Biological Control of the Ambermarked Birch Leafminer (*Profenusa thomsoni*), an invasive species in Alaska

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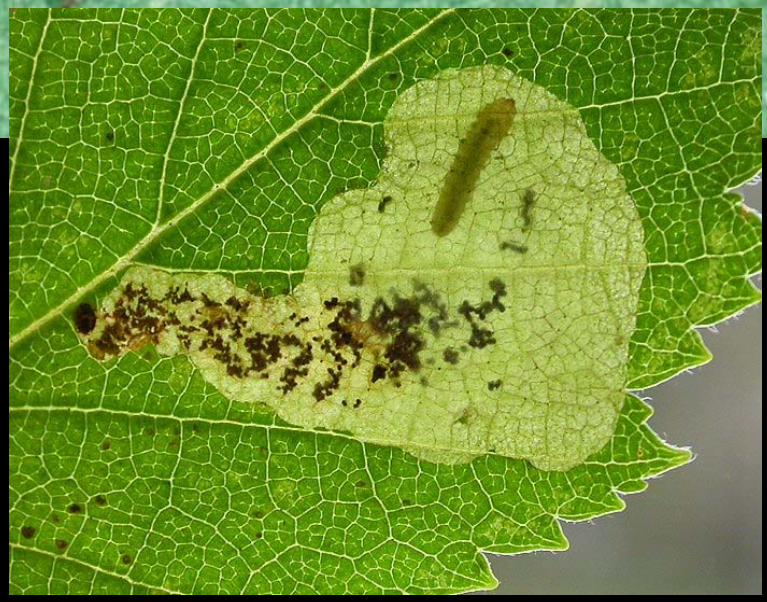
Ambermarked Birch Leafminer

- *Profenusa thomsoni*
- Hymenoptera: Tenthredinidae
- Parthenogenetic
- 1 generation/year in Alaska



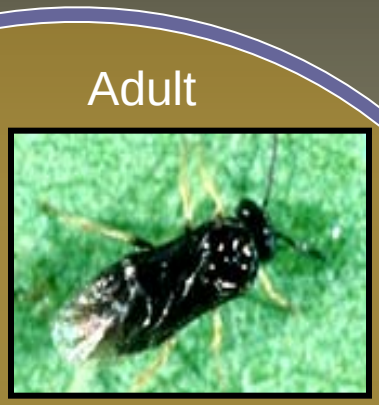
Life cycle corresponds to symptom development…

Profenusa thomsonii

Overwinter in soil
September-June

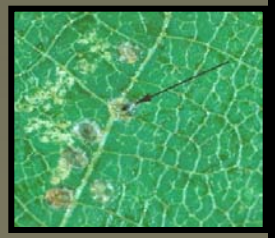
Larvae drop to soil
August-September

Larvae feed
Leaf symptoms develop
July-August



Adults emerge
June-July

Oviposit eggs

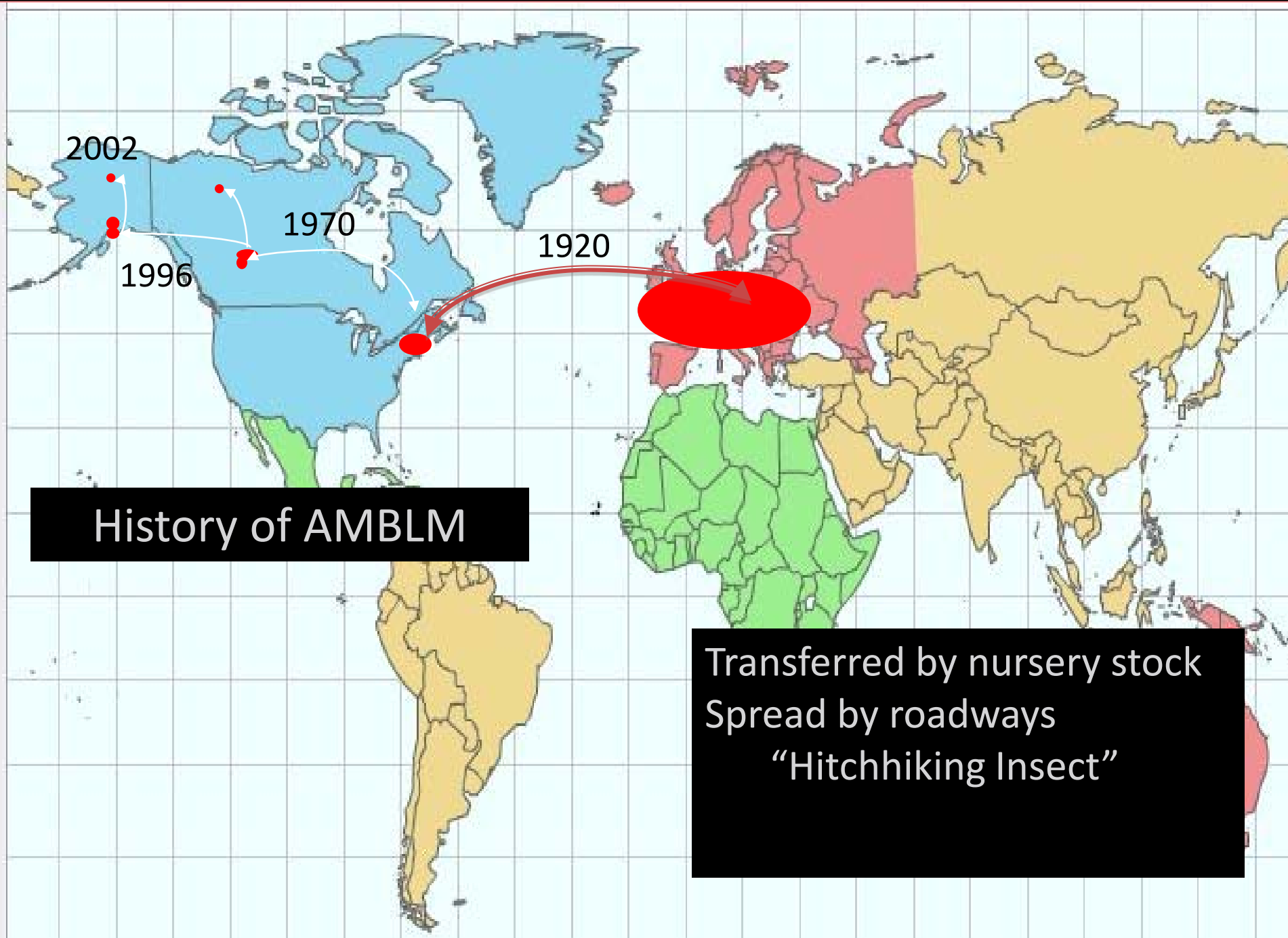


Larvae hatch
July-August

Photos by Chris MacQuarrie and Ed Holsten
Slide by J. Lundquist

Damage caused by Amber Marked Birch Leaf Miner

- Fewer Tree species
  - Unlimited resource
- No Natural Enemies
- Climate change
  - Alaska experiencing warmer summers
- Damage estimated to cover 140,000 acres in Alaska


2002
1996
1970
1920
History of AMBLM
Transferred by nursery stock
Spread by roadways
"Hitchhiking Insect"

Alberta biological control

In 1992 *Lathrolestes luteolator* was reported attacking *Profenusa thomsoni*

(Digweed, S.C. (1998) Environmental Entomology 27: 1357-1367)

Alaska biological control

- In 2003 Cooperative program initiated with the USDA Forest Service, University of Alberta and the Canadian Forest Service
- Parasitoid wasp *Lathrolestes thomsoni* identified for release
- In 2006 University of Massachusetts-Amherst joined to continue with the project

Natural Resources Canada

Biocontrol Agent

- Hymenoptera: Ichneumonidae
- Koinobiont endoparasitoid
- One generation/year
- *Lathrolestes thomsoni*
- Wasps collected from Alberta and Northwest Territories, Canada
- A total of 3636 wasps released from 2004-2008 at eight release sites

Photo: Chris MacQuarrie

Release of wasps

- Wasps released at eight locations in Alaska
  - Five sites in Anchorage
  - Sites expanded to Kenai Peninsula and Eielson Air Force Base

Free release of wasps

- Wasps released directly on to leafminer infested foliage
- Oviposition witnessed immediately

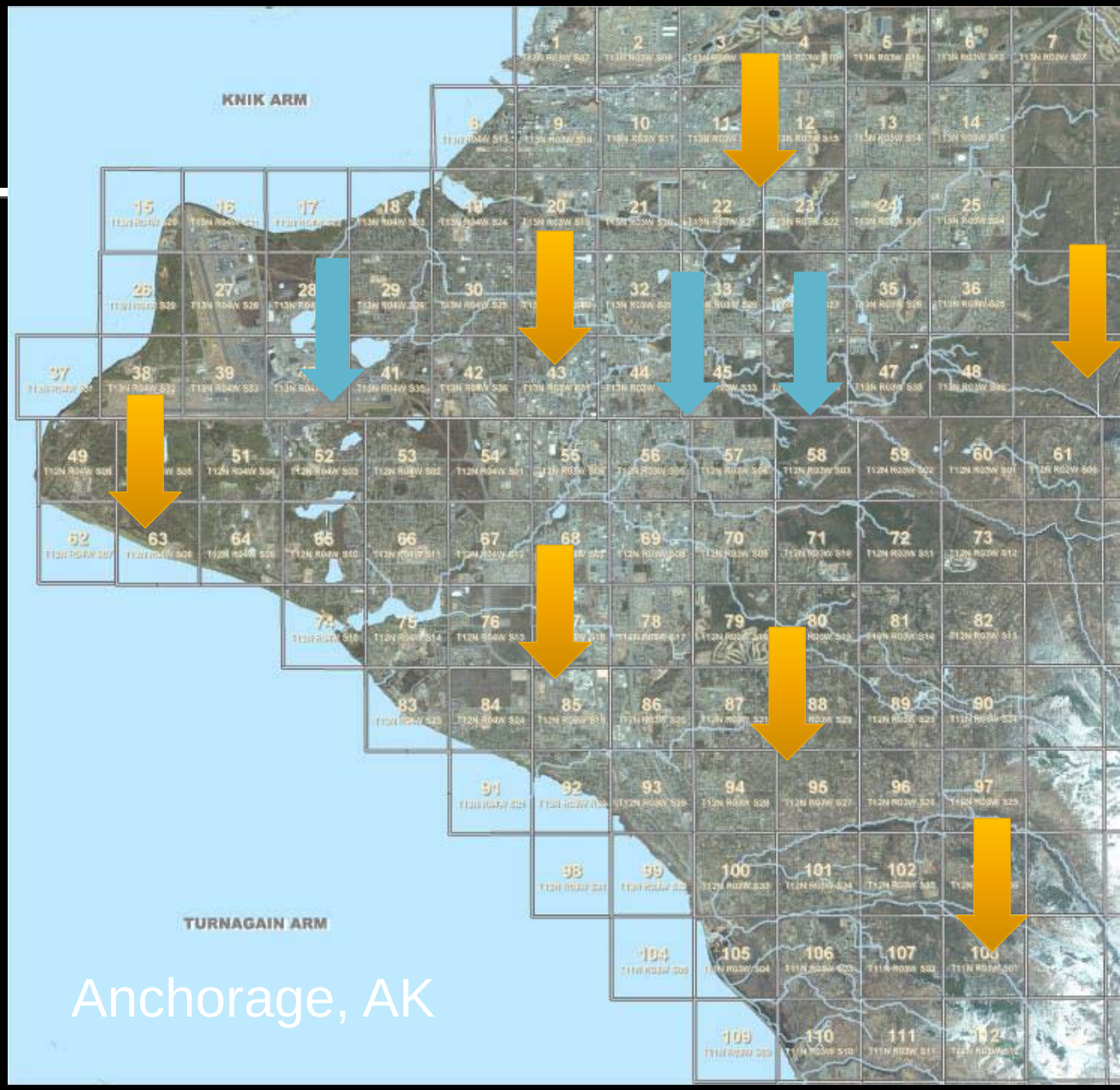
Dissections for establishment

Photo: Chris MacQuarrie

- In 2006, 100 Larvae collected from release sites
- Dissected to determine percent parasitized

Release Sites

Parasitism observed



Native Parasitism

- PCR Molecular techniques
  - Matched larval sequences in the COI gene to wasps recovered at permanent plots
- Determined to be previously undescribed
  - Identified by Alexey Reshchikov as *Lathrolestes soperi*

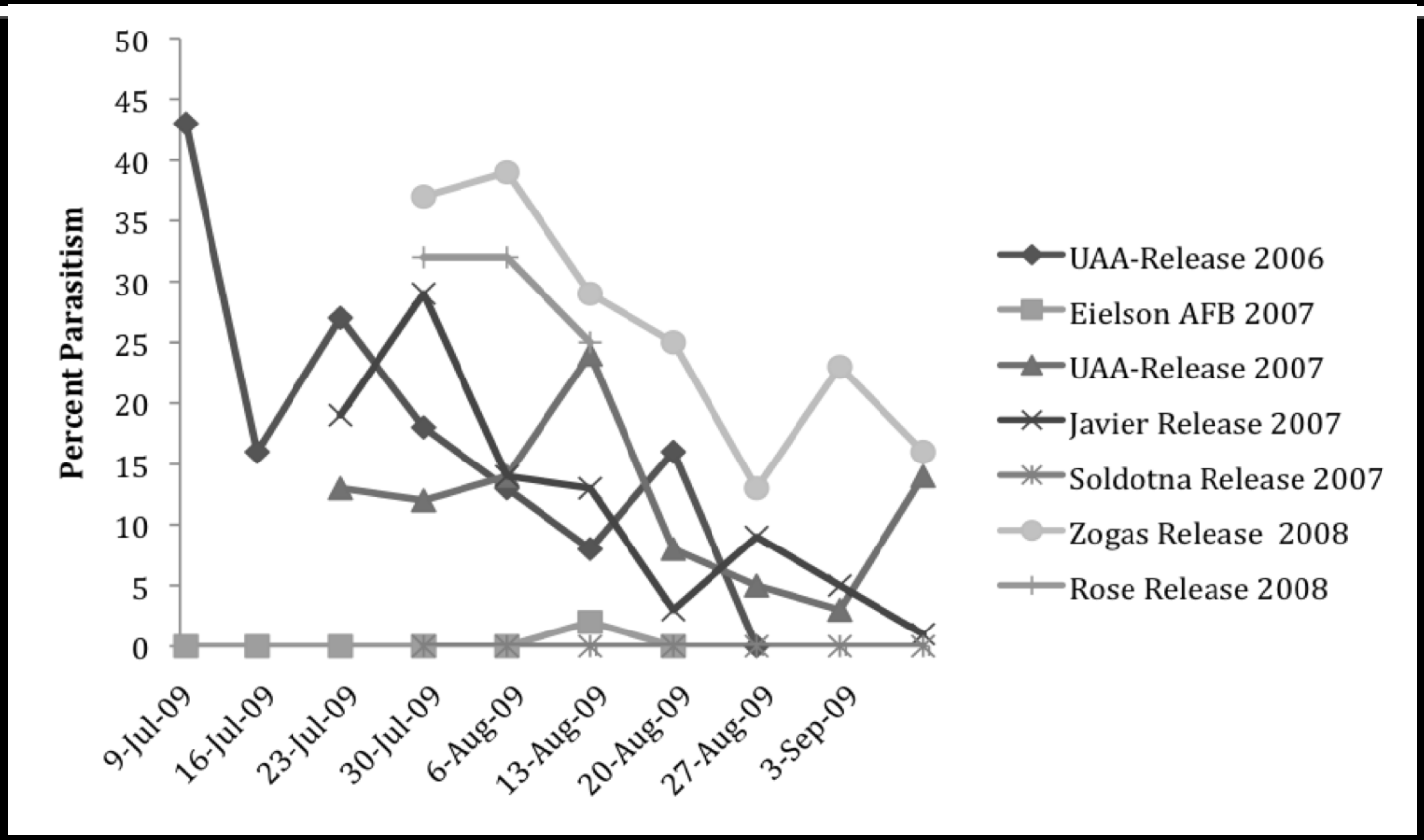
Determining Percent Parasitism

- PCR Molecular techniques
  - Matched larval sequences in the Barcoding region of the COI to wasps recovered at permanent plots
- Can genetically identify *L. thomsoni wasps* and *L. soperi* wasps

Methods

- One hundred larvae collected from all release sites from the first week in July until the third week in September 2009 and 2010
- Larvae were dissected to determine percent parasitism
- Parasitoid larvae preserved in 100% Ethanol
- DNA was extracted and subject to PCR

Percent Parasitism



- *Lathrolestes* spp. parasitism of ambermarked birch leafminer (*Profenusa thomsoni*) larvae collected at *L. thomsoni* release sites from July-September 2009 in Anchorage, Alaska

Parasitoid Split Ratio

Sample Date	Release Site/Year of first release	Total Percent Parasitism[1]	No. of successful DNA amplifications	Parasitoid Split Ratio *L. soperi*	Parasitoid Split Ratio *L. thomsoni*	Calculated % Parasitism[2] *L. soperi*	Calculated % Parasitism[2] L. thomsoni
9 July 2009	UAA-Release 2006	43	26	0.42	0.58	18	25
15 July 2009	UAA-Release 2006	16	13	0.47	0.53	7	9
22 July 2009	UAA-Release 2007	27	19	0.32	0.68	5	12
6 August 2009	Javier Release 2007	14	11	0.91	0.09	13	1
6 August 2009	Rose Release 2008	23	16	0.81	0.19	26	6
6 August 2009	UAA-Release 2006	13	13	0.85	0.15	11	2
6 August 2009	UAA-Release 2007	14	12	0.75	0.25	11	4
6 August 2009	Zogas Release 2008	39	27	0.89	0.11	35	4
11 August 2009	Eielson AFB 2007	1	1	0	1	0	1
12 August 2009	UAA-Release 2007	24	18	0.83	0.17	20	4
13 August 2009	Zogas Release 2008	29	24	0.92	0.04	27	1
20 August 2009	UAA-Release 2007	9	9	0.89	0.11	8	1
20 August 2009	Zogas Release 2008	25	20	0.90	0.10	23	3
27 August 2009	UAA-Release 2007	5	3	0.67	0.33	3	2
27 August 2009	Zogas Release 2008	13	11	0.91	0.09	12	1
1 September 2009	Zogas Release 2008	23	19	0.89	0.11	21	2

Rates of AMBLM parasitism by *Lathrolestes* species at *L. thomsoni* release sites in Anchorage, Alaska, in 2009

2010 Methods for Establishment

- Sweep Sampling employed to determine location and time of flight activity

- All release sites (except Eielson) sweep sampled each week from early June-late September

- Wasps counted and re-released

Establishment

- From 2009-2010 wasps were recovered at all release sites
  - In 2010 42 wasps recovered from 1 site alone

Sweep sampling for spread

- Twenty neighboring trees sampled in four directions
- At one release site, wasps spread 100m

Establishment of Permanent Plots

- Twenty sites established within the city of Anchorage
- Single tree at each site
  - *Betula papyrifera*
- Assess before impacts of the pest

- Sites further classified
  - Urban
  - Forest

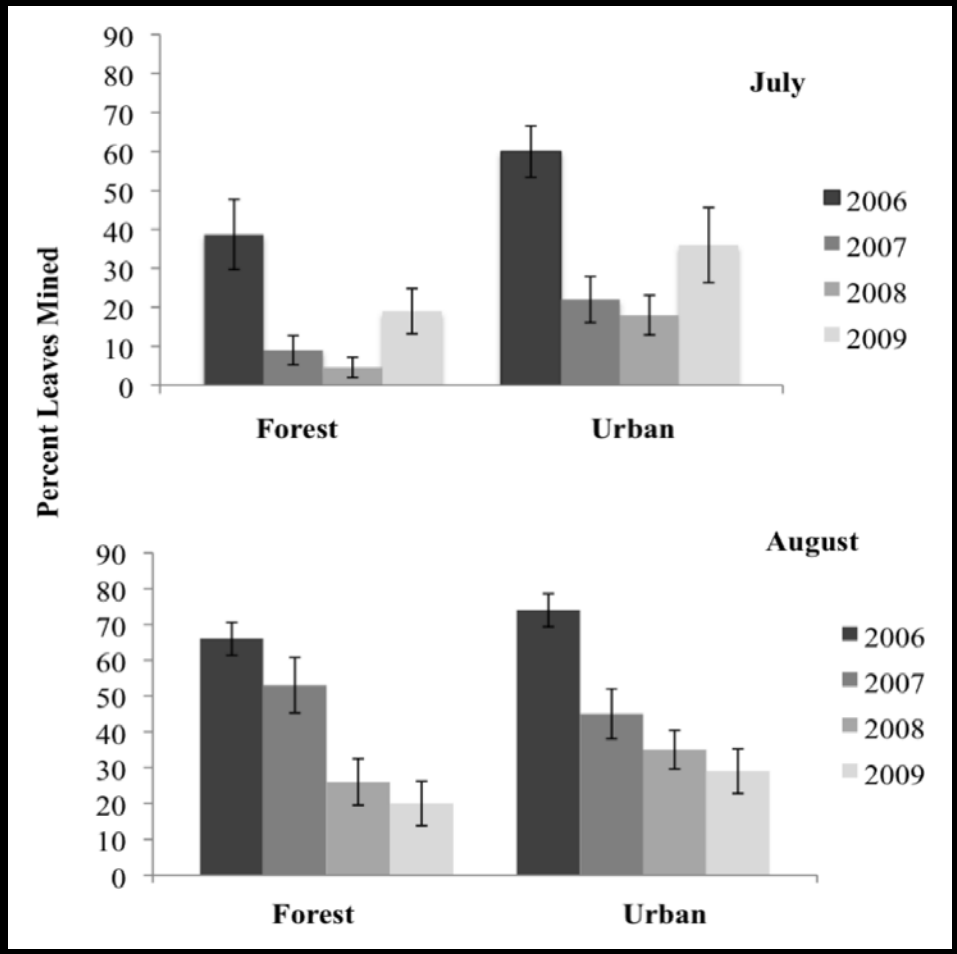
Establishment of Permanent Plots

Forest

Urban

Declining Densities

- Densities of the leafminer are declining



Additional parasitoid discovery

- In 2006 noticed an additional wasp in the system
- When collecting from emergence traps, unknown wasp is the most commonly occurring
  - Accounted for 80% of wasps found in emergence traps over the season

Aptesis segnis

- Identified by Andy Bennett as *Aptesis segnis*
- Known to attack *Profenusa canadensis* (Hawthorn leafminer)
- Facultative hyperparasitoid
- Attacks the leafminer in the soil
- Similar system to that of European apple sawfly (*Holocampa testudinea)*
  - *Aptesis nigrocincta* and *Lathrolestes marginatus*

(Babendreir, D. (2000) Bulletin of Entomological Research 90: 291-297)

Aptesis segnis future research

- Evaluate the impact of *Aptesis segnis*
- What role does this wasp play in the system?
- Could *Aptesis segnis* be a successful biological control agent?
- What are the interactions between *A. segnis, L. thomsoni, and L. soperi?*

Conclusions

- Successfully established *Lathrolestes thomsoni* at all release sites in Alaska for control of the Ambermarked Birch leafminer
- Three parasitoids known to attack *Profenusa thomsoni* in Alaska
- DNA sequencing has made it possible to identify larval parasitoid wasps to distinguish between the introduced and native *Lathrolestes* species
- Potential for Aptesis segnis to offer control of the leafminer as well
- Population densities appear to be declining
  - Cool temperatures
  - Increased parasitism

Leaves in 2010

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