Alaska in the Matanuska/Susitna Valley and on the Kenai Peninsula. For each *A. tenuifolia* genet, we assessed stem condition and sprout abundance. Dominant overstory and understory vegetation and various site characteristics were recorded. For 3 genets per transect, every stem was marked and additional data were collected.

RESULTS

Ten transects were established in south-central Alaska in 2005, where a total of 755 stems were examined within 140 genets. Additionally, within six transects established in 2004, 440 stems within 93 genets were re-assessed in 2005. All transects had some level of dieback occurring. A stem canker, putatively caused by *Valsa melanodiscus,* appears to be the main cause of dieback (see top picture at right). *V. melanodiscus* has been isolated from cankered tissue and pathogenicity tests are underway. Preliminary results indicate:

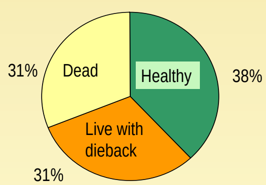

Fig 1: Within the 10 transects established in 2005, stems were nearly evenly divided among three categories: live & healthy, live with dieback, and dead (n=755).

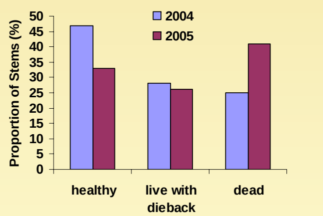

Fig 2: In one year, the proportion of healthy stems decreased 14% and dead stems increased 16% (n=440 stems). This indicates that alder dieback and mortality are continuing at a rapid rate.

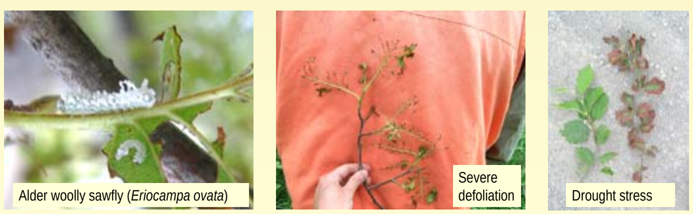

Fig 3: A complex of host stressors is apparent at many affected sites, including severe defoliation by the introduced alder woolly sawfly and continued record-breaking hot, dry summers since 2003. The role of these and other stressors in causing or exacerbating alder dieback and mortality is poorly understood and under investigation.

FUTURE MONITORING AND ASSESSMENTS

- Continued monitoring transects for dieback and mortality;
- Establish transects in Interior Alaska in 2006;
- Continue assessing relationships between incidence of dieback /mortality and host stressors including associated canker fungi, insect defoliation, climate change, and other factors.

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IMPACTS OF ALDER DIEBACK AND MORTALITY ON ECOSYSTEM NITROGEN BALANCE IN ALASKA

The objectives of the study were to 1) establish replicated long-term plots along riparian forests within 3 Alaskan regions (Tanana Valley, Anchorage Basin - Eagle River, and Kenai Peninsula - Quartz Creek), 2) permanently tag and assess stem canker infection and the degree of basal area & canopy losses from stem canker within these plots, 3) measure nitrogen fixation rates and associated characteristics of both soils (climate and chemistry) and plants (nodule biomass, leaf morphology and leaf chemistry, *Frankia* genetic structure) across a range of infected plants within each plot.

The population of stems (N=512) from plants randomly selected for N fixation measurements constituted approximately 14% of the greater than 3500 stems surveyed in all plots across the 3 landscape regions. Preliminary results indicate:

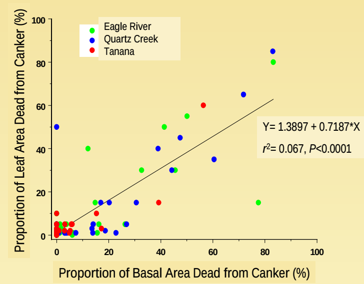

Fig 1: Across the 90 plants selected for N fixation measurements, the proportion of total basal area dead from canker infection scaled linearly with the associated percentage of leaf area lost from these plants.

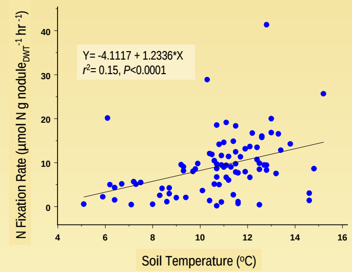

Fig 2: Across plants from all sites, N fixation rate was positively correlated with soil temperature. Soil moisture had no effect on N fixation rates.

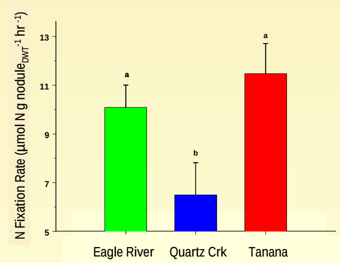

Fig 3: There were significant differences among regions in N fixation rates ($F_{2,80}$= 4.98, *P*=< 0.01), with rates being highest in plants growing along the Tanana River, lowest at the Quartz Creek drainage, and intermediate along the Eagle River.

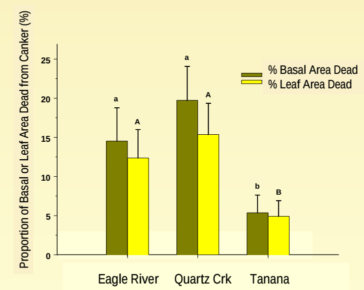

Fig 4: However, using an analysis of covariance, significant regional differences in N fixation rates could be completely explained by the combined independent effects of soil temperature ($F_{1,80}$= 2.74, *P* =< 0.10) and differences in both percentage of total basal area dead from canker ($F_{1,80}$= 3.82, *P*= < 0.05) and percentage of leaf area killed by canker ($F_{1,80}$= 3.70, *P* =< 0.06) among regions.

DISCUSSION

These data suggest that greater levels of canker infection are leading to declines in N fixation rates at a regional scale. Although we haven't completed calculations or analysis of nodule biomass data among plots, our observations during field sampling suggest that substantial amounts of nodule biomass were dying in plots most heavily infected by canker. Thus, we believe that combining N fixation rates with nodule biomass to yield total N inputs will result in even greater effects of canker on N balance at the ecosystem level.

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