

Ecological Effects of Leaf Mining

Plant Performance and Trophic Dynamics



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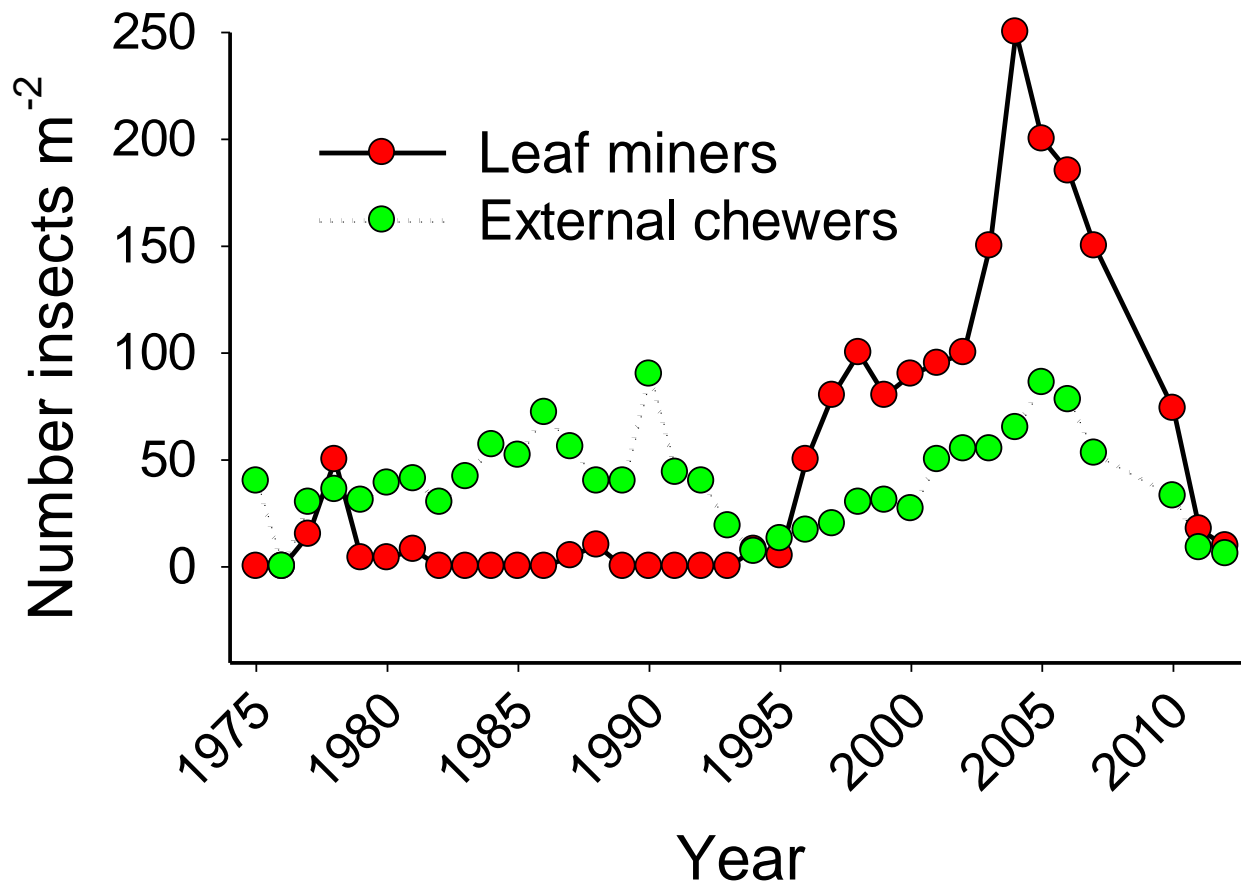
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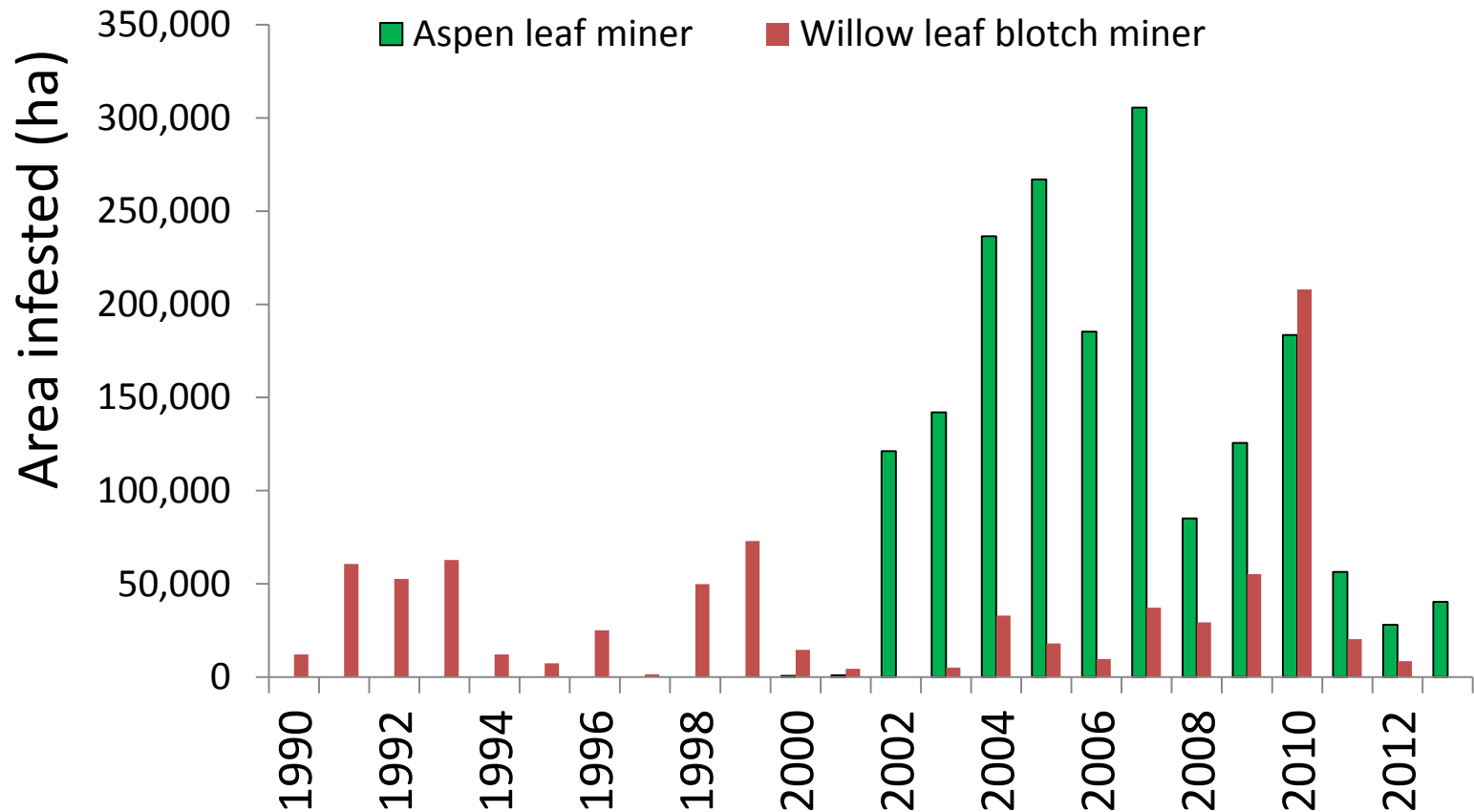




Local leaf miner and chewers densities on deciduous trees



Major leaf miner outbreaks across Alaska



Outline

- Why did ALM outbreak last so long?
- What caused the end of the ALM outbreak?
- How does aspen leaf miner (ALM) affect aspen performance?
- New experiment: Long term ecosystem consequences of insect herbivory, mammalian browsing, and their interaction

Aspen leaf miner moth

(*Phyllocnistis populiella*)

- North American native
- One generation per year
- Larvae consume epidermal cell layer
- Restricted to one side of a single leaf until adulthood
- Adults emerge in June, overwinter under spruce



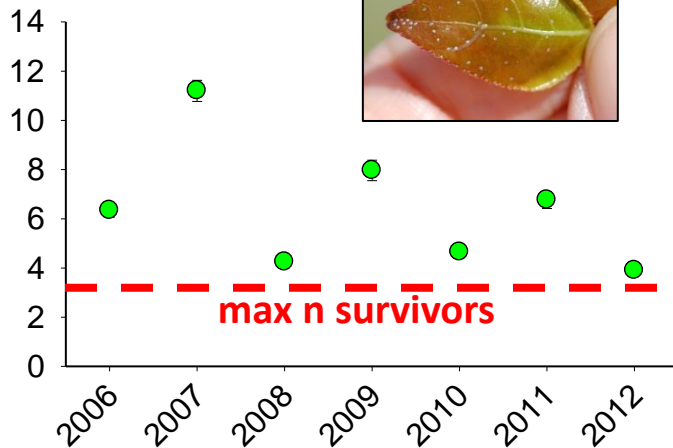


Why did the ALM outbreak last so long?

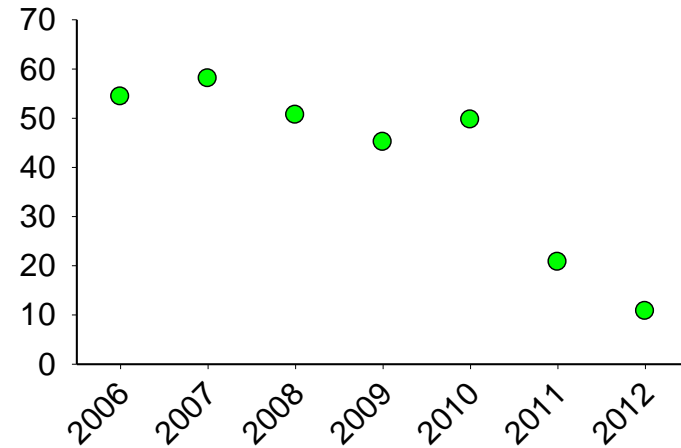
- High plant tolerance of herbivory
 - Nutrient stores
- Insect behavior
 - Larvae unable to attack foliage produced late in growing season (one generation, larvae immobile)
 - Aggression towards conspecifics prevents decimation of food supply

Competition

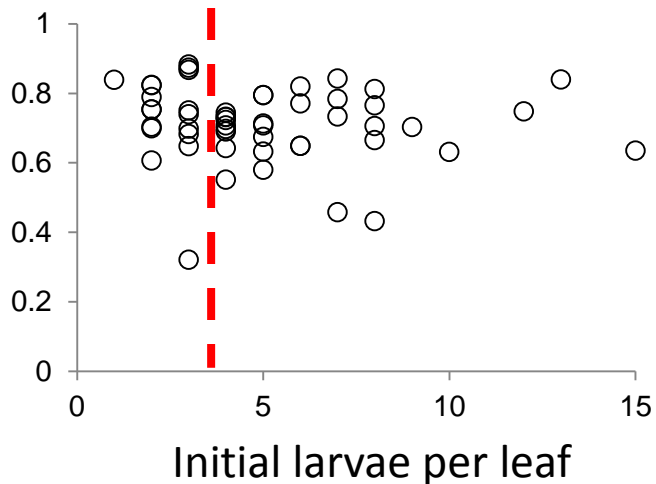
Eggs per leaf



Leaf area mined (%)

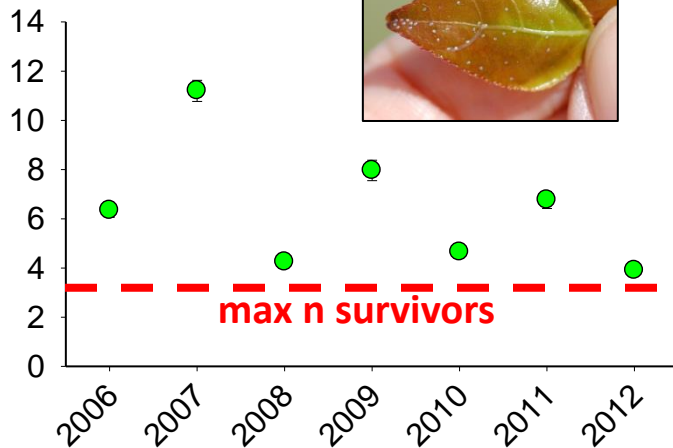


Pupal mass of survivors (mg)

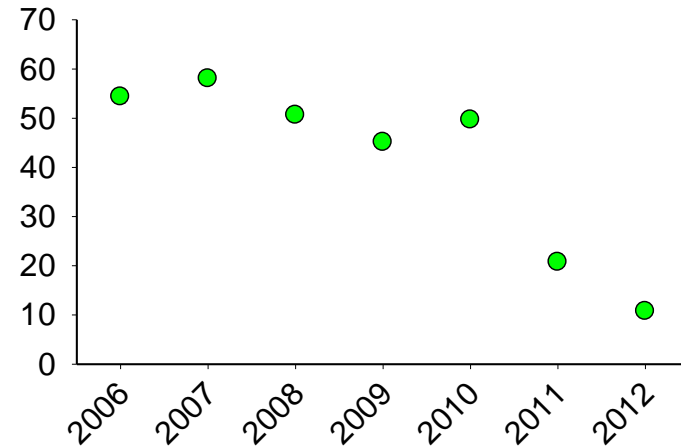


Competition

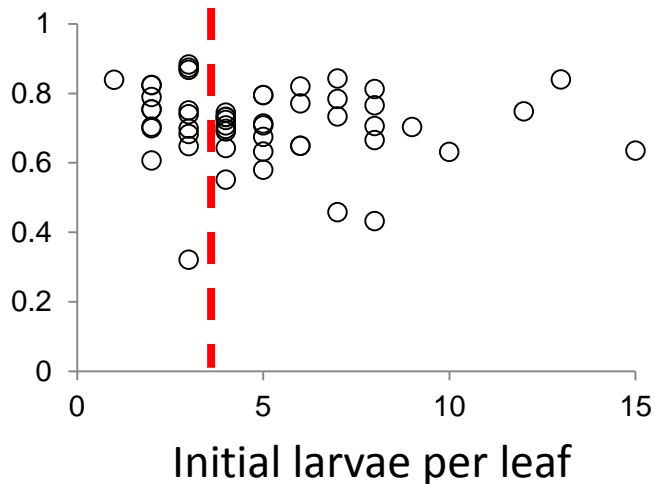
Eggs per leaf



Leaf area mined (%)



Pupal mass of survivors (mg)



Intense interference competition:

- Prevents food limitation
- Allows some larvae to survive leaf overpopulation
- Preserves leaf function

What ended the outbreak?

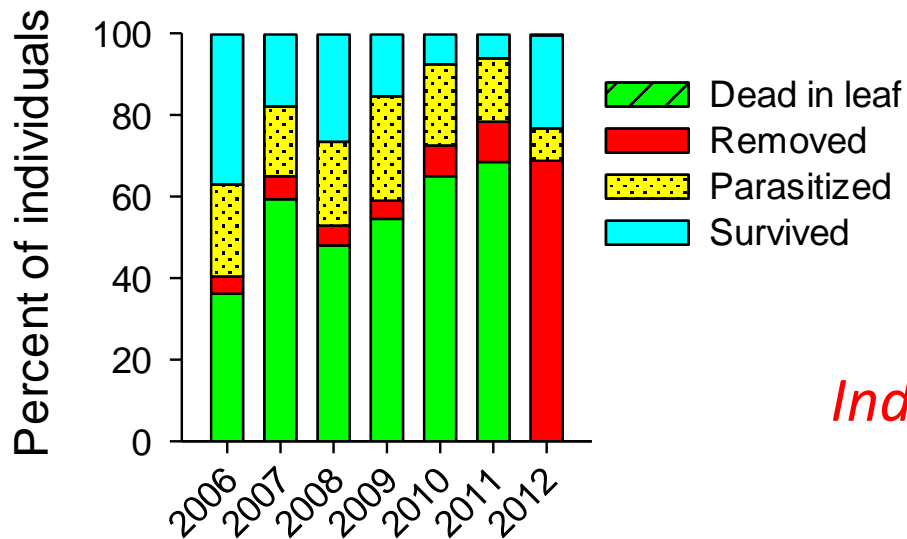
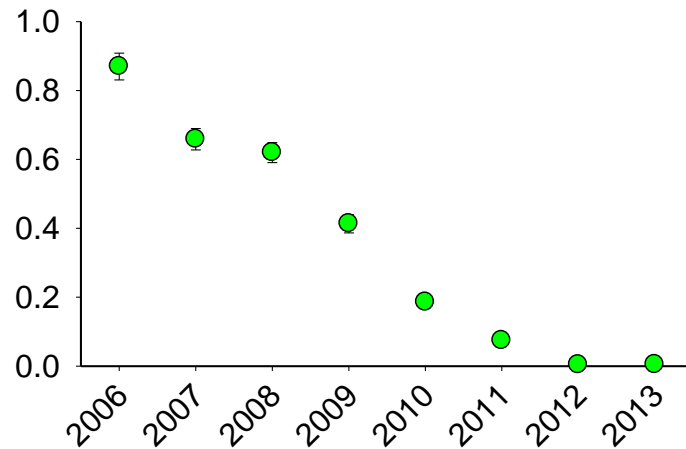
- Phenological mis-match
- Adult overwintering survival
- Egg mortality
- Larval parasitism
- Larval and pupal predation (ants, birds)
- Larval and pupal mortality unassigned (other predators, pathogens, plant quality)

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What ended the outbreak?

Survivors per leaf



Indirect effect of WLBM increase?

Doak & Wagner in review

How does leaf mining affect aspen performance?

Methodology

- Experimental suppression of leaf miner density on aspen < 2m
- 2 sites: Bonanza Creek and Ester Dome; mixed stands
- 7 years

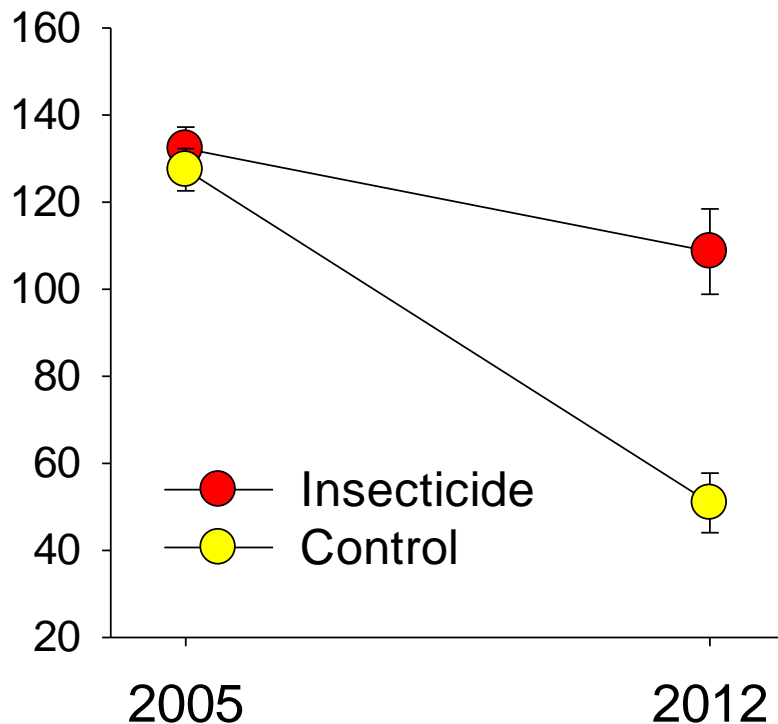
How does leaf mining affect aspen performance?

- Mortality
 - No effect of leaf miner suppression
- Growth and size
 - Strong effects

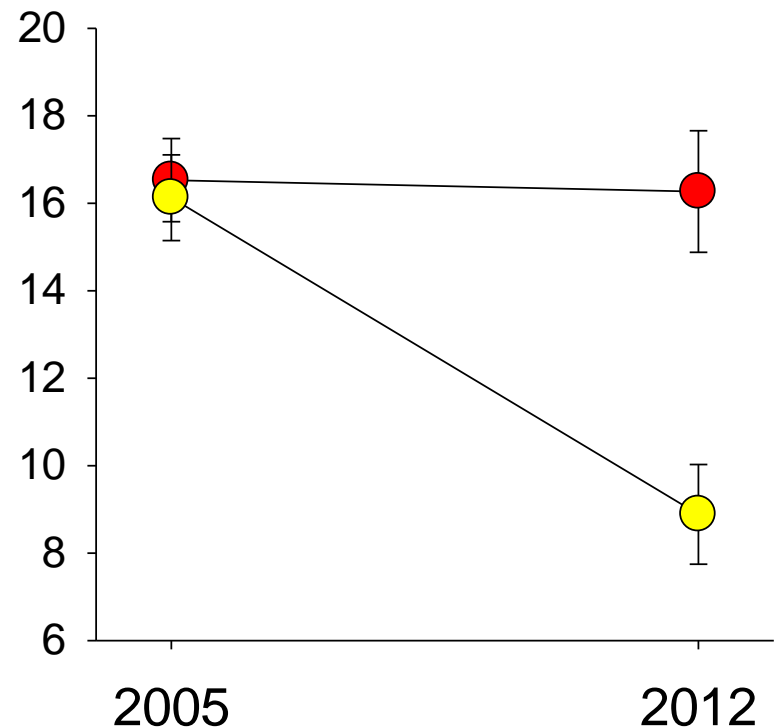


Effects of leaf mining across 7 years

Height (cm)



Diameter at 20 cm (mm)



Implications for browsing, competition

Wagner & Doak 2013

Mechanisms of ALM-caused aspen decline

- Early leaf abscission (Wagner et al. 2008)
- Leaf mining reduces photosynthesis by disrupting stomatal function (Wagner et al. 2008)
- Mining disrupts water balance (unpubl.)
- Mining induces ineffectual defenses
 - Phenolic glycosides (Young et al. 2007)
 - Extrafloral nectar (Newman & Wagner 2013)
 - Both increase costs

Willow leaf blotch miner (*Micrurapteryx salicifoliella*)



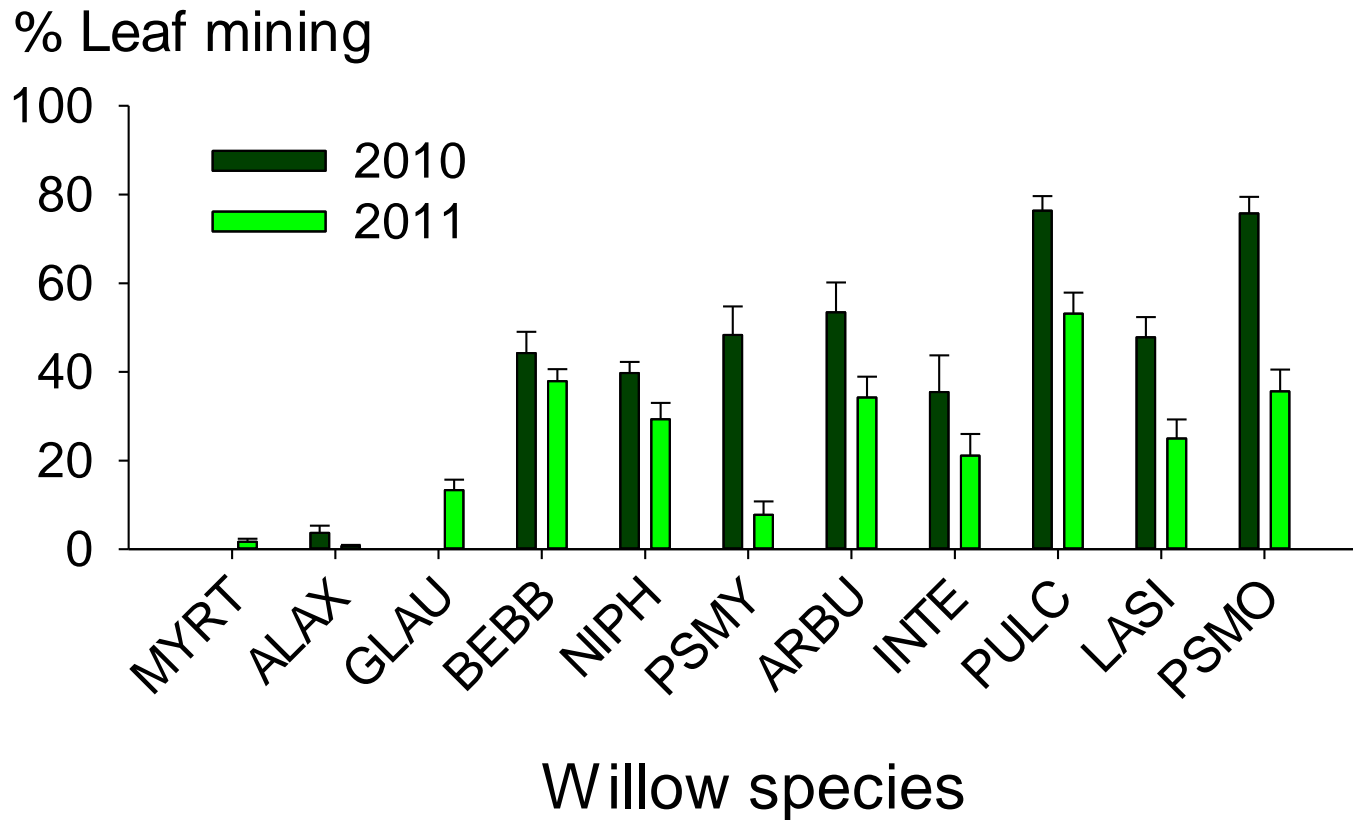
Willow leaf blotch miner

(*Micrurapteryx salicifoliella*)

- One generation
- Multiple *Salix* hosts
- Larvae consume mesophyll
- Mobile – will move to new leaves within plant



Wide variation in susceptibility among willow species

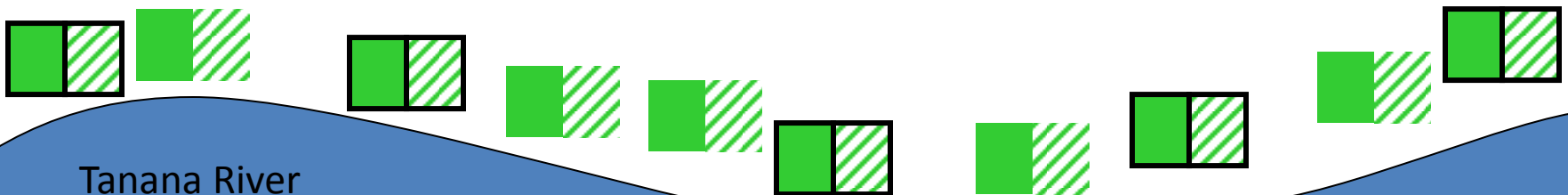


Questions

- What are the individual and combined effects of invertebrate and vertebrate herbivores on the early successional plant community & ecosystem?
- Do invertebrate and vertebrate herbivore interact indirectly through effects on plant:
 - Production
 - Plant chemistry / palatability
- E.g. Summer insect leaf herbivory may affect availability or palatability of species preferred by mammals in winter

Experiment: Impact of, and interactions between, invertebrate & vertebrate herbivores

- Started spring 2012; ~10 year duration
- Invertebrate suppression (insecticide) x exclusion of moose/hares (fencing)
- Dependent variables:
 - Willow herbivory, browse, litter production, chemistry
 - Community composition
 - Soil nutrients, decomposition





Impact of, and interactions between, insect & vertebrate herbivores

- Preliminary results
 - Suppressing insect herbivory increased woody browse production (~ 50% in 2012)
 - No effect of insect suppression on browse C/N, tannin PPC
 - No effect of insect suppression on browsing removal
 - No notable changes in community composition to date

Summary

- Why did ALM outbreak last so long?

Strong interference competition reduced food limitation and plant damage

- What caused the end of the ALM outbreak?

Juvenile mortality by biotic agent

- How does aspen leaf miner (ALM) affect plant performance?

Weak effects on outright mortality; strong negative effects on plant size

- New experiment: Long term consequences of invertebrate herbivory, vertebrate browsing, and their interaction

Underway, more to come