Developing a Biological Control Program for an Invasive Beetle

Leah Bauer
USDA FS &
Michigan State Univ.
E. Lansing, MI

What is Classical Biological Control?

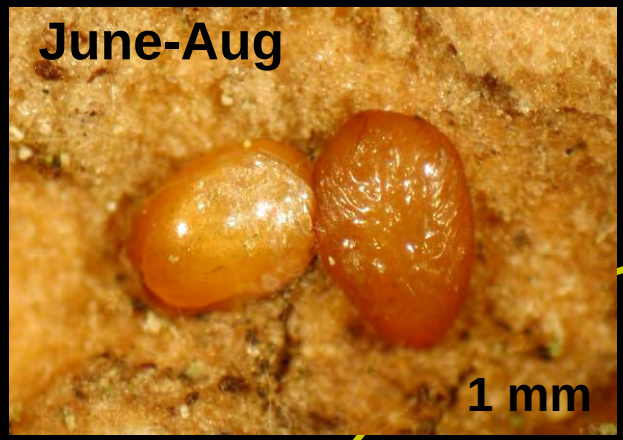
The importation of specialist natural enemies for sustained control of a previously introduced pest.

International Organization for Biological Control (IOBC) recommends use of biological control when a species is:

- ✓ not native
- ✓ established for at least 5 years
- ✓ causes economic or ecological damage
- ✓ eradication is not possible

What steps are involved in classical biological control?

1. Study biology of the invasive species
2. Survey for native natural enemies
3. Foreign exploration for natural enemies
4. Select potential biocontrol agents
5. Import & study biocontrol agents in quarantine
6. Prepare environmental assessment
7. Request & receive permits for field release
8. Select field sites, mass rear, release
9. Determine establishment, efficacy, impact



A Case Study:
Emerald Ash Borer
Agrilus planipennis
(Coleoptera: Buprestidae)

Natural Enemy Survey of EAB Natural Enemie
in Michigan: 2002-2004

<1% parasitism

Balcha indica (7-9 mm) (exotic)

Eupelmidae

Phasgonophora sulcata (8 mm)

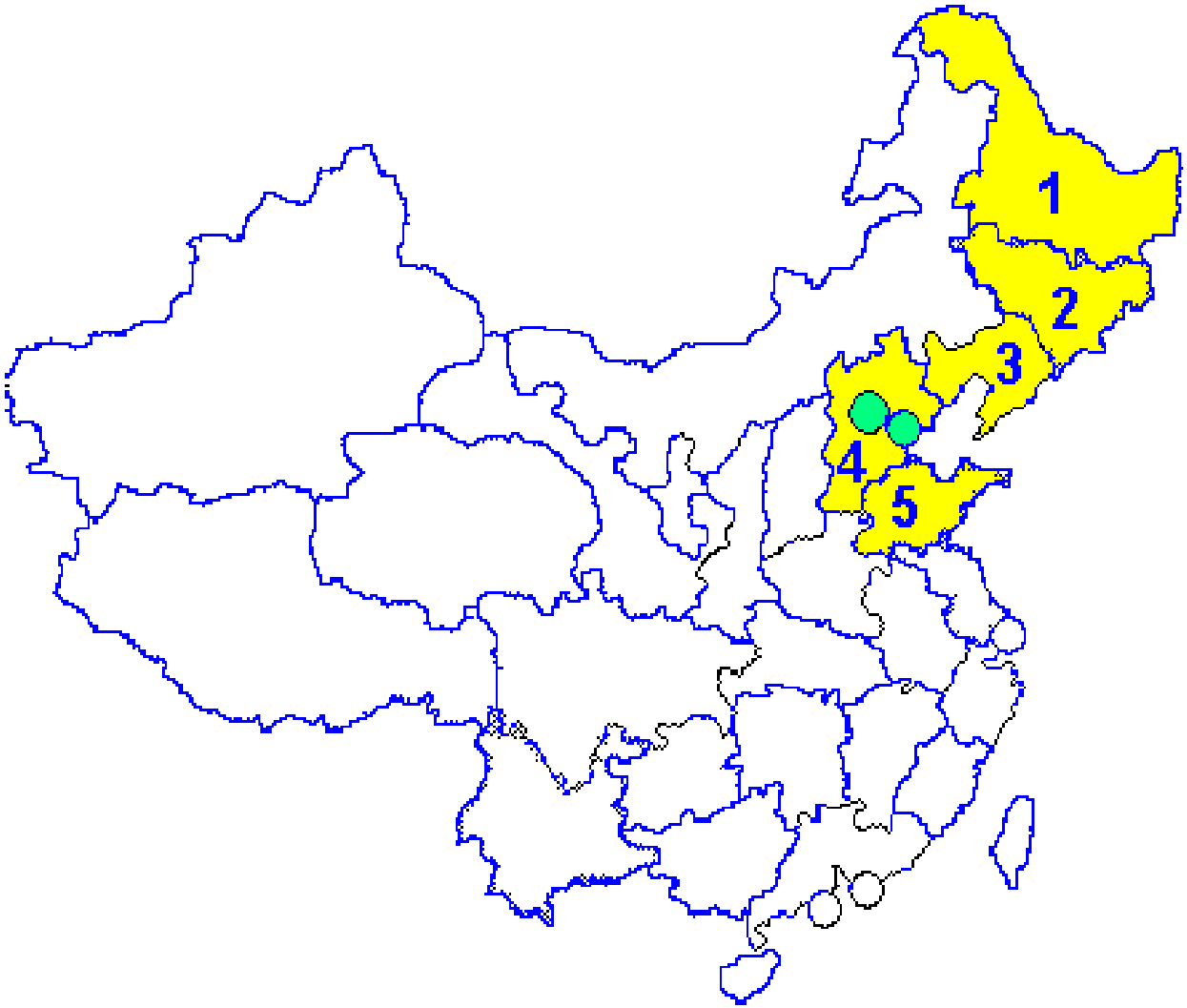
Chalcididae

Atanycolus spp. (12 mm)

Spathius floridanus (4 mm)

Braconidae

Provinces in China Surveyed for Ash, EAB, and Natural Enemies: 2003-2007



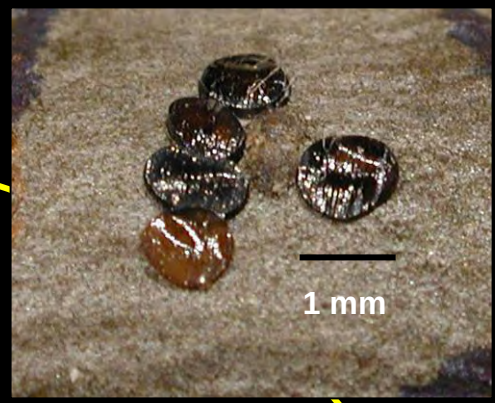
1 Heilongjiang
2 Jilin*
3 Liaoning*
4 Hebei*
5 Shandong
6 Tianjin*
7 Beijing*

* EAB found since 2003

Oobius agrili

(Hymenoptera: Encyrtidae)

- **A solitary egg parasitoid of EAB in China**
- **Parthenogenic (unmated females produce females)**
- **Released at two sites in MI in 2007**
- **Establishment confirmed at two sites in 2008**
- **Releases expanded to new sites in MI, OH & IN in 2008**



Oobius:
4-week life cycle

♀:♂ = 15:1

Tetrastichus planipennisi
(Hymenoptera: Eulophidae)

- **A gregarious larval endoparasitoid of EAB in China**
- **Released at two sites in MI in 2007**
- **Establishment not yet confirmed**
- **Releases continue at new sites in MI in 2008**

Tetrastichus:
4-week life cycle

♀:♂ = 4:1

Spathius agrili
(Hymenoptera: Braconidae)

- Reared by Dr. J. Gould, APHIS, Otis
- A gregarious larval ectoparasitoid of EAB in China
- Released by APHIS at three MI sites in 2007
- Establishment confirmed at one site in 2008
- Releases continue at new sites in MI & OH in 2008

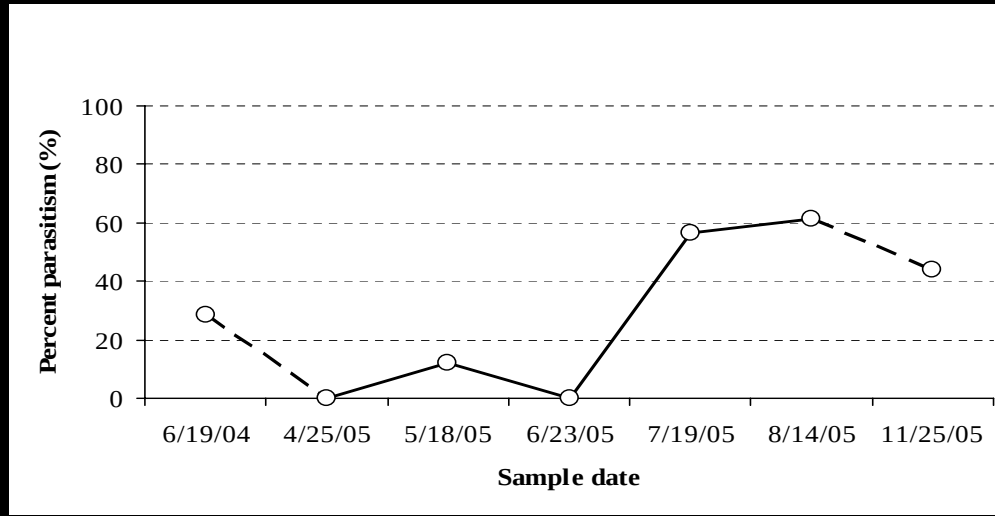
Spathius:
5-week Life Cycle

♀:♂ = 3:1

Jilin Province, China: EAB & 2 Parasitoids on Green Ash: 74% EAB Population Reduction

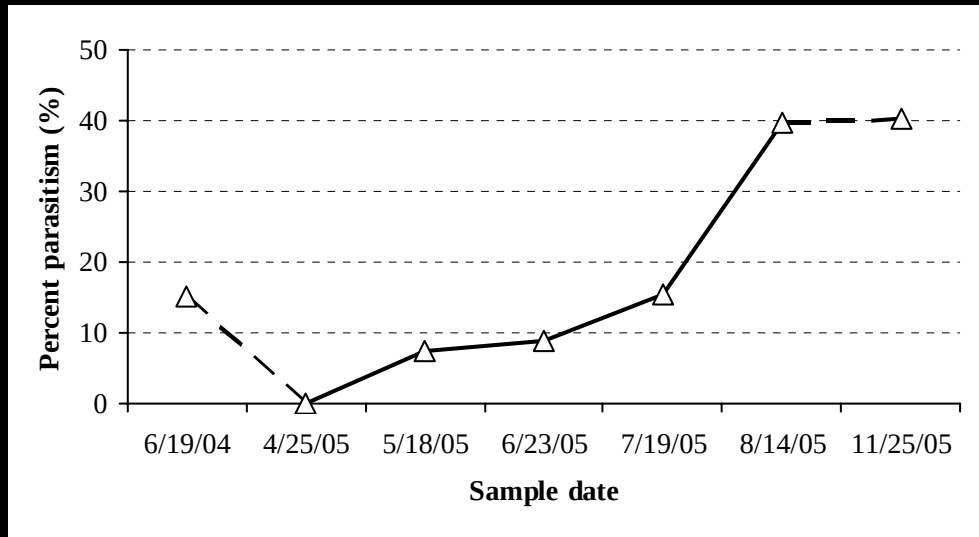
EAB Egg parasite:
Oobius agrili

At least 2 generations/yr
Parasitism – 36.5% average



EAB Larval parasite:
Tetrastichus planipennisi

4 generations/yr
Parasitism – 22.4% average



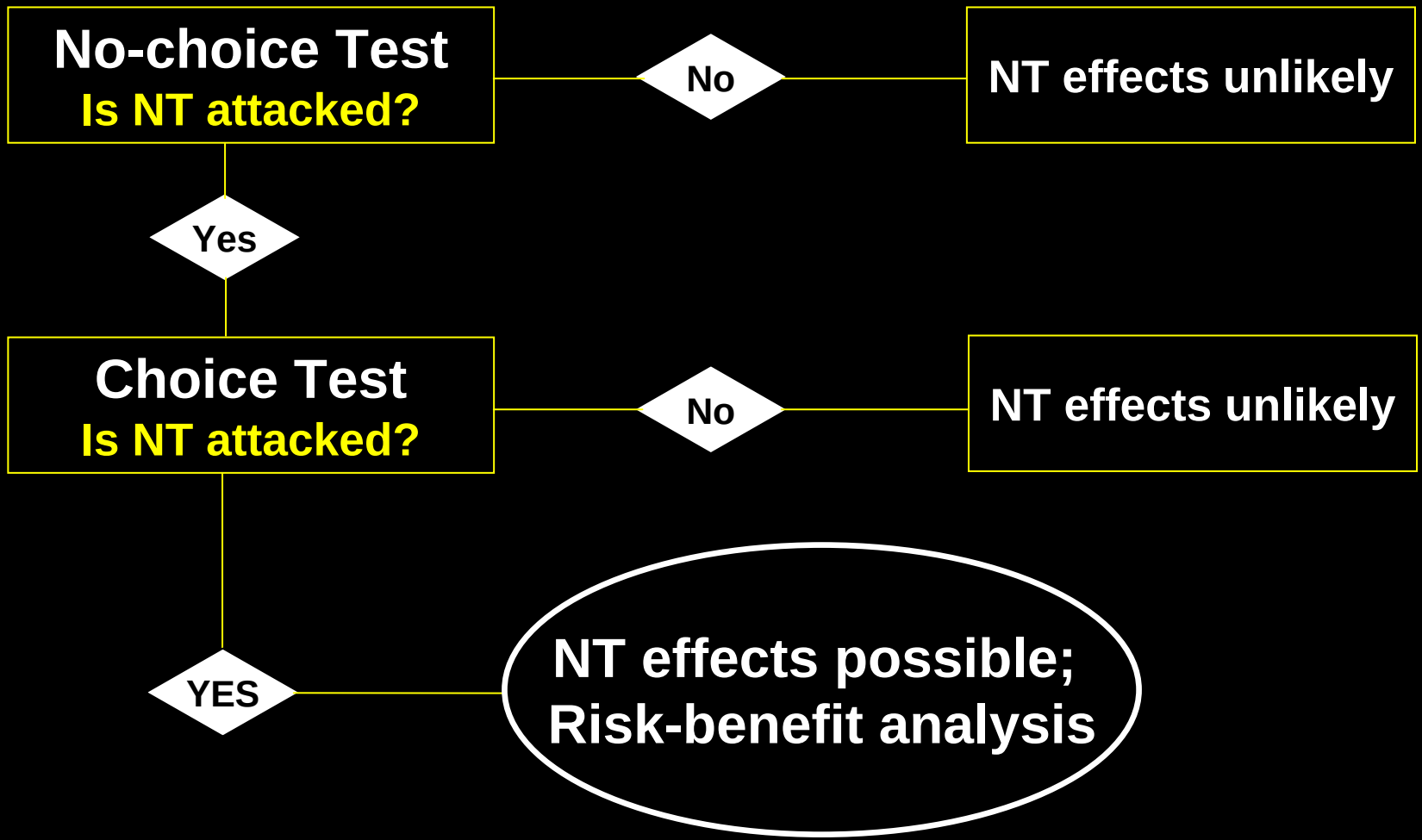
Liu & Bauer. 2007. Biological Control. 42: 61-71

IOBC: Best Practice Guidelines for Host Range Testing

To estimate the host range of a potential biocontrol agent, test 10-20 species that are:

- ✓ **phylogenetically related to target pest**
- ✓ **live in ecologically similar niche**
- ✓ **T&E or economic importance**

Host Specificity Testing Scheme for *Oobius* and *Tetrastichus*



Summary of Host Specificity Studies

Parasitoid Species	No-choice Assays (family or genus)	Species (n)	Host Accept (n)	Choice Assays (n spp.)	Olfacto-metry	Survey in China
Oobius	*Agrilus* Cerambycidae Lepidoptera *Total*	6 2 4 12	3 - -	3 - -	No	No
Tetrastichus	*Agrilus* *Chrysobothris* Cerambycidae *Tenebrio* Lepidoptera Hymenoptera *Total*	5 3 5 1 2 1 17	- - - - - -	No	No	Yes
Spathius	*Agrilus* Cerambycidae Lepidoptera Curculionidae *Total*	9 3 6 1 19	4 - - -	No	Yes	Yes

2007 Timeline for Release of EAB Biocontrol Agents in Michigan:

Permit Application → Parasitoid Release

- Jan: Applied to for release permits from APHIS
- Feb: Biological Assessment complete; F&WS FONSI
- Jun: Environmental Assessment published for 60 days
  - 30 public comments favored releases
  - 11 public comments opposed releases
- Jul: APHIS FONSI and approved by Michigan
  - extensive press coverage
  - federal permit issued
  - parasitoid releases began

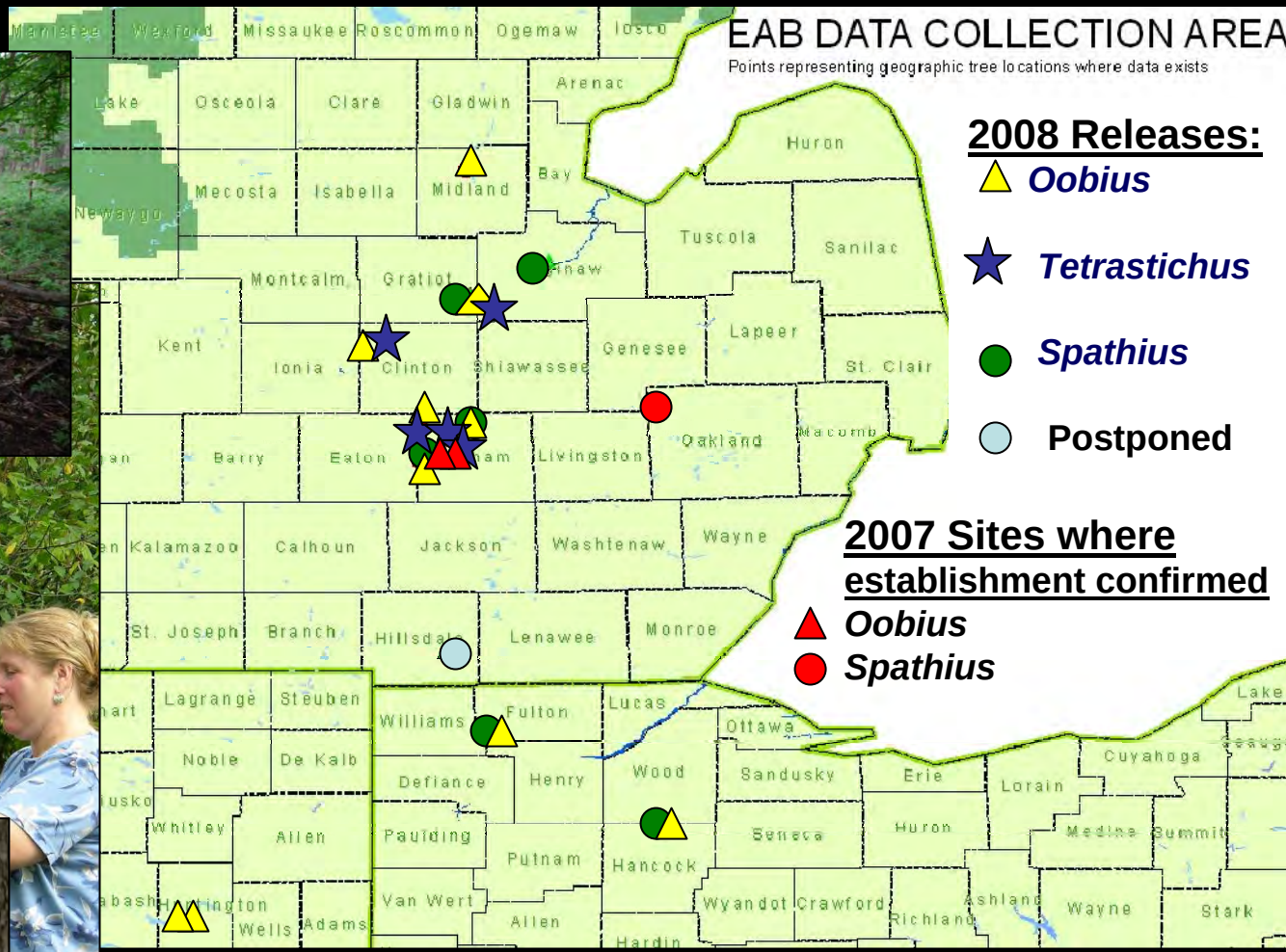
http://www.regulations.gov/fdmspublic/component/main?main=DocketDetail&d=APHIS-2007-0060

Overview of EAB Parasitoid Releases: 2007-2008

Parasitoid	State	Sites (n)	2007	Released (n females)	Establishment Confirmed in 2008 (n sites)
Oobius	MI	2	July-Aug	1406	2
Tetrastichus	MI	2	July-Oct	1360	0
Spathius	MI	3	Sept	311	1

Parasitoid	State	Sites (n)	2008	Released (n females)
Oobius	MI	11	June-Aug	1,680
	OH	2	June	203
	IN	2	June	206
Tetrastichus	MI	6	June-Oct	620
Spathius	MI	3	Aug	79
	OH	2	Aug	118

EAB Biocontrol Release Study Sites

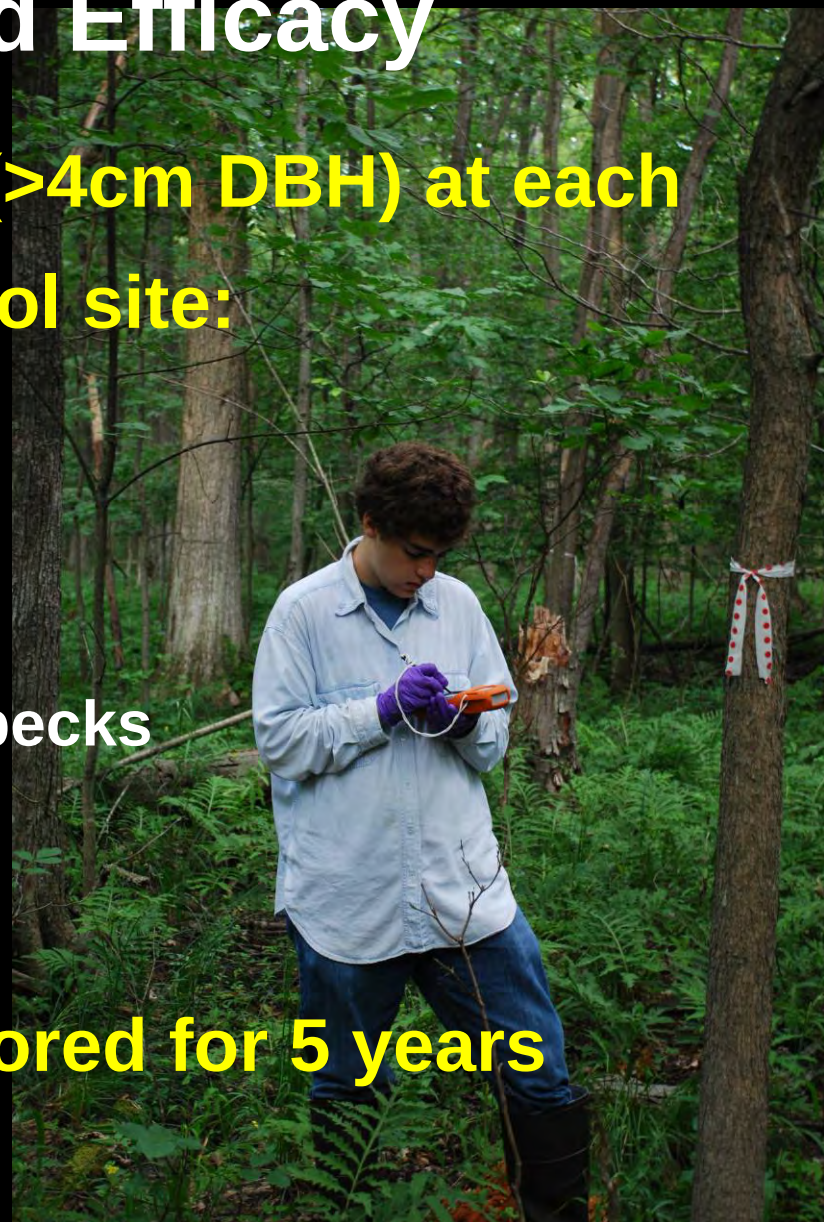


Data Collection at Field Sites to Evaluate Parasitoid Efficacy

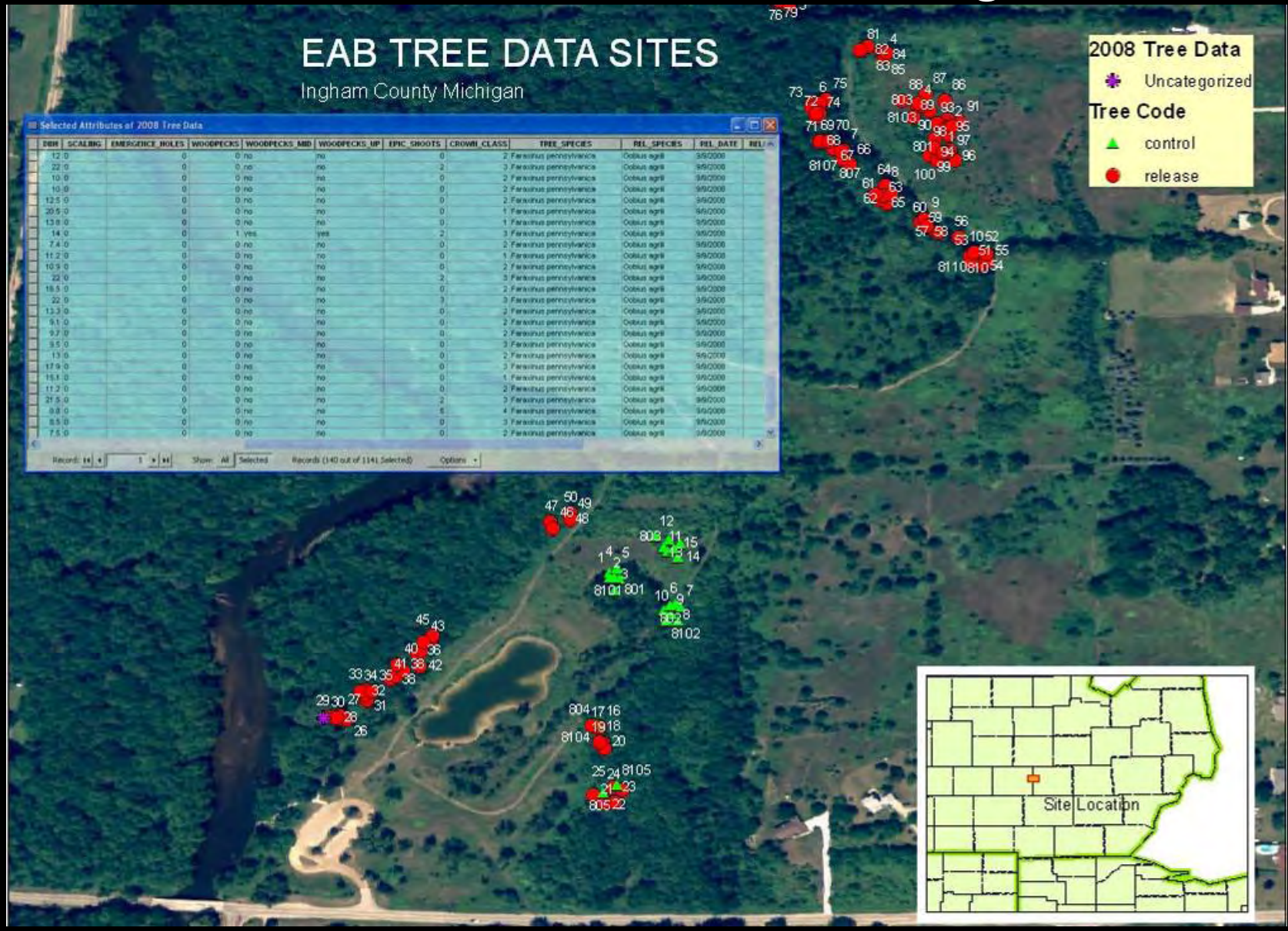
2008: Data on 50 ash trees (>4cm DBH) at each parasitoid release and control site:

- ash species & DBH
- GPS mapped & metal tagged
- crown condition (1-5 rating)
- epicormic branches & woodpecks
- EAB exit holes & bark splits
- data on parasitoid releases

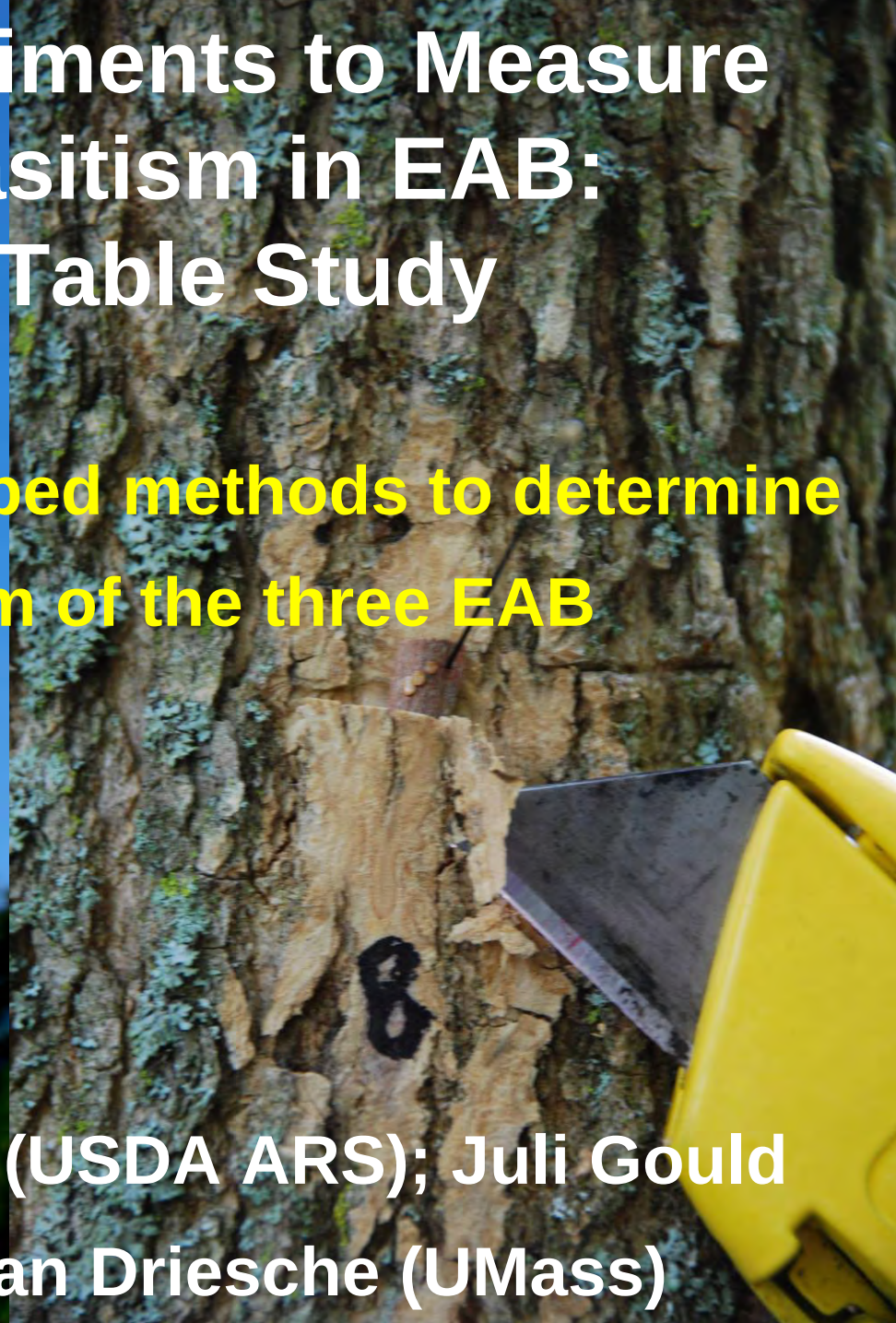
Tree condition will be monitored for 5 years



Long-term Assessment of Ash Tree Health at Release and Control Sites Using ArcGIS



2008: Field Experiments to Measure Levels of Parasitism in EAB: 3-Year Life-Table Study



This summer we developed methods to determine stage-specific parasitism of the three EAB parasitoids.

Collaborators: Jian Duan (USDA ARS); Juli Gould (USDA APHIS); & Roy Van Driesche (UMass)

2008 EAB Biological Control Program: 5-Year Plan

- APHIS rearing lab built in Brighton, MI to:
  - consolidate parasitoid rearing to a central location
  - increase numbers of parasitoids reared
  - increase number of release sites throughout U.S.
- Research at selected field sites:
  - natural enemy establishment
  - efficacy of parasitoids on ash survival, health, recovery
  - factors required for establishment
  - model the effects of parasitoids on EAB density and spread
  - parasitoid-parasitoid interactions & nontarget effects

Acknowledgments

Michigan State University: Houping Liu, Deb McCullough
Chinese Academy of Forestry in Beijing: Tonghai Zhao
Ruitong Gao, Zhongqi Yang
USDA FS, NRS in E. Lansing: Debbie Miller, Kit O'Connor
Toby Petrice, Tina Khun
Purdue University: Cliff Sadof