# Successful biological control of mile-a-minute weed (*Persicaria perfoliata)* in Eastern North America:

## Establishment and impact of the Asian weevil, *Rhinoncomimus latipes*

J. Hough-Goldstein, E. Lake, and R. Reardon

# Mile-a-minute weed: *Persicaria perfoliata* (AKA *Polygonum perfoliatum*)

Triangular leaves, flared ocreae surround stem, small backward-projecting barbs

# Forest edge, disturbed open areas

White Clay Creek State Park, July, 2003

Pea Patch Island, Delaware, Aug. 2003

# Annual vine - vines grow 20 ft+ in a season

**Impacts:**

- Inhibits reforestation/ regeneration
- Interferes with recreational use of natural areas (barbs)
- Reduces quality wildlife habitat
- Likely effects on native flora
  - Blue Hills, Milton MA

White Clay Creek State Park, Delaware
July 23, 2003

Dead vines in winter

- Large numbers of seeds produced, survive 6 years in seed bank
- Seeds germinate under old plants
- Dispersed by birds, deer, water

Cluster of achenes (single-seeded fruits)

Seedlings in May

# Origin of mile-a-minute weed

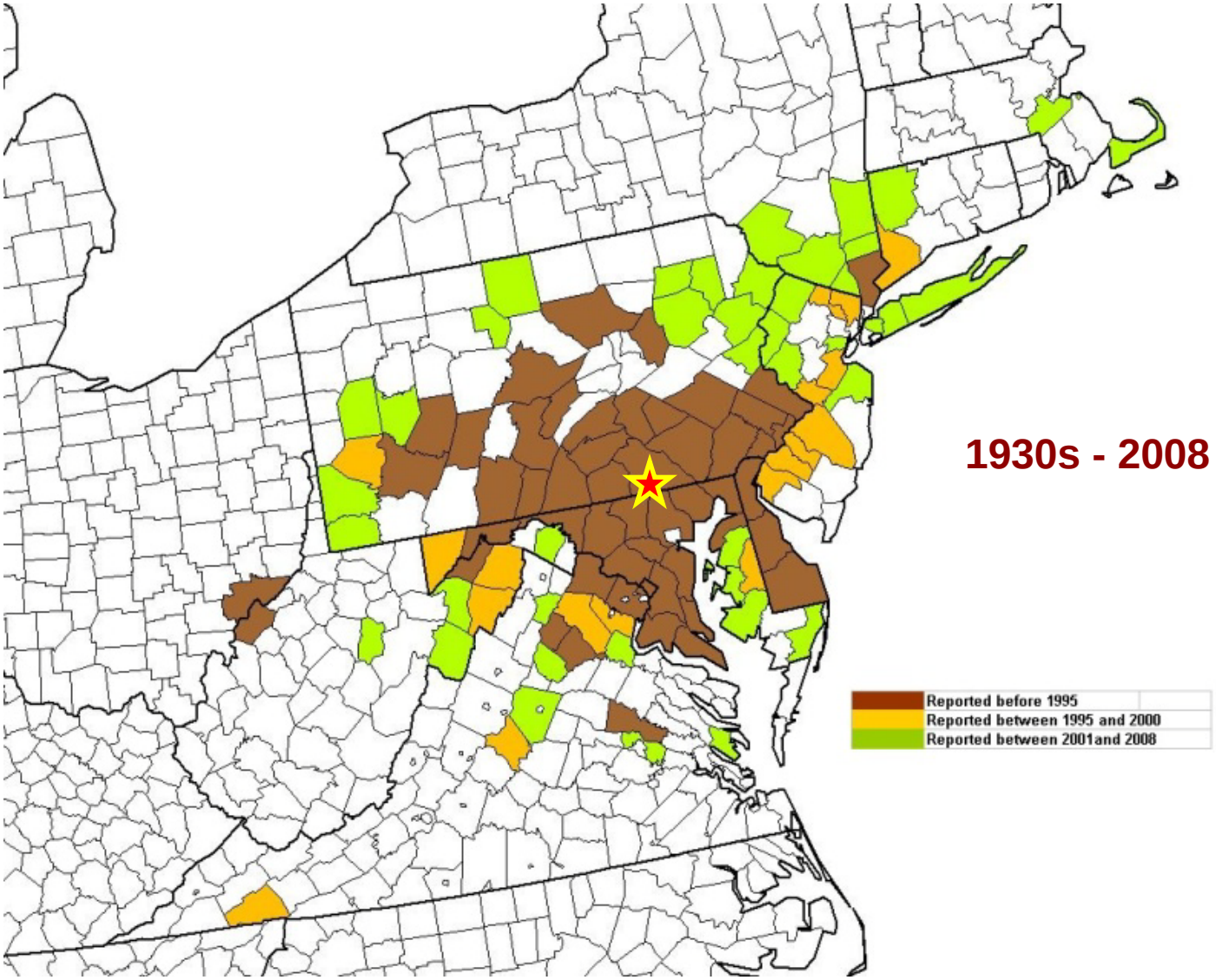

Native to Asia:
China
Japan
Korea
India
Bangladesh
Nepal
Bhutan
Burma (Myanmar)
Thailand
Vietnam
the Malay Peninsula
Taiwan
the Philippines

Also found in:
Turkey
eastern Russia

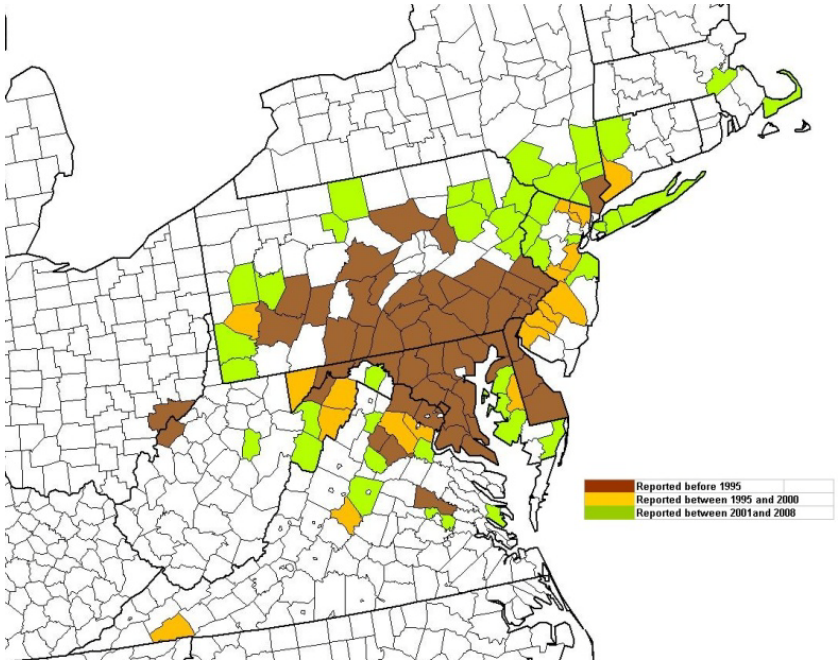
# Establishment in U.S.

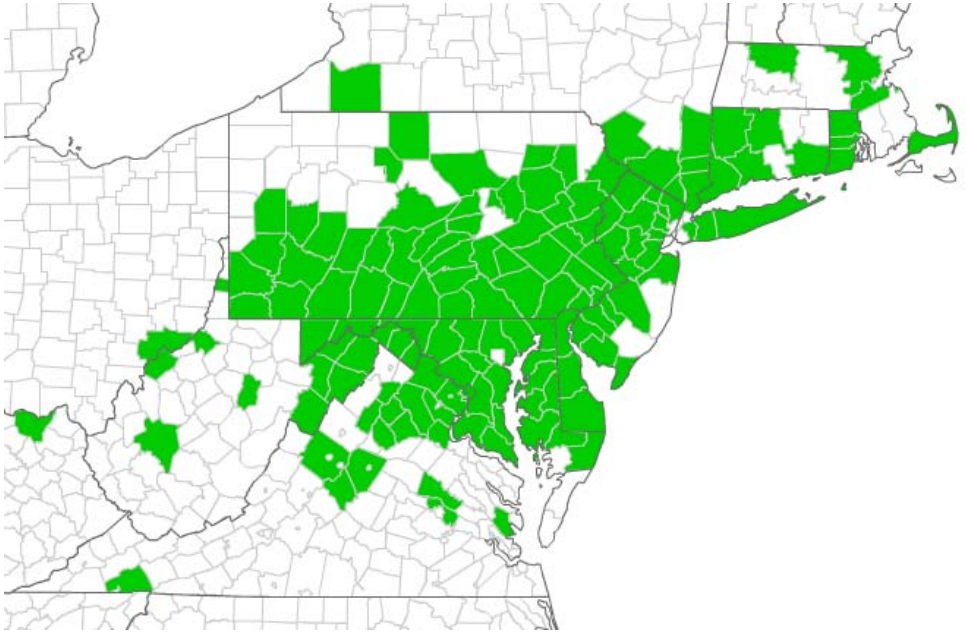
- Nursery in York Co., PA, 1930s
- From Japan, with shipment of holly seed (Moul 1948)
- Before 1980: five counties in PA & parts of MD

# Distribution in U.S.



# ~30 more counties added, 2008 - 2010



EDDMapS – UGA Center for Invasive Species and Ecosystem Health

Summer 2010: NW North Carolina

# Biological Control Program – US Forest Service, 1996

- >100 insect species on MAM weed in China (Ding et al. 2004), heavy feeding
- Preliminary host-range studies in China
- Several species sent to Delaware (quarantine): 1999

MAM in US (Les Mehrhoff, Conn., IPANE)

MAM in China (Ding Jianqing, Wuhan Botanical Garden)

# *Rhinoncomimus latipes* Korotyaev,1997

- Host specificity
- China: tested on 49 plant species (various families, including crops)
- Delaware: tested in quarantine on 28 species, mostly Polygonaceae (all tribes & sections)

Adult weevil ~2 mm long

# Found to be extremely host-specific

- Did not feed at all on any plant species outside Polygonaceae
- Minor adult feeding on a few Polygonaceae
- No egg-laying or larval survival on any host except MAM
- Permit for field release in North America: July 2004 (8 years after start of program)

Colpetzer et al. 2004

# Biology of the Weevil

- **Eggs** laid on plant, hatch in ~3 - 5 days


# Larvae crawl along stems, enter node

- Feed inside stem/node

Newly hatched larva

Larva feeding in stem

Photos by Dan Palmer & Amy Diercks, N. J. Dept. Ag.

# Larvae drop out of stem to pupate in soil

Fully developed larva

Pupa inside pupation capsule, secreted in soil

# Adults emerge from soil ~1 week later

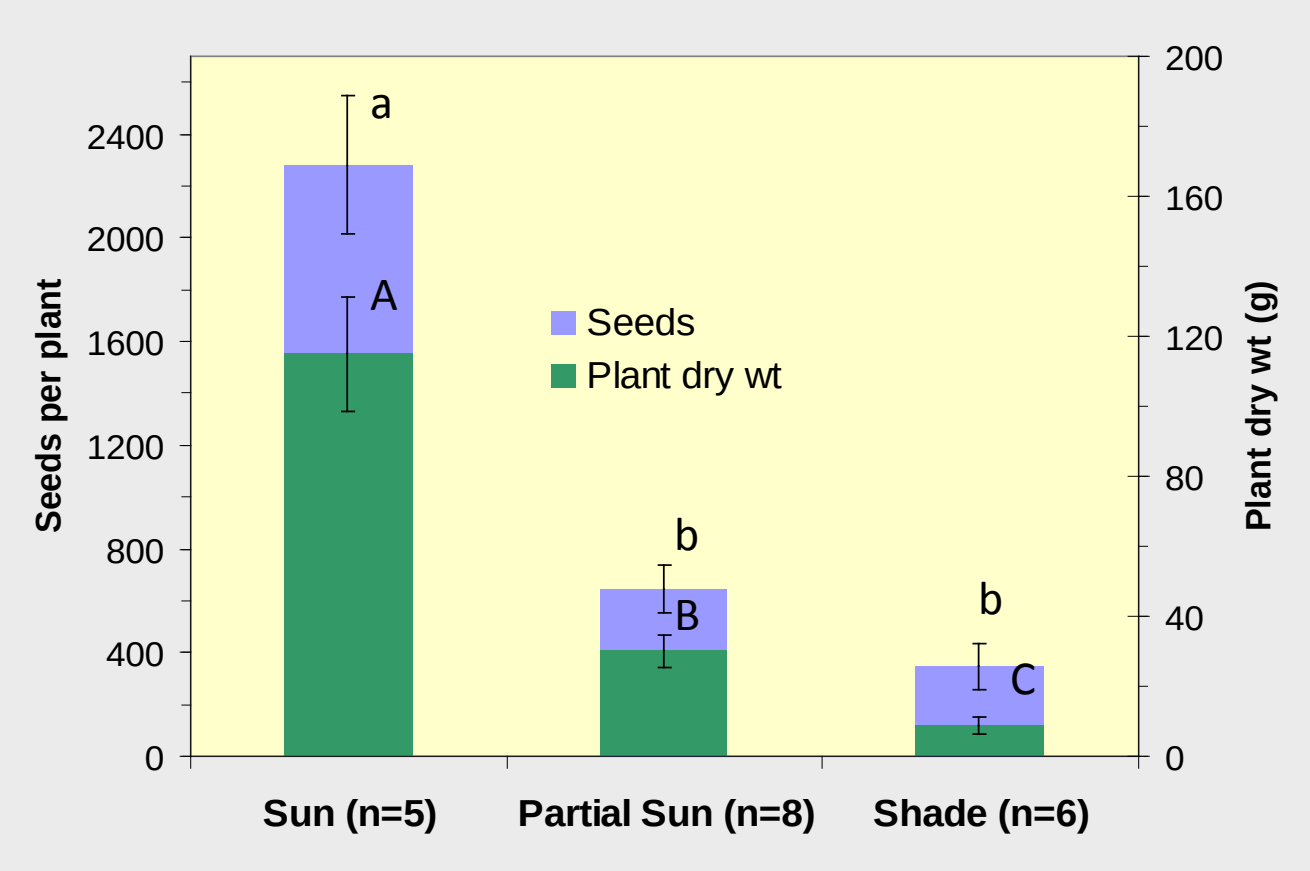
- Black when emerge, turn orange-brown after feeding on mile-a-minute for several days

- Adults mate, lay eggs -- ~26 days from egg to adult
- Multiple overlapping generations continue until September (adults overwinter in soil)

# Impact on plants?
# Cage studies with single plants (isolated in the field) in weevil-proof cages

# 2005 pilot study: Highly significant difference by sun exposure

## Seed production and plant dry weight :

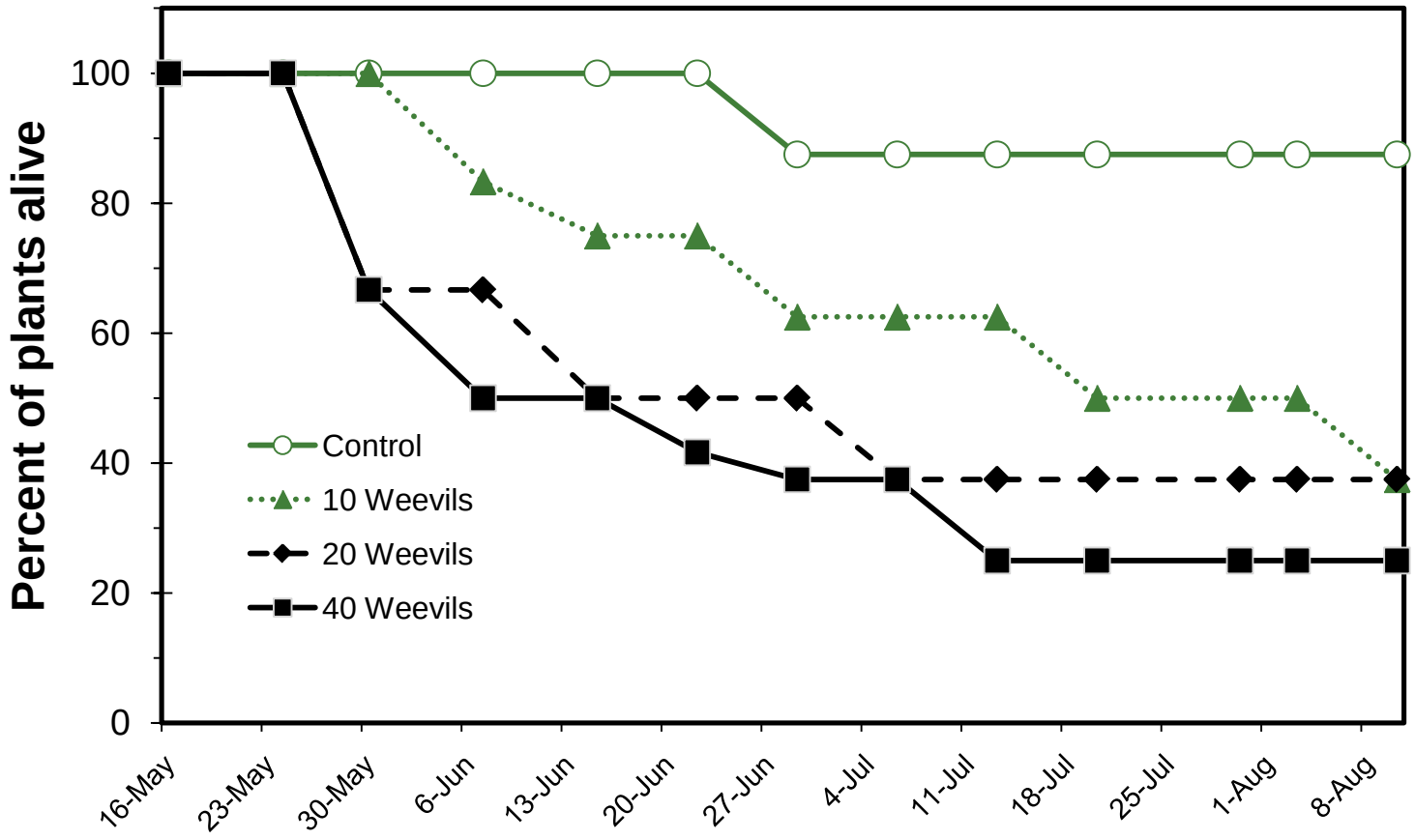


# 2006: plants without competition

- 20 weevils per cage suppressed seed production for ~9 wk

- Were able to produce seeds later in year despite presence of weevils

# 2007 cage study – other plants plus weevils = MAM mortality

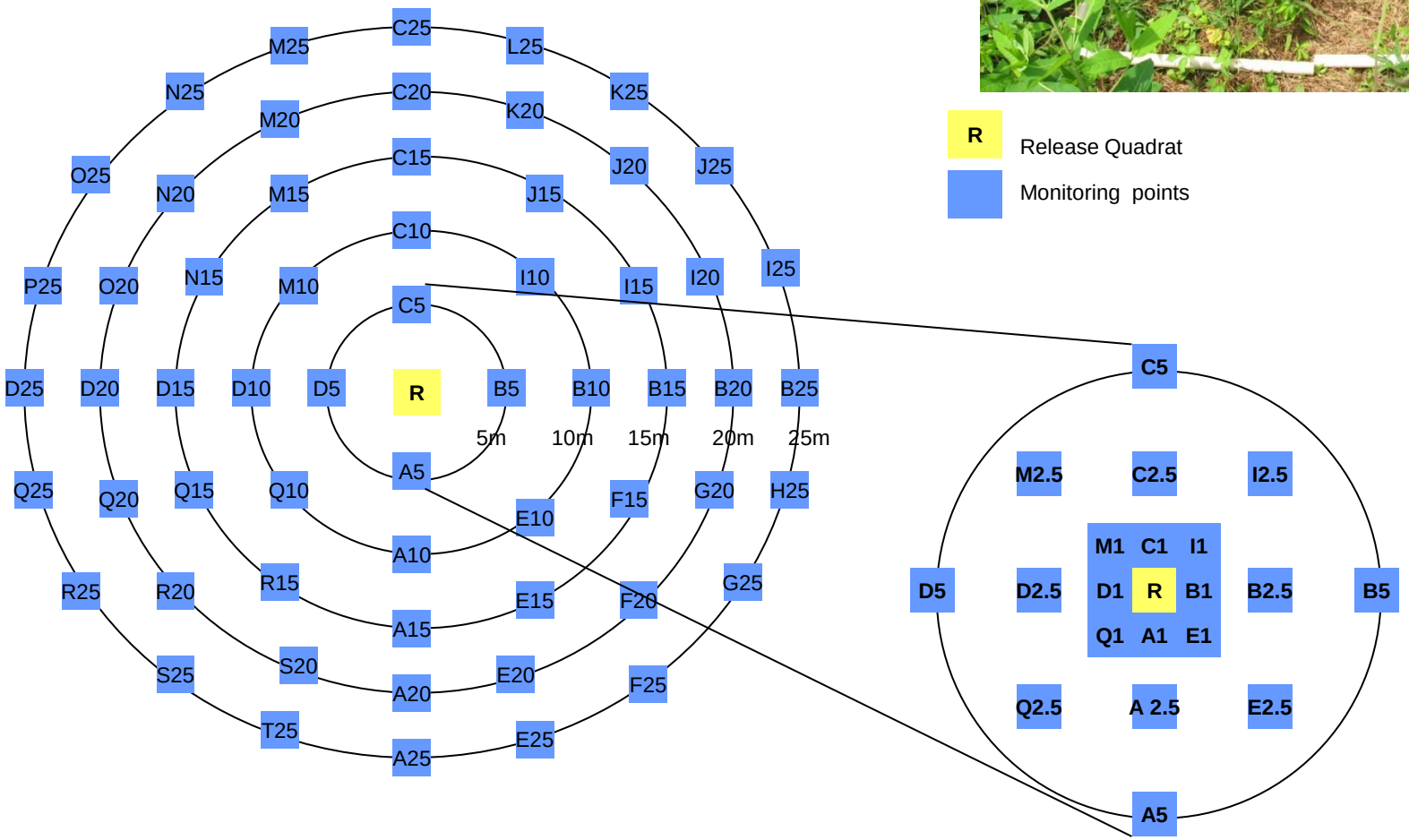



**Seed production in surviving plants again greatly delayed in cages with weevils**

# Field impact: 3 replicated release sites, beginning Spring 2005

- Graduate student Ellen Lake
- Weevil life history, population growth, and dispersal in field
- Impact on mile-a-minute

# 450 weevils released in the center of each array 9 June 05

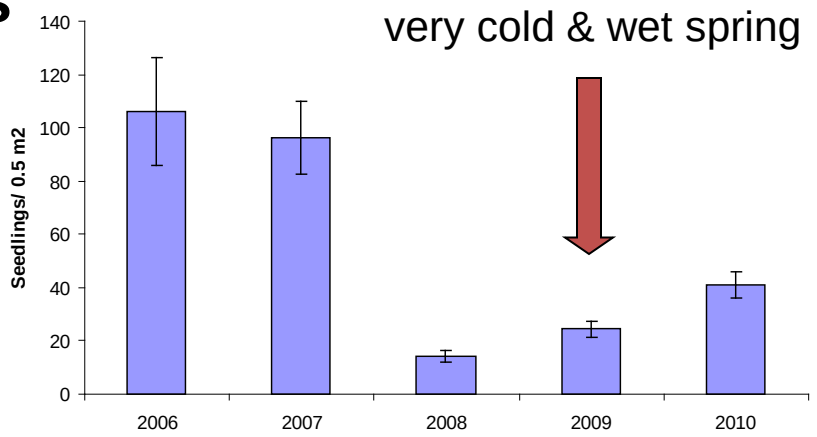


# Life history & dispersal

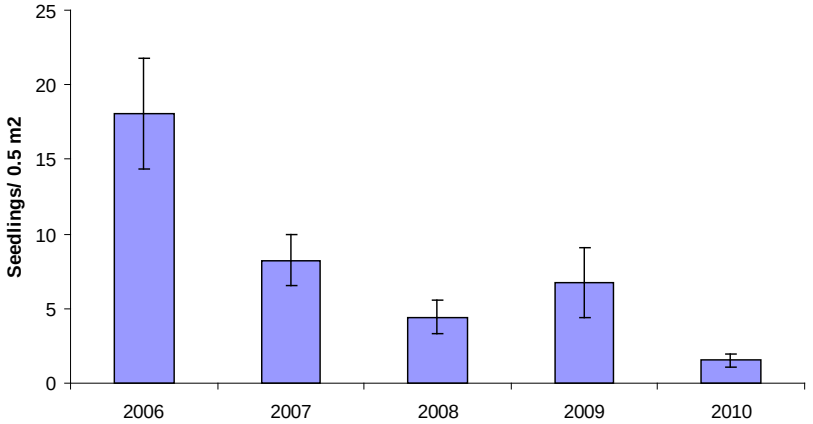
- 3-4 overlapping generations
- Continual egg-laying until mid-August to mid-September
- Dispersed throughout most of arrays (15-25 m) in one season
- October, 200+ meters away, across tree line & hay fields, on isolated MAM plants
- By next year, 600-700 m from release site

# Spring Seedling Counts

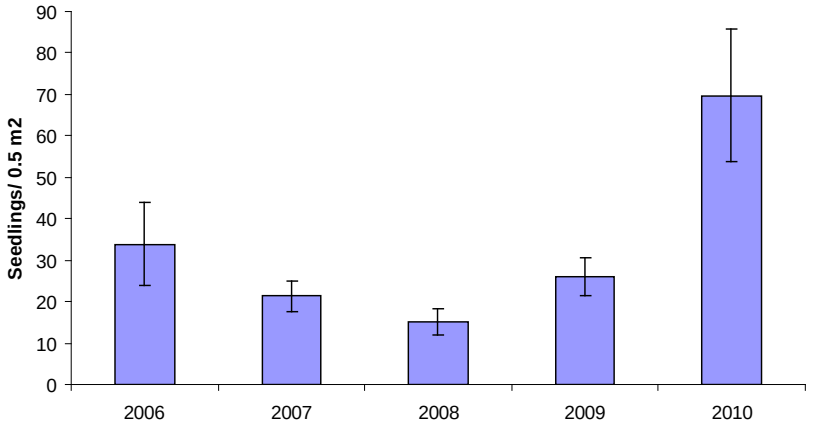
## Laurels




## BVA CREP




## BVA Wetland



# Native plant community

- Currently assessing other vegetation
- Major change in the at the CREP site
- Some alien invasives
- Dramatic increase in elderberry
- Very little MAM left at that site at accessible plots

# Weevils have been reared since 2004 at NJ Dept. Ag Beneficial Insects Lab

Dan Palmer, Amy Diercks, Carol Ott, Tom Dorsey

Oviposition container

Larval development containers

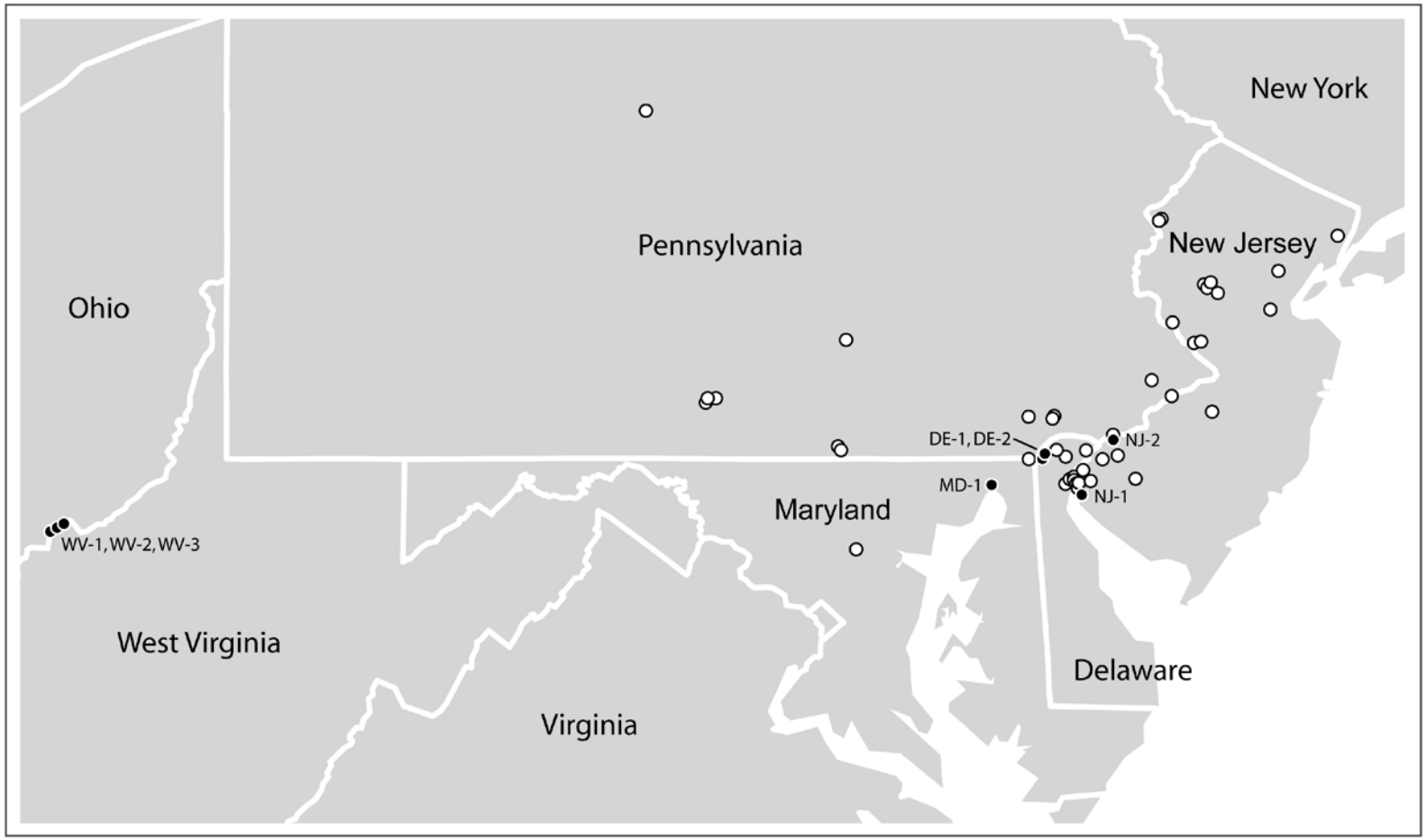
# Establishment

- Overwintered and established at 54 of 56 (96.4%) of sites where released, 2004 – 2007
- Withstood extremes of flooding
- Releases conducted between May and October all successful (however, two that failed were in October)

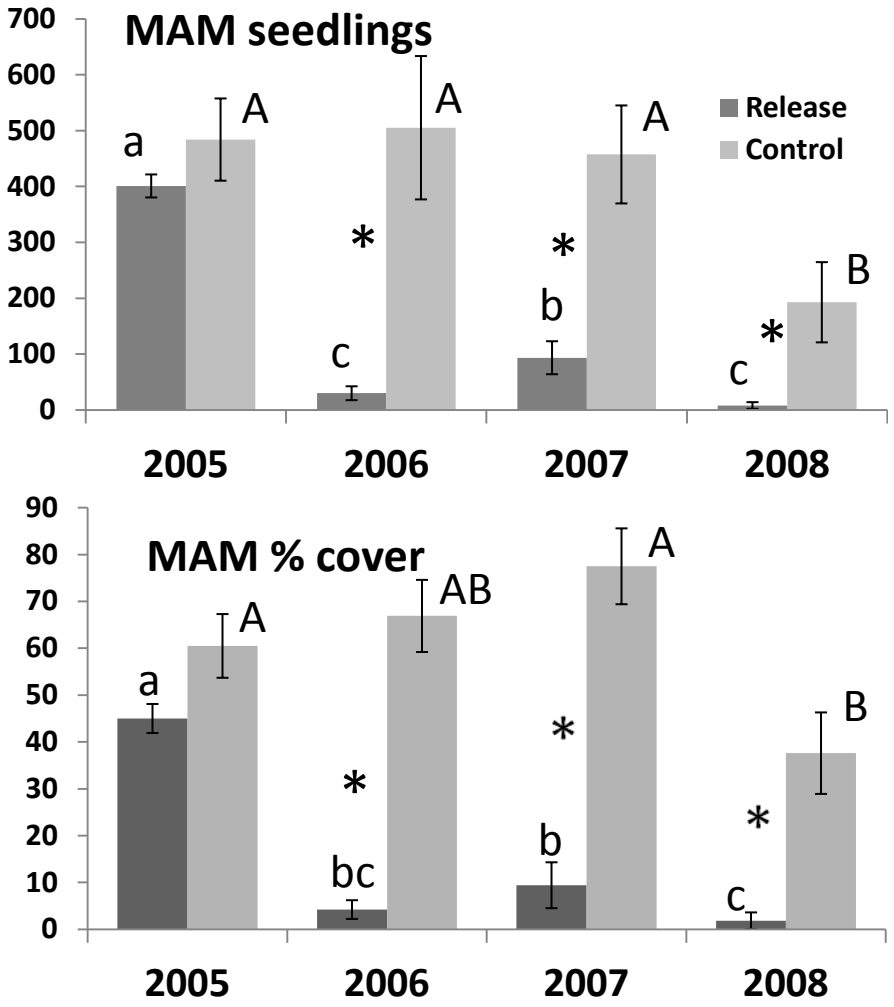
Hough-Goldstein et al. 2009, Biological Control

# Sites where R. latipes were released, 2004 – 2007

- **Closed circles: monitored sites**



# NJ-1 Spring samples




**~7000 weevils released in 2005**

H-G et al. 2009. Biological Control 51:450-457

# Abbott's Meadow (NJ-1) - ~7,000 weevils, 2005





Photos: Mark Mayer, NJ Dept. Ag.

Mark Mayer

# Floodgate Rd. (NJ-2) - 200 weevils in 2004 plus ~3,300 in 2005

**2006**


**2007**

Mark Mayer, NJDA

# Pea Patch Release Site – July 17, 2007

# Pea Patch Sept. 18, 2009

- **Goldenrod, sensitive fern**
- **Japanese stilt grass, Ailanthus**

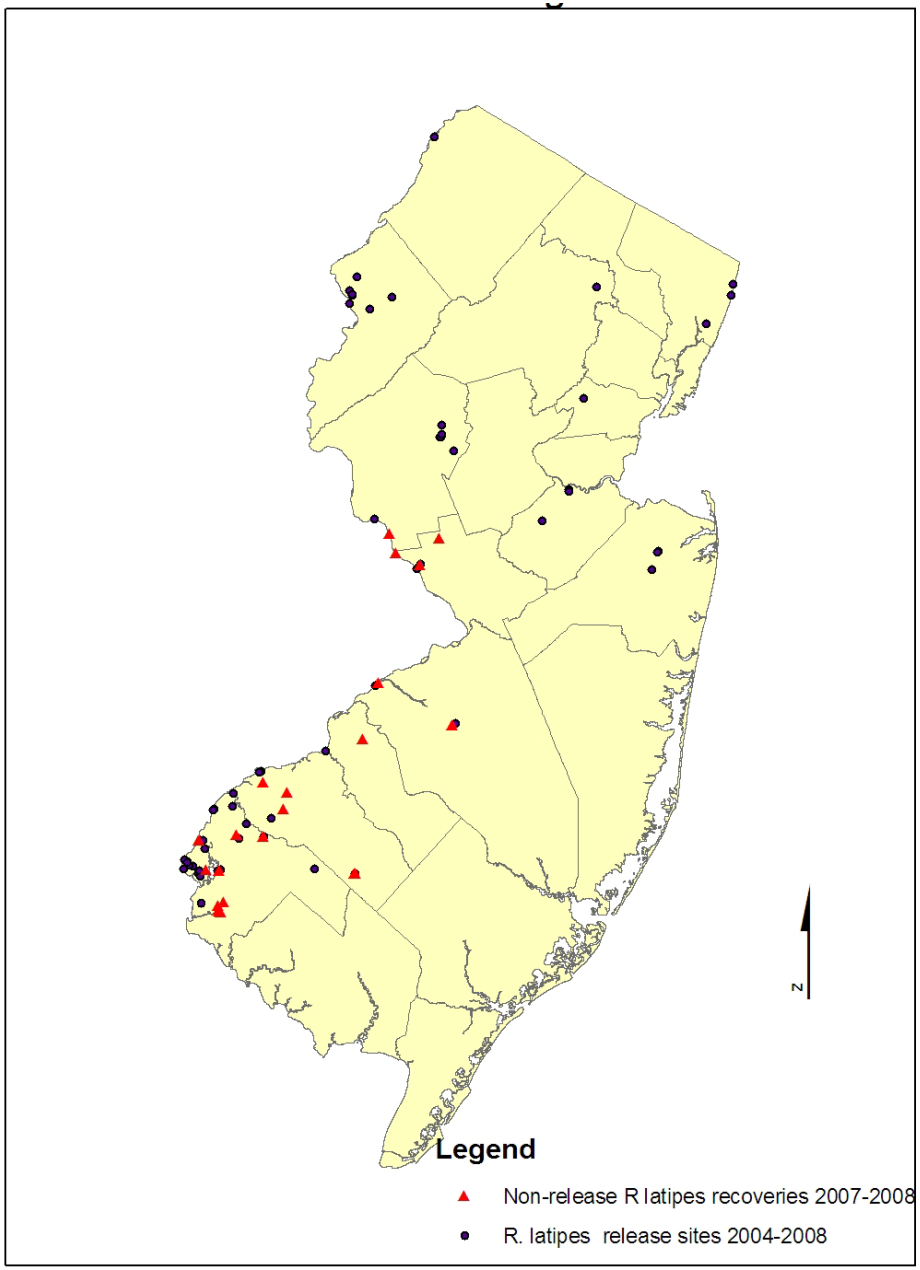
**Sept. 15, 2010: mile-a-minute DEAD with few seeds (drought? – shallow root system + weevils)**

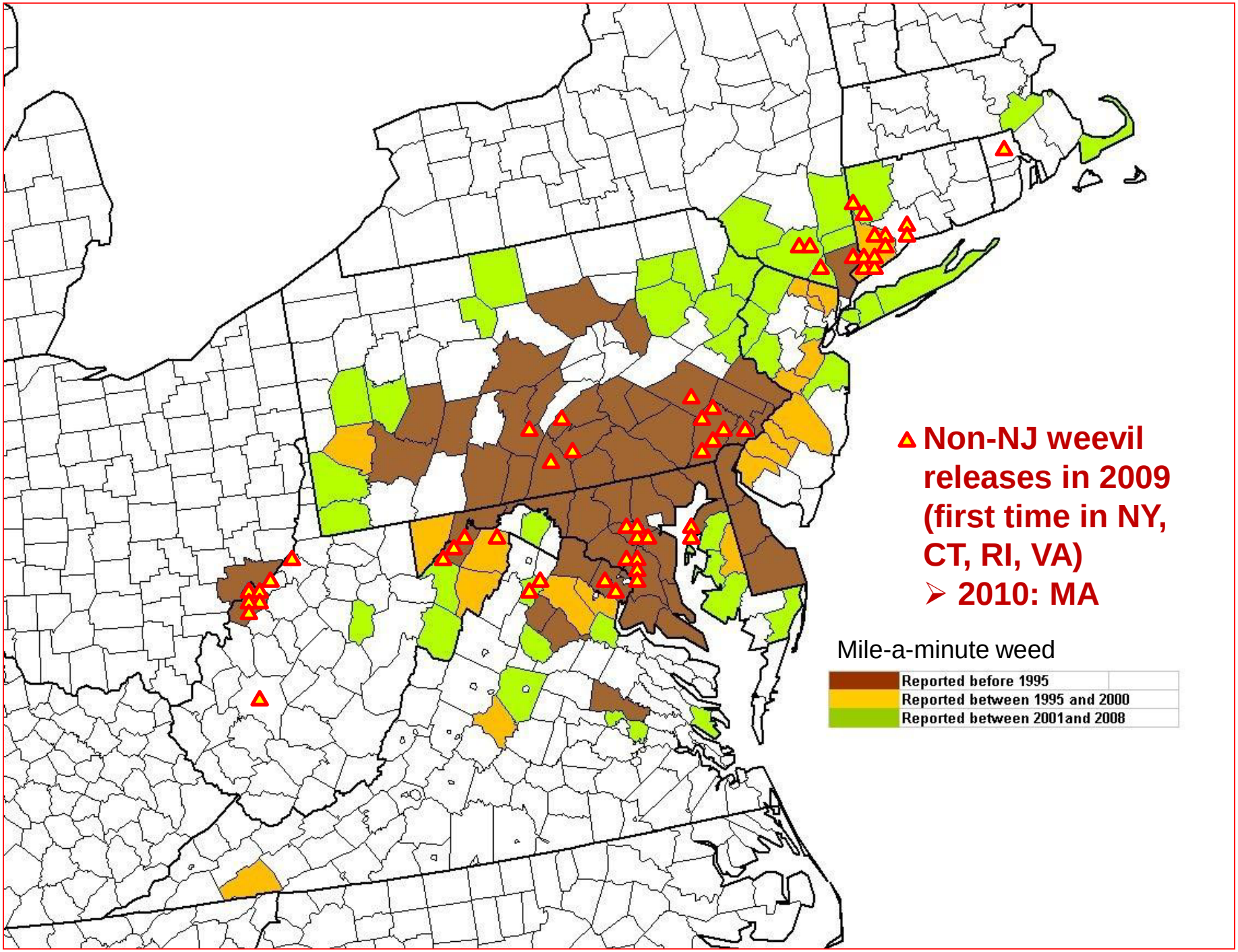
# Dispersal:

- Weevil releases and non-release recoveries in NJ through 2008

- Avg. dispersal distance 2.7 miles per year

(Mark Mayer)




Non-NJ weevil releases in 2009 (first time in NY, CT, RI, VA)
2010: MA
Mile-a-minute weed
Reported before 1995
Reported between 1995 and 2000
Reported between 2001and 2008

# Field host range of the weevil (M. Frye and E. Lake, 2009)

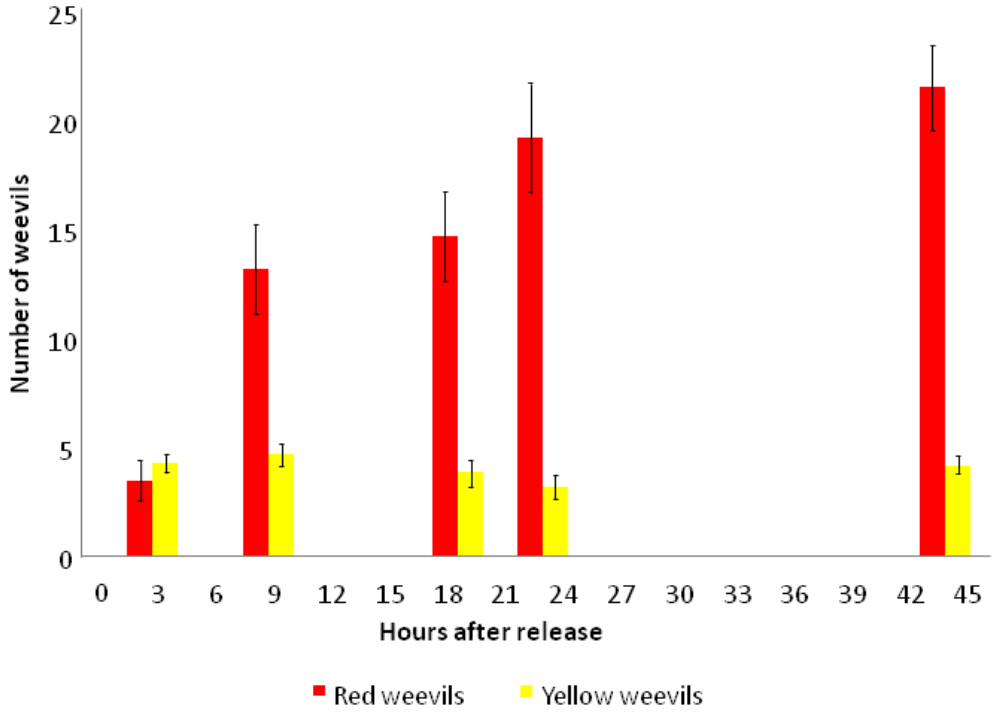
- Close relatives of MAM transplanted to farm field (replicated array)

| | *P. plant* | |
|---|---|---|
| *P. sagittata* | *P. hydropiper* | *P. hydropoides* |
| *P. pensylvanica* | *P. punctata* | *P. arifolia* |
| *P. perfoliata* | *F. esculentum* | *P. lapathifolia* |
| *P. aviculare* | *P. longiseta* | *P. virginiana* |

Weevils coated with fluorescent dust placed at base of the plants (10 per plant)

- Weevils moved from non-target plants to *Persicaria perfoliata* within 3 h
- The likelihood of finding a weevil on a non-target plant by 44 h was 3.5%
- Weevils did not feed or oviposit on any non-target plant under open field conditions

Weevils found on mile-a-minute weed




Red (dusted) weevils placed at base of 12 non-target plant species. Yellow (dusted) weevils placed at base of mile-a-minute weed.

Frye et al. 2010, Biological Control

# MAM and weevils in sun and shade

**<u>Observation</u>:**

- **MAM in shade seems to have less weevil feeding damage than in full sun**

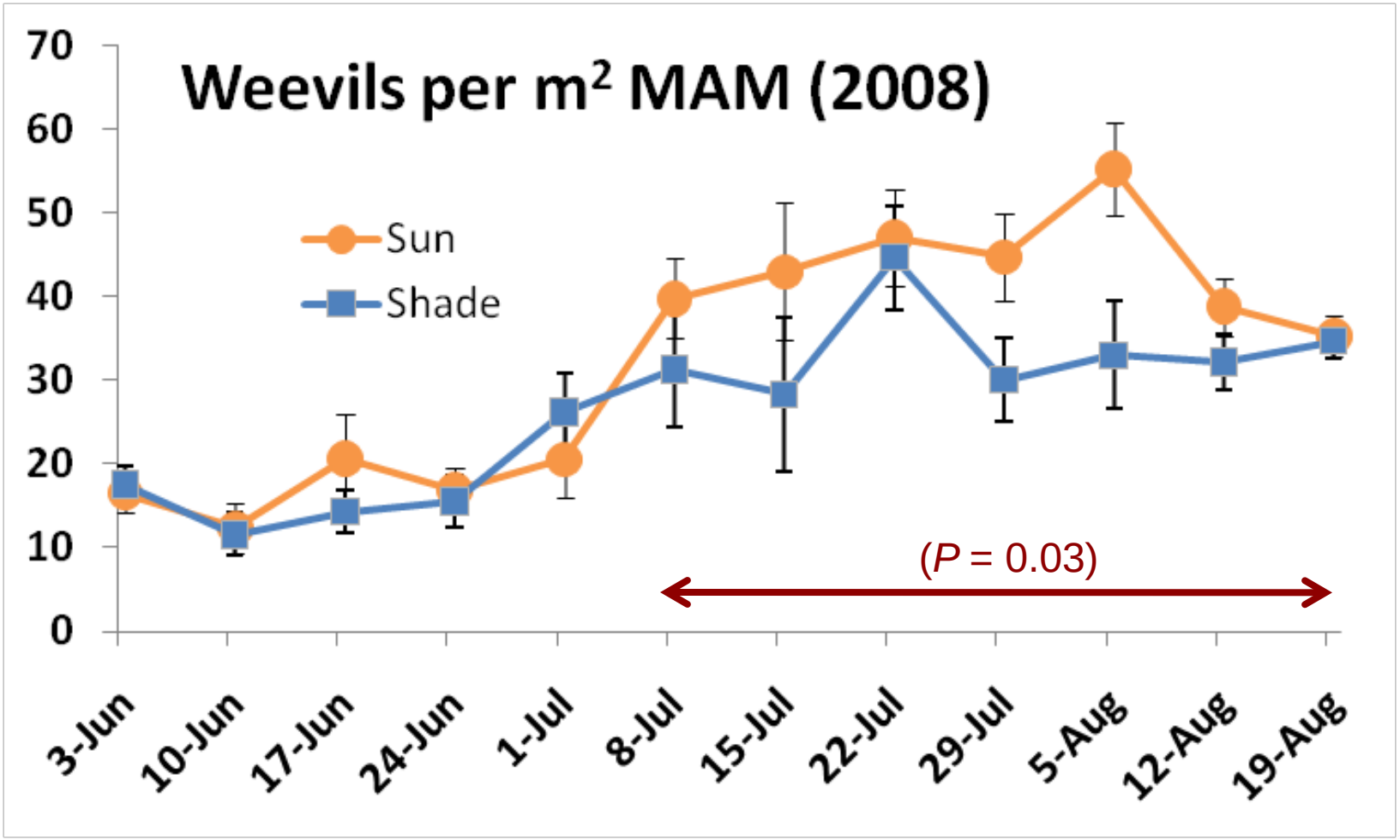
40% shade cloth applied June 2, 2008 (Shane LaCoss), replicated plots with & without shade

# Repeated with fully factorial design in 2010

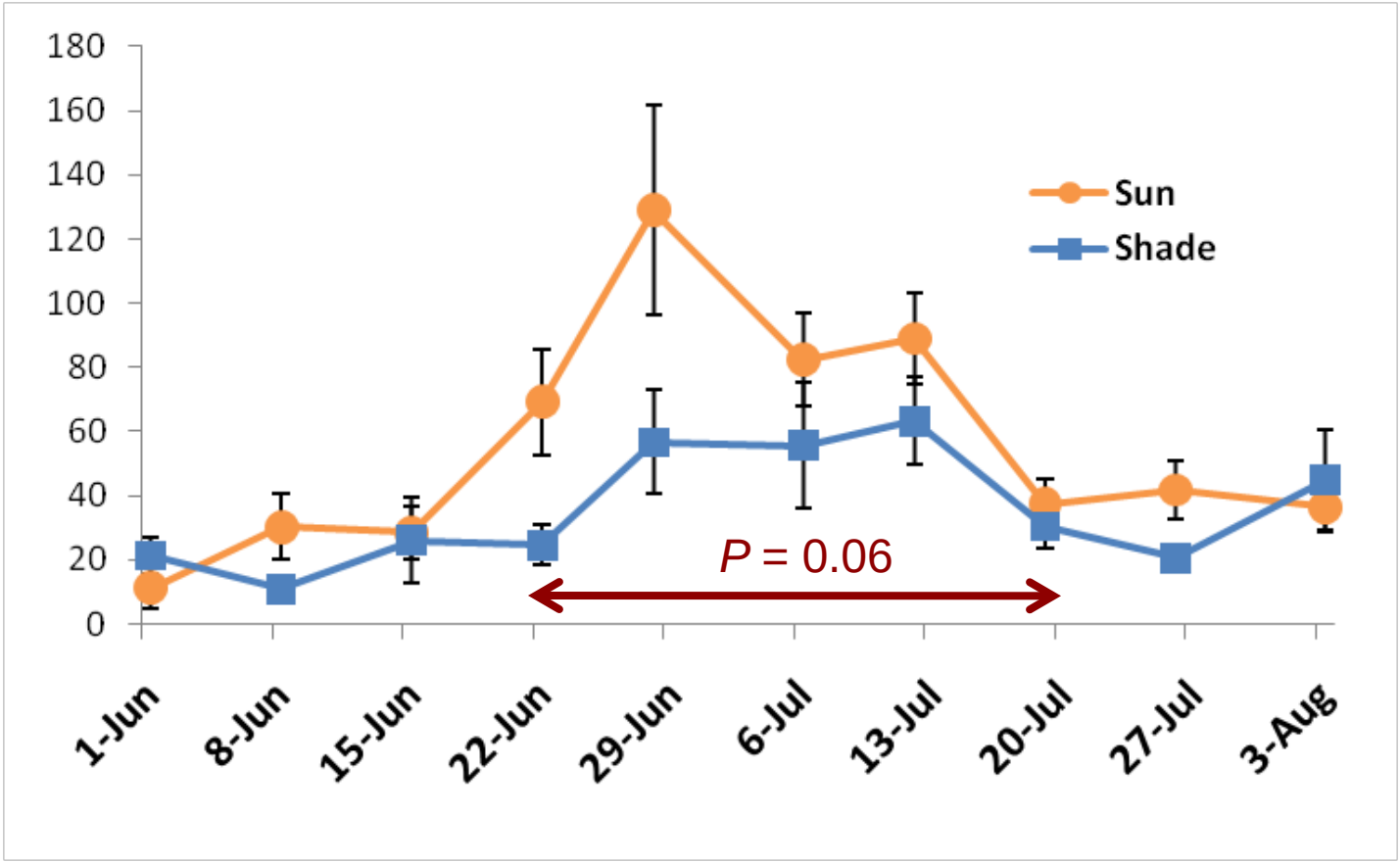
- **Sun and shade, with and without weevils**
- **Dinotefuron (Safari), systemic insecticide used to eliminate weevils**
- **Data from central 1 $m^2$**

Counting weevils and estimating % cover MAM

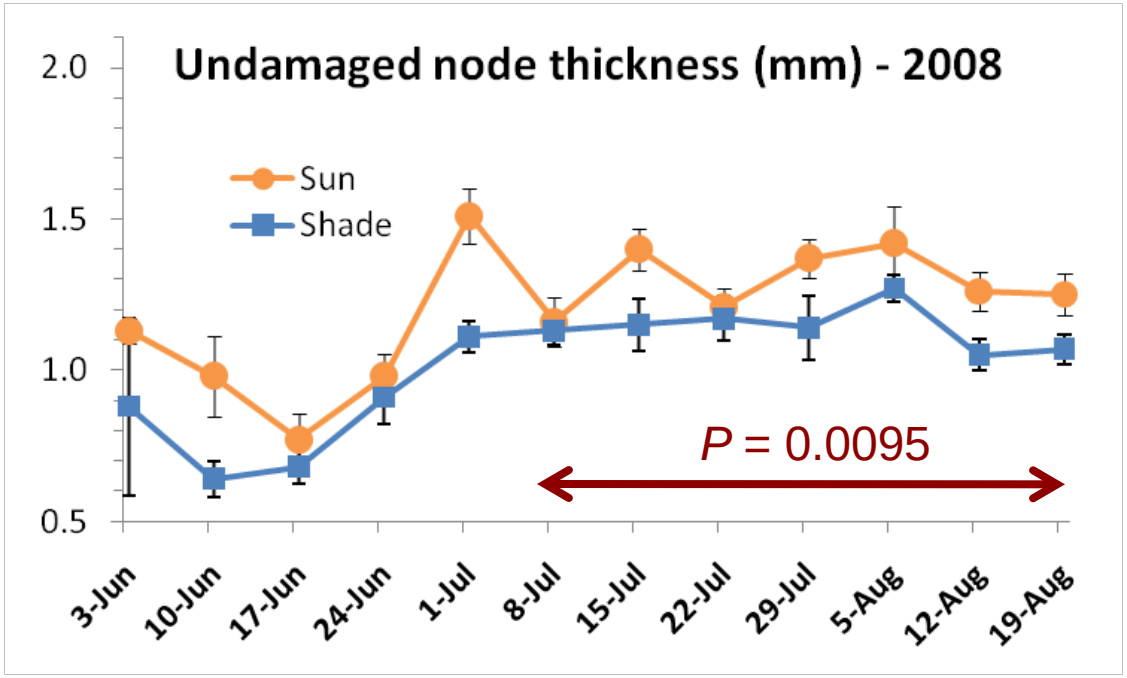
# Higher density of weevils in sun



# Weevils per m² MAM (2010)

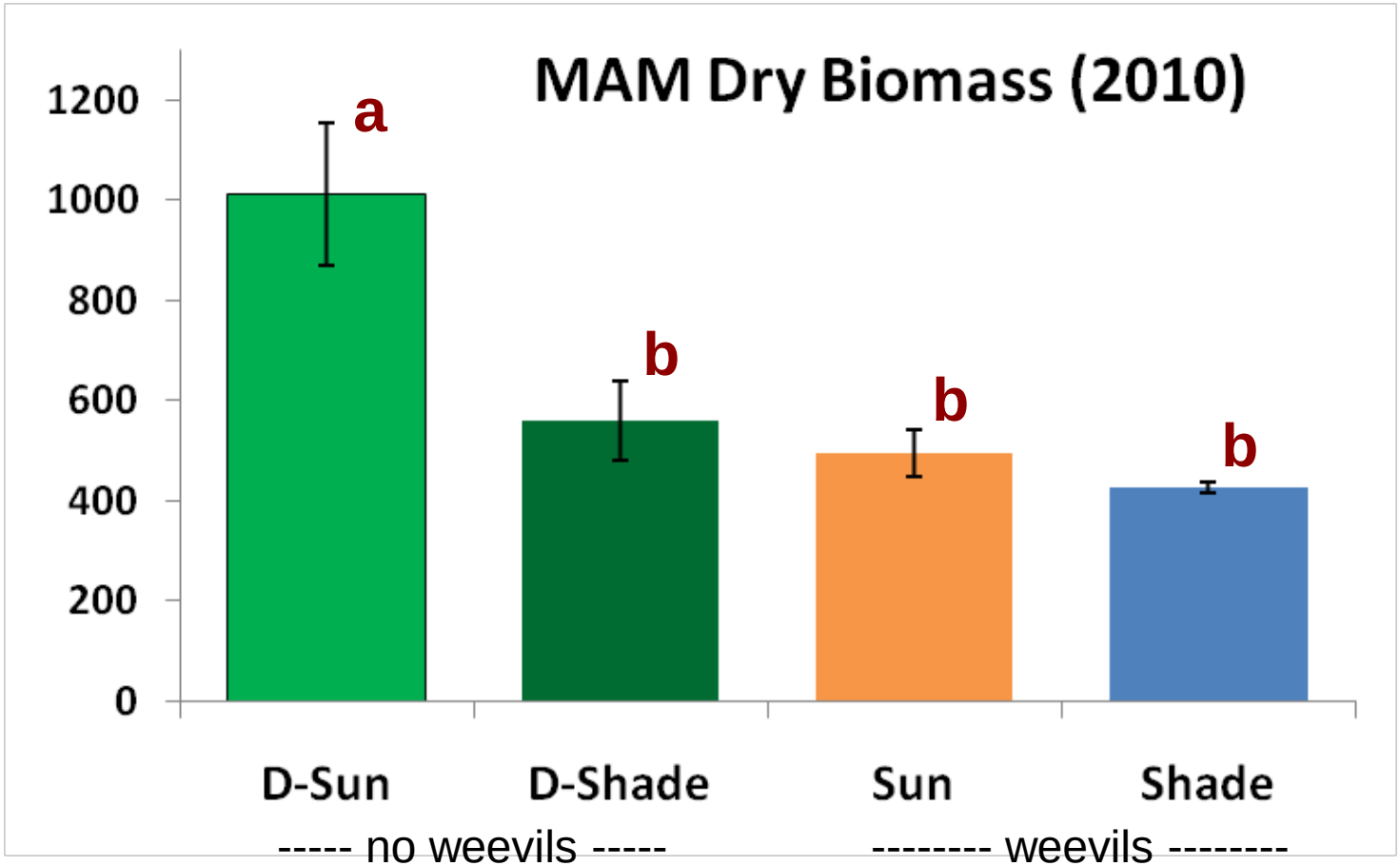


# Why more weevils (node damage, egg-laying) in sun?




Nodes are thicker in sun, may support better larval growth

# MAM harvest Aug. 10: a sun-loving plant, negated by presence of weevils

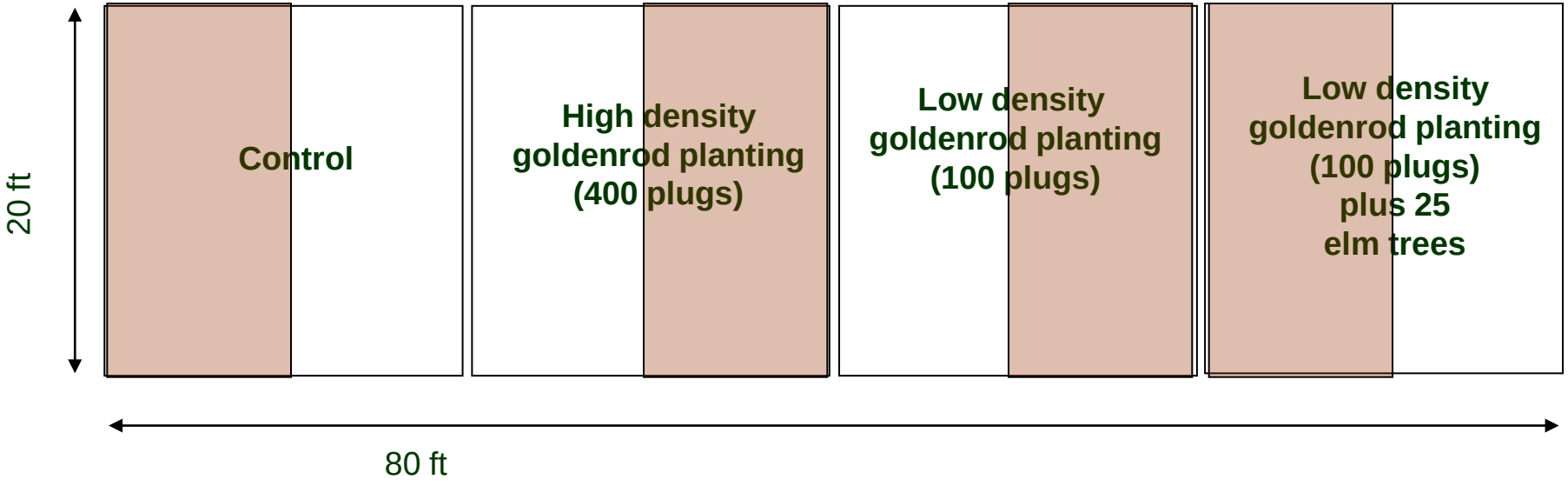


# Conclusion

- *R. latipes* establishes and disperses well, probably ~2-3 miles per year
- No indication of non-target impacts
- Populations can build up rapidly
- Impact on plant community can be very rapid, depending on presence of competing plants
- **In Mid-Atlantic in disturbed areas, competing plants in some areas consist primarily of other non-native invasives**

# Current Research

- **Integrated Weed Management**
- E. Lake PhD project: combining herbicide application and plant competition via restoration planting with biological control
- installed fall 2008 (all high MAM + weevils):



Goldenrod and elms

High density goldenrod

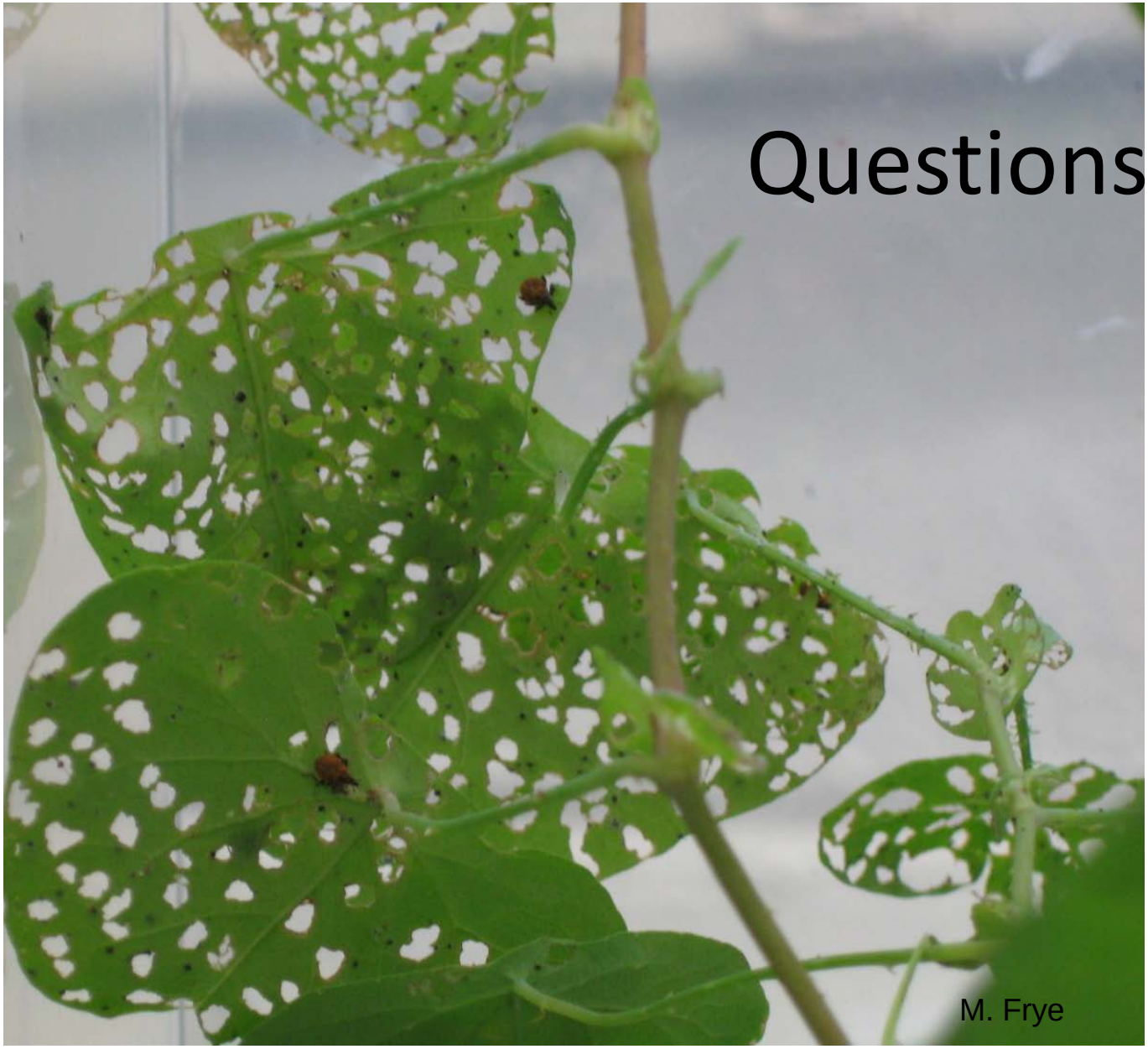
Control

Low density goldenrod

# Native Plant Community

- Botanical survey conducted this fall
- Variety of native plants emerging, including tree seedlings, a variety of goldenrod spp., several sedge spp., bloodroot, etc.
- Lobelia at Crosslands site: dominant vegetation at start was MAM and Japanese stiltgrass

- K. Cutting MS project: assessing impact of planting native seed mix (grasses and herbaceous plants), with and without weevils
- Same treatments in field and greenhouse
- Started Spring 2009


Questions?
M. Frye