Some Insect Updates

ISA Conference November 9, 2017

Drippy Blight of Red Oaks

An unusual association between a scale insect and bacterial pathogen

The insect partner:

Pin oak kermes

Allokermes galliformis

Contribution:

Production of wounds at feeding site.

Damaged tissues allow entry (and exit) of bacterial pathogen.

The pathogen partner:

Lqq

Lonsdalea quercina* var. *quercina

Contribution: **Produces cankers that contribute to twig dieback**

Produces viscous ooze that drips from trees

Examples of bacterial cankers developing around scale feeding sites

Result?

Twig dieback, flagging

Abscission of twigs

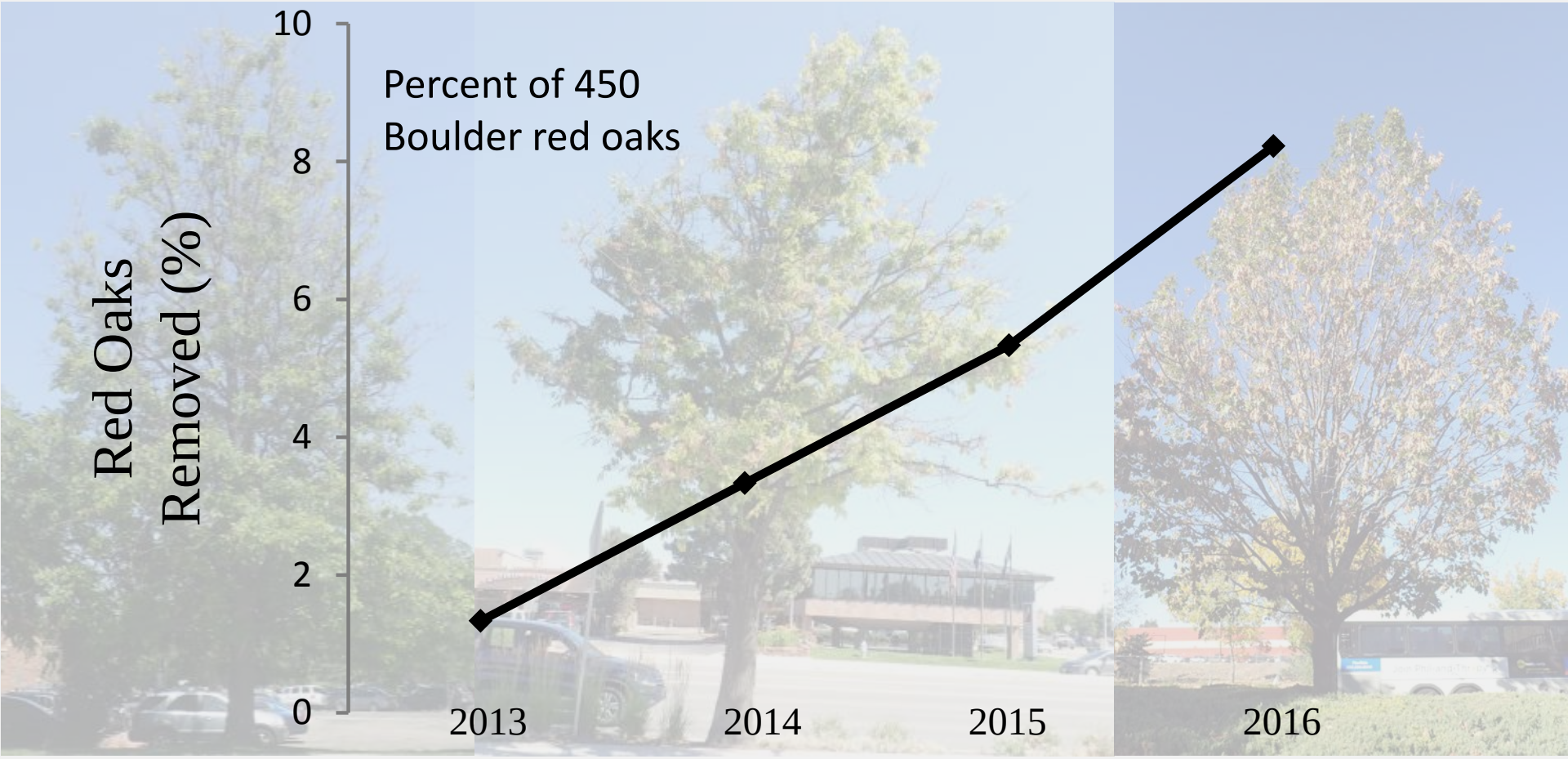
Which leads to:

Reduction in healthy foliage

Progressive dieback of canopy

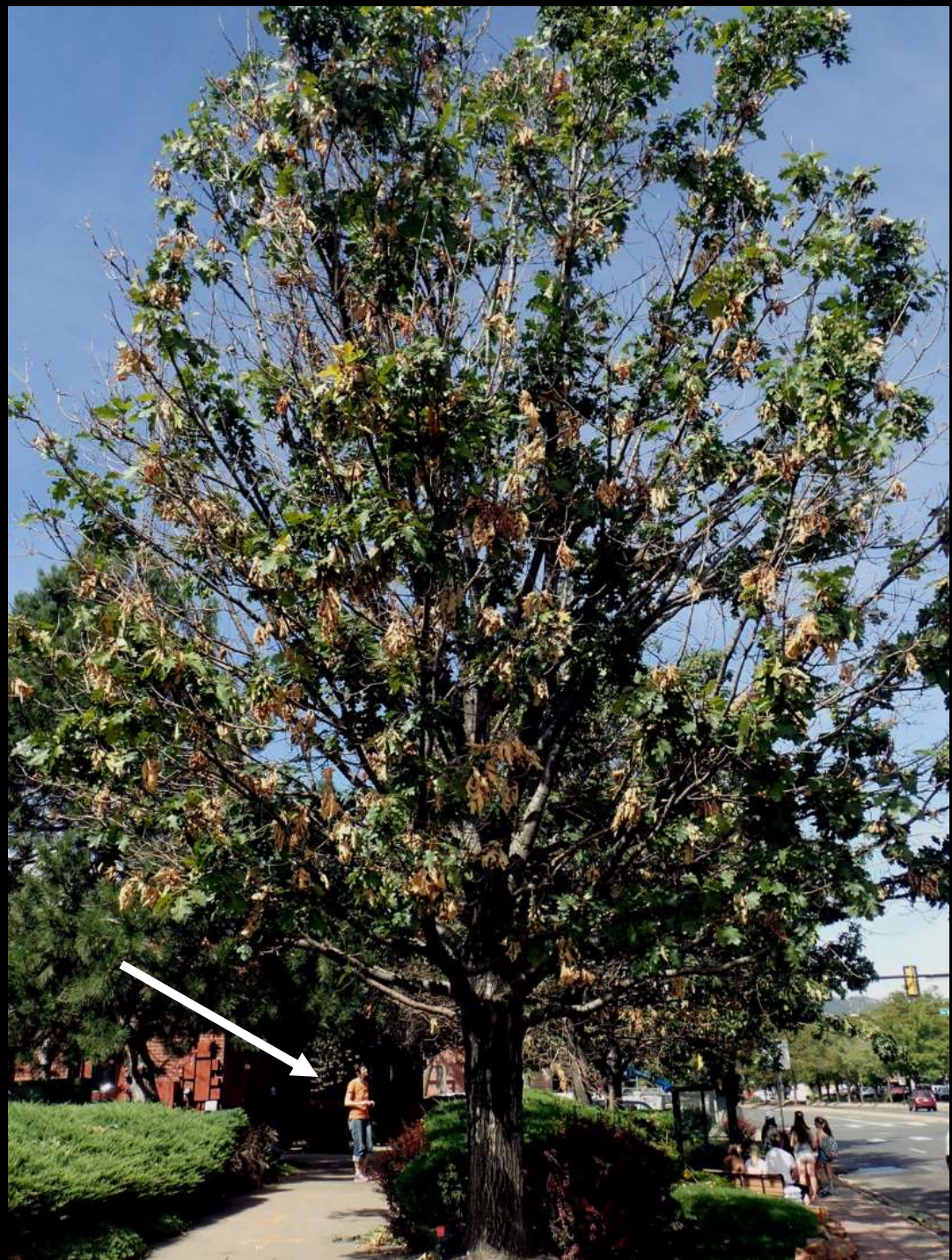
Invasion by flatheaded appletree borer

Trees that have sustained injury decline and become candidates for removal



Important Credit!

The drippy blight work has been done by **Rachael Sitz**



Important Credit!

The drippy blight work has been done by **Rachael Sitz**

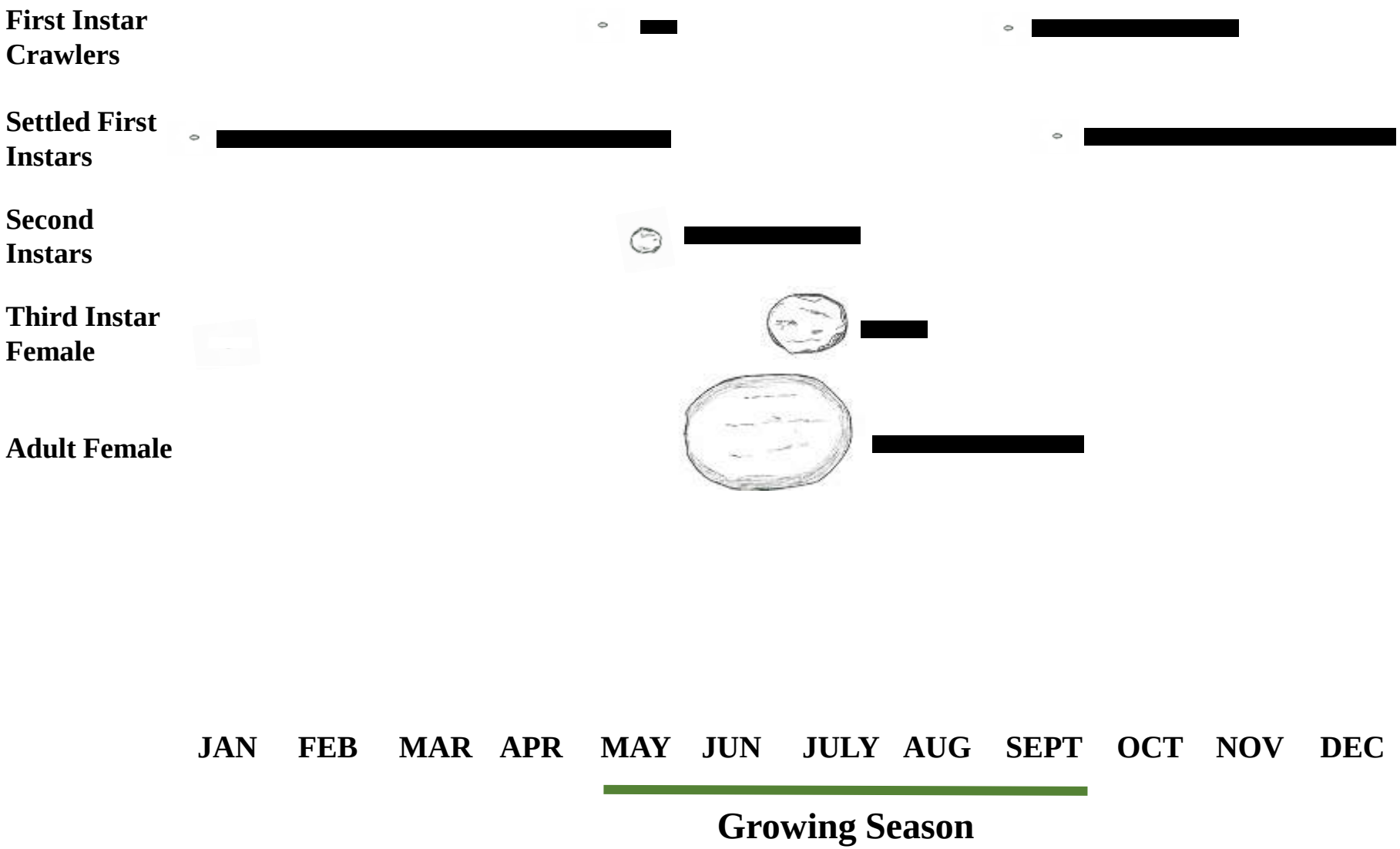
and supported by the

ISA Tree Fund

TREE FUND

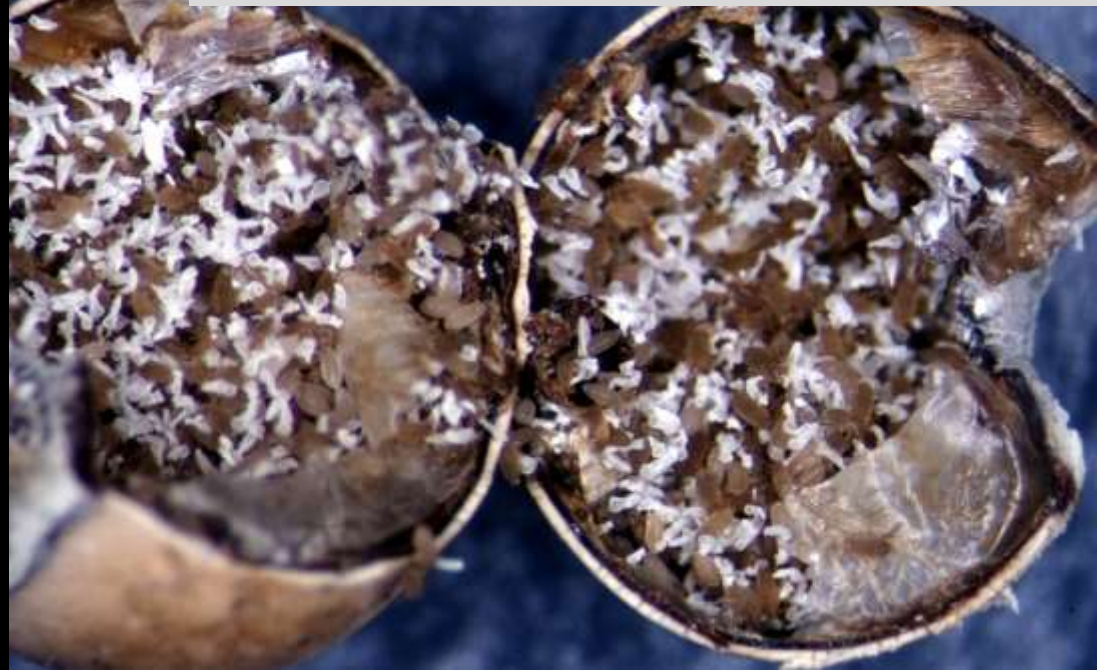
Cultivating Innovation

Allokermes galliformis development



Eggs develop in late August and September

Eggs hatch from midSeptember into November

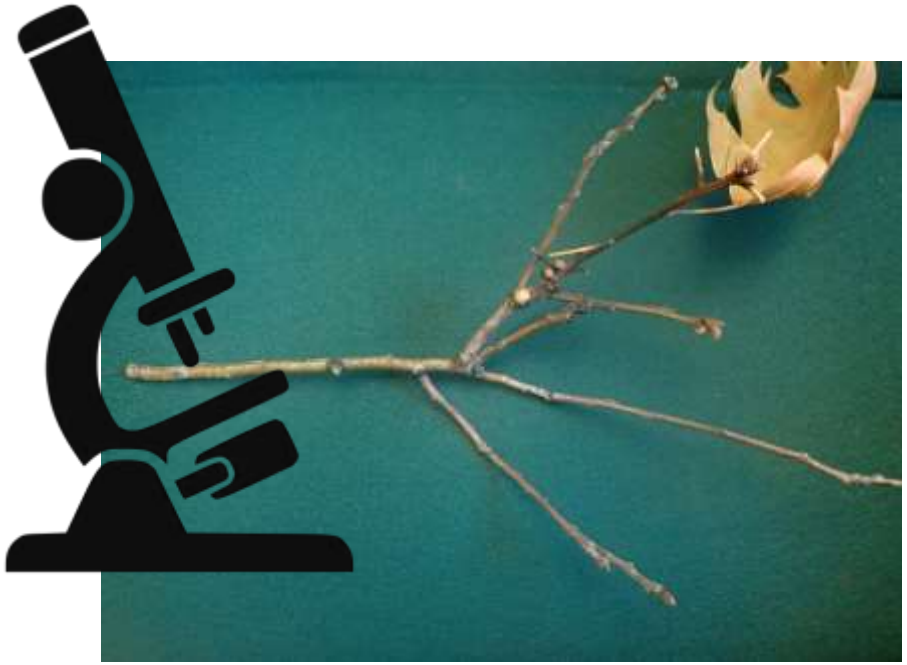


Average number of eggs produced?

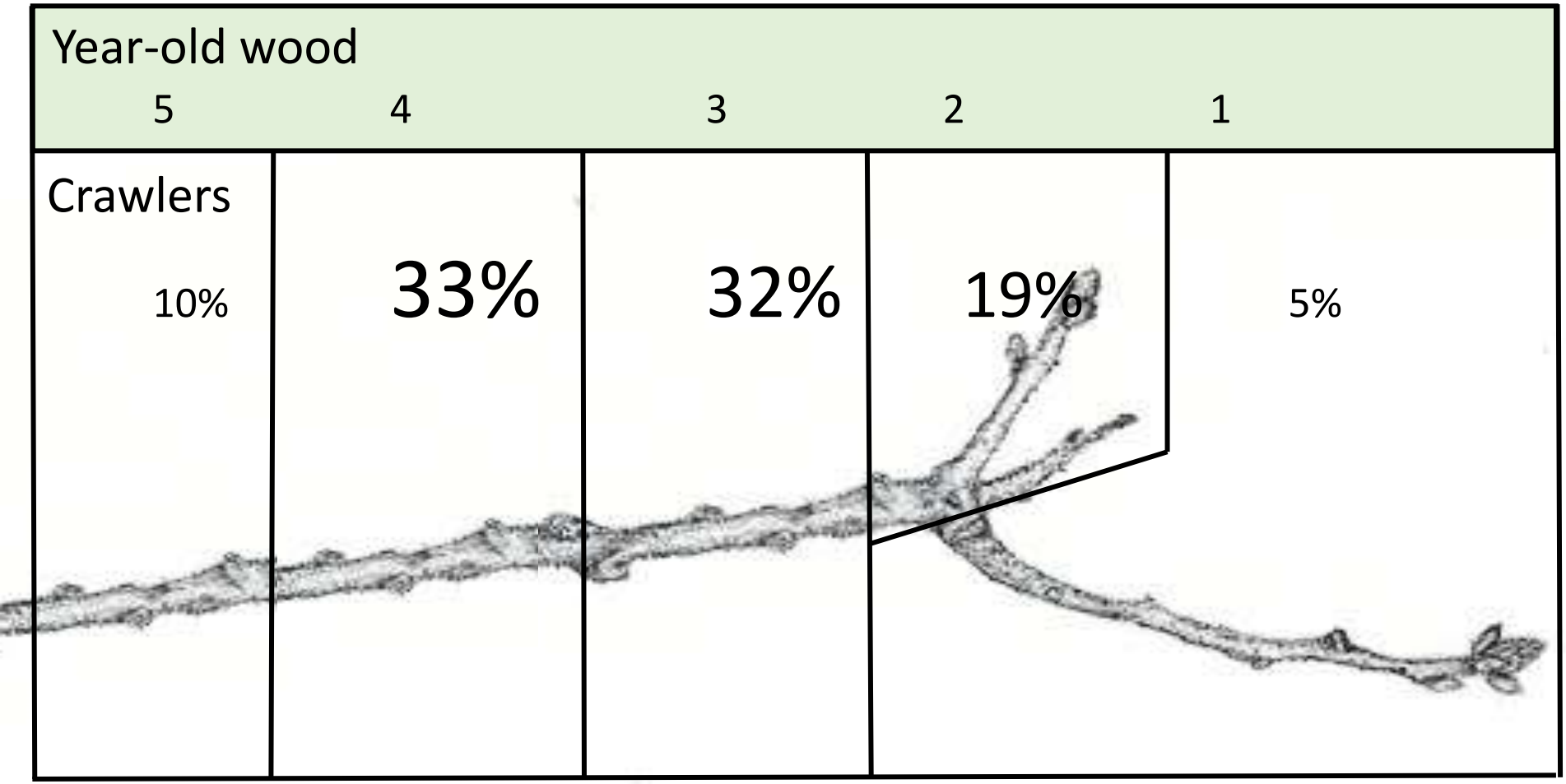
In 2015 the average was
2488 eggs/female
In 2016 the average was
4726 eggs/female

Where do scales overwinter?

- Winter 2014-2015, 3 trees, 55 branches
- Winter 2015-2016, 3 trees, 42 branches
- Branch sections ~50 cm (at least 5 years of growth)



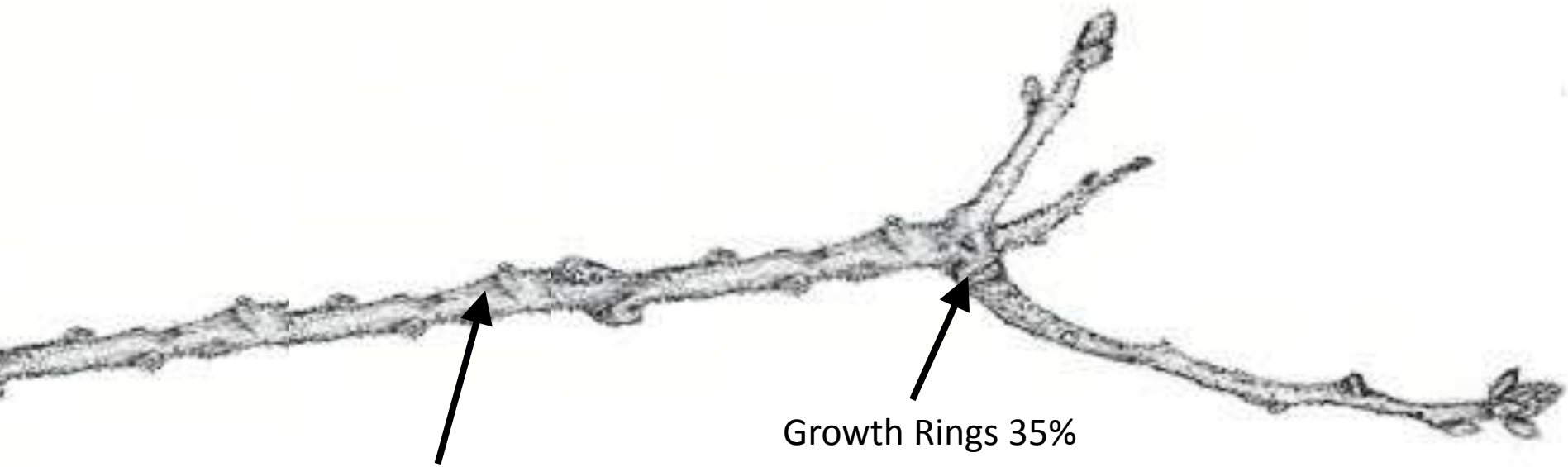
Most of the scales spend winter on wood that is 2-4 years old



Percent of 5,480 crawlers

Nuncketest artist

First instar overwintering locations



Percent of 5,480 crawlers

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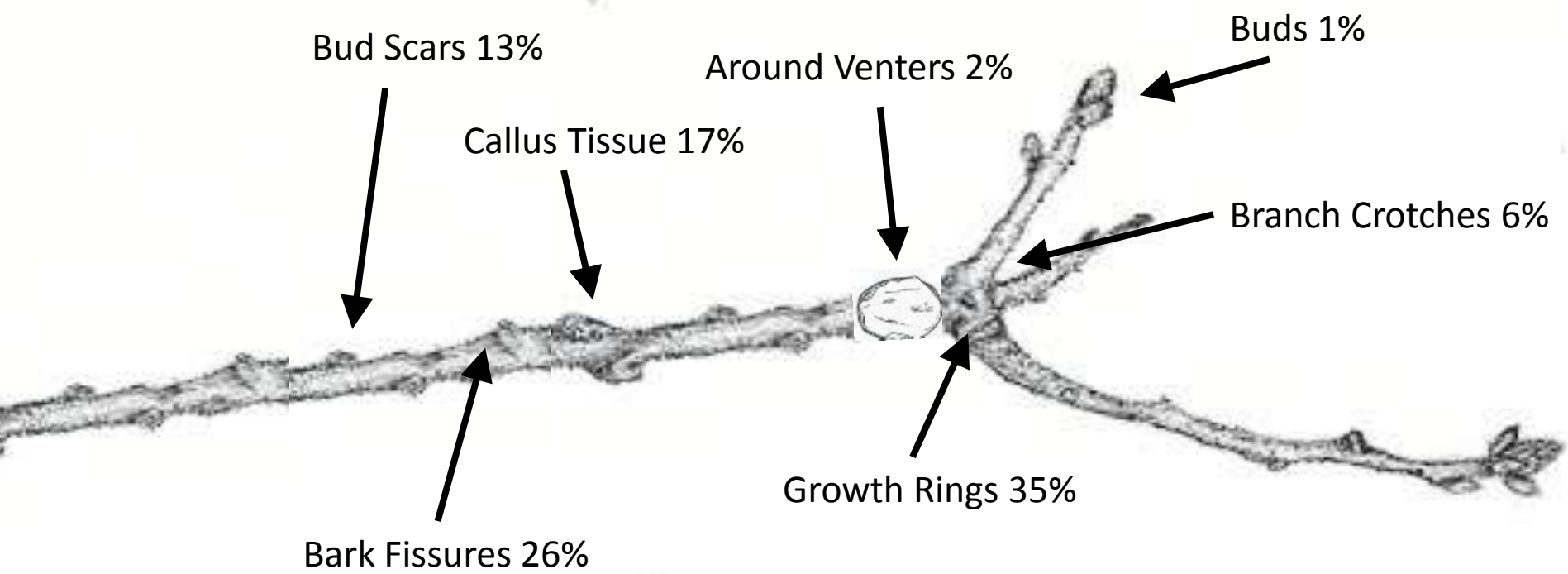
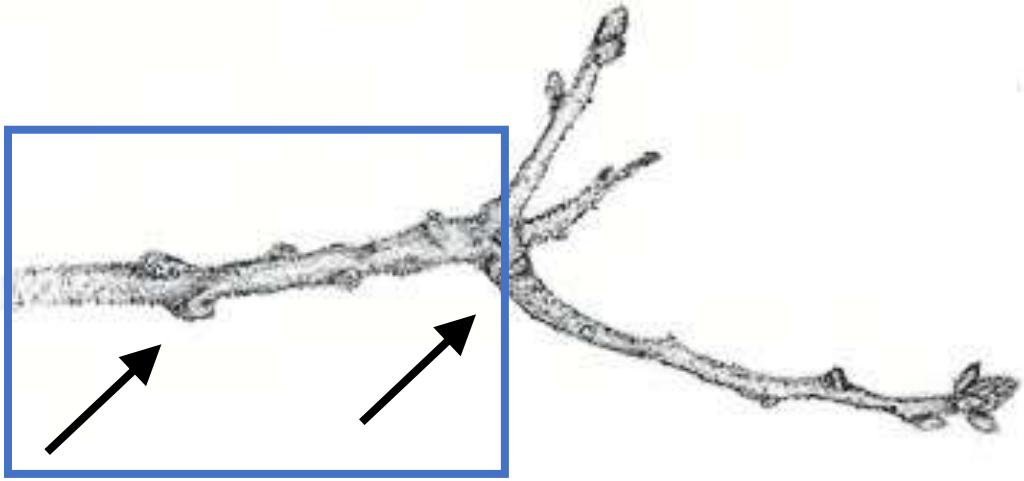


Percent of 5,480 crawlers

Insect overwintering locations

Majority settle on:

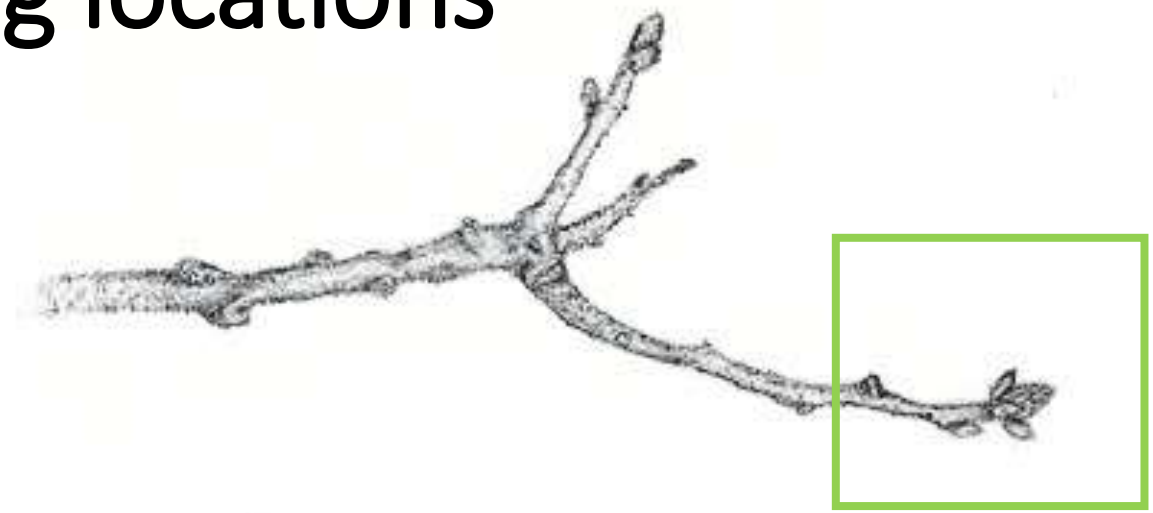
3 to 4 year old growth
Growth rings & bark fissures



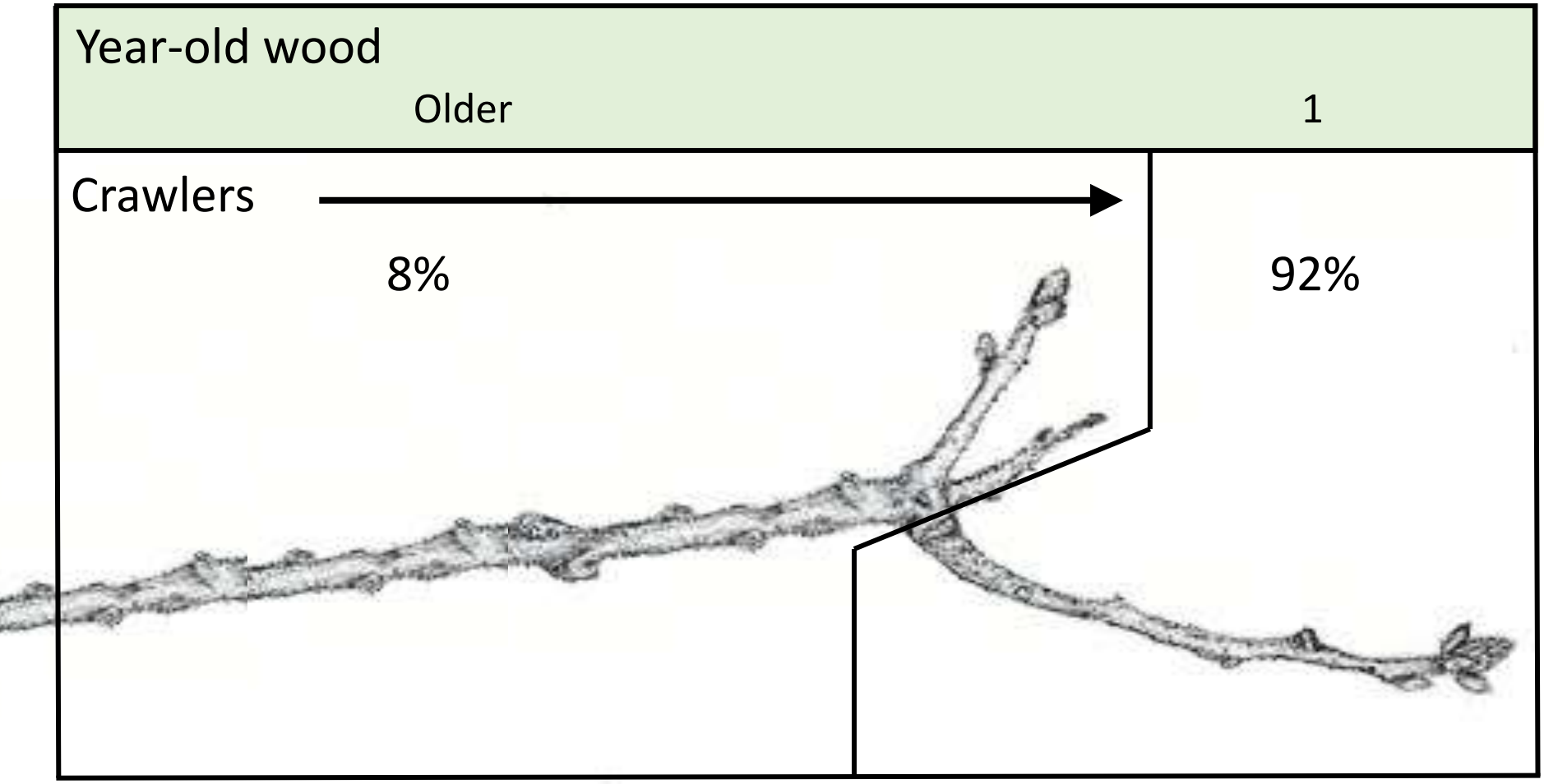
Insect feeding locations

Primarily move to:

New growth
Become sessile



Kermes scale feeding locations



Percent of 2,041 crawlers

There is a spring migration around bud break as the scales move to the new growth

At this point they permanently settle.

The female will grow enormously over the next 2-3 months.

Oozing, dripping, and twig dieback/abscission accelerate in late June and peak in July.

Management of Drippy Blight

- Principal Target – **the Scale**
- Sprays?
  - Dormant season - target stages on 2-4 year wood
  - Bud break – concentrate at buds
  - Treatments
    - Horticultural oils, Distance, other scale products
- Soil Applied systemics?

Management of Drippy Blight

- Principal Target – **the Scale**
- Sprays?
  - Dormant season - target stages on **2-4 year wood**
  - Near bud break – **concentrate at buds**
  - Treatments
    - **Horticultural oils, Distance, other scale products**
- Soil Applied systemics?

Management of Drippy Blight

- Principal Target – **the Scale**
- Sprays?
  - Dormant season - target stages on 2-4 year wood
  - Bud break – concentrate at buds
  - Treatments
    - Horticultural oils, Distance, other scale products
- **Soil Applied systemics?**
  - **More mobile products (e.g., dinotefuran) may be best?**

There are two scale insects on the oaks – and they look kind of alike

Photograph courtesy of David Shetlar

Pin oak kermes

Allokermes galliformis

Oak lecanium

Parthenolecanium quercifex

Overwintering stages?

Pin oak kermes

Tiny first stage nymphs tucked into cracks on branches

Oak lecanium

Maturing females on twigs

Photograph courtesy of David Shetlar

Around bud break?

Pin oak kermes

Overwintered nymphs move to buds, new growth

Oak lecanium

Females rapidly mature and swell

Around June?

Pin oak kermes

They have settled and are starting to grow

Oak lecanium

Production of eggs, then crawlers

Photographs courtesy of David Shetlar

Early summer?

Pin oak kermes

They have settled and are starting to grow

Oak lecanium

Crawlers move to leaves, molt to 2nd stage

Early summer?

Photograph courtesy of Jim Kalisch

Pin oak kermes

Bacterial ooze is often produced at feeding site

Oak lecanium

Honeydew continues to be excreted

Late summer

Photograph courtesy of David Shetlar

Pin oak kermes

Females mature and are producing eggs and crawlers

Oak lecanium

Migration back to branches and overwintering stage

Management of Oak Lecanium

- **Sprays**
  - **Dormant season (developing females on twigs)**
    - **Pyriproxifen**
    - **Horticultural oils**
- **Soil-applied systemics**
  - **Neonicotinoids (imidacloprid, chlothianidan, dinotefuran)**

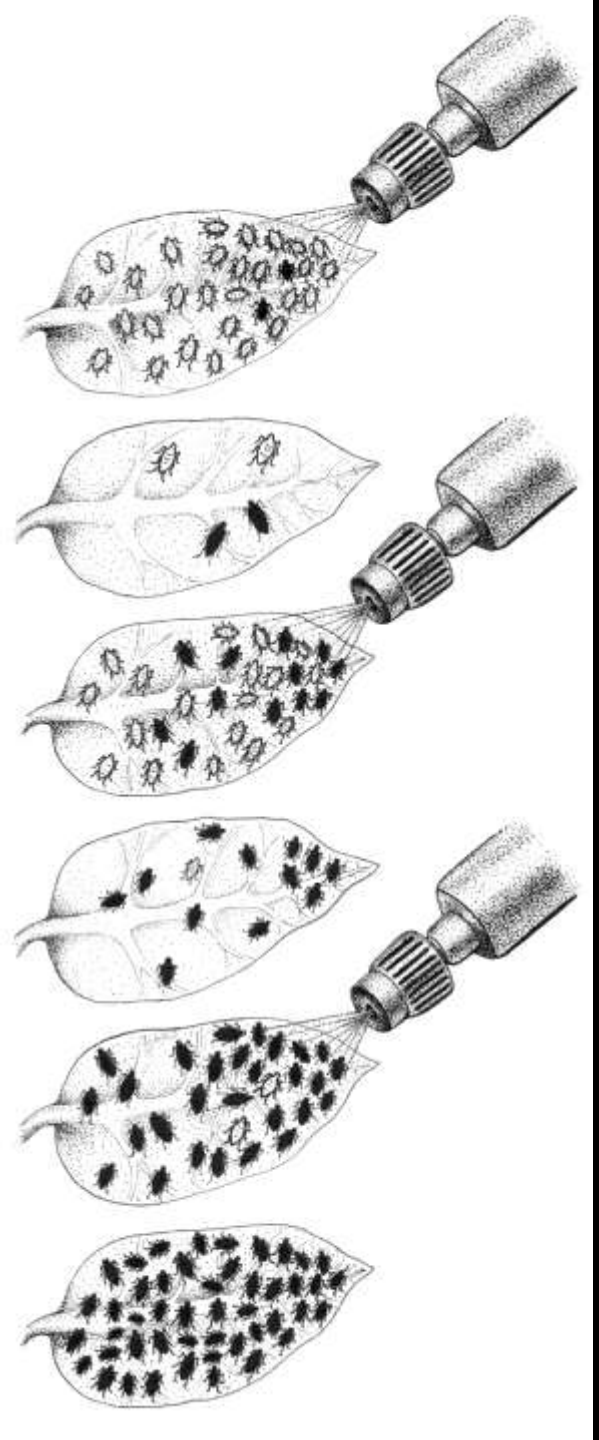
European Elm Scale – *and resistance to neonicotinoid insecticides*

Prior to about 1995 European elm scale was controlled by spraying elm trees with insecticides in spring to kill overwintering stages on the twigs.

European elm scale was one of the first shade tree insects against which the new insecticide imidacloprid was tested (ca 1993).

The results were fantastic.

Soil injection of elm was embraced rapidly by the Colorado tree care community



Insecticide resistance develops by selecting individuals that have genetic traits that allow the insect to resist effects of the pesticide

Recipe for Resistance

Sustained applications of neonicotinoids have been applied to almost every scale-infested elm over large areas in Colorado for almost 2 decades.

European Elm Scale in Colorado – *A poster child example of how to develop insect resistance in a shade tree pest*

Some Neonicotinoid Insecticides Used for Woody Plants

- **Imidacloprid** (Merit, Criterion, Marathon, many generics)
- **Clothianidin** (Arena, Poncho)
- **Thiamethoxam** (Flagship, Meridian)
- **Dinotefuran** (Safari)
- **Acetamiprid** (Tristar)

If resistance develops to one of these insecticides – it develops in all of these insecticides!

European Elm Scale Options in a Post-Neonicotinoid Period?

- Soil/Trunk Injections
  - Acephate
  - Azadirachtin
- Foliar Applications
  - Horticultural Oils
  - Insect growth regulators
    - Pyriproxifen (Distance)

Elm Scale trial at the CSU Oval - 2014

2016 Evaluations European Elm Scale

- **Highest EES numbers**
  - Imidacloprid (Zenith) applied in 2014
    - 48 scales per foot of twig
  - Untreated check (no insecticide since 2012)
    - 33 scales per foot of twig

2016 Evaluations European Elm Scale

- **Lowest EES numbers ***
  - **Distance (applied spring 2014)**
    - 7 scales/foot of twig (with oil)
    - 12 scales/foot of twig (w/o oil)
  - **ACE-Jet (acephate) (trunk injection 2015)**
    - 10 scales/foot of twig
  - AzaGuard (azadirachtin) (trunk injection 2015)
    - 11 scales/foot of twig
  - Lepitect (acephate) (soil injection late spring 2015
    - 14 scales/foot of twig
  - Azasol (azadirachtin) (trunk injection 2015)
    - 19 scales/foot of twig

* Control had 33 scales/foot

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Most Promising "Plan B" Treatments from Elm Scale Trial

- Pyriproxifen (spray)
  - Trade names: Distance, Fulcrum
- Azadirachtin (trunk injected)
  - Trade names: Azasol, Azaguard, others
- Acephate (trunk injected, soil injected)
  - Trade names: ACE-Jet (trunk inject); Lepitect (soil drench)

Pyriproxifen as a scale insect treatment

- Trade names Distance, Fulcrum
- Acts on hormones insects use in development (IGR)
- Mostly works on scales, aphids and related sucking insects
- Very little effect on natural enemies of insect pests

Pyriproxifen as a scale insect treatment

- Trade names Distance, Fulcrum
- **Acts on hormones insects use in development (IGR)**
  - **Juvenile hormone mimic**
- Mostly works on scales, aphids and related sucking insects
- Very little effect on natural enemies of insect pests

Pyriproxifen as a scale insect treatment

- Trade names Distance, Fulcrum
- Acts on hormones insects use in development (IGR)
- **Mostly works on scales, aphids and related sucking insects**
  - Fungus gnats, mosquitoes are other markets
- Very little effect on natural enemies of insect pests

Pyriproxifen as a scale insect treatment

- Trade names Distance, Fulcrum
- Acts on hormones insects use in development (IGR)
- Mostly works on scales, aphids and related sucking insects
- **Very little effect on natural enemies of insect pests**
  - **Allows *integration of biological controls with chemical controls***

What kinds of natural enemies work on European elm scale in Colorado?

Primary EES Predators

Convergent lady beetle

Sevenspotted lady beetle

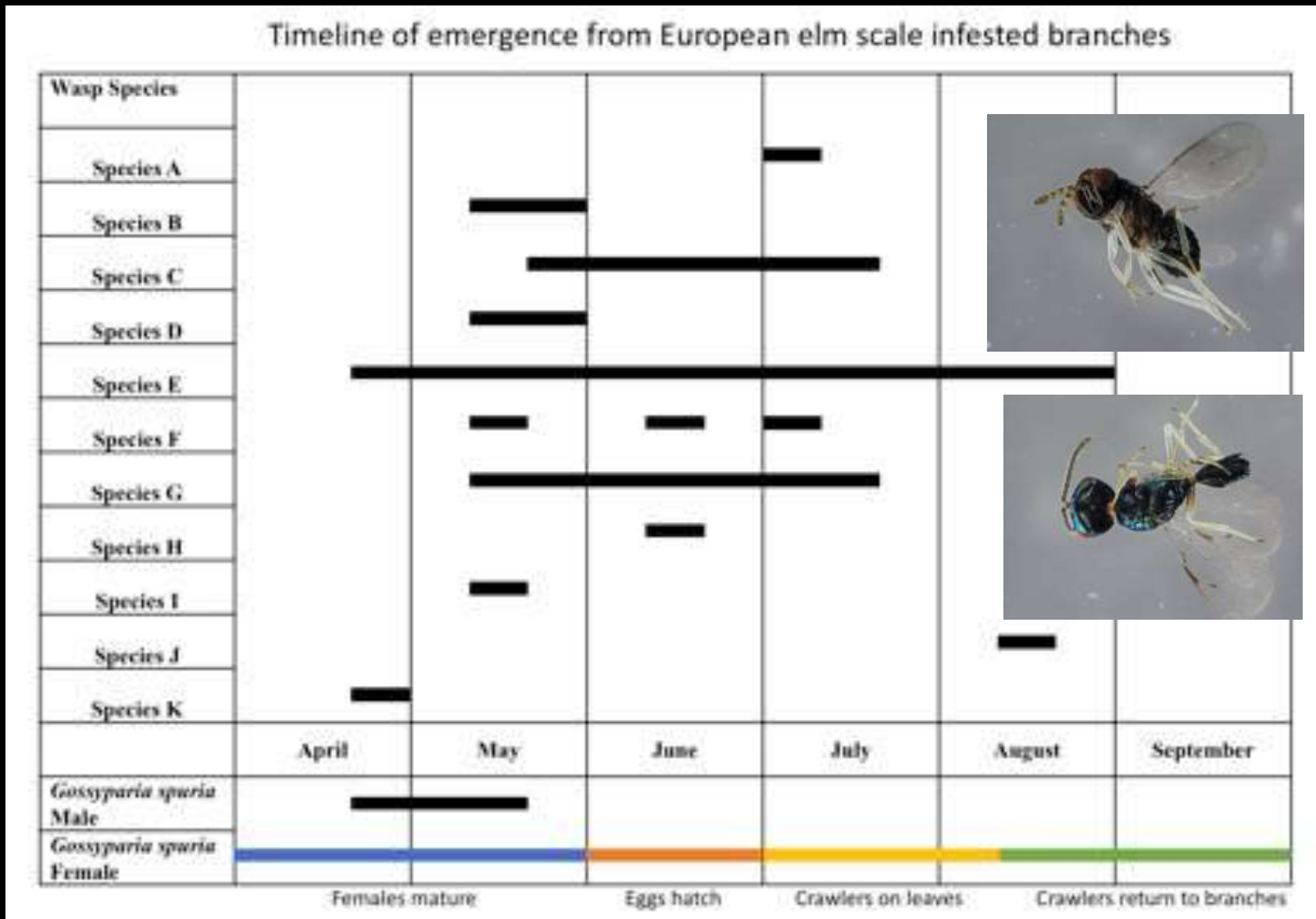
Larvae of green lacewing

Lady beetles mostly seem to be grazing when there are large numbers of crawlers

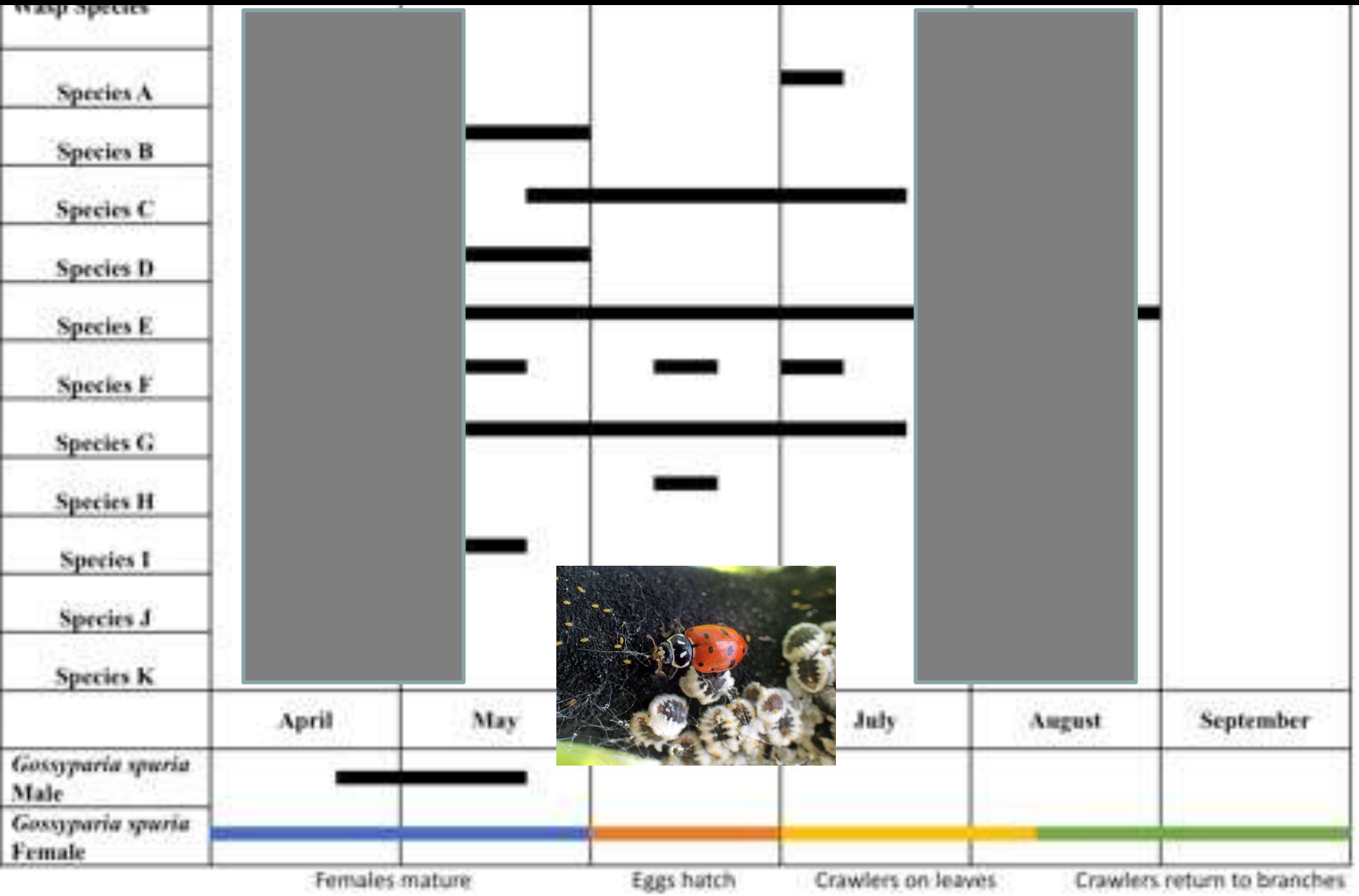
What about parasitoids?

What about parasitoids?

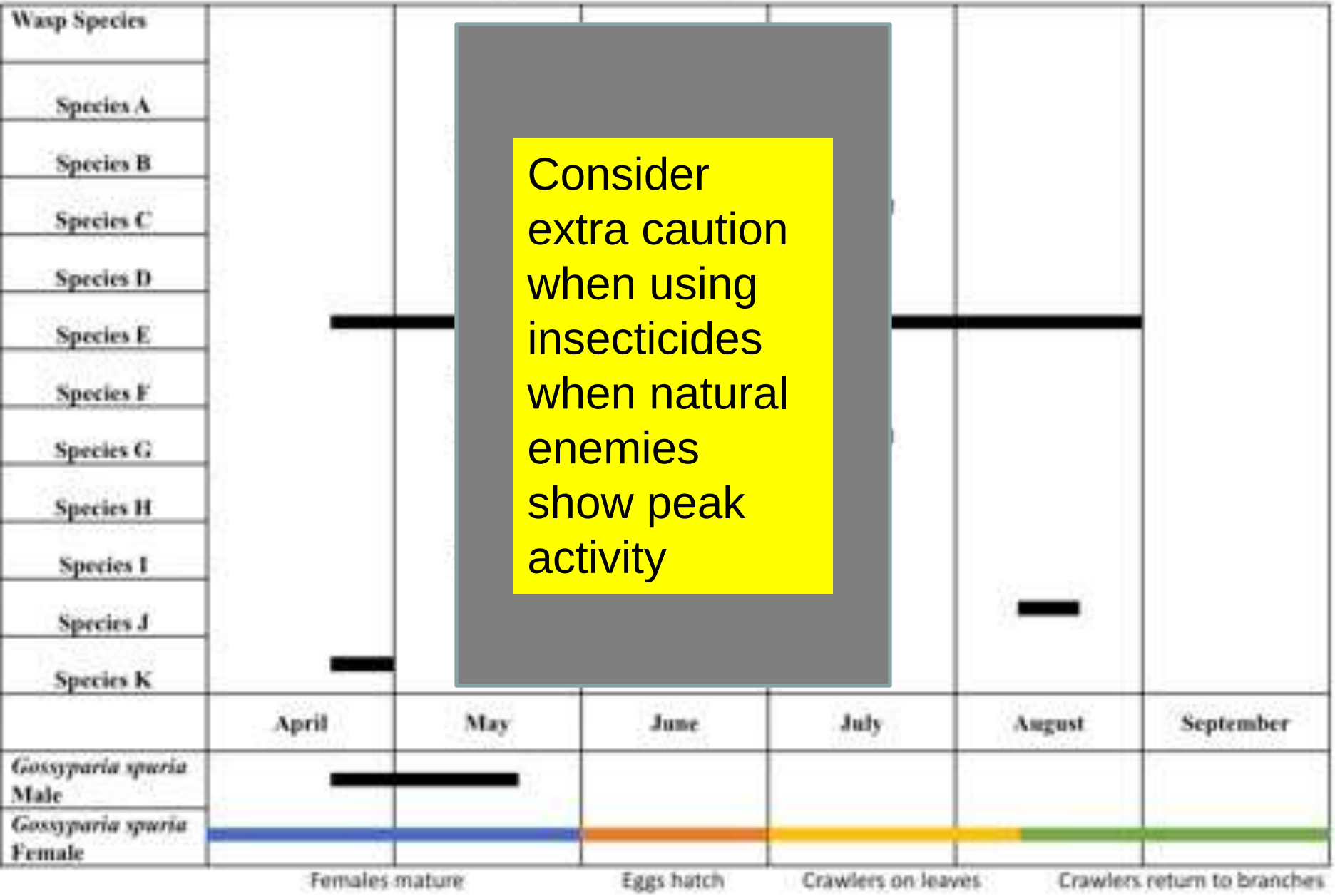
We collected up to 11 different kinds of wasps on the European elm scale-infested branches



Most activity of natural enemies in from midMay through midJuly

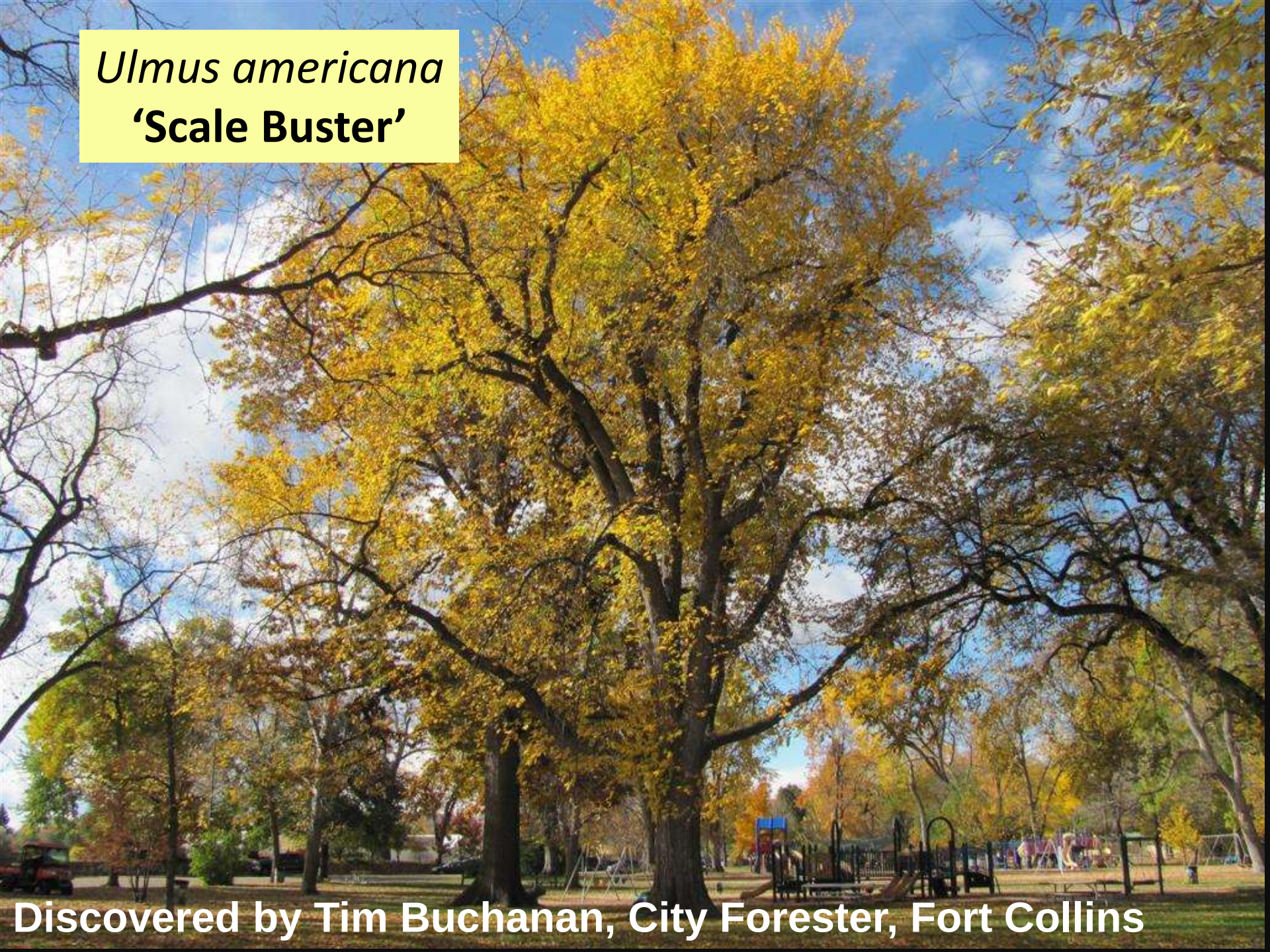


Timeline of emergence from European elm scale infested branches



Consider extra caution when using insecticides when natural enemies show peak activity

American elms resistant to the scale insect?


Ulmus americana
'Scale Buster'
Discovered by Tim Buchanan, City Forester, Fort Collins


Typical American elm


‘Scale Buster’

Observation during 2017 of CU elm scale trial

One untreated tree had the lowest numbers of scale of all trees.

Scales that were present were confined to wound sites/callous tissue

One other tree on campus was also found to never have much scale

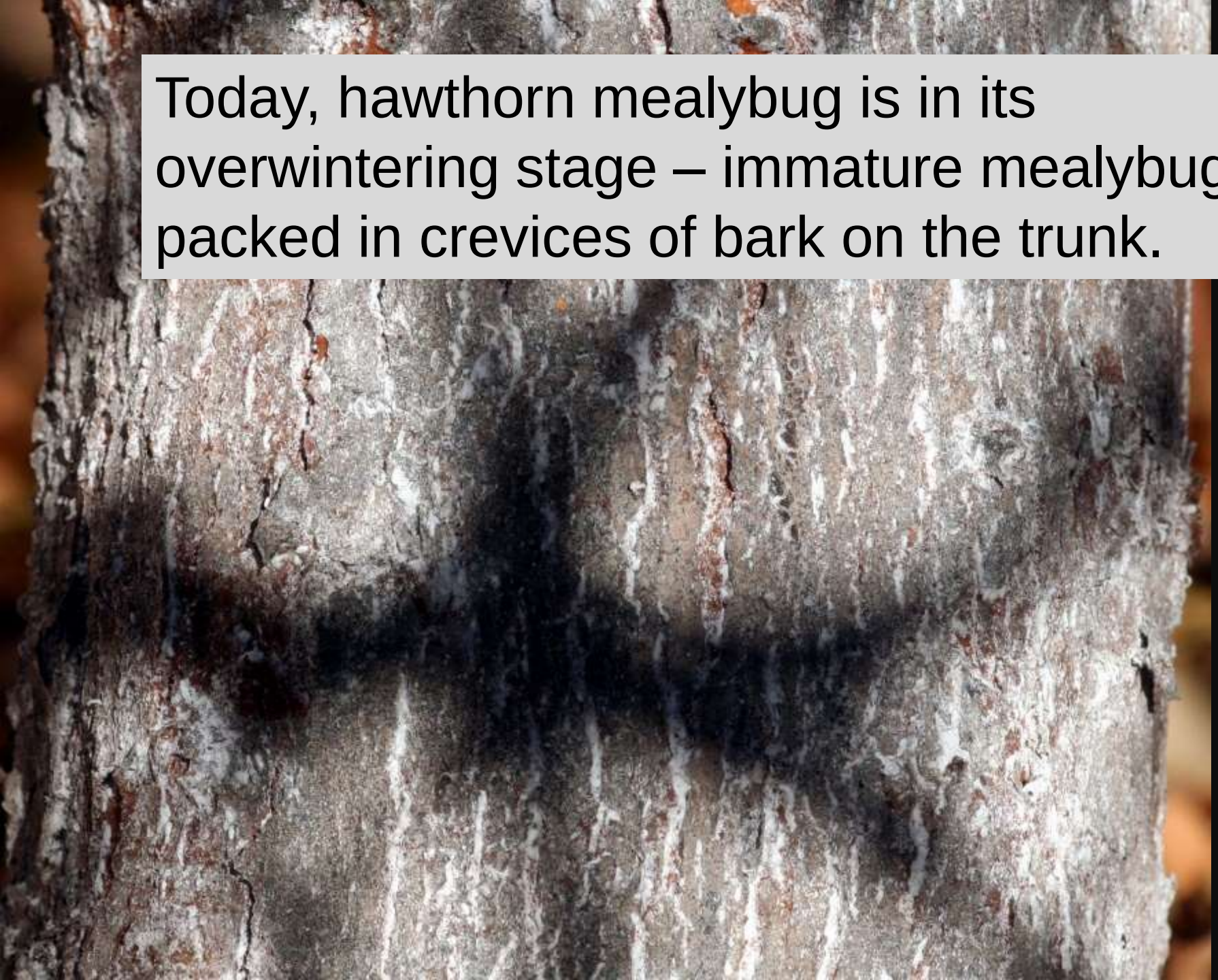
The long-term future for American elm in the West?

It will depend on developing scale-resistant cultivars

Featured Insect

Hawthorn Mealybug

Phenococcus dearnessi



Today, hawthorn mealybug is in its overwintering stage – immature mealybugs packed in crevices of bark on the trunk.

In early spring development resumes.

Adult males emerge and mate with the females.

The females then migrate to twigs.

Later, in May, the females swell enormously filled with eggs.

Crawlers hatch from the eggs over a period of several weeks.

They settle and feed on leaves for a couple of months. They molt to the second stage at this time.

In August they migrate back to the trunk and other protected areas where they will overwinter

Managemnet Issue

Many hawthorn cultivars produce flowers that are heavily visited by pollinators in spring.

Spraying stages on trunks during non-blooming periods avoids risk to pollinators. Oils and several insecticides can be used for this.

Insect growth regulators that disrupt egg production and crawler production can be used on developing females in spring.

Pyriproxifen works well for this and has low hazard to honey bees.

Systemic insecticides?

They work well but pose some risk to pollinators if applied prior to bloom.

Use is recommended only after bloom.

Japanese Beetle

Popillia japonica

Uber-host Plants Favored by Japanese Beetle Adults in CO

- Roses**
- Linden*
- Virginia Creeper*
- Silver lace**

Issue of unusual concern with Japanese beetle

Overlap of adult feeding on flowers – *and use of those flowers by pollinators*


Japanese Beetle Life Stages
egg
1st
2nd
3rd
instar larva
pupa
adult


April-May
June-July
August and September

Overlap of adult feeding on flowers – ***and use of those flowers by pollinators***

Never apply any insecticides to plants that are being visited by pollinators!!

New biological control for Japanese beetle *- and other grubs?*

Bacillus thuringiensis var. *galleriae*

Sold as ***beetleGONE!*** in commercial/ag markets

Sold as ***beetleJUS*** in gardener market

Adult control

Grub control

Bacillus thuringiensis

- Derived from a widely distributed soil bacterium
- Active ingredient a toxic protein crystal that destroys cells of the midgut
- Used as a stomach poison
- Several different strains – each effective against different insects

Several strains are present, each with specific activity

- ***kurstaki, aizawi*** strains (leaf feeding Lepidoptera larvae
- ***tenebrionis*** strain (leaf beetles)
- ***israelensis*** strain (mosquito, gnat, black fly larvae)

Treated Foliage Consumed

Feeding Inhibition（1 Hour）

- Toxin Crystals Dissolve in Gut.
- Larvae Stop Feeding.
- Growth Stops.

Death（2-5 Days）

- Starvation
- Gut Disruption

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Bacillus thuringiensis var. *galleriae*

Sold as ***beetleGONE!*** in commercial/ag markets

Sold as ***beetleJUS*** in gardener market

beetleJUS treated

Water check

beetleJUS for adult Japanese beetle?

Provides **good reduction in feeding** injury by Japanese beetle

Provides **fair mortality** of Japanese beetles and mortality is slow

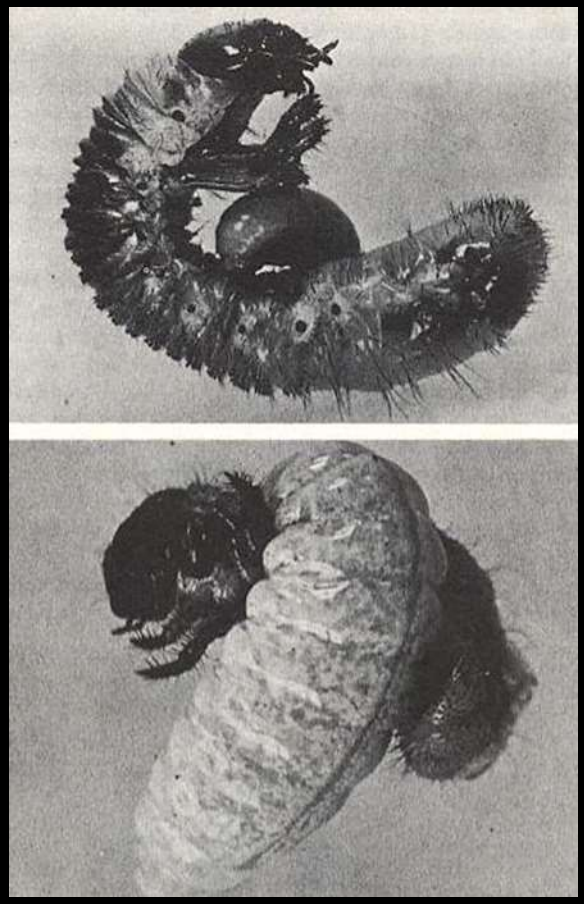
Persistence of effects probably a few days

Bee hazard warnings and use restrictions?

None. You can apply this product to plants in bloom when bees are visiting

After application. Are they dead? **(probably not)**
Are they still feeding? **(probably not)**

Should we now consider trying to introduce natural enemies of Japanese beetle into Colorado?



Natural enemies of Japanese beetle exist elsewhere in the US

- *Paenibacillus popilliae* (Milky spore)
  - Bacterium
- *Istocheta aldrichi*
  - Tachinid fly
- *Tiphia* species
  - Parasitic wasps
- *Ovavesicula popilliae*
  - Microsporidium

Milky Spore for Japanese Beetle?

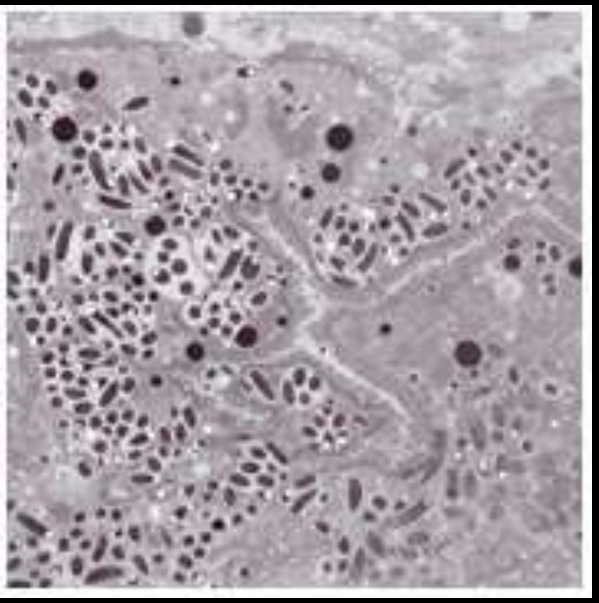
Used to permanently establish a biological control organism – ***not useful for immediate control.***

Milky Spore for Japanese Beetle?

Long term: May help **produce some reduction in numbers of larvae surviving to adulthood. However, infections typically only affect a small percentage of population.**

Natural Enemies of Japanese Beetle for Potential Introduction into Colorado?

Ovavesicula popilliae – a microsporidian disease of Japanese beetle larvae



Ovavesicula infection of Malphighian tubules of Japanese beetle larva

Main observed effects from infection – reduced fecundity, reduced winter survival

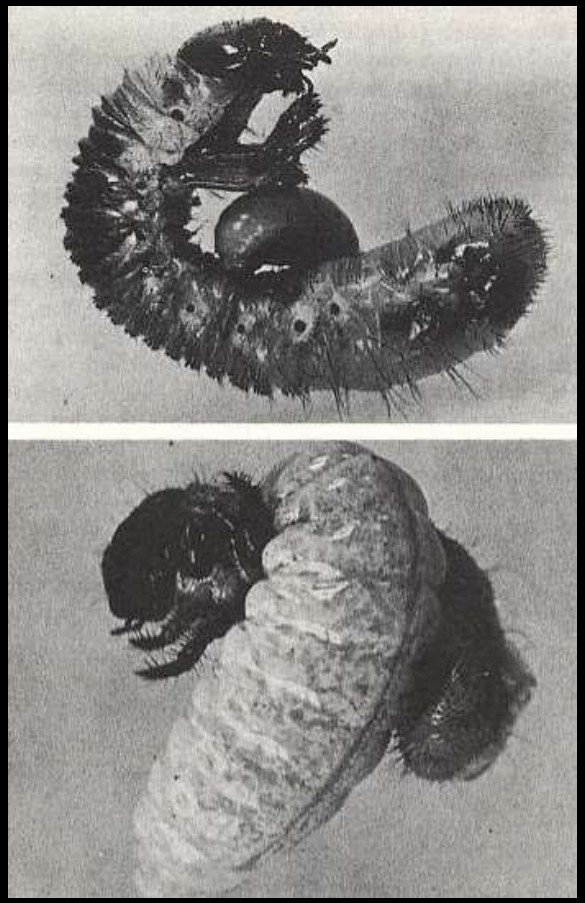
Japanese beetles collected from Michigan that were infected with *Ovavesicula popilliae* were shipped to us in late July 2015. The beetles were frozen, so no live beetles were introduced, but the pathogen should still be viable.

2015 releases of *Ovavesicula popilliae* – It took!

Positive infections confirmed from both Flatirons Golf Course (Boulder) and Pueblo Zoo release sites.

Natural Enemies of Japanese Beetle for Potential Introduction into Colorado?

Tiphia wasps – parasitic wasps (2 species) of Japanese beetle larvae

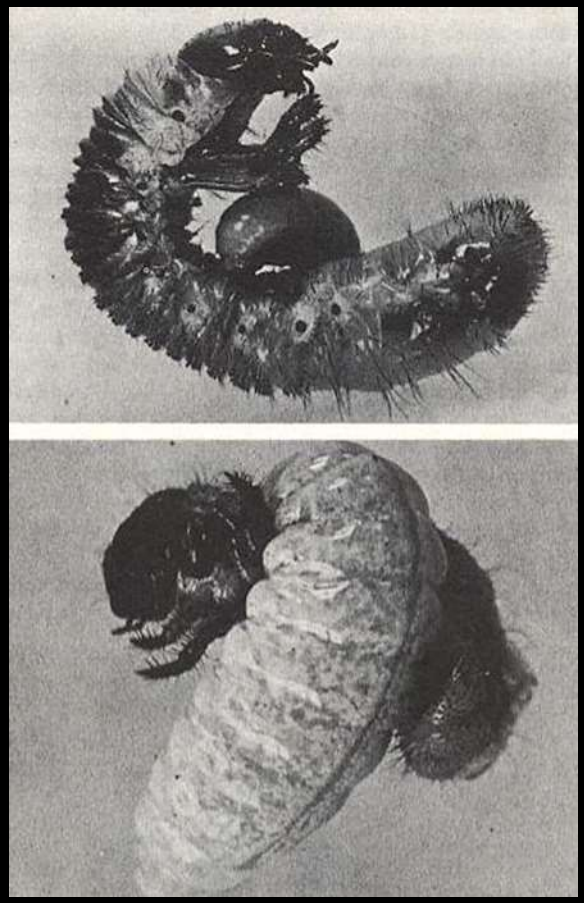


Natural Enemies of Japanese Beetle for Potential Introduction into Colorado?

Istocheta aldrichi – tachinid fly parasitoid of Japanese beetle adults

Should we now consider trying to introduce natural enemies of Japanese beetle into Colorado?

Yes!



Thousand Cankers Disease of Walnut

Caused by the effects of two organisms - bark beetle and a fungus

Geosmithia morbida

Pityophthorus juglandis

Walnut Twig Beetle

Pityophthorous juglandis

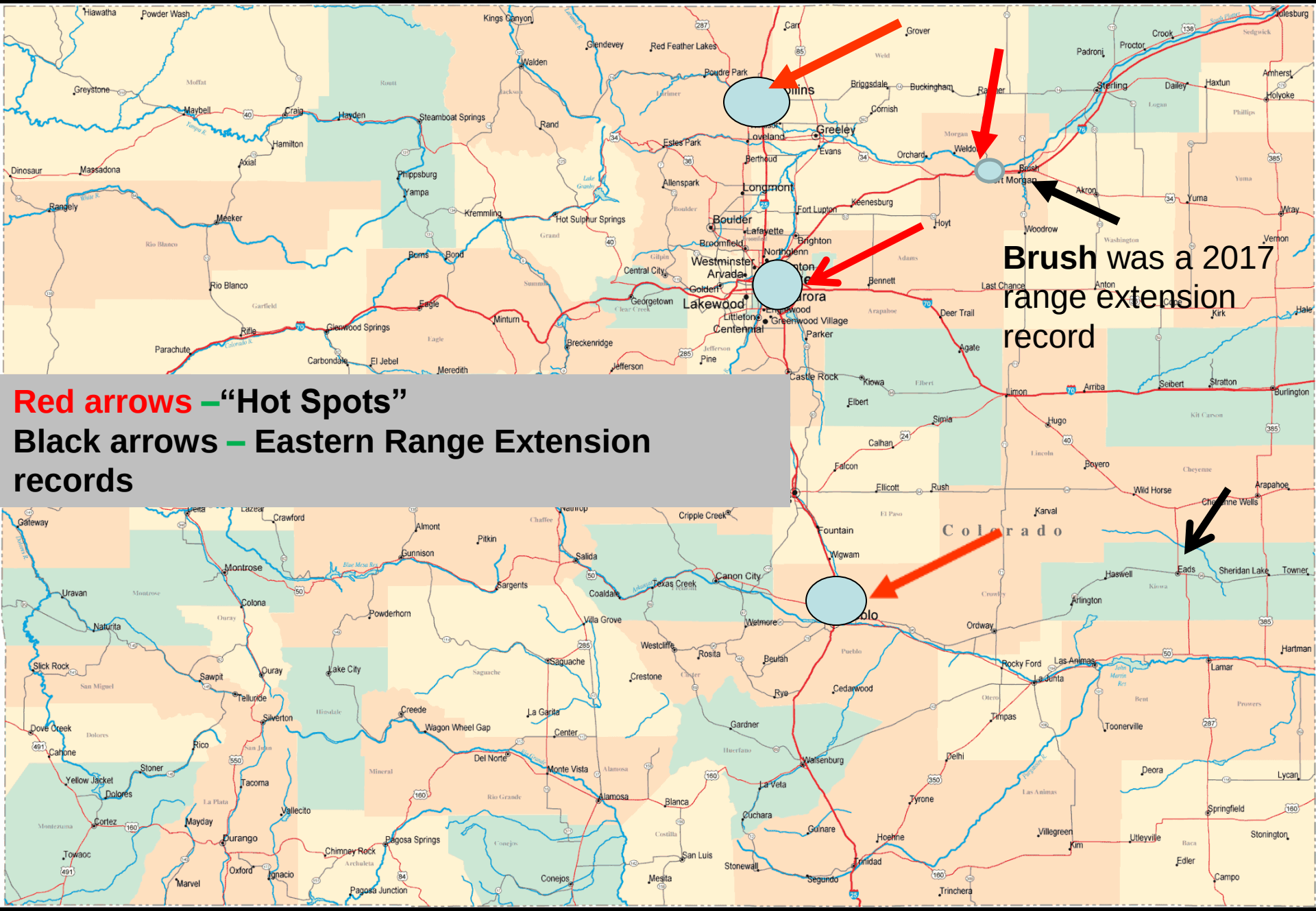
The fungal partner – *Geosmithia morbida*

Growth of the fungus beyond the inoculation site creates a dead region (canker) in the cambium.


June 2008


September 2008

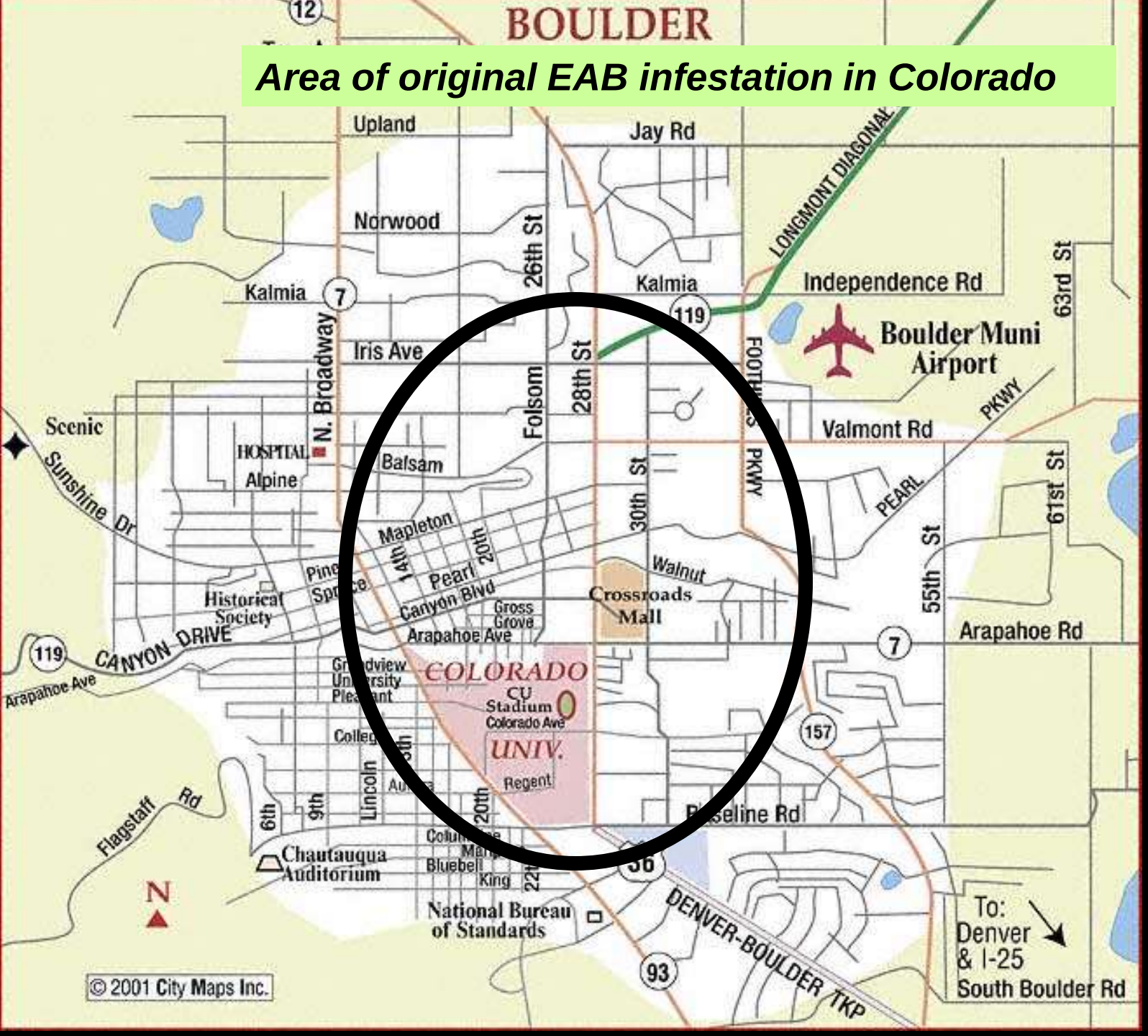

June 2009



Thousand Cankers Status in 2017

Metallic Wood Borer in the News

Emerald Ash Borer


Area of original EAB infestation in Colorado
BOULDER
Upland
Jay Rd
LONGMONT DIAGONAL
Norwood
26th St
Kalmia
Kalmia
Independence Rd
63rd St
Boulder Muni Airport
Iris Ave
N. Broadway
Folsom
28th St
FOOTHILLS PKWY
Valmont Rd
PEARL PKWY
Scenic
Sunshine Dr
HOSPITAL
Alpine
Balsam
30th St
61st St
Mapleton
14th
20th
Pearl
Canyon Blvd
Walnut
Crossroads Mall
55th St
Historical Society
Gross Grove
Arapahoe Ave
Arapahoe Rd
CANYON DRIVE
Arapahoe Ave
COLORADO
CU Stadium
Colorado Ave
UNIV.
Regent
Lincoln
6th
9th
20th
Flagstaff Rd
Pleasant
Chautauqua Auditorium
Bluebell
King
National Bureau of Standards
DENVER-BOULDER TKP
To: Denver & I-25
South Boulder Rd
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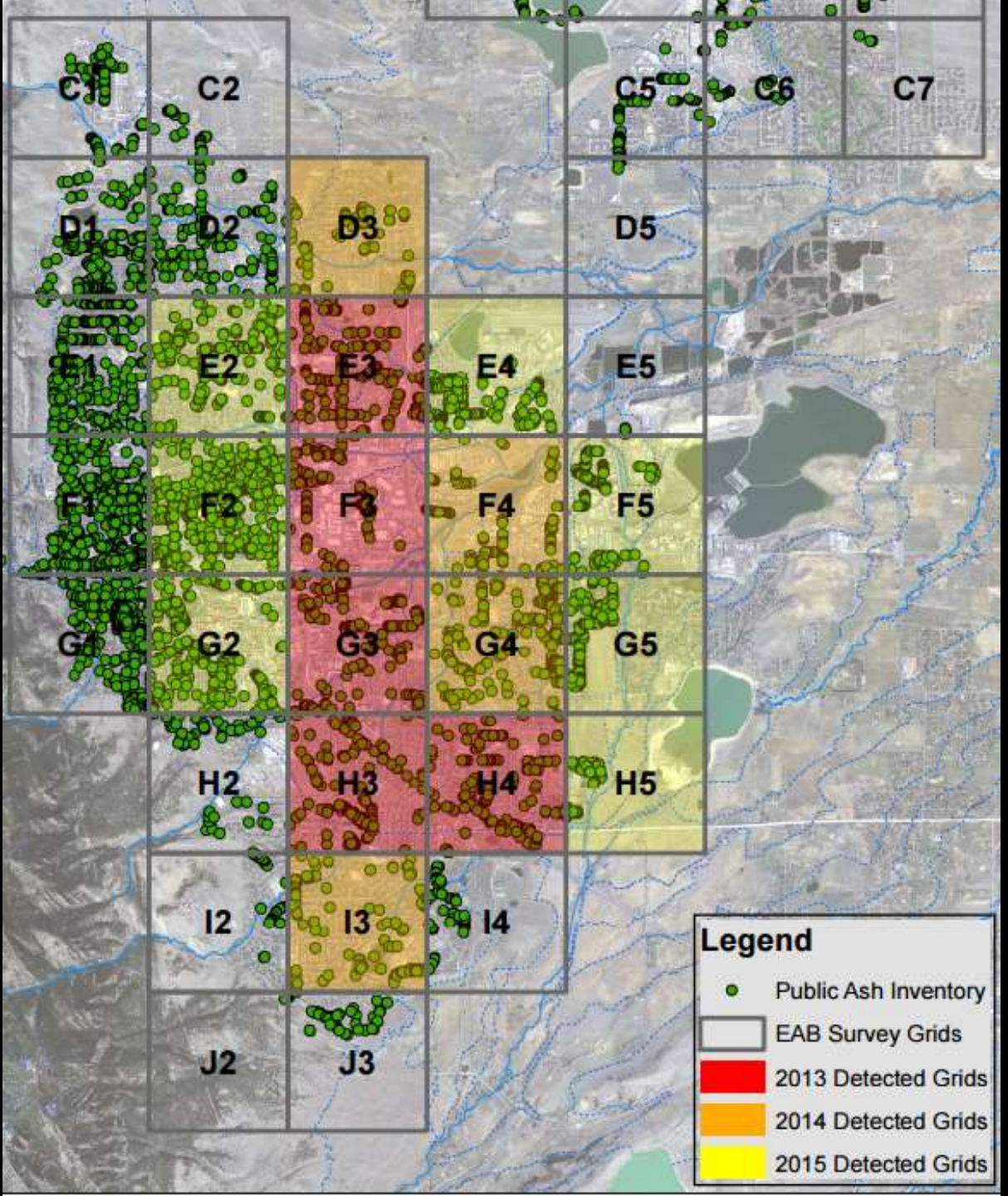
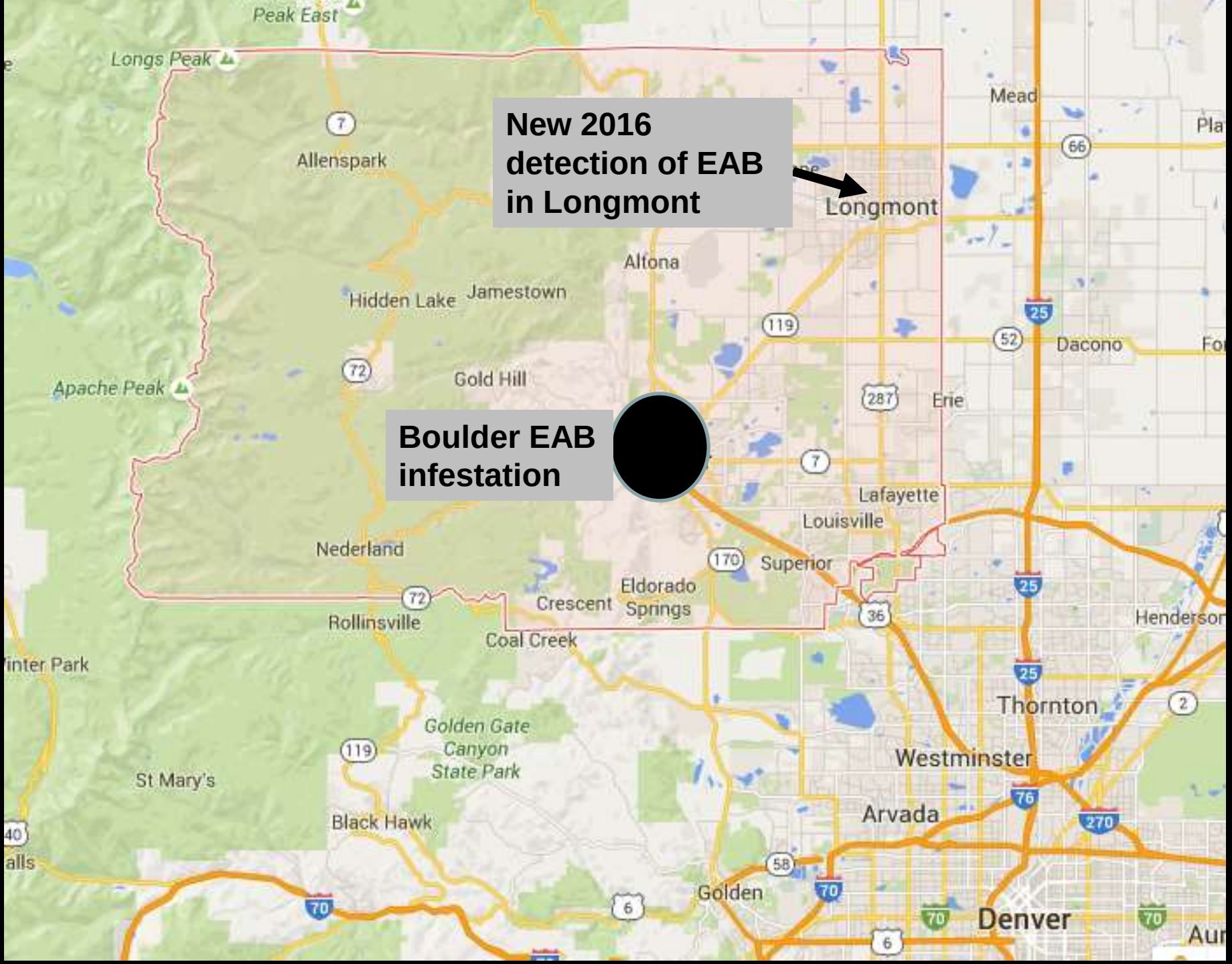


Areas known to be infested with emerald ash borer in Boulder end of 2015

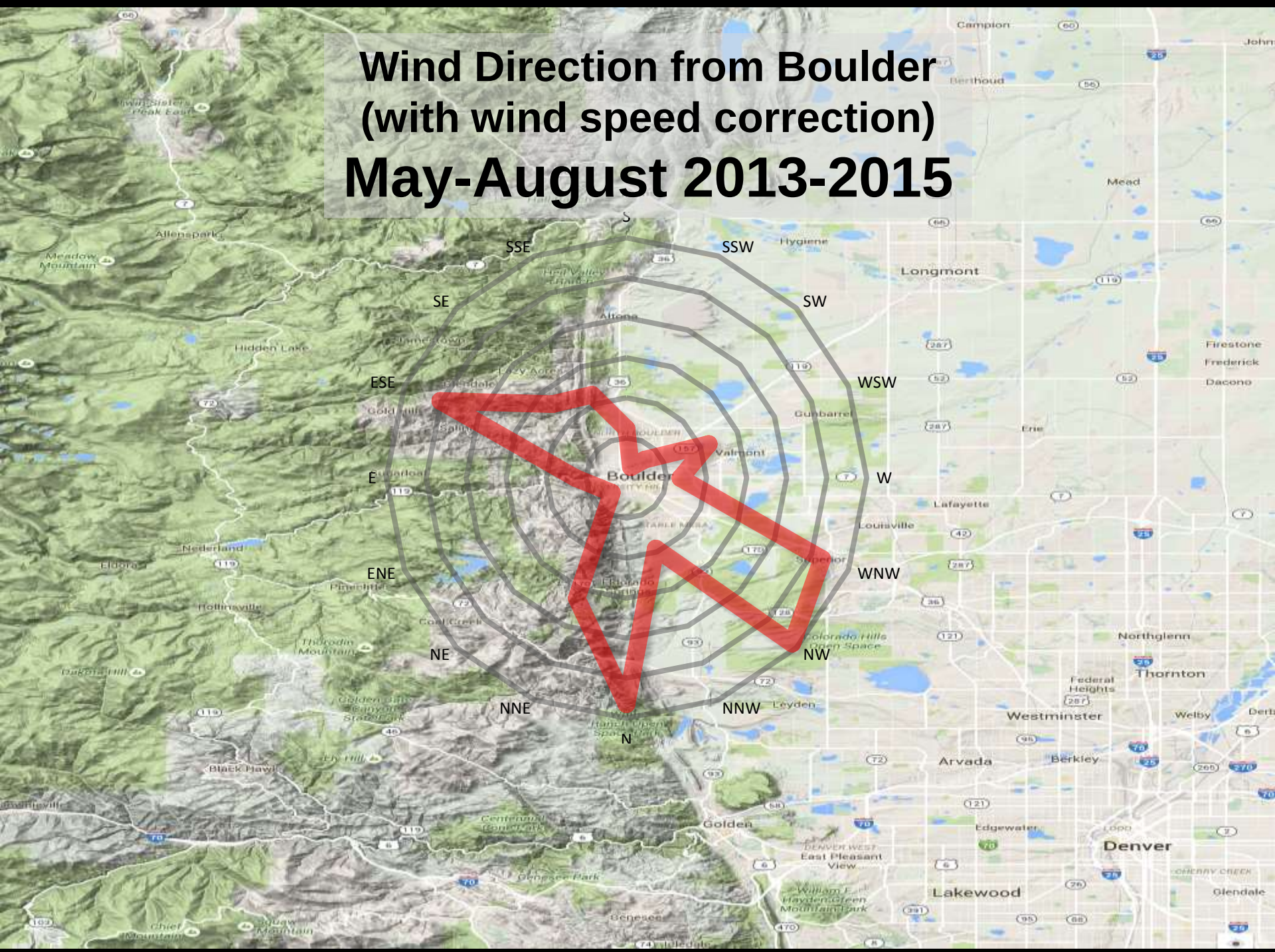
How will EAB spread in Colorado?

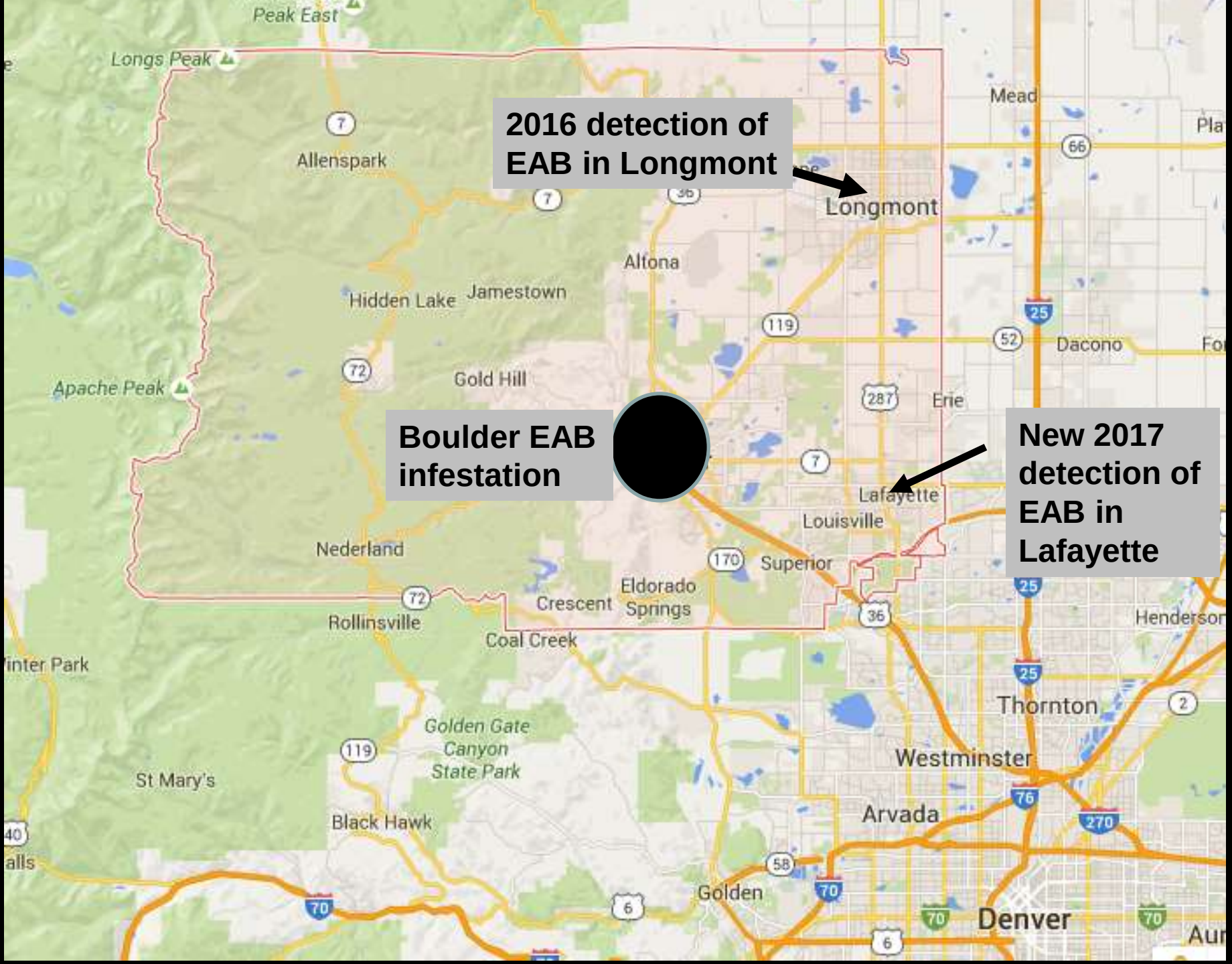
- **Wind-blown dispersal of adults**
  - **Peak period of adult dispersal is late May through late July**
- **Butt-heads that move wood containing developing stages**


New 2016 detection of EAB in Longmont
Boulder EAB infestation
Peak East
Longs Peak
Allenspark
Mead
Longmont
Altona
Hidden Lake
Jamestown
Gold Hill
Apache Peak
Dacono
Erie
Lafayette
Louisville
Nederland
Superior
Eldorado Springs
Crescent
Rollinsville
Coal Creek
Golden Gate Canyon State Park
St Mary's
Black Hawk
Thornton
Westminster
Arvada
Golden
Denver

Wind Direction from Boulder (with wind speed correction)

May-August 2013-2015




2016 detection of EAB in Longmont
Boulder EAB infestation
New 2017 detection of EAB in Lafayette
Peak East
Longs Peak
Allenspark
Longmont
Mead
Altona
Hidden Lake
Jamestown
Gold Hill
Apache Peak
Dacono
Erie
Lafayette
Louisville
Nederland
Superior
Eldorado Springs
Crescent
Rollinsville
Coal Creek
Thornton
Westminster
Golden Gate Canyon State Park
St Mary's
Black Hawk
Arvada
Golden
Denver

Main Points About Emerald Ash Borer in Colorado Today

- **All known infestations remain confined within Boulder County**
- In time it will spread throughout South Platte drainage
- **Treatments are available that can protect individual trees once they first become infested**
  - Each treatment option involves decisions balancing costs, environmental hazards, effectiveness, and ease of application

Emerald Ash Borer Control Options

- Soil applications with systemic insecticides
  - imidacloprid, dinotefuran
- Non-invasive trunk sprays of systemic insecticides
  - dinotefuran
- Trunk injections of systemic insecticides
  - Emamectin benzoate, azadirachtin, imidacloprid

Painted Lady/Thistle Caterpillar *Vanessa cardui*

Painted lady female lays her eggs on thistle

Larva can be damaging to thistle family plants

Painted lady larvae are sometimes known as “thistle caterpillars”


Larva


Prepupa


Pupa (chrysalis)

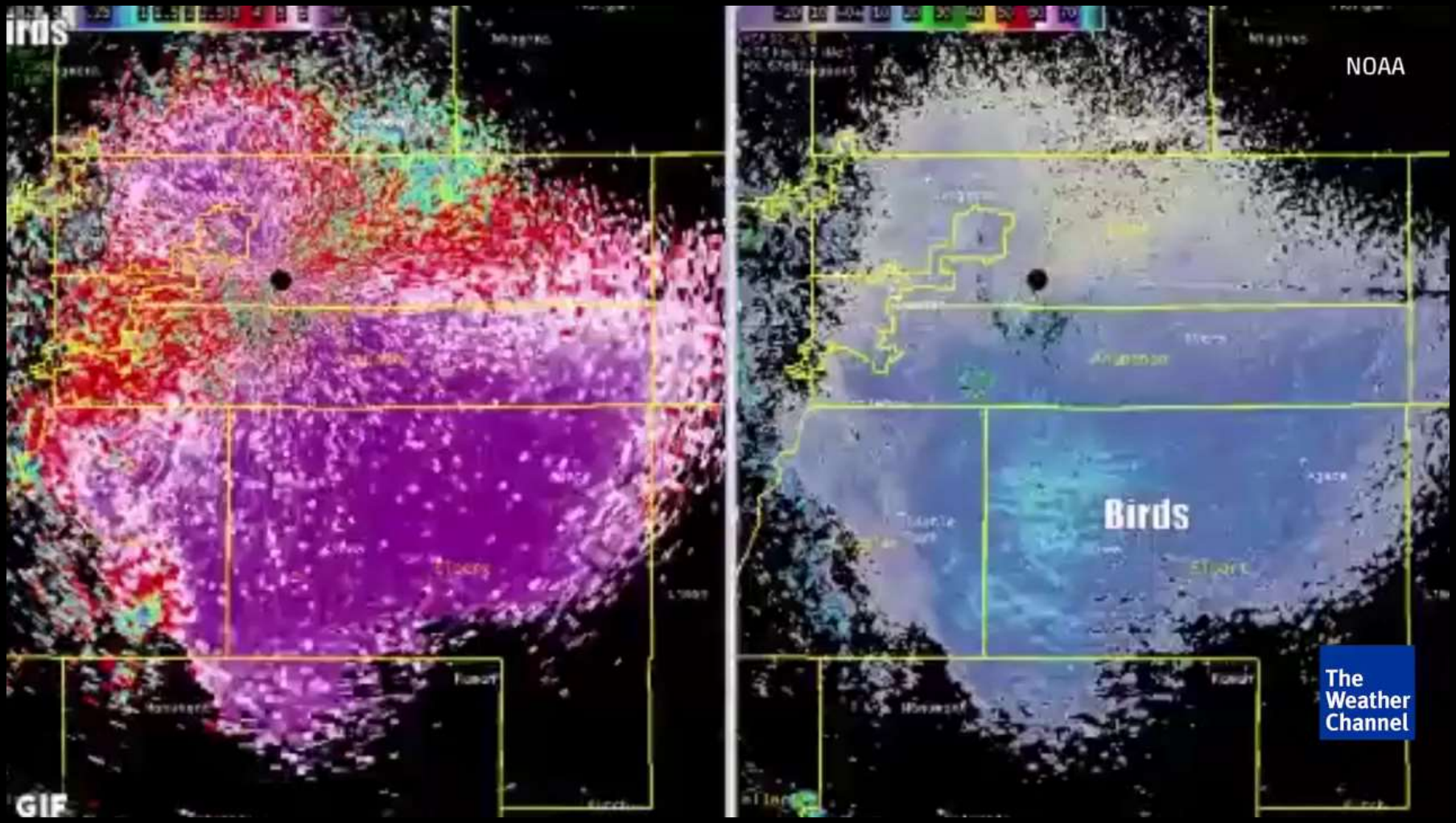

Adult

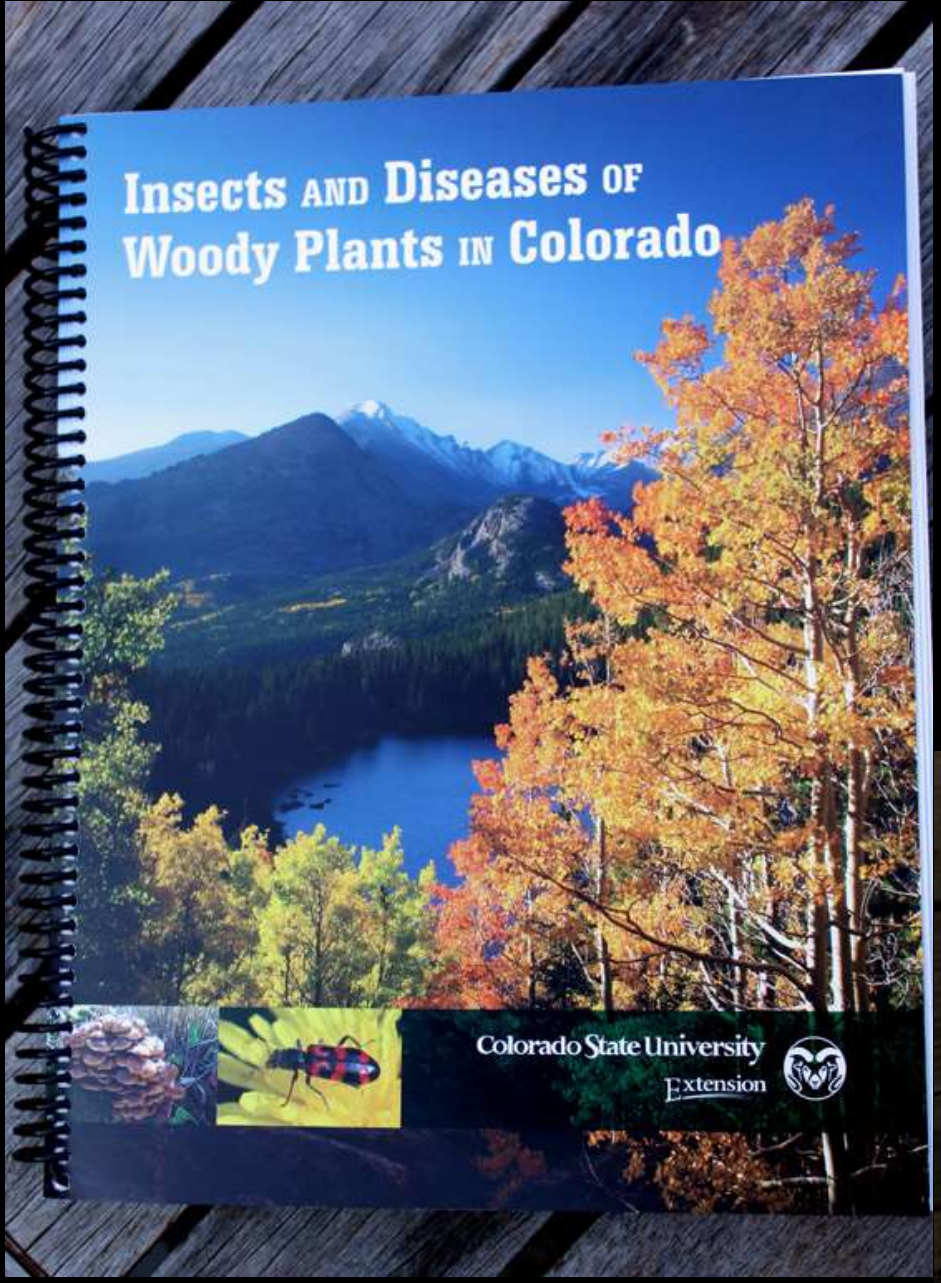
In spring the Painted Lady migrates annually into Colorado from overwintering areas in Baja California

In fall they migrate south/ southwest in a return migration

70-Mile-Wide Butterfly Migration Detected on Radar in Colorado

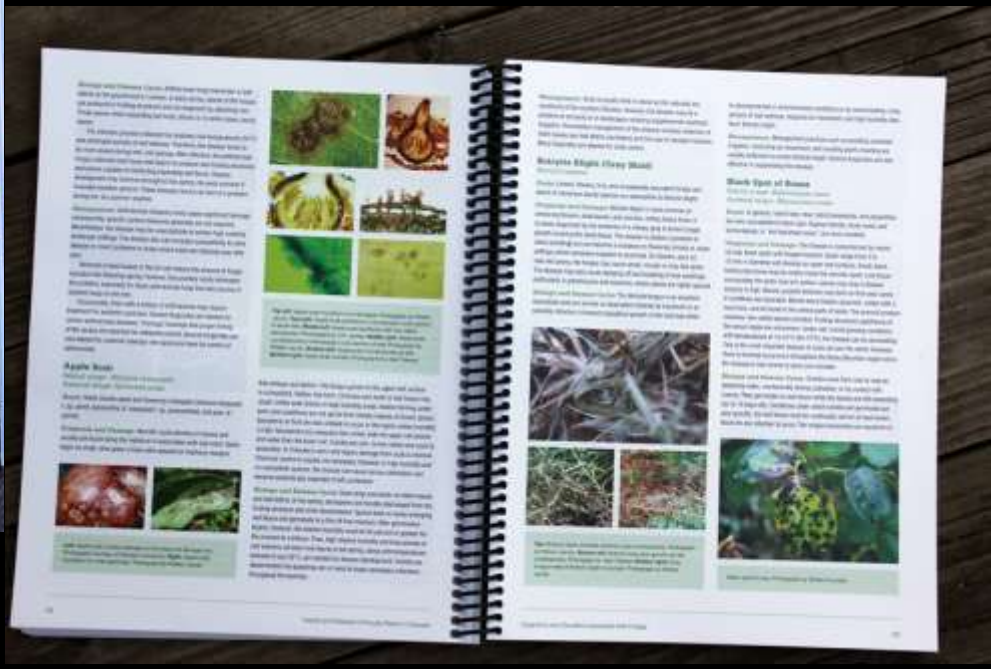
The Weather Channel





Bulletin 506A

Available at for sale at this conference!



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The Ultimate Guide to Backyard Bugs

Second Edition

Whitney Cranshaw & David Shetlar

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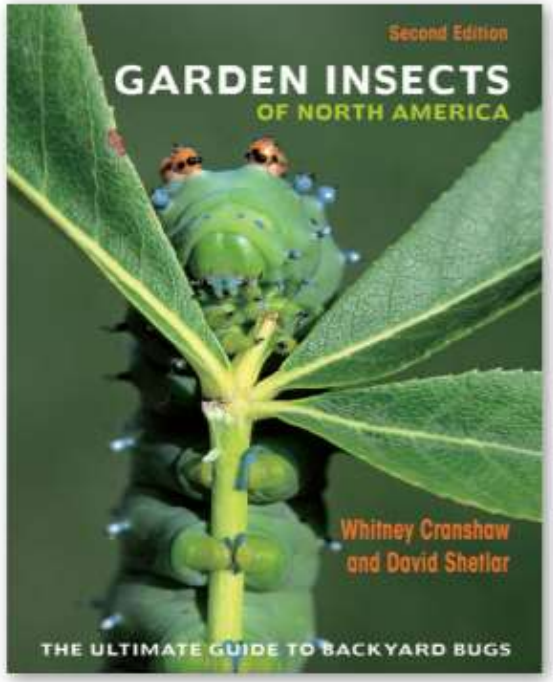

"An exceptionally well organized and complete text on garden insects. . . . Almost every insect is illustrated, with well over 1,000 full-color photographs showing them in various life cycle stages. Its very simple but complete

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- **Co-authored (with David Shetlar, Ohio State University)**
- **Contains over 3000 photos, most all new**
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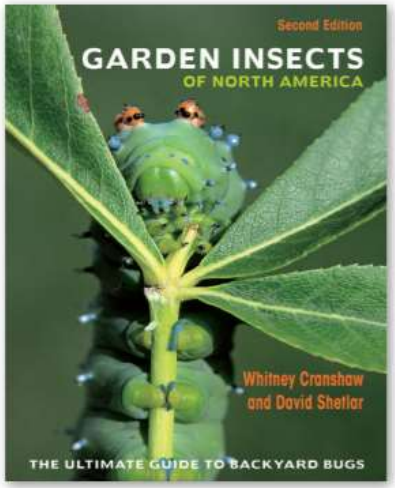

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This presentation will be posted at the Insect Information web site

- Housed at Department of Bioagricultural Sciences and Pest Management
  - Search "BSPM CSU"
- Within "Extension and Outreach"
- "Insect Information"
  - Extension presentations for 2017 posted at bottom of page

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